FINAL

SEPTEMBER 2022

OWASCO LAKE WATERSHED NINE ELEMENT PLAN FOR PHOSPHORUS REDUCTION

PREPARED FOR CAYUGA COUNTY DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

This plan was prepared with funding provided by the New York State Department of State under Title 11 of the Environmental Protection Fund.

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September 2022

Owasco Lake Watershed Nine Element Plan for Phosphorus Reduction

Prepared for
Cayuga County Department of Planning and Economic Development

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FINAL

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

ABBREVIATIONS

2016 Plan	Owasco Lake Watershed Management and Waterfront Revitalization Plan
9E Plan	Nine Element Plan
ACEP	Agricultural Conservation Easement Program
AEM	Agricultural Environmental Management
AMA	Agricultural Management Assistance
AgNPS	Agricultural Nonpoint Source Abatement and Control Program
BEE	Biological and Environmental Engineering Department, Cornell University
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CAST	Chesapeake Assessment Scenario Tool
CCDP&ED	Cayuga County Department of Planning and Economic Development
CCE	Cornell Cooperative Extension
CDBG	Community Development Block Grant
CREP	Conservation Reserve Enhancement Program
CSC	Climate Smart Communities

CSLAP	Citizens Statewide Lake Assessment Program
CSP	Conservation Stewardship Program
CVAP	Clean Vessel Assistance Program
CWIA	Clean Water Infrastructure Act
DWSP2	Drinking Water Source Protection Program
ELAP	Environmental Laboratory Approval Program
EPF	Environmental Protection Fund
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
FLI	Finger Lakes Institute
FLLOWPA	Finger Lakes – Lake Ontario Watershed Protection Alliance
FSA	Farm Service Agency
GIGP	Green Innovation Grant Program
GIS	Geospatial Information System
GWLF	Generalized Watershed Loading Function
HAB	Harmful Algal Bloom
HRU	Hydrologic Response Units
HUC	Hydrologic Unit Code
HWA	Hemlock Woolly Adelgid
LWRP	Local Waterfront Revitalization Program
MEANSS	Method for Estimating Attenuation of Nutrients from Septic Systems
NLCD	National Land Cover Dataset
NMP	Nutrient Management Plan
NOx	Nitrite plus Nitrate- Nitrogen
NRCS	Natural Resources Conservation Service
NYS	New York State
NYSAGM	New York State Department of Agriculture and Markets
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
NYSEFC	New York State Environmental Facilities Corporation
NYSFOLA	New York State Federation of Lake Associations
NYSOPHRP	New York State Office of Parks, Recreation, and Historic Preservation
OLWIPD	Owasco Lake Watershed Inspection and Protection Division
OLWMC	Owasco Lake Watershed Management Council
OWLA	Owasco Watershed Lake Association

ppd	pounds per day
PRISM	Partnership for Regional Invasive Species Management
QAPP	Quality Assurance Project Plan
SRP	Soluble Reactive Phosphorus
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plans
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TP	Total Phosphorus
TSS	Total Suspended Solids
UFI	Upstate Freshwater Institute
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAC	Watershed Advisory Committee
WQIP	Water Quality Improvement Project Program
WQMA	Cayuga County Water Quality Management Agency
WRR	Watershed Rules and Regulations
WWTP	Wastewater Treatment Plant

1 Executive Summary

The Owasco Lake Watershed Nine Element Plan for Phosphorus Reduction (9E Plan) was developed as a companion document to the 2016 Owasco Lake Waterfront Revitalization and Watershed Management Plan (referred to as the 2016 Plan). The objective of expanding the 2016 Plan with this Nine Element Plan for Phosphorus Reduction is to identify focused strategies to ensure that Owasco Lake continues to support its best uses for water supply, aquatic habitat, and recreational uses.

The decision to expand the 2016 Plan with a 9E Plan for Phosphorus Reduction reflects both emerging water quality concerns and guidance from the New York State Department of Environmental Conservation (NYSDEC). Phosphorus is the key element affecting the growth of aquatic plants, algae, and cyanobacteria in Owasco Lake, as it is across the New York State (NYS) Finger Lakes. Understanding and managing phosphorus inputs from the lake watershed is essential for protecting this valuable resource for future generations.

In recent years, Owasco Lake has experienced increased frequency of cyanobacterial bloom reports (referred to as Harmful Algal Blooms, HABs). The Owasco Lake HABs Action Plan (NYSDEC 2018) identified phosphorus as a key contributing factor. Nine Element Plans are a component of the NYSDEC Clean Water Planning framework; a 9E Plan incorporates quantitative approaches to identify pollutant (in this report, phosphorus) sources, define measurable targets, estimate the effectiveness of control measures, and project the water quality response to recommended control measures. The effort to expand the 2016 Plan with the quantitative elements of the 9E Plan was supported by watershed stakeholders.

Three quantitative analyses (mathematical models) of Owasco Lake and its watershed inform the recommendations incorporated into this 9E Plan. The first model, the SWAT model, characterizes the nature of the Owasco Lake watershed and estimates sources and geographical areas that contribute phosphorus from the landscape. This site-specific watershed model helps evaluate the feasibility of achieving reduction targets given underlying conditions of environmental setting, land cover, and management practices. Moreover, the watershed model provides a tool for testing the relative effectiveness of remedial measures and highlighting priority subwatersheds for implementing such measures. While not the focus of this plan, the SWAT model generated quantitative estimates of nitrogen and sediment loads, in addition to phosphorus.

A second tool was applied to estimate phosphorus contributions from a single source: individual on-site wastewater disposal systems (septic systems) located in proximity to surface waters. The septic system estimation tool provides guidance on the relative magnitude of this source and identifies priority areas for improved wastewater management. Like the watershed SWAT model, the framework selected for estimating septic input (MEANSS) was developed using site-specific data and information from the Owasco Lake watershed.

Finally, the Upstate Freshwater Institute developed the Owasco Lake Water Quality Model as a separate initiative from the 9E Plan. This in-lake water quality model enables managers to predict the effectiveness

of external load reduction on meeting water quality targets associated with the lake's best uses for water supply, aquatic life protection, and recreation. The lake model also projects the time frame over which water quality changes may be evident in the lake.

While not specifically modeled, the 9E Plan for Phosphorus Reduction includes many recommendations for structural and non-structural methods to improve the watershed's ability to prepare for and recover from extreme weather events. Increased frequency and intensity of precipitation contributes to flood risk, runoff from the landscape, and erosion of streams, gullies, and roadside ditches. This focus on hydrologic resilience as a guiding principle is reflected in the recommended actions for all categories of land use across the watershed.

Excessive phosphorus inputs and resulting enrichment of lakes and reservoirs can adversely affect local economies through declining property values and tax revenues and reduced tourism. For public water supplies, water quality degradation associated with excessive phosphorus can require additional investment in treatment processes to meet public health standards. The benefits and costs of actions to reduce phosphorus inputs must be balanced across multiple sectors. An important component of all the recommendations is to identify and acquire funding and technical support for their implementation.

Implementing the 9E Plan's recommendations will require continued collaboration among the many partners engaged with lake and watershed management issues. The intermunicipal Owasco Lake Watershed Management Council (OLWMC) is the hub of effective partnerships and programs. Stakeholders from the agricultural community, water supply purveyors, local academic institutions, NYSDEC representatives, New York State Department of State (NYSDOS) representatives, local government, and county and regional agencies are also committed to lake restoration and protection. Cayuga County's Department of Planning and Economic Development (CCDP&ED) has committed to maintaining and updating the watershed modeling tools. Progress will be tracked and reported through continued data collection and evaluation, institutional collaboration, and communication among all stakeholders.

Owasco Lake and its watershed will continue to change. An ongoing commitment to adaptive management, i.e., setting targets, implementing recommendations, monitoring their impact, and adjusting to new conditions, is an essential component of a 9E Plan. This 9E Plan for Phosphorus Reduction is based on current conditions of land cover, management practices, and meteorological conditions. Continued data acquisition and model refinements will enable the 9E Plan to reflect new information and continue to serve as a resource for informed management decisions.

2 Purpose and Background

The goal of the Owasco Lake Watershed 9E Plan is to identify and implement strategies that will protect ecosystem services, including production of food and fiber, clean drinking water, aquatic habitat, and recreational opportunities into the future. A collaborative community-driven approach is the mechanism to meet this goal.

The Owasco Lake Watershed Nine Element Plan for Phosphorus Reduction (9E Plan) was prepared by CCDP&ED with funding support from NYSDOS through the Local Waterfront Revitalization Program (LWRP) (Grant #T1000659). This 9E Plan is a companion document to the 2016 Plan.

The decision to expand the 2016 Plan into a 9E Plan for phosphorus reduction reflects both emerging water quality concerns and guidance from the New York State Department of Environmental Conservation (NYSDEC) Clean Water Planning framework. A central component of NYSDEC Clean Water Planning framework is adoption of the federal United States Environmental Protection Agency (USEPA) guidelines known as the Nine Key Elements for achieving water quality improvements. These Nine Elements are listed in **Table 1**. While many of the Nine Key Elements are reflected in the 2016 Plan, a quantitative analysis of phosphorus sources and required reductions to meet targets was not. The CCDP&ED was awarded additional funding from NYSDOS to develop this companion document to the 2016 Plan that incorporates additional quantitative analyses of phosphorus sources and required reductions to meet the targets.

Table 1: Reference Table for Nine Elements

Nine Element Criteria	NYSDEC/USEPA Definition	Location In Document (Section)
a	Identify the causes and sources of pollution that need to be controlled	8
b	Identify water quality target or goal and pollutant reductions needed to achieve goal	9, 11.2, 12.2
c	Identify the best management practices (BMPs) that will help to achieve reductions needed to meet water quality goal/target	11.2, 12
d	Describe the financial and technical assistance needed to implement BMPs identified in element c	12.3
e	Describe the outreach to stakeholders and how their input was incorporated and the role of stakeholders to implement the plan	3, 7.1
f	Estimate a schedule to implement BMPs identified in plan	12.2
g	Describe the milestones and estimated time frames for the implementation of BMPs	12
h	Identify the criteria that will be used to assess water quality improvement as the plan is implemented	12.4.1
i	Describe the monitoring plan that will collect water quality data need to measure water quality improvement (criteria identified in element h)	12

The 2016 Plan included many recommendations to protect Owasco Lake and watershed which are included in **Appendix A**. One challenge is to direct a community's collective efforts and resources towards priority actions and projects that offer the greatest potential to advance their vision for the lake and watershed.

The 9E Plan for phosphorus reduction includes quantitative tools (mathematical models) to help inform the community's decisions regarding priority actions. To that end, the project team developed a set of key questions (listed below) to guide development of the quantitative modeling tools. These key questions emerged through discussions at public meetings, findings of the Owasco Lake Harmful Algal Blooms (HABs) Action Plan, and conversations among key stakeholders. The questions illustrate the potential for setting priorities among multiple recommendations that arise from use of quantitative modeling tools.

1. Are there geographical areas of the watershed that contribute disproportionate amounts of phosphorus?
2. What does the watershed model estimate as the percent contribution of the following sources of phosphorus to the annual estimated load to the Owasco Lake?
    a. Agriculture – row crops
    b. Agriculture – fertilized pasture

   c. Runoff from developed areas
   d. Forested and wetland areas
3. How does the nonpoint phosphorus load from the landscape compare with estimated contribution from individual on-site wastewater disposal systems (septic systems) and permitted point sources?
4. What land use and land management actions (best management practices, BMPs) are recommended for adoption within the Owasco Lake subwatersheds to reduce phosphorus inputs to the lake?
5. In addition to questions that can be addressed using the modeling tools, what other actions are recommended for long-term protection of Owasco Lake and its continued capacity to support multiple uses?

3 Project Organization

CCDP&ED was the project's lead agency and was responsible for coordination with the NYSDOS, other state, regional, and local entities, and the consultant team. EcoLogic LLC was the prime consultant to CCDP&ED and was responsible for project execution and deliverables. The NYSDOS team reviewed and approved project deliverables and reimbursement requests and provided overall guidance to Cayuga County as they met the contractual requirements of the LWRP grant award.

The NYSDEC played a major role with technical elements of this project. NYSDEC staff were responsible for reviewing all elements of data collection including approval of Quality Assurance Project Plans (QAPPs) for both monitoring and modeling. In addition, NYSDEC staff collected samples from lake and its tributaries, participated in technical review meetings and consultations, and reviewed the mathematical models. NYSDEC provides funding and manages the Citizens Statewide Lake Assessment Program (CSLAP) program . Funding for the Owasco Lake Water Quality Model developed with funding support from the Environmental Protection Fund (EPF) by NYSDEC. Both NYSDEC and NYSDOS are tasked with approval of this 9E Plan.

Following notice of the grant award from the NYSDOS to CCDP&ED to update the 2016 Plan with the 9E Plan, the project team developed a work plan including the Public Outreach and Communication Plan (https://www.cayugacounty.us/DocumentCenter/View/4891/Owasco-Lake-Watershed-Public-Participation-Plan?bidId=). Many key elements and institutional partners continued from the 2016 watershed planning effort.

Technical meetings were held during data gathering and modeling efforts. This included a February 25, 2020, stakeholder meeting with participation from EcoLogic LLC, NYSDOS, Owasco Watershed Lake Association (OWLA), OLWMC, Cayuga County Soil and Water Conservation District (SWCD), Cayuga County Health Department and CCDP&ED. This meeting's objective was to "reach agreement on candidate emphasis projects where our focused energies and project funding requests should deliver near term, targeted practical benefits for the lake and its watershed." There was also an agricultural meeting with New York State Department of Agriculture and Markets (NYSAGM) representatives, the Finger Lakes Institute's Seneca Lake Watershed Manager and representatives from the Cayuga, Genesee, Monroe, Tompkins, and Yates County SWCDs. Finally, there were multiple meetings with the Cayuga County SWCD to gather data and information to be used in the modeling portion of the project.

In addition, key partners participated in conference calls throughout the project to discuss challenges and emerging issues.

Two public meetings were held to update the public on the 9E Plan's progress (August 2018 and September 2021). A final public meeting was held in July 2022 to present the draft 9E Plan. Based on feedback from the Watershed Advisory Committee (WAC) and the public, an updated set of strategies to achieve the goals of the 9E Plan was developed to guide prioritization and implementation of measures to reduce phosphorus input.

Many individuals and firms contributed to this effort. Professor Todd Walter and his Cornell University colleagues from the Department of Biological and Environmental Engineering (BEE) led the watershed modeling effort, which included consultation with the agricultural support community. Key agency contacts include NYSDEC Finger Lakes Water Hub (Anthony Prestigiacomo), NYSDOS (Kate Hogle), NYSDEC (Lauren Townley), CCDP&ED (Michele Wunderlich, Nick Colas (retired), and Greg Hutnik), Cayuga County Health Department (Eileen O'Connor), and Cayuga County SWCD (Doug Kierst, Jason Cuddeback, and Tyler Knapp). Upstate Freshwater Institute (UFI) completed the Owasco Lake Water Quality Model with funding provided by the EPF through NYSDEC . Dr. David Matthews of UFI coordinated with members of the 9E Plan team to share progress and findings of the lake modeling effort.

4 Environmental Setting

This section includes a brief update of the watershed and lake characterization detailed in the 2016 Owasco Lake Watershed Management and Waterfront Revitalization Plan (Appendix A) to provide context for the 9E Plan's quantitative analyses of phosphorus sources and recommended actions.

Owasco Lake is one of the New York Finger Lakes, a group of eleven elongated lakes of glacial origin located in the west-central region of the state. Owasco Lake is part of the Seneca-Oneida-Oswego River Basin. The lake's watershed (defined as the land area that drains into the lake) extends over approximately 205 square miles and encompasses all, or portions of, eleven towns and one village in Cayuga County (representing 81.5% of the watershed area), one town in Onondaga County (2.3%), and three towns and one village in Tompkins County (16.2%).

The major tributaries to the lake include the Owasco Inlet, Dutch Hollow Brook, Veness Brook, and Sucker Brook. Additionally, more than fifty small and/or intermittent streams flow into the lake; most are less than one mile in length. Most of the tributary flow enters the lake from the south, which is characteristic of the Finger Lakes. Owasco Inlet, whose watershed encompasses over 60% of the land area draining to the lake, flows through an extensive wetland complex known as the Owasco Flats as it enters the lake from the south.

The overall area of the watershed influences the scale of analysis selected for a management plan such as a Nine Element Plan. HUC is an acronym for Hydrologic Unit Code; this classification system was developed by the United States Geological Survey (USGS) and the USEPA as a means of identifying and tracking nested watersheds. The hydrologic unit hierarchy is indicated by the number of digits in groups of two (such as HUC2, HUC4, and HUC6) within the HUC code. For example, HUC4 represents the subregion level, delineating large river basins. HUC8 maps the subbasin level, analogous to medium-sized river, and HUC12 is a more local sub-watershed level that captures tributary systems.

Across the Finger Lakes, Total Maximum Daily Load (TMDL) and 9E Plans have been developed at the HUC12 level of analysis. Data and information regarding land uses and management practices are typically available to support a detailed analysis at the HUC12 level. There are five HUC12 tributary subwatersheds to Owasco Lake as displayed in **Figure 1**; these areas form the foundation for the analysis and recommendations of this 9E Plan.

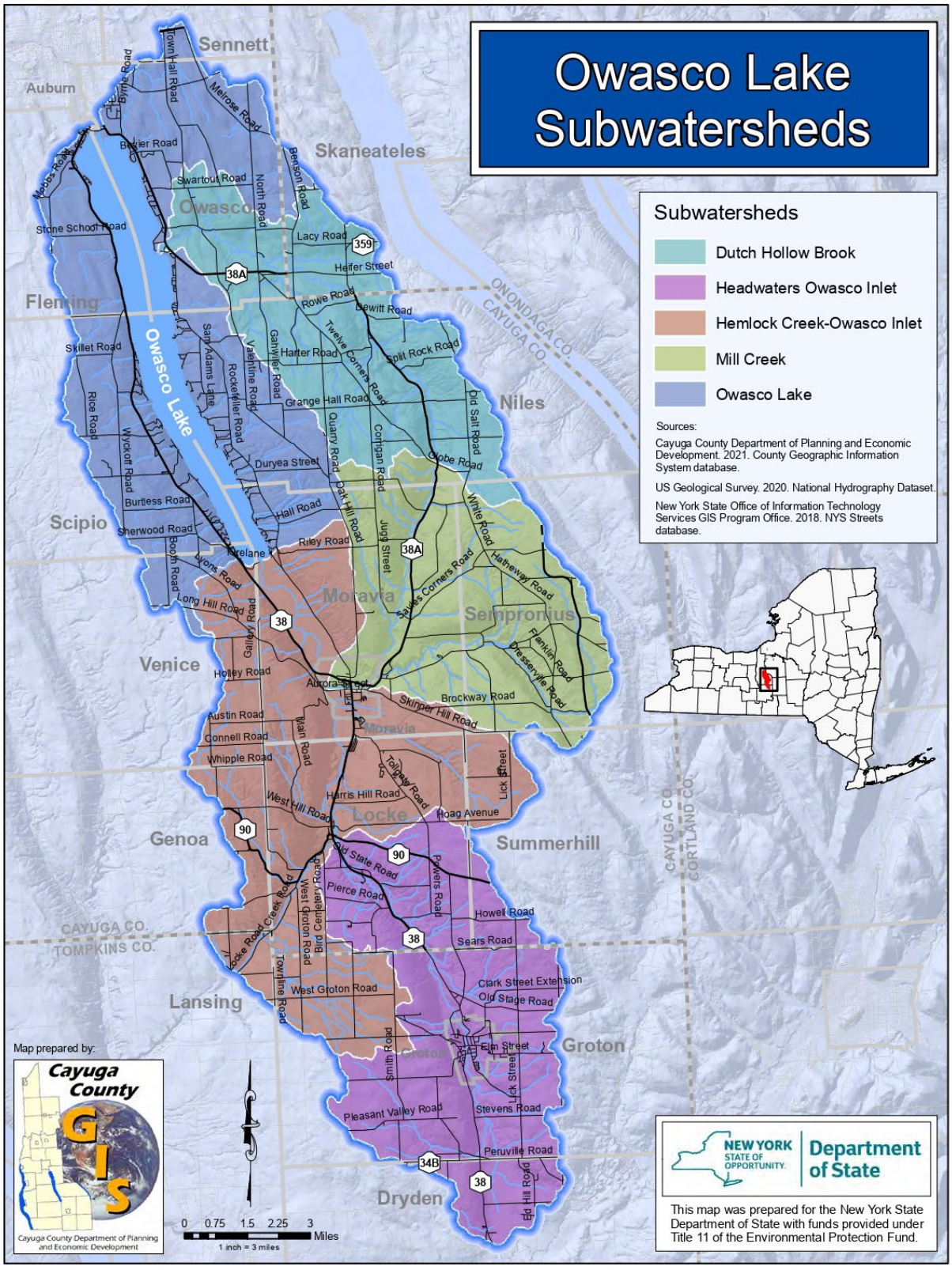

Figure 1: Map of Subwatersheds (HUC12s) within the Owasco Lake Watershed

A land cover map of the watershed based on the 2016 National Land Cover Dataset (NLCD) is included as **Figure 2.** Agriculture is the dominant land use within the Owasco Lake watershed, covering nearly 50% of the watershed area. A general breakdown of land cover class based on satellite imagery allocates the 50% agricultural lands as 30% in cultivated fields and 20% in hay and pasture. Note that rotation cycles and other practices lead to interannual shifts in how agricultural lands are used. Approximately one-third of the watershed is forested, 6% is classified as wetlands, and 6% is developed lands. These developed lands in the Owasco Lake watershed are primarily classified as low to moderate density residential properties.

