ROCHESTER EMBAYMENT AREA OF CONCERN

Eutrophication or Undesirable Algae Beneficial Use Impairment Removal Report

SEPTEMBER 2019

Rochester Embayment Area of Concern

Eutrophication or Undesirable Algae

Beneficial Use Impairment (BUI) Removal Report

September 2019

Prepared by:

New York State Department of Environmental Conservation

And

Monroe County Department of Public Health

This Beneficial Use Impairment (BUI) Removal Report was prepared by the Monroe County Department of Public Health (MCDPH) and the New York State Department of Environmental Conservation (NYSDEC) and was substantially funded by the United States Environmental Protection Agency (USEPA) through the Great Lakes Restoration Initiative (GLRI). The NYSDEC and MCDPH have engaged stakeholders and the public, including the Remedial Advisory Committee (RAC), throughout the BUI removal process. For more information please contact the Remedial Action Plan Coordinator at MCDPH or the AOC Coordinator at NYSDEC Division of Water.

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1. <u>Introduction and Report Purpose</u>

In the Great Lakes Basin, the International Joint Commission (IJC) has identified 43 Areas of Concern (AOCs) under Annex 1 of the Great Lakes Water Quality Agreement (GLWQA) where pollution from past industrial production and waste disposal practices has caused significant ecological degradation. Up to fourteen beneficial use impairments (BUIs), or indicators of poor water quality, are used to evaluate the condition of an AOC.

The Rochester Embayment AOC encompasses the lower portion of the Genesee River from the mouth up to the Lower Falls in Rochester, NY and the portion of Lake Ontario within a straight line drawn from Bogus Point to Nine Mile Point (**Figure 1**). This was originally listed as an AOC due to the known or suspected presence of multiple BUIs, including "Eutrophication or Undesirable Algae," which is generally considered impaired when waters used for body contact recreation exceed standards, objectives, or guidelines for such use.

Following an evaluation of the data and evidence gathered to address this impairment, the New York State Department of Environmental Conservation (NYSDEC) and the Monroe County Department of Public Health (MCDPH) have determined that the overall conditions necessary to remove (or re-designate from 'Impaired' to 'Not Impaired') the Eutrophication or Undesirable Algae BUI have been met. The local community advisory group, called the Remedial Advisory Committee (RAC), fully supports the removal of this BUI. Accordingly, the purpose of this BUI removal report is to present the rationale and supporting data to remove the Eutrophication or Undesirable Algae BUI from the Rochester Embayment AOC.

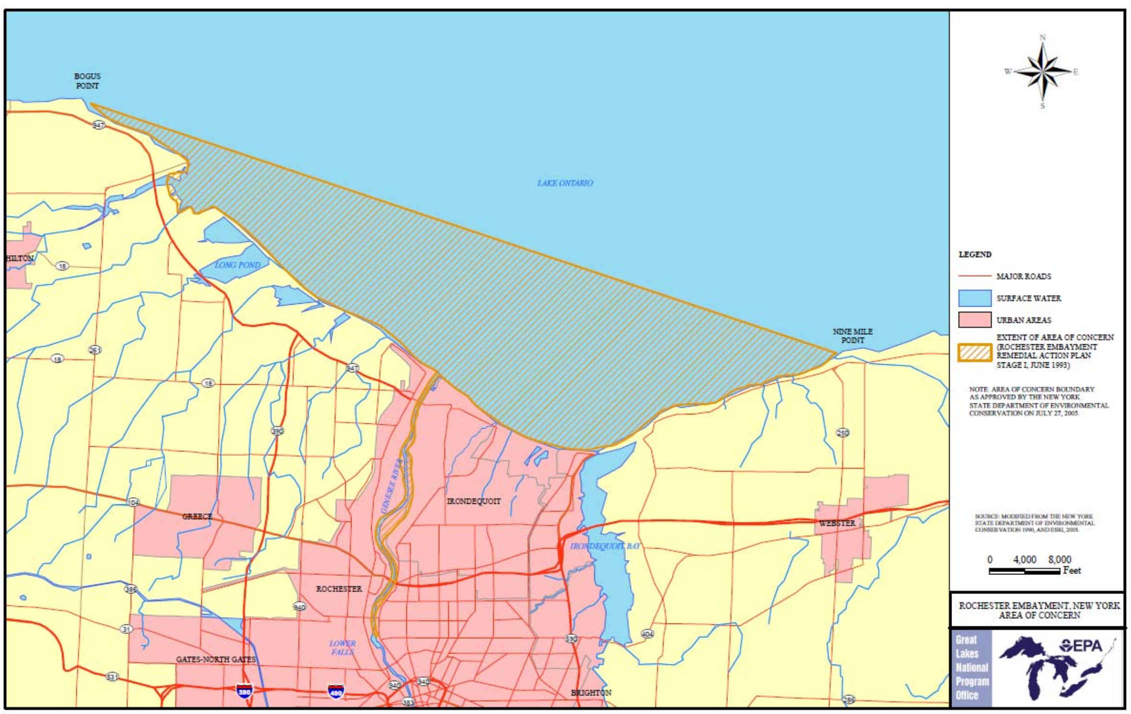

Figure 1. Map of the Rochester Embayment AOC.

2. Background & BUI Removal

All AOCs develop a Remedial Action Plan (RAP) in three stages, which collectively identifies specific BUIs and their causes (Stage I), outlines the restoration work needed (Stage II), and documents completion of these restoration activities and the delisting of the AOC (Stage III). Currently, the RAP for the Rochester Embayment AOC consists of Stage I and Stage II documents.

The Eutrophication or Undesirable Algae BUI was originally listed as impaired in the Stage I and Stage II RAPs due to:

- The introduction of contaminated water from Genesee River tributaries containing fertilizers or phosphate detergents (agriculture, sewage, etc.),
- The reintroduction of phosphorus-containing sediments exposed by benthic sediment disturbance (dredging)*,
- An invasive mussel species introduction resulting in an increase in suitable algal habitat and greater access to sunlight and nutrients.

*This component of the original rationale for the impairment designation was not supported by subsequent data collection efforts, and as such was excluded from subsequent RAP addenda.

2.1. BUI Removal Criteria

The removal criteria and monitoring methods for the Eutrophication or Undesirable Algae BUI were first reported in the 2002 Addendum to the Stage II RAP developed by the RAP Oversight Committee in conjunction with the Water Quality Management Advisory Committee. These removal criteria were reevaluated in 2008 by the RAP Coordinator as well as the RAP Oversight Committee. The RAP Oversight Committee determined that the use of these criteria should continue due to their continued relevance to the local conditions at Rochester Embayment and the IJC Delisting Guideline for this BUI.

As stated in the Rochester Embayment Area of Concern Beneficial Use Impairment Delisting Criteria Report (Ecology and Environment, 2009), the Eutrophication or Undesirable Algae BUI can be removed when:

"When there are no persistent water quality problems (e.g., dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication."

This can be demonstrated by meeting the BUI removal criteria (MCDPH, 2002):

- **Total phosphorus concentrations for nearshore (11 to 12 meter depth) and near-nearshore (1 meter depth) are less than or equal to 15 ppb and 20 ppb, respectively; and**

- **Chlorophyll *a* concentrations for the near (11 to 12 meter depth) and the near-nearshore (1 meter depth) are less than or equal to 3.8 ppb and 5 ppb, respectively; and**

- **Secchi disk measurements in the nearshore (12 meter depth) are greater than or equal to 4 meters.**

The above BUI removal criteria are consistent with United States Environmental Protection Agency (USEPA) Delisting Guidance document (USPC, 2001) and the International Joint Commission (IJC) delisting guidelines (IJC, 1991).

2.2. BUI Removal Comments and Report Preparation

The following questions were asked when evaluating whether to proceed with the removal of the Eutrophication or Undesirable Algae BUI:

1. Are the methods and results cited in the report or presentation materials technically and scientifically sound?
2. Does the information cited in the report regarding restoration of the impaired beneficial use support the delisting criteria?
3. Do the RAC and general public concur that the delisting criteria have been met?

This evaluation included conducting a thorough review of technical reports and supporting documents.

2.3. BUI Indicator Status Resolution

In addition to successfully achieving the criteria as stated above, an alternate form of BUI removal includes supplying evidence that demonstrates the impairment is not localized to the Rochester Embayment AOC, but rather is a regional concern. This exception is in place such that in cases where local actions would result in minimal remedial impact relative to lake-wide impairment, resources can be used more productively.

2.3.1. Strategy and Rationale:

The United States Environmental Protection Agency (USEPA) Delisting Guidance document Restoring United States Great Lakes Areas of Concern: Delisting Principles and Guidelines, accepted by the United States Policy Committee (USPC, 2001) states the following:

“Re-designation of a BUI from impaired to unimpaired can occur if it can be demonstrated that:

- Approved delisting criteria for that BUI have been met;
- The impairment is not solely of local geographic extent, but is typical of upstream conditions OR conditions outside of the AOC boundaries on a regional scale. Such re-designation would be contingent upon evidence that sources within the AOC are controlled;
- The impairment is due to natural rather than human causes.”

The IJC delisting guidelines, Restoring Beneficial Uses in Areas of Concern, state that the Eutrophication or Undesirable Algae beneficial use may be deemed Not Impaired **“**When there are no persistent water quality problems (e.g., dissolved oxygen depletion of bottom waters, nuisance algal blooms, or accumulation decreased water quality) attributed to cultural eutrophication” (IJC, 1991).

As described below, the data collected within the Rochester Embayment AOC demonstrate that the removal criteria established for the Eutrophication or Undesirable Algae BUI have been substantially met. Additionally, reference data collected throughout Lake Ontario support the observation that the problems associated with cultural eutrophication, in particular *Cladophora* blooms, are indicative of lake-wide conditions and are not unique to the Rochester Embayment AOC. The management actions described below have addressed the root causes underlying this BUI to the maximum extent practicable under the RAP. Therefore, this BUI can be removed.

3. Addressing BUI Removal Criteria

A compilation of data collected on the conditions of Lake Ontario including areas both within and external to the Rochester Embayment AOC were compared resulting in the measurements supporting the removal of the Eutrophication or Undesirable Algae BUI described below:

3.1. Criterion 1: Total Phosphorus Concentrations

Bi-national support for phosphorous reduction initiatives has led to a lake-wide decline in total phosphorus concentrations from 25 ppb in 1971 to 10 ppb in the mid-1980s, and most recently 5 to 7 ppb in the mid-2000s. A 2007 study evaluated total phosphorous concentrations at 38 offshore, 5 nearshore, and 3 embayment sites in Lake Ontario within the southern and eastern shores. Data were collected for the spring, summer, and fall seasons to coincide with the *Cladophora* life cycle. Nearshore data were collected at depths of 10 meters (comparable to the delisting criteria of depths of 11 to 12 meters) and offshore samples were collected at 8 and 40 meter depths. Average total phosphorus levels for both nearshore and offshore areas were 7.9 ppb and 7.2 ppb, respectively, which are well below the 15 ppb set delisting criteria. For the areas of the embayment, average total phosphorus levels were determined to be 15.1 ppb, just above the criteria for delisting but a significant improvement in comparison to the 1970 levels (Holeck et al., 2008).

In addition to the information previously stated, results from 2008 reported in two studies support that total phosphorus concentrations are improving within the Rochester Embayment AOC. One study investigated the overall physical and chemical characteristics of the Lake Ontario nearshore environment, while the other study considered the influence of streams on nearshore water chemistry. Data from the study investigating stream influence that found mean total phosphorus concentrations of the Genesee River nearshore areas were 13.7 ppb and 12 ppb for samples collected in June and August. These values are both within the delisting criteria. Similar results were found in the more comprehensive Lake Ontario nearshore study, with most total phosphorus values falling below 15 ppb for both near and near-nearshore samples (Makarewicz et al., 2012a, 2012b).

Long-term lower trophic level monitoring conducted by the NYSDEC also shows significant improvement of nearshore total phosphorus concentrations. In 2018, mean nearshore total phosphorus concentrations at the Oak Orchard Lake and Sodus Bay Lake sites were 5.6 ppb and 4.9 ppb, respectively (Holeck et al 2019). Both sites were sampled at depths of around 10 meters. Additionally, the mean total phosphorus concentration at the Smoky Point-N site was 6.8 ppb, well below the target for removal. This site is located the closest to the Rochester Embayment AOC and was collected at a depth of 22 meters.

Both studies considered the total phosphorus concentrations of the Rochester Embayment AOC in the summer 2008, representing the months of June and August when public use is most prevalent. Additionally, the results found in the comprehensive Lake Ontario nearshore study are helpful in comparing the Rochester Embayment AOC to other embayment areas along the southern shoreline of Lake Ontario. Data from this study show similar spikes in total phosphorus concentrations in the nearshore of these embayment areas over the duration of the study. These results support that total phosphorus concentrations are improving and embayment areas are generally more susceptible to higher phosphorus levels.

3.2. Criterion 2: Chlorophyll *a* Concentrations

Although the available chlorophyll *a* data within the Rochester Embayment AOC are limited, a study assessing the Lake Ontario coastal zone reported chlorophyll *a* concentrations of 3.1 ppb in the Genesee River/Embayment area over the time period between 2003 and 2005. In addition to those results, concentrations of greater than 14 ppb occurred in three locations outside of the AOC as well as two locations within the AOC. (Makarewicz and Howell, 2008).

More recently, a study of phytoplankton in the Lake Ontario nearshore conducted in June 2008 saw similar results with a majority of chlorophyll *a* concentrations within the Rochester Embayment falling below the established BUI removal criteria (Pavlac et al., 2012). A chlorophyll *a* distribution map (Pavlac et al., 2012, figure 6b) shows that a majority of the nearshore chlorophyll *a* levels in the Rochester Embayment fall between the 2 ppb or less range with an exception at the Genesee River mouth where levels are seen to exceed 4 ppb. This example of increased chlorophyll *a* at river mouths can also be seen in neighboring embayment areas such as Sandy Creek in Mexico bay (Pavlac, 2012, figure 6c).

Additionally, a study of Lake Ontario nearshore conditions relative to variability in water quality investigated multiple water quality parameters including chlorophyll *a* throughout the Lake Ontario nearshore environment. This study found that the lake-wide average for chlorophyll *a* concentrations at 20 meters during August and September of 2008 were approximately 2.25 ppb and 1.56 ppb, respectively (Yurista et al., 2012, figure 3). Compared to these averages, the Rochester Embayment levels consistently remain below the removal target of 3.8 ppb while additional areas outside of the Rochester Embayment saw greater spikes in chlorophyll *a* concentrations above the lake-wide averages (Yurista et al., 2012).

In 2018, mean chlorophyll-a concentrations collected at Oak Orchard Lake and Sodus Bay Lake long-term monitoring sites were 1.4 ppb and 0.9 ppb, respectively (Holeck et al 2019). The mean concentration at the Smoky Point-N site was 1.5 ppb. Nearshore chlorophyll-a concentrations in the US have been stable for the period 2005 – 2018 (Holeck et al 2019).

