Chapter 4: Water Quality

Clean water is an essential human need and one whose value will increase as global climates change. The Niagara River and Lake Erie's tremendous water supply supports everything from daily living needs (drinking, bathing, cooking) to recreation (swimming, fishing, boating) and local economies (industry, tourism, shipping). Presently, the Great Lakes and their connecting tributaries provide drinking water to 40 million people in the United States and Canada[1], and support more than 1.5 million U.S. jobs that generate $62 billion in wages, including over 157,000 jobs in New York State.[2]

According to the World Health Organization, more than 2 billion people in the world do not have access to safe drinking water at home, yet we are privileged to have about 20 percent of the world's surface fresh water located at our doorstep in the Great Lakes.

While certain areas of the watershed have improved considerably since the enactment of the Clean Water Act in 1972 (i.e. Buffalo River), there are a number of areas within the watershed with poor and impacted water quality stemming from various types of pollution, existing storm-water management practices, adverse land uses and development trends, and other stressors that threaten our freshwater resources.

Water Classification & Quality Assessment

There are several mechanisms by which water quality is evaluated in New York State. One of the primary methods includes classifying water resources based upon their best uses and determining whether or not the water quality is in line with those uses.[3] For example, a water body used for drinking water has lower thresholds for contaminants or pollutants than a water body used solely for recreation. All waters in New York State are classified into various categories based on their best "beneficial uses" and the state establishes standards by which the resources should be maintained and protected (i.e. Anti-degradation policies). Table 4.1 outlines the various Water Quality Classifications for surface and ground waters in New York State.

[1] First Triennial Assessment of Progress on Great Lakes Water Quality, November 28, 2017.
[2] Vital to Our Nation' Economy: Great Lakes Jobs 2011 Report, http://www.miseagrant.umich.edu/wp-content/blogs.dir/1/files/2018/02/11-203-Great-Lakes-Jobs-report.pdf.
[3] NYS Water Quality Standards Program (overseen by the US EPA.)

Use classifications are applied according to water bodies or water course segments. For the Niagara River/ Lake Erie Watershed there are a total of 5,064 segments provided, with 936 designated as Class A, 1,165 designated as Class B, 2,948 designated as Class C, and 15 designated as Class D. Figure 4.1 identifies each segment's classification as well as segments designated as trout and trout spawning waters.

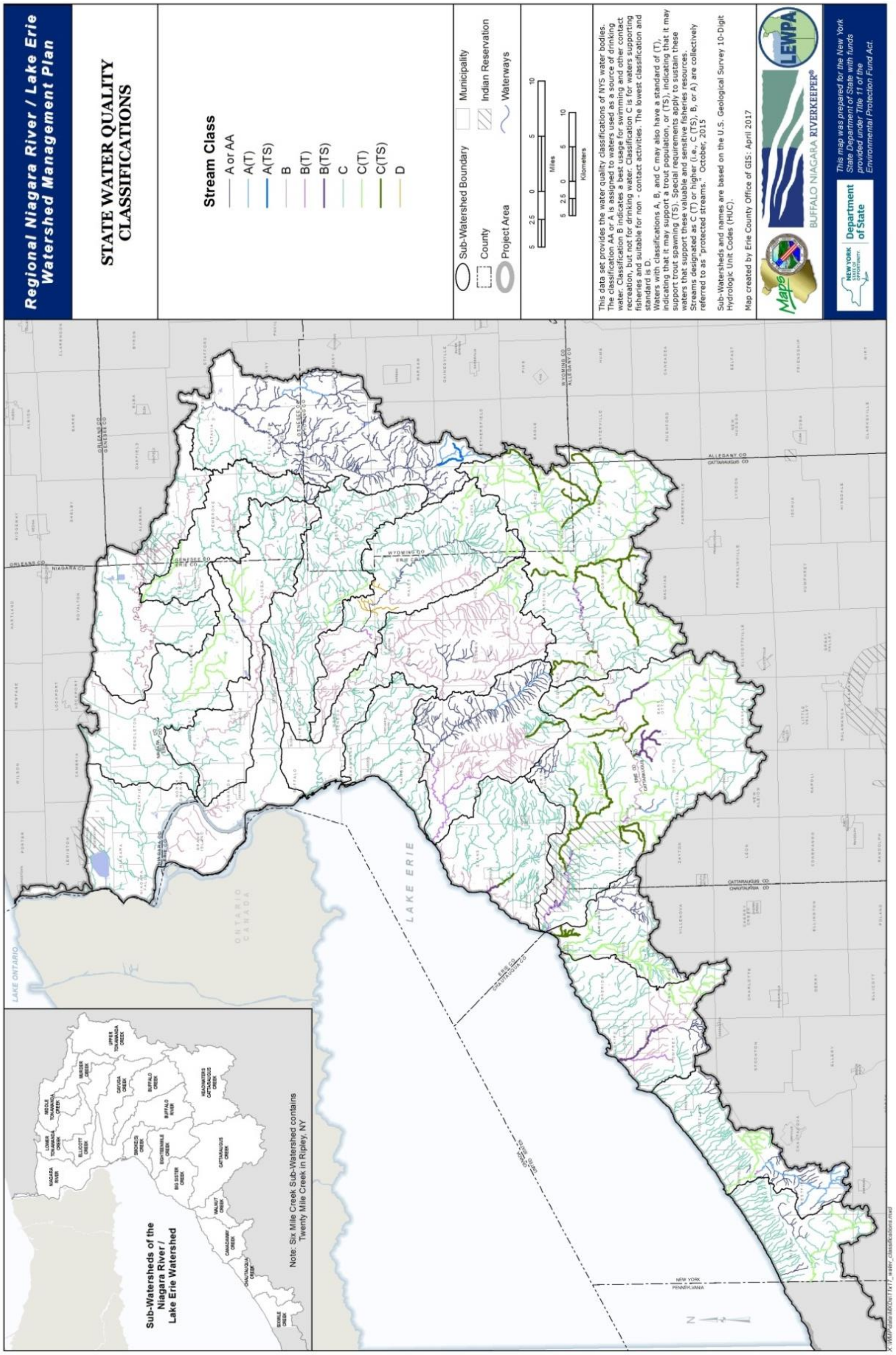
Table 4.1 NYS Water Quality Classifications

Class	Water Type	Best Usages
N	Fresh Surface Water	Suitable for the enjoyment of water in its natural condition (most restrictive) and, where compatible, as drinking water or culinary purposes; bathing; fishing; fish propagation; and recreation. Suitable for fish, shellfish, and wildlife propagation and survival.
AA-Special, A-Special, AA & A	Fresh Surface Water	Suitable for drinking water, culinary or food processing purposes; primary and secondary contact recreation; and fishing; fish, shellfish, and wildlife propagation and survival (A-Special: International Boundary Waters, AA & A: drinking water with disinfection/treatment).
B	Fresh Surface Water	Suitable for primary and secondary contact recreation and fishing; suitable for fish, shellfish, and wildlife propagation and survival.
C	Fresh Surface Water	Suitable for fish, shellfish, and wildlife propagation and survival; primary and secondary contact recreation, although other factors may limit the use for these purposes.
D	Fresh Surface Water	Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation. These waters shall be suitable for fish, shellfish, and wildlife survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
GA	Fresh Groundwater	As a source of potable water supply (all fresh groundwater resources are classified GA).

Note: Saline Water Resource Classifications are not included in this table.

Source: NYS DEC 6 NYCRR Part 701

Figure 4.1: State Water Quality Classifications of the Niagara River/Lake Erie Watershed



NYS Waterbody Inventory & Priority Waterbodies List

New York State's Waterbody Inventory and Priority Waterbodies List (WI/PWL) is an inventory of the state's surface waters. This data set provides a summary of general water quality conditions, tracks the degree to which a waterbody supports its designated uses, and monitors progress toward the identification and resolution of water quality problems, pollutants, and sources. The assessments are conducted every five years as part of DEC's *Rotating Integrated Basin Studies (RIBS)* and categorize each segment as either **Impaired**, waters with **Minor Impacts**, **Threatened** waters, waters with impacts **Needing Verification**, waters having **No Known Impacts**, or **Un-assessed waters** (Table 4.2).

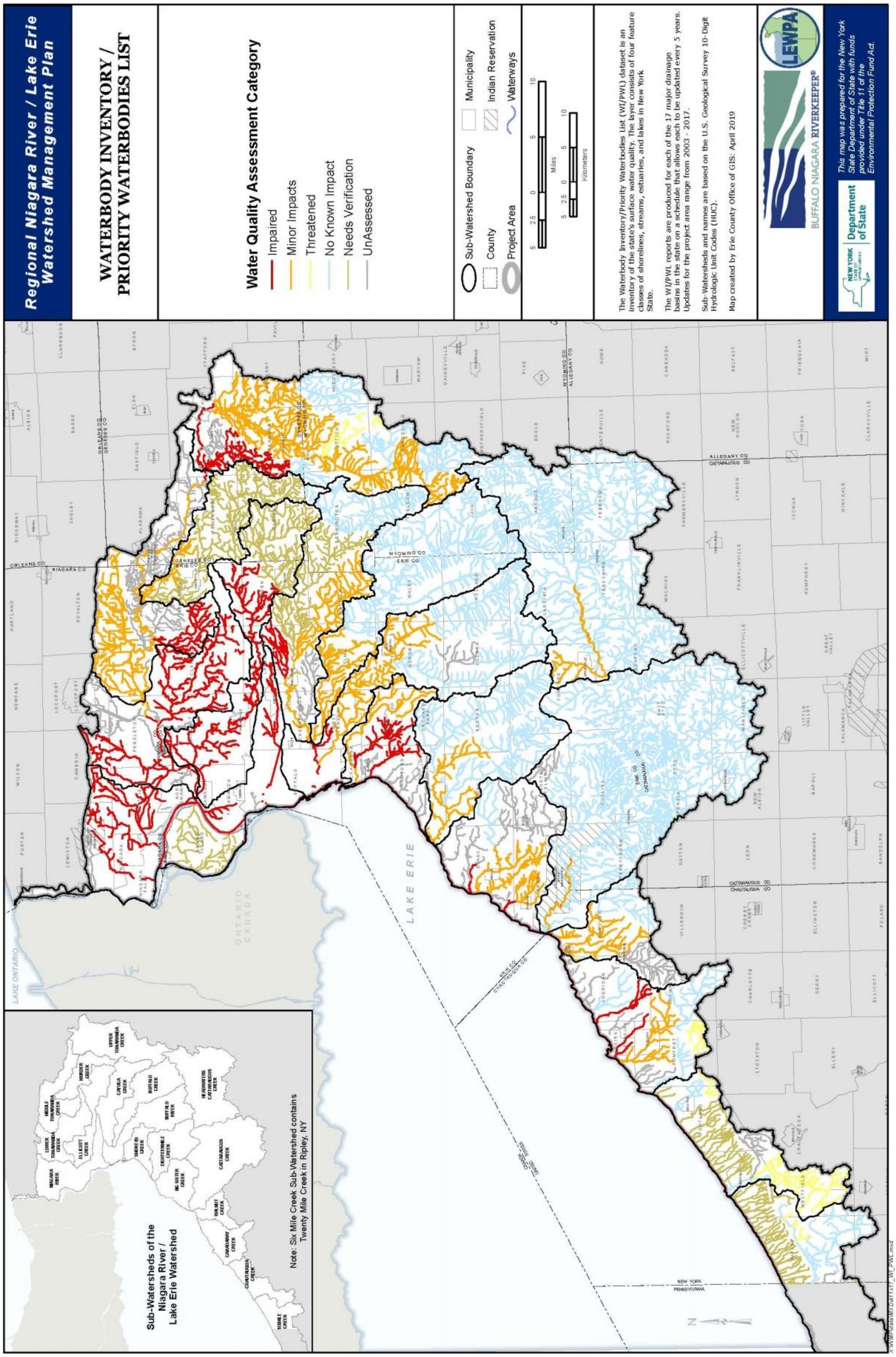
Table 4.2 NYS Water Quality Assessment Categories

Impaired Waters	Waterbodies with well documented water quality problems.
Waters with Minor Impacts	Waterbodies where less severe water quality impacts are apparent, but classification uses are considered fully supported.
Threatened Waters	Waterbodies for which uses are not restricted and no water quality problems currently exist, but where data suggests declining water quality trends or specific land uses or other changes in the surrounding watershed are known to be threatening water quality.
Waters having no Known Impacts	Waterbodies where monitoring data and information indicate that there are no use restrictions or other water quality impacts, threats or issues.
Waters with Impacts Needing Verification	Waterbodies that are thought to have water quality problems, but for which there is not sufficient or definitive documentation. These waterbodies need additional monitoring to determine whether uses are restricted or threatened.
Unassessed Waters	Waterbodies where there is no available water quality information to assess the support of designated uses.

Source: NYS DEC - CALM Section 305(b) Assessment Methodology (May 2009)

The data collected and provided as part of NYS's WI/PWL is submitted to the U.S. Environmental Protection Agency and comprises New York State's *Clean Water Act Section 305(b) Water Quality Report*. Segments that do not meet the standards for their use classification are categorized as either Threatened, Waters with Minor Impacts, or Impaired Waters and are included in the state's Priority Waterbodies List. Waters identified as "Impaired" and requiring Total Maximum Daily Load (TMDL) limits are also provided directly to the U.S. EPA as part of the *Clean Water Act Section 303(d) Impaired Waters List*. Waters included on the NYS Priority Waterbodies List or U.S. Environmental Protection Agency's 303(d) List are the focus of remedial/corrective and resource protection actions, as well as priorities for funding resources. The Priority Waterbodies List for the Niagara River/Lake

Figure 4.2: NYS Waterbody Inventory and Priority Waterbodies List – Status of Water Quality for the Niagara River/Lake Erie Watershed



Erie Basin was reviewed and updated with sampling done in 2015-16 and issued in 2017. The data is collected and maintained by the New York State Department of Environmental Conservation (NYSDEC).

Of the watershed's total 5,543 miles of waterways[4], approximately 481 stream miles have not been assessed. The NYS WI/PWL includes approximately 605 miles of impaired waterways with another 1,015 miles of waterways with minor impacts. Just over 626 miles of waterways need verification of possible impacts, while approximately 102 miles of waterways are considered threatened. About 2,501 miles of waterways, shown in blue on Figure 4.2, have no known impacts.

Historical or legacy contamination issues are well documented in this data. The Niagara River Sub-watershed has a number of impaired stream segments with a variety of toxic substances identified (PCBs, PAHs, Dioxins) as known pollutants. Impairments in this sub-watershed are also quite comprehensive and include impacts/limits on fish consumption, public bathing, aquatic life, recreation, habitat/hydrology modification, and aesthetics. In the Buffalo River Sub-watershed many of the past industrial uses were centered along a portion of the Buffalo River within the City of Buffalo, and again many of the impairments identify toxic or contaminated sediments as the known or suspected cause to the river's beneficial use impairments: fish consumption, aquatic life, and recreation[5]. In addition, during extreme weather events, contaminated sediments may be stirred up and deposited on land in the floodplains. The Smoke(s) Creek Sub-watershed also has legacy toxic contamination of PCBs along the Lake Erie shoreline due to past industrial uses. Additionally, the Lake Erie shoreline and several Lake Erie harbors, including Barcelona Harbor in Westfield and Dunkirk Harbor in Dunkirk, have toxic/contaminated sediment as a source of impairment. There are a few remaining areas within the watershed that have impairments from known or suspected contaminants, and include the more urban/suburban areas of the Canadaway Sub-watershed, Cattaraugus Headwaters Sub-watershed, Cayuga Creek Sub-watershed, Eighteenmile Creek Sub-watershed, Ellicott Creek Sub-watershed, Sixmile Creek Sub-watershed, Smoke(s) Creek Sub-watersheds, and Lower, Middle, and Upper Tonawanda Creek Sub-watersheds (see Table 4.3).

Aside from the historical contamination still present in the watershed, the remaining water quality issues are quite diverse, stemming from various sources of point and non-point source pollution. Many of the known or suspected impairments are attributed to agricultural activities, hydrological modification, sanitary discharges, stormwater run-off, streambank erosion, and failing on-site septic systems, which create aesthetic issues, nutrient (phosphorus) loading, pathogens, sedimentation, and lower dissolved oxygen levels.

[4] According to the U.S. Geological Survey Hydrography Data Set

[5] Please note, public bathing is not evaluated in the Buffalo River, even though unauthorized swimming does occur. Because no public swimming areas have been designated, contaminants that would restrict public bathing are not sampled nor evaluated for the level of threat to public health.

Table 4.3 Niagara River/Lake Erie Watershed - Water Quality Summary Conditions by Sub-watershed (WI/PWL Data)

ID number	Waterbodies/Segments	Length/Size	Water Quality Category	Stream Class	Impacted Uses or Conditions Evaluated & Severity**	Pollutants**	Pollutant Sources**
Niagara River Sub-watershed							
Ont 158 (portion 1)	Niagara River, Lower, Main Stem	12.0 miles	IMPAIRED	A-Special	Fish Consumption - Impaired, Habitat/Hydrology - Impaired	Priority Organics (Dioxin, PCBs, PAHs), Pesticides (mirex, Org.Chlor.Pest/HCB)	Tox/Contaminated Sediment, Habitat Modification
Ont 158 (portion 2)	Niagara River, Upper, Main Stem	24.8 miles	IMPAIRED	A-Special	Fish Consumption - Impaired, Aquatic Life - Stressed, Habitat/Hydrology - poor	Priority Organics (PCBs, PAHs), Pesticides (Org. Chlor. Pest/HCB), Water Level/Flow, Restricted Passage, Pathogens	Habitat Alteration, Tox/Contaminated Sediment, Landfill/Land Disp., Combined Sewer Overflow, Other Permitted Sanitary Discharges, Urban/Storm Runoff
Ont 158 (portion 3)	Chippewa (West) Channel	12.8 miles	IMPAIRED	A-Special	Fish Consumption - Impaired	Priority Organics (PCBs)	Tox/Contaminated Sediment, Landfill/Land Disp.
Ont 158 (portion 4)	Black Rock Canal	2.2 miles	IMPAIRED	C	Fish Consumption - Impaired, Habitat/Hydrology - Impaired	Priority Organics (PCBs)	Tox/Contaminated Sediment, Landfill/Land Disp., Habitat Modification
Ont 158 G.I.-1 thru 6	Grand Island (all tribs to Niagara River)	53.7 miles	Needs Verification	B	Habitat/Hydrology - Threatened	Silt/Sediment	Hydro Modification, Urban/Storm Runoff
Ont 158-6	Gill Creek and Tribs	12.3 miles	IMPAIRED	C	Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	Aesthetics (debris), Unknown Toxicity, Priority Organics (dioxin)	Urban/Storm Runoff, Tox/Contaminated Sediment
Ont 158-6-Pla	Hyde Park Lake	28.1 acres	IMPAIRED	B	Public Bathing - Impaired, Aquatic Life - Stressed, Recreation - Impaired	Algal/Weed Growth, Nutrients (phosphorus), D.O./ Oxygen Demand	Urban/Storm Runoff
Ont 158-8	Cayuga Creek and minor Tribs	21.6 miles	IMPAIRED	C	Fish Consumption - Precluded, Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	Priority Organics (dioxin), Unknown Toxicity, Metals (nickel, zinc), Pesticides (DDE, DDD), Algal/Weed Growth	Tox/Contaminated Sediment, Urban/Storm Runoff
Ont 158-8-1	Bergholtz Creek and Tribs	33.1 miles	IMPAIRED	C	Fish Consumption - Impaired, Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	Priority Organics (PCBs) Nutrients (phosphorus), Pathogens, Metals, Pesticides	Tox/Contaminated Sediment, Urban/Storm Runoff
Ont 158-13	Two-mile Creek and Tribs	7.1 miles	IMPAIRED	B	Public Bathing - Impaired, Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Fair	Aesthetics (odors, floatables), Low D.O./Oxygen Demand, Pathogens, Nutrients, Priority Organics	Municipal Discharges (Kenmore/Town of Tonawanda), Urban/Storm Runoff, Industrial, Other Non-Permitted Sanitary Discharge, Tox/Contaminated Sediment
Ont 158-15	Scajaquada Creek, Upper and Tribs	15.1 miles	IMPAIRED	B	Public Bathing - Impaired, Aquatic Life - Impaired, Recreation - Impaired	Nutrients (phosphorus), Low D.O./Oxygen Demand, Pathogens, Silt/Sediment	Urban/Storm Runoff, Other Non-Permitted Sanitary Discharges
Ont 158-15	Scajaquada Creek, Middle and Tribs	8.3 miles	IMPAIRED	C	Aquatic Life - Precluded, Recreation - Impaired, Habitat/Hydrology - Fair, Aesthetics - Fair	Aesthetics (floatables), Low D.O./Oxygen Demand, Nutrients (phosphorus), Pathogens, Priority Organics, Silt/Sediment	Habitat Alteration, Urban/Storm Runoff, Other Non-Permitted Sanitary Discharges, Tox/Contaminated Sediment

