

Chapter 8: Key Findings and Recommendations

Upon collection and review of the Niagara River/Lake Erie Watershed's health in the previous chapters, key findings were noted as important elements impacting the Watershed and current water quality conditions. These findings are presented in the following summary along with recommendations that aim to address each finding. In addition, the information in the previous chapters was used to rank the eighteen sub-watersheds by priority in preserving and protecting their health, as well as priority for focusing on improvements in water quality. These prioritized rankings follow the key findings and recommendations in this chapter and can be used to focus limited resources or plan for next steps. In chapter 9, the recommendations below are categorized and distilled down to more immediate next steps.

Key Finding #1: A high number of the watershed's stream segments are classified as "Impaired."

Approximately 30% of the Niagara River/ Lake Erie Watershed's stream segments are classified as "Impaired" or "Minor Impacts" by the NYSDEC. This indicates that many of our water courses are not supporting the uses they have been identified for, whether that be for public bathing, aquatic life or recreation. Furthermore, the majority of these impaired segments occur across the northern or more urban sub-watersheds, specifically Niagara River, Ellicott Creek, Lower, Middle, and Upper Tonawanda Creek Sub-watersheds, Smoke(s) Creek, and Canadaway Creek. In many cases, the other waterways in these sub-watersheds are either "Unassessed" or "Need Verification" illustrating that more testing is needed throughout the Watershed.

Recommendations:

- a. Conduct additional data collection to outline the primary contributors to water quality impairments within each sub-watershed, including using Stream Visual Assessments Protocol, water quality sampling, and nutrient and bacterial loading.
- b. Coordinate with County Soil and Water Conservation Districts to create a watershed-wide database of high-erosion areas and highly erodible soils.
- c. Research and pinpoint primary contributors to aquatic life impairments in each sub-watershed.
- d. In the most impaired sub-watersheds:
 - i. Focus additional planning and outreach efforts to limit further degradation of water resources.
 - ii. Limit further loss of natural living infrastructure and focus on restoration efforts.
 - iii. Maximize the implementation of green infrastructure to capture and filter stormwater run-off.

- iv. Severely restrict the addition of new impervious cover.
- v. Create zoning overlays that protect waterways and waterfront lands from adverse land uses and development.
- e. Develop model zoning regulations that provide performance standards to limit impervious cover, implement green stormwater infrastructure, and protect and restore functional forested riparian buffers.
- f. Educate municipal staff and boards on how to review development from a water quality perspective.
- g. Coordinate with the County Health Departments to identify areas of the watershed with high concentrations of septic systems that may be failing and contributing illegal discharges to area waterways.
 - i. Expand the current Chautauqua County program for assessing septic systems within 250 feet of particular water bodies to all priority waterbodies in the Watershed dealing with bacteria contamination.
- h. Collaborate with the WNY Stormwater Coalition, landscape architects, and stormwater engineers to develop design guidelines for Municipal Separate Storm Sewer System (MS4) infrastructure that provide more natural stormwater conveyance systems that mimic nature and filter stormwater prior to its discharge to area waterways.
- i. Encourage waterfront communities to update and maintain Local Waterfront Revitalization Plans with a focus on protecting and restoring natural infrastructure.
- j. Provide educational materials on landowner best management practices that improve water quality and encourage behavior change by:
 - i. including mailings with utility and tax bills;
 - ii. writing articles for newsletters and local newspapers;
 - iii. providing informational real estate handouts for new landowners;
 - iv. creating targeted workshops;
 - v. conducting outreach at festivals and events;
 - vi. social media and peer-to-peer campaigns;
 - vii. including more education and interpretive signage at public sites;
 - viii. developing innovative apps for education and action.

Key Finding #2: The lack of a sufficient regional living infrastructure network contributes to water quality impairments.

Living infrastructure refers to the interconnected natural systems in a landscape such as intact forests, woodlands, wetlands, parks, rivers, aquifers and agricultural soils that provide or protect clean water, air quality, wildlife habitat, and food. These systems contribute to a vibrant and healthy ecosystem by providing protection during flood events; mitigating stormwater run-off and sewer overflow events; filtering pollutants from the air, water, and soil; moderating temperatures and reducing

energy use; providing wildlife habitat; storing carbon; providing food, wood, and other natural resources; increasing property values; providing recreational opportunities and improving quality of life.

The most direct living infrastructure components influencing how water is handled on (and by) the lands through which it passes include riparian buffers, floodplains, wetlands, natural springs, headwater forests, and groundwater recharge areas. Aside from the need for these components to exist and connect to their adjacent waterways and waterbodies, these systems should be interconnected in a larger regional network. When this regional interconnection of living infrastructure occurs, the network (and watershed itself) can better handle natural system ebbs and flows, reducing impacts to waterways and water quality, especially as extreme storm events increase in the region.

The lack of sufficient riparian buffers is a common living infrastructure issue found across many areas of the watershed and directly related to many water quality issues, including erosion and sedimentation, nutrient loading, and thermal pollution. Riparian buffers are the lands directly adjacent to waterways and serve as a transition between aquatic and upland habitats - a link between land and water. Riparian buffers can be designed in such a way to protect the waterway from negative impacts of adjacent land uses.¹ A well-functioning riparian buffer:

- improves water quality by acting as a filter for surface and ground waters;
- stabilizes banks to reduce erosion and sedimentation downstream;
- provides storage during seasonal high-volume and flood events;
- slows the velocity of flood waters;
- improves flooding issues and groundwater recharge by allowing for more surface water infiltration;
- maintains lower water temperatures that support aquatic habitats; and,
- supports wildlife habitat and wildlife movement corridors.

Forested riparian buffers in excess of 300 feet (width) are the gold standard in riparian protections, however smaller width buffers with even minimal vegetation do offer more benefits than mowed or hardened shoreline edges. Many areas of the watershed have inadequate riparian buffers, especially urban sub-watersheds, where development and grey infrastructure has encroached into riparian lands, in some cases leaving less than 25 feet between adjacent land uses and the water. In suburban areas of the watershed, waterfront landowners commonly remove vegetation for lawns and commercial developments build within 25 feet of streams. The restoration, protection, and improved

¹ Maryland Cooperative Extension Fact Sheet #733: "Riparian Buffer Management, Riparian Buffer Systems", University of Maryland College Park-Eastern Shore.

design of our living infrastructure network are essential for long-term sustainability of our water resources.

Recommendations:

- a. Outline and establish regional living infrastructure network through a mixture of conservation, easements, and land use policies/regulations.
- b. Build off of the work of the Niagara River Habitat Conservation Strategy to further implement living infrastructure conservation and restoration opportunities in the watershed and expand the Strategy further south to include the rest of the Niagara River/Lake Erie Watershed.
- c. Focus conservation areas on critical habitat for plants and wildlife, along aquatic corridors, around hydrological reserves, and in areas that could be considered polluting areas if developed (such as steep slopes).
- d. Identify areas where living infrastructure gaps exist and outline methods by which they may be restored. This can be done through a natural resource inventory.
- e. Design and structure living infrastructure additions to address specific waterway impairments found within each sub-watershed. (i.e. pollution levels, nutrient loading, flooding, water classifications).
- f. Vet the use of vacant lands adjacent to waterways for future protections/restoration of regional living infrastructure.
- g. Prioritize the clean-up and reuse of contaminated lands adjacent to waterways for usage as living infrastructure.
- h. Develop model regulations that establish or strengthen protections on living infrastructure lands, especially non-DEC wetlands, floodplains and riparian buffers.
- i. Collaborate with County Soil and Water Conservation Districts, U.S. Department of Agriculture, and rural counties to promote/establish programs that place permanent restrictions/riparian protections on vacant agricultural lands upon transfer.
- j. Investigate models for funding the permanent protection of, management of, and restoration of a regional living infrastructure network.
- k. Conduct public outreach geared towards developers, municipal officials, waterfront landowners, and stormwater engineers to raise awareness of living infrastructure.
- l. Research and outline the cost-benefit of regional living infrastructure as a public service utility.
- m. Produce guidance materials on the appropriate design of riparian buffers and constructed wetlands to ensure restoration projects are functional to watershed health.
- n. Consider living infrastructure in all local and state development review processes, including county planning departments, State Environmental Quality Review Act (SEQRA), NYSDEC, US Army Corps of Engineers, NYS Department of State.