Given the multiple studies referenced above, it can be concluded that chlorophyll *a* concentrations within the Rochester Embayment AOC have been maintained, if not reduced, over time to levels of 3.1 ppb or less, resulting in values that fall within the established BUI removal criteria. These data also support the observation that the concern regarding high chlorophyll *a* concentrations resulting from excessive *Cladophora* growth are not limited to the Rochester Embayment AOC but are indicative of lake-wide conditions.

3.3. Criterion 3: Secchi Disk Measurements

The BUI removal criterion regarding water clarity establishes Secchi disk measurements in the nearshore (12 meter depth) that are greater than or equal to 4 meters. In 2003, average Secchi disk depths for nearshore and offshore areas of Lake Ontario throughout the spring, summer, and fall were reported at 10.3, 7.8, and 6.7 meters, respectively (Mills et al., 2006). Additionally, a 2007 study documented Secchi disk depths at nearshore sites within the Rochester Embayment at 6.9 meters compared to readings of 3.4 meters at other embayment locations of Sodus, Sandy Pond, and Chaumont (Holeck et al., 2008). Results from these studies fall within the established BUI removal criterion for water clarity.

Recent secchi disk measurements recorded through long-term monitoring demonstrate improvement of nearshore water quality conditions. In 2018, mean secchi depth at the Oak Orchard Lake, Smoky Point-N, and Sodus Bay Lake sites were 6.4 meters, 7.5 meters, and 8.2 meters, respectively (Holeck et al 2019). These results fall within the established BUI removal criterion for water clarity.

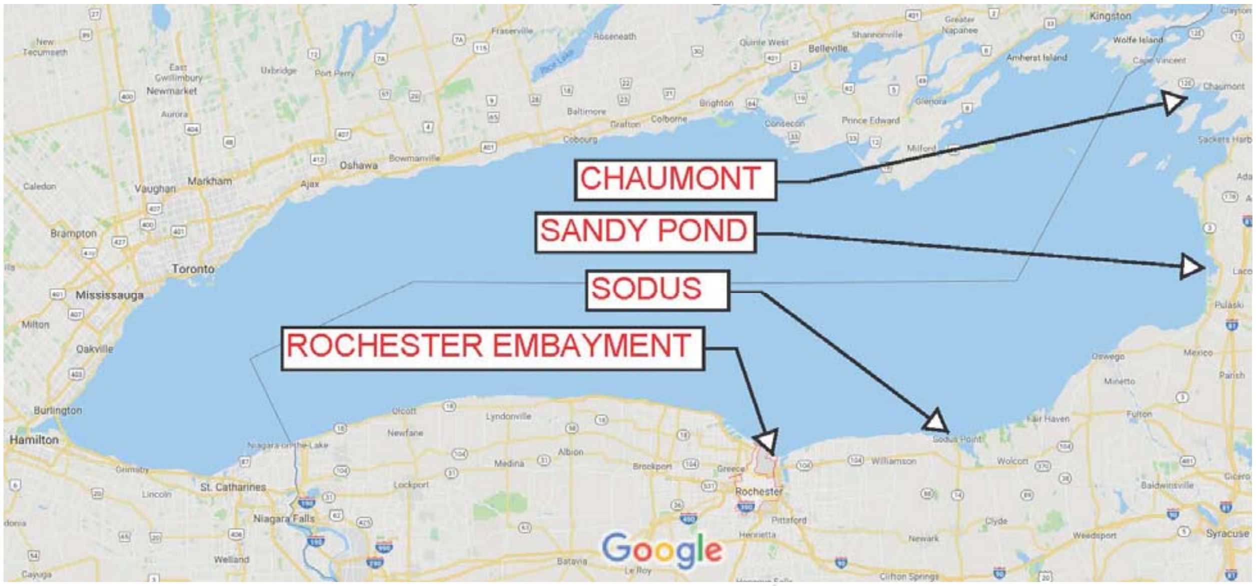

Figure 2. Additional Embayment Locations.

In addition to Secchi disk readings within local embayment areas, other parameters affecting water clarity are used to determine the clarity conditions within embayments and surrounding areas. Two of the main characteristics considered in the 2012 study of the physical and chemical characteristics of the southern Lake Ontario nearshore are total suspended solids (TSS) and algal productivity (Makarewicz et al., 2012a). Average TSS for southern embayment and shore side areas were 17 ppm and 20.9 ppb respectively. Average algal productivity for southern embayment and shore side areas were 33.4 ppm and 17.9 ppb respectively. Comparatively, the averages for all areas sampled were 12.48 ppm for TSS 12.48 and 10 ppb for algal productivity. As both of these properties inversely correspond to water clarity and were detected at significantly higher concentrations at embayment and shore side areas, it follows that water clarity is generally diminished in embayment and shore side areas (Makarewicz et al., 2012a). Therefore, it can be inferred that Secchi readings across southern Lake Ontario, if not lake-wide, would not generally reach the BUI removal criteria established for the Rochester Embayment AOC. These data support the argument that the water clarity impacts associated with the Eutrophication or Undesirable Algae BUI are in fact a lake-wide issue.

3.4. Criteria Conclusions

Through interpretation of the data addressed above, it can be determined that the established removal criteria for the Eutrophication or Undesirable Algae BUI are being met for the Rochester Embayment AOC. Furthermore, it is evident that the water quality and water clarity conditions relevant to the established removal criteria are not unique to the Rochester Embayment AOC but are indicative of lake-wide conditions. Therefore, it is recommended that additional actions and programs be implemented in areas outside of the AOC including other tributaries to Lake Ontario as well as the upstream watershed of the Genesee River. A number of these management actions are described in section four of this report. Through implementing management actions across the Lake Ontario basin geared toward reducing nutrient loads, those conditions that underly the Eutrophication or Undesirable Algae BUI will continue to improve, not just within the Rochester Embayment but throughout the basin.

4. Local Activities Supporting BUI Removal

Several projects and initiatives have been or are in the process of being implemented in order to directly address the problems at the root of the Eutrophication or Undesirable Algae BUI in the Rochester Embayment AOC, particularly in regards to the main factors that contribute to the prolific growth of *Cladophora*. The following projects and programs support or contribute to the BUI removal, as described below.

4.1. Combined Sewer Overflow Abatement Program (CSOAP)

Historical water quality problems associated with effluent discharges in and around Ontario Beach resulted in the development of a comprehensive sewerage system for the City of Rochester in the early 1900's. Still, by the 1960's, most of the County's water resources were affected by pollution. This led to the creation of the Monroe County Pure Waters Agency in 1967. Through this agency, a comprehensive plan was developed and released to address the county's sewerage needs through the year 2020. The plan recommended the construction of a regional sewerage conveyance and treatment system to aid in the handling of effluent entering creeks and streams in Monroe County. In addition to developing a master plan for the Rochester sewage system, in 1972 the extended staff of Pure Waters accepted responsibility for the care and maintenance of these systems.

In conjunction with the Pure Waters plan, the development of the Combined Sewer Overflow Abatement Program (CSOAP) was created and began operation in 1993. Through a series of tunnels and holding basins, over 99% of the total volume of CSOs is captured and properly treated at the Frank E. VanLare Wastewater Treatment Facility. This program prevents an average of 3.75 billion gallons per year of untreated overflow from entering local waterways. This update allows for a significant decrease in nutrient loading into the Rochester Embayment AOC resulting in a better condition for the management of algal growth and eutrophication effects within the local area.

4.2. Comprehensive Nutrient Management Plan (CNMP)

The Genesee River encompasses a watershed of 2,373 square miles in New York including 8 counties outside of Monroe before reaching the Rochester Embayment and flowing into Lake Ontario. This large area linked through one watershed allows for the accumulation of pollutants and nutrients to occur as more tributaries connect to the Genesee River as it flows towards Lake Ontario. As stated in the 2013 Lake Ontario Nearshore Nutrient Study, approximately 42% of total phosphorous deposited by the Genesee River into the Rochester Embayment is due to non-point source farming practices (Makarewicz et al., 2013).

To address non-point agricultural sources, the United States Department of Agriculture (USDA) and the EPA developed the Unified National Strategy for Animal Feeding Operations in 1999 which implemented the voluntary and regulatory expectations for animal feeding operations including the construction of Comprehensive Nutrient Management Plans (CNMP). The practices included in CNMPs encourage environmentally conscious farming methods that help to limit animal waste runoff and other sources of nutrient loading upstream in the Genesee River watershed. These practices include: constructing manure storage facilities, concrete protection in high use areas to inhibit erosion, and planting cover crops to create a riparian zone buffer.

Through the Natural Resources Conservation Service (NRCS), financial aid may be provided through the Environmental Quality Incentives Program (EQIP) to assist in the development and continuation of a CNMP for each project. Education plays another important role in the success of these management plans. Information such as articles with helpful tips for both residential and agricultural fertilizing practices allow for more efficient use of fertilizer and less stress on the surrounding aquatic ecosystems. One example of these educational resources is “5 Best Practices for Late Fall Fertilizer Management,” an article put forth by the University of Minnesota Extension of the “Lawn and Landscaping for the H2O Hero at Home” from the H2O Hero website. These articles detail how the public can best use fertilizer while still reducing the risk of contaminating run off through less use and informed application. By implementing CNMP practices, a greater volume of water high in nutrient load may be reduced or purified naturally before reaching the Genesee watershed thus limiting the nutrient load contamination of the Rochester Embayment AOC.

4.3. Algae Control System

Excessive masses of stagnant algae, especially *Cladophora*, have traditionally accumulated in the nearshore area adjacent to the West Pier at Ontario Beach, and have been responsible for decreased water quality and the expression of eutrophic conditions. In years past, the control of algal mats has required both manual and mechanical collection systems, which resulted in inefficient removal. To address this problem, an algae control system was developed and tested in a demonstration project in 2011. The system consists of a combination of a portable pump, intake, piping and hoses, which collect the algae from the West side of the pier and redistribute to the East side of the pier and into the Genesee River. The algae are eventually carried out to the deeper lake waters via river flow where conditions are less optimal resulting in algal and bacterial death.

The 2011 demonstration project was conducted by the United States Army Corps of Engineers (USACE) with their contractor, URS Corporation. The operation of the system during the demonstration project was made possible by the joint efforts of the Monroe County Departments of Public Health, Environmental Services, and Parks. Upon completion of the successful demonstration project, recommendations were made to implement the system as a permanent operation. Funding was provided from the USEPA Great Lakes National Program Office (GLNPO) to NYSDEC. Monroe County contracted with NYSDEC to acquire the funds to purchase the equipment and complete the work needed to cut the pier, install the piping, and related activities to get the system up and running. Monroe County also matched funding by agreeing to future operation and maintenance of the system. Ownership and maintenance of this system is the responsibility of the Monroe County Department of Environmental Services while operation of the algae pump is overseen by the Department of Parks. After being operational for the full 2015, 2016, 2017, and 2018 beach seasons, the system has proven to be effective in the elimination of algal mats previously known to accumulate in this area.

4.4. Water Education Collaborative (WEC)

One of the greatest sources of nutrient loading and contamination in the Rochester Embayment AOC and other local waterways is stormwater runoff carrying pollution from roadways, parking lots, and other impervious surfaces, as well as from lawn care and other homeowner activities. To help mitigate this problem, the Water Education Collaborative (WEC) was established in 2001 in response to a recommendation originally made in the Stage II Rochester Embayment RAP.

The mission of the WEC is to create a partnership between environmental and community organizations in order to encourage public education through programming consistent with the Rochester Embayment Remedial Action Plan (RAP) and other water resources within the community. Through this platform the WEC, with the support of Causewave Community Partners (formerly the Advertising Council of Rochester) and the Stormwater Coalition of Monroe County, launched the H2O Hero campaign in 2007 with the vision that individuals can have a positive impact on local water conditions through awareness and modest changes in certain everyday activities.

Through the H2O Hero campaign, the WEC offers interactive educational resources on the main sources of residential pollution and shows residents how they can reduce their pollution contribution and exhibit more environmentally responsible behavior through the proper use and storage of household and yard care products. By implementing the WEC and the H2O Hero campaign, the population within the regional watershed of Lake Ontario can better understand how they impact local water quality as well as how they can actively participate in efforts to improve and protect their water resources through the reduction of nutrient and pollutant loading to waterways.

4.5. Genesee River Nine (9) Element Plan

In September 2015, NYSDEC approved a Nine (9) Element Plan for the Genesee River watershed with the goal of reducing nutrient loading to the Genesee River. 9 Element Plans are locally-developed watershed-scale management plans for addressing known water quality issues. In the case of the Genesee River watershed, the primary water quality issues identified in the Nine Element Plan are phosphorous and sediment loading to the Genesee River.
The Nine Element Plan identified the major sub-basins within the Genesee River watershed, and prioritized nutrient and sediment reduction efforts within these sub-basins. Based on the management measures identified, the Nine Element Plan provides target reductions in phosphorous and sediment loading to the Genesee River. In order to assess the effectiveness of the management measures, the Nine Element Plan calls for continuous monitoring of water quality throughout the Genesee River watershed both through NYSDEC's Rotating Intensive Basin Studies (RIBS) program as well as through USGS monitoring in the lower Genesee River. The Nine Element Plan for the Genesee River is included as **Appendix C** to this report.

4.6. Genesee River Watershed Coalition of Conservation Districts (GRWCCD)

NYSDEC is providing support to the New York State Department of Agriculture and Markets (NYSDAM) through the Natural Resource Conservation Service (NRCS) Regional Conservation Practice Program (RCPP) within the Genesee River Basin. The intent of the RCPP is to facilitate the implementation of agricultural Best Management Practices (BMPs) through local agencies, in particular Soil and Water Conservation Districts (SWCDs). Agricultural BMPs include, but are not limited to: soil health improvement, riparian corridor management, and sediment control practices on agricultural lands adjacent to waterways. These types of BMPs have been demonstrated to be effective means of reducing nutrient and sediment loads to the Genesee River from tributaries, and subsequently reducing the nutrient and sediment loading from the Genesee River to the Rochester Embayment and Lake Ontario nearshore. Preliminary results from the program have been encouraging, and the GRWCCD RCPP is anticipated to continue to be implemented through 2021.

4.7. Monroe County Pure Waters Master Plan

Historical water quality problems associated with urban growth throughout Monroe County, particularly within the city of Rochester, outpacing and stressing local sewerage systems led to the creation of the Monroe County Pure Waters Agency in 1967. This agency produced the Monroe County Pure Waters Master Plan in 1969 to address the county's sewerage needs through the year 2020. This comprehensive plan recommended the construction of a regional sewerage conveyance and treatment system to aid in the handling of effluent, and to reduce WWTF discharges to creeks and streams in Monroe County, as well as Irondequoit Bay. As a result of the implementation of the Pure Waters Master Plan, water quality in the lower Genesee River has improved significantly, with over 50 percent reduction in phosphorous loading documented through water quality monitoring performed by MCDPH and the United States Geological Survey (Monroe County Department of Environmental Services, 2016).