Ont 158-15	Scajaquada Creek, Lower and Tribs	0.3 miles	**IMPAIRED**	B	Public Bathing - Precluded, Aquatic Life - Precluded, Recreation - Impaired, Habitat/Hydrology - Stressed, Aesthetics - Stressed	Aesthetics (odors, floatables), D.O./Oxygen Demand, Pathogens, Nutrients (phosphorus), Priority Organics, Silt/Sediment	Combined Sewer Overflow, Urban/Storm Runoff, Habitat & Hydro Modification, Tox/Contaminated Sediment
Ont 158-15-P25	Delaware Park Pond (Hoyt Lake)	1.3 acres	**IMPAIRED**	B	Public Bathing - Impaired, Fish Consumption - Impaired, Recreation - Impaired	Algal/Weed Growth, Nutrients (phosphorus), D.O./Oxygen Demand, Priority Organics (PCBs)	Tox/Contaminated Sediment, Urban/Storm Runoff
Lower Tonawanda Creek Sub-watershed							
Ont 158-12 (portion 1)	Tonawanda Creek, Lower, Main Stem	11.9 miles	**IMPAIRED**	C	Fish Consumption - Impaired, Aquatic Life - Stressed, Recreation - Stressed	Priority Organics (PCBs), Nutrients, Silt/Sediments	Tox/Contaminated Sediment, Urban/Storm Runoff, Other Sanitary Discharge, Streambank Erosion
Ont 158-12-3	Bull Creek and Tribs	48.6 miles	**IMPAIRED**	C	Aquatic Life - Impaired	Unknown Toxicity, D.O./Oxygen Demand, Nutrients	Unknown Source, Municipal, Urban/Storm Runoff
Ont 158-12-6	Ransom Creek, Lower and Tribs	49.5 miles	**IMPAIRED**	C	Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	D.O./Oxygen Demand, Pathogens, Aesthetics (odors), Nutrients, Silt/Sediment	On-Site/Septic System (Clarence Hollow), Private Comm/Institutional (various residential), Urban/Storm Runoff
Ont 158-12-6	Ransom Creek, Upper and Tribs	44.2 miles	**IMPAIRED**	C (T)	Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	D.O./Oxygen Demand, Pathogens, Aesthetics (odors), Nutrients, Silt/Sediment	On-Site/Septic System (Clarence Hollow), Private Comm/Institutional (various residential), Urban/Storm Runoff
Ellicott Creek Sub-watershed							
Ont 158-12-1	Ellicott Creek, Lower and Tribs	112.0 miles	**IMPAIRED**	B	Public Bathing - Stressed, Aquatic Life - Impaired, Recreation - Impaired	Nutrients (phosphorus), Pathogens, Silt/Sediment, Pesticides (chlordane)	Urban/Storm Runoff, Other Non-Permitted Sanitary Discharge, Tox/Contaminated Sediment
Ont 158-12-1	Ellicott Creek, Upper and Tribs	112.1 miles	Needs Verification	C*	Aquatic Life - Stressed (possible), Recreation - Stressed (possible)	Silt/Sediment	Agriculture
Middle Tonawanda Creek Sub-watershed							
Ont 158-12 (portion 2)	Tonawanda Creek, Middle, Main Stem	49.3 miles	**Minor Impacts**	B	Public Bathing - Impaired, Aquatic Life - Stressed, Recreation - Stressed	Silt/Sediment, Pathogens, Nutrients	Agriculture, Streambank Erosion
Ont 158-12-8	Mud Creek and Tribs	113.5 miles	**IMPAIRED**	C	Aquatic Life - Impaired, Recreation - Impaired	Nutrients (phosphorus), Pathogens	Agriculture
Ont 158-12-9	Beeman Creek and Tribs	43.7 miles	**IMPAIRED**	C	Aquatic Life - Impaired, Recreation - Impaired	D.O./Oxygen Demand, Nutrients (phosphorus), Pathogens	
Murder Creek Sub-watershed							
Ont 158-12-11	Ledge Creek and Minor Tribs	28.9 miles	**Minor Impacts**	C (T)	Aquatic Life - Stressed	Silt/Sediment, Nutrients	Agriculture, Streambank Erosion
Ont 158-12-11-1	Murder Creek, Lower and Tribs	75.5 miles	Needs Verification	C*	Aquatic Life - Impaired, Recreation - Stressed	Silt/Sediment, Nutrients (phosphorus)	Streambank Erosion, Agriculture, On-Site/Septic Systems
Ont 158-12-11-1	Murder Creek, Upper and Tribs	106.2 miles	Needs Verification	C*	Aquatic Life - Impaired	Silt/Sediment, Nutrients	Agriculture, Streambank Erosion
Ont 158-12-11-1-P13	Tribs to Akron Reservoir	5.5 miles	No Known Impact	A	Water Supply - Threatened (possible)		
Ont 158-12-11-1-P13	Akron Reservoir	47.4 acres	No Known Impact	A	Water Supply - Threatened (possible)		

Upper Tonawanda Creek Sub-watershed							
Ont 158-12 (portion 1)	Tonawanda Creek, Lower, Main Stem	11.9 miles	**IMPAIRED**	C	Fish Consumption - Impaired, Aquatic Life - Stressed, Recreation - Stressed	Nutrients, Silt/Sediment, Priority Organics (PCBs)	Other Sanitary Discharge, Streambank Erosion, Urban/Storm Runoff, Tox/Contaminated Sediment
Ont 158-12 (portion 3)	Tonawanda Creek, Middle, Main Stem	11.7 miles	**IMPAIRED**	C	Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	Nutrients (phosphorus), D.O./Oxygen Demand, Silt/Sediment	Other Sanitary Discharge, Streambank Erosion, Urban/Storm Runoff, Agriculture, Municipal (Batavia WWTP), On-Site/Septic System (East Pembroke)
Ont 158-12 (portion 4)	Tonawanda Creek, Upper and minor Tribs	255.1 miles	**Minor Impacts**	A	Water Supply - Stressed, Recreation - Stressed, Aquatic Life - Stressed	Silt/Sediment, Nutrients, D.O./Oxygen Demand, Thermal Changes	Agriculture, Streambank Erosion, Hydro Modification, Municipal (Attica WWTP), Other Sanitary Discharge
Ont 158-12-28	Bowen Brook and Tribs	60.6 miles	**IMPAIRED**	C*	Aquatic Life - Impaired, Recreation - Impaired	D.O./Oxygen Demand, Nutrients (phosphorus), Pathogens	
Ont 158-12-32	Little Tonawanda Creek, Lower and Tribs	52.8 miles	**Minor Impacts**	A	Water Supply - Stressed, Public Bathing - Stressed, Recreation - Stressed	Silt/Sediment, Nutrients, D.O./Oxygen Demand	Agriculture, Streambank Erosion
Ont 158-12-32	Little Tonawanda Creek, Upper and Tribs	54.8 miles	No Known Impact	A (T)	No Uses Impaired		
Ont 158-12-41	Tannery Brook and Tribs	14.7 miles	No Known Impact	A	No Uses Impaired		
Ont 158-12-46	Crow Creek and Tribs	20.3 miles	Threatened	A	Water Supply - Threatened	Pathogens	Agriculture
Ont 158-12-46-P20	Attica Reservoir	11.3 acres	**Minor Impacts**	A	Water Supply - Threatened, Public Bathing - Stressed, Recreation - Stressed	Nutrients (phosphorus), Problem Species (Eurasian milfoil), Algal/Weed Growth, Pathogens	Agriculture
Ont 158-12-46-P20a	Attica Water Supply Reservoir	173.4 acres	Threatened	A	Water Supply - Threatened	Pathogens	Agriculture
Cayuga Creek Sub-watershed							
Ont 158..E-1-6	Cayuga Creek, Lower and Tribs	13.5 miles	**Minor Impacts**	C	Recreation - Stressed, Aquatic Life - Stressed	Nutrients, Silt/Sediment, Metals, priority organics (PAHs), Pathogens	Streambank Erosion, Urban/Storm Runoff, Other Non-Permitted Sanitary Discharge
Ont 158..E-1-6	Cayuga Creek, Middle and minor Tribs	116.6 miles	Needs Verification	B	Aquatic Life - Stressed (unconfirmed), Recreation - Stressed (unconfirmed)	Nutrients, Pathogens, Silt/Sediments	On-Site/Septic Systems (Cowlesville), Streambank Erosion, Other Non-Permitted Sanitary Discharges
Ont 158..E-1-6	Cayuga Creek, Upper and Tribs	57.3 miles	No Known Impacts	B	No Uses Impaired		
Ont 158..E-1-6-6	Plumb Bottom Creek and Tribs	27.2 miles	**IMPAIRED**	C	Aquatic Life - Impaired	Unknown Toxicity, D.O./Oxygen Demand, Nutrients	Unknown Source, Municipal, Urban/Storm Runoff
Ont 158..E-1-6-7	Little Buffalo Creek and Tribs	74.4 miles	**Minor Impacts**	C*	Habitat/Hydrology - Stressed	Silt/Sediment	Streambank Erosion
Ont 158..E-1-6-30	Right Branch/Gillett Creek and Tribs	30.1 miles	No Known Impacts	C	No Uses Impaired		
Buffalo Creek Sub-watershed							
Ont 158..E-1*	Buffalo Creek, Lower, and Minor Tribs	63.5 miles	**Minor Impacts**	B	Aquatic Life - Stressed, Recreation - Stressed	Silt/Sediment, Nutrients, Pathogens	Streambank Erosion, Urban/Storm Runoff, Agriculture
Ont 158..E-1*	Buffalo Creek, Upper, and Minor Tribs	285.1 miles	No Known Impacts	A	No Uses Impaired		

Erie/Buffalo River Sub-watershed							
Ont 158-E (portion 2)	Lake Erie (Outer Harbor, North)	7.3 shoreline miles	**IMPAIRED**	B	Fish Consumption - Impaired	Priority Organics (PCBs)	Tox/Contaminated Sediment
Ont 158-E (portion 3)	Lake Erie (Outer Harbor, South)	1.9 shoreline miles	**IMPAIRED**	C	Fish Consumption - Impaired	Priority Organics (PCBs)	Tox/Contaminated Sediment
Ont 158..E-1	Buffalo River, Main Stem	8.6 miles	**IMPAIRED**	C	Fish Consumption - Precluded, Aquatic Life - Stressed, Recreation - Stressed	Priority Organics (PCBs), D.O./Oxygen Demand, Pathogens, Silt/Sediment	Tox/Contaminated Sediment, Habitat & Hydro Modification, Urban/Storm Runoff, Combined Sewer Overflows
Ont 158..E-1-4	Cazenovia Creek and Tribs	51.7 miles	**Minor Impacts**	B	Public Bathing - Stressed Recreation - Stressed Aquatic Life - Threatened	Pathogens	Other Non-Permitted Sanitary Discharges, Urban/Storm Runoff
Ont 158..E-1-4-14	East Branch Cazenovia, Lower and Tribs	33.9 miles	**Minor Impacts**	B	Aquatic Life - Stressed, Recreation - Stressed	Nutrients (phosphorus), Unknown Toxicity	Urban/Storm Runoff
Ont 158..E-1-4-14	East Branch Cazenovia, Upper and Tribs	93.7 miles	No Known Impacts	B	No Uses Impaired		
Ont 158..E-1-4-15	West Branch Cazenovia, Lower and Tribs	25.0 miles	No Known Impacts	B*	No Uses Impaired		
Ont 158..E-1-4-15	West Branch Cazenovia, Upper and Tribs	73.8 miles	No Known Impacts	B	No Uses Impaired		
Ont 158..E-1-4-15-10-P	Orchard Park Reservoir	23.1 acres	**Minor Impacts**	A	Water Supply - Threatened, Public Bathing - Stressed, Recreation - Stressed	Nutrients (phosphorus), Silt/Sediment	Urban/Storm Runoff
Erie/Smoke(s) Creek Sub-watershed							
Ont 158-E (portion 4)	Lake Erie (Northeast Shoreline)	2.8 shoreline miles	**IMPAIRED**	C	Fish Consumption - Impaired	Priority Organics (PCBs)	Tox/Contaminated Sediment
Ont 158-E (portion 5)	Lake Erie (Northeast Shoreline)	9.0 shoreline miles	**IMPAIRED**	B	Fish Consumption - Impaired, Public Bathing - Impaired, Recreation - Impaired	Priority Organics (PCBs), Pathogens	Tox/Contaminated Sediment, Urban/Storm Runoff
Ont 158..E-2	Smoke Creek, Lower and Tribs	7.2 miles	**Minor Impacts**	C	Aquatic Life - Stressed, Recreation - Stressed, Aesthetics - Stressed	Aesthetics (sludge banks), Nutrients (phosphorus), Silt/Sediment, Pathogens	Urban/Storm Runoff, Industrial
Ont 158..E-2	Smoke Creek, Upper and Tribs	25.2 miles	**Minor Impacts**	C	Aquatic Life - Stressed, Recreation - Stressed	Nutrients (phosphorus), Unknown Toxicity	Urban/Storm Runoff, Municipal
Ont 158..E-2-1	South Branch Smoke Creek, Lower and Tribs	27.2 miles	**IMPAIRED**	C	Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	Nutrients (phosphorus), Silt/Sediment, Aesthetics (sludge, debris)	Streambank Erosion, Urban/Storm Runoff
Ont 158..E-2-1	South Branch Smoke Creek, Upper and Tribs	4.7 miles	**Minor Impacts**	B	Aquatic Life - Stressed, Recreation - Stressed	Nutrients (phosphorus), Pathogens	Urban/Storm Runoff
Ont 158..E-2-1-P81b	Green Lake	18.6 acres	**IMPAIRED**	B	Public Bathing - Impaired, Aquatic Life - Stressed, Recreation - Impaired	Nutrients (phosphorus), D.O./Oxygen Demand	Urban/Storm Runoff
Ont 158..E-3	Rush Creek and Tribs	17.2 miles	**IMPAIRED**	C	Public Bathing - Impaired, Aquatic Life - Impaired, Recreation - Impaired, Aesthetics - Stressed	Pathogens, Aesthetics (sludge banks, odors), Oil and Grease, Nutrients (phosphorus), Unknown Toxicity	Municipal (Hamburg, Blasdell SSOs) Urban/Storm Runoff, Other Sanitary Discharge

Eighteenmile Creek Sub-watershed							
Ont 158..E-13	Eighteenmile Creek, Lower & minor Tribs	30.8 miles	**Minor Impacts**	B (T)	Fish Consumption - Stressed, Recreation - Stressed, Habitat/Hydrology - Stressed	Silt/Sediment, Priority Organics (PCBs), Pathogens	Streambank Erosion, Urban/Storm Runoff, Agriculture, Hydro Modification, Tox/Contaminated Sediment
Ont 158..E-13	Eighteenmile Creek, Middle and Tribs	49.5 miles	No Known Impacts	A	No Uses Impaired		
Ont 158..E-13	Eighteenmile Creek, Upper and Tribs	72.3 miles	No Known Impacts	A	No Uses Impaired		
Ont 158..E-13-4	South Branch Eighteenmile, Lower and Tribs	77.8 miles	No Known Impacts	B	No Uses Impaired		
Ont 158..E-13-4	South Branch Eighteenmile, Upper and Tribs	21.7 miles	No Known Impacts	C	No Uses Impaired		
Ont 158..E-13-6	Hampton Brook and Tribs	16.7 miles	**Minor Impacts**	B	Aquatic Life - Stressed	Nutrients (phosphorus), D.O./Oxygen Demand	Agriculture, Urban/Storm Runoff
Erie/Big Sister Creek Sub-watershed							
Ont 158-E (portion 6)	Lake Erie (Main Lake, North)	15.7 shoreline miles	**IMPAIRED**	A-Special	Public Bathing - Impaired, Fish Consumption - Impaired, Recreation - Impaired	Priority Organics (PCBs), Pathogens	Tox/Contaminated Sediment, Urban/Storm Runoff
Ont 158..E-19	Little Sister Creek, Lower, and tribes	4.0 miles	**IMPAIRED**	B	Public Bathing - Stressed, Aquatic Life - Impaired, Recreation - Impaired	Nutrients (phosphorus), Pathogens, D.O./Oxygen Demand	
Ont 158..E-20	Big Sister Creek, Lower, and tribes	19.5 miles	**Minor Impacts**	C*	Aquatic Life - Stressed, Recreation - Stressed	Aesthetics (floatables), Nutrients	Municipal (unknown), Urban/Storm Runoff
Ont 158..E-20-13	Rythus Creek and tribes	19.4 miles	No Known Impacts	C	No Uses Impaired		
Ont 158..E-21	Delaware Creek, Lower, and tribes	2.5 miles	**Minor Impacts**	B (TS)	Aquatic Life - Stressed, Recreation - Stressed	Nutrients, D.O./Oxygen Demand	Agriculture, On-Site/Septic System
Ont 158..E-21	Delaware Creek, Upper, and tribes	20.5 miles	**Minor Impacts**	C	Aquatic Life - Stressed, Recreation - Stressed	Nutrients, D.O./Oxygen Demand	Agriculture
Ont 158..E-22	Muddy Creek, Lower, and tribes	2.4 miles	**IMPAIRED**	B	Public Bathing - Impaired, Recreation - Impaired	Pathogens	Unknown Source, Urban/Storm Runoff, On-Site/Septic System
Ont 158..E-22	Muddy Creek, Upper, and tribes	22.3 miles	**Minor Impacts**	C	Aquatic Life - Stressed	Nutrients	Agriculture
Cattaraugus Headwater Sub-watershed							
Ont 158..E-23 (portion 4)	Cattaraugus Creek, Middle, Main Stem	13.1 miles	**Minor Impacts**	B	Habitat/Hydrology - Stressed	Silt/Sediment	Streambank Erosion
Ont 158..E-23 (portion 5)	Cattaraugus Creek, Upper, and tribes	190.3 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23-27	Connoisarauley Creek, Lower, and tribes	39.0 miles	No Known Impact	B (TS)	No Uses Impaired		
Ont 158..E-23-27	Connoisarauley Creek, Upper, and tribs	20.6 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23-32	Spring Brook and tribs	16.3 miles	**Minor Impacts**	C*	Aquatic Life - Stressed, Recreation - Stressed, Habitat/Hydrology - Stressed	Silt/Sediment, Nutrients	Agriculture. Streambank Erosion, Hydro Modification, Municipal (Springville WWTP)
Ont 158..E-23-33	Buttermilk Creek and tribs	81.1 miles	No Known Impact	C	No Uses Impaired		
Ont 158..E-23-43 thru 47	Minor Tribs to Cattaraugus Creek	68.4 miles	No Known Impact	C	No Uses Impaired		
Ont 158..E-23-48	Elton Creek, Lower, and tribs	43.4 miles	No Known Impact	C (TS)	No Uses Impaired		
Ont 158..E-23-48	Elton Creek, Upper, and tribs	82.2 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23-48-3	Lime Lake Outlet and tribs	34.5 miles	No Known Impact	C (TS)	No Uses Impaired		
Ont 158..E 23 48 3 P130	Lime Lake	159.5 acres	**Minor Impacts**	B	Public Bathing - Stressed, Recreation - Impaired, Aquatic Life - Fully Supported	Harmful Algal Blooms, Algal Plant Growth (native), Nutrients (phosphorus)	On-Site/Septic System, Urban/Storm Runoff

Ont 158..E-23-48-9-P133	Beaver Lake	18.9 acres	Needs Verification	B	Public Bathing - Stressed (possible), Recreation - Stressed (possible)	Algal Weed Growth, Nutrients	Agriculture
Ont 158..E-23-56	Clear Creek and tribs	74.2 miles	No Known Impact	C (TS)	No Uses Impaired		
Ont 158..E-23-56-11-P141	Skim Lake	18.9 acres	No Known Impact	B	No Uses Impaired		
Ont 158..E-23-56-14-P146	Moores Pond	15.6 acres	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23-56-14-P147	Crystal Lake	33.8 acres	Needs Verification	B	Aquatic Life - Threatened, Recreation - Threatened	D.O./Oxygen Demand, Nutrients (phosphorus)	
Ont 158..E-23-P152	Java Lake	53.0 acres	**IMPAIRED**	B	Recreation - Impaired, Aesthetics - Stressed	Algal/Weed Growth, Nutrients (phosphorus)	On-Site/Septic System, Construction (residential development)
Cattaraugus Sub-watershed							
Ont 158..E-23 (portion 1)	Cattaraugus Creek, Lower, Main Stem	10.0 miles	**Minor Impacts**	B (T)	Habitat/Hydrology - Stressed	Silt/Sediment	Streambank Erosion
Ont 158..E-23 (portion 2)	Cattaraugus Creek, Middle, Main Stem	9.1 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23 (portion 3)	Cattaraugus Creek, Middle, Main Stem	21.8 miles	No Known Impact	B	No Uses Impaired		
Ont 158..E-23- 1 thru 18 (selected)	Minor Tribs to Cattaraugus Creek	151.4 miles	No Known Impact	C	No Uses Impaired		
Ont 158..E-23- 6	Clear Creek, Lower, and tribs	11.4 miles	No Known Impact	C (TS)	No Uses Impaired		
Ont 158..E-23- 6	Clear Creek, Upper, and tribs	97.5 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23- 6-4	North Branch Clear Cr, Lower, and tribs	34.8 miles	No Known Impact	C	No Uses Impaired		
Ont 158..E-23- 6-P100	Clear Lake	47.5 acres	**Minor Impacts**	A	Aquatic Life -Stressed, Recreation - Stressed	Nutrients (phosphorus), Silt/Sediment	Agriculture, Streambank Erosion
Ont 158..E-23-19	Point Peter Brook, Upper, and tribs	14.9 miles	No Known Impact	A (T)	Water Supply - Threatened (possible)		
Ont 158..E-23-19 thru 31 (selected)	Minor Tribs to Cattaraugus Creek	131.0 miles	No Known Impact	C	No Uses Impaired		
Ont 158..E-23-20	South Branch Cattaraugus, Lower, and tribs	97.5 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23-20	South Branch Cattaraugus, Upper, and tribs	80.0 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23-20-11	Mansfield Creek and tribs	93.0 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-23-20-P??	Rainbow, Timber Lakes	38.8 acres	**Minor Impacts**	C (T)	Recreation - Stressed	Algal/Wed Growth, Nutrients	Agriculture, Streambank Erosion
Erie/Walnut Creek Sub-watershed							
Ont 158..E-24	Halfway Brook and tribs	6.1 miles	**Minor Impacts**	C (TS)	Aquatic Life - Stressed, Recreation - Stressed	Nutrients (phosphorus), D.O./Oxygen Demand	Agriculture
Ont 158..E-25	Silver Creek, Lower, and minor tribs	21.7 miles	**Minor Impacts**	C (T)	Recreation - Stressed, Aquatic Life - Stressed, Habitat/Hydrology - Stressed	Aesthetics (turbidity, odors), D.O./Oxygen Demand, Silt/Sediment, Nutrients	Municipal (silver Creek WWTP), Streambank Erosion, Silviculture
Ont 158..E-25	Silver Creek, Upper, and tribs	32.7 miles	No Known Impact	A	No Uses Impaired		
Ont 158..E-25- 1	Walnut Creek, Lower, and tribs	25.1 miles	**Minor Impacts**	C	Aquatic Life - Stressed, Recreation - Stressed, Habitat/Hydrology - Stressed	Nutrients (phosphorus), D.O./Oxygen Demand, Silt/Sediment	Agriculture, Streambank Erosion, Silviculture
Ont 158..E-25- 8-P??	Silver Creek Reservoir	43.7 acres	No Known Impact	A	No Uses Impaired		

Erie/Canadaway Creek Sub-watershed							
Ont 158-E (portion 7)	Lake Erie (Main Lake, South)	39.6 shoreline miles	**IMPAIRED**	A-Special	Public Bathing - Impaired, Fish Consumption - Impaired, Recreation - Impaired	Priority Organics (PCBs), Pathogens	Tox/Contaminated Sediment, Urban/Storm Runoff
Ont 158-E (portion 7a)	Lake Erie (Dunkirk Harbor)	2.8 shoreline miles	**IMPAIRED**	B	Public Bathing - Impaired, Fish Consumption - Impaired, Recreation - Impaired, Aesthetics - Stressed	Priority Organics (PCBs), Pathogens, Aesthetics	Tox/Contaminated Sediment, Urban/Storm Runoff, Other Sanitary Discharges, Unknown Source
Ont 158..E-31	Beaver Creek and tribs	14.9 miles	No Known Impact	C	No Uses Impaired		
Ont 158..E-32	Scott Creek and tribs	14.0 miles	**IMPAIRED**	C	Aquatic Life - Impaired	Unknown Toxicity, D.O./Oxygen Demand, Nutrients	Unknown Source, Municipal, Urban/Storm Runoff
Ont 158..E-36	Crooked Brook and tribs	8.1 miles	**IMPAIRED**	C	Aquatic Life - Impaired	Unknown Toxicity, D.O./Oxygen Demand, Nutrients	Unknown Source, Municipal, Urban/Storm Runoff
Ont 158..E-37	Canadaway Creek, Lower, and tribs	36.8 miles	**Minor Impacts**	B	Habitat/Hydrology - Stressed	Silt/Sediment	Streambank Erosion
Ont 158..E-37	Canadaway Creek, Upper, and tribs	30.5 miles	No Known Impact	B	No Uses Impaired		
Ont 158..E-37- 7-P160	Fredonia Reservoir	51.2 acres	**Threatened**	A	Water Supply - Threatened		
Ont 158..E-37- 7-P160-	Tribs to Fredonia Reservoir	14.2 miles	**Threatened**	A	Water Supply - Threatened		
Ont 158..E-43	Little Canadaway Creek and tribs	15.8 miles	No Known Impact	C	No Uses Impaired		
Erie/ Chautauqua Creek Sub-watershed							
Ont 158..E-44 thru 67 (selected)	Minor Tribs to Lake Erie	74.4 miles	Needs Verification	C	Aquatic Life - Stressed (possible)		
Ont 158..E-50	Slippery Rock Creek and tribs	11.3 miles	No Known Impact	C	No Uses Impaired		
Ont 158..E-50-P160k	Brocton Reservoir	17.4 acres	**Threatened**	A	Water Supply - Threatened		
Ont 158..E-50-P160k	Tribs to Brocton Reservoir	5.5 miles	**Threatened**	A	Water Supply - Threatened		
Ont 158..E-68	Chautauqua Creek, Lower, and minor tribs	6.0 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-68	Chautauqua Creek, Upper and tribs	56.6 miles	**Threatened**	A (T)	Water Supply - Threatened		
Ont 158..E-68- 2-P165a	Minton Reservoir	12.7 acres	**Threatened**	A	Water Supply - Threatened		
Erie/ Sixmile Creek Sub-watershed							
Ont 158-E (portion 7b)	Lake Erie (Barcelona Harbor)	.07 shoreline miles	**IMPAIRED**	B	Fish Consumption - Impaired	Priority Organics (PCBs)	Tox/Contaminated Sediment
Ont 158..E-69 thru 95	Minor Tribs to Lake Erie	88.5 miles	Needs Verification	C	Aquatic Life - Stressed (possible)		
Ont 158..E-96	Twentymile Creek and minor tribs	53.3 miles	No Known Impact	C (T)	No Uses Impaired		
Ont 158..E-96- 3	Upper Belson Creek/Gage Gulf and tribs	12.4 miles	**Threatened**	A	Water Supply - Threatened		

*has smaller tributaries under different classification

(T) indicates Trout waters

** only known or suspected are included in this chart unless otherwise specified

This chart was updated May 2019

Lake Erie itself is experiencing rather complicated water quality issues resulting from a resurgence of algae blooms, including toxic blue-green algae; bioaccumulation of organochlorine compounds, pesticides, and mercury; shoreline erosion and sedimentation; ecosystem stresses from invasive species; and nutrient loading[6]. For more detailed information on the leading causes of water quality impairments in the watershed see the section of this chapter titled "Causes & Contributors of Water Quality Degradation."