Owasco Lake has a relatively large ratio of watershed area to lake water surface (17:1) compared with other Finger Lakes (NYSDEC 2019). This relatively large catchment area can increase the unit loading of nutrients and sediment, depending on land use and land cover conditions. However, the large drainage area also contributes to a relatively short hydraulic retention time. The average water residence time of the lake is estimated at two to four years. Owasco Lake has a mean depth of 29 meters, a maximum depth of 54 meters, and undergoes stable thermal stratification. Little information is available regarding groundwater resources and their potential contribution to the lake's hydrologic budget. Based on the water balance constructed for the Owasco Lake Water Quality Model (UFI 2021), direct flux of groundwater into the lake appears to be minimal relative to other sources.

The water quality and aquatic habitat of Owasco Lake reflect its natural setting: environmental conditions of the watershed such as topography, soils, land cover, and climate; and physical features of the lake itself: depth, water residence time, and the extent of littoral zone habitat. These natural features are affected by the multitude of ways in which humans utilize the lake and its watershed, through settlement patterns, resource extraction, cultivation of agricultural crops, animal husbandry and waste management, water withdrawals, water level controls, wastewater disposal, recreational uses, introduction of invasive species, and other factors.

Figure 2: Land Cover of the Owasco Lake Watershed

5 Owasco Lake Water Quality

5.1 Trophic State Assessment

Lakes are typically classified according to their trophic state and assigned a term describing their position on a continuum of primary productivity. Highly productive lakes exhibit elevated concentrations of phosphorus and phytoplankton and low water clarity. These lakes are termed "eutrophic" from the Greek word meaning well-fed and exhibit high levels of phytoplankton and low clarity. At the other end of the trophic continuum are lakes of low productivity; "oligotrophic" (poorly fed) lakes generally have low concentrations of phosphorus and phytoplankton and exhibit high water clarity. The designation "mesotrophic" refers to lakes that fall somewhere in between. *Diet for a Small Lake: The Expanded Guide to New York State Lake and Watershed Management* identifies various trophic state indicator parameters to track productivity (**Table 2**). Key trophic state indicator parameters include:

- **Total Phosphorus (TP).** Phosphorus is most frequently the limiting nutrient for growth of phytoplankton in freshwater lakes (defined as microscopic algae and cyanobacteria) that form the base of the lake's food web. Therefore, phosphorus availability is a key determinant of trophic state for most lakes at this latitude.

- **Chlorophyll-a.** Chlorophyll-a is a photosynthetic pigment present in phytoplankton. It's concentration in lake water samples is an excellent surrogate for phytoplankton density.

- Water clarity, as measured by **Secchi disk transparency**. Secchi disks are 20 cm diameter flat disks with alternating quadrats of black and white. The disk is lowered through the water column (from a boat or dock) until it is no longer visible, and the depth is recorded. This simple metric is widely used for its ease and comparability.

Table 2: Trophic State Indicator Parameters

Parameter	Trophic State		
	Oligotrophic	**Mesotrophic**	**Eutrophic**
Total Phosphorus (TP)	< 10 µg/l	10-20 µg/l	> 20 µg/l
Chlorophyll-a	< 2 µg/l	2-8 µg/l	> 8 µg/l
Secchi Disk Transparency	> 5 meters	2-5 meters	< 2 meters
Dissolved Oxygen in Lower Waters (Percent Saturation)	80 - 100	10-80	<10

Reference: NYSDEC 2018 https://www.dec.ny.gov/docs/water_pdf/section305b2018.pdf

Graphs of trophic state indicator parameters included in the 2016 Plan were updated with recent data from the NYSDEC CSLAP program, which began routine monitoring of Owasco Lake in 2017 (**Figure 3**). Data indicate that Owasco Lake remains mesotrophic, defined as moderately productive (NYSDEC 2019). Owasco Lake summer TP concentrations in the upper water usually ranges between 10 and 20 µg/L, although it has been ~10 µg/L in recent years. The NYSDEC recently completed an updated assessment of Finger Lakes water quality conditions and concluded that Owasco Lake's current water quality is comparable to conditions measured during the 1970s (12 µg/L) and the late 1990s (12 µg/L) (NYSDEC 2019). However, the report noted that current chlorophyll-a concentrations are above reference points from the late 1980s. Dr. Steven Effler, founder of UFI, completed a trophic state assessment of Owasco Lake in 1986 and compared total phosphorus concentrations from 1972-1973 (avg. 9 µg/L) to those measured in 1985-1986 (avg. 5 µg/L). The reduction was attributed to the state's 1972 ban on high phosphorus detergents (UFI 1988).

Trophic state indicator parameter data have been routinely collected at two open water sites in Owasco Lake (designated north and south). Samples are collected from the upper waters between June 1 and September 30. Prior to 2017, the data were collected and analyzed by Professor John Halfman of the Finger Lakes Institute and Hobart and William Smith Colleges. Beginning in 2017, water quality data was collected and analyzed through CSLAP and meet all the state requirements for use. As described later in **Section 7.3.1**, water quality data that were not collected using a NYS-approved QAPP or analyzed by a NYS-certified laboratory are not used in a quantitative manner for the modeling components of this 9E Plan.

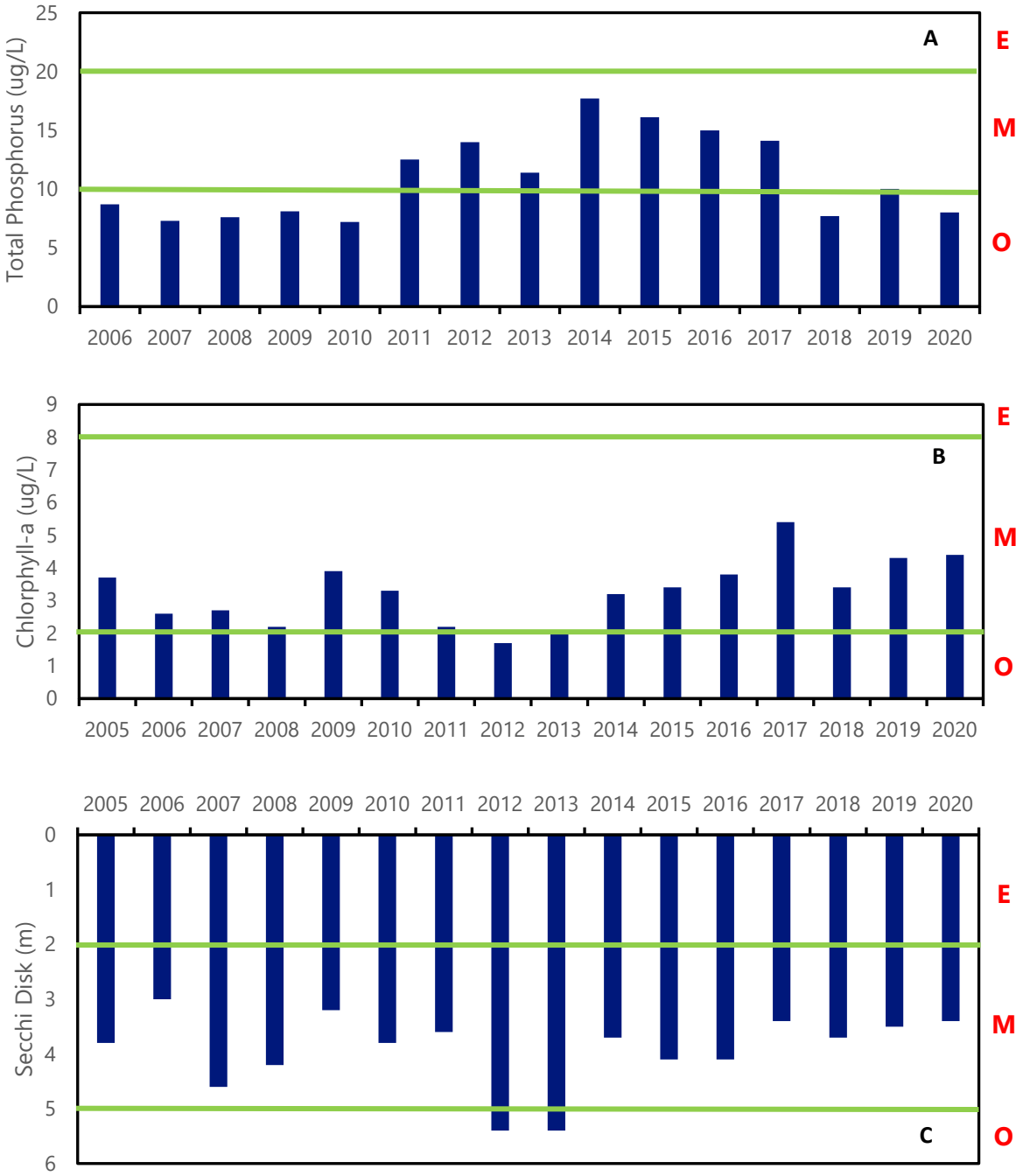

Figure 3: Summer Average Values of Trophic Indicators, Owasco Lake

Note: Summer refers to June 1-Sept. 30 average for trophic state indicator parameters A) Total Phosphorus, B) Chlorophyll-a, and C) Secchi Disk depth, measured in Owasco lake at two open-water mid-lake sites (designated north and south). E, M, and O indicate eutrophic, mesotrophic, and oligotrophic (respectively) ranges as defined by NYSDEC publication Diet for a Small Lake.

Data Sources: Finger Lakes Institute/Professor John Halfman data (2005-2016); NYSDEC CSLAP Data (2017-2020).

Water clarity changes in response to both watershed inputs of silts and sediment and fluctuations in plankton abundance. Note that water clarity measurements at the mid-lake monitoring locations may not reflect the impact of sediment inflows on nearshore areas. Monitoring data and visual observation document that turbid waters following storm events have a significant effect on water clarity (**Figure 4**).

Figure 4: Photograph of Turbidity Plume Entering Owasco Lake
Photo credit: Bill Hecht

5.2 Cyanobacteria and HABs

Cyanobacterial blooms have been reported and confirmed in Owasco Lake every year since 2013 (NYSDEC Finger Lakes Water Quality Report, 2018). HAB reports are archived on the NYSDEC HABs Reporting website (https://www.dec.ny.gov/chemical/83332.html); reports from 2013-2021 are summarized in **Table 3**.

Table 3: Summary of Reported HABs, 2013-2021

Year	Bloom Period (Date Reported, Date Removed)	# Weeks on Notification Page (pre 2019) Number of reported blooms (post 2019)
2013	8/25 - 10/3	7
2014	8/22 - 10/12	12
2015	7/10 - 10/16	9
2016	7/29 - 10/14	9
2017	7/21 - 10/20	10
2018	8/17 - 9/21	4
2019	7/31 - 10/11	*56 reports
2020	7/24 - 10/5	*70 reports
2021	8/5 - 10/6	*47 reports

*Notes: Shoreline HABs surveillance began in 2018. In 2019, NYSDEC modified the format of Archived HABs notices.
Source: NYSDEC Harmful Algal Blooms Archive Page.

Although full consensus on the cause(s) of cyanobacterial blooms and their associated toxins has not been reached, it is generally accepted that nutrient availability, water temperature, and turbulence affect their frequency, magnitude, intensity, species composition, and toxicity (NYSDEC, 2018. HABs Action Plan for Owasco Lake). Cyanobacteria encompass many species; not all are associated with production of neurotoxins and/or hepatotoxins that affect mammalian health. Given the high resource value of Owasco Lake, both as a drinking water source and a community asset, there is significant imperative to reduce the risk of cyanobacterial blooms.

Two water purveyors, the City of Auburn and Town of Owasco, rely on Owasco Lake as their source of drinking water. Both purveyors monitor their raw water (intake water, prior to treatment) and finished drinking water (fully treated) for the presence and concentration of cyanotoxins (microcystin) among a suite of other water quality parameters related to public health. The public water supplies report annually on their findings. In 2016, the Town of Owasco Water Treatment Plant first reported detectable concentrations of microcystin, a cyanotoxin, in their finished water. These detections spurred a rapid response to test, select, and install activated carbon treatment technology at both water treatment plants. This rapid response was supported by a substantial investment from NYS to protect the quality of the public water supply from HABs.

Recent data demonstrate the effectiveness of the enhanced treatment at both the City of Auburn and Town of Owasco facilities. During one sampling event in 2017, the City of Auburn's water treatment plant reported microcystins in their finished drinking water above the USEPA method detection limit, but below the USEPA method reporting limit of 0.3 µg/L. Similarly, a single sample from finished drinking water from

the Town of Owasco treatment plant in 2019 was reported to have microcystin above the USEPA method detection limit, but below the USEPA method reporting limit of 0.3 µg/L.

In 2021, the City of Auburn and Town of Owasco water supply microcystin monitoring programs each analyzed 20 paired samples of raw water (intake, prior to treatment) and finished drinking water (fully treated) between mid-August and late October. This period reflects the typical HABs season on Owasco Lake. The paired samples were collected during times when there was visual indication of a cyanobacterial bloom. In the City of Auburn's raw water, 16 of the 20 samples detected microcystins, with eleven of them above the method reporting limit of 0.3 µg/L. In the Town of Owasco raw water, six of the 20 samples had detectable concentration of microcystins; three were above the method reporting limit of 0.3 µg/L. There were no detections of microcystin above the method detection limit in the finished drinking water from either water treatment plant during 2021.

Efforts have also focused on surveillance of nearshore areas for HABs. In 2016, NYSDEC began a pilot project for HABs surveillance on Owasco Lake using trained volunteers from OWLA. Additional information on OWLA's HABs Surveillance Program can be found on their website: https://owla.org/owla-owasco-lake-habs-tracker/. The program was designed to document conditions and build awareness of potential public health risks from exposure.

The HABs surveillance program was standardized and expanded in 2018. Under NYSDEC training and oversight, volunteers are assigned specific shoreline zones for weekly monitoring. This network of trained observers reports observations to NYSDEC including bloom appearance and extent. Blooms suspected of being HABs are photographed and may be sampled for microscopic evaluation and/or assayed for the presence of cyanotoxins. Data are reported using an innovative, interactive Geospatial Information System (GIS)-based mapping and reporting tool (NYHABS). Additional information regarding the NYSDEC HABs Program is available at http://www.dec.ny.gov/docs/water_pdf/habsprogramguide.pdf.

5.3 Aquatic Community

5.3.1 Fisheries

Fisheries biologists from NYSDEC held a public information session in early 2018 to review the state of the lake's fish community (https://www.dec.ny.gov/outdoor/113023.html). As described in the 2016 Plan, Owasco Lake supports a two-story fishery; anglers catch cold-water species such as rainbow, brown, and lake trout as well as warmwater species including largemouth and smallmouth bass, walleye, and northern pike. Panfish including yellow perch, rock bass, black crappie, and sunfish are reported in angler diaries and creel census reports.

It is hypothesized that the walleye population is slowly declining in Owasco Lake based on low catch rates in 2019, 2020, and 2021, with no juvenile fish recently observed. Natural production of walleye fry is likely minimal to low in the lake due to predation by alewives. NYSDEC is actively managing Owasco Lake to improve the populations of brown and rainbow trout. To this end, the State stopped stocking walleye in

2006, and has reduced stocking of lake trout by half to reduce predation on brown and rainbow trout (Blackburn, 2022).

5.3.2 Invasive Species

Multiple invasive aquatic species, both animal and plants, have been detected in Owasco Lake. As of 2022, the list includes:

- Alewife
- Asian clam
- Chinese mystery snail
- Common carp
- Curly-leaf pondweed
- Eurasian watermilfoil
- European rudd
- Quagga mussel
- Starry stonewort
- Water-flea

Certain invasive species can contribute to the presence of HABs by altering the food web, increasing sediment suspension, and altering nutrient composition in the water column. For example, alewife consumption of large zooplankton may cause an increase of phytoplankton because fewer zooplankton are present to control the phytoplankton population. In addition, smaller zooplankton are less efficient grazers of phytoplankton, allowing for phytoplankton to increase in abundance. Aquatic macrophytes such as Eurasian watermilfoil and curly-leaf pondweed, can also function as nutrient pumps, redistributing nutrients from bottom sediment back into the water column during senescence.

Dreissenid mussels have been linked to changes in water quality such as alterations in stoichiometric ratios and more frequent HABs due to selective consumption of non-cyanobacterial phytoplankton species (Lampert 1982, Vanderploeg et al. 2001) and high excretion rates of bioavailable phosphorus into the water column (Hecky et al. 2004).

Terrestrial invasives can also affect water quality. The hemlock woolly adelgid (HWA) kills hemlock trees, which are the third most common tree in the Owasco Lake watershed and comprise much of the forest along shorelines, gorges, and streams. The loss of hemlocks in these areas would lead to erosion, reduction in water quality and increase in water temperature.

5.3.3 Fish Consumption Advisories

The New York State Department of Health (NYSDOH) provides advisories for individual waterbodies and sportfish species and maintains a web site with current information https://www.health.ny.gov/environmental/outdoors/fish/health_advisories/. The most recent (2020) fish consumption advisories for Owasco Lake are based on elevated mercury levels (**Table 4**). Note that the drinking water supplies for the City of Auburn and Town of Owasco are evaluated annually for mercury; this contaminant has not been detected in the finished water.

Table 4: Fish Consumption Advisories for Owasco Lake

Fish Species	Men Over 15 & Women Over 50	Women Under 50 & Children Under 15	Chemicals of Concern
Yellow Perch	Up to 4 meals/month	Greater than 10", up to 1 meal/month; less than 10", up to 4 meals/month	Mercury
Smallmouth bass, Walleye	Up to 1 meal/month	DON'T EAT	Mercury
Rainbow trout	Up to 4 meals/month	Greater than 20", up to 1 meal/month; Less than 20", up to 4 meals/month	Mercury
Rainbow smelt	Up to 4 meals/month	Up to 1 meal/month	Mercury
All other fish	Up to 4 meals/month	Up to 1 meal/month	Mercury

Source: NYSDOH Finger Lakes Region Fish Advisories

5.4 Water Quality Challenges

Owasco Lake is challenged by emerging issues beyond local control. Some of the most significant issues are related to climate variability; increased frequency and intensity of rainfall events, warming waters, and altered wind conditions are all implicated in an increased risk of HABs. Transport of suspended and dissolved materials from the landscape increases with higher streamflow; phosphorus export from all land cover classes is projected to increase in response to changing hydrology (Verma et al., 2015). A warming climate affects the duration and extent of ice cover as well.