5. Evidence Supporting Lake-Wide Issue

A thorough analysis of available research was completed to assess the status of the Eutrophication or Undesirable Algae BUI in the context of the removal scenario whereby it can be demonstrated that: "The impairment is not solely of local geographic extent, but is typical of upstream conditions OR conditions outside of the AOC boundaries on a regional scale. Such re-designation would be contingent upon evidence that sources within the AOC are controlled" (USPC, 2001). As a result of this analysis, it has been determined that removal of the Eutrophication or Undesirable Algae BUI is also appropriate under this scenario. The relevant research that was considered in this analysis is discussed below.

5.1. Invasive Mussel Species

Though the algal genus *Cladophora* is native to the Great Lakes ecosystem, anthropogenic causes, such as excessive nutrient deposition, have allowed for this genus to flourish to the point of system impairment. Policies have been established to reduce these deposits, but the use of these nutrients is amplified in the ecosystem due to invasive mussel species including zebra and quagga mussels. These mussels act to transfer nutrients suspended in the water into the benthic sediments allowing for the algae to access these nutrients and grow excessively. In addition to nutrient transfer, the invasive mussels consume phytoplankton resulting in a decrease in phytoplankton population and an increase in water clarity. This increase in clarity allows for sunlight to penetrate farther in water thus expanding the littoral zone or area suitable for *Cladophora* growth and further increasing the abundance of undesirable algae. Examples of these mussel invasions and environmental impacts can be seen in the Rochester Embayment area but are present lake-wide and are of environmental concern for a majority of the Great Lakes.

5.2. Increased Surface Water Temperature

Lake Ontario has experienced a gradual increase in surface water temperatures over the past few decades, resulting in adverse effects relating to nuisance algae growth. Since 1980, the surface water temperatures for Lake Ontario have risen approximately 0.96˚C per decade, allowing for environmental changes to occur including spikes in *Cladophora* algal growth (Malkin, 2008). Increases in water temperatures can lead to a decrease in annual ice coverage and in turn an increase in the growing seasons for algae.

In addition to lengthening growth periods, rising water temperatures contribute to the overall expansion in the suitable habitat ranges for invasive species such as zebra and quagga mussels.

By increasing their suitable habitat, these species can better facilitate a nutrient-rich environment for *Cladophora* to grow at nuisance levels. This change in water temperature can be seen locally in the Rochester Embayment AOC but is also evident throughout Lake Ontario and therefore is indicative of lake-wide conditions.

5.3. Lake-Wide Nutrient Deposition

Due to the natural flow of the Great Lakes, with Lake Ontario farthest downstream, nutrient loading throughout the Great Lakes Basin adds to the impacts of eutrophication seen in Lake Ontario and the Rochester Embayment AOC. With approximately 83% of all surface water in Lake Ontario deriving from Lake Erie via the Niagara River, the transfer of soluble nutrients and pollutants can occur from lake to lake (EPA, 2001). With this large of a water contribution, the Niagara River is responsible for the greatest amount of nutrient deposition of all major sources into Lake Ontario.

In addition to the interconnectedness of the Great Lakes, Lake Ontario is also strongly influenced by nutrient sources contained within the lake's watershed. Lake Ontario has the highest ratio of lake watershed area to lake surface area and therefore is more sensitive to terrestrial non-point sources of nutrients and pollutants as compared to the other Great Lakes. This is compounded by the increased difficulty of tracking down nutrient sources upstream of major river systems flowing into Lake Ontario including the Genesee River and other highly developed river systems.

Proliferation of nuisance free floating algae is a complex and dynamic process driven by many factors. While excess nutrients available for uptake can promote nuisance and harmful algal blooms, it is not a singular influence. Climate warming leading to increases in surface water temperature and significant changes in weather patterns has had profound effects. Under these conditions, vertical stratification is intensified, and seasonal warming can lengthen the period of stratification (Paerl and Paul, 2012). Studies mentioned in this report have clearly demonstrated achieved targets to increase water clarity, and decrease total phosphorus and chlorophyll-a concentrations, regardless of instances of nuisance algal blooms. It is important to note long-term monitoring programs currently in place will continue to document temporal changes in nearshore areas lake-wide.

Major tributaries lake-wide contain higher concentrations of contaminants and nutrients such as total phosphorus and chlorides as compared to the bodies of water they flow into. Examples of these for northern tributaries include Grimsby, Ajax, Cobourg, and two additional greater Toronto rivers. All five rivers sampled contained total phosphorus and chloride concentrations that were significantly higher than the shore side areas surrounding them (Howell, 2012). This same condition can be observed along the southern shore of Lake Ontario at tributary areas such as the Genesee River, Oak Orchard Creek, and Mexico Bay where total phosphorus concentrations were greatest at tributaries with levels decreasing further from shore (Makarewicz et al., 2012a).

High concentrations of contaminants in tributaries can also be amplified by seasonal changes in lake currents that can restrict natural flow and dispersion, resulting in a buildup of nutrients at embayment areas. These restrictions occur in the Rochester Embayment mainly in June, when the lake current flows from east to west causing river deposits to disperse west towards the shore instead of out into Lake Ontario (Makarewicz et al., 2012b). During this time, an increased level of both total phosphorus and chlorophyll *a* can be seen compared to other months. This shows that delisting parameters are greatly affected by both the inputs from upstream of the AOC in Genesee River watershed and seasonally variable lake conditions. With the amount of water passing through the Rochester Embayment via external sources, whether inter-lake or upstream, nutrient load dependent eutrophication is amplified due to sources outside of the AOC thus supporting the observation that these conditions are lake-wide issues.

5.4. Lake-Wide *Cladophora* Shoreline Occurrence

Due to the multitude of factors discussed above, *Cladophora* has developed excessively across a broad extent of the Lake Ontario shoreline. This is documented at the international level through research conducted on the Canadian coast of Lake Ontario. A 2006 study of the Lake Ontario coastal zone indicated widespread nuisance levels of algae growth along the northern coast of Lake Ontario with the highest algae biomass occurring on the western shore including the Toronto and Halton area (Makarewicz and Howell, 2008). This information on the occurrence of algae in Halton was also recorded in the Lake Ontario Shoreline Algae Action Advisement Committee (LOSAAAC) report developed specifically to address excessive *Cladophora* growth in this area. A review of the reported cases of *Cladophora* growth along the Lake Ontario coast including areas external to the Rochester Embayment AOC supports the observation that this impairment is in fact a lake-wide condition. Therefore, additional management actions to address these lake-wide conditions go beyond the scope of the Rochester Embayment RAP.

6. Public Outreach

NYSDEC and MCDPH hosted a public meeting on the status of multiple Rochester Embayment BUIs at 5:30 p.m. on March 15, 2018 at the Roger Robach Community Center located 180 Beach Avenue in Rochester. Notification of this meeting was distributed to local government officials, local media, and local environmental advocacy groups. Postcards were mailed to 600+ local resident addresses. Three BUIs were featured at this event: Beach Closings, Eutrophication or Undesirable Algae, and Restrictions on Dredging Activities.

Approximately 40 people attended this event. Pamphlets about the Area of Concern and its Beneficial Use Impairments were distributed and posters on each Beneficial Use Impairment were displayed and staffed by State and County experts. Draft copies of the Eutrophication or Undesirable Algae BUI removal report were available for attendees. Overall, the comments received were positive and the few questions formally posed were answered. No formal comments were submitted in writing, and as such no responsiveness summary is included in this document.

7. Summary, Conclusion, and Removal Statement

The Eutrophication or Undesirable Algae BUI was originally listed as impaired due to increased phosphorus concentrations due to the introduction of contaminated water from Genesee River tributaries containing fertilizers or phosphate detergents (agriculture, sewage, etc.), an increase in phosphorus concentrations due to the reintroduction of phosphorus sediments exposed by benthic sediment disturbance (dredging), and the influence of invasive mussel species resulting in an increase in suitable algae habitat and greater access to sunlight and nutrients.

Through the RAP process, several management actions have been undertaken to improve water quality and reduce the occurrence of eutrophication or undesirable algal blooms within the Rochester Embayment AOC to the maximum extent practicable under the RAP. MCDPH and NYSDEC have determined that the established removal criteria for the Eutrophication or Undesirable Algae BUI have been substantially met. Additionally, data presented herein illustrate that the water quality impairments underlying the Eutrophication or Undesirable Algae BUI are not unique to the Rochester Embayment AOC, but are representative of lake-wide conditions. Therefore, the Eutrophication or Undesirable Algae BUI can removed, and further actions to address the root problems associated with this BUI should be given to programs with a broader focus, such as the Lake Ontario Lakewide Action and Management Plan, or LAMP. The Rochester Embayment RAC fully supports the removal of this BUI.

7.1. Post-Removal Responsibilities

New York State Department of Environmental Conservation

NYSDEC will continue to monitor water quality in the lower Genesee River and throughout the Lake Ontario Basin through a variety of statewide programs and initiatives, including the Rotating Intensive Basin Studies (RIBS) program. The RIBS program monitors for a broad suite of contaminants, including nutrients such as phosphorous and nitrogen that can contribute to eutrophication-related issues.

United States Environmental Protection Agency

USEPA will continue to provide funding for RAP/RAC coordination and technical assistance to the extent that resources are available to support the removal of remaining BUIs and ultimately the delisting of the Rochester Embayment AOC. NYSDEC Great Lakes Program staff will continue to assist with these efforts.

Monroe County Department of Public Health

With EPA/GLRI funding, MCDPH currently provides a Coordinator for the Rochester Embayment AOC RAP, facilitation with RAC efforts, and technical assistance for AOC documentation and project design. With ongoing funding support, MCDPH will continue in these roles to assist the RAC and USEPA in achieving the long-term goal of delisting the Rochester Embayment AOC.

Remedial Advisory Committee

The RAC will continue to forward the objectives of the RAP by evaluating, supporting, and documenting the restoration of the Rochester Embayment AOC, until all of the Beneficial Use Impairments are restored and the long-term goal of delisting the AOC can be achieved.

Appendices

A. List of Remedial Advisory Committee Members

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585-753-5470

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B. References

Brooks, C., et al., A satellite-based multi-temporal assessment of the extent of nuisance *Cladophora* and related submergent aquatic vegetation for the Laurentian Great Lakes, *Remote Sensing of Environment*. 2014.

Ecology and Environment. March, 2009. Rochester Embayment Area of Concern Beneficial Use Impairment Delisting Criteria Report.

Ecology and Environment. June, 2011. Rochester Embayment Area of Concern Strategic Plan for Beneficial Use Impairment Delisting.

Howell, E.T., Chomicki, K.M., Kaltenecker, G., 2012. Patterns in water quality on Canadian shores of Lake Ontario: Correspondence with proximity to land and level of urbanization. J. Great Lakes Res. 38 (Suppl. 4), 32–46.

H2ohero.org. (2017). *The Watershed: H2O University: Learn to live the H2O Hero way*.

International Joint Commission. 1991. Restoring Beneficial Uses in Areas of Concern.

Holeck, K.T., Watkins, J.M., Mills, E.L., Johannsson, O., Millard, S., Richardson, V., Bowen, K. 2008. Spatial and long-term temporal assessment of Lake Ontario water clarity, nutrients, chlorophyll a, and zooplankton: Aquatic Ecosystem Health Management, 11 (2008), pp. 377-391

Holeck, K.T., Rudstam, L.G., Hotaling, C., Lemon, D., Pearsall, W., Lantry, J.R., Connerton, M.J., Legard, C., Lepan, S., Biesinger, Z., Lantry, B.F., and Weidel, B.C. 2019. 2018 status of the Lake Ontario lower trophic levels, in: NYSDEC (Ed.), NYSDEC 2018 Annual Report, Bureau of Fisheries Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission's Lake Ontario Committee. Albany, NY.

2008. Lake Ontario Lakewide Management Plan Update. Available online at http://www.epa.gov/greatlakes/ontario.html

Lake Ontario Shoreline Algae Action Advisory Committee. January 2008. Final Report

Malkin, Sairah, et al., Modeling the growth response of *Cladophora* in a Laurentian Great Lake to the exotic invader *Dreissena* and to lake warming, *Limnology Oceanography*. 2008.

Makarewicz, J.C, et al. 2013. Lake Ontario Nearshore Nutrient Study : 2013. Lake Ontario Nearshore Nutrient Study : 2013.

Makarewicz, J.C., Lewis, T.W., Pennuto, C.M., Atkinson, J.F., Edwards, W.J., Boyer, G.L., Howell, E.T., Thomas, G., 2012a. Physical and chemical characteristics of the nearshore zone of Lake Ontario. J. Great Lakes Res. 38 (Suppl. 4), 21–31.

Makarewicz, J.C., Lewis, T.W., Boyer, G.L., Edwards, W.J., 2012b. The influence of streams on nearshore water chemistry, Lake Ontario: Journal of Great Lakes Research 38 (Suppl. 4), 62–71

Makarewicz, J.C., Lewis, T.W., Snyder, B., Winslow, M.J., Pettenski, D., Rea, E., Dressel, L., and Smith, W.B. “Genesee River Watershed Project. Volume 1. Water Quality Analysis of the Genesee River Watershed: Nutrient Concentration and Loading, Identification of Point and Nonpoint Sources of Pollution, Total Maximum Daily Load, and an Assessment of Management Practices using the Soil Water Assessment Tool (SWAT) Model. A report to the USDA.” (2013) *Technical Reports.* 124.

Makarewicz, J.C. and Howell, T. October 2008. Lake Ontario Coastal Zone: Status and Assessment. Lake Ontario Intensive Year 2006. Kingston, Ontario.

Mills, E.L., Dermott, R. 2006. Final Report for Developing the Next Generation of Great Lakes Lower Food Web Assessment Tools. The 2003 Lake Ontario Lower Food Web Assessment (LOLA).

Monroe County Department of Environmental Services, “A History of Pure Waters.” (2016) https://www2.monroecounty.gov/files/DES/PureWatersHandout-Final%20C.pdf

Monroe County Department of Health (MCDOH). August, 1993. Rochester Embayment Remedial Action Plan Stage I.

Monroe County Department of Health (MCDOH). September, 1997. Rochester Embayment Remedial Action Plan Stage II.

MCDPH, Rochester Embayment Remedial Action Plan 1999 Addendum, 1999.

MCDPH, Rochester Embayment Remedial Action Plan 2002 Addendum, 2002.

Paerl, H.W. and Paul, V.J. 2012. Climate change: links to global expansion of cyanobacteria. Water Research. 46: 1349-1363

Pavlac, M.M., Smith, T.T., Thomas, S.P., Makarewicz, J.C., Edwards, W.J., Pennuto, C.M., Boyer, G.L., 2012. Assessment of phytoplankton distribution in the nearshore zone using continuous in situ fluorometry. J. Great Lakes Res. 38 (Suppl. 4), 78–84.