Water Quality Monitoring for Baseline Data

The NYSDEC has contracted with the U.S. Geological Survey to conduct water quality monitoring at 19 sites throughout the Niagara River/Lake Erie Watershed for nutrients and other water quality parameters. This will help determine the nutrient loading to Lake Erie from New York State. Sampling started in the fall of 2017 and will continue through fall 2019. Sites are listed in Figure 4.3. While the report isn't due until 2020, results can be viewed online.[7] Gages are located on the following streams within the watershed: Chautauqua Creek, Canadaway Creek, Silver Creek, Walnut Creek, Cattaraugus Creek Gowanda, Cattaraugus Creek New Albion, Cattaraugus Creek Perrysburg, Big Sister Creek, Eighteenmile Creek Hamburg, Eighteenmile Creek Eden, Buffalo Creek, Cayuga Creek, Cazenovia Creek, Black Rock Canal, Black Rock Lock, Tonawanda Creek Attica, Tonawanda Creek Batavia, Tonawanda Creek Rapids, and Ellicott Creek.

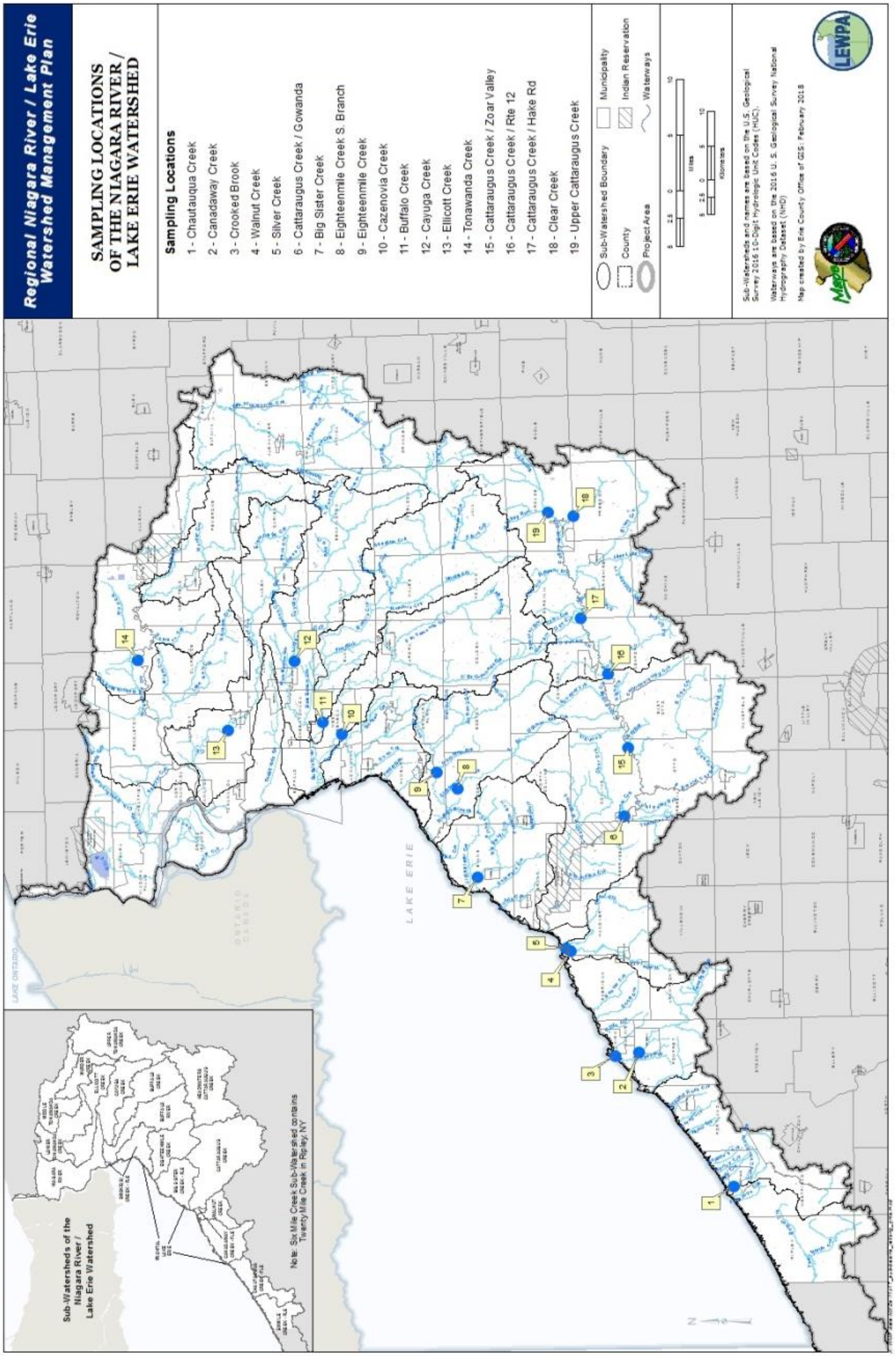
In addition, the Lake Erie Watershed Protection Alliance is sampling for bacteria at the same 19 sites. E. coli, fecal coliform, and total coliform, as well as general water quality parameters are being collected monthly from spring 2019 through spring 2020. In addition, three storm sampling events are planned as well.

Total Maximum Daily Loads (TMDLs)

Waters that do not support their classified uses and require Total Maximum Daily Load (TMDL) limits are placed on the U.S. EPA 303(d) Impaired Waters List. According to the Clean Water Act, states must consider the creation of TMDLs or another strategy to reduce the input of specific pollutants that contribute to the waters impairment. A Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards[8]. For TMDL development, studies are conducted to identify the source pollutant for the impairment and identify appropriate threshold limits. Upon establishing the TMDL, a timeline is established with specific strategies needed to reduce the contaminant levels and reduce pollutant levels to fall within the TMDL threshold.

[6] Myers, Donna N., et al. *Water Quality in the Lake Erie-Lake Saint Clair Drainages* (USGS 2000)
[7] https://bit.ly/2XpZr5e
[8] U.S. EPA

Figure 4.3: U.S. Geological Survey and LEWPA Sampling Locations



Most often implemented for nutrient loading impairments (phosphorus & nitrogen), TMDLs are a mechanism through which watershed managers can apply point and non-point source pollution thresholds on stream segments to address segments that are failing to meet water quality standards. The thresholds are developed by determining the levels by which pollution inputs would need to be reduced to bring stream segments back into water quality compliance. Once TMDLs are established, there are opportunities to seek additional funding for management and strategy implementation through the U.S. EPA. In the Niagara River/Lake Erie Watershed 26 out of the 41 impaired waterbodies/segments (63%) identified in the Waterbody Inventory and Priority Waterbodies List are identified as waters with "Impairments Requiring TMDL Development" (Table 4.4 below).

Table 4.4: Waters Requiring TMDL Development within the Niagara River/Lake Erie Watershed

ID number	Waterbodies/ Segments	Stream Class	Cause Pollutant	Suspected Source
Ont 158-6	Gill Creek and Tribs	C	Unknown (biological impacts)	Urban Runoff, Contaminated Sediment
Ont 158-6-Pla	Hyde Park Lake	B	Phosphorus	Urban/Storm Runoff
Ont 158-8-1	Bergholtz Creek and Tribs	C	Phosphorus, Pathogens	Urban/Storm Runoff
Ont 158-12-6	Ransom Creek, Lower and Tribs	C	Oxygen Demand, Pathogens	On-Site Waste Treatment System
Ont 158-12-6	Ransom Creek, Upper and Tribs	C (T)	Oxygen Demand, Pathogens	On-Site Waste Treatment System
Ont 158-13	Two-mile Creek and Tribs	B	Floatables, Oxygen Demand, Pathogens	Combined Sewer Overflows, Municipal
Ont 158-15	Scajaquada Creek, Upper and Tribs	B	Low D.O., Pathogens, Phosphorus	Combined Sewer Overflows, Urban Runoff
Ont 158-15	Scajaquada Creek, Middle and Tribs	C	Floatables, Low D.O., Pathogens, Phosphorus	Combined Sewer Overflows, Urban Runoff
Ont 158-15	Scajaquada Creek, Lower and Tribs	B	Floatables, Low D.O., Pathogens, Phosphorus	Combined Sewer Overflows, Urban Runoff
Ont 158-E (portion 5)	Lake Erie (Northeast Shoreline)	B	Pathogens	Urban/Storm Runoff
Ont 158-E (portion 6)	Lake Erie (Main Lake, North)	A-Special	Pathogens	Urban/Storm Runoff
Ont 158-E (portion 7)	Lake Erie (Main Lake, South)	A-Special	Pathogens	Urban/Storm Runoff
Ont 158-E (portion 7a)	Lake Erie (Dunkirk Harbor)	B	Pathogens	Urban/Storm Runoff
Ont 158..E-2-1-P81b	Green Lake	B	Phosphorus	Urban/Storm Runoff
Ont 158..E-3	Rush Creek and Tribs	C	Pathogens, Phosphorus	Combined Sewer Overflows, Urban Runoff, Municipal

None of these waters listed are scheduled for TMDL development by the NYS DEC at this time and the Niagara River/Lake Erie Watershed is currently the only area of the state that has not had any TMDLs developed. According to NYS DEC Region 9 staff this is due to a number of factors, including the lack of comprehensive baseline data existing in the region (although baseline monitoring is currently underway); the considerable expense in developing TMDLs for rivers and streams versus lakes; how some of the listed stream segments would not realistically benefit from TMDL development (other major factors at play such as non-point source pollution over point source pollution); and, how there historically hasn't been enough local support for advancing this work in the region nor adequate land use tools and regulations to do so in a "Home Rule" state. A discussion of TMDL development and other alternatives is listed in Appendix C as a deliverable of this project, put together by Buffalo Niagara Riverkeeper. A Nine-element Watershed Management Plan (9e Plan) is considered a preferable alternative to TMDL development in watersheds where non-point sources are more of a concern than point sources. Development of a 9e Plan is the course of action being pursued in the Niagara River/Lake Erie Watershed and this Watershed Characterization Report is a component of that Plan by illustrating potential pollution sources.

Aquatic Habitat - Water Quality Indicators

Figure 4.4: Macroinvertebrate Sampling

Additional resources exist to assist in categorizing the quality of our waters that pay special attention to aquatic habitat. The NYS DEC Priority Waterbodies List includes data generated from the state's Stream Biomonitoring Program (SBP) Assessment. This assessment is also performed throughout the state on a rotating basis. One element of the program uses the presence or absence of aquatic macroinvertebrates to determine the quality of ecosystem health using the Biotic Assessment Profile (BAP). The BAP scores water quality in a tributary by taking into consideration several indices including species richness, community balance, and presence of pollution-tolerant species to calculate a single score. A higher score demonstrates better quality of aquatic habitat and water quality in general. The map provided in Figure 4.5 contains BAP scores from 3 different years of sampling (2001, 2005, 2010) ranked by the assessment score (2013 NYSDEC data). Scores ranging from 0-2.5 fall under the "poor" category, 2.5-5 are "fair, 5-7.5 are "good," and 7.5-10 are "very good."

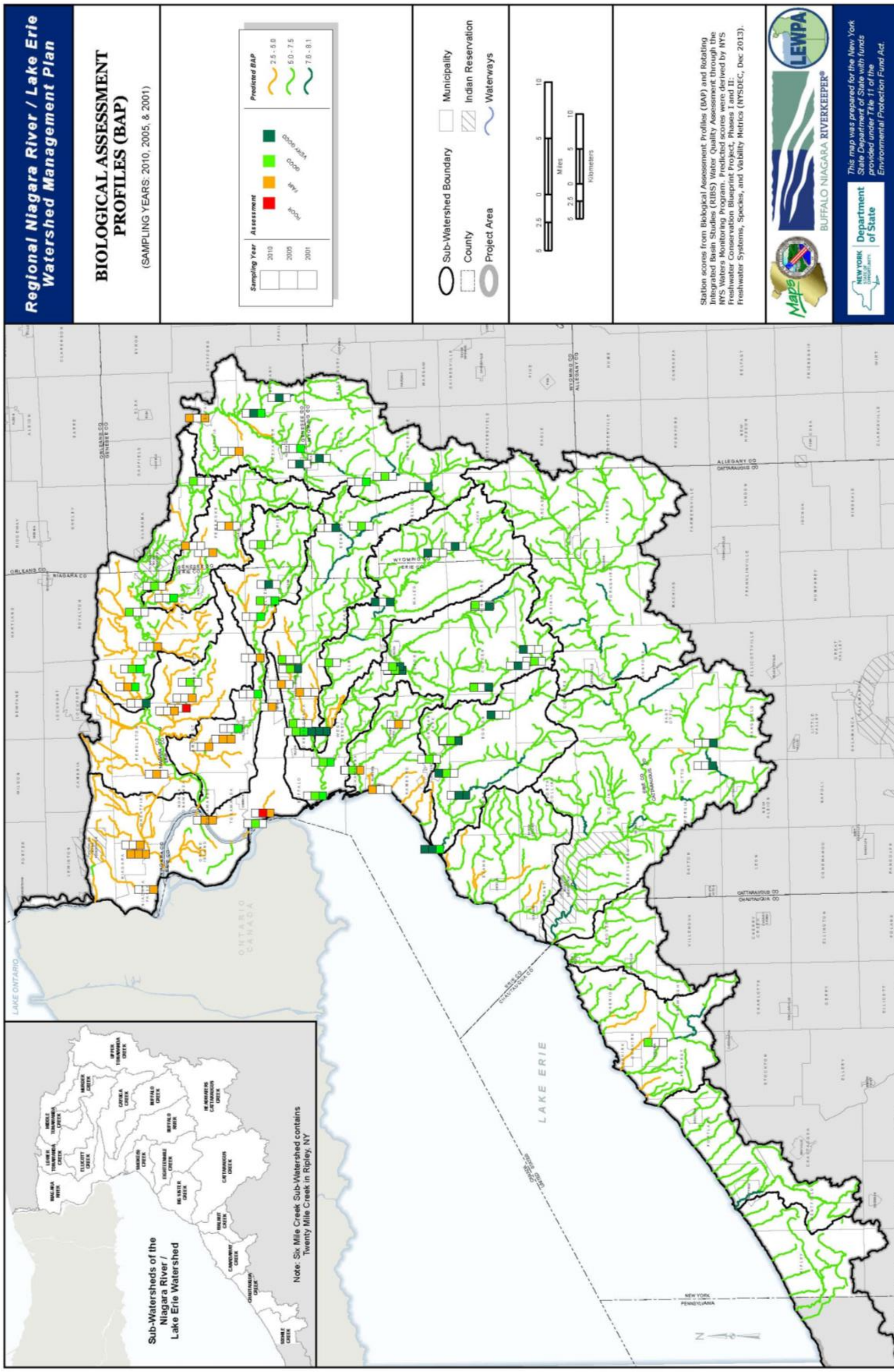
Predicted BAP scores are also displayed on the map for each stream segment using the same color coding scheme referenced in the point data. Predicted BAP scores were developed by The New York Natural Heritage Program's New York State Freshwater Conservation Blueprint Project. This analysis used the highest BAP score at each sampling location and applied a regression modeling tool in order to show how the observed data related to a number of other environmental variables. The variables included 146 local and regional attributes that apply to stream segments inducing stream velocity, land cover, geology, precipitation, stream order, and temperature. The regression model then used the importance and correlation of each attribute relative to the known BAP scores to extrapolate a predicted score for all of the streams in the watershed. The BAP scores (point & predicted) show similar findings to the overall RIBS data set, which indicates poorer water quality conditions in the more urbanized and downstream areas of the watershed, especially in the northern sub-watersheds.

Predicted BAP scores by percentage of waterways within each sub-watershed are displayed in Table 4.5 for comparison purposes. The total shows that the majority of the waterways in the Niagara River/Lake Erie Watershed are considered to be in good condition. The four sub-watersheds in green font have the highest percentage of waterways within their limits at the "very good" category. Those in orange font have the highest percentage of waterways within their limits at the "fair" category. None of the waterways are categorized as "poor." While Cayuga Creek Sub-watershed has a relatively high percentage of waterways categorized as "very good," there is still a higher percentage categorized as "fair" in that watershed. Unfortunately, biological assessment data collection isn't occurring frequently enough or comprehensively enough in the watershed to effectively capture detailed trending at the stream segment level at this time.

Table 4.5: Predicted BAP Scores in Sub-watersheds by Percentage of Waterways in Each Category

	Poor	Fair	Good	Very Good
Sub-watershed	**<2.5 Score**	**2.5-5.0 Score**	**5.0-7.5 Score**	**>7.5 Score**
Big Sister Creek	0.0%	16.9%	83.1%	0.0%
Buffalo Creek	0.0%	5.3%	91.6%	3.1%
Buffalo River	0.0%	0.0%	97.9%	2.1%
Canadaway Creek	0.0%	17.3%	74.5%	8.2%
Cattaraugus Creek	0.0%	0.3%	91.1%	8.6%
Cayuga Creek	0.0%	16.8%	72.6%	10.6%
Chautauqua Creek	0.0%	0.0%	94.9%	5.1%
Eighteenmile Creek	0.0%	0.8%	89.2%	9.9%
Ellicott Creek	0.0%	30.6%	69.4%	0.0%
Headwaters Cattaraugus Creek	0.0%	0.0%	92.4%	7.6%
Lower Tonawanda Creek	0.0%	77.4%	22.6%	0.0%
Middle Tonawanda Creek	0.0%	50.8%	49.2%	0.0%
Murder Creek	0.0%	18.7%	81.3%	0.0%
Niagara River	0.0%	88.2%	11.8%	0.0%
Sixmile Creek	0.0%	0.0%	89.0%	11.0%
Smoke(s) Creek	0.0%	22.7%	77.3%	0.0%
Upper Tonawanda Creek	0.0%	3.7%	92.2%	4.1%
Walnut Creek	0.0%	0.0%	100.0%	0.0%
Grand Total	**0.0%**	**16.4%**	**79.1%**	**4.5%**
prepared by L. Matthies-Wiza, 5/24/19				

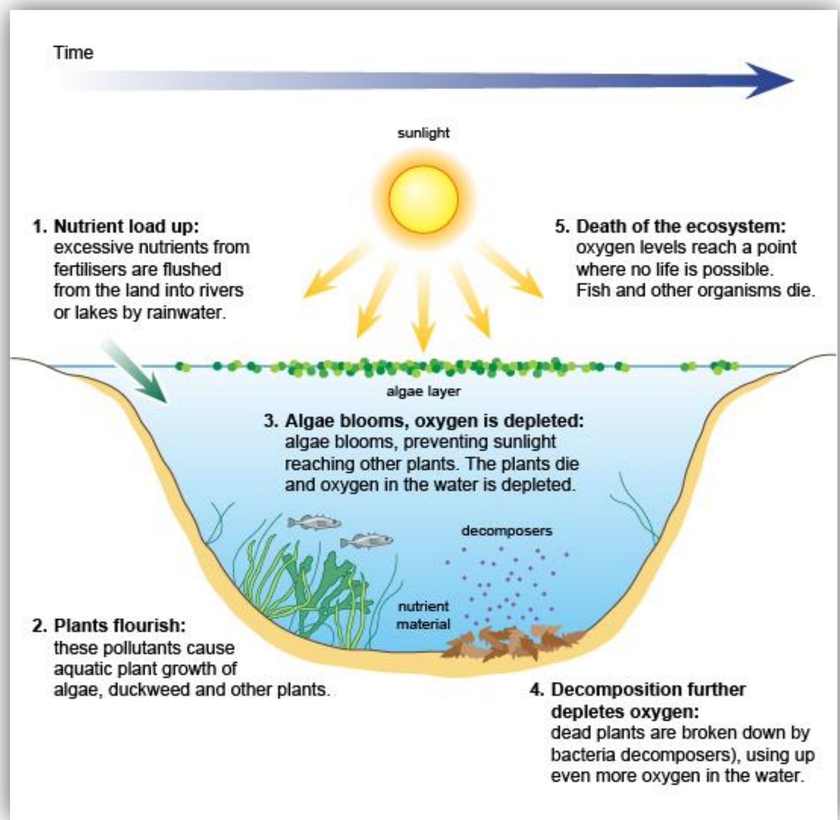
Figure 4.5: Biologic Assessment Profiles in Niagara River/Lake Erie Watershed



Water Quality of Wetlands & Smaller Lakes and Ponds

Wetland water quality monitoring is an important aspect of implementing the Clean Water Act; unfortunately New York State does not have a wetlands water quality monitoring program in effect at this time. The NYS DEC has worked towards creating standards by which wetlands water quality is assessed, but, “standards have not been adopted due to workload issues and the difficulty of smoothly incorporating wetlands protection into delivery of water quality standards.”[9] According to the U.S. EPA Clean Water Act guidance, development of wetland water quality standards provides a regulatory basis for a variety of water quality management activities including, but not limited to, monitoring and assessment under Section 305(b), permitting under Sections 402 and 404, water quality certification under Section 401, and control of non-point source pollution under Section 319.

Figure 4.6: Eutrophication Diagram



Source: British Broadcasting Company, GCSE: Bitesize Science online.