- o. Incorporate living infrastructure design and best management practices into site plan review procedures for waterfront properties.
- p. Create financial incentive programs that provide landowners benefits for the re-establishment, protection, and permanent conservation of living infrastructure lands.
- q. Collaborate with the Buffalo Niagara River Land Trust, Western New York Land Conservancy, Chautauqua Watershed Conservancy, and Grassroots Gardens on permanent conservation and land management projects involving living infrastructure.
- r. Establish and showcase living infrastructure restoration projects in public parks as a means to educate the public, landowners, and municipal officials on their benefits and functional design.

Key Finding #3: The loss of wetlands within the watershed is substantial.

Wetlands are important components of the living infrastructure supporting clean and healthy water, flood resiliency, and thriving ecosystems. A lack of wetlands impairs how our watershed functions, and in certain sub-watersheds the loss of historic wetlands is greatly impacting water quality. For example, Scajaquada Creek once had a tremendous amount of wetlands in upstream riparian areas that have since been filled and channelized into drainage ditches. The Buffalo River within the City of Buffalo was also once predominantly marshland before it was dredged, filled and drained to support development.

Today DEC classified wetlands are protected from encroachment and filling, but Federal identified (non-DEC classified) wetlands are not. For non-protected wetlands, municipalities and developers commonly “mitigate” them to accommodate development with in-fill and permits allowing the re-creation of wetlands elsewhere. However the new wetland created doesn’t always translate to the same functionality and benefits for our waters, especially if it no longer has connectivity to the surface or ground waters it once served.

Recommendations:

- a. Conduct on-the-ground assessments of wetland complexes to identify their quality and functionality.
- b. Identify high quality aquatic habitats and riparian wetlands for conservation.*
- c. Identify and protect wetland sites with high ecological value and use as reference sites for habitat restoration.*
- d. Conduct shoreline assessments to identify ideal locations for the restoration of shoreline marshes, especially in highly urbanized sub-watersheds.
- e. Identify vacant and underutilized land for wetland restoration in highly urbanized sub-watersheds.

- f. Expand the Wetland Lidar Analysis conducted within the Niagara River Greenway Communities to the entire Niagara River/ Lake Erie Watershed to better identify smaller wetland habitats not yet documented by NYSDEC or the U.S. Fish and Wildlife Service National Wetlands Inventory.
- g. Encourage alternative solutions to typical “wetland mitigation” measures (i.e. removal and re-creation elsewhere) for development projects.
- h. Establish regional policies with county and municipal planning departments to evaluate wetlands prior to permit submittal for wetland mitigation to the NYSDEC.
- i. Create wetlands and other natural filter systems to protect waterways and beaches from un-treated stormwater discharges, sedimentation, thermal pollution, and nutrient loading.
- j. Outline design policies/guidelines that protect wetland functions in their use as stormwater infrastructure.
- k. Guide the creation of stormwater retention ponds to be designed with functional wetland/marsh habitats.
- l. Provide data on existing high-quality wetlands to county and municipal planning departments to better inform development decisions.
- m. Further develop the educational programming and signage at publically accessible wetland areas, such as the Tiff Nature Preserve and wetlands along Route 219, on environmental stewardship and wetland function.
- n. Create unique wetland restoration habitats with educational and public access components on public park land to foster citizen stewardship of wetlands in addition to providing water quality benefits.
- o. Protect wetlands from mitigation and development with environmental conservation overlays in municipal zoning ordinances.

**Indicates Action Strategies outlined by the Niagara River Habitat Conservation Strategy.*

Key Finding #4: A loss of floodplains and floodplain connectivity from floodplain development and encroachment exists in the watershed.

Floodplains are meant to store and slow the speed of floodwaters, reducing shoreline erosion and turbidity. These processes protect water quality and storm damage to stream channels, lake shores, private property, and public infrastructure. The National Flood Insurance Program’s base flood regulations, dictating development within flood prone areas, allow for development within the 100 year floodplain. Over time, this ability has left many communities with floodplain development, reducing the functionality of this living infrastructure. A majority of the Niagara River/ Lake Erie Watershed’s municipalities have the bare minimum FEMA flood regulations.

When development encroaches into floodplains, homes and roads are built-up to bring them above base flood elevations. They also increase impervious cover in the floodplain. While one or two developments of this nature will not raise base flood elevations, several hundred of these developments collectively over time will reduce floodplain storage capacity and also restrict a waterway's connection to its floodplain, creating backups and new flooded areas elsewhere along the river corridor. This scenario is what has occurred within Erie County and is visible in the change from FEMA Flood Rate Insurance Maps created in the 70's versus those created more recently.

Recommendations:

- a. Identify areas to create new floodplain in or near areas where floodplain has previously been lost and contributes to existing neighborhood flooding issues. Consider vacant land that would fulfill this purpose.
- b. Co-locate public parks and greenways within protected floodplains to reduce development pressures and educate the public on the purpose of this living infrastructure.
- c. Include public access to waterways for fishing, boating, etc. at these locations to encourage stewardship of the water and floodplain.
- d. Develop model flood regulations that restrict the development of new structures within flood prone areas. Models can be developed to outline various protection thresholds.
- e. Collaborate with county and municipal emergency planning officials in the buyout and removal of private structures that frequently flood and incur damages.
- f. Reclaim previously built-up floodplains in high-vacancy neighborhoods to reduce excess housing stock, restore living infrastructure, and create public greenspace.
- g. Guide municipalities through the steps to upgrade how they educate residents, plan for, regulate, and respond to flooding issues in order for property owners to qualify for flood insurance discounts through the National Flood Insurance Program's Community Rating System.
- h. Create educational materials and signage for the public on the importance of floodplains and their function as living infrastructure.
- i. Call attention to case studies that connect the protection and maintenance of floodplain to reduced flood events, improved resiliency, and better water quality and promote examples of proactive municipal planning for resiliency.
- j. Outline design guidelines for developments near flood prone areas to ensure road infrastructure, stormwater drainage, and re-grading do not negatively impact the floodplain.
- k. Collaborate with Cornell Local Roads program to develop an educational series on designing transportation infrastructure that supports the movement of stormwater and maintains connections to floodplain.

1. Encourage county and municipal planning departments to complete and implement resiliency planning.

Key Finding #5: Erosion and sedimentation issues cause major water quality impairments within the watershed.

Erosion of shorelines contributes to turbidity and sedimentation of our waterways and their effects are evident in our water quality data. The Buffalo Niagara Riverkeeper Riverwatch program, for example, identifies turbidity issues in the Buffalo River, Niagara River, Buffalo Creek, Buffalo's Inner and Outer Harbor, Lower and Middle Tonawanda Creek, Cayuga Creek, Gill Creek, and in tributaries on Grand Island. Lack of riparian buffers, poor shoreline stabilization practices, and land uses that disturb soils are most often the primary causes of erosion and sedimentation issues. County Soil and Water Conservation Districts are also aware of some high-erosion areas throughout the Watershed.

Recommendations:

- a. Conduct additional research and data collection to fully characterize the erosion and sedimentation issues in the watershed including Stream Visual Assessments.
 - i. Inventory culverts, bridge abutments, stormwater infrastructure, and shorelines to identify erosion problems earlier.
- b. Prioritize erosion mitigation projects based on high-turbidity water quality data, threats to important habitat, and public infrastructure.
- c. Identify and protect highly erodible soil areas and make information available to local planning entities to better inform planning and development processes.
- d. Mitigate erosion and sedimentation issues from stormwater runoff through improved stormwater infrastructure design, greater usage of green infrastructure, and installation/protection of high-quality forested riparian buffers.
- e. Establish lakefront development setbacks that protect the shoreline from natural erosion processes and impacts from extreme storm events, as well as protect natural shoreline infrastructure such as sand dunes, islands, beaches, and wetlands that provide resiliency benefits

Key Finding #6: A majority of the watershed's tributaries receive additional downstream impacts from highly urbanized sub-watersheds.

A large portion of the watershed encompasses major metropolitan areas that can contribute to certain kinds of water quality issues. Urban and suburban development often translates to channelized waterways and/or waters that are directed underground; development encroachment into riparian buffers limiting their effectiveness; and increased impervious cover, in the form of pavement, sidewalks, and dense building development. With all of these elements, the natural systems necessary

to protect and filter our waters are limited or non-existent. In the Niagara River/ Lake Erie Watershed these urban areas are also located downstream from the headwaters of each sub-watershed, meaning urban influences are contributing to waters already impacted from rural land uses found upstream, compounding the problem. The result is waters with both rural and urban water quality issues directly conveyed to Lake Erie and the Niagara River with little natural opportunities for filtration.