United States Army Corps of Engineers (USACE), 2011, “Engineering and Design Work Plan for Algae Control Study”. Prepared for the USACE by URS/Baird JV 2011.

United States Department of Agriculture (USDA). 2003. “Cost Associated With Development and Implementation of Comprehensive Nutrient Management Plans.”

United States Policy Committee. 2001. Restoring United States Areas of Concern: Delisting Principles and Guidelines. Adopted by the US Policy Committee on December 6, 2001.

Yurista, P.M., Kelly, J.R., Miller, S., Van Alstine, J., 2012. Lake Ontario: Nearshore conditions and variability in water quality parameters. J. Great Lakes Res. 38 (Suppl. 4), 133–145.

C. Genesee River Nine Element Watershed Plan

Nine Key Element Watershed Plan Assessment Form

New York State Department of Environmental Conservation, Division of Water is responsible for t reviewing and approving watershed plans to ensure the plans meet the Nine Key Elements established by the USEPA. This form is to be completed by NYSDEC staff to ensure each of the Nine Key Elements are addressed in plans that are designated as State Approved Plans.

Watershed plan title: Genesee River Basin Nine Element Watershed Plan for Phosphorus and Sediment

Pollutant(s) addressed by plan: Phosphorus and Sediment

Prepared by: New York State Department of Environmental Conservation Division of Water

Submitted by: New York State Department of Environmental Conservation Division of Water

☐ Addresses watershed with an existing TMDL

☒ Update to previously approved plan

Reviewer 1: Karen Stainbrook Reviewer 2: Cameron Ross

Comments:

☒ Watershed plan is approved as a State Approved Nine Key Element Watershed Plan

Date Approved: 9/30/2015

Directions to the reviewer
For each item on the form, indicate if the item is present. If an item is not applicable, indicate N/A and explain in the comments section. Where possible, indicate the page number or section in the plan where the item is found. It is not necessary for every item on the form to be included in the watershed plan. However, each of the nine key elements must be satisfactorily addressed for the plan to receive approval. The reviewer is directed to the Handbook for Developing Watershed Plans to Restore and Protect our Waters (USEPA Office of Water Nonpoint Source Control Branch, 2008; EPA 841-B-08-002) to assist in determining if each element is adequately addressed. Additional comments or concerns can also be included in the comments sections.

Section 1. Qualifications of the plan preparer(s)

Preparers and Role

Role	Name
Modeling	Makarewicz research group at The SUNY College at Brockport
Best Management Practices	Makarewicz research group at The SUNY College at Brockport
Outreach	Various
Monitoring	Various
Partnerships	Various

Section 2. Nine Elements Checklist

Element A. Causes/Sources of Pollution Identified

Identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed plan.	Item present (Y/N/NA)		Page or section number
1. Pollutant(s) to be addressed by watershed plan are clearly stated?	Y	Y	
2. Are sources of pollution identified, mapped and described? Are causes identified?	Y	Y	
3. Are loads from identified sources quantified?	Y	Y	
4. Are there any sub-watershed areas? If so, are the sources broken down to the sub-watershed level?	Y	Y	
5. Are data sources indicated? Are estimates and assumptions reasonable?	Y	Y	
Comments:			

Element B. Expected Load Reductions for Solutions Identified

Estimate of the load reductions expected for the management measures described under Element C.	Item present Y/N/NA		Page or section number
1. Are expected load reductions analyzed to ensure water quality standards and/or other goals will be achieved?	Y	Y	
2. Are expected load reductions linked to a pollution cause/source identified in Element A?	Y	Y	
3. Is the complexity of modeling used appropriate for the watershed characteristics, the scale and complexity of the impairment, and the extent of water quality data identified in Element A?	Y	Y	
4. Does the plan explain why the BMPs were selected? Will the BMPs described in the plan effectively achieve load reductions?	Y	Y	
5. Are estimates, assumptions, and other data used in the analysis reasonable?	Y	Y	
Comments: Load reduction estimated were calculated at the sub-watershed (assumes 100% implementation for all BMPs throughout watershed); this is not realistic.			

Element C. Nonpoint Source Management Measures Identified

A description of the NPS management measures that will be implemented to achieve the load reductions estimated in Element B and identification of the critical areas for implementation.	Item Present (Y/N/NA)		Page or section number
1. Does the plan list and describe BMPs that will address the causes/sources of pollution identified in Element A?	Y	Y	
2. Have critical and priority areas been identified? Is the methodology for identifying critical and priority areas explained?	Y	Y	
3. Is the rationale given for the selection of BMPs?	Y	Y	
4. Are BMPs applicable to the pollutant causes and sources?	Y	Y	
5. In selecting and siting the BMPs at the sub-watershed level, are the estimates, assumptions and other data used in this analysis technically sound?	Y	Y	
Comments:			

Element D. Technical and Financial Assistance

An estimate of the amounts of technical and/or financial assistance needed, associated costs, and/or the sources and parties that will be relied upon to implement this plan.	Item present (Y/N/NA)		Page or section number
1. Estimate of Technical Assistance Needed			
a. Are potential sources of technical assistance included?	Y	Y	
b. Does the watershed plan describe the anticipated involvement of assisting agencies, watershed groups or volunteers?	Y	Y	
c. Are additional technical assistance needs identified?	NA	NA	
2. Estimate of Financial Assistance Needed			
a. Is a detailed cost estimate included?	Y	Y	
b. Does the cost estimate include a reasonable estimate of all planning and implementation costs?	Y	Y	
c. Are potential funding sources included?	Y	Y	
Comments:			

Element E. Education/Outreach

An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation.	Item present (Y/N/NA)		Page or section number
1. Does the watershed plan identify relevant stakeholders?	Y	Y	
2. Does the watershed plan include methods to inform and engage stakeholders and landowners in continued participation and implementation?	Y	Y	
3. Were stakeholders involved in development of the plan? Does the plan provide describe the stakeholders? Do the stakeholders referenced in the plan seem appropriate for the objectives of the watershed plan?	Y	Y	
4. Does the watershed plan identify potential partners who may be involved in implementation?	Y	Y	
5. Do the education components emphasize the need to achieve water quality standards?	Y	Y	
6. Does the education components prepare stakeholders for continued proper operation and maintenance of the BMPs after the project is completed?	Y	Y	
Comments:			

Element F. Implementation Schedule

A schedule for implementing nonpoint source management measures identified in this plan that is reasonably expeditious.	Item present (Y/N/NA)		Page or section number
1. Does the schedule/timeline present projected dates for the development and implementation of the actions needed to meet the goals of the watershed plan?	Y	Y	
2. Is the schedule appropriate based on the complexity of the impact and the size of the watershed?	Y	Y	
Comments:			

Element G. Milestones Identified

A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Item present (Y/N/NA)		Page or section number
1. Are the identified milestones measurable and attainable?	Y	Y	
2. Does the watershed plan identify incremental milestones with anticipated completion dates?	Y	Y	
3. Does the watershed plan include progress evaluations and possible "course corrections" as needed?	see comment		
4. Are the milestones appropriately linked with the proposed schedule in Element F?	Y	Y	
Comments: Does not explicitly state in this section that progress evaluations will be used to update plan, however, the other elements identify adaptive management as part of the planning process.			

Element H. Criteria to Evaluate Load Reductions

A set of criteria that will be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards.	Item present (Y/N/NA)		Page or section number
1. Are criteria measureable and quantifiable?	Y	Y	
2. Do the proposed criteria effectively measure progress towards the load reduction goal?	Y	Y	
3. Are the types of data to be collected identified?	Y	Y	
4. Does the watershed plan include a review process to determine if anticipated reductions are being met?	Y*	Y*	
5. Is there a commitment to adaptive management in the watershed plan?	Y	Y	
Comments: *Addressed in Element I.			

Element I. Monitoring

A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under Element H.	Item present (Y/N/NA)		Page or section number
1. Explanation of how monitoring fits into Plan			
a. Does the plan describe how monitoring will effectively measure the evaluation criteria identified in Element H?	Y	Y	
b. Does the watershed plan include a routine reporting element in which monitoring results are presented?	Y	Y	
2. Monitoring Methods			
a. Are the parameters appropriate?	Y	Y	
b. Is the number of sites adequate?	Y*	Y*	
c. Is the frequency of sampling adequate?	Y*	Y*	
d. Is the monitoring tied to a quality assurance plan?	Y*	Y*	
Comments: *Number of sites not provided; NYSDEC monitoring programs will ensure adequate number of sites and distribution of locations, and frequency of sampling to assess progress and QAPP.			

Section 3. Additional documentation

Documentation and References

Additional information and documentation preferred to be included in the 9 element plan by the Department	Item present (Y/N/NA)	Page or section number
1. Does the plan include a copy or link to a data monitoring quality assurance project plan (QAPP)? Was the QAPP approved by NYS DEC or other state or federal agency?	N*	
2. Does the plan include a copy or link to an electronic copy of a modeling QAPP? Was the QAPP approved by NYS DEC or other state or federal agency?	N*	
3. If the plan referenced other reports or plans as the basis for any of the elements in Section 2, did the plan preparers provide links to electronic copies or paper copies?	Y	
Comments: *Descriptions in Makarewicz research group reports.		

NEW YORK STATE OF OPPORTUNITY. | Department of Environmental Conservation

GENESEE RIVER BASIN

NINE KEY ELEMENT WATERSHED PLAN

FOR PHOSPHORUS AND SEDIMENT

September 2015

DIVISION OF WATER
Bureau of Water Resource Management

625 Broadway, Albany, NY 12233-3508

www.dec.ny.gov

Document Change Log

Date	Revision Author	Description
June 2014	S. Gladding	Initial draft submitted for approval
July 2015	S. Gladding	Updated to incorporate feedback from CEI June 2015 conference; public comments (comment period June-July 2015)
September 2015	K. Stainbrook & C. Ross	Edited document for consistent and concise language; finalized edits. Submitted to EPA for concurrence.

Contents

Background

The U.S. EPA has identified nine key elements that should be contained within a watershed plan (EPA, 2008). The Genesee River basin is well studied and collectively these reports can serve as the basis for a 9 element plan. This document compiles these existing documents to address the nine key elements into the Genesee River Basin 9 Key Element Watershed Plan to address phosphorus and sediment. Information and conclusions are summarized from the existing reports, to support consistency with each of the nine elements. References to the original reports are included; please refer to the original reports for the specific details of the analyses.

Introduction

The Genesee River originates in Potter County, Pennsylvania and then flows north across New York to Rochester where it flows into Lake Ontario. Impacts from nutrient and sediment are observed throughout the watershed and within the Rochester embayment of Lake Ontario. The Genesee River is the second largest tributary loading of phosphorus to Lake Ontario. To address nutrient and sediment pollution within this large watershed (2,490 square miles), management practices are needed in all of the major sub-basins (Figure 1). This 9 Key Element Watershed Plan identifies and prioritizes areas within the major sub-basins where conservation efforts should be focused.

An adaptive management approach is necessary for successful implementation. The plan will be updated as the plan is implemented, local water quality problems improve, new priorities arise and when additional information becomes available. When watershed plans are developed at smaller scales, that are better able to identify, prioritize and address local water quality concerns, they should be incorporated into this framework and given equal consideration so long as they are consistent with the overarching goals of this document; reducing phosphorus and sediment loads within the Genesee River basin.

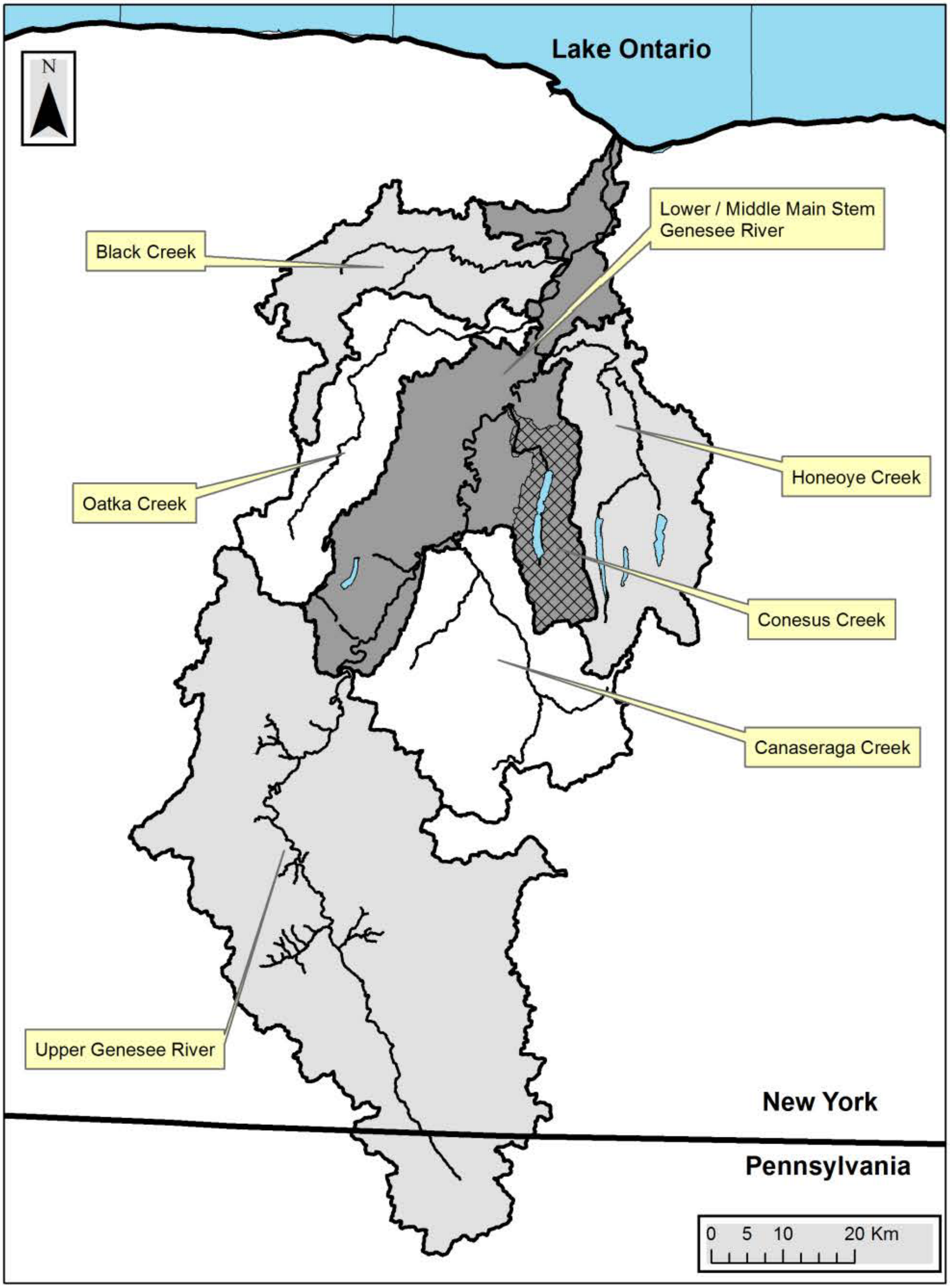

Figure 1: Major subbasins within the Genesee River watershed (Makarewicz J. C., et al., 2013)

Element A. Identification of causes of impairments and pollutant sources

The 2014 New York State 303(d) list identifies impaired waterbodies within New York State and includes both the cause and source(s) of the impairment(s). Impairments relevant to phosphorus and sediment for the Genesee River basin are listed in Table 1. Additional information on each waterbody can be found in the NYS 303(d) list and in the Genesee River Waterbody Inventory and Priority Waterbodies List (WI/PWL).