Wetlands within the Niagara River/Lake Erie Watershed and their benefits to water quality are described in the Watershed Characterization in Chapter 2. Wetlands are threatened by a number of human and environmental influences. Urbanization brings new or expanding roads, schools, and housing developments which are often built on or near wetlands. This may cause shifts in vegetation types and drainage of soils in and near wetlands, thus disturbing the flow of water into and out of the wetlands. Wetlands in poor health filter fewer pollutants, capture less carbon, and provide less storm protection. Preserving and restoring wetlands, together with other water retention, provide natural flood control and healthier waters.

[9] NYS DEC New York State Wetlands Assessment

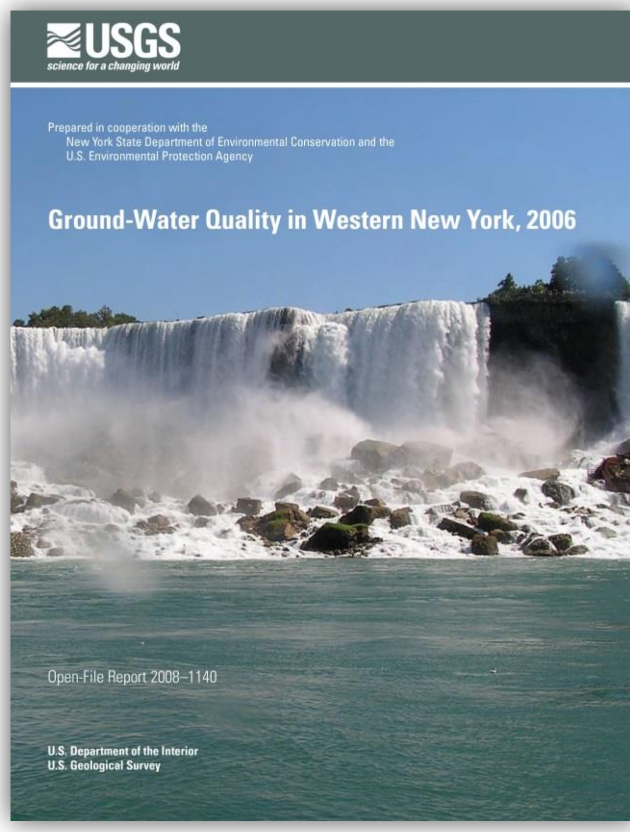
Smaller lakes and ponds within the watershed are monitored as part of the NYS WI/PWL, and drinking-water bodies are assessed by the NYS Department of Health's Source Waters Assessment Program (SWAP). The Niagara River/Lake Erie Watershed has 19 smaller lakes and reservoirs included in the NYS WI/PWL (See Table 4.3) of which Delaware Park Pond (Hoyt Lake), Green Lake, Hyde Park Lake, and Java Lake are the most degraded according to their use classifications, while Akron Reservoir, Moores Pond, Silver Creek Reservoir, Silver Lake have no known impacts. The causes for water quality impairments in the lakes, ponds, and reservoirs are very similar to the other primary watershed impairments, with data showing nutrient loading, low dissolved oxygen, and signs of eutrophication in addition to issues such as pathogens, toxic sediments, and silt/sediment.

So far, harmful algal blooms (HABs) have not played a substantial role in water quality impairments of these lakes and ponds. HABs occur when algae colonies release toxins that can have harmful effects on people, fish, mammals, and birds. With excessive or ongoing nutrient pollution, it could become a future issue. NYSDEC has a notification website where potential HABs can be reported.[10]

Groundwater Quality

In 2001, the U.S. Geological Service, in cooperation with the NYS DEC and the USEPA, began an assessment of ground water quality in NYS river basins (Ground-Water Quality in Western New York, 2006[11]). Water samples were taken from 7 production wells and 26 private residential wells across Western New York in 2006, with sixteen of the sampling wells located in the Niagara River/ Lake Erie Watershed. These samples were analyzed for five physical properties and 219 constituents that included inorganic major ions, nutrients, organic carbon, trace elements, radon-222, Volatile Organic Compounds (VOCs), phenolic compounds, pesticides, and bacteria. According to the 2006 Report, the quality of the ground water was generally considered acceptable, except where concentrations of some constituents

Figure 4.7: Ground-Water Quality in Western New York Report Cover



[10] https://www.dec.ny.gov/chemical/83310.html

[11] Eckhardt, D.A.V., Reddy, J.E., and Tamulonis, K.L., 2008, Ground-water quality in western New York, 2006: U.S. Geological Survey Open-File Report 2008–1140, 36 p., available online at http://pubs.usgs.gov/ofr/2008/1140

exceeded maximum USEPA and NYS DOH standards. The constituents exceeding standards in one or more wells were pH, sodium, chloride, sulfate, aluminum, arsenic, iron, lead, manganese, and radon-222. The report also indicates that 18 pesticides were detected in 14 of the 33 wells sampled, and 14 VOCs were detected in 12 samples, but neither of their concentrations exceeded regulatory thresholds. Total coliform bacteria were detected in 12 samples and *Escherichia coli* (*E. coli*) was detected in 2 samples. Any detection of these bacteria exceeds the NYS DOH standards.

NYSDEC and U. S. Geological Survey have partnered on 305(b) groundwater monitoring on a rotating basis. In a 2011 report, 31 wells were sampled including 6 of the same wells from the 2006 report. Sixteen of those 31 wells were in the Niagara River/Lake Erie Watershed. The results indicate that groundwater generally is of acceptable quality, although at 30 of wells, at least one of the following constituents was detected at a concentration that exceeded current or proposed Federal or New York State drinking-water standards: pH, sodium, sulfate, total dissolved solids, aluminum, arsenic, iron, manganese, radon-222, benzene, and total coliform bacteria. None of the pesticides analyzed exceeded existing drinking-water standards.[12]

Groundwater is also assessed on a site-by-site basis at inactive hazardous waste sites monitored by NYSDEC. Historic contamination from spills and dumping of industrial wastes commonly results in contamination of groundwater, which may then travel offsite in plumes and/or enter surface water and waterway sediments through river and stream banks. Groundwater recovery pumping systems are often used to reduce the migration of contaminants off-site and into waterways. Many environmental remediation projects are concentrated in urbanized areas including the cities of Buffalo, Dunkirk, Lackawanna, Lockport, Niagara Falls, North Tonawanda, and Tonawanda; the towns of Amherst, Cheektowaga, Lancaster, Lockport, Niagara, Orchard Park, Tonawanda, West Seneca, and Wheatfield; and the villages of Depew and Gowanda.[13]

It is also of note that groundwater from certain rock formations in the Niagara River/ Lake Erie Watershed naturally discharge methane. Especially in the southern portion of the Watershed, Devonian black shale deposits have methane that bubbles up from groundwater. This can be seen, for instance, at the Eternal Flame in Chestnut Ridge Park in Erie County, as well as other locations throughout the Watershed.[14] In some locations, the groundwater methane amount is over the 10mg/L action level for water wells set by the federal Office of Surface Mining, meaning the well should continue to be monitored. When levels reach 28 mg/L, the water is considered saturated with methane and as it is released in to the air, it can become explosive.

[12] Reddy, J.E., 2013, Groundwater quality in western New York, 2011: U.S. Geological Survey Open-File Report 2013–1095, 28 p., at http://pubs.usgs.gov/of/2013/1095

[13] http://www.dec.ny.gov/chemical/37554.html

[14] Dissolved methane in New York Groundwater, August 2012. https://pubs.usgs.gov/of/2012/1162/pdf/ofr2012-1162_508_09072012.pdf

Beach Water Quality Sampling

Chautauqua and Erie County Departments of Health, as well as NYS Parks, Recreation and Historic Preservation Department (NYS Parks) have beach sampling programs throughout the summer months to determine the water quality at bathing beaches for the purpose of protecting public health. These programs sample beaches for *E. coli* and results take 24-hours. Therefore closures are based upon the previous day's sample except in cases where rainfall amount, lake condition observations, or beach model results, if available, may indicate a need to close on a particular day.

Chautauqua County Department of Health monitored eight beaches in 2018; Town of Hanover, Sunset Bay Beach Club, Sheridan Bay Park, Wright Park East, Wright Park West, Main Street, Point Gratiot, and Blue Water Beach Campground Beaches, but only four of those beaches operated active swimming areas. Twelve notices of beach closures were made for a total of 12.32 days collectively based upon actual hours of operation lost. If there were multiple swim areas at a particular location and one notice was higher than the NYS Beach standard of 235 cfu/100ml, but another was below the standard, no notice was issued for the beach and swimmers were directed to the open swimming location. Wright Park East had the highest percentage of unsatisfactory monitoring results at 31.3% or 10 out of 32 samples.

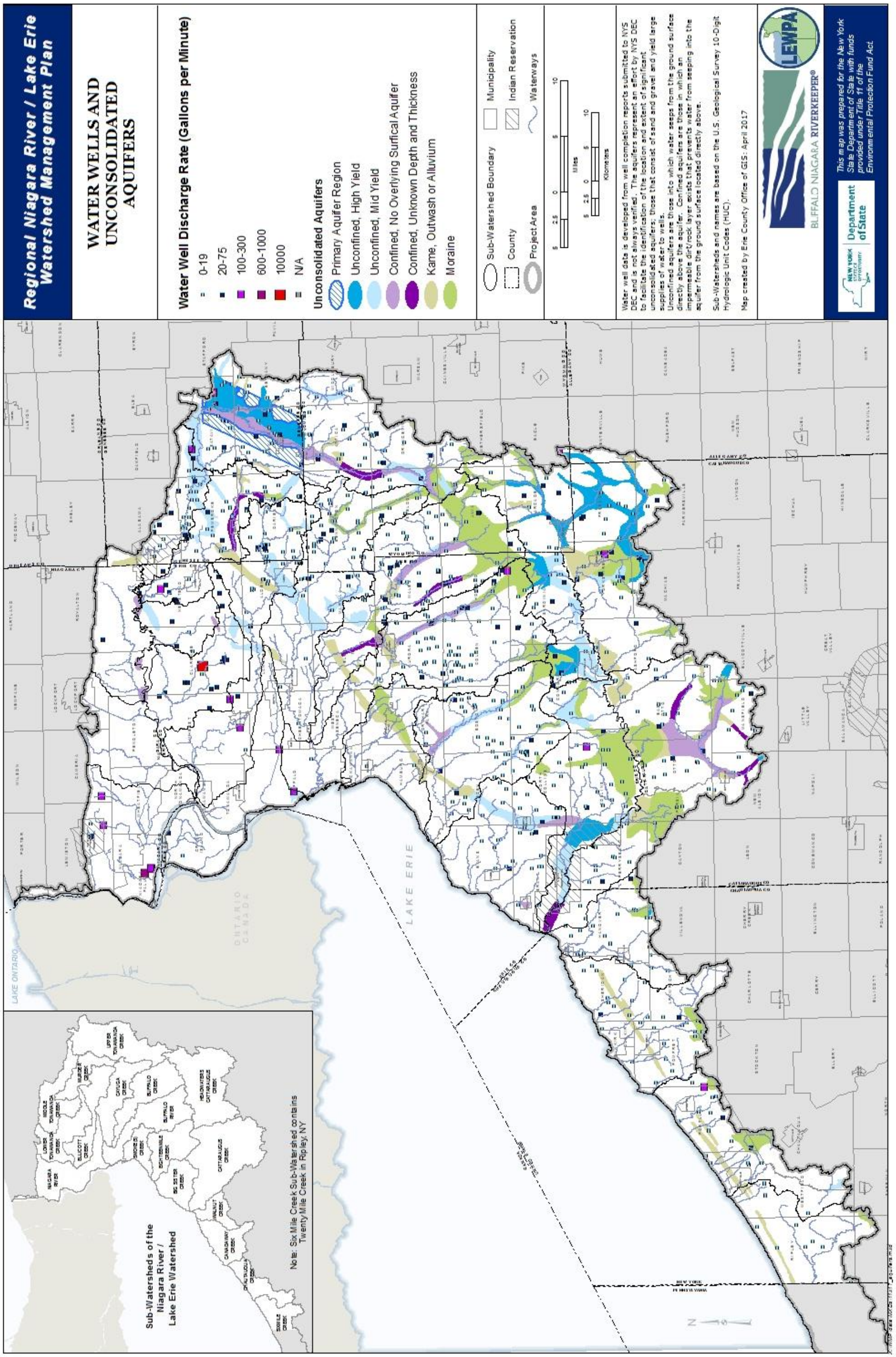
The Erie County Department of Health sampled five beaches in the 2018 season; Bennett Beach, Evans Town Park, Hamburg Beach, Lake Erie Beach, and Camp Pioneer. Thirteen percent of the samples for *E. coli* exceeded the standard of 235 cfu/100ml with Hamburg Beach having the highest number of exceedances (6). There were 38 closure notices issued, some for more than one day, resulting in 66 days of beach closures collectively. The longest closure lasted eight days. Hamburg Beach had both the highest number of closure notifications (14) and the highest number of days closed (19).

Finally NYS Parks sampled at three beaches in 2018; Evangola State Park Beach, Lake Erie State Park Beach, and Woodlawn Beach State Park. Woodlawn Beach had the highest number of closures at 22 based on a mixture of sample results, model prediction, and rainfall amounts.

Drinking Water Supplies

The largest water suppliers are the Erie County Water Authority (ECWA) and Buffalo Water Authority. As of 2016, the ECWA served 480,939 people in 35 municipalities in Erie, Genesee and Wyoming counties and the Buffalo Water Authority served 276,000 people within the City of Buffalo. Their water sources are from Lake Erie and the Niagara River. More information about these water supplies can be found in their most recent water quality reports that are included in the Appendices D and E. There are other smaller water treatment providers along Lake Erie and the Niagara River including the Ripley Water Filtration Plant, Westfield Water Treatment Plant, Brocton

Figure 4.8: Water Wells and Unconsolidated Aquifers in the Niagara River/Lake Erie Watershed



Filtration Plant, Dunkirk Water Treatment Plant, Fredonia Water Treatment Plant, Tonawanda, Water Treatment Plant, Grand Island Water Department, North Tonawanda Water Treatment Plant, and Niagara Falls Water Board.

Many of the rural communities and residents that are not supplied by these systems rely on ground water from bedrock or from surficial deposits of sand and gravel. Some smaller community water systems use surface water from small reservoirs or lakes, while others obtain water from bedrock wells. A map of the watershed's wells and aquifers is provided in Figure 4.8. Many rural residents have private wells. Shallow wells that tap sand and gravel aquifers are susceptible to contamination by several types of substances including volatile organic compounds, pesticides, deicing chemicals, and nutrients from nearby roads, and commercial, agricultural and residential areas. The movement of these contaminants to the water table can be relatively rapid. Bedrock wells in lowland areas with carbonate rock may be vulnerable to contamination from surface runoff. Aquifers can also contain elements such as sodium, chloride, methane, and radon gasses.

Areas of Concern (AOCs)

As mentioned previously, the Buffalo and Niagara Rivers each have areas designated as "Areas of Concern" due to the extent of their historical contamination. The U.S.-Canada Great Lakes Water Quality Agreement (Annex 2 of the 1987 Protocol) defines Areas of Concerns (AOC) as "geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area's ability to support aquatic life." In 1987, 43 Areas of Concern were identified throughout the Great Lakes Basin; 26 within the US, 12 within Canada, and 5 shared between the US and Canada. These areas were identified based on their impairments to fourteen listed Beneficial Uses and were required to develop and implement Remedial Action Plans (RAPs). A RAP is developed in three stages: Stage I identifies and assesses use impairments, and identifies the sources of the stresses from all media in the AOC; Stage II identifies proposed remedial actions and their method of implementation; and Stage III documents evidence that uses have been restored[15]. Areas of Concern are "delisted" when all Beneficial Use Impairments (BUIs) have been restored.

Buffalo River Area of Concern

The Buffalo River Area of Concern is located in the City of Buffalo, Erie County, NY. The AOC includes the lower 6.2 miles of the Buffalo River and the adjacent City Ship Canal. The River flows westerly through the City of Buffalo and discharges into Lake Erie near the head of the Niagara River.

[15] US EPA

The Buffalo River and City Ship Canal are man-made waterways which were created to allow for increased shipping and industrialization of the area. Industrial activities led to the contamination of river-bottom sediments, poor water quality, and degradation of nearby wildlife habitat.

The Buffalo River RAP was completed in 1989 by NYS Department of Environmental Conservation (NYSDEC) in partnership with a local citizen's advisory committee. The combined Stage I and Stage II RAP included a remediation strategy of stream water quality monitoring, contaminated bottom sediment assessment and action determination, inactive hazardous waste site remediation, point and nonpoint source discharge evaluation, combined sewer overflow assessment, remedial measure implementation monitoring, fish and wildlife beneficial use restoration, and habitat protection. Between 1989 and 2003, NYSDEC coordinated the Buffalo River Remedial Action Plan process. In October 2003, the USEPA Great Lakes National Program Office (GLNPO) selected Friends of the Buffalo Niagara Rivers (FBNR)[16] to take over coordination of the RAP. With the assistance of the Remedial Advisory Committee (RAC), NYSDEC, and over 30 other governmental and non-governmental agencies and organizations, Riverkeeper is working towards the goal of delisting the Buffalo River as an Area of Concern.

Currently, the Buffalo River has 9 of the 14 BUIs listed as Impaired[17] (Table 4.6). The main impairment causes are contaminated sediments, loss of wildlife habitat, and ongoing contamination from point and non-point source pollution.

Table 4.6 Buffalo River AOC Beneficial Use Impairments

Beneficial Use Impairment Indicator		Current Status	Known or Likely Cause of Impairment
1	Restrictions on Fish & Wildlife Consumption	Impaired	PCB's and Chlordane in sediments.
2	Tainting of Fish & Wildlife Flavor	Impaired	PAHs in sediments.
3	Degradation of Fish & Wildlife Populations	Impaired	Low dissolved oxygen, river channelization, and contaminated sediments.
4	Fish Tumors and Other Deformities	Impaired	Contaminated sediments and navigational dredging.
5	Bird or Animal Deformities or Reproductive Problems	Impaired	PCBs, DDT, and metabolites in sediments.
6	Degradation of Benthos	Impaired	Contaminated sediments and navigational dredging.
7	Restrictions on Dredging	Impaired	Various contaminants in sediments.

[16] FBNR changed its name in July 2005 to Buffalo Niagara RIVERKEEPER®.
[17] https://www.dec.ny.gov/lands/98943.html

8	Eutrophication or Undesirable Algae	Not Impaired	
9	Restrictions on Drinking Water	Not Applicable	
10	Beach Closings	Not Applicable	
11	Degradation of Aesthetics	Impaired	Floatables, debris and foul odor from CSOs and upper watershed.
12	Added Cost to Agriculture	Not Impaired	
13	Degradation of Phytoplankton or Zooplankton Populations	Not Impaired	
14	Loss of Fish & Wildlife Habitat	Impaired	Physical disturbance such as bulk heading, dredging and steep slopes, and lack of suitable substrate.

Work to remediate the contaminated sediment in the Buffalo River AOC began in August of 2011. Phase I (Navigational Dredging; August 2011 – January 2012) removed 550,000 cubic yards of sediment from the center channel of the river. This work was conducted by the US Army Corps of Engineers and funded ($4.6 million) by the Great Lakes Restoration Initiative. Phase II of the project began in October 2013 and was funded ($20 million) by the Great Lakes Legacy Act Program. Phase II dredged approximately 453,000 cubic yards of contaminated sediment from the side slopes of the River and capped approximately 9 acres in the City Ship Canal with 65,000 cubic yards of clean sediment[18]. Dredging was completed in 2014, leading to significant progress towards delisting 7 of the 9 Impaired Beneficial Uses.

Figure 4.9: Phase II of Buffalo River Dredging (2013)

Restoring fish and wildlife habitat is a critical step needed to delist the Buffalo River as an AOC. As part of the Great Lakes Legacy Act Project, five in-water sites were enhanced/restored with in-water plantings and the placement of in-water structures at Ohio Street, City Ship Canal, Katherine Street Peninsula, Buffalo Color Peninsula, and Riverbend. Erie County also received funding from USEPA to enhance shoreline and upland habitat at two of their Natural Habitat Parks on the River (Red Jacket Riverfront Park and Thomas Higgins Park). Although these habitat improvements are complete, it may take years before fish advisories are less restrictive.

[18] More information on the project can be found at www.buffaloriverrestoration.org

Niagara River Area of Concern

The Niagara River Area of Concern is a bi-national AOC. The New York State portion of the AOC is located in Erie and Niagara Counties and extends from the mouth of Smokes Creek at Lake Erie north to the mouth of the Niagara River at Lake Ontario. The Niagara River AOC experienced degradation due to contaminated discharges, shoreline alteration, habitat degradation and inputs from combined sewer overflows and other point and non-point source pollution.

NYSDEC applied a phased approach in the development of this RAP. In 1989, a group of interested citizens was appointed by New York State Department of Environmental Conservation (NYSDEC) as the Niagara River Remedial Action Committee to help develop the RAP. The committee comprised 26 environmental, industrial, sports people, academic, community and local government representatives. Committee representatives and NYSDEC staff created an Executive Committee that directed RAP development. The Executive Committee established RAP goals, mapped out a work plan, defined responsibilities and reviewed draft sections of the RAP. The RAP was completed in 1993 and published as final in 1994; it addresses problems, sources, existing remediation programs and recommends remedial strategies.

Currently, the Niagara River has 6 of the 14 BUIs listed as Impaired (Table 4.7). The main causes of these impairments are contaminated sediment, contamination from hazardous waste sites, and habitat loss. Ongoing water monitoring has shown a significant decrease in the River's contaminant levels since 1987. The improvement is mainly the result of government programs that now routinely address hazardous waste sites, maintain strict limits on pollutants in wastewater discharges, reduce the number of sewer overflows and enhance control of nonpoint source pollution.

Table 4.7 Niagara River AOC Beneficial Use Impairments

Beneficial Use Impairment Indicator		Current Status	Known or Likely Cause of Impairment
1	Restrictions on Fish & Wildlife Consumption	Impaired	Hazardous waste sites, contaminated sediment
2	Tainting of Fish & Wildlife Flavor	Not Impaired	
3	Degradation of Fish & Wildlife Populations	Impaired	Loss of habitat and contamination
4	Fish Tumors and Other Deformities	Not impaired	
5	Bird or Animal Deformities or Reproductive Problems	Impaired on U.S. side/ Not Impaired on Canadian side	Hazardous waste sites, contaminated sediment. The Canadian impairment was removed in 2009.
6	Degradation of Benthos	Impaired	Hazardous waste sites, contaminated

			sediment.
7	Restrictions on Dredging	Impaired on U.S. side/ Not Impaired on Canadian side	Hazardous waste sites, contaminated sediment. The Canadian impairment was removed in 2009.
8	Eutrophication or Undesirable Algae	Not Impaired	
9	Restrictions on Drinking Water	Not Impaired	
10	Beach Closings	Not Impaired on U.S. side/ Impaired on Canadian side	Bacteria
11	Degradation of Aesthetics	Not Impaired	
12	Added Cost to Agriculture	Not Impaired	
13	Degradation of Phytoplankton or Zooplankton Populations	Not Impaired	
14	Loss of Fish & Wildlife Habitat	Impaired	Bulkheading, filling, water diversion, marine development, etc.