Invasive species pose additional challenges to the lake's ecosystem. Proliferation of dreissenid mussels has affected nutrient cycling, particularly phosphorus exchange between the lake benthos and the overlying water (Li et al. 2021). These changes impact the lake ecosystem as well as the lake's continued support of its best uses for water supply, recreation, and aquatic habitat.

While this 9E Plan focuses on the lake watershed and recommends local actions to reduce phosphorus export, it is important to recognize the overall management challenges facing lakes across the region. Impacts of climate change and invasive species are less amenable to evaluation using the quantitative tools developed for the 9E Plan. However, the watershed and lake models provide insight into the relative magnitude of change as well as priority land cover and locations with potential for effective management.

6 Key Partners and Initiatives in Watershed Management

Those committed to planning for a healthy future for Owasco Lake and its watershed are not alone. Many organizations are working in a coordinated manner to gather data and information to characterize the lake and watershed, implement projects, and monitor their success. A recommendation of the 2016 Plan was to convene an annual planning meeting to coordinate data collection among the stakeholders actively tracking stream and lake conditions. This recommendation has been implemented, resulting in improved spatial and temporal coverage and a robust data set to support the quantitative analyses and mathematical models included in the 9E Plan.

In addition to data gathering, the Owasco Lake watershed has a well-developed institutional framework to foster collaboration and positive outcomes on water quality and natural resource management. Members of the Owasco Lake watershed partners are in frequent communication with other watershed and lake management groups, including Intermunicipal Organizations, Watershed Networks, Soil and Water Conservation Districts, County and Regional Planning agencies, the Finger Lakes-Lake Ontario Watershed Protection Alliance (FLLOWPA), the Finger Lakes Institute (FLI), Finger Lakes Partnership for Regional Invasive Species Management (PRISM), and New York State Federation of Lake Associations (NYSFOLA). Regional meetings and conferences among the many water resources management professionals represented by these organizations have helped facilitate information exchange on cyanobacterial blooms and other lake management challenges.

This section of the 9E Plan describes both elements of the collaboration: monitoring and analysis as well as information exchange and advocacy.

6.1 Partners: Monitoring and Analysis

6.1.1 Citizens Statewide Lake Assessment Program (CSLAP)

CSLAP is a volunteer lake monitoring program and education program that DEC contracts with NYSFOLA to administer. Owasco Lake has participated in CSLAP since 2017. Trained volunteers from OWLA monitor water quality conditions and collect samples for chemical analyses from surface and deep waters in the lake. CSLAP conducts biweekly monitoring from June through September (8 total sampling events each summer). Monitored parameters include water condition observations, water temperature, water clarity, specific conductance, pH, color, total phosphorus, nitrogen, chlorophyll-a, calcium, and chloride. The program also samples algal blooms to determine the potential presence of cyanobacteria and toxins. Water samples are sent to an Environmental Laboratory Accreditation Program (ELAP) certified laboratory (currently UFI, located in Syracuse, New York) for analyses.

6.1.2 OWLA Stream and Lake Monitoring

OWLA conducts annual stream monitoring, as described in the 2016 Plan. In 2017, the organization sampled the lower reaches of 17 inflows to Owasco Lake, focusing on high flow events when materials are most likely to be carried from the landscape to the waterways. The monitoring program focused on phosphorus, nitrogen, and sediments. In 2018, OWLA expanded their monitoring efforts to include

upstream stream locations to help locate potential sources of contamination. Stream monitoring continued in 2019 and 2020 with a focus on sampling during high flow conditions and measuring discharge (flow) at the time of sample collection. In 2021, OWLA with assistance from the Owasco Lake Watershed Inspection and Protection Division (OLWIPD) and OLWMC conducted stream monitoring during baseflow and high flow events in multiple locations (**Figure 5**). Sampling locations aligned with those of water surface elevation (Hyfi) sensors that had been installed as part of a pilot program (**see Section 6.2.2**), as well as priority locations used for the development of the watershed model.

As discussed in **Section 5.2**, OWLA volunteers conduct shoreline surveillance for HABs, reporting observations to the NYSDEC and the Cayuga County Department of Health. Trained OWLA members also sample water clarity in nearshore regions of the Owasco Lake to evaluate recreational suitability.

6.1.3 NYSDEC Rotating Integrated Basin Studies (RIBS) and Finger Lakes Water Hub

The objectives of the Rotating Integrated Basin Studies (RIBS) program are to assess water quality of all waters of the state, including the documentation of good quality waters and the identification of water quality problems; identify long-term water quality trends; characterize naturally occurring or background conditions; and establish baseline conditions for use in measuring the effectiveness of site-specific restoration and protection activities. The program is designed so that all major drainage basins in the state are monitored every five years (https://www.dec.ny.gov/chemical/30951.html). NYSDEC has developed a program to make lake and stream monitoring data collected across the state under their programs available online (https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=692b72ae03f14508a0de97488e142ae1).

The Finger Lakes Water Hub is housed in NYSDEC Region 7. The Hub was organized in 2017 to provide increased capacity for research, monitoring and assessment, and public outreach across the Finger Lakes and their watersheds. The research scientists working at the Hub have played a significant role in organizing monitoring programs and training citizen scientists (Clinkhammer 2017). The Finger Lakes Water Hub conducted stream monitoring along Owasco Lake tributaries in winter-spring of 2018 to fill data gaps, helps coordinate volunteer monitoring efforts in Owasco, and has conducted the Finger Lakes Winter Limnology Project since 2018.

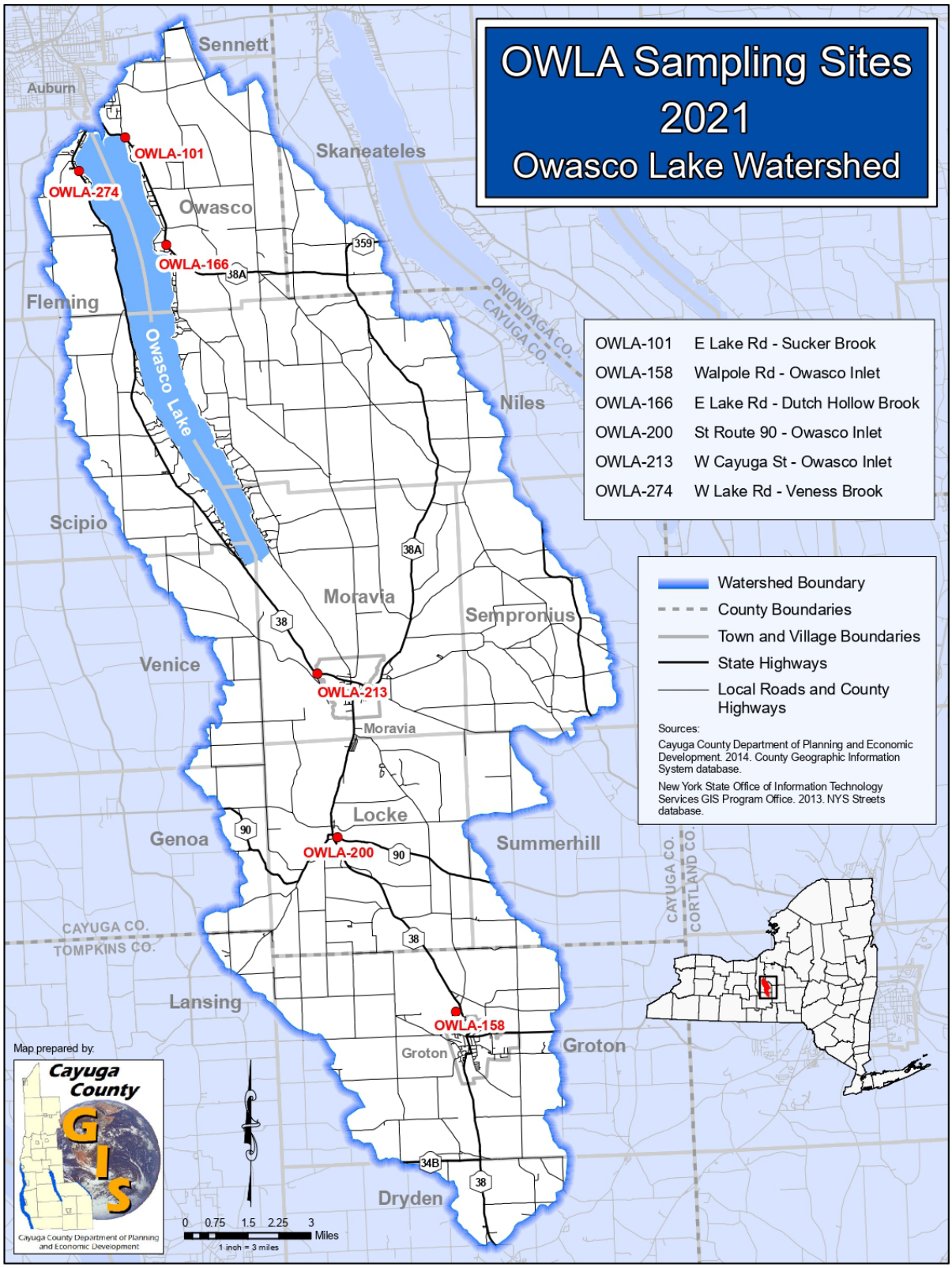

Figure 5: 2021 OWLA Sampling Sites

6.1.4 Monitoring by Professor John Halfman and Team

Since 2004, Professor John Halfman of Hobart and William Smith Colleges and the FLI has deployed a meteorological and water quality monitoring buoy in Owasco Lake between May and October. The buoy is located at a mid-lake site south of Burtis Point at a water depth of 50 meters. Lake surface meteorological parameters (wind speed and direction, relative humidity, air temperature, light intensity, and barometric pressure) were measured every 30 minutes. Water quality parameters (water temperature, dissolved oxygen, turbidity, specific conductance, total chlorophyll, chlorophyll-a, and phycocyanin (blue-green algal pigment)) were measured at 1.5 meters depth intervals through the water column twice each day during deployment. UFI modelers used this extensive data set to develop and test the hydrodynamic framework underlying the Owasco Lake Water Quality Model.

Cayuga County has supported John Halfman's lake and watershed monitoring program and other nearshore efforts since 2011. The lake program includes monthly monitoring of two mid-lake sites during the May through September field seasons to investigate water quality trends by collecting and analyzing Secchi disk transparency, plankton tows, and surface and bottom water samples for total phosphorus (TP), soluble reactive phosphorus (SRP), nitrite plus nitrate- nitrogen (NOx), and total suspended solids (TSS). Beginning in 2020, lake monitoring increased to weekly surveys during August and September when the risk of HABs is greatest. This data set provides insights into factors affecting cyanobacterial blooms.

The watershed program led by John Halfman has included water quality sampling and discharge measurements of both major and minor tributaries. The 2017 field program included stream segment analyses of Dutch Hollow Brook, the Owasco Inlet, and the tributary at Fire Lane 20. Sampling was conducted during the late May through September field season to further investigate nutrient (TP, SRP, NOx) and TSS sources. In 2018, the program was modified to include stream segment analyses of Dutch Hollow Brook, water quality analysis of grab samples at the Rt. 38 Moravia Site on Owasco Inlet, and the small, first-order tributaries at the ends of Fire Lanes 20 and 26. This watershed sampling effort extended from late May through July.

This watershed monitoring program has also gathered data describing nutrient and sediment concentrations and loads at various locations during events and base flow conditions. Monitored sites included Route 38A and North Road sites along Dutch Hollow, where samples were collected every eight hours. The North Road site was discontinued in 2017. In 2018, sample frequency was reduced to a daily record of event versus base flow nutrient and sediment loads at the mouth of Dutch Hollow Brook from mid-April through September/October.

Beginning in 2017, the field monitoring program was expanded to include remote sensing. Drones were flown over selected nearshore areas to map spatial and temporal distributions of macrophytes and algal/cyanobacterial blooms. In 2019, water quality monitoring sondes were placed at two nearshore sites to monitor and record water temperature and dissolved oxygen concentration. The program was intended to investigate water quality linkages to development of HABs.

In 2020, this element of the monitoring program was expanded to provide more detail regarding the environmental conditions associated with HABs. Four shoreline sites were monitored to evaluate water quality, meteorology (air temperature, barometric pressure, humidity, light intensity, wind speed and direction), and the spectral signatures associated with abundance of aquatic plants and cyanobacteria. Taken together, this data set provides an opportunity to explore linkages between environmental drivers and the risk of HABs.

6.1.5 Stream Discharge Monitoring

Two USGS gauging sites continued operation in the lake watershed since completion of the 2016 Plan as displayed in **Figure 6**. The Owasco Inlet, the major tributary inflow to Owasco Lake, is gauged; this site is listed as the 'Owasco Inlet below Aurora St. in Moravia' and has recorded water surface elevation and stream discharge continually at this location since April 2009. The lake outlet is also gauged; a USGS station listed as 'Owasco Lake Near Auburn' has recorded the elevation of Owasco Lake water level since 1967.

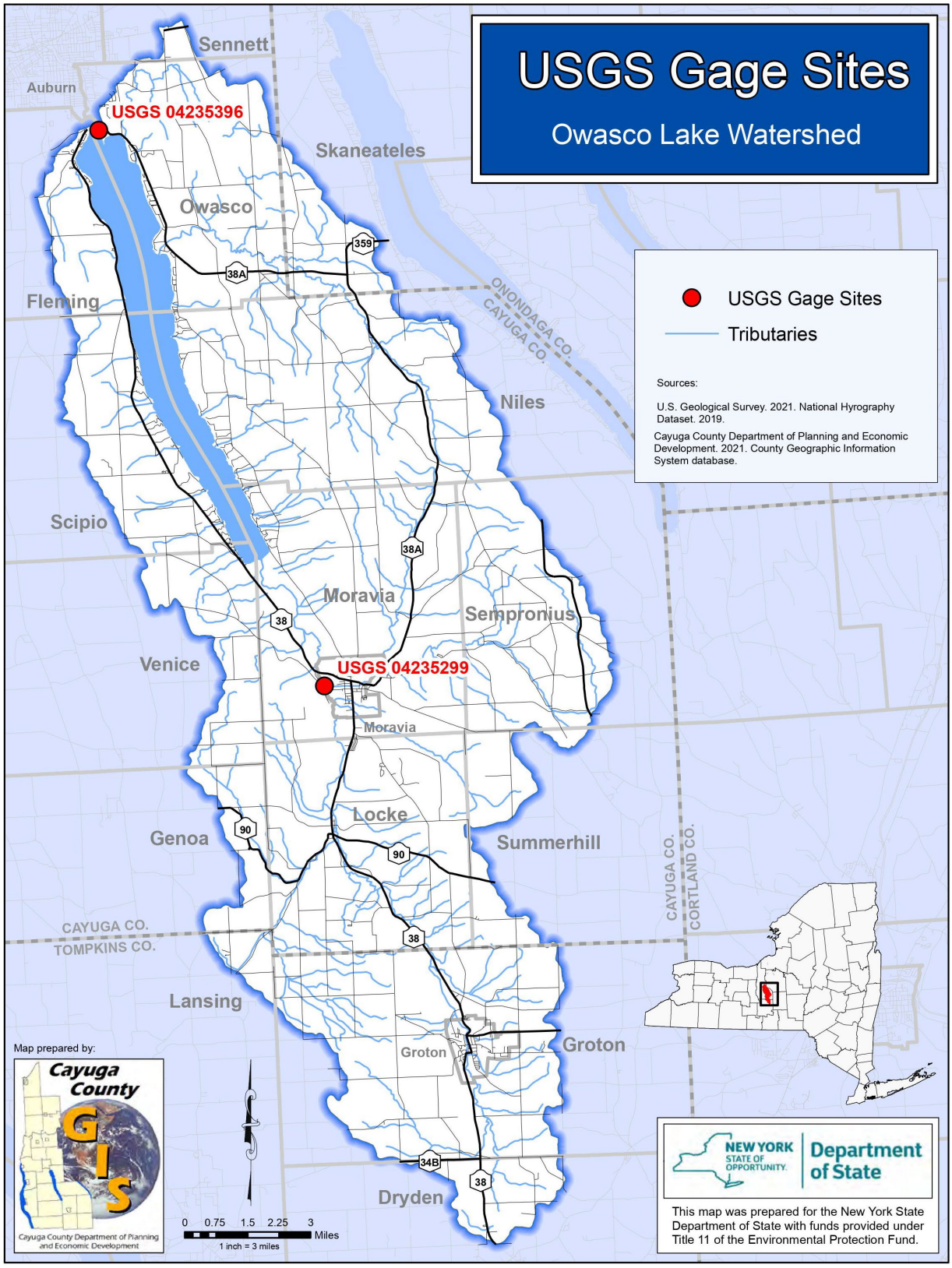

Figure 6: USGS Gage Sites in the Owasco Lake Watershed

In 2020 and 2021, water level sensors provided by Hyfi were installed in tributaries around the Owasco Lake watershed and in the Owasco Flats Wetland Restoration and Riparian Buffer Project area (project described further in **Section 6.3.3**). This effort was part of a pilot program funded by the Great Lakes Protection Fund for Hyfi to test their new technology. The Hyfi water level sensors measure and record real time water surface elevation of watershed streams and stormwater basins using wireless technology. When coupled with velocity measurements and stream/basin cross sectional area, water surface elevation data can be used to estimate discharge. By further coupling concurrent constituent (e.g., phosphorus, nitrogen, suspended solids) concentration data with estimated discharge, managers can estimate tributary constituent loads to Owasco Lake. Ultimately, these site-specific load estimates can be used to update the Soil and Water Assessment Tool (SWAT) model. In 2021, OWLA with assistance from the OLWIPD and OLWMC collected tributary water quality data at some of the locations of the Hyfi installations. This work continued in 2022.

6.1.6 Cornell University Stream Monitoring

Graduate students from Cornell University's BEE program collected stream samples within the Owasco Lake watershed to ensure adequate spatial coverage for developing and testing the SWAT model of the watershed. Monitoring locations were selected in collaboration with the CCDP&ED to represent a range of conditions and land uses. The project team collected and analyzed samples from spring to fall in 2016, 2017, and 2018.

6.1.7 USGS Owasco Lake Platform

The USGS and NYSDEC launched the Owasco Lake Platform in September of 2018 as part of New York State's HABs initiative. The buoy remained on Owasco Lake during the open water seasons of 2019 and 2020 and collected high-resolution temporal data using sensors to monitor both weather conditions (temperature, atmospheric pressure, wind speed and light intensity) and lake water quality data (specific conductance, dissolved oxygen, pH, chlorophyll fluorescence, dissolved organic matter, turbidity, soluble reactive phosphorus, and nitrate+nitrite-N). Data from the USGS platform and photos from the webcam were uploaded to a publicly available data viewer in near real-time (https://ny.water.usgs.gov/maps/habs/). The monitoring buoy provided important data and information to support the Owasco Lake Water Quality Model developed by the Upstate Freshwater Institute.

6.2 Partners: Information Exchange and Advocacy

6.2.1 Owasco Lake Watershed Management Council (OLWMC), Inc.

The OLWMC, an intermunicipal nonprofit organization, is the primary entity responsible for coordinating implementation of recommendations to protect and improve Owasco Lake and its watershed. The OLWMC manages the OLWIPD; this division is tasked with monitoring activities across the watershed for compliance with applicable rules and regulations.

The OLWMC was formed in 2011 by agreement among three parties: the City of Auburn, Town of Owasco and Cayuga County, with provisions for other watershed municipalities to join. The current members include Town of Owasco, Cayuga County, City of Auburn, Town of Niles, Town of Locke, Town of Scipio,

Town of Fleming, Village and Town of Moravia, Village of Groton, Town of Summerhill, Town of Sennett, and the Town of Dryden. Note that five of the listed municipalities joined the OLWMC since completion of the 2016 Plan (Villages of Moravia and Groton, and Towns of Summerhill, Sennett, and Dryden).