Recommendations:

- a. Identify opportunities where living infrastructure/riparian lands can be restored for each urban water corridor and work through re-establishing these areas through a mixture of municipal policies & programs and restoration projects.
- b. Prioritize ideal areas for the removal of hardened shoreline and replace with shoreline protection that implements in-water habitats and shoreline marshes.
- c. Soften the hardscape surrounding urban creek corridors to create unique natural respites from urban life (greenways) and utilize features to educate the public on natural systems and garner public ownership for our environmental corridors.
- d. Revise zoning regulations and development review procedures to limit the expansion of impervious cover.
- e. Develop model zoning language provisions for incentive zoning or performance standards to encourage creative design methods to improve on-site stormwater infiltration and storage in site design.
- f. Restore underground and channelized waterways in urban areas back to traditional meander and flow patterns as a method to both restore ecological function and create unique urban blueways.
- g. Create and maintain waterfront greenways as a means to better connect citizens to their natural resources in their communities, facilitating stewardship of water resources.
- h. Develop collaborations between city governments, non-profits, block clubs, community foundations, planners, and developers to launch green initiatives that restore the image of our waterfront cities and create a citizen movement to protect and restore water resources.
- i. Co-locate multi-use public trail systems with urban shoreline greenways (riparian lands) and green infrastructure networks to alleviate automotive usage and support public connections to the natural world.
- j. Relocate adverse land uses from within critical riparian lands surrounding urban river/creek corridors, such as junk yards, car impound lots, gas stations, auto maintenance facilities, and heavy manufacturing operations.
- k. Vet the usage of vacant and underutilized land within the watershed's cities, towns, and villages for opportunities to create green stormwater infrastructure, water habitats,

riparian buffers, shoreline wetlands, and floodplains, especially in communities with combined sewer systems.

1. Coordinate with watershed municipalities to establish regional policies that establish impervious cover thresholds by sub-watershed.

Key Finding #7: The watershed’s agricultural sub-watersheds create sedimentation and nutrient loading impacts.

While only 23% of the land in the watershed is used for agricultural purposes, much of the agricultural land uses are concentrated in the eastern and southern portion of the watershed. The highest number of agricultural-use acres can be found in Cattaraugus Creek, Upper Tonawanda Creek, Headwaters Cattaraugus Creek, Buffalo Creek, Middle Tonawanda Creek, Cayuga Creek, Canadaway Creek, and Murder Creek sub-watersheds, in that order. Sixmile Creek and Chautauqua Creek sub-watersheds are included in the list as well when looking at percentage of land use in agriculture. Over 25% of the land use is agricultural in all listed sub-watersheds. Because of the amount of agriculture upstream, urban areas in Dunkirk, Buffalo, and Tonawanda receive high levels of agricultural pollution inputs that further compound the urban and suburban pollution inputs occurring downstream.

Recommendations:

- a. Expand the financial resources available to the local U. S. Department of Agriculture Natural Resource Conservation Service and County Soil and Water Conservation Districts to better assist farms in layout and implementation of structural and operational best management practices to reduce impacts from agriculture runoff.
- b. Evaluate all state and federal agriculture programs that exist to support environmentally responsible, economically viable and sustainable businesses and identify hurdles limiting their successful use.
- c. Ensure the NYSDEC has the resources and expertise necessary to enforce existing Concentrated Animal Feeding Operation (CAFO) regulations while providing financial assistance to farms so that they may fully implement their CAFO plans.
- d. Collaborate with state, federal, and other agencies to promote the use and expansion of programs that install and protect vegetative riparian buffers on agricultural lands.
- e. Provide additional technical assistance funding to assist small and medium sized farms in implementing Agricultural Environmental Management Plans.
- f. Collaborate with NYS Department of Agriculture and Markets to further promote agriculture best management practices that support water quality to watershed farmers.

Key Finding #8: Most municipalities do not adequately protect water resources in planning, regulations and development review.

While many municipalities in the watershed have taken steps to improve elements that affect water quality that are within their control, there remains much more that can be done to comprehensively protect the health of our watershed at the municipal level. Presently community planning incorporating water quality usually stems from flooding issues or MS4 SPDES permitting requirements, not the protection of natural resources. Very few of the municipalities in the watershed have undertaken conservation planning or have programs in place to conserve and protect natural resources. Of the several regulatory tools afforded to our “home rule” communities, zoning districts, permitted land uses, site plan review, flood regulations, environmental overlays, subdivision review, and setback requirements are rarely structured to evaluate and protect water resources.

In addition to a lack of regulatory tools, municipal training on how to interpret and utilize regulatory tools from the water resource protection lens is needed. According to the outreach conducted from the Municipal Laws & Practices Assessment, many communities are interested in doing this work, but require training on how to interpret development plans and enforce regulatory tools for planning and zoning boards.

Recommendations:

- a. Encourage watershed counties and municipalities to conduct a natural resource inventory and develop open space and conservation plans that address the protection living infrastructure.
- b. Investigate and promote programs that provide for permanent conservation of land.
- c. Encourage municipalities to plan for the protection and function of regional living or greenway infrastructure networks in comprehensive planning processes.
- d. Develop and promote model environmental zoning overlay protections for sensitive waterfront environments, water quality, wetlands, headwater forests, important habitats and riparian buffer protection.
- e. Ensure public access to waterways is not hindered by non-water-dependent development.
- f. Expand development setbacks on waterfront yards to a minimum of 100 feet, encroachment should require a variance.
- g. Strengthen local floodplain regulations to better protect flood prone areas from unnecessary or inappropriate development.
- h. Restrict the spread of sewer, water, and road infrastructure in order to curb sprawling development patterns.
- i. Encourage low impact design, green infrastructure, and reduction of impervious cover in private development through incorporating performance standards or stricter regulations into zoning and site plan review ordinances.

- j. Incorporate stronger regulatory protections for conservation/natural resources in subdivision review procedures.
- k. Develop design guidelines and model zoning regulations that outline appropriate design and vegetation usage for functional riparian buffers.
- l. Train municipal staff, councils, and planning boards on how to review development through a water quality lens and offer alternative design examples to common development scenarios that protect water resources from development impacts.
- m. Pursue enabling language in New York State statutes to create special taxing districts to maintain and improve MS4 infrastructure and living infrastructure networks.
- n. Restrict the siting of adverse land uses adjacent to stream, creeks, and waterbodies.
- o. Regulate private dock placement and design in waterfront communities to protect shorelines and habitat areas.
- p. Implement marina ordinances that guide best management practices in marina design, operations and maintenance including adding services like fish cleaning stations to prevent pollution of waterways. Legally municipalities have jurisdiction 1100' out into the navigable waterways and can pursue their regulatory authority.
- q. Document green initiatives and practices initiated by municipal staff into formal department policies in order to retain departmental knowledge as staff change-over occurs.
- r. Develop outreach and educational materials for waterfront landowners that addresses better yard management practices, riparian buffer design, and how best to mitigate shoreline erosion.
- s. Develop a Clean Marina citizen education program to improve management of private marinas and docking facilities.
- t. Implement Certificates of Occupancy requirements to ensure development occurs according to permit requirements.
- u. Collaborate with NYS Department of Agriculture and Markets to draft model regulations that incorporate appropriate best management practice into zoning codes addressing Agricultural Districts.
- v. Collaborate with the Agricultural and Farmland Protection Program, such as conducting workshops about conservation options for rural landowners and purchasing development rights in priority agricultural areas which are experiencing the most developmental pressure. Encourage programs such as the Navigator Program through the American Farmland Trust, which match farmers looking to sell farmland to farmers looking to purchase land to keep it as working farmland.
- w. Promote agricultural Best Management Practices or enrollment in the Agricultural Environmental Management Program through educational brochures and collaborative workshops with County Soil and Water Conservation Districts.

- x. Develop fines and enforce ordinance violations, especially regarding provisions that affect water quality (shoreline vegetation removal, yard waste dumping, etc.).
- y. Ensure proper maintenance and upkeep of private stormwater management systems by adopting codes that strengthen enforcement authority (i.e. establishing fines for violations).
- z. Develop regulations to address BMP forestry practices, site clearing, and limit vegetation removal along creeks, wetlands, and in floodplains.
- aa. Conduct municipal tree inventories and establish policies to maintain and enhance urban forests and canopy cover throughout the municipality.

Key Finding #9: The watershed is experiencing sprawl and an increase in development despite substantial population losses, compounding water quality issues.