A total of 44 hazardous waste sites were found to be potential sources for contaminant migration to the Niagara River. Thirty-seven of these sites are fully remediated. The remaining seven sites currently have remediation under way and only two of the sites continue to contribute pollutants to the Niagara River system. Projects to address contaminated sediment have been completed at 19 locations, resulting in the removal of over 500,000 cubic yards of contaminated material. NYSDEC, the U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, and U.S. Geological Survey are working together to evaluate and address remaining contaminated sediment in the River and tributaries (source areas). In 2014, the U.S. Environmental Protection Agency agreed to add portions of four tributaries (Smoke Creek, including the south branch, Scajaquada Creek, Cayuga Creek, and Gill Creek) to the Area of Concern to make them eligible for federal funding to address contaminated sediment under the Great Lakes Legacy Act. The U.S. Environmental Protection Agency is considering the addition of up to six additional tributaries that may also be sources of contaminants to the Niagara River. These include Two Mile Creek, Rattlesnake Creek, Lackawanna Ship Canal, Tonawanda Creek, Bergholtz Creek, and the Little Niagara River at Cayuga Island.

Other efforts have focused on the habitat loss and impacts to fish and wildlife. More than 40 habitat related projects are either completed or ongoing. These include eight habitat projects the New York Power Authority agreed to fund as a benefit of the 2007 Niagara Power Project relicensing. The Power Authority also agreed to provide additional funds for future projects. A regional commission has created a Greenway Plan to expand and enhance parks and conservation areas along the River, increasing public access for recreation.

The Canadian RAP is entering its final phase and is also working to delist this AOC. A bacteria track-down study completed in 2019 identified sources of bacteria that result in restrictions on swimming at one beach in the Canadian section of the AOC, and efforts are underway to design and plan implementation of remedial actions to address the issue. Future contaminant issues will be addressed through routine federal, provincial and municipal abatement and enforcement programs.

In addition, the agencies participating in the binational Niagara River Toxics Management Plan continue to monitor contaminant levels in the river in order to eventually delist the restrictions on fish consumption.

Binational Water Quality Reports

Under the Great Lakes Water Quality Agreement (GLWQA), the governments of Canada and the United States agreed to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem. Lakewide Action and Management Plans (LAMPs) for each lake are developed to identify actions required to restore and protect the lakes and evaluate the effectiveness of those actions.

The Binational Nutrient Management Strategy[19] was developed in 2011 as a coordinated and strategic response from Canada and the United States to outline nutrient management actions to reduce phosphorus loading and the eutrophication of Lake Erie. It required the development of Domestic Action Plans for reducing phosphorus loading by the province of Ontario and four states draining to Lake Erie. New York State is not required to develop a Domestic Action Plan for phosphorus at this point, however nutrient monitoring is underway.

The 2019-2023 Lake Erie LAMP is still under development. The 2018 Lake Erie LAMP Annual Report[20] by the Lake Erie Partnership describes the progress toward goals set forth in the previous LAMP and other binational reports. It includes not only the Lake Erie Watershed, but also the St. Clair River, Lake St. Clair, and the Detroit River watersheds, which drain into Lake Erie. The 2108 Annual Report focused on phosphorus entering Lake Erie including the development of the Domestic Action Plans for phosphorus. In addition, this Annual Report includes updates on the progress toward cleaning up Areas of Concern (AOC), including the Buffalo River AOC and Niagara River AOC.

[19] Lake Erie LAMP. 2011. Lake Erie Binational Nutrient Management Strategy: Protecting Lake Erie by Managing Phosphorus. Prepared by the Lake Erie LAMP Work Group Nutrient Management Task Group. https://www.epa.gov/sites/production/files/2015-09/documents/binational_nutrient_management.pdf

[20] https://binational.net/2019/03/21/lear2018/

The Lake Erie Biodiversity Conservation Strategy[21] is another binational initiative. It identifies specific strategies and actions for protecting the native biodiversity of Lake Erie with the goals of assembling available biodiversity information and defining a vision for its conservation and restoration, as well as describing the ways in which conservation strategies can benefit people through ecosystem services. The high priority critical threats in the eastern basin of Lake Erie are shoreline alternations, point and non-point source pollution, invasive species, development, climate change, and contaminated sediments.

The Niagara River portion of the Niagara River/Lake Erie Watershed is located in the Lake Ontario LAMP area since connecting channels have been designated by the U.S. Environmental Protection Agency to "belong" to the Great Lake watershed to which they drain. The draft 2018-2022 Lake Ontario Lakewide Action and Management Plan[22] is out for public comment. Lake Ontario is assessed to be in "fair" condition. As the most downstream of the Great Lakes, the majority of contaminants in Lake Ontario originate from upstream sources in Lake Erie and the Niagara River.

The Niagara River Toxics Management Plan is also being used to track the chemical loading on both ends of the Niagara River at Fort Erie and Niagara-on-the Lake. The overall goal is to achieve significant reductions in toxic contaminants in the Niagara River.

Fish Consumption

Figure 4.10: Fishing on Niagara River

Because of the industrial past of the Western New York region, fish consumption advisories exist throughout a large portion of the watershed today. The NYS Department of Health issues advisories with support from the NYS DEC who performs regular testing of fish species. Presently there are many local fish species on the advisories;[23] those specifically listed include Carp, Rock Bass, Yellow perch, Burbot, Channel catfish, White perch, White sucker, Lake trout, and Brown trout. However, there are several locations within the watershed where the Department of Health has advisories for "all other fish" as well, such as the Niagara River, Lewiston Reservoir, Delaware Park (Hoyt) Lake, Cayuga Creek (Niagara County), Buffalo River, City of Buffalo Inner and Outer Harbor, and portions

[21] https://binational.net//wp-content/uploads/2015/02/LakeErieBCSen.pdf
[22] Environment and Climate Change Canada and the U.S. Environmental Protection Agency. 2018. Lake Ontario Lakewide Action and Management Plan, 2018-2022. https://binational.net/wp-content/uploads/2019/04/2018-Lake-Ontario-For-Public-Comment-APRIL-2019.pdf
[23] https://www.health.ny.gov/publications/2792.pdf

of the Erie Canal. Contaminants of concern include PCBs, Dioxins and Mirex. Advisories caution that consumption be limited to either 1-4 meals/month or not at all, depending on your demographic, with the most restrictions provided for children under the age of 15 and women of child bearing years.

Unfortunately, many of Buffalo's immigrant and refugee populations often engage in subsistence fishing on the Buffalo and Niagara Rivers, unknowingly exposing themselves to toxic chemicals. Many of these people are uninformed about the potential health risks resulting from exposure to contaminants via the degraded waterway and fish consumption. To better inform these anglers in the City of Buffalo and regional anglers overall, Buffalo Niagara Riverkeeper, in partnership with Jericho Road Ministries, developed more accessible and easily understood versions of the New York State Fish Consumption Advisory, using more symbols and illustrations to convey information to non-English speakers. Also, pamphlets detailing the risk of consumption to mother and child are translated into several languages and presently given out at family clinics; informative and aesthetically pleasing posters are hung in doctor's offices; and, pocket-sized fishing guides, also translated into different languages, are given out at fishing sites. A fish consumption sign was also installed at Broderick Park. Despite these efforts, Riverkeeper has found that additional outreach is necessary to better inform and educate these vulnerable populations.

Causes & Contributors to Water Quality Impairments

According to the NYSDEC many of the watershed's Impacted Uses identified in the RIBS data are associated with a variety of point and non-point pollution sources, including combined and sanitary sewer overflows, stormwater runoff, and historic contamination. In addition, there are other new and emerging threats affecting the watershed at this time, such as climate change, ecosystem changes, pharmaceuticals and other man-made chemical compounds.

Types of Pollution

There are five main types of pollution affecting our waters; toxic, sediment, nutrient, bacterial, and thermal. *The Protecting Water Resources through Local Controls and Practices: An Assessment Manual for New York Municipalities*[24] outlines four of the pollution types as follows:

> Water pollution can be described as the introduction of substances into a body of water that adversely affects its quality or intended use. As direct (or "point source") pollution from sewage treatment plants and industry has decreased, attention has turned to other sources of water pollution. Non-point source pollution such as rainwater and snow melt running off of

[24] Prepared by Genesee/Finger Lakes Regional Planning Council (June 2006).

roofs, parking lots, streets, lawns, agricultural lands, and construction sites has significant impacts on water quality. Point sources of pollution can often be more easily monitored and regulated using existing technologies because the pollutants enter the environment at a specific location, whereas non-point sources are more difficult to evaluate and regulate because pollutants come from a broader area. Rain water flowing over land picks up a wide array of contaminants ranging from salt used for de-icing roads, leaked motor oil and gasoline on driveways and parking lots, agricultural and lawn chemicals, and large amounts of silt from construction sites. Streams, rivers, ponds, lakes and wetlands that are polluted by stormwater runoff can suffer from such effects as salinization (high levels of dissolved salts), eutrophication (excessive nutrient levels), and siltation (large deposits of silt), to name a few.

Pollutants can be classified as being toxic, sediment, nutrient, bacterial, or thermal.

Toxic pollution includes chemicals that poison and kill organisms. When high levels of toxins accumulate in fish tissue that threaten human health, advisories to limit consumption are issued, such as those mentioned earlier. Contaminated legacy sediments from past industrial activity and hazardous waste sites are a significant issue in our urban waterways, especially within the Areas of Concern. Examples of toxic pollutants include pesticides and herbicides; gasoline, oil, and other automotive chemicals; household cleaning products; paints and solvents; battery acid; and industrial chemicals and byproducts such as radioactive materials.

Sediment pollution includes soil, sand, silt, clay, and minerals eroded from the land surface and washed into water. Sediment is typically generated from areas with exposed soils. Without vegetative cover, rainwater flows quickly off land surfaces picking up soil particles, rather than slowly soaking into the ground. Hard surfaces such as roofs, streets, and parking lots prevent rain water from slowly soaking (infiltrating) into the ground. The resulting increase in water quantity and velocity can erode stream banks leading to further sedimentation. Sediment overload causes a number of problems for aquatic organisms by increasing turbidity and blocking light. Sediment also often picks up other forms of pollution such as toxins, nutrients, or bacteria.

Nutrient pollution results from an overabundance of substances such as nitrogen and phosphorus, and is often referred to as nutrient loading. Higher nutrient levels induce the prolific growth of aquatic plants and algae. When large quantities of algae die off, bacterial decomposition uses dissolved oxygen, depriving living organisms of the oxygen they need (aka. eutrophication). The depletion of oxygen also kills the small aquatic invertebrates consumed by fish. Higher nutrient levels from the fertilizing and growth of vegetation can also make swimming, boating, and fishing difficult. Sources of nutrient pollution can include sewage treatment plant discharges, leaking septic systems, industrial discharges, and agricultural and lawn/garden care fertilizers.

Bacterial pollution occurs when an excess of harmful bacteria is present. This can cause sickness or be lethal to animals and humans that consume contaminated water. Sources of bacterial pollution include combined sewage overflows, sanitary sewer overflows, failing septic systems, leaking sanitary sewer infrastructure, and animal or wildlife wastes.

In addition to toxic, sediment, nutrient, and bacterial pollution types outlined in the Genesee/Finger Lakes Regional Planning Council Guide, thermal pollution should also be considered a major pollution type within the Niagara River Watershed. Thermal pollution is defined as the degradation of water quality by any process that changes ambient water temperature. Water temperature can be affected by many things, including natural influences and man-made influences. For example, a stream corridor's lack of overhanging trees and vegetation would be considered a natural heating process, as exposure to sunlight is causing a thermal increase in the stream. Man-made influences can include power plants and other manufacturing processes where high water volumes of heated water are discharged into a waterway.

Thermal pollution can have a negative effect on aquatic species including fish, amphibians, and macroinvertebrates by altering their metabolic rates, reducing the amount of dissolved oxygen, and increasing bacterial levels. Dissolved oxygen levels also have a direct effect on the frequency and extent of algal blooms, further impacting water ecosystems. Even with minor temperature changes, stream corridors can go from habitable to inhabitable for certain species, such as Brook Trout, Brown Trout, and Salmon.

SPDES Facilities & Other Permitted Discharges

Point source pollution comes from facilities and infrastructure that discharge directly into streams and water bodies. In the Niagara River/Lake Erie Watershed, these include National Pollution Discharge Elimination System (NPDES) permitted facilities; State Pollution Discharge Elimination Systems (SPDES) permitted facilities, Combined Sewer Overflows (CSOs), Sanitary Sewer

SPDES facilities can contribute toxic, sediment, nutrient, bacterial, and thermal pollution depending on the type of facility discharging.

Figure 4.11: State Pollutant Discharge Elimination System locations

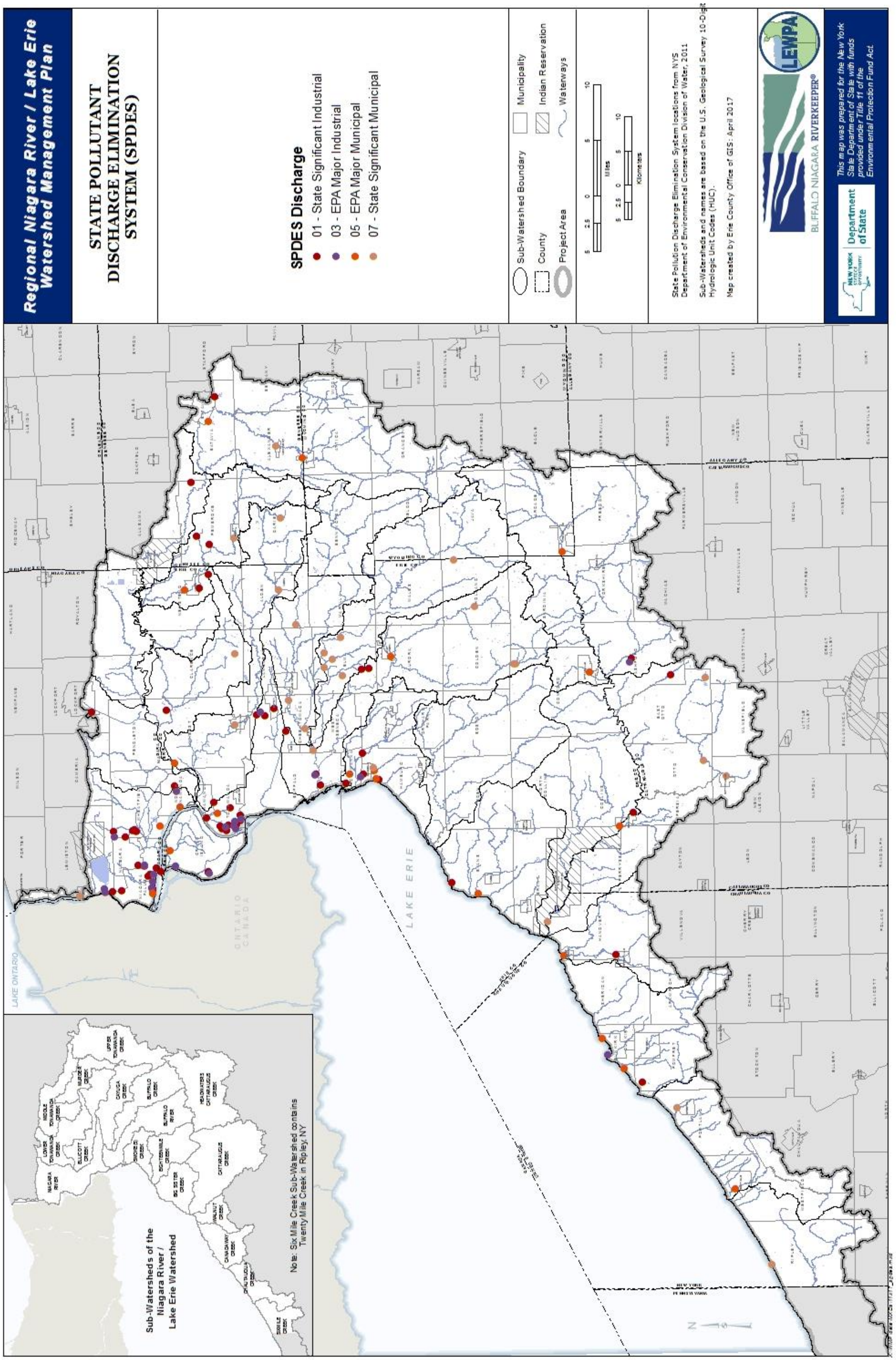


Figure 4.12: Environmental Protection Agency Regulated Facilities (1 of 2)

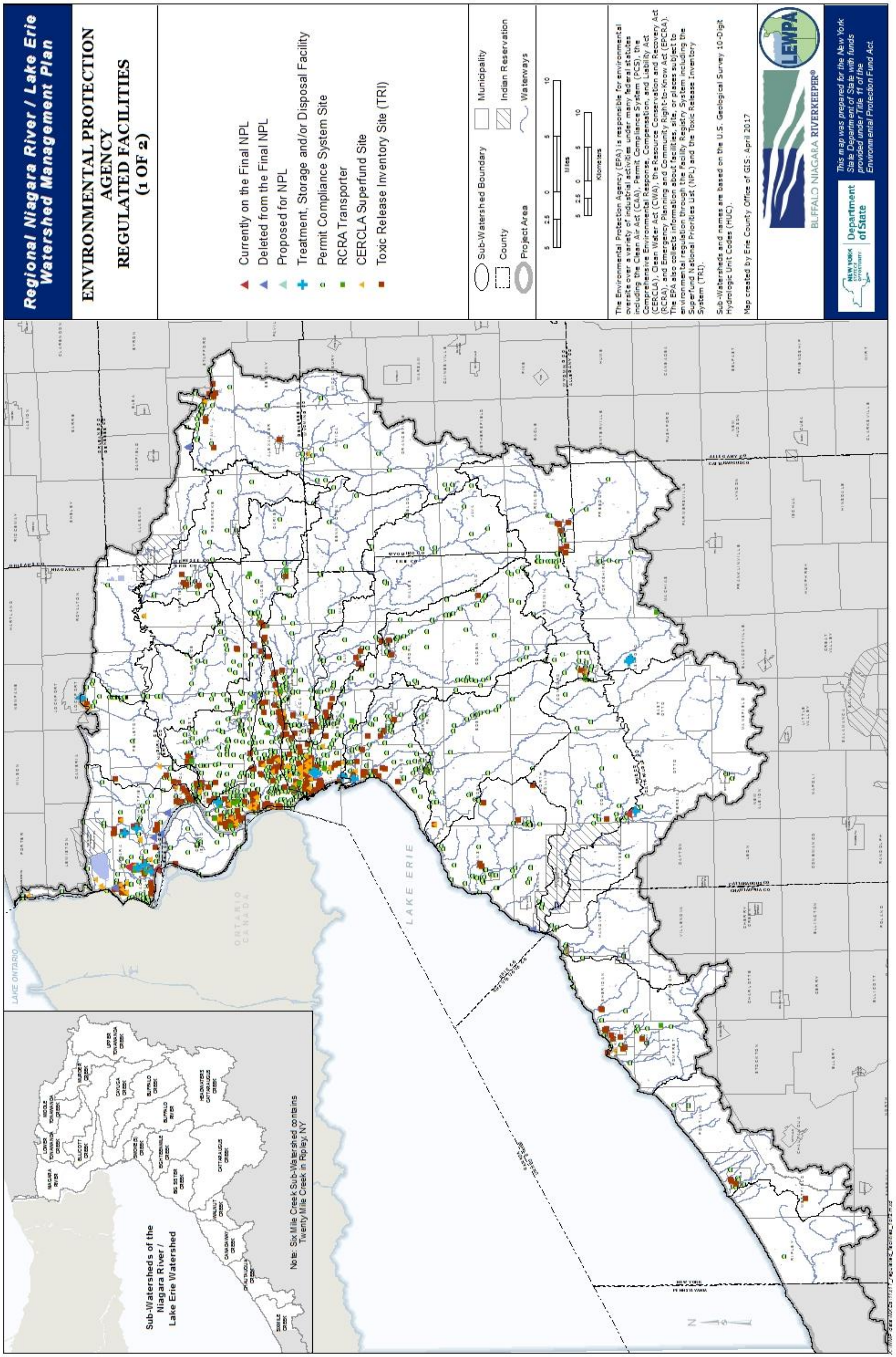
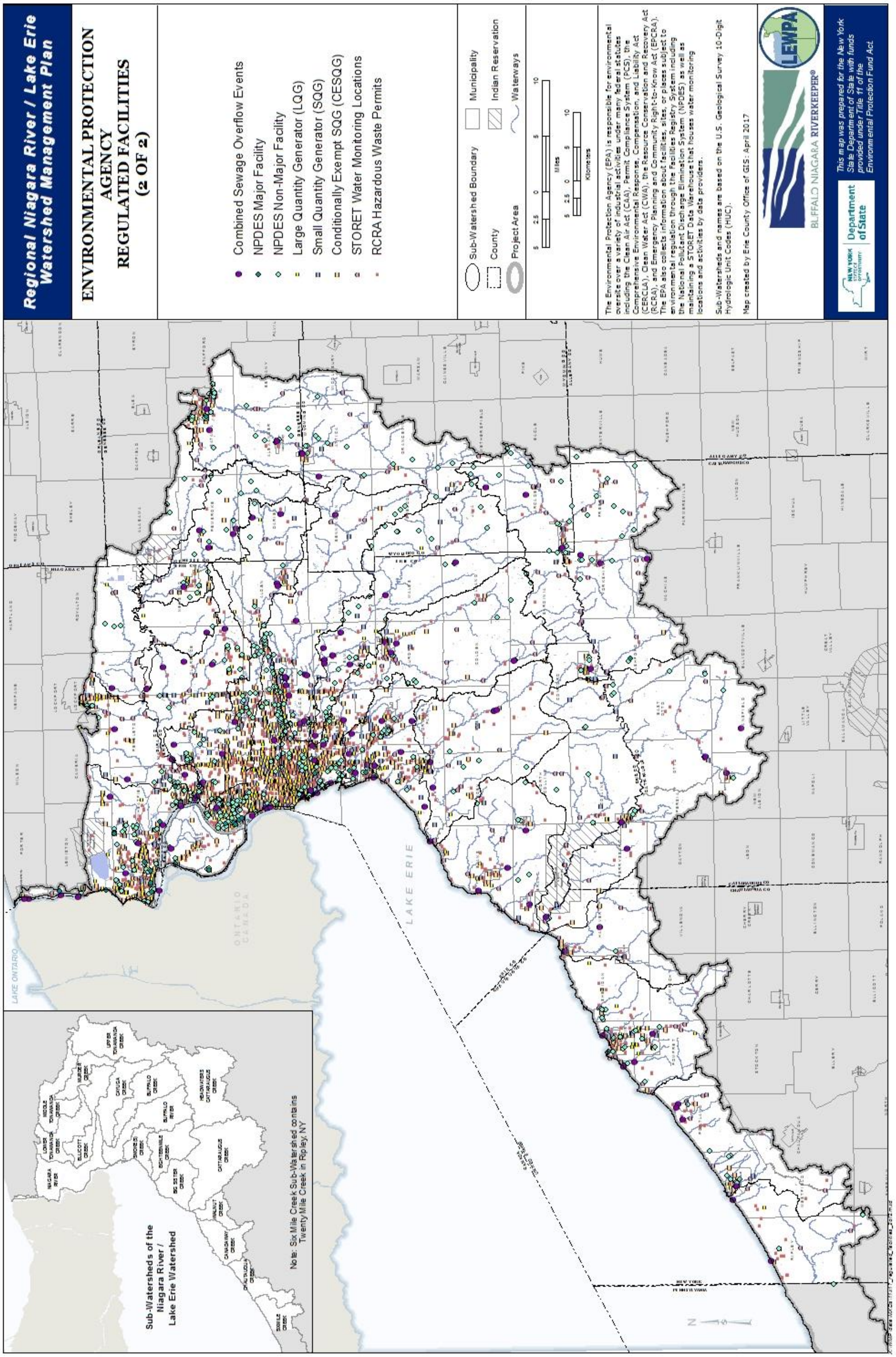


Figure 4.13: Environmental Protection Agency Regulated Facilities (2 of 2)



Overflows (SSOs), and Municipal Separate Storm Sewer Systems (MS4s).