The OLWMC actively collaborates with other partners to implement projects and educational programs, increase public awareness, monitor, and evaluate water quality, and support research in the watershed to identify problem areas. In 2020, the OLWMC summarized the status of projects, according to the recommendations included in the 2016 Plan. The OLWMC and the CCDP&ED provided project updates again in 2022. This document is included as **Appendix B**.

6.2.2 Owasco Watershed Lake Association (OWLA)

Members of the OWLA engage in activities to protect and restore Owasco Lake and its watershed. Current efforts include testing innovative technologies, funding watershed erosion prevention projects, fighting invasive plants and insects, and tracking down sources of excessive phosphorus, nitrogen, and sediment entering the lake. OWLA volunteers also participate each year in CSLAP to help assess and track the lake's water quality (**Section 6.1.1**), conduct shoreline HABs surveillance (**Section 5.2**), and sample water from several watershed inflows and streams (**Section 6.1.2**).

For four years, OWLA has partnered with the Cayuga County SWCD to reduce erosion from roadside ditches. OWLA has to date raised $57,000 to offset costs of ditch remediation that otherwise fall to the County and local highway departments. Volunteers have also collaborated with a farmer in 2021 to plant 2,500 willow tree canes and grass to create a natural buffer between a large crop field and a stream. OWLA members who are active farmers helped develop revisions to the existing Owasco Lake Watershed Rules and Regulations to incorporate latest best management practices and agricultural scientific experience.

In 2021, OWLA initiated a campaign to find and suppress the invasive HWA. Work continues with surveying of the presence and locations of the watershed's hemlocks followed by treating infested trees in critical areas. In 2021, 4,000 hemlocks were treated with insecticide by New York State-certified HWA insecticide foresters. OWLA has been awarded a Great Lakes Restoration Initiative United States Forest Service grant that will enable treating an estimated 10,000 additional hemlocks that line ravines throughout the southern region of the Owasco Lake watershed.

Finally, OWLA continues a broad scope of outreach and education including monthly articles contributed to print and on-line media outlets, an annual public information symposium, newsletters, and educational programming for teachers. Additional information about the organization can be found at their website www.owla.org.

6.2.3 Cayuga County Water Quality Management Agency

The Cayuga County Water Quality Management Agency (WQMA) was created in 1990 to advise the Cayuga County Legislature on matters related to water resource management and planning. The WQMA is charged with identifying problems, proposing priorities, and coordinating activities designed to manage

and protect the County's water resources. Members include environmental advisors from County agencies (Cayuga County Department of Planning and Economic Development, Environmental Health, Buildings and Grounds, Soil and Water Conservation District, and Solid Waste Management Program; and Cornell Cooperative Extension of Cayuga County), local officials, and representatives from waterbody associations. The WQMA develops annual work plans with specific objectives for focused working groups, including the Nutrient and Sediment Working Group, Invasive Species Working Group, and the Communications and Outreach Working Group.

6.2.3.1 Manure Management Working Group

In 2014, the Cayuga County WQMA formed a Manure Management Working Group prompted by manure runoff incidents that occurred on frozen and saturated ground during the winters of 2013-2014 in Cayuga County and across the State. This committee was organized by County legislators to investigate how practices involving the storage, application, processing, and transport of manure can be improved so that their negative impacts on water quality are minimized.

Deliberations and ultimate findings of the Working Group were informed by detailed and constructive input from agricultural producers, representatives of agricultural support agencies, public health and environmental professionals, and local elected officials. The outcome of this inclusive and thorough process was the document "*Improving Manure Management: A Fourteen-Point Countywide Agenda for Action*" (http://cayugacountywater.org/wp-content/uploads/2018/05/Agenda-for-Action_Jan_26_2016.pdf). In February 2016, the Cayuga County Legislature voted to approve and adopt the document and charged the parties identified as responsible for each action item to implement the recommended actions. One of the recommended tasks of the Agenda for Action was development of specific guidelines for manure management. The WQMA convened a Working Group to develop the *"Cayuga County Water Quality Management Agency: Manure Management Guidelines"* (https://www.cayugacounty.us/DocumentCenter/View/1507/Cayuga-County-Water-Quality-Management-Agency-Manure-Management-Guidelines-PDF?bidId=); these guidelines were adopted by the WQMA in March 2017.

6.2.3.2 Nutrient Working Group/Nutrient and Sediment Working Group

The Nutrient Working Group of the Cayuga County WQMA, in consultation with county and town highway officials and staff of Cornell University's Local Roads Program, prepared the *"Cayuga County WQMA Guidelines for Municipal Maintenance of Roadside Ditches"* (http://cayugacountywater.org/wp-content/uploads/2018/05/Ditch-guidelines.pdf). This is a set of ditch maintenance guidelines recommended for municipalities to follow to minimize the degradation of water quality that can result from excess nutrient loading. This document was approved and adopted by the WQMA on November 2, 2017, and by the Cayuga County Legislature on January 23, 2018. The Cayuga County WQMA and Legislature encourage adoption and implementation of these practices among government employees and officials at all levels.

The Nutrient and Sediment Working Group of the Cayuga County WQMA also prepared the *"Cayuga County WQMA Residential Guidelines to Protect Water Quality in Cayuga County"* (http://cayugacountywater.org/wp-content/uploads/2020/01/Final_Residential_Guidelines-pdf-for-web.pdf), a set of guidelines recommended for homeowners to follow to minimize the impact of stormwater from their properties. This document was approved and adopted by the Cayuga County WQMA on February 6, 2020, and by the Cayuga County Legislature on February 25, 2020. The WQMA and Legislature encouraged adoption and implementation of these practices across the watershed community.

6.2.4 Save Owasco Now!

Save Owasco Now! was formed in response to detected cyanotoxins in the finished drinking water drawn from Owasco Lake. This citizen advocacy group has been working to raise awareness of the risk of harmful algal blooms and mobilize New York State's response.

6.2.5 Partners for Healthy Watersheds

A consortium of organizations representing New York Dairy farmers: Cayuga County Farm Bureau, the Northeast Dairy Producers Association, Inc., the American Dairy Association – Northeast and the New York Animal Agriculture Coalition, formed the Partners for Healthy Watersheds. This group advocates for feasible and practical solutions to nutrient management. The Partners for Healthy Watersheds organization is strongly committed to outreach and public education regarding best water quality management practices. The group uses multiple approaches to community outreach including print and radio, informational forums, farm tours, and social media.

6.2.6 The Nature Conservancy and Evidn

The Nature Conservancy (TNC) is actively working in the Owasco Lake watershed with the applied behavioral science company, Evidn. Evidn uses behavioral science to understand what motivates people to act, identify barriers, and find effective strategies to bring about meaningful positive change. The first step in the process is to conduct detailed interviews with key watershed stakeholders, including the agricultural community. These interviews help the firm's behavioral scientists construct a profile of current behaviors and underlying motivations and use this understanding to predict effective approaches to modifying targeted behaviors. The firm tailors their outreach programs to specific issues and communities. Evidn began working with TNC on Owasco Lake management challenges in early 2020 and this effort is ongoing.

6.3 Related Projects

6.3.1 Update to the Local Laws Assessment

The Owasco Lake Watershed: Institutional Framework and Assessment of Local Laws, Programs, and Practices Affecting Water Quality was developed as part of the development of the 2016 Plan. The document provides a description and analysis of the broad institutional framework that guides decision making in the watershed, an overview of the roles and responsibilities of local governments, an inventory

of specific local laws and gap analysis, and preliminary recommendations for municipal governments. An update of local laws for water resource protection is provided as **Appendix C**.

6.3.2 Updated Watershed Rules and Regulations

In New York, purveyors of public water can adopt local watershed rules and regulations that guide management of potential sources of contamination that could affect water quality. These local watershed rules and regulations are subject to review and approval by the NYSDOH. While the authority to develop and enforce watershed rules and regulations has existed for decades under New York State law, Owasco Lake watershed is among the first to reexamine their rules since the emergence of HABs as a significant water quality and public health issue. The City of Auburn and the Town of Owasco recently proposed updates to their current (1984) Watershed Rules and Regulations (WRR) for Owasco Lake. The current WRR has unclear language that can hinder enforcement efforts, does not include provisions requiring protection from erosion and sedimentation on construction sites under one acre, and other limitations. The proposed revisions to the WRR close these gaps and strengthen other protections, while incorporating a waiver process to consider site-specific conditions. The existing institutional framework for watershed inspection and communication remains unchanged in the proposed revisions.

The process to review the current watershed rules and regulations and consider what, if any, modifications were appropriate, began in 2017 with resolutions of support from the City of Auburn, Town of Owasco, and Cayuga County Legislature. Numerous public information meetings and forums were convened over a two-year period; events included presentations with review and discussion sessions led by independent facilitators, and an interactive project website with project information, drafts of regulations, and minutes of public meetings. A steering committee with representatives of many stakeholder groups was formed with guidance from the CCDP&ED and the OLWMC. The steering committee engaged with representatives of the agricultural community and OWLA to ensure that their perspectives were captured.

A revised set of WRR for the Owasco Lake watershed was released for public comment in March 2019. Following receipt of extensive public comments, the project team revised the initial draft and created a final draft which was approved by the Steering Committee on March 12, 2020. A joint meeting of the Auburn City Council and Owasco Town Board was held on October 29, 2020, to discuss adoption of the updated WRR. Both the Auburn City Council and the Owasco Town Board passed resolutions in support of the revised WRR and authorized their submittal to the NYSDOH for review.

6.3.3 Owasco Flats Wetland Restoration and Riparian Buffer Project

Cayuga County received two grants from the New York State Environmental Facilities Corporation's (NYSEFC) Green Innovation Grant Program to advance the Owasco Flats Wetland Restoration and Riparian Buffers Project. This project is located on land owned by the City of Auburn off Route 38 in the Town of Moravia. The project was designed to install water control structures and reconnect the Owasco Inlet with its floodplain. During high flow events, water flows into wetlands (both existing and newly created) to enhance sediment settling and nutrient retention. The created wetlands were designed to act like natural vernal pools; that is, retain standing water for a week or two following storm events. This cycle of wet and

dry conditions will encourage amphibian reproduction, while limiting predatory fish species, nesting waterfowl, and habitat for mosquitoes. Riparian buffers were added along drainageways and the Owasco Inlet to further reduce nutrients and sediment inputs. The project was completed in June 2021.

6.3.4 Drinking Water Source Protection Plan (DWSP2)

The City of Auburn is preparing a Drinking Water Source Protection Plan (DWSP2), a new initiative of NYSDEC and NYSDOH. The plan identifies and maps potential contaminant sources, addresses potential threats, and recommends long-term measures for protecting the quality of the water supply. The plan, which is scheduled for completion in 2022, identifies a Plan Management Team to track progress toward implementing recommendations related to protecting the quality of the source of public water supply (Owasco Lake). The Plan Management Team is tasked with reporting annually to the community in addition to NYSDEC and NYSDOH.

7 Classification and Best Uses of the Waterways

7.1 Vision, Goals, Targets, and Strategies

The project team led a discussion of vision and goals as part of the first public outreach session for the 9E Plan. The overall agenda of the August 2018 session was to introduce the rationale for and approach to this effort and provide context for how the 9E Plan relates to the 2016 Plan and the HABs Action Plan. The session on vision and goals provided a forum for the community to share their thoughts of what a successful outcome of the 9E Planning process would mean for both environmental and human resources- those who live, work, and recreate within the watershed.

The vision statement that resulted from this process was:

- **Owasco Lake is a functioning, dynamic and healthy ecosystem providing natural, spiritual, economic, recreational, and community benefits to current and future generations.**

The overarching goal for the 9E Plan was expressed as follows:

- **Restore and protect the viability of Owasco Lake as a drinking water source, economic resource, recreational asset, and healthy aquatic ecosystem.**

Participants ranked the following strategies as central to meeting the overall goal and expressed their interest in seeing them reflected in the 9E Plan:

- Identify, quantify, and reduce watershed sources of sediment, nutrients, and other potential contaminants.
- Build community awareness of how human actions affect Owasco Lake water quality.
- Increase capacity for collaboration among stakeholders in watershed management.
- Respond to threats, challenges, and emerging issues, including climate change.
- Continue water quality monitoring to assess effectiveness of actions.
- Apply adaptive management strategies to improve the Owasco Lake Watershed.
- Secure resources to implement the plan.
- Promote the strengthening of municipal controls to protect and preserve water quality in the watershed.

For the 9E Plan for Phosphorus Reduction, targets are defined as measurable concentrations of phosphorus that correspond to the desired condition. That is, phosphorus concentrations that correspond to maintaining the lake's best uses, as described in the following section.

7.2 Classification and Use Attainment

Owasco Lake is designated by NYSDEC as a Class AA- Special (TS) water body. The AA-Special designation signifies that the lake's best use is as a water supply and requires limited treatment. The designation TS signifies that the lake sustains a cold-water fishery (trout and salmon) with suitable spawning habitat.

Owasco Lake supplies drinking water to over 48,000 residents. The Town of Owasco and City of Auburn operate water intake and treatment facilities. Treated water is also distributed to residents within the Villages of Cayuga, Port Bryon and Weedsport, and the Towns of Sennett, Fleming, Throop, Brutus, Montezuma, Springport, Mentz, and Aurelius. The lake also is a source of potable water to the Cayuga County Water Authority, the Thruway Authority, and numerous private systems for lakeshore residents.

The federal Clean Water Act requires states and tribes to evaluate water quality and habitat conditions of waterways under their jurisdiction and evaluate whether the best uses (for water supply, recreation, aquatic life protection) are supported. Waterbodies that may not fully support their best uses are placed on the 303(d) list, named after the section of the Clean Water Act that requires its development.

The NYSDEC had included Owasco Lake on the state's 303(d) list of impaired waters since the inaugural list was released in 1998. The lake was classified as "Impaired" for recreational uses due to elevated fecal coliform bacterial counts in nearshore areas that required occasional beach closings. From 1998 to 2016, Owasco Lake was included in Part 3a of the 303(d) list, signifying that a TMDL (Total Maximum Daily Load) may be deferred pending verification of the impairment. In 2016, Owasco Lake was moved to Part 3b of the New York State's 303(d) list. Part 3b waters include those for which the impairment is verified, but require further investigation to determine the underlying cause, pollutants, and sources.

The NYSDEC 2020-2022 draft list of impaired waters, which was released for public comment on December 29, 2021, continues to list Owasco Lake as impaired (confirmed) by fecal coliform bacteria for primary and secondary recreation. Owasco Lake is listed as impaired (unconfirmed) for fishing due to pH and as impaired (unconfirmed) for water supply due to pH and iron. The iron and pH listings reference 2012 data as the basis for the assessment.

The draft 2020-2022 list of impaired waterbodies also includes changes for lake tributaries. Owasco Inlet, Lower, and minor tributaries (segment 0706-002) are newly listed as impaired by pH. An adjacent reach of Owasco Inlet, Upper, and tributaries (segment 0706-014) remains on the impaired waterbodies list; this segment has been designated as impaired by nutrients since 2008. Another change associated with the draft 2020-2022 303(d) listing is the proposed delisting of all waters in New York State that had previously been listed as stressed, threatened, impaired, or precluded for their best use by excessive silt and sediment; this regulatory change affects the waterbody assessments of Owasco Inlet, Dutch Hollow Brook, and unnamed tributaries. The regulatory status of Owasco Lake waters on the current (2018) and proposed (2020-2022) impaired waterbodies list is summarized in **Table 5**.

Table 5: Section 303(d) List of Impaired Waterbodies in the Owasco Lake Watershed 2018 Final List Compared to the 2020-2022 Draft List

Waterbody Name	2018 Status	Cause/Pollutant and Year Listed	2020-2022 Draft
Owasco Lake	Impaired	Fecal coliform bacteria (2008)	Continued listing as impaired by fecal coliform bacteria
Owasco Inlet, Lower, and Minor Tribs	Not listed	pH (2022)	Newly listed as impaired by pH
Owasco Inlet, Upper, and Tribs	Impaired	Nutrients (2008)	Continued listing as impaired by nutrients

Sources: (a) NYSDEC 2018 Section 303(d) Impaired Waterbodies List, Final June 2020
https://www.dec.ny.gov/docs/water_pdf/section303d2018.pdf
(b) NYSDEC 2020-2022 Section 303(d) Impaired Waterbodies List, Draft December 29. 2021
https://www.dec.ny.gov/fs/docs/spreadsheets/Draft_2020_2022_Section_303d_List.xlsx

7.3 Quantitative Tools to Estimate Phosphorus Sources and Define Priority Actions

7.3.1 Quality Assurance Project Plans (QAPPs)

The Owasco Lake 9E Plan for Phosphorus Reduction draws on data collected within this system to construct mathematical models of Owasco Lake and its watershed. All data used in a 9E Plan are required to have an approved QAPP. In addition, mathematical models of the lake and watershed are required to have an approved QAPP. These documents were prepared in accordance with NYSDEC Quality Assurance standards to outline objectives of monitoring and modeling programs, procedures for data collection and analysis, model assumptions, and criteria for acceptance (https://www.dec.ny.gov/chemical/23850.html).

Stream data used for the watershed model development, calibration, and verification were collected by trained volunteers, graduate students, or NYSDEC staff. Samples were analyzed by certified testing laboratories as described in the approved Owasco Lake Watershed Tributary Monitoring QAPP (**Appendix D**). The approved original and amended Owasco Lake Watershed Model QAPPs (**Appendix E**) describe the quality objective for the project, which was to set up, calibrate, and validate a model of the Owasco Lake watershed to support development of the 9E Plan. The QAPP summarizes data usability criteria, the model calibration/verification process, and performance evaluation criteria. Any changes from the original QAPP were provided in the Amended QAPP, approved by NYSDEC in 2020.

The lake modeling team also completed all data acquisition and modeling tasks in compliance with approved QAPPs. These documents are described in the UFI report "A Water Quality Model for Owasco Lake, New York" dated November 2021.

7.3.2 Watershed Model

A primary task to meet the requirements for a 9E Plan was to develop a mathematical model of the Owasco Lake watershed capable of predicting transport of phosphorus from the landscape to the waterways. The Cornell research team selected the SWAT model as the watershed modeling framework because of its wide application in agricultural watersheds. SWAT is applied to quantify and predict the impacts of land management practices on water, phosphorus, sediment, and other nutrient yields in large complex watersheds with varying soils, land use, and management conditions. The SWAT model is widely used for Clean Water Plans in New York State and many other areas, including Cayuga Lake, other Finger Lake watersheds, and Lake Champlain. The Owasco watershed modeling team led the watershed model development in neighboring Cayuga Lake which provided a strong foundation for this effort.

The SWAT model was set up using data specific to of the Owasco Lake watershed. This requirement for site-specific data encompassed both the environmental setting (soils, topography, stream network, and meteorology) and the human impacts on the watershed lands (land cover, development patterns, roadways, and management practices). Incorporating detailed information on specific watershed conditions is necessary to ensure that the final model provides realistic projections of the impact of various management actions.

The SWAT model has the capability to simulate transport of phosphorus from the landscape to surface waters. While the focus of this 9E plan is total phosphorus, the Owasco Lake HABs Action Plan includes a description of the different forms of phosphorus and their relative ability to support phytoplankton (algae and cyanobacteria) growth (NYSDEC 2018). In general, dissolved forms of phosphorus are more readily available than particulate forms to support phytoplankton growth (Prestigiacomo et al. 2016) and should be strongly considered in application of watershed best management practices (NYSDEC Draft Cayuga Lake TMDL, April 2021).

Each SWAT model analyzes the watershed dynamics by breaking the landscape into a series of unique combinations of key attributes (e.g., soils, slopes, land cover, management practices) to create a mosaic of Hydrologic Response Units (HRUs). For the Owasco Lake watershed, the model tracks 50 sub-basins and 413 unique HRUs to capture the variability across the 205 square mile watershed. Details on the data sources and input files needed to develop, calibrate, and verify the watershed model are presented in **Appendix F.**

7.3.3 Estimated Contribution from Septic Systems

Cayuga County planners applied the Method for Estimating Attenuation of Nutrients from Septic Systems (MEANSS) tool to estimate phosphorus contribution from individual on-site wastewater disposal systems (septic systems) located close to Owasco Lake and its tributary streams. This approach uses site-specific data on the number and locations of septic systems and the nature of the soils underlying each leach field. Findings of the MEANSS estimation tool helps assess the relative contribution of septic systems to overall phosphorus loading. In addition, the findings of the MEANSS calculations help identify priority

areas for improved wastewater management. Additional details on the MEANSS approach and its application to the Owasco Lake watershed are presented in **Appendix G**.