Between 2000 and 2010, the Niagara River/ Lake Erie Watershed added an additional 13,398 acres of land considered “urbanized” according to the US Census Bureau. During this same time, the watershed lost approximately 35,722 people. This trend is indicative of sprawl, where communities and development is sprawling outwards from city and village centers in a way that requires more land and space to supply a smaller population with its built environment. Thirty-six percent (36%) of land use in the Watershed is considered residential. Unfortunately low-density residential development carries implications for water quality, including increased non-point source pollution; channelizing natural waterways into stormwater corridors; fragmenting agricultural and forest lands; degrading wildlife habitat; and increasing the cost of infrastructure. The most visible consequence of sprawling trends is the large-scale loss of natural forests, fields, and other undeveloped land.

Recommendations:

- a. Remove the watershed’s “essential lands” from development pressures (i.e. regional living infrastructure network) through local and regional land use policies.
- b. Municipal policies should focus on reducing low-intensity residential development by addressing how land is converted to residential uses (i.e. conservation, subdivision, site design regulations).
- c. Restrict the expansion of water, sewer, and road infrastructure as it aids sprawling development patterns, unless the infrastructure is necessary to address issues directly affecting water quality (i.e. failing septic systems associated within an already built out area). If expansion is necessary, create appropriate zoning and regulations to protect water quality from future development.
- d. Encourage first and second ring suburbs to conduct Smart Growth planning that clearly outlines sustainable development practices and policies.
- e. Identify and highlight the best municipal programs utilized to combat sprawl and excessive development pressures within New York municipalities.

- f. Participate in implementing the One Region Forward plan and continue to track watershed health metrics for impact/performance.
- g. Implement zoning performance standards that allow for creative development patterns and layouts, such as cluster development, that limit the footprint of developments and infrastructure, and protect sensitive natural features found on-site.
- h. Conduct workshops with local officials on determining critical environmental site features and implementing sustainable site design alternatives for their protection.
- i. Foster in-fill development through variances and other zoning provisions that allow creative use of small lots or underutilized properties or turn those small lots into enhanced green infrastructure to limit stormwater from surrounding areas from impacting water quality.
- j. Adopt incentive zoning provisions or overlay districts that protect natural resources, conserve open space, large old-growth forests, and important agricultural lands.
- k. Create and implement tax incentive programs that support the preservation of large tracts of open space, especially within agricultural and forested areas.
- l. Conduct agricultural and forestry preservation planning in second and third ring suburbs.
- m. Investigate the use of impact fees for development proposed in non-urbanized areas.
- n. Establish Transfer of Development Rights programs in second and third ring-suburban communities within the watershed.

Key Finding #10: The inadequate amount of water quality and watershed infrastructure data available limits the ability to plan for watershed health.

During the research for the various components of the Watershed Management Plan, a lack of data relative to water course base conditions and modeling, and water quality became evident across the board. There are several data sets that, if produced would assist in a wide variety of watershed analysis and planning. Presently the current extent of condition identification, trends, and recommended actions for the Niagara River/ Lake Erie Watershed is limited by a lack of data in several areas, primarily on-the-ground data that is collected frequently, such as water quality sampling, Stream Visual Assessments, and sediment loading.

Recommendations:

- a. Expand collection of hydrologic flow data in rivers, streams and creeks to determine baseline conditions for:
 - i. sediment transport loading and critical erosive force thresholds;
 - ii. pollution inputs and critical pollution thresholds;
 - iii. stormwater and MS4 infrastructure contributions; and
 - iv. frequency and effect of storm events.

- b. Continue to collect additional water quality data to adequately characterize the water quality conditions in our rivers, streams and creeks, including:
 - i. a more comprehensive sampling of sites throughout the watershed to assess the waterways that haven't been assessed in over 15 years;
 - ii. a greater frequency of collection than once every 5 years; and,
 - iii. the regular collection and analysis of bacterial and nutrient inputs, such as *E-coli*, phosphorus, and nitrogen.
- c. Conduct water quality sampling of small lakes and ponds to better understand the conditions occurring and plan for corrective actions.
- d. Conduct additional assessments according to the Natural Resource Conservation Service's Stream Visual Assessment Protocol in order to effectively characterize conditions of wade-able streams.
- e. Inventory and document high erosion areas along local waterways to lessen the impact of channel and bank erosion on water quality, infrastructure and private property.
- f. Expand invasive species mapping and monitoring to document the extent and spread of invasive species and better inform mitigation programs and funding needs.
- g. Conduct water quality sampling and ecological assessments of wetlands to identify the highest quality wetlands, inform wetland restoration efforts, and prioritize those that need protection.
- h. Track volumes of combined sewer overflow (CSO) and sanitary sewer overflow (SSO) discharge events, in order to determine pollutant inputs and track the progress of corrective actions and infrastructure upgrades.
- i. Conduct Biologic Assessment Profiles more frequently and more comprehensively throughout the watershed to effectively capture detailed trending information necessary for planning and mitigation actions.
- j. Expand Rotating Integrated Basin Studies to address areas classified as "needing verification" and "un-assessed".
- k. Conduct a comprehensive and current assessment of the ground-water quality as identified by the *USGS Ground-Water Quality in Western New York 2006* Report.
- l. Incorporate volunteers into data collection programs to better engage citizens in the health and stewardship of the watershed.
- m. Conduct a dam assessment to ensure proper maintenance of necessary dams and removal of unnecessary dams.

Key Finding #11: The lack of climate change data and trend tracking affects the ability to plan for watershed resiliency.

The extent to which climate change will affect the Niagara River/ Lake Erie Watershed is unknown at this point. There are larger-context predictions outlined by New York State, however in order to

adequately plan for what climate change will actually do to Lake Erie and our watershed, additional data collection and long-term trend tracking is needed. For example, if the frequency and extent of extreme weather events are likely to occur, the region will require additional investments into coastal ecosystems and living infrastructure to buffer the impact of these storms. This type of research, data collection, trend analysis, and planning is what is needed for effective and comprehensive resiliency planning. At this time, only Niagara County has undertaken an initial resiliency planning effort.

Recommendations:

- a. Collect sufficient data to evaluate potential climate change trends to influence more comprehensive planning efforts. Data collections should include:
 - i. rainfall levels at more points within the watershed;
 - ii. waterway base flow and high-water data;
 - iii. lake levels;
 - iv. storm frequency and intensity tracking;
 - v. Lake Erie seiche events and inland high-water level effect;
 - vi. damaging freeze-thaw (ice flow) events and locational damage;
 - vii. temperature changes;
 - viii. seasonal flooding (frequent low-level flooding); and,
 - ix. aquifer volume estimates.
- b. Conduct an inventory of assets and vulnerabilities to fully understand what infrastructure may be at risk and to what degree (i.e. risk analysis).
- c. Collaborate with area universities and NYSDEC to analyze climate change trends and identify trends and preemptively evaluate potential impacts to habitat and watershed health.
- d. Identify high-erosion areas, highly erodible soils, and steep slopes for use in local land-use planning decisions.
- e. Regularly inspect culverts, shorelines, sewer connections, outfalls, manholes and bridge abutments to identify vulnerable and under-sized infrastructure.
- f. Conduct county-wide or Watershed-wide resiliency planning to identify the best methods or needs to quickly recover from natural disasters and intense storm events.
- g. Incorporate findings from County All-Hazard Emergency Management Plans into municipal land use planning decisions.
- h. Coordinate with county emergency management officials to document areas with frequent damage to highlight problem areas before major storms occur.
- i. Investigate state and federal funding opportunities to preemptively fix failing infrastructure, especially along shorelines, and replace with living shoreline infrastructure when possible.

Key Finding #12: The NYSDEC Water Classifications do not always reflect desired public uses.

Currently, most of our waterways are designated as Class C, meaning that they are protected for fishing but not for primary contact, such as swimming, even though the community has a strong desire for primary contact in area waterways, and in some cases is already using it this way. If water quality is not assessed for these uses, they are not typically planned for in management policy or plan restoration. This is a concern within the City of Buffalo currently where no waters are designated for public bathing. Unfortunately this does not stop residents from swimming along the Outer Harbor, in the Buffalo River, Black Rock Canal and in Cazenovia Creek at Cazenovia Park on hot summer days.

Recommendations:

- a. Conduct reviews of water quality classifications at least once every three years, according to the U.S. Clean Water Act (40 CFR §131.20).
- b. Ensure water quality classification reviews conducted by the NYSDEC occur with an open public process that incorporates citizen input in decision making.