All of these point source discharges are regulated as part of the Clean Water Act. New York State's SPDES permitting program administers all the NPDES permitting in the state and is currently broader in scope than required by the Clean Water Act, in that it controls point source discharges to ground waters, as well as surface waters. The dataset for SPDES and NPDES from NYSDEC identifies 725 permitted facilities (points) within the Niagara River/ Lake Erie Watershed. All of these facilities are provided in Figures 4.11, 4.12, and 4.13.

NYS's SPDES Program does have General Permits in place for the following activities:

- Multi-Sector General Permit (stormwater discharges from industrial activity)
- Aquatic Pesticides
- Private/Commercial/Institutional (to groundwater, 1,000 – 10,000 gpd)
- Concentrated Animal Feeding Operations (Medium or Large)
- Construction
- Vessels

Combined Sewer Overflow Systems (CSOs), Sanitary Sewer Overflows (SSOs), and Municipal Separate Storm Sewer Systems (MS4s) are discussed in detail on the following pages. The remaining facilities making up NPDES and SPDES permitted facilities include industrial operations, food processing plants, private sewer districts, and power generation facilities, to name a few. The discharges released by these types of facilities can include untreated waters that have such things as heavy metals, chemical compounds, food wastes and bi-products in them as long as the levels fall below permitted amounts. Some permits require waters to be pre-treated prior to release, but again the amount of contaminants must remain within allowable levels, as dictated by state regulations.

CSOs contribute toxic, sediment, nutrient and bacterial pollution.

Combined Sewer Overflows (CSOs)

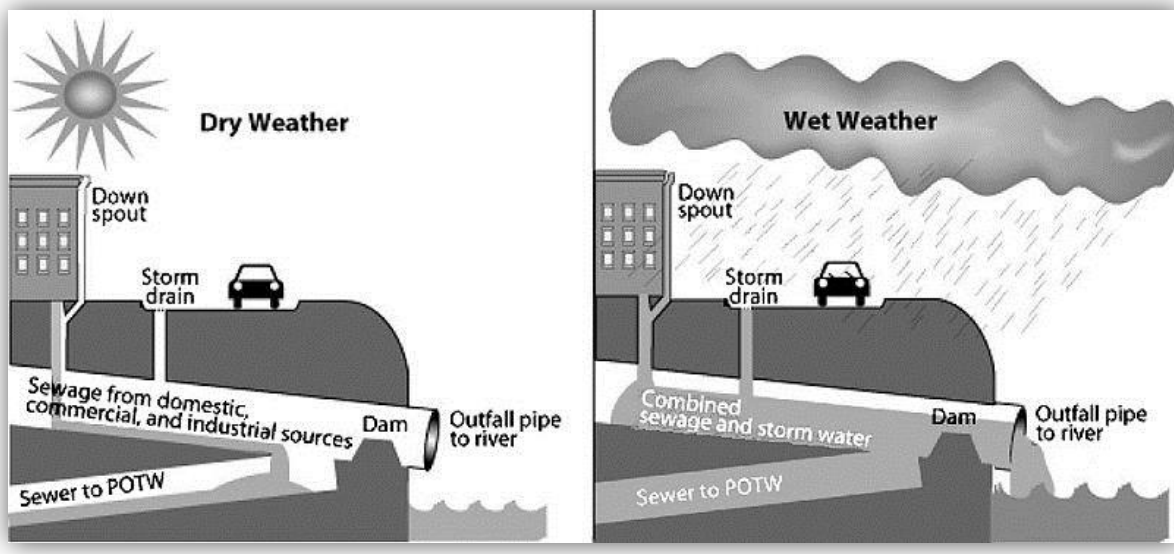
Combined Sewer Systems are conveyance systems that are designed to collect stormwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of the wastewater to a sewage treatment plant, where it is treated before being discharged to a local waterbody.

However, during periods of heavy rainfall or snowmelt, the total water volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. In this instance, CSOs will overflow and discharge untreated or partially treated water directly into streams, rivers, or other waterbodies in order to prevent basement back-ups and flooding (Figure 4.10).

These systems contribute to water quality issues when they overflow. Types of pollutants that can empty into local water bodies from combined sewer system overflow events are:

- Untreated human waste, which can host *E. coli* and Botulism (Type C) bacteria;
- Industrial waste;
- Litter and trash;
- Sediment and debris;
- Toxic pollutants from fertilizers and pesticides.

Figure 4.14 Combined Sewer System Outfalls in Dry and Wet Weather



Source: US EPA

In the Niagara River Lake Erie Watershed, five communities have Combined Sewer Systems: The cities of Buffalo, Dunkirk, Lockport, North Tonawanda, and Niagara Falls, the Town of Lewiston, and the Village of Lewiston.

Combined sewer overflows are regulated as point sources of pollution by the New York State Department of Environmental Conservation. The Buffalo Sewer Authority manages the largest CSO system in the watershed, having 790 miles of combined sewer lines and 52 permitted outfalls. The NYSDEC and the U.S. Environmental Protection Agency accepted Buffalo Sewer Authority's Long Term Control Plan in March 2014 through an Administrative Order. The Plan consists of green, smart, and grey infrastructure solutions and is expected to have a major positive impact on water quality in the Niagara River/Lake Erie watershed as it is implemented over 20 years.

The Buffalo system overflows into the Niagara River and four of its tributaries: the Buffalo River, the Black Rock Canal, Scajaquada Creek, and Cazenovia Creek. When implemented, the Plan is expected to reduce annual CSO volume activations from 41-69 per waterway to 2-9 per waterway and increase the wet weather flow percent capture from 91.3% to 97.4%. Buffalo Sewer Authority has already completed four Smart Sewer projects, which maximize usage of existing storage capacity in the collection system and have captured over 1,000 acres of stormwater runoff through the use of green infrastructure.

The City of Niagara Falls has significantly fewer combined sewer overflow points than the City of Buffalo, six in total. The Niagara Falls CSOs are owned and operated by the Niagara Falls Water Board, a separate water-sewer utility entity. All of the CSOs discharge to the Niagara Gorge. Several high-profile discharges have occurred recently into the Niagara River. The Water Board suspects that groundwater is infiltrating the system via cracked pipes and deteriorated pipe connections, adding to the amount of rainfall entering the system and overall number of overflow events. The Water Board is under a consent order from the NYSDEC as of December 2017. The State is contributing $20 million and the Water Board is contributing $13.5 million toward upgrades to the treatment plant.

Figure 4.15: Combined Sewer Outfall, Cazenovia Creek

The City of Lockport is divided by the Niagara Escarpment, the northern boundary of the watershed, meaning a portion of its infrastructure is located outside of the watershed, including the wastewater treatment plant. In addition, only a portion of the City of Lockport's sewer system is a combined system (approximately 30%). The city currently has 10 CSOs, 7 of which are located in the watershed. There are plans in the engineering stages to close several of the CSOs.

The City of North Tonawanda's combined sewer system includes 5 CSOs, all of which discharge to the Niagara River. The city typically only utilizes the CSOs, or old bypasses as they are referred to, during major residential flooding events, which has been few times per year, typically during snow melt or heavy rains.

The City of Dunkirk Waste Water Treatment Plant has one CSO. Any overflow is dosed with chlorine at the plant before an overflow event. Repairs and upgrades are underway at the plant to increase capacity in preparation for the new Athenex facility in Dunkirk. There are temporarily more CSO events occurring during this construction period as portions of the plant are taken offline for repair, but that is expected to decrease once construction is complete.

There are also two CSOs located in the Village and Town of Lewiston, both discharging to the lower Niagara River, one of which is near the Stella Niagara property. These each see several overflows per year based upon the intensity of rainfall or snow melt events.

SSOs contribute toxic, sediment, nutrient and bacterial pollution.

Sanitary Sewer Overflows (SSOs)

Sanitary Sewer Overflows (SSOs) fulfill a similar purpose to Combined Sewer Overflows. However, sanitary sewer systems are designed to carry domestic sanitary sewage, but not stormwater. System blockages, groundwater and stormwater infiltration into sewage pipes, or infrastructure problems can result in sanitary sewage overflow events into local waterways.

New York State has a Sewage Pollution Right to Know Law that requires treatment plants and sewer systems to publically disclose discharges. This includes sanitary sewer overflows and discharges from one sewer system to another. For instance, the Village of Kenmore does not discharge to any waterbodies, but empties to the Town of Tonawanda sewer system. There are multiple connection points and thus, many notifications are generated during each storm event. According to reporting to NYSDEC, approximately 1,710 overflow events occurred between June 13, 2018 and May 31, 2019. The volumes discharged are mostly estimated and mostly due to storm events causing infiltration into the system, although in some cases there may be a blockage, pipe breakage, illicit tie-in, or other issue with the system. Of these reported incidents, the top five communities with discharges during this timeframe are as follows:

1. Village of Kenmore = 657 reports
2. Town of Cheektowaga = 274 reports
3. City of Niagara Falls = 168 reports
4. Town of West Seneca = 160 reports
5. Town of Tonawanda = 155 reports

In this same data set where the receiving waters of the discharge were noted, Two Mile Creek was the most reported. The Village of Kenmore reports this as the discharge waterway, but the flow from Kenmore enters the Town of Tonawanda for treatment and there are fewer reports of discharges to Two Mile Creek from the Town of Tonawanda. Cazenovia Creek, Scajaquada Creek, Niagara River, and Ellicott Creek receive the most discharges in that order. In the majority of cases heavy rain events were cited as the cause, meaning old, cracked or broken infrastructure is receiving stormwater and groundwater inflows that contribute to the need to open a SSO pipe rather than inundate the wastewater treatment plants. Funding for infrastructure upgrades is critical in the Watershed, especially in older urban areas where pipes may be in a state of disrepair.

Many communities in the watershed have taken steps to identify where their inflow problems are and address them slowly with infrastructure upgrades as municipal budgets allow. However, there are some communities, such as Cheektowaga, where some of the issues may stem from poor private connections to the public sewer and with a lower-income tax base there is little desire to force tax payers to bear the burden of fixing it. In order for the SSO situation to improve at a faster rate, innovative funding mechanisms should be identified and implemented.

Stormwater Infrastructure and Municipal Separate Storm Sewer Systems

As mentioned in Chapter 2, stormwater infrastructure and Municipal Separate Storm Sewer Systems (MS4s) are a conveyance network of pipes, culverts and ditches that transport stormwater into retention ponds or area waterways. Stormwater infrastructure is the primary collector of non-point source pollution, as stormwater run-off typically picks up roadway contaminants, sediments, animal wastes, fertilizers and pesticides, and litter, amongst other things. Unlike combined sewer systems, where stormwater has the opportunity to be treated at a waste water treatment plant prior to release, stormwater conveyed through separated infrastructure is not treated.

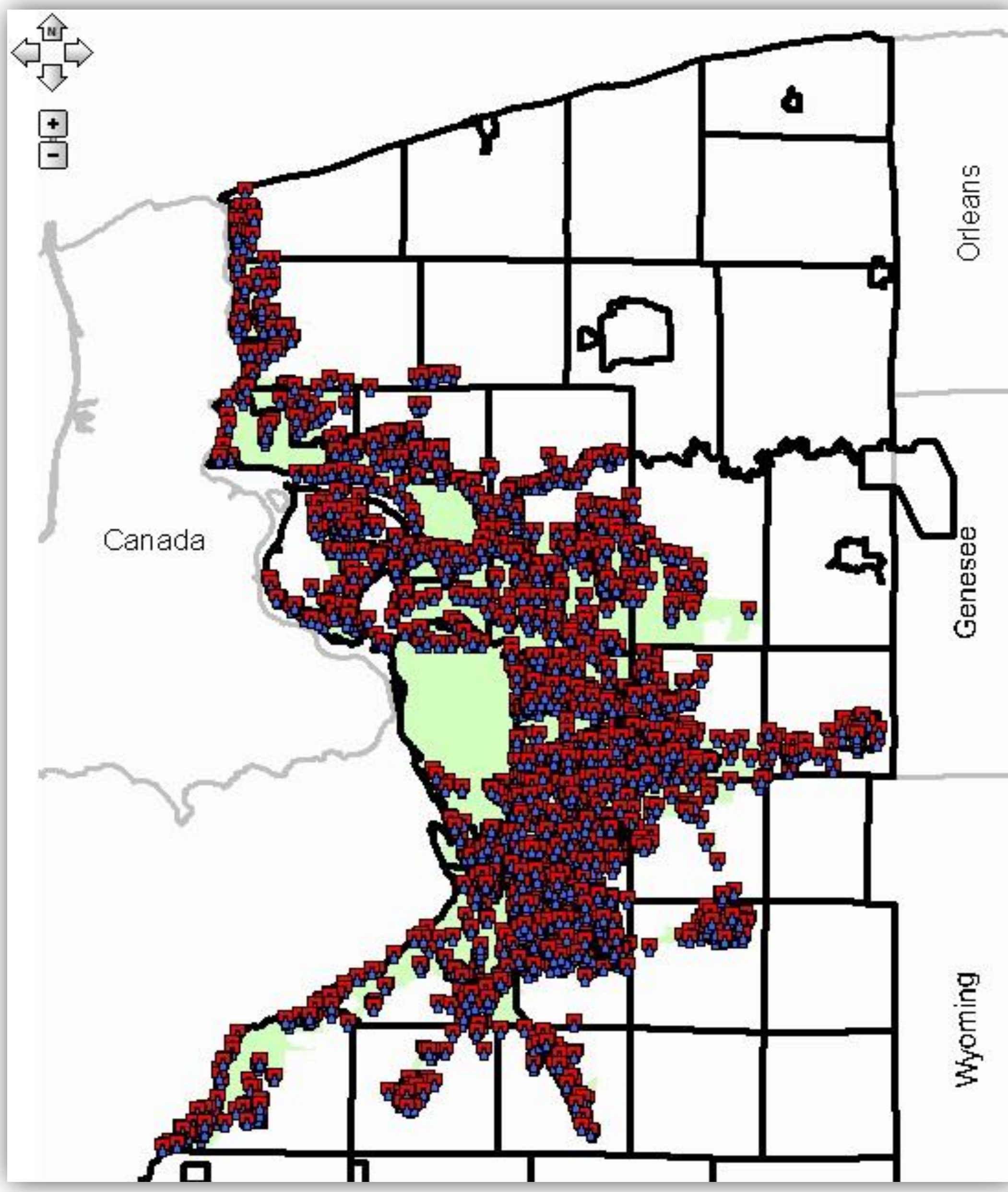
Urban and Rural Stormwater Runoff contribute sediment, nutrient, bacterial and thermal pollution to the watershed.

Water quality impacts from stormwater runoff can be significant with multiple impacts on water quality and aquatic life. Many rivers, streams and lakes are impaired and degraded due to polluted stormwater runoff. Nutrients such as phosphorus and nitrogen can cause the overgrowth of algae resulting in waterway oxygen depletion once those organisms start to die off. Toxic substances from motor vehicles and careless application of pesticides and fertilizers threaten water quality and can kill fish and other aquatic life. Bacteria from animal wastes and improper connections to storm sewer systems can make lakes and waterways unsafe for recreation and fish consumption. Eroded soil is a pollutant that clouds the waterway and interferes with the habitat of fish and plant life.

Figure 4.16: Example of MS4 Pollution

All areas of the watershed have some form of stormwater infrastructure. In more urban areas, stormwater infrastructure may be fully underground, with storm drains and pipes. In rural communities much of the stormwater network is made up of roadside ditches and retention ponds.

Figure 4.17 WNY Stormwater Coalition Outfall Locator



Suburban municipalities usually include a mixture of both types of infrastructure. The WNY Stormwater Coalition has undertaken a major mapping effort to document the stormwater infrastructure, their flow directions, and outfall locations in order to better plan and maintain this infrastructure in MS4 regulated communities. Figure 4.17 outlines the MS4 outfall locations in the watershed as documented by the WNY Stormwater Coalition[25]. Maps have been provided to MS4 communities in order to better track down contaminants and maintain stormwater infrastructure in the Watershed. More information on MS4s can be found in Chapter 2.

Increasing development and higher levels of impervious cover (as found in high-density urban areas), contribute more and more stormwater into these conveyance systems, reducing the ability for rain water and snow melt to be filtered and cleaned through groundwater infiltration because most of this infrastructure is designed to move stormwater quickly and without treatment to our waterways. Poor design can create channelized stormwater routes that funnel water rapidly to waterways causing flash flooding or intense erosion points. Un-vegetated ditches or steep slopes in ditches without check dams can direct sediment to waterways, which is a major pollutant. This redirect of waters decreases base flow in headwater streams, which often results in negative impacts on channel stability and the health of aquatic biological communities. Common problems include bank scouring and erosion, increased downstream flooding, and loss of in-stream habitat for macroinvertebrates, fish, and other organisms.

As regulatory requirements have increased for MS4 communities subject to NPDES permitting, there has been increasing interest in evolving MS4 infrastructure into "greener" systems. Opportunities exist with stormwater system designs to build in natural green infrastructure that can capture, store, and filter stormwater prior to its direct release into area waterways. In communities around the country, wetlands are being constructed as a means to filter stormwater prior to discharge into drinking water bodies. The Town of Aurora has begun considering roadside ditches and discussing best management practices with neighboring landowners as a means to reduce sediment erosion and improve filtering opportunities. In order to affect the volume of stormwater entering our waterways, as well as its quality, efforts should be undertaken to improve MS4 design and maintenance practices in the watershed to improve their support of water quality (i.e. natural filtration, buffering, reduced erosion, and increased infiltration).

Transportation Infrastructure Impacts

In addition to stormwater infrastructure along transportation infrastructure, such as ditches, road and railway bridges over waterways can cause water quality impacts. Poor culvert placement or undersized culverts can create a raised step on a waterway creating barriers to fish migration, breaking stream connectivity, and stranding aquatic life. Raised culverts can also cause erosion and pooling at the base. A crucial area of interference is the intersection of a waterway by a roadway. Without careful design, bridge abutments change the geometry of the stream bed and floodplain. They can constrict the channel, increase velocity, and cause scour around the abutments weakening the bridge's structural integrity and causing sediment to enter the waterway.

[25] http://gis2.erie.gov/HTML5/ENSSO/PublicLaunchPage.aspx

Well-designed bridges should span the entire waterway without disturbing or altering the waterway bed or banks. Culvert bottoms should be placed below the stream bed to allow for gravel substrate as aquatic habitat to continue upstream without large steps. Roadside maintenance practices are a potential source of contamination from bridge washing/ painting and can often aid the spread of invasive species as well, when groundcover is disturbed.

The North Atlantic Aquatic Connectivity Collaborative has developed common protocols to assess culverts for fish passability. It has recently been adopted locally by agencies such as U.S. Fish and Wildlife, Buffalo Niagara Riverkeeper, and local Soil & Water Conservation Districts who are assessing culverts and adding the information to the nationwide database. This information can be used by highway departments as they replace old culverts to ensure they are the correct size and placement for fish habitat. In many cases, upsizing culverts for fish passage may increase resiliency to storm impacts by allowing for more storm volume to pass through previously constricting culverts. This can reduce the number of road wash-outs as the intensity of storms increases. It is important to note that in a few cases, perched culverts may be acceptable to stop the spread of steelhead from impacting native brook trout population upstream. These are considered low priority for replacement as a result.

In addition, transportation infrastructure can contribute water quality pollution to the watershed as a result of salt application and other de-icing materials used to keep roadways safe. Both roads and airports use de-icing materials to prevent the formation of ice on surfaces, including airplanes, during the winter. Snowmelt and spring rains can cause salt and other pollutants to enter nearby waterways. Current water quality monitoring underway in the watershed measures specific conductivity. The higher the specific conductance, the more ions and/or inorganic materials dissolved in the water causing electricity to be conducted. If the results come back elevated, plans are in place to track down potential sources of ions or inorganic materials, which can include de-icing materials.

Agricultural Operations

Agriculture Districts are located throughout the Watershed for the purpose of promoting the continued use of farmland for agricultural production. Benefits include partial real property tax relief and protections against overly restrictive local laws, government funded acquisition or construction projects, and private nuisance suits involving agricultural practices.[26] For example, local laws requiring buffers or setbacks, constructing fences, and otherwise restricting land used for agricultural purposes are generally considered unreasonably restrictive.[27] Therefore, it can be difficult to require farmers to maintain buffers for water quality purposes.

[26] New York State Agriculture and Markets website https://www.agriculture.ny.gov/ap/agservices/agdistricts.html
[27] https://www.agriculture.ny.gov/AP/agservices/guidancedocuments/305-aZoningGuidelines.pdf

Agricultural Operations can impact neighboring waters in numerous ways. The 2000 National Water Quality Inventory reported that agricultural non-point source pollution is the leading source of water quality impacts on surveyed lakes and rivers, the second largest impairment to wetlands, and a major contributor to contamination of surveyed estuaries and groundwater. In the Niagara River/ Lake Erie Watershed, three of the 18 sub-watersheds have over 30% of their land use in agriculture, with another eight hosting 20-29%, and the last seven less than 19%.

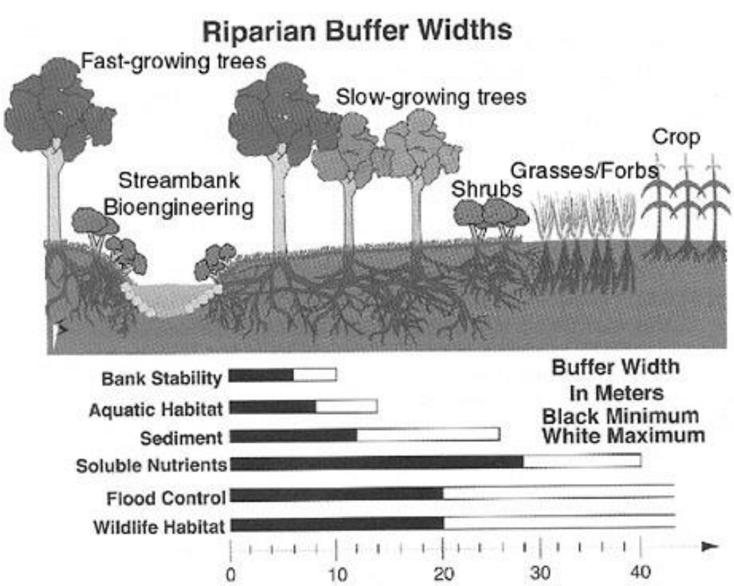
Table 4.8 Percentage of Agricultural Land Use by Sub-Watershed

Sub-watershed	% Land Use for Agriculture
Smoke(s) Creek	1%
Buffalo River	7%
Ellicott Creek	7%
Niagara River	8%
Lower Tonawanda Creek	12%
Walnut Creek	16%
Big Sister Creek	19%
Eighteenmile Creek	20%
Canadaway Creek	25%
Chautauqua Creek	25%
Cattaraugus Creek	26%
Headwaters Cattaraugus Creek	26%
Cayuga Creek	28%
Middle Tonawanda Creek	29%
Murder Creek	29%
Sixmile Creek	34%
Buffalo Creek	35%
Upper Tonawanda Creek	40%

Non-point source pollution stemming from farms and farming practices can include:

- Erosion and sedimentation from farm fields, irrigation channels and over-grazing;
- Streambank erosion and instability caused by encroachment of fields & pastures into riparian areas.
- Toxins and nutrient loading from improper pesticide and fertilizer use; and,
- Pathogens and bacteria, like E-coli, from poor animal waste management practices or allowing animals to wade in streams.