7.3.4 Lake Water Quality Model

Scientists and engineers from UFI developed a mechanistic Owasco Lake Water Quality Model as a separate initiative from this 9E Plan for Phosphorus Reduction. The in-lake water quality model enables managers to predict the effectiveness of external load reduction on meeting water quality targets associated with the lake's best uses for water supply, aquatic life protection, and recreation. The lake model also projects the time frame over which lake water quality changes may be evident.

8 Sources of Phosphorus

8.1 Point Sources

Two small wastewater treatment plants (WWTP) serving the Village of Moravia and the Village of Groton discharge treated effluent to the Owasco Inlet upstream of the confluence with Owasco Lake (**Figure 7**). Both wastewater facilities have been upgraded to provide advanced phosphorus removal, as summarized in **Table 6**. The updated Groton WWTP was fully operational in 2012; the Moravia WWTP was upgraded in stages, with advanced treatment completed in 2013. Since 2010, annual phosphorus discharge from the two facilities combined has averaged 423 pounds per year. Each facility discharges total phosphorus substantially below its respective regulatory permit limit. The Groton WWTP is currently permitted to discharge 4 pounds per day (ppd) of total phosphorus; average performance is 0.52 ppd. The Moravia WWTP is permitted to discharge 2.5 ppd; average performance is 0.76 ppd. The relative contribution of point sources to the total external phosphorus input to Owasco Lake is summarized in **Table 6**.

Table 6: Point Sources of Phosphorus, Owasco Lake Watershed

Year	Groton WWTP Annual Load (lbs/yr.) (SPDES ID: NY0025585)	Moravia WWTP Annual TP Load (lbs/yr.) (SPDES ID: NY0022756)	Summed Point Source Annual TP Load (lbs/yr)
2001	2,204	317	2,521
2002	3,513	548	4,061
2003	4,390	433	4,823
2004	3,037	364	3,401
2005	2,425	556	2,981
2006	1,461	975	2,436
2007	1,097	696	1,793
2008	956	398	1,354
2009	374	389	763
2010	224	313	537
2011	569	396	965
2012	135	384	519
2013	106	242	348
2014	95	332	427
2015	110	329	439
2016	110	329	439
2017	211	329	540
2018	215	267	482
2019	153	319	472
2020	157	300	457
2021	172	166	338
Actual average annual point source total phosphorus load, post WWTP upgrades (2017-2021), lb/yr.			**458**
Permitted annual point source total phosphorus load (Groton = 4 ppd; Moravia = 2.5 ppd), lb/yr.			**2,373**

Source: ECHO Database, DMR and TRI Multi-Year Loading Report (https://echo.epa.gov/trends/loading-tool/water-pollution-search/)

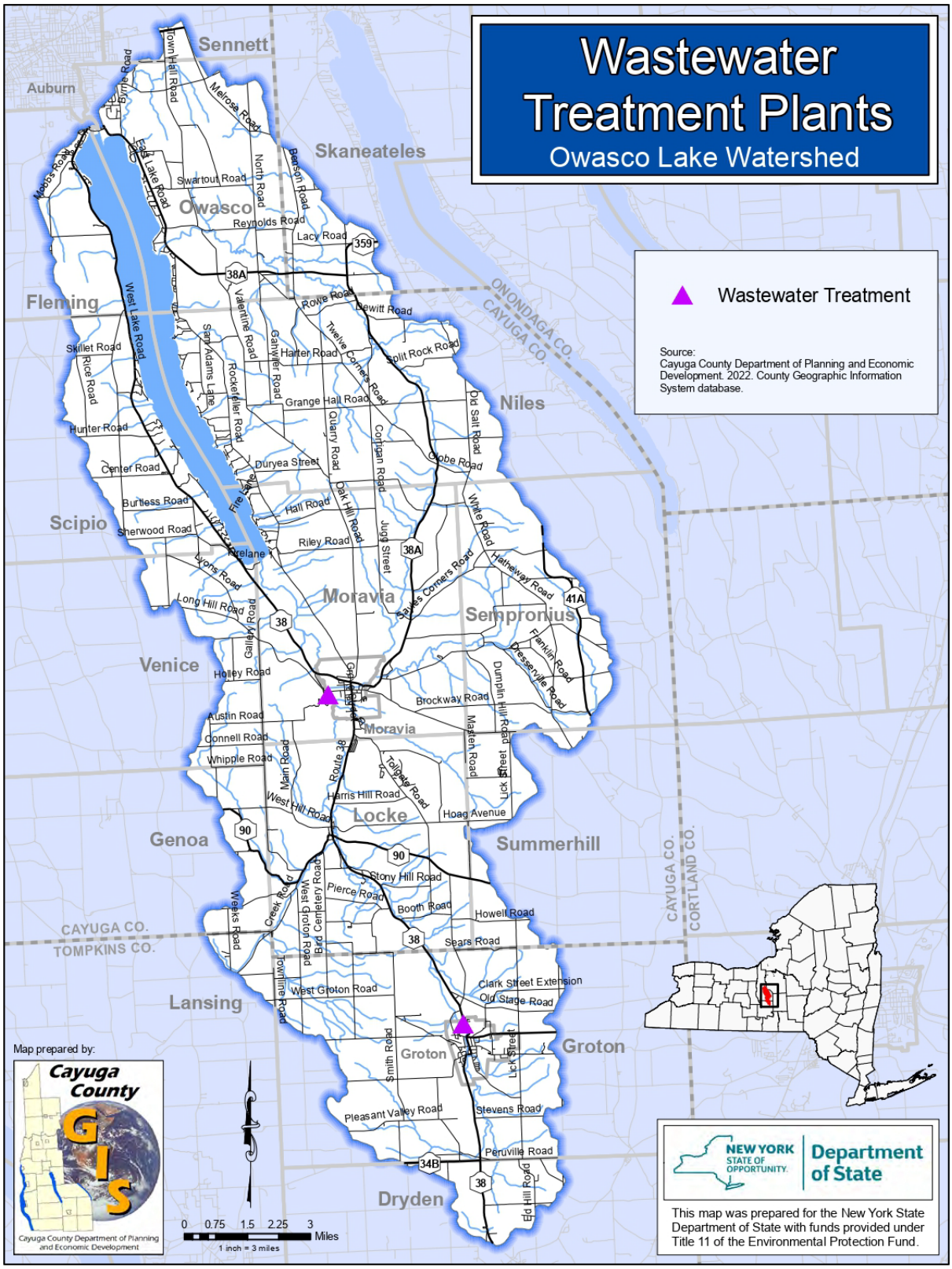

Figure 7: Wastewater Treatment Plants in the Owasco Lake Watershed

8.2 Nonpoint Sources

The Cornell team applied the calibrated SWAT model to estimate nonpoint sources of phosphorus from the Owasco Lake watershed landscape, as summarized in **Table 7**. Note that land cover classifications reflect the 2016 NLCD that was available at the onset of the modeling effort. There is interannual variation in agricultural land cover based on many factors, including crop rotation.

Table 7: Nonpoint Source Phosphorus Load to Owasco Lake by Land Cover, SWAT Model Estimates

Source	Watershed Land (Acres)	Percent Watershed Land Cover	Unit Phosphorus Load (lb/acre/yr.)	Estimated Total Phosphorus Load (lb/yr.)
Developed Lands, Low Intensity and Open Space	7,572	7%	0.07	512
Developed Lands, Medium and High Intensity	269	<1%	2.28	615
Forest, Deciduous, Evergreen, and Mixed	42,900	38%	0.02	1,004
Hay/Pasture	24,515	22%	0.39	9,464
Cultivated Crops	36,875	33%	0.37	13,590
Total	**112,131**	**100%**	**-**	**25,185**

Agricultural lands (pasture/hay and cultivated crops) collectively cover more than half of Owasco Lake's watershed area and are significant contributors of phosphorus. According to SWAT (**Figure 8**), approximately 90% of the TP loads to the landscape comes from agricultural lands. The SWAT watershed model does not explicitly simulate erosion from stream beds and banks; it estimates material transport from the landscape to the streams and is calibrated to stream data collected within the Owasco Lake watershed over a range of hydrologic conditions.

Phosphorus measurements collected in the Owasco Lake tributary monitoring sites include both soluble and sediment-bound fractions. Phosphorus can reach the monitoring sites through various processes: sheet flow across the landscape, transport through road ditches and tile drainage outlets, groundwater seepage, any upstream point source discharges, as well as erosion of stream beds and banks. Additional information on the SWAT watershed model can be found in **Appendix F**.

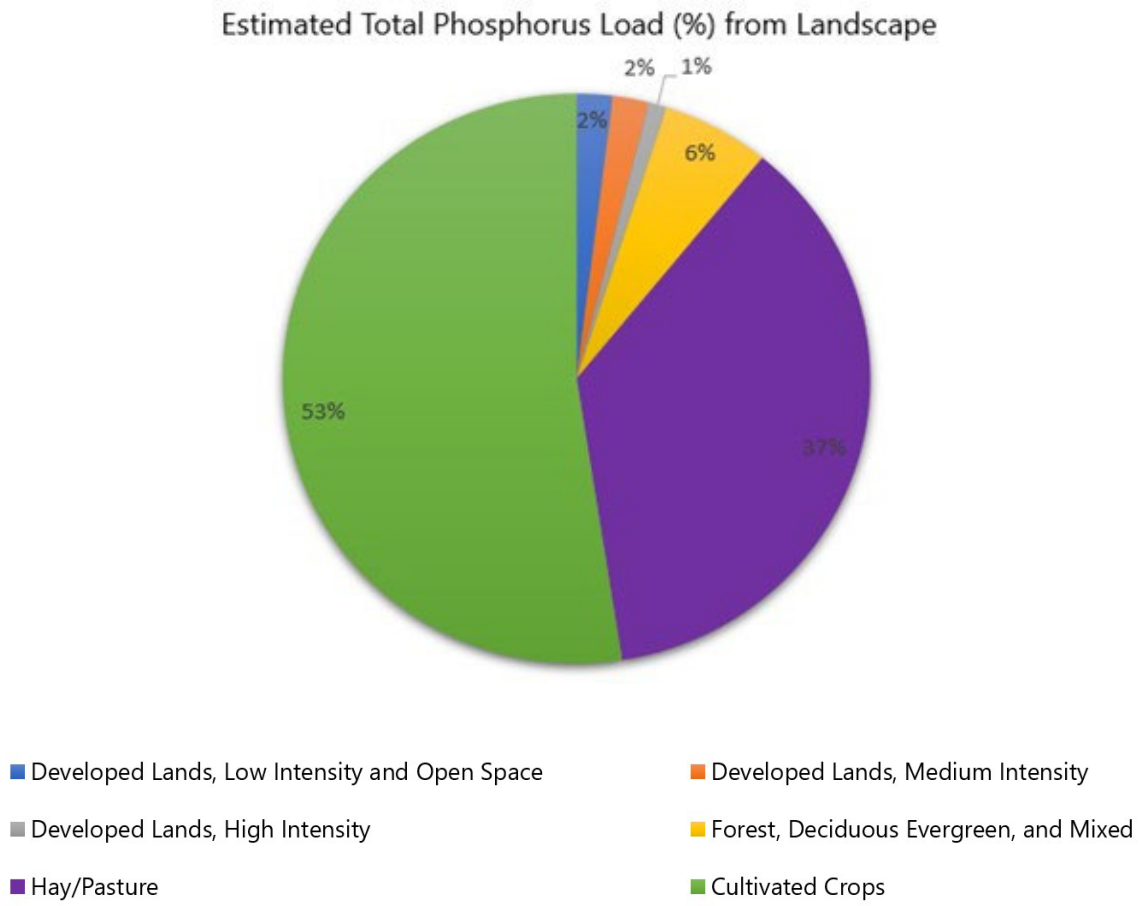

Figure 8: Nonpoint Source Sector Loads (Percentages) to Owasco Lake, SWAT Model Projections

The estimated annual loads of TP from the landscape generated from the calibrated SWAT model for Owasco Lake are shown in **Figure 9**, in units of pounds per acre per year. **Figure 10** displays the estimated annual loads of TP from the landscape generated from the calibrated SWAT model for Owasco Lake in pounds per year. Data are presented at the HUC12 subwatershed scale. The scales are color-coded and arranged from areas of lowest TP contribution to areas of highest TP contribution. Note that the estimated contribution of phosphorus from point sources and septic leachate have been subtracted from the baseline SWAT model projections in Figure 10.

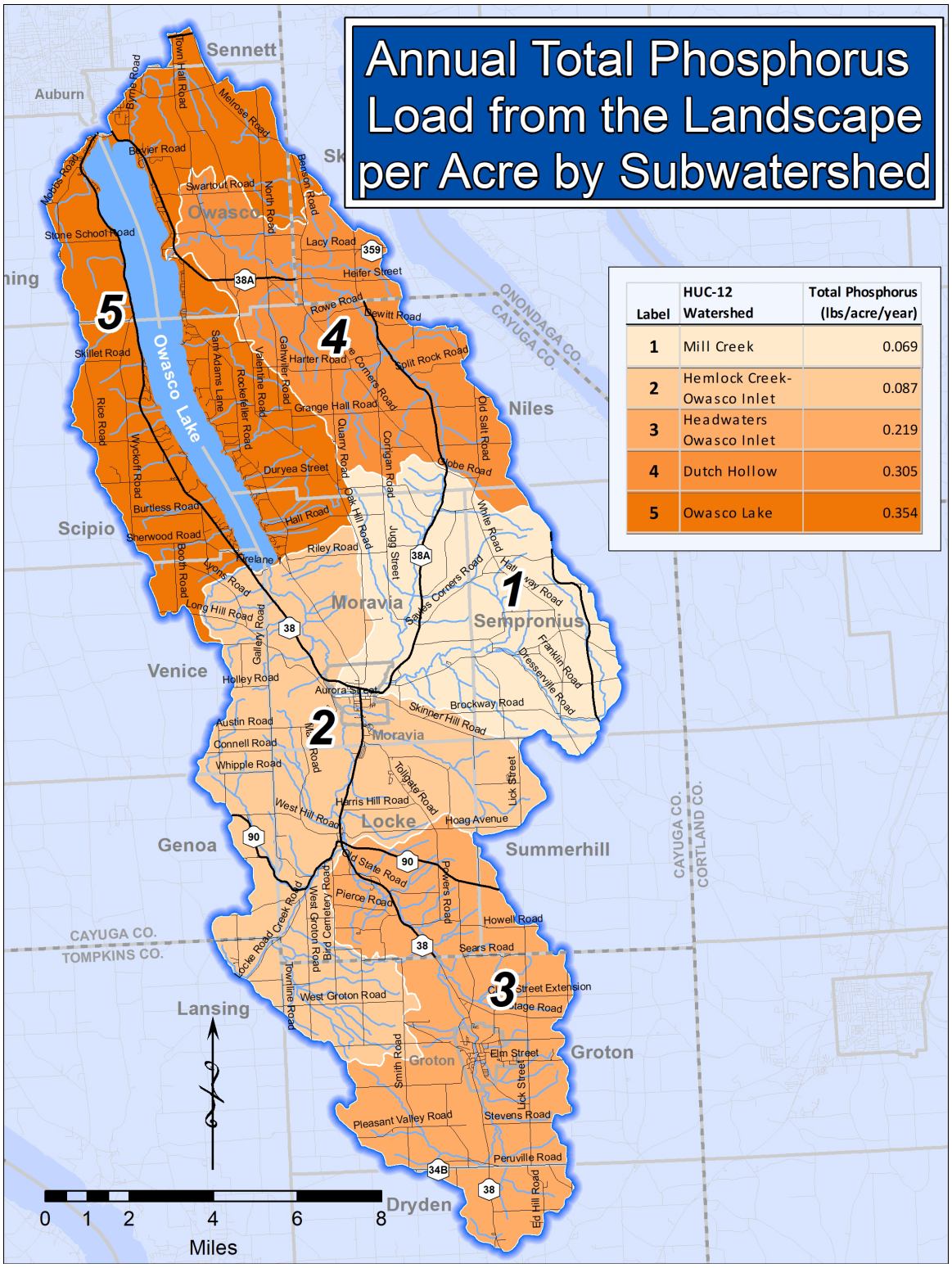

Figure 9: Baseline SWAT Model Projection: Estimated Annual Total Phosphorus Load from the Landscape per Acre by Subwatershed

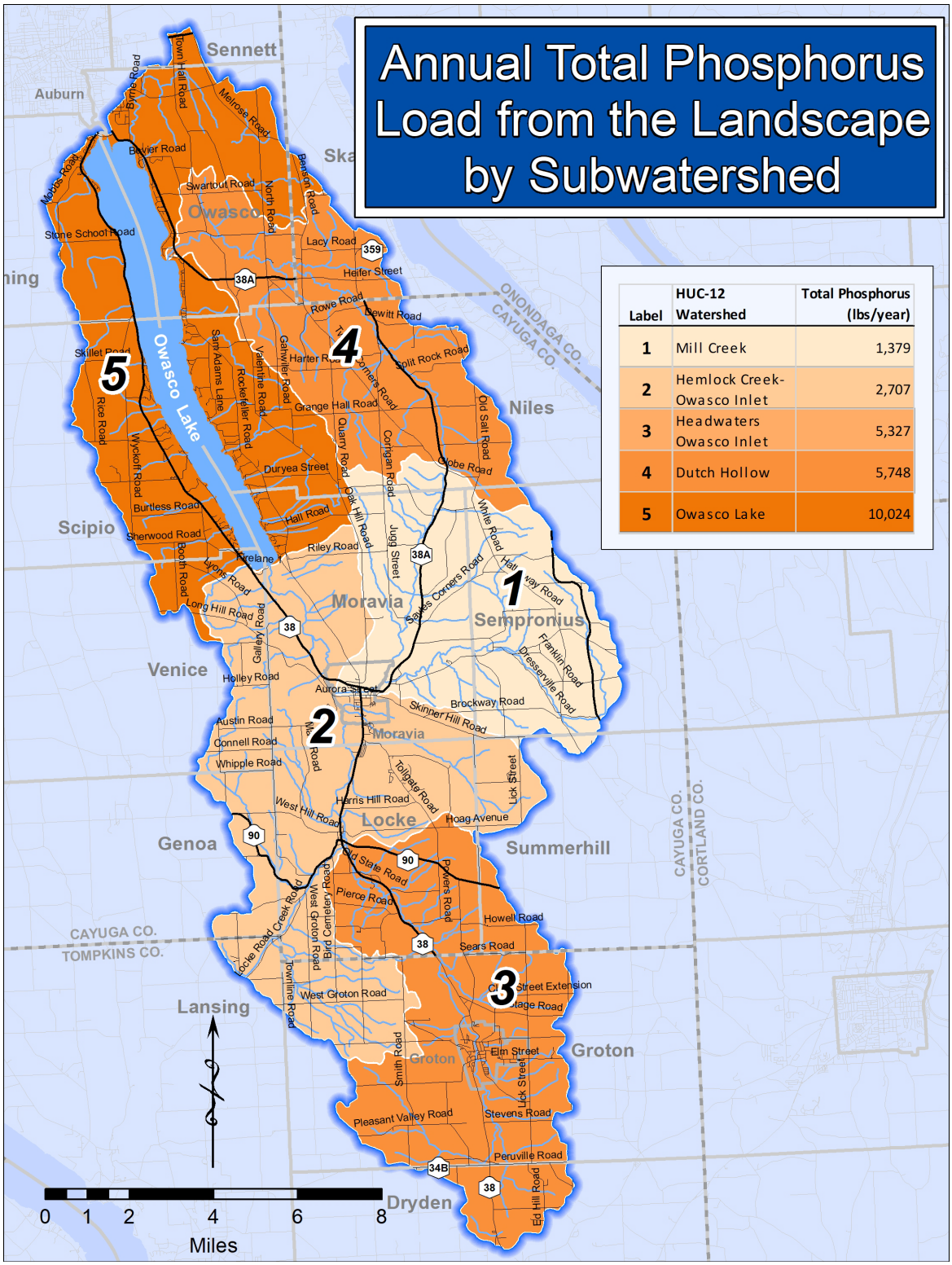

Figure 10: Baseline SWAT Model Projection: Estimated Annual Total Phosphorus Load from the Landscape by Subwatershed

A map of septic systems within the Owasco Lake watershed is displayed in **Figure 11.** The MEANSS projections of TP input to the waterways from septic systems are displayed in **Figure 12.** Coupling the SWAT projections and the MEANSS projections provides an estimate of annual nonpoint source phosphorus loads, as summarized in **Table 8**.