The Makarewicz research group at The SUNY College at Brockport produced a series of reports which characterized the loads and sources of phosphorus and sediment for the entire Genesee River basin (Makarewicz J. C., et al., 2013) (Makarewicz J. C., Lewis, Snyder, & Smith, 2013) (Makarewicz, Lewis, & Snyder, 2013) (Winslow, Makarewicz, & Lewis, 2013) (Rea, Makarewicz, & Lewis, 2013) (Pettenski, Makarewicz, & Lewis, 2013). The projects included flow measurements, intensive water quality sampling and analysis over several years. Calibrated SWAT models were developed using those data. The SWAT models were then used to further identify and allocate sources of sediment and phosphorus and estimate potential load reductions from various management practice scenarios. The reports estimated that the current sediment load to Lake Ontario from the Genesee River is 8.5×10^{8} lb/yr. The estimated phosphorus load to Lake Ontario is between 909,417 lb/yr (estimated by Makarewicz reports) and 968,000 lb/yr (estimated by Hayhurst et al. (2010) for 2003-2008). Appendix B summarizes total phosphorus and sediment loads for each sub-basin.

Table 1: Impaired waterbodies in the Genesee River basin (NYSDEC, 2014). Only impairments relevant to nutrients or silt/sediment are included.

Watershed Index No.	Waterbody Name	Cause/Pollutant	Source
Ont 117 (portion 1)	Genesee River, Lower, Main Stem	Phosphorus Silt/Sediment	Various, multiple
Ont 117 (portion 2)	Genesee River, Middle, Main Stem	Oxygen Demand Phosphorus	Agriculture
Ont 117-19	Black Creek, Lower and minor tribs Black Creek, Middle and minor tribs Black Creek, Upper and minor tribs	Phosphorus	Agriculture, Municipal
Ont 117-19-4	Mill Creek/ Blue Pont Outlet and tribs	Phosphorus	Agriculture
Ont 117-25-7-4-P2a	LeRoy Reservoir	Phosphorus	Agriculture
Ont 117-27-P57	Honeoye Lake	Phosphorus Oxygen Demand	Unknown
Ont 117-40-P67	Conesus Lake	Phosphorus Oxygen Demand	Agriculture
Ont 117-42	Christie Creek and tribs	Phosphorus	Agriculture
Ont 117-66-8-2	Bradner Creek and tribs	Phosphorus	Agriculture
Ont 117-169-P159a Ont 117-169-P159b	Amity Lake Saunders Pond	Phosphorus	Unknown
Ont 117-27-34	Hemlock Lake Outlet and minor tribs	Phosphorus Pathogens	Onsite Waste Treatment Systems
Ont 117-19-30	Bigelow Creek and tribs	Phosphorus	Agriculture
Ont 117-27-13	Unnamed Trib to Honeoye Creek and tribs	Nutrients	Agriculture
Ont 117-57	Jaycox Creek and tribs	Phosphorus Silt/Sediment	Agriculture
One 117-66-22	Mill Creek and minor tribs	Silt/Sediment	Stream bank erosion

Estimated phosphorus loads were attributed to different source sectors based on Makarewicz J. C., et al. (2013) modeling results. Using the percentages documented in that report, estimated loads from each source sector were calculated (Table 2). There are small discrepancies between measured and modeled loads reported in the various documents cited above. Also, while not discussed in this document, model results from some river reaches estimated greater sediment and phosphorus loads upstream than the downstream load estimates. Loads reported here should be considered order of magnitude estimates rather than absolute values, but are deemed sufficiently accurate for this plan.

Table 2: Estimated source sector loads for the entire Genesee River basin as estimated by Makarewicz et al. (2013).

Land Use/Activity	Estimated percent load	Estimated phosphorus load (lb/yr)	Estimated sediment (TSS) load (lb/yr)
Agricultural crops	28.3	208,192	
Tile drainage	5.3	38,990	
Farm animals (CAFO only)	8.8	64,738	
Stream bank erosion	5.0	36,783	
Wetlands	0.3	2,207	
Groundwater	29.3	215,548	
Forest	5.4	39,726	
Urban Runoff	1.9	13,978	
Rochester storm sewer*		5,020	1.3×10^6
Rochester CSO*		3,382	0.8×10^6
Point sources	11.5	104,583**	
Septic systems	4.2	30,898	
Sum of sources		755,642	
Total (includes % error)	100	909,417	8.5×10^8

*The Makarewicz research group produced an additional model of the sewer contributions from the city of Rochester (Dressel, 2014). The estimated loads are included here as a subset of the urban runoff loads from the greater Genesee River model (Makarewicz J. C., et al., 2013).

**Point source contributions were estimated based upon limited available data. Additional data from facility Discharge Monitoring Reports indicate the current contribution of phosphorus to the Genesee River from wastewater treatment plants is approximately 79,400 lb/yr.

Priority watersheds in the lower/middle Genesee River basin

The lower/middle Genesee River Basin receives inputs from all of the other subwatersheds identified in Figure 1. The lower/middle basin contributes approximately 97,734 lb/yr of phosphorus, or just over 10% of the total load from the entire watershed. The lower/middle Genesee River basin was not considered separately in the modeling conducted by Makarewicz et al. (2013), but rather was incorporated as part of the model of the entire Genesee River basin.

Data and information from the USGS Sparrow model results (Robertson & Saad, 2011), and information from the WI/PWL (NYSDEC, 2003) and 303(d) list (NYSDEC, 2014) were used to identify lower/middle basin watersheds with high phosphorus load contribution estimates and demonstrated nutrient impacts. High priority watersheds within the lower/middle Genesee River basin are listed in Table 3. Appendix A (Tables 17-19) and Figure 2 summarize the prioritization for all HUC12s.

Table 3: High priority watersheds in the lower/middle Genesee River watershed. See Appendix A for the entire Genesee River basin list and for a map of HUC12 locations.

Subwatershed	Watershed Index Number	HUC12
Genesee River, lower	Ont 117 (portion 1)	041300030704
Genesee River, middle	Ont 117 (portion 2)	041300030703
Jaycox Creek	Ont 117-57	041300030502
Christie Creek	Ont 117-42	041300030504
Conesus Lake	Ont 117-40-P67	041300030102
Conesus Lake tributaries	Ont 117-40-P67-	041300030102

High priority subwatersheds, within the Conesus Lake watershed, identified in the Conesus Lake Watershed Management Plan (CLWMPP, 2003) are included in Table 3 as part of the Conesus Lake tributaries and the associated HUC12. The high priority subwatersheds identified in the Plan include: North and Long Point Gullies, Northwest, Sand Point, No Name, Cottonwood and Central Creek subwatersheds. Moderate and Low priority subwatersheds were also identified in the Plan and are shown in Maps 4-1 and 4-2 of that report. Areas of stream bank and ditch erosion are also indicated within the CLWMPP report in Maps 5-1 and 5-2, respectively. NYSDEC is currently developing a 9 Key Element Watershed Plan for the Conesus Lake watershed. Once completed, the document will be considered part of this plan and may be used to guide implementation at a finer scale.

The Makarewicz research group also applied the Storm Water Management Model (SWMM) to the lower Genesee to determine the impact from the barge canal, storm sewers and combined sewer overflows (Dressel, 2014). Contributions from combined sewer overflows were estimated to be 3,382 lb/yr and 784,555 lb/yr for phosphorus and total suspended solids, respectively. Separate storm sewers were estimated to contribute 5,020 lb/yr of phosphorus and 1,379,405 lb/yr of total suspended solids. The model identified the Merrill, Irondequoit, Kendrick and Elmwood sewersheds as the greatest contributors of phosphorus and sediment.

Priority watersheds in the upper Genesee River basin

The upper Genesee River basin encompasses 985 square miles. The Makarewicz J. C., Lewis, Snyder, & Smith (2013) study suggested that approximately 60% of the total phosphorus load can be attributed to anthropogenic sources. Land use in the upper Genesee River basin is primarily forest (57%) and agricultural (35%); range/grassland (4%), residential (3%) and wetlands (1%) are minor contributors. in the upper Genesee River basin. The greatest contribution to the total phosphorus load (total load estimated at 507,234 lb/yr) in the upper Genesee Basin is agriculture: estimated 45% from crops and 10% from farm animals (CAFO). The estimated sediment load from the upper Genesee River basin is 9.3×10^{8} lb/yr.

Areas that contributed the greatest amount of phosphorus to the total upper Genesee River basin were identified as the highest priority HUC12s based on data from Makarewicz J. C., Lewis, Snyder, & Smith (2013). Additional priority HUC12s may also be identified based on other information, reports or impairments. The highest priority watersheds within the upper Genesee River watershed are listed in Table 4. Appendix A (Tables 17-19) and Figure 2 summarize the prioritization for all HUC12s.

Stream bank erosion is a serious problem from Caneadea to Fillmore (3.3 mi) and Belmont to Angelica (2.6 mi) along the main stem of the Genesee River. Tributaries with observed eroded stream banks were Phillips Creek (1.0 mi), Cold Creek (0.7 mi), Van Campen Creek (1.3 mi) and Angelica Creek (0.7 mi). Additional details and specific site locations are identified in Makarewicz J. C., Lewis, Snyder, & Smith (2013) (see Tables 12 through Table 16; Table 15 and 16 identify high priority sites).

Makarewicz J. C., Lewis, Snyder, & Smith (2013) indicated that, at the time of their study, there were 17 concentrated animal feeding operations (CAFOs) in the upper Genesee River Basin. The model results from that study indicate the CAFOs contribute approximately 10% of the total phosphorus load within the basin, primarily through the spreading of manure on fields for fertilizer.

Table 4: High priority watersheds in the upper Genesee River watershed based upon phosphorus load. See Appendix A for the entire Genesee River basin list and for a map of HUC12 locations.

Subwatershed	Watershed Index Number	HUC12
Brimmer Brook	Ont 117-180	041300020503
Black Creek	Ont 117-148	041300020601
Black Creek	Ont 117-155-9	041300020401
Caneadea Creek	Ont 117-136	041300020603 041300020604
Cold Creek	Ont 117-118	041300020801
Headwaters East Koy Creek	Ont 117-104-3	041300020703
Rush Creek	Ont 117-117	041300020803

Priority watersheds in the Honeoye Creek basin

The Honeoye Creek watershed encompasses 267 square miles, which is dominated by agricultural (43%) and forested (39%) lands. Range/grassland, residential and water/wetlands make up the remaining land at roughly 6% each. Of the 28,135 lb of phosphorus load estimated from the watershed each year, it was estimated that 71.5% was from anthropogenic sources (Makarewicz, Lewis, & Snyder, 2013). Agriculture, wastewater treatment plants and natural sources were identified as the primary sources, with each estimated to contribute roughly one-third of the total load. The total annual sediment load was estimated to be 1.3×10^7 lb/yr.

Areas that contributed the greatest amount of phosphorus to the total Honeoye Creek basin were identified as the highest priority HUC12s based on data from Makarewicz, Lewis & Snyder (2013). In addition, the Hemlock Lake Outlet was identified as a high priority due to the use impairments (Table 1) and because it was identified as a high priority watershed in the Genesee River Basin Action Strategy (GFLRPC, 2004).

The Honeoye Lake Watershed Task Force characterized the tributaries to Honeoye Lake (GFLRPC, 2007) (PH, 2007) (PH, 2014); the Honeoye Inlet has been identified as a high priority area to reduce sediment and phosphorus into the lake. Those reports also characterize and prioritize the other tributaries to Honeoye Lake. The highest priority watersheds within the Honeoye Creek basin are indicated in Table 5. Those documents should be used to guide prioritization and implementation at the local level. Appendix A (Tables 17-19) and Figure 2 indicate the prioritization for all HUC12s.

Table 5: High priority watersheds in the Honeoye Creek basin based upon phosphorus loads. See Appendix A for the entire Genesee River basin list and for a map of HUC12 locations.

Subwatershed	Watershed Index Number	HUC12
Honeoye Lake	Ont 117-27-P57	041300030205
Hemlock Lake Outlet	Ont 117-27-34	041300030204
Honeoye Inlet	Ont 117-27-P57-10	041300030201

NYSDEC is currently developing a 9 Key Element Watershed Plan for the Honeoye Lake and Hemlock Lake watersheds. Upon completion, the priorities and recommendations of those reports will be incorporated into this document as well.

Priority watersheds in the Canaseraga Creek basin

The Canaseraga Creek basin encompasses an area of 342 square miles. The dominant land uses are agriculture (46.8%) and forest (44.4%). Urban and range/grass lands are minor contributors at 5.7% and 3.0%, respectively. The estimated annual phosphorus load is 124,261 lb/yr and the estimated annual sediment load is 1.56×10^{8} lb/yr (Rea, Makarewicz, & Lewis, 2013).

Identification of the highest priority HUC12s correspond to watershed found by Rea, Makarewicz, & Lewis (2013) to contribute the greatest amount of phosphorus. Additional priority HUC12s may also be identified based upon other information, reports and impairments. The highest priority HUC12s in the Canaseraga Creek basin are indicated in Table 6. Tables 17-19 and Figure 2 indicate the prioritization for all HUC12s.

Table 6: High priority watersheds in the Canaseraga Creek basin based upon phosphorus loads. See Appendix A for the entire Genesee River basin list and for a map of HUC12 locations.

Subwatershed	Watershed Index Number	HUC12
Bradner Creek	Ont 117-66-8-2	041300020906
Keshequa Creek, Upper	Ont 117-66-3	041300020909
Keshequa Creek, Middle	Ont 117-66-3	041300020910
Buck Run Creek	Ont 117-66-1 -1	041300020911
Canaseraga Creek, Lower	Ont 117-66	041300020911

Stream bank erosion in the Groveland Flats area has been identified as a significant contributor of sediments to the basin (Rea, Makarewicz, & Lewis, 2013) (GFLRPC, 2004). Stream bank erosion is also suspected within the Mill Creek watershed.

Priority watersheds in the Black Creek basin

The Black Creek watershed encompasses an area of 202 square miles. Agriculture is the dominant land use (62.5%) with wetlands (14.3%), forested lands (12.8%) and urban lands (10.0%) accounting for the remaining significant land uses (GFLRPC, 2012). Modeling by Winslow, Makarewicz, & Lewis (2013) estimated the total phosphorus load for Black Creek to be 36,376 lb/yr and the sediment load to be 1.8×10^7 lb/yr.