Key Finding #13: A high loss of fish habitat is evident in the watershed.

According to the Niagara River Habitat Conservation Strategy, the northern portion of the Niagara River/Lake Erie watershed has seen a decline in fish habitat due to a number of factors. In some cases this is due to the hardening of shorelines and employment of shoreline engineering techniques that remove sloped areas and transitional-marshes that support fish spawning and young fish habitat. In other areas of the watershed, migratory cold-water fish face increased water temperatures caused by the lack of forested riparian buffers and higher-temperature stormwater in-flows. In Grand Island and other areas with small tributaries off the Niagara River, migratory fish barriers in the stream channels reduce the ability of fish to migrate further. These fish barriers include improperly designed culverts, invasive species, sedimentation and small dams.

Recommendations:

- a. Assess and address known barriers to native and naturalized trout spawning.*
- b. Identify opportunities to mitigate the effects of channelization and altered flows.*
- c. Remove known fish barriers to up-stream fish spawning locations for native migratory fish within the watershed.
- d. Identify ideal locations to restore lost spawning habitat along coastal and in-land tributaries.
- e. Train municipal officials on the appropriate design and installation of culverts and other infrastructure to support fish migration.

- f. Encourage public works departments and County Soil and Water Conservation Districts to conduct regular culvert inventories to identify problem culverts for fish passage and plan for their upgrade or replacement. This can be combined with resiliency planning efforts to address both habitat and resiliency at the same time. Data can be used through the North Atlantic Aquatic Connectivity Collaborative.
- g. Conduct further research into declining fish populations and integrate findings into watershed planning.
- h. Document in-water and shoreline invasive plant species and prioritize areas for removal actions.
- i. Identify methods to limit the impacts of aquatic invasive species on native fish populations.
- j. Track emerging (not yet established) invasive aquatic species to identify the immediate and long-term threats to the Great Lakes ecosystem.
- k. Collaborate with Cornell Local Roads program to develop a training module on designing road side ditches and MS4 infrastructure to limit thermal loading, erosion, and sedimentation.
- l. Promote transitional shoreline environments that employ bioengineering and healthy riparian buffers to protect fish habitat in lieu of traditional hardened shorelines with limited habitat potential.

**Indicates Action Strategies outlined by the Niagara River Habitat Conservation Strategy.*

Key Finding: #14: There is a substantial lack of grassland and shrub habitat in the watershed.

In the Niagara River Habitat Conservation Strategy, a lack of sufficient grassland and shrub habitat was found.

Recommendations:

- a. Increase grassland habitat values for breeding birds.*
- b. Collaborate with County Parks Departments on the management of public parks and open space to protect grassland areas and support breeding of grassland bird species.
- c. Develop educational guidance materials on the management of grassland open space for the ecological benefit.
- d. Conduct educational outreach to owners of capped landfills and hay fields on recommended mowing practices to support breeding of grassland bird species.
- e. Re-establish or promote conservation incentive programs for protecting grassland areas such as NYSDEC's Landowner Incentive Program for Grassland Protection and Management and U.S. Fish and Wildlife Service's grassland restoration services.

**Indicates Action Strategies outlined by the Niagara River Habitat Conservation Strategy.*

Key Finding #15: The lack of shoreline wetlands and marshes is affecting habitat and watershed health.

Shoreline wetlands and marshes are part of a living infrastructure network that not only help our river systems function and lake shores stabilize, but provide essential habitat that supports clean water. Shoreline wetlands and marshes provide a transitional zone for young fish and other smaller organisms that require protection from stronger currents and larger predators. The ecological conditions found in these areas also significantly support water quality through filter feeding, oxygenation, turbidity reduction, and erosion protection.

Many of our downstream river corridors of the watershed's main tributaries no longer host shoreline wetlands or marshes due to navigational dredging, shoreline development, and traditional engineering structures. The re-creation of these environments is essential for watershed health and biological diversity.

Recommendations:

- a. Encourage municipalities to conduct natural resource inventories to identify high quality aquatic habitats and riparian wetlands for conservation.*
- b. Identify and protect sites with high ecological value and use as reference sites for habitat restoration.*
- c. Evaluate shoreline areas for the creation of new shoreline wetlands and marshes.
- d. Collaborate with U.S. Fish and Wildlife, NYSDEC, and Buffalo Niagara Riverkeeper to identify priority locations for the creation of new shoreline wetlands/marshes within the Areas of Concern, Impaired stream segments, and along important fish migration routes.

**Indicates Action Strategies outlined by the Niagara River Habitat Conservation Strategy.*

Key Finding #16: The lack of wildlife corridors limits wildlife movements and safe migration.

Wildlife migrates for food, breeding, and to follow seasonal changes. In the Niagara River/ Lake Erie watershed, the Niagara River corridor is designated as an Important Bird Area, and is really the only wildlife corridor officially recognized and managed as such. Opportunities to expand the migratory bird connections exist, but are commonly an afterthought in local and regional land use planning.

Other land and water wildlife corridors are planned for or protected even less so. For example, land development commonly fragments large tracts of forest land, isolating wildlife and limiting habitat area, which negatively affects their viability. In-water wildlife corridors have the same impacts; however, in-water fragmentation is often caused by dams, invasive species, poorly designed culverts, thermal changes, pollution, and sedimentation.

Recommendations:

- a. Support wildlife corridors and movement through the creation/protection of the regional living infrastructure network that includes interconnected waterways, lakes, ponds, riparian buffers, wetlands, flood plains, headwater forests, grasslands, large forest tracts, and agricultural lands.
- b. Encourage municipalities to plan for the protection and connectivity of the natural areas outlined in Recommendation #15. a. in comprehensive planning.
- c. Develop model environmental overlays in zoning ordinances that incorporate protections for regional living infrastructure networks.
- d. Identify and protect at-risk forested areas from fragmentation due to development pressure.*
- e. Identify opportunities to mitigate the effects of channelization and altered flows.*
- f. Assess and address known barriers to native and naturalized trout spawning.*
- g. Collaborate with NYSDEC to identify important wildlife migration corridors and utilize the information to inform regional planning and development.

**Indicates Action Strategies outlined by the Niagara River Habitat Conservation Strategy.*

Key Finding #17: Thermal pollution exists within the watershed, impairing ecosystems.

As temperatures rise in rivers, streams, and water bodies their ecosystems are affected, placing stressors on species that influence water quality. Macroinvertebrates, cold water fish species, and amphibians, are all sensitive to rising temperatures. Higher water temperatures are caused by the increased solar radiation from the lack of forested cover, urban and suburban stormwater run-off, poorly designed MS4 infrastructure, dams, and industrial processes. Various trout species are especially vulnerable and warming of streams in the southern extent of the watershed is evident in the reduction of trout habitat there.

Recommendations:

- a. Improve forest canopy over streams and lake edges through riparian buffer protections in zoning ordinances and design guidelines for waterfront landowners.
- b. Encourage landowners and municipalities to use NYSDEC programs such as *Buffer in a Bag* and *Trees for Tribes*, or the Lake Erie Watershed Protection Alliance riparian buffer program.
- c. Design MS4 infrastructure that buffers stormwater from solar loading and allows for opportunities to cool stormwater prior to discharge into lakes and streams.
- d. Eliminate the use of materials in MS4 infrastructure and drainage channels that amplify solar impacts in stormwater.

- e. Encourage the installation of green infrastructure with tree features to collect and store stormwater on-site, especially for parking lots.
- f. Restrict lot-clearing to the building envelope for existing forested properties within a 25 mile radius of sub-watershed headwaters.

Key Finding #18: Inadequate tracking and management of invasive species limits the ability to reduce their impact.

Several kinds of invasive species have been documented in the Niagara River/ Lake Erie Watershed, however for certain species there is very limited data outlining their location, extent, and movement. Essentially, invasive species lack inventories and analysis of trending, both of which are necessary to plan for their management and reduction.

Recommendations:

- a. Support the efforts of Western New York Partnership for Regional Invasive Species Management (WNY PRISM) to combat the spread of invasive species in region.
- b. Conduct regular inspections for invasive aquatic plants in waterways, lakes and small ponds, and engage volunteers in removal efforts.
- c. Expand public knowledge of the iMap Invasives Website and other citizen's campaigns to document invasive species in New York State.
- d. Support on-going funding of Buffalo State College's Great Lakes Center, the NY Sea Grant Program, WNY PRISM, and U.S. Fish and Wildlife Service as they continue to research invasive species and removal techniques. Collaborate on communication of the results and findings.
- e. Improve public knowledge of invasive species, identification, threats and best management practices through expanded educational programming, outreach materials, and signage.
- f. Expand research into removal and mitigation techniques for invasive species to identify the most effective methods with the least impact on native species.