Figure 4.18: Optimal Riparian Buffer Widths

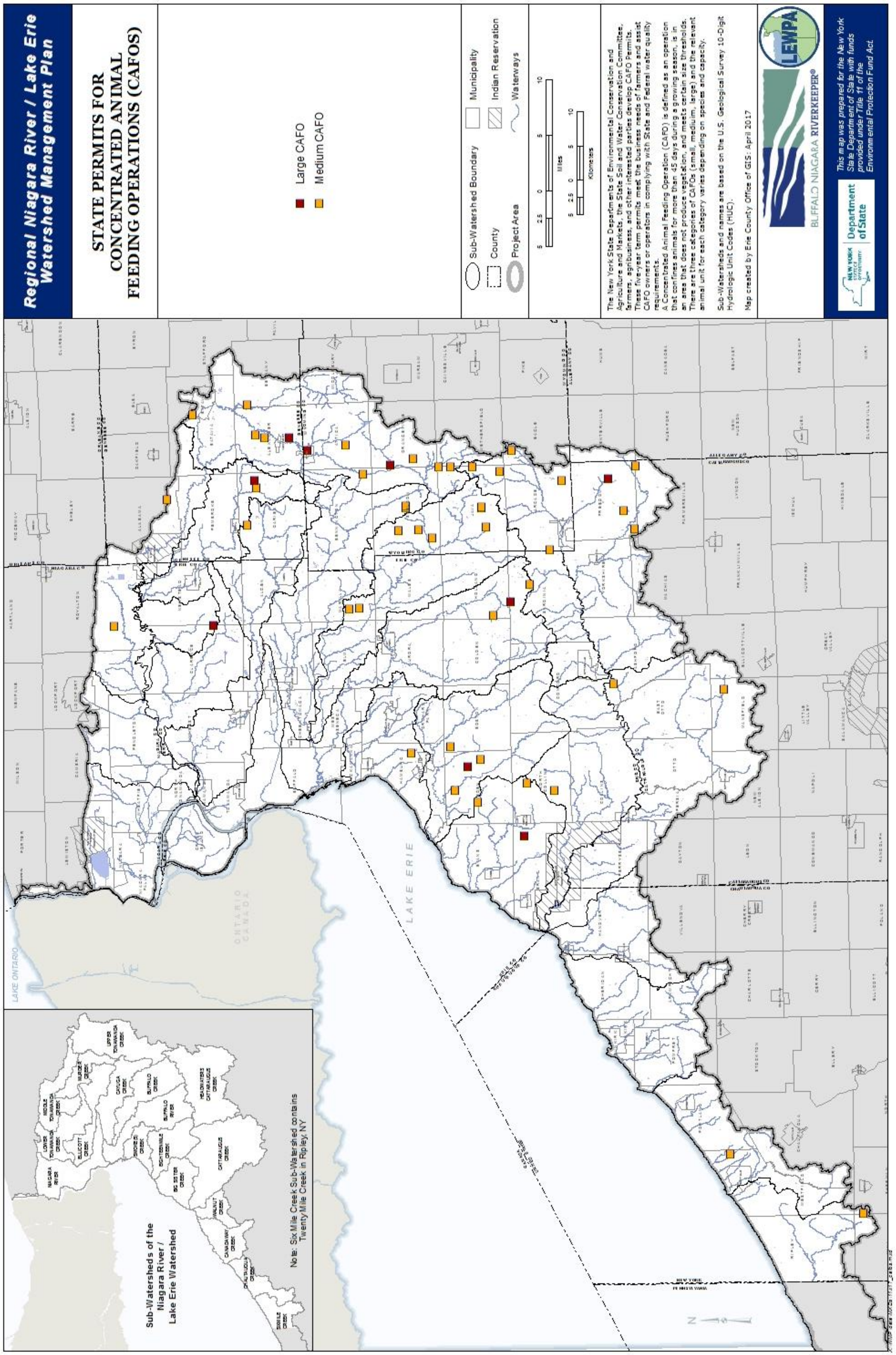


Source: The National Academies Press

Many of these causes of non-point source pollution stemming from farms can be alleviated or greatly reduced by improving farm layout and design, providing outreach and education on best management practices, as well as technical & financial assistance to install BMPs and implement management changes on farms, much of which is done by the U.S. Department of Agriculture National Resources Conservation Service and county Soil and Water Conservation Districts.

For example, maintaining a forested

Figure 4.19: Concentrated Animal Feeding Operations in Niagara River/Lake Erie Watershed



buffer of ideally 300 feet or 100 meters along a waterway can create valuable services that address the issues discussed above such as, intercepting excess nutrients, bacteria, and other pollutants, as well as minimizing erosion of streambanks by holding sediment in place and preventing animals from wading into the water. In addition forested buffers provide additional ecosystem services like controlling stream temperature for aquatic species, provide food and habitat for wildlife, allow for movement of wildlife along connected corridors, and reduce downstream flooding. Even if there is not space for a 300 foot buffer, any vegetated buffer of at least 15 feet will have some of these benefits.[28]

Agricultural Operations can contribute sediment, nutrient, bacterial, and toxic pollution to the watershed.

As part of the Clean Water Act, the U.S. Environmental Protection Agency regulates farms of a certain size, which are referred to as Consolidated Animal Feeding Operations (CAFOs) and considered a source of point source pollution. For more than 40 years, the Clean Water Act has enacted statutes, regulations and performance standards for CAFOs. NYSDEC currently regulates CAFOs under its authority as part of the State Pollution Discharge Elimination System (SPDES). Farms that are classified as a CAFO, operate under a SPDES permit that requires the farm to develop and fully implement a Comprehensive Nutrient Management Plan (CNMP) to reduce impacts to the environment. Figure 4.19 documents the large and medium-sized CAFOs in the watershed.

Animal feeding operations (AFOs) that do not meet the CAFO criteria can still complete CNMPs voluntarily with the help of county Soil and Water Conservation Districts as part of the Agricultural Environmental Management Program (AEM) or through the U. S. Department of Agriculture Natural Resources Conservation Service's Environmental Quality Incentives Program. It is estimated that over 13,000 farms in NYS participate in the AEM, however many small to medium sized farms who go through the planning process are finding it difficult to implement the plans, either from lack of funding or technical assistance available.

Emerging agricultural concerns in the watershed include the use of acid whey and biosolids. Wyoming County is currently the largest dairy producing county in the State and is host to major yogurt production facilities. Acid whey is a manufacturing byproduct of yogurt production and can be land-applied to add nutrients to soil. Also, food waste, yard waste, and wastewater treatment facility waste produces nutrient-rich organic biosolids when digested. Biosolids from anaerobic digesters in West Seneca and Wheatfield have been controversial in recent years due to concerns about a lack of testing in wastewater treatment waste for emerging contaminants, heavy metals, and pharmaceuticals. As of spring 2019, there were no wastewater treatment facilities sending sludge to

[28] https://conservationtools.org/guides/132-a-scientific-foundation-for-shaping-riparian-buffer-protection-regulations

these digesters. Only food and yard waste is currently being anaerobically digested at these facilities for eventual land application.

Acid whey and biosolids are both byproducts that have the potential for beneficial use in the agricultural industry. Acid whey has the potential to be used as a feed source for livestock and as a feedstock for anaerobic digesters, and both have the potential for use as a fertilizer product. These byproducts, like many others including commercial fertilizer, pesticides, and manure have the potential to cause detrimental effects to the environment and human health when mismanaged. Improper management of these products such as land applications above agronomic rates, poorly timed applications, and applications near sensitive areas can result in acidification of the soil and aluminum leaching, accumulation of excess nutrients and heavy metals in soil, and runoff into streams and hydrologically sensitive areas. When these products enter the aquatic system they cause nutrient loading and reduction of dissolved oxygen; bioaccumulation of toxic metals and chemicals in the food web; fish kills; the impairment of the aquatic ecosystem; and the contamination of water bodies used for municipal water supplies. Proper management, planning, education and regulatory oversight will be needed to insure the safe use of these products within the watershed.

Brownfields may contribute toxic pollution to sediments, groundwater and surface water.

Historic Contamination (Brownfields)

Properties contaminated with toxic substances (brownfields) are considered point source pollution in the watershed. Surface and ground waters can pick-up toxic substances present in soils contaminated by former land-use practices, which can then migrate contaminants off-site into streams, water bodies, and the ecosystem. Former industrial and commercial operations (i.e. gas stations, auto repair) often utilized toxic chemicals and other pollutants as part of their regular operations. Sometimes these materials were poorly handled in the past, creating opportunities for spills, dumping and other environmental exposures. Unfortunately heavy concentrations of industry were located in the cities of Buffalo, Dunkirk, Lackawanna, and Niagara Falls and along major waterways well before many of the environmental regulations we have today were in effect. Because of this, these areas of

the watershed have high concentrations of brownfields. Today the U.S. Environmental Protection Agency oversees many of the most highly contaminated brownfields (National Priority List and Superfund Sites), while the remaining sites are under state jurisdiction. The EPA Regulated Facilities Maps in Figures 4.12 and 4.13 outline the following facilities, where past history or current operations pose a potential threat to the environment:

- sites or facilities that are proposed for, currently on, or removed from the U.S. EPA National Priorities List (NPL), which considers contaminated properties for inclusion in the EPA's Superfund list;

- U.S. EPA CERCLIS[29] Superfund sites;
- National Pollution Discharge Elimination System (NPDES)[30] permitted facilities and pipes;
- Combined Sewer Overflow event locations;
- facilities that hold, generate, transport and/or dispose of hazardous waste as regulated by the U.S. EPA (RCRA[31] permits); and,
- facilities or sites where a hazardous substance release occurred (Toxic Release Inventory, EPCRA[32]).

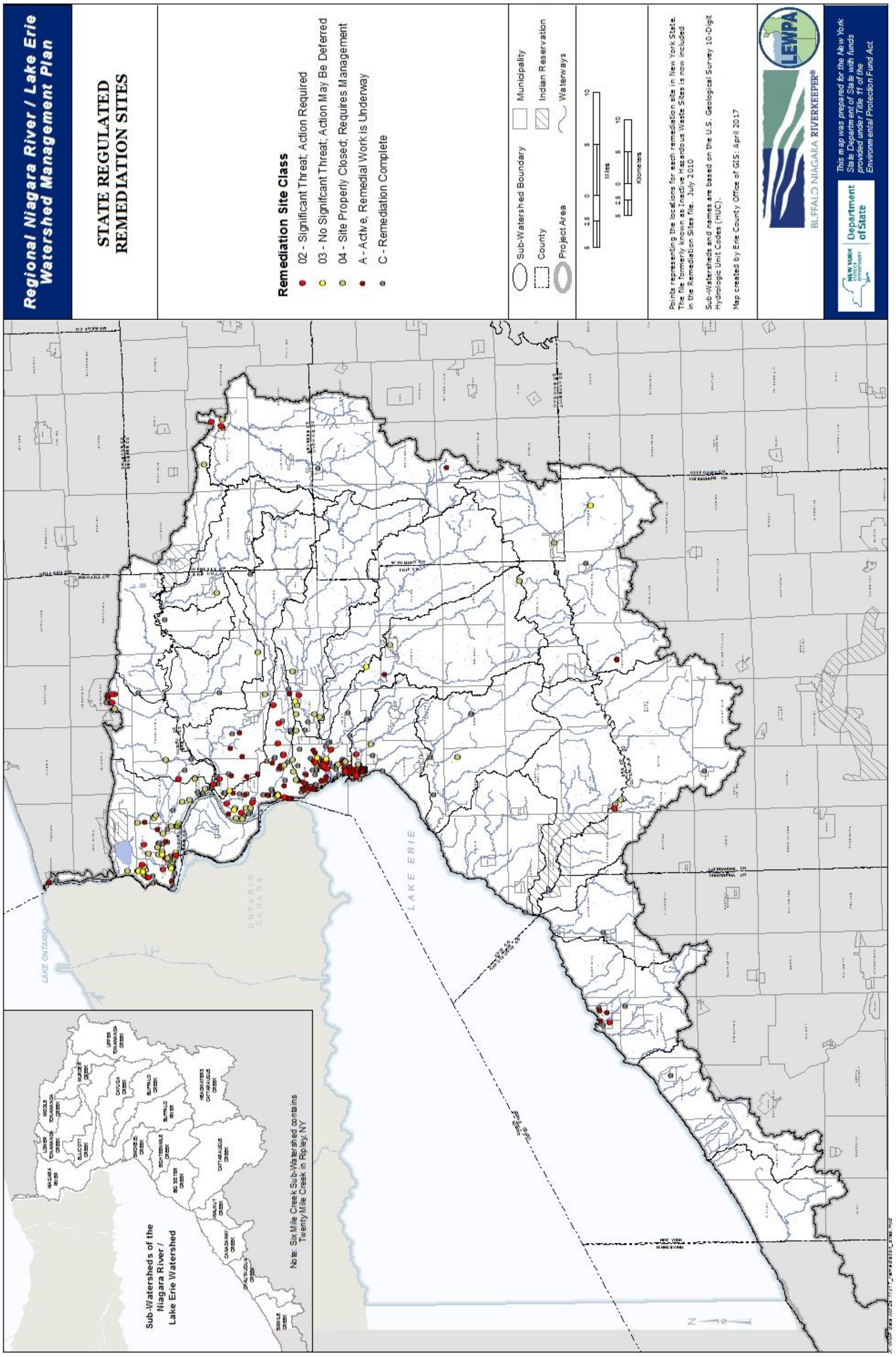
Figure 4.20: Cherry Farm, a former Superfund landfill now remediated, located on the Niagara River in Tonawanda (US EPA)

Presently, the watershed hosts ten sites on the National Priorities List, six of which are in the Niagara River sub-watershed. There are 76 Superfund Sites, including the infamous Love Canal, Hooker Chemical Plant properties and a half dozen landfills. Many of the documented hazardous waste sites in the watershed are part of the Buffalo River and Niagara River Areas of Concern and their Remedial Action Plans. Because remediation (clean-up) and rehabilitation of brownfield properties can take decades, many of them are still considered "active" sites today and can still pose a threat to surface and groundwater resources in the watershed.

In addition to brownfield properties there are a number of existing industrial, commercial, retail and institutional facilities in the watershed that utilize hazardous substances as part of their everyday operations. RCRA permitted facilities are those facilities required to track the generation, use and/or disposal of certain hazardous materials. There are 1,310 small quantity generators, 428 large quantity generators, and 28 transporters. RCRA facilities are also monitored and regulated at the state and federal level in order to ensure proper handling and to limit exposures to people and the environment. Unfortunately spills do occur at these facilities and sometimes in transport of their hazardous materials. The Toxic Release Inventory sites documents where a spill has occurred as part

[29] Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS).
[30] As part of the Clean Water Act
[31] Resource Conservation and Recovery Act
[32] Environmental Protection and Community Right-to-Know Act

Figure 4.21: State Regulated Remediation Sites



of the Environmental Protection and Community Right-to-Know Act. There are 313 spills or releases documented in the watershed on the map.

Known brownfields and Hazardous Waste Sites under NYS jurisdiction are represented in Figure 4.21, the State Regulated Remediation Sites Map. The Niagara River Sub-watershed has 152 remediation sites, the most of all the sub-watersheds. Buffalo River sub-watershed also has a numerous sites listed in the database (79). Figure 4.21 also clearly shows these sites concentrated in the urban areas of the watershed, along the Lake Erie and Niagara River shoreline, and along Tonawanda Creek, Scajaquada Creek, and Smokes Creek.

While the sheer numbers of hazardous sites within the watershed and along key waterways are alarming, former brownfield properties do offer opportunities when remediated and redeveloped. In many cases, environmental conditions limit options for redevelopment allowing sites to be reclaimed for features that would support watershed health, such as flood plains, wetlands, grasslands, riparian buffers, and green stormwater infrastructure, which are lacking in urban areas where brownfields concentrate.

Mining

Sand, gravel, and crushed rock mining has been a source of economic development in rural communities, especially in the southern portion of the Niagara River/Lake Erie Watershed. Limestone is also a large commodity mined mostly in the northern areas of the Watershed. The NYSDEC Division of Mineral Resources regulates mining operations, which are required to have a mining plan and reclamation plan with secured resources prior to permitting. Reclaimed mining sites can become farms, wetlands, habitat, public recreation areas, or residential developments, but it is important that these plans connect to existing community visions and master plans. Erie County has 43 active mines with the county with the highest percentage of acreage permitted by mining in the Watershed at 1,969 acres as of 2016.[33]

Water quality concerns with mining include land changes that can alter water flow in a region and can adversely impact adjacent properties. In addition, water quality impacts and sedimentation can be an issue if the mine is located in a floodplain or is inundated by heavy storm events. Transportation to and from the mine is a concern, both from atmospheric pollution that can deposit on land, as well as non-point source pollution issues with vehicle fluids, brake dust, etc. due to the increased amount of traffic in an area. Habitat areas are often disturbed for mining operations and can be lost permanently if the mine is reclaimed as developed land once closed. It is important to consider the cumulative impacts of mining operations within a sub-watershed.

[33] https://www.dec.ny.gov/lands/92956.html

Oil & Gas Production

Impacts of natural gas drilling can include heavy truck traffic on local roads, noise and odors emanating from drilling sites, and deterioration of air and water quality.[34] With proper management practices and maintenance, the land use impacts associated with this type of well are considered low. However, old wells run the risk of well casing failure, and without proper maintenance and testing, can become a public risk due to gas leakage into the atmosphere and surrounding water sources. Potential negative impacts to the surrounding environment can include chemical spills, road damage due to heavy truck traffic, water contamination, and drilling noise. Vigilant performance from the well operators is necessary to protect the watershed from these impacts.

Old gas wells are periodically reworked for performance enhancement. Reworking an existing active storage well consists of cleaning out the wellbore, installing a new casing inside the existing casing and then perforating the new casing and hydro fracking. These small hydraulic fracturing treatments are commonly used to remedy "skin damage," a low-permeability zone that sometimes forms at the rock-borehole interface. In such cases the fracturing may extend only a few feet from the borehole, though still using a considerable amount of fracking and drilling fluids.

This becomes a bigger environmental issue when dealing with high volume, hydraulically fractured (HVHF) gas wells. This is due to the drastic difference in scale of an HVHF site. A typical HVHF gas drilling permit application may encompass a 640 acre (one square mile) spacing unit. These wells are much deeper and the actual fracturing of the rock extends much further from the borehole. The scale of all potential environmental impacts increases accordingly. For example, reworking a vertical well uses approximately 14,000 gallons of fracking fluid and 10,000 gallons of drilling fluid. In comparison, one HVHF gas well uses 5 – 8 million gallons of water mixed with varying amounts of chemicals, estimated by researchers to range from 30 – 300 tons of chemicals.

HVHF has been banned in New York State, but reworking existing wells is still a concern. The gas development industry has been under pressure to reduce its environmental footprint by developing Best Management Practices to maintain the integrity of each well system, isolate the well from the surrounding subsurface environment, and effectively contain the produced gas and other fluids within the well's innermost production conduit so the wastewater that is returned to the surface can be efficiently captured, contained, treated, and ultimately recycled. The American Petroleum Institute (API) has taken the lead in reviewing and evaluating the industry's practices for drilling, completing, and operating oil and natural gas wells and has published an extensive number of documents describing recommended practices for well planning, well design, well construction, well completion, and well decommissioning. These practices can certainly be improved upon, but at a very minimum it should be required for all operators to employ drilling, completion, and environmental

[34] Gas Drilling in the Town of Colden, 2013 http://townofcolden.com/site/wp-content/uploads/2014/05/Gas-Drilling-Report.pdf

control technologies and practices that fully meet these evolving standards and that are considered up-to-date. Chapter 2 includes maps of where these wells are located in the Watershed.

Utility Infrastructure and Right-of-Ways

Utilities such as communications, electric, and natural gas often have infrastructure that follows roadways or requires a separate right-of-way to reach its destination. These right-of-ways are often wide strips of land mowed annually to prevent trees from growing into pipelines or wires. This mowing can isolate native habitat, disrupt the ecosystem, and create runoff.

A right-of-way can be managed to maintain diversity of plants and animals though by adding native grassland grasses and wildflowers, and by eliminating non-native invasive plant species. Management of the corridor can follow NYS DECs best management practices for grassland nesting birds and pollinators[35], and USFWS best management practices for pollinators[36]. Timing of the migration of birds, butterflies, and other pollinators should be considered when mowing to ensure that critical habitat, such as milkweed, is not mowed prior to mass migrations.

The ‘ecosystems approach’ to watershed management seeks to manage water quality through the sustainable exploitation of water resources and the maintenance of biodiversity within watersheds. It is founded upon the sharing of habitat with other ecosystem components and the minimization of human impact. By this definition, the best management practices described above allow for maintaining native habitats while meeting the needs of current and future human generations.

The Northern Access Pipeline is proposed to connect McKean County, Pennsylvania with an existing compressor station in Elma, New York. Additional work will construct an interconnection in Wales, New York, a new compressor station in Pendleton, New York, and a new natural gas dehydration facility in Wheatfield, New York. The NYSDEC issued a denial of the 401 certification, in particular due to the degradation of waterways, as this project is expected to cross 196 streams with a 75-foot right-of-way. Trenchless technology, which has the least impact on water quality, would only be used at five of the stream crossings. NYSDEC indicated that this pipeline would negatively impact fish and wildlife habitat as well as stir up sediment, a major water quality contaminant, thus impairing several waterbodies of their best uses and violating NYS water quality standards. The issue is now tied up in a legal battle between the Federal Energy Regulatory Commission and NYSDEC.

In addition to construction disturbances, the proposed project would have involved right-of-way maintenance for the pipeline. Riparian habitat loss at the waterway crossings would be maintained through regular mowing preventing large trees from establishing along the stream banks. This could cause long-term negative impacts on fish and wildlife habitat. Right-of-way maintenance through

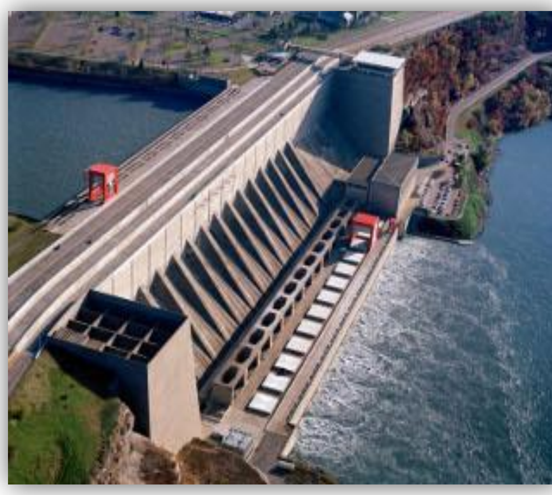
[35] http://www.dec.ny.gov/pubs/86582.html and http://www.dec.ny.gov/docs/administration_pdf/nyspollinatorplan.pdf

[36] https://www.fs.fed.us/wildflowers/pollinators/BMPs/documents/PollinatorFriendlyBMPsFederalLandsDRAFT05152015.pdf

wetlands could compact soils, change vegetation types, and decrease the wetland function as a water quality filter and natural sponge in periods of precipitation. It is important to consider these long-term impacts when developing utility projects and to mitigate the impacts wherever possible.