Identification of the highest priority HUC12s began with the corresponding areas of the watershed found by Winslow, Makarewicz, & Lewis (2013) to contribute the greatest amount of phosphorus for the watershed. The Draft Upper Black Creek and Bigelow Creek TMDL also identified the Upper Black Creek above Bigelow Creek as a priority area (NYSDEC, 2014). The Black Creek Watershed Management Plan also identifies the headwaters of upper Black Creek, Bigelow Creek, Mill Creek and Hotel Creek as priority areas (GFLRPC, 2015). The highest priority HUC12s within the Black Creek basin are indicated in Table 7. Additional priority HUC12s may also be identified based upon other information or reports. Tables 17-19 and Figure 2 indicate the prioritization for all HUC12s.

Table 7: High priority watersheds in the Black Creek basin based upon phosphorus loads. See Appendix A for the entire Genesee River basin list and for a map of HUC12 locations.

Subwatershed	Watershed Index Number	HUC12
Spring Creek	Ont 117-19-28	041300030601
Bigelow Creek	Ont 117-19-30	041300030602
Black Creek, Upper	Ont 117-19	041300030602
Hotel Creek-Black Creek	Ont 117-19	041300030604
Mill Creek-Black Creek	Ont 117-19-4	041300030605

Areas of significant stream bank erosion in the Lower Black Creek watershed were noted in Figure 26 of Winslow, Makarewicz, & Lewis (2013). Of the 3.2 miles of stream bank surveyed, 32% showed signs of erosion. Within the Draft Black Creek TMDL, one site (lat: 42.9244, long: -78.1178) also exhibited significant stream bank erosion (NYSDEC, 2014). The Genesee River Basin Action Strategy also identified stream bank erosion as a known major source of pollution within all reaches of Black Creek (GFLRPC, 2004). An inventory of sites with erosion within the Black Creek watershed are also included and prioritized in a report by the Genesee/Finger Lakes Regional Planning Council (GFLRPC, 2005).

Priority watersheds in the Oatka Creek basin

The Oatka Creek watershed has a drainage area of 215 square miles. Agriculture is the primary land use within the basin, accounting for 73.8% of the total area. Forest is the other dominant land use within the basin (21.6%). Additional minor contributions are from urban (2.7%) and wetlands (0.8%). Modeling by Pettenski, Makarewicz, & Lewis (2013) estimated an annual phosphorus load of 33,109 lb/yr and an annual sediment load of 1.1×10^7 lb/yr.

Identification of the highest priority HUC12s began with the corresponding areas of the watershed found by Pettenski, Makarewicz, & Lewis (2013) to contribute the greatest amount of phosphorus for the watershed. The Oatka Creek Watershed Management Plan identifies the Pearl Creek and White Creek (Oatka Creek, Middle subwatershed) as priority areas (GFLRPC, 2015). The highest priority watersheds within the Oatka Creek basin are indicated in Table 8. Additional priority HUC12s may also be identified based upon other information, reports or impairments. Tables 17-19 and Figure 2 indicate the prioritization for all HUC12s.

Table 8: High priority watersheds in the Oatka Creek basin based upon phosphorus loads. See Appendix A for the entire Genesee River basin list and for a map of HUC12 locations.

Subwatershed	Watershed Index Number	HUC12
Oatka Creek, Upper	Ont 117-25	041300030401
Pearl Creek	Ont 117-25-20	041300030402
Oatka Creek, Middle	Ont 117-25	041300030403
Oatka Creek, Middle	Ont 117-25	041300030405

Sites of significant stream bank erosion were identified on the main stem of Upper Oatka Creek (HUC12: 041300030401). Of the 2.5 mi. segment surveyed, 27.3% was found to be experiencing erosion. Agricultural activities in the Pearl Creek subwatershed (HUC12: 041300030402) were identified as the probable source of elevated sediment loads (Pettenski, Makarewicz, & Lewis, 2013). The Genesee River Basin Action Strategy also identifies stream bank erosion and agriculture as known major sources of pollution throughout the Oatka Creek watershed (GFLRPC, 2004). An inventory of sites with erosion within the Oatka Creek watershed are also included and prioritized in a report by the Genesee/Finger Lakes Regional Planning Council (GFLRPC, 2005).

Point sources within the Genesee River basin

There are 37 permitted point sources discharging significant amounts of phosphorus, 30 of which are publicly owned treatment works (POTWs). Based upon Discharge Monitoring Report data analyzed by NYSDEC, these 30 facilities discharge approximately 79,400 lb/yr of phosphorus, or about 8.7% of the total Genesee River phosphorus load. It is generally possible to meet a 1.0 mg/L total phosphorus limit in POTW effluent using chemical addition, such as alum or ferric chloride. Chemical addition can typically be incorporated without substantial investment of capital, making it cost effective in terms of dollars per pound of phosphorus removed. However, each facility must be evaluated individually to determine feasibility and cost effectiveness. Treatment below this level often requires additional facilities or equipment making further reductions from this source sector much less cost effective. Treatment to achieve concentrations below 1.0 mg/L is only recommended at this time if needed to improve local water quality.

If all of these facilities were required to meet a 1.0 mg/L phosphorus limit the amount of phosphorus discharged from these point sources would be reduced by 38,600 lb/yr, or nearly 50%. A reduction of 22,900 lb/yr could be realized if seven facilities were required to meet the 1.0 mg/L limit. Those facilities (Table 9) should be the priority for phosphorus reductions from point sources. Identification of these facilities within this watershed plan is done only as a suggestion of where it may be cost effective to pursue reductions from this source sector. Inclusion here in no way indicates a requirement.

Table 9: High priority SPDES discharges for phosphorus reductions

Facility Name	SPDES Permit Number	Watershed
Avon (V) STP	NY0024449	Lower/Middle Genesee
Conesus Lake SD Lakeville STP	NY0032328	Lower/Middle Genesee
Geneseo (V) STP	NY0030635	Lower/Middle Genesee
LeRoy (V) STP	NY0030546	Oatka Creek
Mt. Morris (V) STP	NY0030741	Canaseraga Creek
Perry (V) STP	NY0022985	Lower/Middle Genesee
Warsaw STP	NY0021504	Oatka Creek

Element B. Load reductions expected from management measures

The estimated load reductions expected from the implementation of management measures found in this section come from the work completed by the Makarewicz research group (Makarewicz, Lewis, & Snyder, 2013) (Makarewicz J. C., et al., 2013) (Makarewicz J. C., Lewis, Snyder, & Smith, 2013) (Pettenski, Makarewicz, & Lewis, 2013) (Rea, Makarewicz, & Lewis, 2013) (Winslow, Makarewicz, & Lewis, 2013) (Dressel, 2014).

The SWAT and SWMM models developed by the group could be used to identify the most efficient use of management measures by specific area as well as estimate the percent reduction of phosphorus and sediment.

The estimated load reductions presented in Tables 10-15 represent implementation of the management practices at the whole watershed level; for example, the grassed waterway load reduction value in Table 10 is the estimated load reduction that would be achieved if all waterways were grassed. It is not realistic that any management practice would be implemented across the entire watershed. It is expected that a combination of management practices would be implemented and that each management practice would be applied in strategic locations. This approach will achieve the water quality reduction goals identified in Element H.

Table 10: Estimated total reductions for the entire Genesee River basin based on the sub-basin phosphorus and sediment load reductions associated with different management measures (values are the summed results from Tables 11-15).

Management measure	Phosphorus reduction (lb/yr)	TSS reduction (lb/yr)
Grassed waterway	293,400	85,074,087
Stream bank stabilization	65,058	20,156,617
Buffer strips	126,774	5,171,497
Contouring	130,058	3,952,783
Terracing	169,681	129,852
Cover crops	182,187	8,598,784
Conservation tillage	5,772	5,611,401
Strip cropping	36,645	2,970,812

Table 11: Phosphorus and sediment load reductions associated with different management measures in the upper Genesee River basin (Makarewicz J. C., Lewis, Snyder, & Smith, 2013).

Management measure	Phosphorus reduction (lb/yr)	TSS reduction (lb/yr)
Grassed waterway	264,554	38,140
Stream bank stabilization	5,070	141,757
Buffer strips	118,168	12,125
Contouring	87,523	3,968
Terracing	162,701	6,393
Cover crops	135,805	12,125
Conservation tillage	-	-
Strip cropping	-	-

Table 12: Phosphorus and sediment load reductions associated with different management measures in the Honeoye Creek basin (Makarewicz, Lewis, & Snyder, 2013).

Management measure	Phosphorus reduction (lb/yr)	TSS reduction (lb/yr)
Grassed waterway	8,466	165,347
Stream bank stabilization	-	-
Buffer strips	3,142	196,211
Contouring	-	-
Terracing	4,352	123,459
Cover crops	5,549	143,300
Conservation tillage	-	-
Strip cropping	-	-

Table 13: Phosphorus and sediment load reductions associated with different management measures in the Canaseraga Creek basin (Rea, Makarewicz, & Lewis, 2013).

Management measure	Phosphorus reduction (lb/yr)	TSS reduction (lb/yr)
Grassed waterways	58,632	7,036,133
Stream bank stabilization	5,759	77,241,099
Buffer strips	-	-
Contouring	39,393	3,752,604
Terracing	-	-
Cover crops	40,833	8,443,359
Conservation tillage	-	-
Strip cropping	36,645	2,970,812

Table 14: Phosphorus and sediment load reductions associated with different management measures in the Black Creek basin (Winslow, Makarewicz, & Lewis, 2013).

Management measure	Phosphorus reduction (lb/yr)	TSS reduction (lb/yr)
Grassed waterways	9,255	7,629,501
Stream bank stabilization	1,356	12,978,727
Buffer strips	6,120	5,159,141
Contouring	-	-
Terracing	-	-
Cover crops	-	-
Conservation tillage	5,772	5,611,401
Strip cropping	-	-

Table 15: Phosphorus and sediment load reductions associated with different management measures in the Oatka Creek basin (Pettenski, Makarewicz, & Lewis, 2013).

Management measure	Phosphorus reduction (lb/yr)	TSS reduction (lb/yr)
Grassed waterways	5366	-
Stream bank stabilization	-	9764
Buffer strips	2486	231
Contouring	-	-
Terracing	2628	-
Cover crops	-	-
Conservation tillage	-	-
Strip cropping	-	-

Element C. Nonpoint source management measures

High priority sub-watersheds in the Genesee River watershed that were prioritized for implementation are identified in Element A. Specific recommendations for management measures within each sub-basin are discussed below; the recommendations are based on the cost per pound removal rates. Cost was the only metric upon which the selection of management measures was based. A more important metric is the willingness of the landowner to implement a given BMP since this plan relies almost entirely upon voluntary implementation of best management practices. Any management measures which reduce phosphorus or sediment loads to the Genesee River and its tribtaries will help to attain the load reductions.

Therefore, additional management measures will also be considered consistent with this watershed plan:

> Additional agricultural measures may include, but are not limited to: hydroseeding, cover crops, silage leachate management, animal waste storage, no till, nutrient management, riparian buffers and manure storage facilities.
>
> For develped land uses, green infrastructure (GI) projects which reduce sediment or phosphorus loads to the Genesee River or its tributaries are consistent with this watershed plan. Projects may include, but are not limited to: stormwater ponds, stream bank stabilization, riparian buffer enhancements, and other GI practices that will increaseinfiltration and restore natural hydrology.
>
> For both the agricultural and developed land sectors, additional guidance on management measure design and specifications can be found in the Management Practices Design Catalogue (NYSDEC, n.d.), the Stormwater Management Design Manual (NYSDEC, 2010) and the NRCS National Conservation Practice Standards (NRCS, n.d.).

In addition to implementing nonpoint source managementmeasures to reduce existing sources of loading, it is also important to prevent new sources from being created. Land use regulations at the local level can help achieve this goal. For example, local requirements for percolation testing prior to septic system installation, the adoption of stream buffers or riparian setbacks for new development, and stormwater management and erosion control laws. Any local controls or laws which will reduce phosphrous and sediment loads from new development or redevelopment should be considered part of larger approach to nonpoint source management.

Reducing phosphorus and sediment loads to the Genesee River, the Rochester embayment and Lake Ontario, may also reduce the amounts of other pollutants (e.g. pathogens, nitrogen and metals) reaching these waterbodies. Similarly, management measures meant to reduce loads of other pollutants may also reduce loads of phosphorus and sediments.

Lower/middle Genesee River Basin

The agricultural nonpoint management measures recommended for the lower/middle Genesee River basin by Makarewicz et al. (2013) are the same as for the entire basin: grassed waterways, buffer strips, and conservation tillage.

Grassed waterways were identified as the single most effective management measure.

Within the Conesus Lake watershed additional nonpoint source management measures have been identified by the Conesus Lake Watershed Management Plan (CLWMP): comprehensive nutrient management plans, strip cropping and other erosion control practices, managed intensive grazing and stream fencing. The CLWMP also suggests management measures to address other stressors to the Lake including development, stormwater, roadways, and recreation. Stream bank and ditch erosion controls were also recommended.

The Stormwater Coalition of Monroe County has finalized a Draft Stormwater Assessment and Action Plan for Little Black Creek (SCMC, 2011), a direct tributary to the Genesee River. The Plan identifies and prioritizes a number of stormwater management measures aimed at reducing the sediment and phosphorus loads from the watershed into the Genesee River (refer to the report for more information about project identification, location and prioritization).

Upper Genesee River Basin
The Makarewicz J. C., Lewis, Snyder, & Smith (2013) report recommended grassed waterways and streambank stabilization. Other management measures identified by the report include buffer strips, contouring, terracing and cover crops. Critical areas are areas where crops are grown up to the stream edge Makarewicz J. C., Lewis, Snyder, & Smith (2013) identifies several locations (see Tables 15 and 16).

Honeoye Creek Basin
Cover crops, strip cropping, buffer strips and grassed waterways were all identified in Makarewicz, Lewis, & Snyder (2013) as potential management measures.

For the Hemlock Lake Outlet management of the septic system load is needed. While a robust inspection and repair program may be sufficient, it is recommended that the feasibility of connecting the area to a municipal wastewater treatment plant be explored (GFLRPC, 2004).

The Honeoye Lake Watershed Task Force is developing a large restoration project for the Honeoye Inlet area intended to reduce sediment and phosphorus, restore natural conditions to sections of the Inlet and create habitat. The proposed actions include floodplain restoration, ditch plugging, restoring stream meander and wetland creation (PH, 2014).

Canaseraga Creek Basin
Grassed waterways were identified as the most efficient management measure for control of phosphorus while stream bank stabilization was identified for sediment control (Rea, Makarewicz, & Lewis, 2013). Terracing, cover crops and contouring were also identified as potentially effective management measures.

Black Creek Basin
Buffer strips and grassed waterways were identified as the most efficient management measures for the control of phosphorus. Sediment load loads could be reduced by

improving stream bank stabilization (Winslow, Makarewicz, & Lewis, 2013). The Draft Upper Black Creek TMDL also indicated that the establishment of riparian buffers, particularly along the upper reaches of the watershed would help reduce phosphorus and improve macroinvertebrate community health (NYSDEC, 2014).