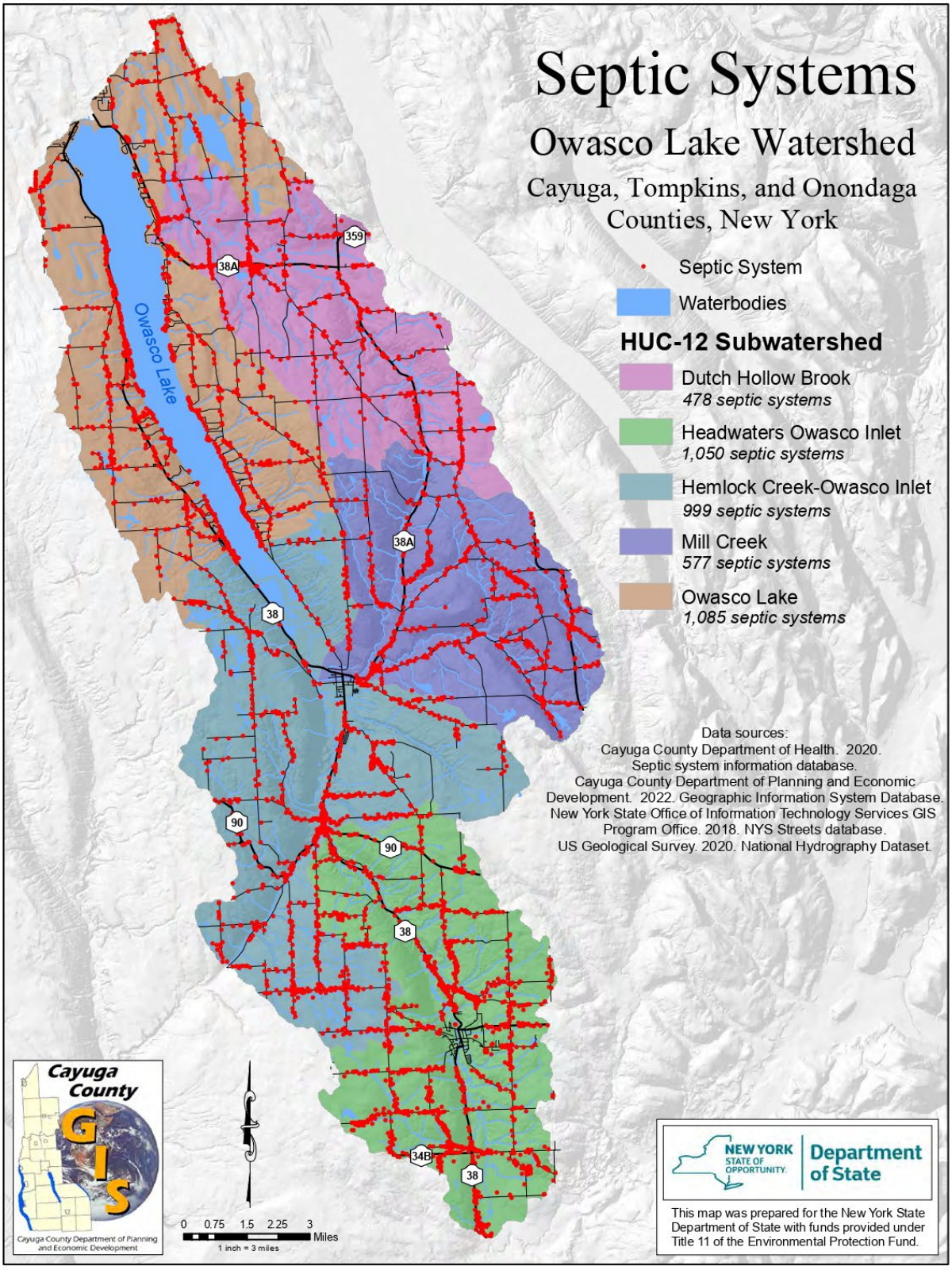

Figure 11: Septic Systems within the Owasco Lake Watershed

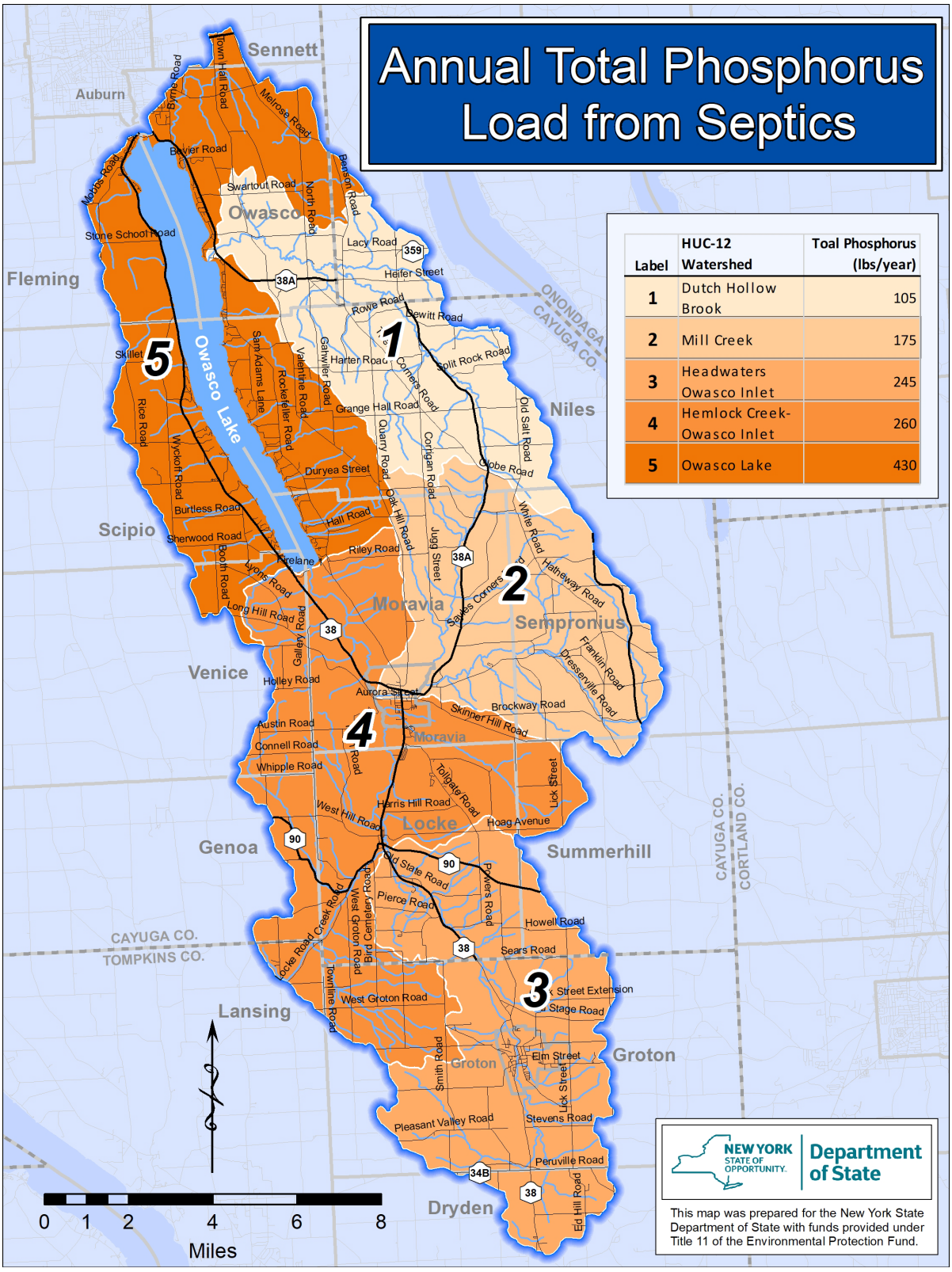

Figure 12: Baseline MEANSS Model Projection: Estimated Annual Phosphorus Load from Septics by Subwatershed

Table 8: Estimated Phosphorus Loads to Owasco Lake; Nonpoint Source SWAT and MEANSS Projections, and Average Point Source TP Load (2017-2021)

Subwatershed (HUC12)	Acres	SWAT Projected TP Load from the Landscape (lbs)	Estimated TP Load from Septics (lb/yr.)	Average Point Source TP Load (lb/yr.)	Summed Estimated TP Load, all sources (lb/yr.)
Dutch Hollow Brook	18,825	5,748	105	0	5,853
Headwaters-Owasco Inlet	24,305	5,327	245	182[a,]	5,754
Hemlock Creek-Owasco Inlet	31,110	2,707	260	276[b]	3,243
Mill Creek	19,861	1,379	175	0	1,554
Owasco Lake	28,349	10,024	430	0	10,454
Total	**122,450**	**25,185**	**1,215**	**458**	**26,858**

[a] Groton WWTP 2017-2021 mean TP load

[b] Moravia WWTP 2017-2021 mean TP load

8.3 Summary of Watershed Phosphorus Loading

The data and information reviewed for the 9E Plan, and the modeling calculations support the finding that nonpoint sources from the landscape are the major contributor of phosphorus to Owasco Lake, representing more than 90% of the external load (**Table 9**). This conclusion is consistent with the findings of the 2018 HABs Action Plan for Owasco Lake; NYSDEC staff applied the LENS model (Stainbrook et al. 2022) to estimate the relative contribution of point, nonpoint, and septic phosphorus inputs to Owasco Lake. The actual percent contribution from these three categories will vary each year based on meteorological conditions, land cover and management practices, and WWTP performance. However, the focus of long-term water quality protection measures for Owasco Lake is clearly the nonpoint sources of phosphorus from the watershed.

Table 9: Summary Contribution of All Phosphorus Sources

Phosphorus Source	Annual Load (pounds)	Percent Contribution
SWAT estimate of watershed input	25,185	93.8%
Point Sources: Groton and Moravia WWTP	458	1.7%
Septic Systems (estimated with MEANSS)	1,215	4.5%

9 Phosphorus Reduction Targets

A component of a 9E Plan is to consider in-lake water quality targets and goals associated with meeting the waterbody's best use. For Owasco Lake, best uses include water supply, aquatic life protection, fishing, and recreation in and on the waters. These uses have associated ambient water quality standards or guidance values used to evaluate the extent to which they are supported by ambient water quality conditions.

The supply of phosphorus regulates growth of phytoplankton (including algae and cyanobacteria) in most inland lakes, including Owasco. While New York State has not adopted a numerical water quality standard for phosphorus in lakes and ponded waters, there is a narrative ambient water quality standard for phosphorus and nitrogen, promulgated in regulation in 6NYCRR 703.2. This narrative standard sets forth a limit for phosphorus as "None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages".

New York also has a statewide numerical guidance value for phosphorus in all Class A, A-S, AA, AA-S, or B ponded waters except Lakes Erie, Ontario, and Champlain. The guidance value is based on aesthetic effects for primary and secondary recreation. NYSDEC uses a representative summer (June – September) average TP from the lake's upper waters of 20 µg/L to evaluate whether these recreational uses are supported. The state is developing numerical nutrient criteria for waterbodies to protect water quality for best uses in addition to recreation, including water supply. In support of this effort, NYSDEC scientists and others continue to explore relationships among various water quality parameters related to the best uses of waters, including water supply.

As nutrient criteria development is underway, one option for the Owasco Lake 9E Plan for Phosphorus Reduction is to adopt a water-body specific target that relates phosphorus to chlorophyll-a concentrations. Owasco Lake is classified AA (T) waters with a best use for water supply with minimal treatment. In the absence of a statewide nutrient criterion for phosphorus, the selected target is based on the state's most stringent (lowest) chlorophyll-a target of 4 µg/L as set forth in the 2021 draft Cayuga Lake TMDL. This value was based on research demonstrating the link between chlorophyll-a concentrations in water supply lakes and reservoirs and the risk of formation of disinfection byproducts (Callinan et al. 2013). CSLAP data from Owasco Lake from 2016 through 2020 shows the summer average of chlorophyll-a exceeding 4 ug/L in three of the five years (refer to **Section 5.1, Figure 3**).

The remaining task is to translate the chlorophyll-a target to a total phosphorus target. The Owasco Lake Water Quality Model (UFI 2021) is a mechanistic model that can be applied to quantify the linkage between phosphorus inputs, lake temperature, lake biology, and lake water quality metrics, including chlorophyll-a. The lake model offers a probabilistic projection of how external loading influences in-lake phosphorus concentrations, chlorophyll-a, Secchi disk transparency, and the percent contribution of cyanobacteria to phytoplankton community biomass, summarized in **Table 10**.

Table 10: Lake Water Quality Model Projection, Impact of Reduced Phosphorus Load

Scenario	Description	Chlorophyll-a (µg/L)	Total Phosphorus (µg/L)
-	Current Conditions (modeled)	3.2 ± 0.3	8.1 ± 0.9
1	10% total phosphorus load reduction	3.0 ± 0.3	7.7 ± 0.8
2	20% total phosphorus load reduction	2.9 ± 0.3	7.2 ± 0.7
3	30% total phosphorus load reduction	2.8 ± 0.3	6.8 ± 0.6
4	30% total phosphorus load reduction (all particulate phosphorus)	3.1 ± 0.3	7.5 ± 0.6
5	30% total phosphorus load reduction (all dissolved phosphorus)	2.3 ± 0.2	5.9 ± 0.6
6	30% total phosphorus load reduction and 2˚C increase in air temperature	2.9 ± 0.3	6.8 ± 0.6

Note: Values are summer (June-September) averages, standard deviations are based on a 19-year simulation.
Source: UFI, 2021

The implications of the model projections indicate that long-term protection of Owasco Lake water quality will require reductions in external phosphorus inputs from the watershed to offset the projected impacts of a changing climate on cyanobacteria. Note that the concentrations of chlorophyll-a are projected to meet targets. The lake water quality model also provides insight and guidance on the importance of focusing on the dissolved fraction of the phosphorus load. These projections were used as a basis for estimating target reductions (**Table 11**).

A reduction of 30% in external phosphorus load was selected as a target to guide long-term efforts in managing the lake and watershed. While this target is ambitious, model projections and local commitment indicate that it is achievable. Expansion of cover crops across more agricultural acreage is an accepted practice that has willing participants and increased funding allocations, for example. Model projections indicate that expansion of cover crops and other agricultural BMPs, coupled with efforts to increase infiltration, can meet the 9E Plan targets.

Table 11: Target Phosphorus Load Reductions

Subwatershed (HUC12)	Current Nonpoint Phosphorus Load (lb/yr.) Landscape	Current Nonpoint Phosphorus Load (lb/yr.) Septic	Current Point Source Phosphorus Load (lb/yr.) WWTP	Current Total Phosphorus Load (lb/yr.) All Sources	Target Phosphorus Load with 30% Reduction (lb/yr.)
Dutch Hollow Brook	5,748	105	0	5,853	4,097
Headwaters-Owasco Inlet	5,327	245	182	5,754	4,028
Hemlock Creek-Owasco Inlet	2,707	260	276	3,243	2,270
Mill Creek	1,379	175	0	1,554	1,088
Owasco Lake	10,024	430	0	10,454	7,318
Watershed Total Phosphorus Load	**25,185**	**1,215**	**458**	**26,858**	**18,801**

The Owasco Lake HAB Action Plan documents the complexity of factors contributing to HABs risk, including dissolved phosphorus, water temperature, dreissenid mussels, lake orientation and morphology, and quiescent waters (NYSDEC 2018). Reducing phosphorus inputs was identified as the primary issue for local watershed managers to address. Maintaining low ambient phosphorus concentrations in the lake is necessary, but may not be sufficient, to reduce frequency, intensity, duration, and toxicity of cyanobacterial blooms. The presence of dreissenid mussels and warming waters elevate the risk; these factors are beyond local control.

10 Development and Evaluation of Alternatives

A key component of this 9E Plan is to identify feasible and effective actions to reduce phosphorus input. Because farming is a major land use in the watershed, the project team worked with Cayuga County SWCD staff and other agricultural experts to compile local knowledge of natural resources, existing land use and management practices, issues and trends affecting the agricultural community, and interest and capacity to adopt various BMPs. The SWCD's strategic five-year plan for their Agricultural Environmental Management (AEM) program provided a basis for the SWAT modeling team to evaluate effectiveness of a realistic set of management actions.

Resource managers can apply this tool to help evaluate the effectiveness of estimated loading reductions. Model projections are an important component of setting realistic expectations of how quickly and to what extent BMP implementation will alter in-lake water quality conditions. For example, if recommended BMPs are implemented in priority subwatersheds and achieve a 30% reduction in TP load, how will that affect algal abundance and cyanobacteria in the lake? Would the response be different if BMPs were designed to target reductions in dissolved phosphorus? How does lake temperature affect the model predictions? What is the significance of biologically mediated processes (such as transformation of particulate phosphorus to dissolved phosphorus by dreissenid mussels)?

These questions are intended to emphasize several key considerations. Lakes are complex ecosystems and our collective ability to capture all the interrelated processes in a series of mathematical equations is still evolving. In addition, year-to-year variability in watershed inputs is largely driven by meteorological conditions- wet years vs. dry years, magnitude runoff events, timing of runoff events with respect to the agricultural cycle, etc. Finally, lakes are not static and factors such as invasive species and a warming climate will continue to affect management strategies.

Scenario testing uses the watershed model to evaluate how land management practices to improve hydrologic resilience could affect hydrology and pollutant transport. The lake model can then be applied to estimate how the modified load could affect lake water quality and biota. The project team worked with CCDP&ED, Cayuga County SWCD staff, and other agricultural support professionals to develop scenarios that reflect current agricultural practices and the potential for their expansion.

For agricultural BMPs, Cayuga County SWCD staff developed a database of current practices and the extent of their implementation throughout the watershed. Data were compiled at the HUC12 subwatershed scale which aligns with the SWAT model framework. The Cayuga County SWCD staff applied their local knowledge of existing practices, land base, trends in land management, and the interest and willingness of farmers to adopt BMPs to develop their District's Agricultural Environmental Management (AEM) Five-Year Implementation Strategy. The specific goals incorporated into the AEM strategy enabled the SWAT modeling team to use realistic targets for model projections. The project team drew on these projections to evaluate three scenarios using the SWAT model.

- 20% reduction in phosphorus application to simulate the effect of adopting comprehensive nutrient management plans for all agricultural lands, regardless of whether they are currently regulated as concentrated animal feeding operation (CAFO). As defined in the Natural Resources Conservation Service (NRCS) Compendium for New York, Nutrient Management (Practice 590) is commonly applied with a suite of conservation practices designed to mitigate soil erosion and nutrient runoff that reflect site-specific conditions for an individual farm. The 20% reduction was selected to represent the net impact of changes in conservation tillage, crop rotation, manure handling, barnyard management, and other practices.

- Expanded adoption of winter cover crop plantings on agricultural lands (number of acres with cover crops informed by the AEM Strategic Plan's 5-year goals specified for each subwatershed).

- A third scenario was selected to demonstrate the potential impact of restricting application of manure and fertilizer to agricultural lands in model segments (HRUs) immediately adjacent to surface waters. Two subwatersheds, Dutch Hollow Brook and the Owasco Inlet, were selected for this demonstration in consultation with local agricultural experts. The model scenario was applied to agricultural lands along the length of the two tributary streams to simulate impact of setbacks (riparian buffers) on agricultural lands. The width of the HRU segment and thus the total acreage varies depending on the specific characteristics of each HRU (such as soil, slope, land cover, practices, etc.) that intersects surface waters.