Dams

Figure 4.22: NYPA Hydroelectric Dam in Lewiston, NY



Dams can significantly alter the ecosystem of a waterway. Reservoirs created by dams can block fish migration, increase water temperatures, trap sediments, decrease water speed, reduce dissolved oxygen, increase nitrogen levels, and alter riparian areas. Because these changes to the ecosystem can lead to eutrophication and cause stress on fish populations and riparian habitats, older non-functioning dams in the watershed should be investigated for possible removal and restoration of waterway hydrology and habitat. In many cases reservoirs have protected lands and forests surrounding them. These areas should be conserved for habitat and water quality benefits along restored waterways. In cases where the dams are necessary, measures can be taken to mitigate negative impacts such as the installation of fish ladders.

There are several dam mitigation projects being planned or underway in the watershed. Smith Mills Reservoir Dam in the Town of Silver Creek in Chautauqua County is being removed starting in 2018 due to safety hazards. The best fish habitat is upstream of the dam and is expected to result in better fisheries on Silver Creek. Streambank and habitat restoration is also planned as part of this project.

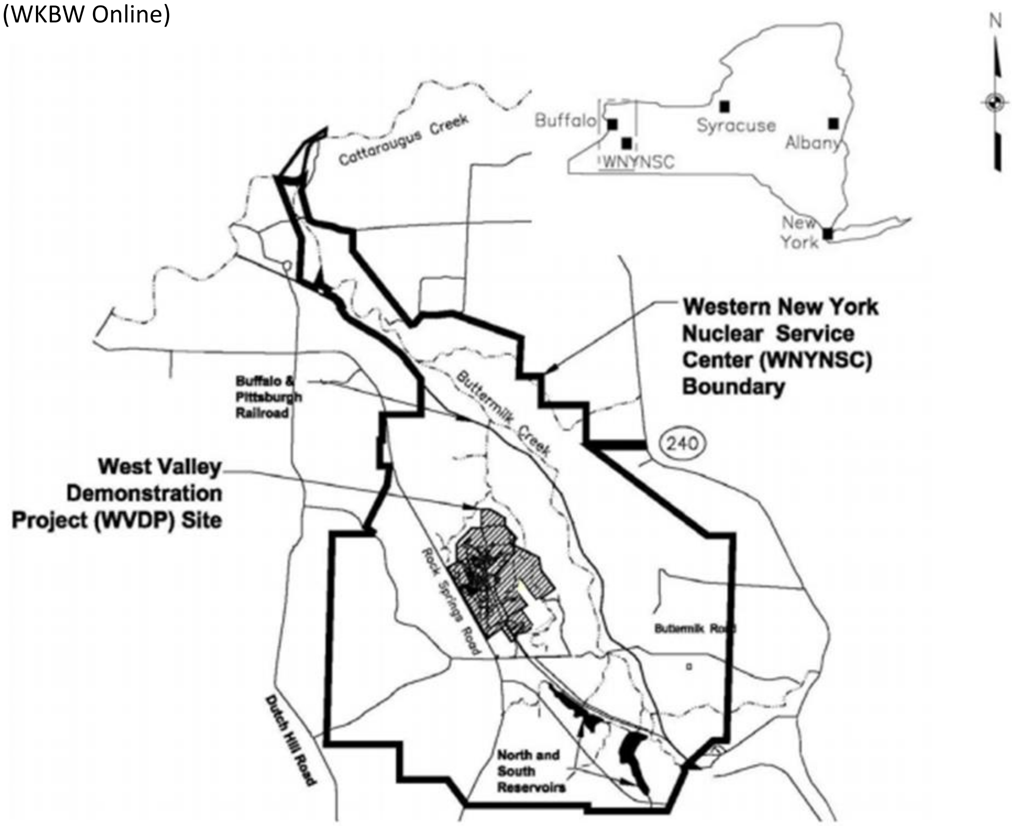
Scoby Dam on Cattaraugus Creek is being considered for lowering from 40 feet to approximately 13 feet with the addition of a fish ladder and sea lamprey controls. This is anticipated to connect the upper and lower fisheries. Prior to removal, the U.S. Army Corps of Engineers is studying the sediment that is currently trapped behind the dam to ensure that contaminants will not be released downstream upon lowering the dam. There is concern that upstream industrial activities may have released contaminated sediment. The West Valley Demonstration project is located upstream of this site along a tributary to Cattaraugus Creek

West Valley Demonstration Project

The West Valley Demonstration Project Site is a nuclear waste remediation site in West Valley, New York. The purpose of the project, which was created by an act of congress in 1980 and is jointly managed by state and federal agencies, is the cleanup and containment of radioactive waste left behind after the abandonment of a commercial nuclear fuel reprocessing plant. In accordance with the West Valley Demonstration Project Act, the U.S. Department of Energy (DOE) took the lead in solidifying the liquid high-level waste, and in decontaminating and decommissioning the facilities used in the solidification project. The New York State Energy Research and Development Authority (NYSERDA) is responsible for management of the shut-down commercial radioactive waste disposal site and surrounding Western New York Nuclear Service Center (WNYNSC) and, as the owner, is also the licensee for the site. While progress has been made on the site, the clean-up work still continues.

Figure 4.23: West Valley Demonstration Site Map

(WKBW Online)



The West Valley Demonstration Project Site watershed is drained by Quarry Creek, Franks Creek, and Erdman Brook. Most surface water runoff from the project premises funnels into a single stream channel at the confluence of Franks Creek and Erdman Brook located just inside the perimeter of the project premises. These waters flow into Buttermilk Creek, which runs through the retained premises east and north of the project premises. Buttermilk Creek enters Cattaraugus Creek at the north end of the WNYNSC in the Headwaters Cattaraugus Creek Sub-watershed.

The depth of groundwater in the sand and gravel unit on the north plateau ranges from the surface to 16 feet below the surface. The groundwater flows generally northeastward toward Franks Creek.

Near the northwestern margin of the sand and gravel until, flow is toward Quarry Creek and, at the southeastern margin, toward Erdman Brook. Groundwater seeps to the surface in places along stream banks and the edges of the north plateau. Underlying the north plateau and the south plateau is more than 500 feet of Pleistocene-age glacial tills.

The West Valley Citizen Task Force (CTF) was formed in 1997 to provide broader public participation in the Environmental Impact Statement and decontamination and decommissioning processes. The CTF issued a report in 1998 addressing what it felt should occur and has been meeting regularly since then. Members of the CTF are drawn from local government, community and environmental organizations, representatives of elected officials and the Seneca Nation of Indians. The CTF continues to meet regularly and public meetings are held quarterly.

Concern about contamination of the watershed has been expressed by the community, especially because of the unstable soil and the potential impacts of climate change on the site. Monitoring must continue to ensure that hazardous materials are not leaching into the Niagara River/ Lake Erie Watershed.[37]

NYPA Niagara Power Project Impacts & Relicensing

Findings from environmental studies completed as part of the relicensing of the Lewiston Hydroelectric Generation facility identified major impairments caused by the water diversions necessary for the operations of the plant. Water level draw-downs average 1.5 feet/day just above the intakes, up to 12 feet/day in the gorge area above the tailrace, up to 36 feet/day in the Lewiston Reservoir, and .6 feet/day at Lake Ontario.[38]

The water fluctuations may destabilize nearshore habitats for many plants and animals including spawning fish, nesting shorebirds, amphibians, and reptiles.[39] One NYPA study[40] identified 49 rare, threatened, or endangered species and three significant natural communities that were likely affected by these fluctuations, including pied-billed grebe, lake sturgeon, and the deep emergent marsh community at Buckhorn State Park. As a result, $9 millions /year over 50 years from 2007 was negotiated to restore public access and habitat to the communities impacted.

Thermal Increases

Thermal pollution affects many aquatic species.

Increases in the temperature of waters can negatively affect water conditions in how they support aquatic life and the ecosystem. For

[37] http://westvalleyctf.org/site-information/history and WVDP Phase 1 Decommissioning Plan for the West Valley Demonstration Project (2008)

[38] Niagara River Water Level and Flow Fluctuation Study (URS Corporation, 2005)

[39] Buffalo and Niagara Rivers Habitat Assessment and Conservation Framework (Buffalo Niagara Riverkeeper, 2008)

[40] Assessment of the Potential Effects of Water Level and Flow Fluctuations and Land Management Practices on Rare, Threatened, and Endangered Species and Significant Occurrences of Natural Communities at the Niagara Power Project. (Riveredge Associate, LLC., 2005)

example, cold water fish species are sensitive to raises in water temperature as higher temperatures reduce the amount of dissolved oxygen and cold water fish require larger amounts of oxygen. As mentioned previously, temperature increases can be caused by both natural conditions and man-made conditions. In the case of the Niagara River Watershed thermal increases are attributed to:

- Lack of forested riparian cover to shade rivers and stream corridors;
- Stormwater run-off traveling over heated surfaces (black top, concrete channels);
- Loss of forested wetlands;
- Industrial discharges; and,
- Climate change (increased air temperatures).

Thermal pollution is most evident in the loss of trout found in the watershed. In recent years the number of stream segments with trout documented in the watershed has been decreasing. Presently trout is found closest to the headwaters of Tonawanda Creek, Buffalo River, Buffalo Creek, and Cattaraugus Creek where springs help keep water temperatures colder than other areas of the watershed.

The primary means to affect thermal pollution in the watershed is by the restoration and protection of forested riparian areas and improved design of stormwater conveyance systems. Stream Visual Assessment Protocol (SVAP) data collection assesses the quality of riparian areas for the watershed as a whole. Where SVAPing has occurred, inadequate riparian cover is consistently documented as an issue affecting stream health. Continued SVAPing is recommended to assess more of the Niagara River/Lake Erie Watershed.

Erosion & Sedimentation

Many of the causes of erosion and sedimentation in the watershed have already been touched on as part of the discussion on stormwater infrastructure and agricultural operations. However, there are erosion and sedimentation problems occurring in the watershed from causes aside from these factors. Other common erosion and sedimentation causes stem from topographical and geological conditions, such as steep slopes/banks and highly erodible soils; stream channel changes include down cutting and meandering; and man-made conditions include loss of riparian buffers.

Erosion causes sediment pollution and degrades water quality.

A full comprehensive erosion assessment or geomorphic assessment does not currently exist for the Niagara River/ Lake Erie Watershed. Major erosion areas are mostly known in a piecemeal fashion, from projects and requests for assistance to the Soil and Water Conservation Districts, and at the municipal/county level from where erosion is threatening neighboring infrastructure (i.e. roads, bridge abutments) or private property.

Figure 4.24: Forested Riparian Buffer in Agricultural District (USDA)

Conducting Stream Visual Assessments are more involved than the GIS assessment and are unrealistic to utilize for all stream miles of the watershed, but these assessments also document shoreline erosion. In-depth SVAPing has occurred in five of the 18 sub-watersheds. Buffalo Niagara Riverkeeper traversed approximately 118 miles of streams in 2015 and 2016 to determine the riparian zone and bank stability, among other observations, in the Eighteenmile Creek, Buffalo River, Smoke(s) Creek, Lower Tonawanda Creek, and Upper Tonawanda Creek Sub-watersheds. Results can be found online.[41]

The most primary suspected cause of erosion and sedimentation in the watershed is the lack of adequate riparian buffers. In many stream corridors riparian buffers have been removed or severely reduced causing the benefits and protections of these vegetative strips to be ineffective in strengthening shorelines and protecting water quality. A well-functioning riparian buffer:

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

Studies on recommended buffer widths have been summarized as follows to show recommended widths for particular ecosystem benefits[42]:

Erosion/sediment control:	30 feet to 98 feet
Water quality:	
Nutrients	49 feet to 164 feet

[41] https://bnwaterkeeper.org/projects/healthyniagara/

[42] Riparian Buffer Zones: Functions and Recommended Widths by Ellen Hawes and Markelle Smith, Yale School of Forestry, April 2005, http://www.eightmileriver.org/resources/digital_library/appendicies/09c3_Riparian%20Buffer%20Science_YALE.pdf

Pesticides	49 feet to 328 feet
Biocontaminants (fecal, etc.)	30 feet or more
Aquatic habitat:	
Wildlife	33 feet to 164 feet
Litter/debris	50 feet to 100 feet
Temperature	30 feet to 230 feet
Terrestrial habitat:	150 feet to 330 feet

The lack of riparian buffers has negative effects on the integrity of shorelines, limiting a shore's ability to withstand erosive forces. In the Watershed, riparian buffers have been lost due to land use practices, where residential, commercial, and agricultural property owners mow down vegetation all the way to the waters' edge. In other cases riparian loss is replaced with costly riprap to reduce further erosion, but while riprap may reduce erosion issues, the shoreline receives no additional benefits a vegetative buffer provides.

Figure 4.25: Riparian Areas along Cayuga Creek

A Statewide Riparian Opportunity Assessment was conducted to prioritize riparian sites for restoration on the hydrological unit code 12-digit scale. Nine ecological health indicators and seven ecological stress indicators were used to rate each catchment or sub-watershed (HUC12). These were combined into composite scores for health and stress, as well as a comprehensive score and the results were mapped.[43] This assessment generally shows that the headwaters areas tend to have a higher ecological health score and the urban areas and downstream areas tend to have a higher ecological stress score. When using this tool, a low comprehensive score is an area that should be prioritized for riparian buffer restoration activities.

As watershed planning continues, the state of riparian lands should be comprehensively assessed in the watershed, plus outreach and education programs, land use policies, and bioengineering solutions should be developed and implemented to improve and protect riparian lands.

Invasive Species

The invasive species found in the watershed and the problems they cause are documented in Chapter 5. Invasive species threaten the health of the watershed's ecosystems and in some cases, such as zebra mussels and hydrilla, contribute to water quality degradation, infrastructure issues, and/or algae blooms. Documentation of the extent of invasive species within the watershed depends on the specific species and how much research has been conducted. In recent years certain species have received more attention than others, such as Water Chestnut where several efforts exist to remove it and educate the public to limit transporting it.

Some invasive species may block out native plants and degrade the quality of a riparian buffer. In some cases, they may have much more shallow roots than native species and not provide the same bank stabilization benefits. In other cases, when large stands of invasive species are removed, stream banks are left vulnerable until native species can reestablish themselves. Invasive species can also block taller native species from establishing in areas where cold water fisheries need shaded streambanks.

Invasive Species contribute to thermal, nutrient, and bacterial pollution.

There are also the more difficult species to address, such as Japanese Knotweed, which can severely impact habitat and riparian areas, but its long-term removal involves the use of herbicides that can cause other water quality impacts.

Unfortunately the most common issue with trying to address invasive species in the watershed is the need to comprehensively document their extent and spread in a cost-effective manner. The iMAP Invasives website[44] utilizes online and smart phone spatial mapping applications to document invasive

[43] http://www.nynhp.org/treesfortribsny Conley, Amy K., Erin L. White, and Timothy G. Howard. 2018. New York State Riparian Opportunity Assessment. New York Natural Heritage Program, State University of New York College of Environmental Science and Forestry, Albany, NY.

[44] www.imapinvasives.org

species in the field as a good start in creating better base datasets, but additional data collection is needed. In addition, strategies and public education should focus on outlining the best ways to address invasive species that present the least impact on water quality and habitat (i.e. hand removal vs. herbicides).

Emerging Contaminants

As outlined by the *Emerging Contaminant Threats and the Great Lakes: Existing Science, estimating relative risk and determining policies* report completed by the Alliance for the Great Lakes (2011), the last two decades have seen a growing concern about human health risks from chemical contaminants in the environment. Exposure to some of these manmade and naturally occurring chemicals is unavoidable as they end up in wastewater, air and land. Many come from every day products such as personal care products, plastics, pharmaceuticals and flame retardants. For instance, Perfluoroalkyl substances (PFAS), which are used to repel water and oil, have been found in drinking water supplies and are used in numerous products, including dental floss. In addition, they have been used in fire-fighting foam at fire training centers and on the Niagara Falls Air Base for decades. The impacts of emerging contaminants on the health of organisms in the Great Lakes and human populations are largely unknown. The data that does exist suggest they are a health concern, but more data and further study are needed.

Figure 4.26: Pharmaceuticals

There are millions of pounds of medications that expire or go unused in the United States every year. Improper disposal of these medications has generated concerns about their impacts on aquatic and human health. A number of studies have observed fish developing sexual and behavioral abnormalities. The scientific consensus appears to be that pharmaceuticals threaten aquatic organisms, though the effects on human health aren't as clear. Scientists say there's not enough data or understanding about emerging contaminants in the Great Lakes, but what is known is cause for concern. Pharmaceutical chemicals have been found in 41 million Americans drinking water in 24 major metro areas.

The growing number of pharmaceuticals and other chemical byproducts in the Great Lakes pose a health risk to the more than 40 million who rely on the lakes for drinking water, as well as to fish and wildlife. A comprehensive Alliance for the Great Lakes study analyzed existing data on emerging contaminants in the Great Lakes, and what this could mean for our health. Some highlights from the study:

- Flame retardants, pesticides, the antibacterial and antifungal agent Triclosan, and the insect repellent DEET are all found in the Great Lakes.
- Bisphenol A (BPA), used in plastics from baby bottles to food packaging, is found in more than half the water samples analyzed in all studies to date.
- Most emerging contaminants found in the Great Lakes come from everyday products such as shampoos, sunscreens, plastics and pharmaceuticals.
- Emerging contaminants have been implicated in hormone disruption and cancers, but few studies have looked at long term impacts in drinking water.

Addressing the problem of emerging contaminants requires focus on four main areas: new research, new technologies aimed at removing more contaminants during wastewater treatment, marketplace behavioral changes, and policy reforms. A recent success has been the banning of microbeads from personal care products. These tiny plastic molecules were not able to be captured by most wastewater treatment plants and were found in fish and drinking water. Studies showed that micro plastics were contaminating, not only the Great Lakes, but also the tributaries that feed them. In a Great Lakes study that included Buffalo River and Tonawanda Creek, urban tributaries contributed more plastic fragments, foams, and films than rural tributaries. Meanwhile, plastic microfibers, such as from polyester clothing, were found across all tributaries in the study.[45] Further study is needed on the contributing factors, but the existence of plastic in water supplies has been shown. Because of the ability for plastic to adsorb other contaminants in the water and be mistaken for food by fish and wildlife, these contaminants are being moved up the food web with the potential to impact human health.

Few regulations exist regarding emerging contaminant control. The existing theory that a chemical cannot be removed from the marketplace without data showing a negative impact on people and the environment underscores the need for a more effective and realistic risk assessment program. Changing federal policies governing the production and use of new chemicals and existing contaminants may have the biggest impact. Few laws exist to control emerging contaminants, and current U.S. regulatory approaches don't keep pace with the deluge of new chemicals.

Climate Change

Changes to regional climate pose increased risks to the water resources, built environment and infrastructure, ecosystems, and recreation and tourism sectors that already face other pressures. The expected changes in climate are discussed in Chapter 2. Heavy rainfall (over short time periods) produces the most water quality impact, more than any other extreme weather event. With

[45] Plastic Debris in 29 Great Lakes Tributaries: Relations to Watershed Attributes and Hydrology by Austin K. Baldwin, Steven R. Corsi, and Sherri A. Mason from Environmental Science and Technology Journal.

increasing temperatures, and with rainfall making up a greater percentage of annual precipitation, this poses a serious threat for regional water quality.

In the next several years weather patterns are predicted to become more variable, with multiple weather events occurring simultaneously, for instance, droughts followed by heavy rains. This example would have multiple repercussions for water quality, by "negatively affecting turbidity, contaminant concentrations, and organic matter in raw water supplies."[46] Other anticipated climate change impacts include increased heat waves; exacerbated drought; more invasive species; shifts in native species range; changes in timing of ecological events including blooming and maturation of crops; reduced lake ice cover causing more evaporation and increased erosion of shorelines from wind events can lead to "increased turbidity and organic matter, hypoxia, eutrophication leading to algal and cyanobacteria growth, taste and odor problems, increased presence or risk of pathogens and changes to conductivity, pH and alkalinity."[47] In addition, extreme rainfall events can increase erosion, which can further increase sedimentation and turbidity of waterways.

The ability to estimate future flood risks and develop effective future flood mitigation strategies will become vital for municipalities. Current Base Flood Elevation levels from Flood Insurance Rate Maps used for many municipal building codes do not take climate change or future flood impacts into consideration. Ultimately, the relationship between climate change and water quality and quantity impacts is complex, demonstrating the need for long-term stream flow data to help guide future flood hazard mitigation and water resources planning.

Impacts on crops and livestock can mean additional fertilizers or pesticides may be needed to retain crop yields or additional infrastructure for cooling animals or storing manure may need to be constructed. Heavier late winter or spring rains or an increased number of snow melt and runoff events can mobilize contaminants and cause higher nutrient loading. If heavy rains occur frequently, reservoirs may have little time to recover from increased turbidity, and if those rains occur after a dry spell, organic materials can be flushed downstream all at once. Efforts to prepare for these immediate and longer-term impacts are needed, including planning for variable lake levels. Climate variability and change exacerbate many existing vulnerabilities and add to the complexity of resource management, capital investment, and community planning.[48]

The impact of climate change on Great Lakes water levels is a critical question for the region's economy and environment, and for one of the nation's key shipping corridors. Even small drops in lake water levels could create problems for shipping and navigation, recreational boating, hydro-electric production and other uses. Sustained periods of higher lake levels can mean increased erosion

[46] Great Lakes Integrated Science Assessments, 2012
[47] American Water Works Association, *Climate Change: how does weather affect surface water quality?*, 2013
[48] NYS's Open Space Conservation Plan, 2016

and flooding in coastal areas, which may have a significant economic impact as structures are damaged. Planning for climate change resiliency should take this variability into consideration.

Water level fluctuation in the Great Lakes basin and major tributaries also impact both biotic and abiotic components in near-shore, shoreline, and riparian zones. Wind and wave action can be modified by the depth of Lake Erie, causing shorelines to erode and fine sediment to be resuspended and deposited into deeper areas. Decreasing water levels or intense flooding both may result in the loss of macrophyte vegetation, lowering diversity and reducing habitat that would typically uptake nutrients or support fish spawning. The results can be an increase in algal growth or an increase in invasive species. Increasing water levels also can cause loss in invertebrate communities, increasing invasive species well.[49]

[49] Tamar Zohary & Ilia Ostrovsky (2011) Ecological impacts of excessive water level fluctuations in stratified freshwater lakes, Inland Waters, 1:1, 47-59, https://www.tandfonline.com/doi/pdf/10.5268/IW-1.1.406

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