The Black Creek Watershed Management Plan (BCWMP) recommends similar management measures, including agricultural and soil health initiatives such as nutrient management, cover crops, conservation tillage and conservation cropping. It also recommends the adoption of green infrastructure standards and to integrate these standards into site plan reviews. Finally, restoration of severely eroded stream bank segments is recommended. Several locations of stream bank erosion have been identified previously (GFLRPC, 2005). Additional recommendations are also outlined in the section on management practices, approaches and strategies section of the BCWMP (GFLRPC, 2015).

Oatka Creek Basin
Grassed waterways, buffer strips and cover crops were identified as the most efficient management measures for control of phosphorus within the Oatka Creek watershed. Pettenski, Makarewicz, & Lewis (2013) also indicated particular attention should be paid to the Pearl Creek subwatershed and the White Creek subwatershed (Ont 117-25-12).

The Oatka Creek Watershed Management Plan (OCWMP) includes several recommendations, including the development of riparian buffers for streams adjacent to agricultural lands, restoration of severely eroded stream bank segments, and encouraging private land owners to follow sound forest management practices. Locations of stream bank erosion needing restoration have been identified (GFLRPC, 2005). Additional recommendations can also be found in the management practices, approaches and strategies section of the OCWMP (GFLRPC, 2015).

Element D. Technical and financial assistance

This plan relies almost entirely upon voluntary implementation of best management practices on agricultural lands. The Great Lakes Restoration Initiative, Water Quality Improvement Project Program and the Resource Conservation Partnership Program are all potential sources of funding. Additionally, roughly $4 million are available to implement projects in the lower Genesee River below the lower falls as the result of a recently settled Natural Resource Damages (NRD) claim.
In those instances where septic systems have been identified as a source of pollution the Clean Water State Revolving Fund and the NYSDEC/NYSEFC Engineering Planning Grants are also potential sources of funding.

Estimates of cost per unit for different management practices are listed in Table 16. Cost and efficiency information were based off data found in the CAST program of the Chesapeake Bay Program (Devereux & Rigelman, 2014). Costs estimates are intended to provide order of magnitude estimates to aid the planning process. Values have been annualized over the lifespan of the management measure based upon a 5% interest rate.

Implementation of riparian buffers and stream bank stabilization measures would reduce phosphorus loading to reach the phosphorus reduction goal and would come close to attaining the sediment reduction goal. There are roughly 5,048 miles of streams and rivers in the Genesee River basin. Implementation of 35 foot buffer strips along both sides of the entire length would cost approximately $6.2 million annually. Stream bank stabilization, while modeled as implemented basin wide, is likely only applicable to a portion of banks within the watershed. In some watersheds, 30% of stream banks showed signs of erosion (Makarewicz J. C., Lewis, Snyder, & Smith, 2013). For the purpose of this cost estimate, for the entire Genesee River basin, an estimate of 10% of all river miles are assumed to need stabilization. Stream bank stabilization is estimated to cost approximately $37 million annually. Attainment of the buffer strip and stream bank stabilization goals outlined here are estimated to cost on the order of $43 million, noting that this is an annualized cost over the life of these projects. While these scenarios can be used for cost estimates, a more realistic implementation will utilize whichever management measures are effective and acceptable for the conditions which exist in the field. Final decisions of which best management measures to install should be made by the land owner and experienced technical staff.

Load reductions from point sources may also be a cost effective means to achieve phosphorus reductions. Chemical addition to all of the seven point sources listed in Table 9 could be achieved at an annualized cost of $100,000 to $200,000 assuming no substantial capital upgrades are needed. These costs include both an initial investment and ongoing chemical costs. Implementation could be expedited if finances could be provided to help offset some of the costs. Identification of these projects as a priority for grant and loan funding could help in the funding application process.

Table 16: Estimates of cost to install management measures on agricultural land and the phosphorus and sediment load reductions estimated for basin wide implementation. Costs are annualized over the expected life of the project (Devereux & Rigelman, 2014).

Management Measure	Lifespan (yr)	Measure Unit	Annual Cost ($/unit)	Annual Phosphorus Cost ($/lb)	Annual Sediment Cost ($/lb)
Nutrient Management Plan	3	Acre	3.90	31	-
Barnyard Runoff Control	15	Acre	567	45	2.39
Prescribed Grazing	3	Acre	13	82	0.24
Stream Restoration	20	Feet	60	91	0.13
Septic Connection	25	System	527	99	-
Land Retirement	10	Acre	169	113	0.25
Grass Buffers	10	Acre	147	144	0.28
Forrest Buffers	75	Acre	231	156	0.30
Tree Planting	75	Acre	70	187	0.22
Septic Pumping	3	System	88	338	-
Intensive Rotational Grazing	3	Acre	74	456	1.34
Cover Crops	1	Acre	73	530	0.95
Wet Ponds	50	Acre	352	667	0.72
Stream Fencing	10	Acre	5307	843	2.22
Wetland Restoration	15	Acre	544	1034	2.06
Bioswale	50	Acre	922	1049	1.41
Bioretention/ Raingarden	25	Acre	1127	1132	1.53
Dry Pond	50	Acre	365	1556	0.74
Stormwater Retrofit	10	Acre	1545	4263	2.71
Street Sweeping	20	Acre	916	15120	5.18
Permeable Pavement	20	Acre	14220	15172	20
Dirt Road Erosion and Sediment Control	20	Feet	0.83	-	0.35

Element E. Information and education

There are a number of stakeholder groups that are working to improve water quality within the Genesee River watershed. Information and data collected by these groups has been used to develop this watershed plan. The stakeholder groups engaged in the planning and implementation of this plan are summarized below.

<u>Water Assessments by Volunteer Evaluators (WAVE)</u>
The WAVE program is a citizen-based water quality assessment program developed by NYSDEC. The program trains citizen scientists to collect biological data (macroinvertebrates) for assessment of water quality on wadeable streams in New York State that are submitted to NYSDEC for identification. The program encourages citizen

participation in the water quality evaluation process through both training and educational components. While the program does not directly measure sediment or phosphorus, the results can be used to identify waters that may be impacted by these pollutants and to identify those waters which show no signs of water quality impacts.

Genesee/Finger Lakes Regional Planning Council (G/FLRPC)

The Genesee/Finger Lakes Regional Planning Council (G/FLRPC) works to identify, define, and inform its member counties of issues and opportunities critical to the physical, economic, and social health of the region. The G/FLRPC includes member counties which make up the middle and lower portions of the Genesee River. Program areas include regional, local and water resources planning. G/FLRPC has completed watershed management plans for the Black (GFLRPC, 2015) and Oatka (GFLRPC, 2015) Creek watersheds. The Southern Tier West and Southern Tier Central Regional Planning and Development Boards facilitate similar activities in Allegany and Steuben Counties, respectively.

Water Education Collaborative (WEC)

The Water Education Collaborative (WEC) was formed in 2001 in response to a need for public education on what people can do to make a difference in local water quality issues. In 2007 the WEC set out to develop an awareness campaign to educate the residents of the Genesee Regional Watershed of Lake Ontario about the impact they can have on the water quality in the area. WEC plans, coordinates and facilitates Water Quality Education Programs and serves as a clearing house for water education programming.

Genesee River Wilds

The Genesee River Wilds project seeks to establish riparian buffers, parks and trails along the length of the Genesee River from the headwaters in Pennsylvania to the southern boundary of Letchworth State Park in New York. The project goal isto engage a comprehensive range of stakeholders and funding sources to create a large and attractive resource for conservation, recreation and tourism.

Center for Environmental Initiatives (CEI)

The Center for Environmental Initiatives (CEI) is a nonprofit organization working for environmental protection and enhanced quality of life in the Greater Rochester and Finger Lakes region through education, collaboration and informed action. Through their Genesee River Watch initiative, CEI is working to develop partnerships, promote public interest and attract project funding to the Genesee River basin to improve water quality. In February 2014 CEI brought together stakeholders from throughout the entire Genesee River basin to discuss the water quality problems facing the river and to identify potential projects that will help address those problems. At the second Genesee River Basin Summit held by CEI in June 2015, NYSDEC informed attendees about this watershed plan and solicited feedback and input for this planned revision.

Soil and Water Conservation Districts (SWCD)
A major component of this watershed plan is implementation of best management practices on agricultural land. The Soil and Water Conservation Districts play a critical role in the outreach and coordination with the agricultural community. They may also hold educational events which introduce farmers to and highlight the benefits of management measures.

New York State Department of Environmental Conservation
NYSDEC will continue to solicit input from stakeholders to revise and improve this watershed plan. NYSDEC has communicated with Soil & Water Conservation Districts, presented the plan at the 2015 Genesee River Basin Summit and completed an official comment period, which was last held from June 10 to July 10, 2015.

Element F. Implementation schedule

Implementation of the Genesee River basin watershed plan should initially focus on the sub-watersheds identified as high priorities in this plan, and referenced in the supporting documents. Implementation progress will depend on available funding and the implementation schedule must take into account this dependency. Significant delays in securing sufficient funding will necessitate an extension of the implementation schedule.

Given these considerations, the following timeframes have been established for implementation of management measures, to the greatest extent practical, within the identified watersheds:

- High priority watersheds – 10 years from plan date
- Medium priority watersheds – 15 years from plan date
- Low priority watersheds 25 – years from plan date

Element G. Milestones

Implementation progress can be measured by the miles or acres of management measures installed within the watershed. For each of the high, medium and low priority watersheds, implementation should be assessed at the 5, 13 and 20 year marks from plan date, respectively, with the goal of having 60% of the needed practices on the ground at the respective assessment points. Assessments should be made at the HUC12 level and aggregated up to the entire basin. Measurements of implementation may include:

- Miles of stream banks stabilized
- Miles of buffer strips
- Acres of cover crops
- Acres of contouring
- Acres of conservation tillage
- Miles of grassed waterways

Element H. Assessment criteria

This watershed plan focuses on identifying and reducing loads of total phosphorus and sediment. The phosphorus assessment criteria, for the entire Genesee River basin, is the soluble reactive phosphorus (SRP) load delivered to Lake Ontario. The same assessment criteria identified in the GLRI Action Plan (GLRI, 2010) is adopted for this watershed plan: reduce the annual baseline SRP loading of 187,400 lb to the target loading of 178,600 lb.

The criteria to assess sediment reduction was adopted from Rochester Embayment Remedial Action Plan (MCDPD, 2002). The Rochester Embayment Remedial Action Plan established a sediment concentration criteria for the Genesee River where it enters Lake Ontario: "suspended sediment concentration (SSC) in the Genesee River remain less than 30 mg/L for at least 80% of a year, and exceed 200 mg/L for no more than 5 events with a combined duration of not greater than 20 days, as determined by a 5 year average."

Measurements of SRP and suspended sediment concentrations in the Genesee River at Rochester will be used to determine if the criteria have been met. However, for planning purposes, the above criteria can be converted into approximate values for annual total phosphorus and total suspended solids loads.

<u>Total phosphorus equivalency</u>
The modeling results from Makarewicz et al. (2013) indicate the total phosphorus load at Charlotte is approximately 11.2% SRP. If it is assumed that management measures reduce total phosphorus and SRP equally, the above SRP reduction can be achieved by a total phosphorus reduction of 79,000 lb/yr, or approximately 8% of the current total phosphorus load.

<u>Total suspended solids (TSS) equivalency</u>
An equivalency between TSS and SSC may be assumed, the SSC criteria can be approximated as achieving an annual TSS load of 5×10^8 lb/yr, a reduction of 3.4×10^8 lb/yr, or about 40% of the annual load. This estimate is conservative as it assumes SSC does not exceed 200 mg/L.

It is expected that implementation of a combination of management practices identified in Element C will result in the achievement of the assessment criteria for TP and TSS.

Element I. Monitoring

The Genesee River is monitored regularly by the following programs that collect, analyze and report data on phosphorus and sediment:

The NYSDEC Rotating Intensive Basin Studies (RIBS) program has sampled the Genesee River in Rochester approximately 6 times per year for the last 13 years. Water quality parameters measured include phosphorus and sediment. On a rotating five year schedule the RIBS program conducts focused monitoring of different watersheds across the state. These efforts collect samples across the entire watershed, with the Genesee River basin being sampled as part of the 2014 cycle.

The USGS conducts regular monitoring of the Genesee River in Rochester as well. Samples are collected every six weeks and includes both phosphorus and sediment. The USGS and NYSDEC are collaborating on sampling at select major tributaries within the basin. There is interest in continuing this sampling beyond the current two year scope.

Monroe County has conducted monitoring on Black, Honeoye and Oatka Creeks for nearly ten years. The Lower Genesee River is also sampled weekly. Parameters include total phosphorus, soluble reactive phosphorus and total suspended solids.

References

CLWMPP. (2003). Conesus Lake Watershed Management Plan. Livonia: Conesus Lake Watershed Management Plan Project.

Devereux, O. H., & Rigelman, J. R. (2014). Chesapeake Assessment Scenario Tool. Chesapeake Bay Program. http//www.casttool.org

Dressel, L. (2014). The Impact of Rochester Storm Sewers on the Water Quality of the Lower Genesee River: A Modeling Approach using PCSWMM. Environmental Science and Biology Theses. Paper 89. Brockport: The SUNY Collge at Brockport. http://digitalcommons.brockport.edu/env_tech/

EPA. (2008). Handbook for developing watershed plans to restore and protect our waters. Washington D.C.: EPA 841-B-08-002.

GFLRPC. (2004). The Genesee River Basin Action Strategy. Rochester: Genesee/Finger Lakes Regional Planning Council. http://www.gflrpc.org/Publications.htm

GFLRPC. (2005). Identification and Analysis of the Riparian Corridor in the Black & Oatka Creek Watersheds. Rochester: Genesee/Finger Lakes Regional Planning Council. http://www.gflrpc.org/Publications.htm

GFLRPC. (2007). Honeoye Lake Watershed Management Plan. Rochester: Genesee/Finger Lakes Regional Planning Council. http://www.gflrpc.org/Publications.htm

GFLRPC. (2012). Black Creek watershed characterization report: A componenet of the Black creek Watershed Management Pland. Rochester: Genesee/Finger Lakes Regional Planning Council. http://www.gflrpc.org/Publications.htm

GFLRPC. (2015). Black Creek Watershed Management Plan. Rochester: Genesee/Finger Lakes Regional Planning Council. http://www.gflrpc.org/Publications.htm

GFLRPC. (2015). Oatka Creek Watershed Management Plan. Rochester: Genesee/Finger Lakes Regional Planning Council. http://www.gflrpc.org/Publications.htm

GLRI. (2010). GLRI Action Plan FY2010 - FY2014. Great Lakes Restoration Initiative. http://greatlakesrestoration.us/actionplan/pdfs/glri-action-plan-2.pdf

Hayhurst, B. A., Coon, W. F., & Eckhardt, D. A. (2010). Water resources of Monroe County, New York, water years 2003-08: Streamflow, constituent loads and trends in water quality. U.S. Geological Survey Scientific Investigations Report 2010-5216, 34 p.: also available at http://pubs.usgs.gov/sir/2010/5216 .