  Inclusion of this third scenario reflects recommendations for riparian buffers included in the 2016 Plan and the 2018 HABs Action Plan. In addition, the proposed revisions to the Owasco Lake Watershed Rules and Regulations reference expanding vegetated and forested riparian buffers. A literature review report by Sweeney and Newbold (2014) concluded that riparian buffers, especially those with tree cover and that are a minimum of 35 feet, protect water quality, help manage runoff, and improve hydrologic resilience across the watershed. Tree canopies intercept rainfall and reduce potential energy to disturb soils. Vegetative cover retards overland flow and increases infiltration of precipitation and snowmelt. However, there is no uniform standard for buffer widths and their effectiveness depends on site specific conditions of slope, soils, land cover, upstream land cover, management practices, and other factors.

Changes in number, location, and performance of septic systems can influence phosphorus and other nutrient loading from developed areas. The MEANSS tool was utilized for evaluating the impact of those changes on estimated downgradient nutrient transport.

Streambank stabilization projects are an example of a beneficial watershed management strategy that is not captured by the SWAT model framework. Although the Owasco Lake watershed SWAT model is calibrated to existing conditions measured in the Owasco Lake tributaries, water quality analyses cannot differentiate between landscape and instream sources of phosphorus and sediment. Cayuga County SWCD and others have completed streambank stabilization efforts along Owasco Lake shoreline and tributaries. Data and information from these successful projects could provide an estimate of reduction in

sediment and nutrient transport to support the recommendation to continue and expand these efforts. In addition, the in-lake water quality model completed by UFI included analysis using the Generalized Watershed Loading Function (GWLF), which estimates streambank erosion. This tool is another resource available to watershed managers.

The 9E Plan recommendations reflect priority areas as identified by tributary monitoring and modeling, SWAT scenario testing, cost analyses, and feasibility of adoption. Recommendations were guided by the WAC, other technical stakeholders, and public input. While this section focuses on identification and mitigation of phosphorus loading to Owasco Lake, it also includes recommendations for activities that can indirectly affect phosphorus loading to surface waters. As described throughout the 9E Plan, measures to improve hydrologic resilience underlie recommendations for all land cover types and uses. Increased risk of extreme precipitation events is a primary driver of water quality degradation (Carpenter et al. 2017) and the recommendations reflect this understanding.

The model projections presented in **Table 12, 13, and 14** provide insights into priority agricultural BMP actions and locations to enhance lake and watershed stewardship. Meeting the AEM Strategic Plan goals will require continued investment in staff and resources for the agriculture community to offset the cost of implementing the BMPs. The SWAT model projections indicate that expanded adoption of cover crops is one example of an agricultural practice with potential for a significant reduction in annual phosphorus export from the landscape to the surface waters (**Table 12**). Keeping vegetative cover on the landscape for longer periods each year not only stabilizes soils and improves infiltration, but also incorporates nutrients from the soil profile into plant biomass. The net result is phosphorus retention and improved hydrologic resiliency.

Expansion of nutrient management planning to farms regardless of size is also projected to reduce nutrient export from the landscape to the waterways (**Table 13**). Actual phosphorus reductions will vary based on site-specific configuration of farm fields and structures, soil types and infiltration capacity, herd sizes, existing manure handling practices, crop rotations, opportunities to capture and infiltrate runoff, and many other factors. The estimated benefit of expanding nutrient management plans (NMPs) reflects the relative importance of agricultural lands within the watershed. Overall, the SWAT projections reinforce the need for increased regional capacity for both technical and financial support to the agricultural sector and the willingness to implement and maintain these practices.

The BEE team modeled the third scenario, which restricted application of manure and fertilizer within model segments (HRUs) adjacent to surface waters (**Table 14**). This model run was applied to two subwatersheds to indicate the relative magnitude of phosphorus reduction load associated with this practice modification. Because the SWAT model was developed and calibrated to existing land cover conditions, the projections should be considered as indicating a general benchmark of the efficacy of phosphorus reduction from adopting this practice. Note that associated land cover change (e.g., from cultivated lands to pasture, scrub, or forests) was not included in the simulation. Due to this limitation, this scenario did not encompass all the HUC12 subwatersheds. The two subwatersheds were selected in

consultation with local agricultural experts and support agencies. Dutch Hollow Brook and Headwaters-Owasco Inlet were considered the priority subwatersheds that would benefit most from restricted application of fertilizer and manure in riparian areas. However, recommendations to adopt BMPs designed to reduce the risk of phosphorus export to surface waters apply across the entire watershed.

Table 12: Estimated Landscape Phosphorus Load Reduction from Expanded Cover Crops, by Subwatershed

Subwatershed	Land Area (Acres)				Annual Landscape TP Load by HUC12 Subwatershed (lb/yr.)			
	Total HUC12 Subwatershed	Cultivated Crops	Current Conditions: Croplands with Cover Crops	AEM 5-Year Goal for Expanded Cover Crops	Current Conditions: Baseline Load from Landscape	Estimated Future Load from Landscape with Expanded Cover Crops	Landscape Load Reduction	% Reduction from Current P Load from Landscape with Expanded Cover Crops
Dutch Hollow Brook	18,825	7,914	247	2,900	5,748	3,717	2,031	35%
Headwaters- Owasco Inlet	24,305	5,364	1,046	1,800	5,327	4,422	905	17%
Hemlock Creek- Owasco Inlet	31,110	8,893	369	2,300	2,707	1,719	988	36%
Mill Creek	19,861	5,994	636	1,150	1,379	675	704	51%
Owasco Lake	28,349	14,229	289	4,650	10,024	7,072	2,952	29%
Sum for Watershed	**122,450**	**42,394**	**2,587**	**12,800**	**25,185**	**17,605**	**7,580**	**30%**

Source: SWAT model projections

Table 13: Estimated Landscape Phosphorus Load Reduction from Expanded Nutrient Management Planning (NMP) Tier 3 or Equivalent by Subwatershed

Subwatershed	Land Area (Acres)				Annual Landscape TP Load by HUC12 Subwatershed (lb/yr.)			
	Total HUC12 Subwatershed	Current Agricultural Lands under NMPs	AEM 5-Year Goal for Expanded NMPs	AEM 10-Year Goal for Expanded NMPs	Current Conditions: Baseline TP Load from Landscape	Estimated Future TP Load Reflecting 10 Year Goal for NMPs	Landscape Load Reduction	% Reduction from Current TP Load
Dutch Hollow Brook	18,825	6,025	7,500	9,000	5,748	4,139	1,609	28%
Headwaters- Owasco Inlet	24,305	2,628	3,100	4,000	5,327	4,092	1,235	23%
Hemlock Creek- Owasco Inlet	31,110	757	3,300	5,000	2,707	2,112	595	22%
Mill Creek	19,861	-	1,700	3,300	1,379	1,004	375	27%
Owasco Lake	28,349	3,550	5,400	7,500	10,024	7,026	2,998	30%
Sum for Watershed	**122,450**	**12,960**	**21,000**	**28,800**	**25,185**	**18,373**	**6,812**	**27%**

Source: SWAT model projections

Table 14: Estimated Landscape Phosphorus Load Reduction from Restricted Application of Fertilizer and Manure in Areas that Abut Streams

Subwatershed	Land Area (Acres)		Annual Landscape TP Load by HUC12 Subwatershed (lb/yr.)			
	Total HUC12 Subwatershed	Riparian Land Area Affected by Management Simulation	Current Conditions: Baseline TP Load from Landscape	Estimated TP Load from Landscape with Riparian Restriction	Landscape Load Reduction	% Reduction from Current TP Landscape Load with Riparian Restriction
Dutch Hollow Brook	18,825	1,260	5,748	5,186	562	10%
Headwaters- Owasco Inlet	24,305	4,130	5,327	4,225	1,102	21%

Source: SWAT model projections

Table 15: Phosphorus Load Reductions from Relocating Septic Systems Located Within 100 ft of Surface Waters

Subwatershed (HUC12)	Estimated Annual TP Load (lbs) (Current Conditions)	Estimated Annual TP Load (lbs), No Systems Within 100 ft of Surface Waters	Estimated Decrease in Annual Total Phosphorus Load (lbs)
Dutch Hollow Brook	105	84	20
Headwaters-Owasco Inlet	245	194	51
Hemlock Creek-Owasco Inlet	260	200	60
Mill Creek	175	138	36
Owasco Lake	430	227	203
Total	**1,215**	**842**	**371**

Source: MEANSS estimation

The SWAT model is an excellent tool for evaluating potential benefits associated with adopting agricultural BMPs and provide insight into defining priority areas for implementation. However, there are a range of other management scenarios that are not amenable to evaluation using SWAT. Many of the projects advanced by Owasco Lake stakeholders during development of the 9E Plan fall in this category.

For example, the SWAT model does not specifically simulate phosphorus input to surface water originating from septic systems. NYSDEC and their contractors applied the LENS tool to estimate septic contribution as part of the 2018 Owasco Lake HABs Action Plan. As discussed in **Section 7.3.3**, a more detailed estimation tool (MEANSS) was applied during development of the 9E Plan. The LENS and MEANSS estimation approaches reach similar conclusions on the relative magnitude of septic systems to overall phosphorus load to Owasco Lake. Installation of forested or vegetated riparian buffers was also not able to be modeled.

Stream bank stabilization present a land management challenge. With increasing frequency and intensity of rain events, storms with the potential to undercut stream banks and shorelines, and transport sediment downstream are more likely. The SWAT model cannot be applied to project the reduced load from stream stabilization efforts. Other tools such as STEPL, GWLF, and literature estimates may be used to track these BMP reductions. Many stream restoration projects have been completed across the Finger Lakes region and can be used for planning-level estimates of costs and benefits. While well-designed field studies extending over multiple hydrologic cycles could refine the estimates; these studies are rare.

Road ditches are another important pathway for sediment and phosphorus to make their way from the landscape to surface waters that SWAT cannot model. Ongoing research by Cornell University faculty and others reinforces the finding that roadside ditches affect water flux and pollutant transport. The Cornell Local Roads Program offers a suite of BMPs related to road ditch design and maintenance that will improve hydrologic resilience.

Also, in 2015, NYSDEC issued the New York State Stormwater Management Design Manual to provide guidance on selecting, sizing, locating, and designing stormwater management practices to meet the state's performance standards. The Design Manual is currently being updated; a revised version is anticipated to be released in 2022. This document was prepared by the Center for Watershed Protection and is distributed by the Empire State Chapter of the Soil & Water Conservation Society. Chapter 10 of the Design Manual https://www.dec.ny.gov/docs/water_pdf/swdm2015chptr10.pdf was prepared as a supplement to address Enhanced Phosphorus Removal for stormwater projects in phosphorus-limited watersheds. While not a regulatory requirement, Owasco Lake communities are encouraged to consult this resource as they plan and design green infrastructure measures for stormwater management.

Continued regional collaboration and partnerships are essential to address the complex issues that challenge Owasco Lake.

11 Priority Areas and Restoration Strategies

11.1 Prioritization

Because resources are limited, recommended actions are prioritized for their potential benefits and costs. The HUC12 subwatersheds were reviewed for their current conditions and vulnerability as well as the potential effectiveness of management intervention. The priority rankings (**Table 16**) reflect the relative magnitude of phosphorus export in units of lb/acre/yr.

Table 16: Priority Subwatersheds

Subwatershed (HUC12)	Estimated Total Phosphorus Annual Loads From All Sources		Priority
	lb/acre/yr	lb/yr	
Owasco Lake	0.369	10,454 lb/yr.	High
Dutch Hollow Brook	0.311	5,853 lb/yr.	High
Headwaters-Owasco Inlet	0.237	5,754 lb/yr.	Moderate
Hemlock Creek-Owasco Inlet	0.110	3,243 lb/yr.	Moderate
Mill Creek	0.078	1,554 lb/yr.	Low

11.2 Reductions Needed and Proposed BMPs

The projected targets for reductions were informed by current water quality conditions, chlorophyll-a target range, and the watershed modeling tools that estimate load and identify priority areas and sources.

Under current conditions, Owasco Lake met the chlorophyll-a target of 4 µg/L during 13 of 16 years between 2005 and 2020 (refer to **Section 5.1, Figure 3**). Note that most of the exceedances are in recent years, consistent with the findings of the HABs Action Plan. The lake model projection of the effectiveness of nutrient load reductions (summarized in **Table 10**) incorporates this interannual variability in the standard deviation figure.

The lake model projections (refer to **Table 10**) highlight the emerging concern of climate change affecting lake water quality management. Even meeting a target reduction of 30% in external loading, the water quality response is projected to be modest according to UFI's Owasco Lake Water Quality Model.

A major goal of the Owasco Lake Watershed 9E Plan for Phosphorus Reduction is to identify and implement strategies that will protect land and water resources into the future and help ensure that the lake continues to support its best uses. A collaborative community-driven approach is the mechanism to meet this goal.

As introduced in **Section 5.4**, more extreme precipitation events are expected to decrease water quality. High intensity rain events contribute to flood risk, runoff from the landscape, and erosion of streams,

gullies, and roadside ditches. These processes transport phosphorus and sediment to Owasco Lake; both soluble and particulate phosphorus have a direct impact on abundance of HABs, phytoplankton, aquatic macrophytes, water clarity, and aquatic habitat.

A challenge for watersheds dominated by nonpoint sources of pollution is the reliance on voluntary actions to reduce phosphorus export from private property. Education and outreach are key. Local leaders can strengthen municipal codes related to impervious cover, setbacks, building on steep slopes, etc. to incorporate water resource protection measures. State and federal programs offer technical support and access to some cost sharing opportunities to the agricultural and forestry sectors.

Recommendations from multiple stakeholders are incorporated into the 9E Plan. Key categories are noted below with a brief explanation of their potential contribution to the overall goal of improved hydrologic resiliency and managing the loss of phosphorus and other pollutants from the landscape.

- Measures to increase infiltration, and slow velocity and erosive potential of overland flow, and reduce peak flow rates in the stream network. Examples: WASCOBs, floodplain restoration, wetland creation, protection, and restoration, stormwater ponds, road ditch improvements, streambank stabilization, forested or vegetated riparian buffers, and other green infrastructure projects to promote natural hydrology.
- Measures to reduce the risk of sediment transport from disturbed lands. Examples: local laws for sediment and erosion control measures, steep slope ordinances, forested or vegetated riparian buffers, and winter cover crops.
- Measures to reduce the risk of phosphorus, manure, and other agricultural chemicals reaching the waterways. Examples:
    - Encourage development of nutrient management plans for farms of all sizes across the Owasco Lake watershed and provide technical assistance
    - Improve management of silage leachate, animal waste handling, and manure storage infrastructure (including alarm systems)
    - Implement improvements to barnyard runoff
    - Encourage installation and maintenance of forested or vegetated riparian buffers,
- Measures to reduce the risk of nutrient-enriched wastewater from individual on-site wastewater disposal systems from reaching surface waters.

12 Implementation Partners and Strategy

12.1 Overview of the Implementation Plan

Many recommended actions within the Owasco Lake Watershed 9E Plan will require funding support for their implementation. **Table 17** provides an overview of recommended practices in various categories. The prioritization is organized by high, medium, and low. High indicates a 0-2 year timeline. Medium indicates a 2-5 year timeline. Low indicates a 5-10+ year timeline. The prioritization and partners listed in **Table 17** should be considered as a general guideline. The OLWMC and partner agencies will continue to review available funding opportunities and respond to updated program priorities.

Preventing new sources of phosphorus from reaching Owasco Lake is critically important. Measures such as land use regulation and guidelines, education and outreach, and continued surveillance to identify and treat invasive species will affect phosphorus loading to surface waters. For example, adoption of riparian setbacks, conservation subdivision codes, steep slope ordinances, and impervious surface guidelines can help reduce adverse impacts of new development. Monitoring vulnerable trees and treating to control the HWA helps maintain and stabilize riparian habitat in critical areas. Although the impact of these preventative measures cannot be directly quantified and were not modeled as part of the 9E Plan development, continued partnerships and community engagement are key to protecting Owasco Lake and watershed for future generations.

9E Plans take an adaptive management approach to dealing with change. With defined metrics to measure progress and a commitment to monitoring and assessment, the community can respond to new information and emerging issues. The Owasco Lake watershed community is well positioned for this adaptive management approach; the OLWMC is the hub of effective partnerships and programs. Stakeholders from the agricultural community, water supply purveyors, local academic institutions, NYSDEC representatives, NYSDOS representatives, local government, and county and regional agencies are also committed to lake restoration and protection.

The CCDP&ED has committed to maintaining and updating the watershed modeling tools. Progress will be tracked by monitoring agricultural BMP adoption, streambank restoration projects, adoption of green infrastructure practices and other low impact development efforts to improve hydrologic resilience, Owasco Lake trophic state indicator parameters, lands under conservation easements or other protections, progress with the Owasco Flats restoration project, public water supply data, beach closures or HABs advisories, and other metrics discussed in **Section 12.4**. This data and information will provide guidance on progress and additional measures needed to reduce phosphorus inputs to meet the goals of the 9E Plan.

Another important implication of the UFI water quality model of Owasco Lake is the relative effectiveness of reduction in dissolved phosphorus compared with particulate phosphorus. Total phosphorus incorporates both the total and dissolved fractions. However, the dissolved phosphorus fraction is associated with a higher biological availability, meaning that it is more potent for supporting growth of

cyanobacteria and other phytoplankton. Management practices that address dissolved phosphorus are considered the most cost-effective strategies to mitigate the risk of eutrophication (Sonzogni et al. 1982: NYSDEC 2021- Draft TMDL for Phosphorus in Cayuga Lake). The UFI lake model has the capability of projecting the response of the phytoplankton assemblage including the cyanobacteria to reductions in total phosphorus, particulate phosphorus, and dissolved phosphorus.

For agricultural land cover, the ratio of total and dissolved phosphorus in runoff is a complex function of processes related to soil type, erosion, desorption and dissolution reactions, plant residue decomposition, and the field's baseline phosphorus index and infiltration capacity (wetness index). These baseline conditions are influenced by soil and fertilizer phosphorus management practices such as tillage and the nutrient and solids content of applied fertilizers. The timing of rainfall events with respect to land application is also a significant determinant. Identifying agricultural practices with the greatest potential to minimize loss of dissolved phosphorus is an active area of research. Recommendations include phosphorus placement near the seed depth at planting by tillage, injection, or deep banding. Infiltration basins with vegetative cover can capture dissolved phosphorus during the active growing season (Osmond et al. 2019).

Enhanced dissolved phosphorus removal in runoff from developed areas is another area of active research. A report by the Center for Watershed Protection (Hirschman et al. 2017) describes measures to increase nutrient removal in green infrastructure practices such as bioretention. Potential strategies include adding media amendments to chemically bind soluble phosphorus, increasing water residence time, and maximizing plant uptake. These and other research and development initiatives will help inform the adaptive management approach to long-term protection of Owasco Lake.