Key Finding #19: Combined sewer overflows are a major pollution contributor within the watershed.

While it's not fully known the exact volume of untreated sewage that combined sewer overflows contribute to the watershed each year, the estimates are extensive and the evidence is quite apparent in the Niagara River, Buffalo River, and Scajaquada Creek. The most predominant contributor is the City of Buffalo's Sewer Authority, where over 52 permitted outfalls discharge to the Niagara River and Buffalo River Sub-watersheds. The discharges of these systems disrupt the natural balance of our waterways, impacting water quality, ecosystems, and recreation.

Recommendations:

- a. Outline the issues associated with accurate reporting of CSO discharges and identify ways to improve discharge volume tracking.
- b. Create tools to assist municipalities in tracking and maintaining infrastructure.
- c. Ensure CSO communities participate in watershed planning initiatives.
- d. Prepare and implement Long-term Control Plans for the mitigation of CSO events that minimize the use of grey infrastructure solutions and maximize the use of green infrastructure solutions as practical.
- e. Utilize adaptive management to adjust Long-Term Control plans based on actual results.
- f. Collaborate with NYSDEC and U.S. EPA to maintain oversight on CSO communities and implementation of Long-Term Control Plans.
- g. Advocate for NYS Environmental Facilities Corporation to prioritize CSO communities for NYS Green Infrastructure Grant Program funding.
- h. Amend zoning regulations to incorporate performance standards that require 100% on-site stormwater capture, storage, and infiltration for 2” or less rain events; and, limit the percentage of impervious cover on individual lots and subdivision development to reflect current understanding of Best Management Practices.
- i. Incorporate low-impact development and sustainable sites design into development regulations.
- j. Utilize vacant lots for stormwater storage, infiltration, and green infrastructure installations.
- k. Develop downspout disconnection programs and educate private property owners on how they can help mitigate CSO issues.
- l. Investigate the use of utility discounts to encourage property owners to install green infrastructure or conduct downspout disconnections.

Key Finding #20: Sanitary sewer overflows are a bigger problem than originally suspected.

Sanitary sewer overflows (SSOs) present the same impacts to waterways as combined sewer overflows, since they also discharge raw untreated sewage intended for the wastewater treatment plant. In many cases SSOs occur during heavy rain events in the spring, when snowmelt and rainfall inflow and infiltrate into sanitary sewers through broken connections and pipes. Presently Scajaquada Creek, Niagara River and Ellicott Creek receive the brunt of these discharges.

Recommendations:

- a. Collaborate with the sanitary sewer operators to effectively characterize the full extent of Sanitary Sewer Overflow issues within the watershed, including:
 - i. volumes discharged during each event;
 - ii. all discharge locations;

- iii. current and most recent conditions leading to the discharge event; and,
- iv. suspected causes for each discharge event.
- b. Create tools to assist municipalities in tracking and maintaining infrastructure.
- c. Identify SSO event hot spot areas in the watershed to prioritize for engineering investigations and design system improvements.
- d. Encourage sanitary sewer operators to conduct regular inspections on infrastructure and perform corrective actions on cracked, broken or undersized pipes.
- e. Host a round-table discussion on SSO events and their impact on water quality and what some of the watershed's sanitary sewer operators are doing to address.
- f. Establish funding mechanisms to address SSO issues at the local and regional level.
- g. Develop programs that assist private property owners in repairing broken sanitary sewer connections in low-income communities.
- h. Encourage municipalities to enforce violations and establish fines for illicit discharge and connections to sanitary sewers.

Key Finding #21: Improved design and maintenance of stormwater infrastructure is needed to reduce non-point source pollution.

The infrastructure that makes up storm sewer systems includes a wide variety of elements that together store and direct stormwater run-off into area waterbodies. Stormwater infrastructure, which typically includes such things as storm drains and underground pipes, roadside ditches, stormwater retention ponds, and cisterns, rarely includes components that filter stormwater prior to its release into area waterways. Because this infrastructure is primarily designed to quickly collect and convey stormwater away from land surfaces, stormwater infrastructure can contribute to water quality impairments based on its design and maintenance. For example, narrow and deep roadside ditches may have a smaller footprint, but ultimately contribute to erosion and sedimentation of the ditch and downstream. Direct conveyance of stormwater from streets, roofs, driveways and parking lots are major contributors to PAHs and PCBs in our waterways.

Recommendations:

- a. Develop design guidelines for stormwater infrastructure to improve function and protection of water quality.
- b. Create tools to assist municipalities in tracking and maintaining infrastructure.
- c. Identify stormwater outfall locations with high pollutant loading and prioritize for infrastructure improvements within the upstream conveyance systems, including green infrastructure interceptors that filter waters prior to discharge.
- d. Set regional policies to require end-of-pipe buffers and filter systems prior to discharge of stormwater in high pollutant load stream segments.

- e. Highlight municipal stormwater improvement projects that demonstrate enhanced design and protection of water quality at the WNY Stormwater Coalition Conference and NYS Floodplain and Stormwater Managers Association's Annual Conference.
- f. Host training events for Stormwater Management Officers on new stormwater management designs and technology that reduces erosion, sedimentation, and thermal inputs, plus improve filtration.
- g. Advocate for the NYS Environmental Facilities Corporation to expand the Green Infrastructure Grant Program to fund design improvements for poorly functioning stormwater infrastructure.
- h. Provide training to municipal and county engineers and public works departments on the design and installation of culverts and roadside ditches to support water quality, as well as fish passage and climate change.
- i. Improve oversight and enforcement actions by local Stormwater Management Officers, including the establishment and issuance of fines for violations for improper design and maintenance of stormwater infrastructure.
- j. Collaborate with the WNY Stormwater Coalition to develop educational materials and tools geared towards private property owners on how to maintain the function of MS4 infrastructure that abuts their properties in a way that protects water quality.
- k. Establish beginning-of-pipe programs for homeowners to expand public knowledge of property maintenance practices that generate stormwater pollutants.
- l. Collaborate with the Cornell Local Roads Training Program to educate public works staff on best management practices for roadside stormwater ditch maintenance.
- m. Collaborate with the Lake Erie Watershed Protection Alliance for hydroseeding of ditches after cleaning to prevent erosion and sedimentation.

Key Finding #22: Innovative funding mechanisms are needed to address infrastructure-related pollution issues.

Municipalities today face a difficult situation in determining how and to what extent they fund the maintenance, replacement, and creation of infrastructure. A recurring theme for water and sewer entities is the desire to make their systems more effective in addressing water pollution with limited funding mechanisms beyond the rate payers or the municipal budget. This issue is evident in the CSO, SSO and MS4 infrastructure conditions and long-term plans needed to address infrastructure that is out of compliance. Aside from traditional grey infrastructure, green stormwater infrastructure and living infrastructure networks also lack adequate funding mechanisms to support their protection and maintenance.

Recommendations:

- a. Outline a funding plan to implement watershed and sub-watershed management plans; develop additional phases of watershed planning to reach EPA planning standards; and, track watershed plan progress over the long-term and amend plans as necessary.
- b. Research innovative funding programs and mechanisms employed in other areas of New York State and the U.S. for the:
 - i. purchase, conservation and/or protection of regional living infrastructure networks;
 - ii. creation and restoration of wetlands, riparian buffers, floodplains and habitat;
 - iii. improved capacity to manage and design MS4 infrastructure;
 - iv. correction of combined sewer and sanitary sewer overflows;
 - v. design and implementation of green stormwater infrastructure;
 - vi. creation of waterfront public access, blueway and greenway trails; and,
 - vii. purchase, conservation and/or protection of important open space and wildlife corridors, headwater forests, and primary agricultural lands.
- c. Develop a coalition of regional partners to address the funding needs identified in Recommendation #22b. i.-vii. (above), including, but not limited to, an evaluation of special taxing districts, impact fees, violation-fine programs, public utilities, and voluntary donation programs.

Key Finding #23: Legacy contamination is a substantial problem within urban sub-watersheds.

Remnants of our industrial past still dot our landscape today. Many of the highly contaminated properties in the region have been remediated and are not considered a threat to public health or the environment any longer. However, known or suspected contaminated properties still remain that require investigation and clean-up. Our urban sub-watersheds, Buffalo River, Niagara River, and Canadaway Creek Sub-watersheds host the majority of these sites.