Makarewicz, J. C., Lewis, T. W., & Snyder, B. (2013). Genesee River Watershed Project. Volume 3. Water Quality Analysis of Honeoye Creek Watershed: Nutrient Concentration and Loading, Identification of Point and Nonpoint Sources of Pollution, Total Maximum Daily Load, and an Assessment of Management Practice. Brockport: The College at Brockport, State University of New York. http://digitalcommons.brockport.edu/env_tech/

Makarewicz, J. C., Lewis, T. W., Snyder, B. J., Winslow, M., Pettenski, D., Rea, E., Smith, W. B. (2013). Genesee River project volume 1. Water quality analysis of the Genesee River watershed: Nutrient concentration and loading, identification of point and nonpoint sources of pollution, total maximum daily load, and an assessment of management practices using. Brockport: The College at

Brockport, State University of New York. Retrieved from http://digitalcommons.brockport.edu/tech_rep/124/

Makarewicz, J. C., Lewis, T. W., Snyder, B., & Smith, W. B. (2013). Genesee River Watershed Project. Volume 2. Water Quality Analysis of the Upper Genesee River Watershed: Nutrient Concentration and Loading, Identification of Point and Nonpoint Sources of Pollution, Total Maximum Daily Load, and an Assessment of Managemen. Brockport: The College at Brockport, State University of New York. http://digitalcommons.brockport.edu/env_tech/

MCDPD. (2002). Rochester Embayment Remedial Action Plan State II Addendum. Rochester: Monroe County Department of Planning and Development.

NRCS. (n.d.). National conservation practice standards. United Stated Department of Agriculture Natural Resources Conservation Service.

NYSDEC. (2003). The 2001 Genesee River basin waterbody inventory and priority waterbodies list. Albany: New York State Department of Environmental Conservation.

NYSDEC. (2010). New York State Stormwater Management Design Manual. Albany: New York State Department of Environmental Conservation. Retrieved from http://www.dec.ny.gov/chemical/29072.html

NYSDEC. (2013). 2012 Section 303(d) list of impaired waters requiring a TMDL/other strategy. Albany: New York State Department of Environmental Conservation.

NYSDEC. (2014). 2014 Section 303(d) list of impaired waters requiring a TMDL/other stategy. Albany: New York State Department of Environmental Conservation.

NYSDEC. (2014). Draft Total Maximum Daily Load (TMDL) for Phosphorus in Upper Black Creek and Bigelow Creek. Albany: New York State Department of Environmental Conservation.

NYSDEC. (n.d.). Management Practices Catalogue for Nonpont Source Pollution Prevention and Water Quality Protection in New York State. Albany: New York State Department of Environmental Conservation. Retrieved from http://www.dec.ny.gov/chemical/96777.html

Pettenski, D., Makarewicz, J. C., & Lewis, T. W. (2013). Genesee River Watershed Project. Water Quality Analysis of the Oatka Creek Watershed. Volume 6. Nutrient Concentration and Loading, Identification of Point and Nonpoint Sources of Pollution, Total Maximum Daily Load, and an Assessment of Management Practi. Brockport: The College at Brockport, State University of New York. http://digitalcommons.brockport.edu/env_tech/

PH. (2007). Honeoye Lake Nutrient and Hydrologic Budget. Ringoes: Princeton Hydro, LLC.

PH. (2014). Update of the Hydrologic and Nutrient Budgets of Honeoye Lake Inlet and Honeoye Lake. Ringoes: Princeton Hydro, LLC.

Rea, E., Makarewicz, J. C., & Lewis, T. W. (2013). Genesee River Watershed Project. Volume 5. Water Quality Analysis of the Canaseraga Creek Watershed Nutrient Concentration and Loading, Identification of Point and Nonpoint Sources of Pollution, Total Maximum Daily Load, and an Assessment of Management Pr. Brockport: The College at Brockport, State University of New York. http://digitalcommons.brockport.edu/env_tech/

Robertson, D. M., & Saad, D. A. (2011). Nutrient inputs to the Laurential Great Lakes by source and watershed estimated using SPARROW watershed models. Journal of the American Water Resources Association, 47(5), 1011-1033.

SCMC. (2011). Draft Little Black Creek Stormwater Assessment and Action Plan. Rochester: Stormwater Coalition of Monroe County.

Winslow, M. J., Makarewicz, J. C., & Lewis, T. W. (2013). Genesee River Watershed Project. Water Quality Analysis of the Black Creek Watershed. Volume 4. Nutrient Concentration and Loading, Identification of Point and Nonpoint Sources of Pollution, Total Maximum Daily Load and an Assessment of Management Practic. Brockport: The College at Brockport, State University of New York. http://digitalcommons.brockport.edu/

Appendix A. HUC12 Prioritization

Each HUC12 within the watershed is prioritized as either high (Table 17), medium (Table 18), or low (Table 19) priority. Counties with land in each HUC12 are identified for reference.

Table 17: High Priority HUC12s

HUC12	Watershed Name	County 1	County 2	County 3
41300020401	Black Creek-Angelica Creek	Allegany		
41300020503	Brimmer Brook-Genesee River	Allegany		
41300020601	Black Creek-Genesee River	Allegany		
41300020603	Headwaters Caneadea Creek	Allegany	Cattaraugus	
41300020604	Caneadea Creek	Allegany		
41300020703	Headwaters East Koy Creek	Wyoming		
41300020801	Cold Creek	Allegany	Wyoming	
41300020803	Rush Creek	Allegany		
41300020906	Bradner Creek	Livingston		
41300020909	Headwaters Keshequa Creek	Allegany	Livingston	
41300020910	Keshequa Creek	Livingston		
41300020911	Canaseraga Creek	Livingston		
41300030102	Middle Conesus Creek	Livingston		
41300030204	Outlet Hemlock Lake	Livingston	Ontario	-
41300030205	Honeoye Lake-Honeoye Creek	Ontario	-	-
41300030401	Headwater Oatka Creek	Wyoming	-	-
41300030402	Pearl Creek-Oatka Creek	Genesee	Wyoming	-
41300030403	White Creek-Oatka Creek	Genesee	Wyoming	-
41300030405	City of LeRoy-Oatka Creek	Genesee	Monroe	
41300030502	Jaycox Creek-Genesee River	Livingston		
41300030504	Christie Creek-Genesee River	Genesee	Livingston	
41300030601	Spring Creek	Genesee	-	-
41300030602	Headwaters Black Creek	Genesee	Wyoming	-
41300030703	Town of Gates-Genesee River	Monroe		
41300030704	Genesee River	Monroe		
41300030604	Hotel Creek-Black Creek	Genesee	Monroe	
41300030605	Mill Creek-Black Creek	Genesee	Monroe	
41300030201	Honeoye Inlet	Livingston	Ontario	

Table 18: Medium Priority HUC12s

HUC12	Watershed Name	County 1	County 2	County 3
41300020101	Middle Branch Genesee River	Potter (PA)		
41300020102	West Branch Genesee River	Potter (PA)		
41300020103	Headwaters Genesee River	Allegany	Potter (PA)	
41300020201	Upper Dyke Creek	Allegany	Steuben	
41300020202	Middle Dyke Creek	Allegany	Steuben	
41300020203	Lower Dyke Creek	Allegany		
41300020301	Marsh Creek	Allegany	Potter (PA)	Steuben
41300020302	Cryder Creek	Allegany		
41300020303	Marsh Creek-Genesee River	Allegany	Potter (PA)	
41300020304	Chenunda Creek	Allegany		
41300020305	Ford Brook-Genesee River	Allegany		
41300020402	Baker Creek	Allegany		
41300020403	Angelica Creek	Allegany		
41300020501	Vandermark Creek	Allegany		
41300020502	Knight Creek	Allegany		
41300020504	Phillips Creek	Allegany		
41300020505	West Branch Van Campen Creek	Allegany		
41300020506	Van Campen Creek	Allegany		
41300020507	Gordon Brook-Genesee River	Allegany		
41300020602	White Creek-Genesee River	Allegany		
41300020605	Crawford Creek-Genesee River	Allegany		
41300020701	Trout Brook	Wyoming		
41300020702	Headwaters Wiscoy Creek	Allegany	Wyoming	
41300020705	Wiscoy Creek	Allegany	Wyoming	
41300020802	Shongo Creek-Genesee River	Allegany		
41300020902	Sugar Creek	Livingston		
41300020903	Bennett Creek-Canaseraga Creek	Allegany	Livingston	Steuben
41300020907	Twomile Creek	Livingston		
41300020908	Mud Creek-Canaseraga Creek	Livingston	Steuben	
41300030203	Hemlock Lake	Livingston	Ontario	Steuben
41300030206	Bebee Creek-Honeoye Creek	Livingston	Ontario	
41300030301	Spring Brook-Honeoye Creek	Livingston	Monroe	Ontario

Table 19: Low Priority HUC12s

HUC12	Watershed Name	County 1	County 2	County 3
41300020704	East Koy Creek	Allegany	Wyoming	
41300020804	Village of Fillmore-Genesee River	Allegany		
41300020901	Headwaters Canaseraga Creek	Allegany	Livingston	
41300020904	Mill Creek	Livingston	Steuben	
41300020905	Stony Brook-Canaseraga Creek	Livingston	Steuben	
41300021001	Hamlet of Portageville-Genesee River	Allegany	Livingston	Wyoming
41300021002	Wolf Creek-Genesee River	Livingston	Wyoming	
41300021003	Eastover Brook-Genesee River	Livingston	Wyoming	
41300021004	Silver Lake	Wyoming		
41300021005	Outlet Silver Lake-Genesee River	Livingston	Wyoming	
41300030101	Upper Conesus Creek	Livingston		
41300030103	Lower Conesus Creek	Livingston		
41300030202	Canadice Lake-Outlet Canadice Lake	Livingston	Ontario	
41300030302	Honeoye Creek	Livingston	Monroe	
41300030404	Mud Creek	Genesee	Livingston	Wyoming
41300030406	Oatka Creek	Genesee	Livingston	Monroe
41300030501	Beards Creek	Livingston	Wyoming	
41300030503	Browns Creek-Genesee River	Genesee	Livingston	Wyoming
41300030505	Dugan Creek-Genesee River	Livingston	Monroe	
41300030603	Robins Brook-Black Creek	Genesee	Orleans	Monroe
41300030606	Black Creek	Monroe		
41300030701	Little Black Creek	Monroe		
41300030702	Red Creek	Monroe		

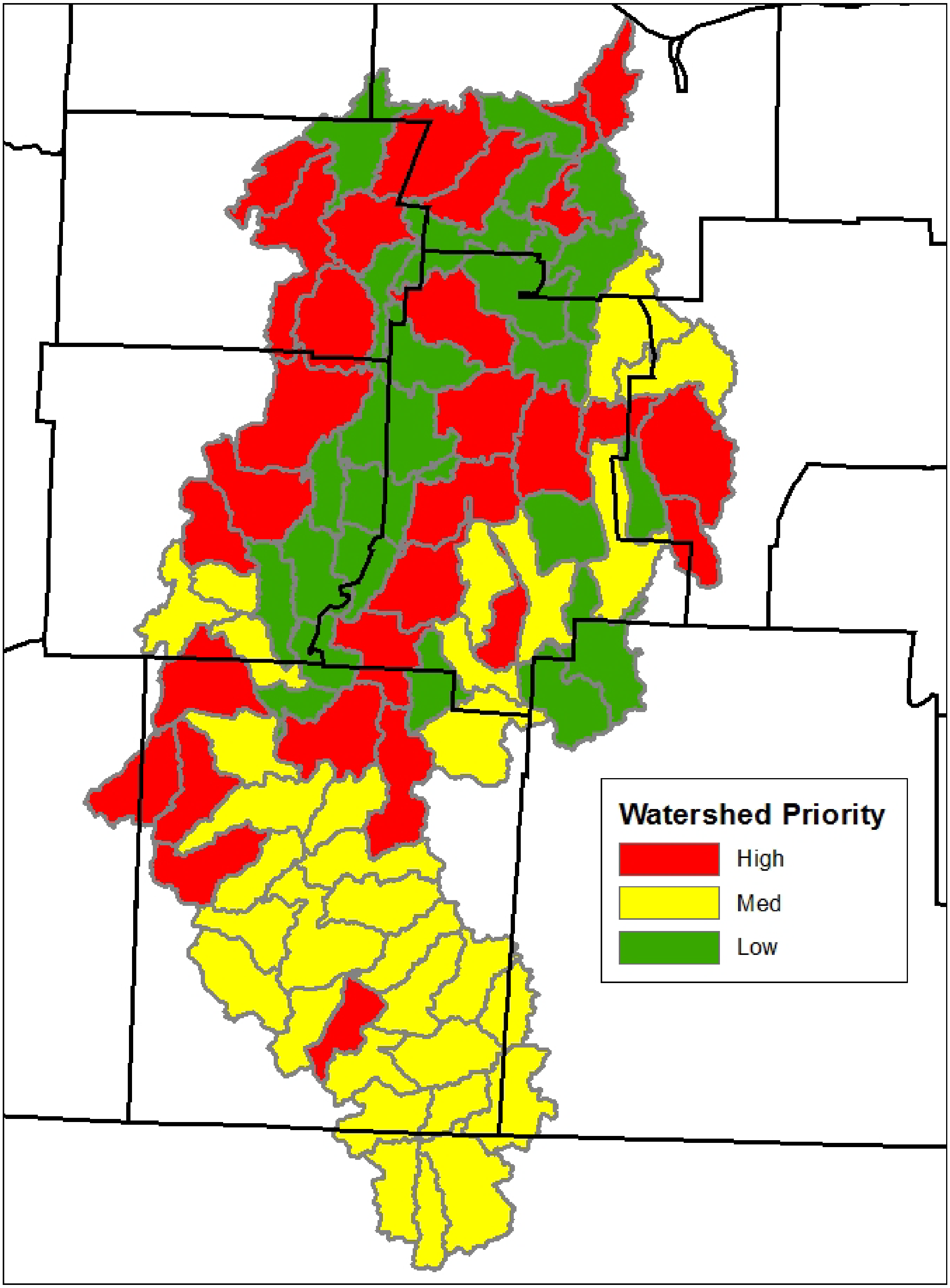

Figure 2: Highest priority HUC12s within the Genesee River basin

Appendix B. Major Sub-Basin Loadings

Basin	Estimated phosphorus load (lb/yr)	Estimated sediment load (lb/yr)
Lower / Middle Genesee River	97,734	-
Upper Genesee River	507,234	9.8E+08
Honeoye Creek	28,135	1.3E+07
Canaseraga Creek	124,261	1.6E+08
Black Creek	36,376	1.8E+07
Oatka Creek	33,109	1.1E+07