In addition, legacy contamination is still present in various forms in our waterways themselves, most often as contaminated sediments and past illegal dumping. Contaminated sediments found in river and creek bottoms are caused by erosion from contaminated properties and groundwater migration. Once in sediments, contaminants can work their way up through the food chain. In the Buffalo and Niagara River Areas of Concern (AOC), the presence of various contaminants in biological samples (fish and other aquatic species) confirms this toxic past. While dredging and capping of contaminated sediments has occurred in the Buffalo River, other waterways are impacted throughout the Watershed on a smaller scale.

Recommendations:

- a. Engage the U.S. Congressional Delegation to maintain funding for the U.S. EPA Great Lakes Legacy Act Program as the leading resource to investigate and remediate contaminated sediments found within the Areas of Concern.
- b. Advocate for NYS to continue funding for New York State's Environmental Restoration Program (ERP) Initiative and NYS Department of State Brownfield Opportunity Area.
- c. Advocate for NYS to continue tax incentives for the NYSDEC Brownfield Cleanup Program.
- d. Continue to support the management of the Areas of Concern and their Remedial Action Plans locally and communicate progress and setbacks with regional stakeholders.
- e. Support post-dredging monitoring of the Buffalo River sediments to meet delisting criteria for the Buffalo River Remedial Action Plan.
- f. Implement monitoring protocols of the Buffalo River Remedial Action Plan to confirm the progress/impact of delisting actions.
- g. Conduct sediment investigation within the Niagara River Area of Concern to characterize contaminant inputs from tributary source areas.
- h. Identify quality habitat areas within the Niagara River Area of Concern for long-term protection and/or acquisition to foster delisting of BUI #14.
- i. Identify shoreline and in-water areas ideal for habitat creation and restoration within the Niagara River Area of Concern to foster delisting of BUI #14.
- j. Conduct public outreach on the watershed's legacy contamination, efforts to address the contamination, and ways to ensure future actions do not repeat the past.
- k. Continue to monitor NYSDEC managed Inactive Hazardous Waste Sites.
- l. Encourage the U.S. EPA to foster engagement between the various Great Lakes Areas of Concern to review what's worked, progress made, and lessons learned.
- m. Ensure site access and long-term monitoring is provided for Buffalo River habitat restoration projects to inform delisting evaluation under the Buffalo River Remedial Action Plan.

Key Finding #24: The impacts of emerging contaminants in the watershed are unknown.

Aside from the watershed's legacy contamination, there are new substances that pose a threat to water quality. For example, current wastewater treatment plants are unable to filter and process chemicals such as pharmaceuticals, micro plastics, microfibers, flames retardants (PFAS) and leachates (BPA) at this time. The threats from these to ecology, wildlife, and public drinking water are not fully characterized at this time.

Recommendations:

- a. Identify emerging contaminants, new technologies, and behavioral changes with the potential to affect watershed health.
- b. Partner with area research universities to further evaluate the threat from emerging contaminants.
- c. Draft and advocate for policy reforms to limit the impact of emerging contaminants.
- d. Continue and expand County-wide efforts to collect pharmaceutical drugs for property disposal through “Drug Drop Off” days.
- e. Develop and disseminate public educational materials to highlight the potential threat from emerging contaminants.
- f. Collaborate with hospitals and pharmacies to address proper disposal of prescription drugs with educational materials distributed with prescriptions.

Key Finding #25: Some small improvements in watershed health indicators are evident.

Some areas of the watershed have seen slight improvements that indicate some improvement is occurring. Along the Buffalo River, vacant land uses have naturally regenerated from past industrial uses, as well as habitat restoration projects have been implemented and there is evidence of wildlife returning to the Buffalo River corridor in the city. This trend may be assisted by wildlife located nearby at the Tiff Nature Preserve outgrowing their habitat constraints and venturing into new areas, as well as the 100’ development buffer enacted by the City of Buffalo over a decade ago. Deer, beaver, fox, garter snake, perch, geese, ducks, heron, skunk, and turtles have all be sighted along the Buffalo River in greater frequencies on former industrial properties.

According to macroinvertebrate sampling (Predicted Biotic Assessment Profile Scores), continually degrading water quality conditions are evident in much of the Watershed; however there are a few stream segments that have improved slightly in recent years. These include portions of Rush Creek, Smokes Creek, Eighteenmile Creek (near the Lake Erie shoreline), and Little Tonawanda Creek.

Recommendations:

- a. Research areas of the watershed that see improvements to identify the conditions influencing these trends.
- b. Continue to track and communicate watershed improvements to citizens to outline progress in watershed management planning and implementation.
- c. Track Best Management Practices throughout the Watershed to track improvements in water quality.

- d. Document before and after conditions of watershed improvement projects, such as shoreline restorations, green infrastructure installations, and MS4 design improvements to gauge benefits and inform project design decisions.

Prioritization of Sub-watersheds

The dual goals of any watershed plan are to preserve and protect the conditions leading to high water quality and vital ecological habitat, and also to intervene in conditions which lead to impairment of water quality and habitat.

Measuring the health of a watershed is imprecise, subjective and involves the interplay of numerous factors. The fact that we do not always have substantial, consistent, pertinent, and measurable direct data across the Niagara River/Lake Erie Watershed forces us to look at predictors and indicators. The data gathered for the Watershed Characterization Report and other sources were used to score and rank each sub-watershed for each specific characteristic. Each sub-watershed was ranked from 1 to 5 in each category. A high score was given when healthy characteristics were low or unhealthy characteristics were high. For instance, a sub-watershed with a high amount of impervious cover, which can lead to large amounts of polluted runoff, was given a low score, whereas a high percentage of forest cover, which can absorb water and potential pollutants, was given a high score.

Sub-watershed Prioritizing Data Sets	Good Indication	Poor Indication
% of Impervious Cover	Low % Impervious Cover	High % Impervious Cover
% of Forest Cover	High % Forest Cover	Low % Forest Cover
% of Industrial Land Use	Low % Industrial Land Use	High % Industrial Land Use
% Total Acres of Land Protected	High % Protected	Low % Protected
Density of Stream Miles	High Density	Low Density
# of Road/Bridge Crossings per acre	Low # of Crossings	High # of Crossings
# of Remediation Sites per acre	Low # Sites	High # Sites

Metrics for Prioritization

Impervious Cover

The effects of urbanization on stream ecosystems are largely driven by impervious or impermeable cover. This metric typically increases with the increase in residential and commercial development including pavement, roofs, and other impermeable surfaces in a sub-watershed. Impervious surfaces associated with urbanization reduce infiltration and increase surface runoff altering the pathways by which water and any associated contaminants reach urban streams. This impervious cover data is from GIS overlays. Urban sprawl should be avoided, but implementing green infrastructure where possible should be encouraged.

Sub-watershed	% of Sub-watershed	Score
Niagara River	23.81%	1
Smoke(s) Creek	18.51%	2
Ellicott Creek	15.31%	2
Buffalo River	11.67%	2
Lower Tonawanda Creek	9.39%	3
Cayuga Creek	6.72%	3
Canadaway Creek	5.46%	3
Big Sister Creek	4.12%	4
Buffalo Creek	3.99%	4
Middle Tonawanda Creek	3.72%	4
Eighteenmile Creek	3.58%	4
Murder Creek	3.58%	4
Upper Tonawanda Creek	3.51%	4
Chautauqua Creek	3.30%	5
Sixmile Creek	3.15%	5
Walnut Creek	3.07%	5
Headwaters Cattaraugus Creek	2.92%	5
Cattaraugus Creek	2.80%	5

Forest Cover

Forested areas are the most healthy land cover in a watershed. They increase rainwater infiltration, reduce runoff, stabilize soil and are the least polluting land use and are of critical importance to water quality. Natural forested areas should be protected but urban management and reforestation are important components of watershed management.

Sub-watershed	% of Sub-watershed	Score
Niagara River	8.40%	1
Lower Tonawanda Creek	16.10%	2
Ellicott Creek	18.30%	2
Middle Tonawanda Creek	18.80%	2
Murder Creek	21.30%	2
Smoke(s) Creek	24.30%	3
Upper Tonawanda Creek	31.80%	3
Cayuga Creek	33.00%	3
Buffalo Creek	39.20%	4
Big Sister Creek	43.9%	4
Canadaway Creek	45.90%	4
Sixmile Creek	46.00%	5
Eighteenmile Creek	47.60%	5
Buffalo River	48.00%	5
Headwaters Cattaraugus Creek	49.50%	5

Walnut Creek	52.40%	5
Chautauqua Creek	53.50%	5
Cattaraugus Creek	56.70%	5

Industrial Land Use

Industrial land use contributes numerous impairments to water quality. Industrial waste is a big contributor to ground and surface water pollution. Surface water runoff disturbances and impervious cover are also components of industrial use.

Sub-watershed	% of Sub-watershed	Score
Murder Creek	13.92%	1
Ellicott Creek	23.22%	1
Upper Tonawanda Creek	3.63%	2
Niagara River	3.64%	2
Smoke(s) Creek	6.44%	2
Buffalo River	1.42%	3
Headwaters Cattaraugus Creek	2.08%	3
Lower Tonawanda Creek	2.17%	3
Middle Tonawanda Creek	2.48%	3
Cattaraugus Creek	0.45%	4
Buffalo Creek	0.63%	4
Canadaway Creek	0.67%	4
Cayuga Creek	0.89%	4
Walnut Creek	0.05%	5
Sixmile Creek	0.24%	5
Big Sister Creek	0.25%	5
Chautauqua Creek	0.26%	5
Eighteenmile Creek	0.38%	5

Protected Land

Approximately 12% of the Niagara River/ Lake Erie Watershed is considered protected through a variety of mechanisms, including conservation easements, fee title acquisition, regulatory protections on environmental features (i.e. wetlands), reservations, and land under governmental jurisdiction (parks, forests, trails, canals) according to the 2014 NYS Natural Heritage Program. These lands are less likely to be developed and are more likely to remain natural and provide ecosystem services.

Sub-watershed	% of Total Acres Protected	Score
Walnut Creek	3.22	1
Sixmile Creek	3.52	1
Chautauqua Creek	4.32	1
Eighteenmile Creek	4.72	1

Canadaway Creek	6.14	2
Cayuga Creek	6.14	2
Headwaters Cattaraugus Creek	7.23	2
Buffalo Creek	7.84	2
Buffalo river	7.87	2
Smoke(s) Creek	10.99	3
Niagara River	12.43	3
Ellicott Creek	13.29	3
Upper Tonawanda Creek	15.70	3
Cattaraugus Creek	16.11	4
Big Sister Creek	16.91	4
Lower Tonawanda Creek	18.67	4
Murder Creek	24.27	5
Middle Tonawanda Creek	29.46	5

Stream Density

High stream density is indicative of a large number of waterways miles per square mile in the sub-watershed. It is a measure of how well a watershed is drained by stream channels. In the Niagara River/ Lake Erie Watershed these tend to be in the forested headlands of the sub-watersheds.

Sub-watershed	Stream Density per mile	Score
Niagara River	1.3883	1
Lower Tonawanda Creek	1.7597	1
Canadaway Creek	1.8577	1
Big Sister Creek	1.9155	2
Buffalo River	1.9316	2
Smoke(s) Creek	1.9410	2
Ellicott Creek	2.0328	2
Chautauqua Creek	2.2525	3
Eighteenmile Creek	2.2847	3
Walnut Creek	2.2999	3
Sixmile Creek	2.3444	3
Buffalo Creek	2.4300	4
Headwaters Cattaraugus Creek	2.4518	4
Middle Tonawanda Creek	2.6789	4
Cattaraugus Creek	2.7120	4
Cayuga Creek	2.8019	5
Upper Tonawanda Creek	2.9610	5
Murder Creek	3.0475	5

Road/Waterway Crossings

The intersection of a waterway by a roadway is a crucial area of interference. Bridge abutments change the geometry of the stream bed and floodplain. They narrow the channel, increase the velocity and cause scour around the abutments. They also have the potential to impeded fish passage.

Sub-watershed	Count Per Acre	Score
Ellicott Creek	19.1296	1
Buffalo River	20.5898	1
Niagara River	31.0269	1
Smoke(s) Creek	33.1416	1
Eighteenmile Creek	11.1916	2
Canadaway Creek	11.3141	2
Cayuga Creek	11.4271	2
Lower Tonawanda Creek	11.9285	2
Chautauqua Creek	8.1963	3
Murder Creek	8.9963	3
Big Sister Creek	9.6214	3
Walnut Creek	10.5513	3
Upper Tonawanda Creek	6.2054	4
Buffalo Creek	7.0822	4
Sixmile Creek	1.1268	5
Headwater Cattaraugus Creek	5.1037	5
Cattaraugus Creek	5.4673	5
Middle Tonawanda Creek	5.9406	5

Remediation Sites

The NYS DEC Environmental Site Remediation Database includes state regulated hazardous waste sites in the watershed.

Sub-watershed	By Acre/1000	Score
Niagara River	152	1
Smoke(s) Creek	46	2
Buffalo River	79	2
Cayuga Creek	10	3
Lower Tonawanda Creek	16	3
Ellicott Creek	17	3
Cattaraugus Creek	6	4
Headwaters Cattaraugus Creek	6	4
Upper Tonawanda Creek	7	4
Canadaway	8	4
Big Sister Creek	1	5
Chautauqua Creek	1	5

Murder Creek	1	5
Walnut Creek	1	5
Middle Tonawanda Creek	3	5
Eighteenmile Creek	4	5

Overall Scoring

	Big Sister Creek	Buffalo Creek	Buffalo River	Canadaway Creek	Cattaraugus Creek	Cayuga Creek	Chautauqua Creek	Eighteenmile Creek	Ellicott Creek	Headwaters Cattaraugus	Lower Tonawanda	Middle Tonawanda	Murder Creek	Niagara River	Sixmile Creek	Smoke(s) Creek	Upper Tonawanda	Walnut Creek
Impervious Cover	4	4	2	3	5	3	5	4	2	5	3	4	4	1	5	2	4	5
Forest Cover	4	4	5	4	5	3	5	5	2	5	2	2	2	1	5	3	3	5
Industrial	5	4	3	4	4	4	5	5	1	3	3	3	1	2	5	2	2	5
Protected Land	4	2	2	2	4	2	1	1	3	2	4	5	5	3	1	3	3	1
Stream Density	2	4	2	1	4	5	3	3	2	4	1	4	5	1	3	2	5	3
Road Crossings	3	4	1	2	5	2	3	2	1	5	2	5	3	1	5	1	4	3
Remediation Sites	5	5	2	4	4	3	5	5	3	4	3	5	5	1	5	2	4	5
Total	27	27	17	20	31	22	27	25	14	28	18	28	25	10	29	15	25	27

Prioritize for Protection and Preservation**

Watersheds where the goal is to protect and preserve high quality conditions are generally characterized by a large amount of forest cover. They have low levels of urbanization and impervious cover. By focusing on these sub-watersheds tools can be developed and outcomes measured which will be most effective in protecting the health of sub-watersheds. It is also important to continue to address issues that do arise in these sub-watersheds in order to preserve their health.

Sub-watershed	Score
Cattaraugus Creek	31
Sixmile Creek	29
Middle Tonawanda	28
Headwaters Cattaraugus	28
Buffalo Creek	27
Walnut Creek	27
Big Sister Creek	27
Upper Tonawanda	25
Eighteenmile Creek	25
Chautauqua Creek	25
Murder Creek	25

Priority Sub-watersheds to Protect & Preserve (Good Conditions):

- Cattaraugus Creek Sub-watershed
- Sixmile Creek Sub-watershed
- Middle Tonawanda Creek Sub-watershed
- Headwaters Cattaraugus Creek Sub-watershed

Prioritize for Addressing Impairments**

Watersheds that should be targeted for water quality improvement have the most potential to affect factors contributing to the impairment of water quality and habitat conditions. They are often characterized by high density urban development and have a large percentage of impervious cover and industrialization. There may be large amount of infrastructure interfering with the natural flow of water.

Sub-watershed	Score
Niagara River	10
Ellicott Creek	14
Smoke(s) Creek	15
Buffalo River	17
Lower Tonawanda	18
Canadaway Creek	20
Cayuga Creek	22
Chautauqua Creek	25
Murder Creek	25
Upper Tonawanda	25
Eighteenmile Creek	25

Priority Sub-watersheds to Address Impairments (Poor Conditions):

- Niagara River Sub-watershed
- Ellicott Creek Sub-watershed
- Smoke(s) Creek Sub-watershed
- Buffalo River Sub-watershed

***It should be noted that the Priority Sub-watersheds identified are based on the full sub-watershed geography as a whole, not solely the principle tributary for which the sub-watershed is named.*