Table 17: Implementation Strategy and Project Overview

Category	Recommended Practice	Priority	Potential Organizational Partners
Hydrologic Resilience			
Watershed Wide Strategies	Develop strategies and programs to maintain natural existing and functioning hydrology within and across the watershed, with emphasis on water infiltration and landscape retention.	High	SWCDs, Finger Lakes Land Trust, OWLA, TNC, Cornell Cooperative Extension (CCE), NYSDOS (if practice is on public land), and others
	Identify priority areas and continue to use easements, acquisition, and other conservation tools.	High	TNC, Finger Lakes Land Trust, The Wetland Trust, Owasco Flats Nature Reserve, NYSDOS (if practice is on public land), and others
	Encourage land conservation efforts for both forested "upslope" areas (headwaters) including gullies, as well as natural floodplains and wetlands to enhance storage and filtration of high flows.	High	TNC, OLWMC, Finger Lakes Land Trust, The Wetland Trust, Owasco Flats Nature Reserve, NYSDOS (if practice is on public land), and others
	Identify, prioritize, and implement shoreline and streambank stabilization projects (including Owasco Lake shoreline).	High	Landowners, OLWIPD, Cayuga County SWCD, Great Lakes Commission, FLLOWPA, NYSDOS (if practice is on public land)
	Identify and prioritize key areas for construction and restoration of wetlands and stream channels through reconnection of the floodplain to capture pollution and increase infiltration.	High	Landowners, TNC, SWCDs, NYSEFC, NYSDEC, NYSDOS (if practice is on public land)
	Work with municipalities to review and update their local codes and laws with consideration of water quality, climate impacts, and other water resource management challenges.	Medium	NYSDOS– Model Local Laws; Central New York Regional Planning and Development Board; County Planning Depts., OLWMC
	Remove silt/sediment deposits from affected segments of the Owasco Inlet to reduce phosphorus (as well as sediment and nitrogen) into Owasco Lake.	Medium	SWCDs, NYSDEC, NYSDOS (if practice is on public land)

Category	Recommended Practice	Priority	Potential Organizational Partners
Developed Landscape	Expand use of riparian buffers on residential and commercial land.	High	Landowners, OWLA, OLWIPD, Local municipalities, NYSDEC
	Expand use and funding of Green Infrastructure on private and public lands.	Medium	Landowners, OWLA, OLWIPD, Cayuga County, Local municipalities, NYSEFC, NYSDOS (if green infrastructure is on public land)
Roadways, Ditches, and Culverts	Work with county and municipal highway and public works departments and the OLWIPD to identify, map and prioritize roadways, ditches, and culverts and implement remedial measures.	High	State, county and local highway departments, Cornell Local Roads, SWCDs, OWLA, NYSDOS (if practice is on public land)
	Stabilize and hydroseed road ditches.	High	State, county, and local highway departments; Cornell Local Roads, SWCDs, OWLA, NYSDOS (if practice is on public land)
	Improve management of roadways, culverts, and ditches including adoption and implementation of the Cayuga County WQMA Guidelines for Municipal Maintenance of Roadside Ditches.	High	State, county, and local highway departments; Cornell Local Roads, SWCDs, OWLA, OLWIPD, NYSDOS (if practice is on public land)
	Disconnect ditches from streams and redirect the water to detention ponds, infiltration basins, and other structures designed to enhance groundwater recharge.	High	State, county, and local highway departments; Cornell Local Roads, SWCDs, OWLA, NYSDOS (if practice is on public land)
Agricultural Landscape	Reduce nutrient and sediment loss from the landscape, reduce runoff velocities and encourage water infiltration in agricultural fields through use of best management practices including WASCOBs, reduced tillage, crop rotations, green infrastructure, barnyard runoff control, cover crops, conservation tillage, manure incorporation, riparian buffers, tile drain runoff treatment, and P balance agriculture.	High	Farmers, SWCDs, AEM, Farm Service Agency (FSA), WQIP, NYSAGM, USDA NRCS and others

Category	Recommended Practice	Priority	Potential Organizational Partners
Agricultural Landscape	Expand institutional capacity of the agricultural support agencies to provide technical and financial support to identify and implement best management practices appropriate for individual producers.	High	Federal, State, and County partners
	Provide technical assistance to small farms across the County; encourage the development of Tier 3 or equivalent plans and provide recommended best management practices.	High	Farmers, SWCDs, NYSAGM, and USDA NRCS
	Assist farms that currently do not have Tier 3 or equivalent plans to develop an appropriate plan that meet the operational needs of the farm and include recommendations for applicable best management practices that address identified natural resource concerns.	High	Farmers, SWCDs, NYSAGM, and USDA NRCS
	Support development and use of innovative technologies, including precision agriculture and enhanced phosphorus capture.	Medium	Farmers, SWCDs, CCE, ProDairy, Partners for Healthy Watersheds, NYSAGM, USDA NRCS and others
	Install measures to prevent spills at agricultural facilities (high level alarms, automatic pump shutoffs, etc.).	Medium	Farmers, SWCDs, and others
	Support adoption, use and implementation of the Cayuga County Water Quality Management Agency Manure Management Guidelines.	Medium	Farmers, SWCDs, Cayuga County WQMA
Water and Wastewater Infrastructure			
Water Infrastructure	Continue efforts to detect and respond to cyanotoxins.	Medium	City of Auburn, Town of Owasco, Cayuga County Health Department
	Support recommended actions of the 2022 Drinking Water Source Protection Plan for the City of Auburn.	Low	City of Auburn, Town of Owasco, NYSDEC, OLWMC, County Health Departments, and CCDP&ED
Wastewater Infrastructure	Encourage residents to utilize the NYS septic system replacement program.	High	Homeowners, Cayuga County Health Department
	Continue to invest in wastewater collection and treatment infrastructure.	High	Municipalities, Homeowners

Category	Recommended Practice	Priority	Potential Organizational Partners
	Track research and development initiatives related to nutrient removal in septic systems, promote and incentivize their adoption.	Medium	Health Departments, TNC
	Support Tompkins and Onondaga Counties in efforts to adopt a septic inspection program comparable to that in place in Cayuga County.	Medium	Tompkins and Onondaga Health Departments
Invasive Species			
Invasive Species	Support and expand the stewards at Owasco Lake boat launches, if needed.	High	Finger Lakes PRISM, FLI, NYSDEC, NYSDOS
	Continue Invasive Species: Early Detection/Rapid Response efforts.	High	Finger Lakes PRISM, FLI, CCDP&ED, CCE
	Continue surveillance and treatment for Hemlock Wooly Adelgid.	High	PRISM, OWLA, USDA, CCE
	Acquire an additional weed harvester and transporter and identify funds to staff and maintain the equipment.	High	Cayuga County SWCD
	Establish additional watercraft washing stations if needed to remove invasive species and encourage station use by boaters.	Medium	FLLOWPA, Finger Lakes PRISM, NYSDOS, boaters
Education, Outreach, Monitoring and Partnerships			
Institutional Support for Adaptive Management	Support the Owasco Lake Watershed Management Council's central role in lake and watershed management.	High	OLWMC
	Develop an annual work plan based recommendations of this and other relevant plans (e.g., HABs Action Plan, DWSP2, etc.).	High	OLWMC, Cayuga County SWCD, County Health Departments, NYSDEC and Finger Lakes Water Hub, OWLA, CCDP&ED, NYSDOS

Category	Recommended Practice	Priority	Potential Organizational Partners
Institutional Support for Adaptive Management	Develop and implement annual lake and tributary monitoring programs consistent with an approved QAPP, with all laboratory analyses completed by a lab certified by the state's ELAP.	High	OLWMC, Cayuga County SWCD, County Health Departments, NYSDEC, OWLA, CCDP&ED, NYSDOS
	Continue partnerships on research, monitoring, management, and outreach.	High	NYSDEC and Finger Lakes Water Hub, OWLA, FLI, Finger Lakes PRISM, UFI, Local colleges and universities, NYSDOS, US Army Corps of Engineers (lake level management), FLLOWPA, TNC and Evidn, Finger Lakes Land Trust, Partners for Healthy Watersheds, and others.
	Advocate for increased institutional capacity of NYSDEC to ensure monitoring for compliance with existing regulations such as Stormwater Pollution Prevention Plan (SWPPPs) and Comprehensive Nutrient Management Plans for CAFOs.	High	NYSDEC, OLWMC
	Update the Owasco Lake Watershed Rules and Regulations.	High	City of Auburn, Town of Owasco, Cayuga County, OLWMC, Cayuga County SWCD, County Health Departments, NYSDEC, NYSDOH, NYSDOS, New York State Department of Transportation (NYSDOT), NYSAGM, OWLA, CCDP&ED
	Update watershed SWAT model with new data and information, including hydrologic data files.	Medium	CCDP&ED, FLLOWPA
	Increase funding for the Watershed Inspection and Protection Division.	Medium	City of Auburn, Town of Owasco, Cayuga County, NYSDOS
	Invest in new technologies to expand the collection of site-specific meteorological data, in lake water quality data and stream discharge.	Medium	OLWMC, CCDP&ED, Hyfi

Category	Recommended Practice	Priority	Potential Organizational Partners
Public Awareness	Promote adoption and implementation of "Residential Guidelines to Protect Water Quality in Cayuga County" by watershed residents.	High	OLWMC, OLWIPD, WQMA
	Continue to implement and advance the behavioral science tools, strategies, and practices of the Our Owasco project to improve watershed communication, coordination, and capacity aimed at improving water quality.	Medium	TNC, Evidn
	Continue to participate in Lake Friendly Living program and other nutrient, erosion and pesticide education and outreach programs.	Medium	Lake Friendly Living partners, OLWMC, Municipalities

12.2 Projects and Reduction Targets

The project team received input and guidance from many interested parties over the course of expanding the 2016 Plan into this 9E Plan. Ideas for projects and initiatives emerged from discussions with (among others) the OLWMC, Cayuga County SWCD, OWLA, WQMA, TNC, Evidn, Partners for Healthy Watersheds, and members of the public. Discussions shared a common theme: a strong commitment to protecting the lake and watershed and a desire to direct efforts into cost-effective measures that reflect the best available science.

As discussed, not all recommended actions can be evaluated in a quantitative manner. The watershed modeling tool SWAT is best suited for evaluating BMPs for agricultural watersheds and has been applied to estimate nonpoint source loading for many of the Finger Lakes. Additional monitoring and assessment of water quality changes in response to implemented actions will likely improve the precision and accuracy of the model projections. The SWAT model projections for Owasco Lake are based on recent water quality monitoring data collected within this watershed and capture site-specific conditions of soils, topography, hydrology, and current management practices.

Another important tool to identify and screen recommendations that are not directly addressed by the SWAT model is the NYSDEC catalogue of recommended practices for inclusion in watershed management plans https://www.dec.ny.gov/chemical/96777.html. This catalogue, which has been approved by USEPA for consistency with provisions of the Clean Water Act Section 319, encompasses practices for a range of land use and provides guidance on their costs and effectiveness. Effectiveness and costs of agricultural BMPs are also informed by guidance from the NYSAGM and the NRCS. In addition to these resources, BMP costs and effectiveness are tracked by agencies and researchers working within the Chesapeake Bay watershed program. The Chesapeake Assessment Scenario Tool (CAST) provides another means to estimate the effectiveness of practices in meeting reduction goals for watershed nonpoint sources.

These multiple guidance documents are reflected in the summary of recommendations included as **Table 18**. Although the focus of this 9E Plan is phosphorus reduction, the listed BMPs offer other benefits, including reducing inputs of nitrogen. The projected effectiveness and estimated costs reflect experience across a range of systems and highlight the importance of continued monitoring and assessment to capture site specific data for the Owasco Lake watershed.

Targets for adoption of many BMPs included in **Table 17** incorporate input from the Cayuga County SWCD for consistency with the AEM Strategic Plan and other major initiatives related to road ditches, streambank restoration, and hydroseeding. This level of detailed information enabled projections by HUC12 subwatershed to estimate percent phosphorus load reduction for several key practices.

The projected phosphorus load reductions in **Table 18** indicate that meeting the overall target reduction of 30% reduction in phosphorus loading is achievable over the next decade. Sustained focus on nonpoint sources from the landscape is key. Expansion of winter cover crops is a priority.

Table 18: Projects and Target Reductions

Note: Nitrogen and phosphorus load reduction efficiencies derived from CAST source data (version Phase 6 – 7.0.0) and SWAT model. Cost estimates derived from CAST and other various technical resources.

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Developed Landscape								
Expand use of forested riparian buffers on residential and commercial properties	Watershed Wide	Expand use of riparian buffers along 50% of stream miles within developed areas	Variable, per subwatershed. Estimated annual TP capture by buffers on developed landscape is 0.35 lbs/acre/year. (Source: CAST BMPs, forest buffer)	Variable, per subwatershed. Estimated annual N capture by buffers on developed landscape is 5.86 lbs/acre/year. (Source: CAST BMPs, forest buffer)	Landowners, OWLA, OLWIPD, Cayuga County	10 years	$243/acre (Source: CAST BMPs, forest buffer)	Trees for Tribs, Urban and Community Forestry Program, Water Quality Improvement Program, Five Star and Urban Waters Restoration Grant, Climate Smart Communities Grant Program

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Roadways, Ditches, and Culverts								
Stabilize and hydroseed road ditches	Dutch Hollow Brook	Stabilize 100% (27,800 linear feet, length of ditch) of road ditches	<2.2 lbs/year per linear ft. of ditch (Source: CAST narrow grassed buffer)	<2.2 lbs/year per linear ft. of ditch (Source: CAST narrow grassed buffer)	DOT, Cayuga County, Municipalities, SWCD Road Ditch and Critical Area Seeding Program, OLWIP	10 years	$35,750 (Source: OLWIPD)	State, County and municipal highway and public works departments, Water Quality Improvement Program, SWCD, OWLA, and FLLOWPA
	Headwaters - Owasco Inlet	Stabilize 100% (21,800 linear feet) of road ditches					$13,150 (OLWIPD)	
	Hemlock Creek-Owasco Inlet	Stabilize 100% (15,250 linear feet) of road ditches					$11,625 (OLWIPD)	
	Mill Creek	Stabilize 100% (11,100 linear feet) of road ditches					$14,050 (OLWIPD)	
	Owasco Lake	Stabilize 100% (13,850 linear feet) of road ditches					$19,025 (OLWIPD)	

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Streambanks, Shoreline, and Hydrologic Restoration								
Identify, prioritize, and implement shoreline and streambank restoration projects	Watershed Wide	Implement one priority project each year	Variable	Variable	SWCD, OWLA, Highway Departments,	10 years	Variable	Great Lakes Commission, Great Lakes Restoration Initiative, Great Lakes Basin Program for Soil Erosion and Sediment, FLLOWPA, US Fish and Wildlife Service
Agricultural Nonpoint Source Reduction Strategies (Ex. Upland management, livestock management, drainage management)								
Increase the use of cover crops	Dutch Hollow Brook	Increase the use of cover crops from the current 3% estimated adoption (247 acres) to 40% (total 2,900 acres)	2,183 lbs/year (Source: Owasco Lake watershed SWAT projection-impact of expanded practice) **HUC12 Load reduced by 37%**	8,378 lbs/year (Source: Owasco Lake watershed SWAT projection-impact of expanded practice)	SWCD, NYSAGM, USDA-NRCS, Farmers	5 years	$211,700	Agricultural Nonpoint Source Abatement and Control Program, Climate Resilient Farming,

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Increase the use of cover crops *(Continued)*	Headwaters - Owasco Inlet	Increase the use of cover crops from current 34% of agricultural parcels (1046 acres) to 60% (total 1,800 acres.)	1,367 lbs/year (Source: Owasco Lake watershed SWAT projection- impact of expanded practice) **HUC12 Load reduced by 24%**	5,975 lbs/year (Source: Owasco Lake watershed SWAT projection- impact of expanded practice)	SWCD, NYSAGM, USDA-NRCS, Farmers	5 years	$131,400	Environmental Quality Incentives Program, Eastern Finger Lakes Cover Crops, Great Lakes Basin Program for Soil Erosion and Sediment, Great Lakes River Basin Initiative, Agricultural Environmental Management Program
	Hemlock Creek- Owasco Inlet	Increase the use of cover crops from current 7% of agricultural parcels (369 acres) to 40% (total 2,300 acres.)	1,720 lbs/year (Source: Owasco Lake watershed SWAT projection- impact of expanded practice) **HUC12 Load reduced by 50%**	19,996 lbs/year (Source: Owasco Lake watershed SWAT projection- impact of expanded practice)			$167,900	
	Mill Creek	Increase the use of cover crops from current 14% of agricultural parcels (636 acres) to 25% (total 1,150 acres)	860 lbs/year (Source: Owasco Lake watershed SWAT projection- impact of expanded practice) **HUC12 Load reduced by 56%**	1,720 lbs/year (Source: Owasco Lake watershed SWAT projection- impact of expanded practice)			$84,000	

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Increase the use of cover crops *(Continued)*	Owasco Lake	Increase the use of cover crops from current 2% of agricultural parcels (289 acres) to 40% (total 4,650 ac.)	3,483 lbs/year (Source: Owasco Lake watershed SWAT projection-impact of expanded practice) **HUC12 Load reduced by 33%**	85,253 lbs/year (Source: Owasco Lake watershed SWAT projection-impact of expanded practice)	*(Above)*	*(Above)*	$339,500	*(Above)*
Increase implementation of reduced tilling practices	Dutch Hollow Brook	Increase the use of reduced tillage to 45% of agricultural lands (additional 3,300 acres)	22 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)	4,189 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)	SWCD, NYSAGM, USDA-NRCS, Farmers	5 years	$54,500	Agricultural Nonpoint Source Abatement and Control Program, Climate Resilient Farming, Environmental Quality Incentives Program, Eastern Finger Lakes Cover Crops, Great Lakes Basin Program for
	Headwaters - Owasco Inlet	Increase the use of reduced tillage to 70% of agricultural lands (additional 2,050 acres)	187 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)	2,646 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)			$33,800	

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Increase implementation of reduced tilling practices *(Continued)*	Hemlock Creek-Owasco Inlet	Increase the use of reduced tillage to 35% of agricultural lands (additional 2,000 acres)	176 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)	2,579 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)	SWCD, NYSAGM, USDA-NRCS, Farmers	5 years	$33,000	Soil Erosion and Sediment, Great Lakes River Basin Initiative, Agricultural Environmental Management Program
	Mill Creek	Increase the use of reduced tillage to 20% of agricultural lands (additional 900 acres)	88 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)	1,168 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)			$14,900	
	Owasco Lake	Increase the use of reduced tillage to 45% of agricultural lands (additional 5,200 acres)	463 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)	6,724 lbs/year total for expanded practice (Source: CAST, conservation tillage practices)			$85,800	

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Install soil erosion control systems (examples: WASCOB, bioswales, vegetated filter strips)	Dutch Hollow Brook	Install 6 systems	Variable by system.	Variable by system.	SWCD, NYSAGM, USDA-NRCS, Farmers	5 years	$180,000	Agricultural Nonpoint Source Abatement and Control Program, Climate Resilient Farming, Environmental Quality Incentives Program, Eastern Finger Lakes Cover Crops, Great Lakes Basin Program for Soil Erosion and Sediment, Great Lakes River Basin Initiative, Agricultural Environmental Management Program
	Headwaters - Owasco Inlet	Install 2 systems					$60,000	
	Hemlock Creek-Owasco Inlet	Install 3 systems					$90,000	
	Mill Creek	Install 4 systems					$120,000	
	Owasco Lake	Install 2 systems					$60,000	

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Increase participation in Tier III AEM Program or Equivalent (Field/NMP)	Dutch Hollow Brook	Increase participation from current 50% (6,025 acres) to 75% (9,000 acres)	1,609 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)	43,189 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)	SWCD, NYSAGM, USDA-NRCS, Farmers	10 years	$74,000	Agricultural Nonpoint Source Abatement and Control Program, Climate Resilient Farming, Environmental Quality Incentives Program, Eastern Finger Lakes Cover Crops, Great Lakes Basin Program for Soil Erosion and Sediment, Great Lakes River Basin Initiative, Agricultural Environmental
	Headwaters - Owasco Inlet	Increase participation from current 24% (2,628 acres) to 35% (4,000 ac.)	1,235 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)	23,259 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)			$34,000	
	Hemlock Creek-Owasco Inlet	Increase participation from current 6% (750 acres) to 40% (5,000 acres)	595 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)	53,771 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)			$125,000	

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Increase participation in Tier III AEM Program or Equivalent (Field/NMP) *(Continued)*	Mill Creek	Increase participation from current 0% to 40% (3,300 ac.)	375 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)	13,404 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)	SWCD, NYSAGM, USDA-NRCS, Farmers	10 years	$82,500	Management Program
	Owasco Lake	Increase participation from current 19% (3,550 acres) to 40% (7,500 acres)	2,998 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)	166,802 lbs/year total for expanded practice (Source: Owasco Lake watershed SWAT projection)			$99,000	*(Above)*
Increase participation in Tier III AEM Program or Equivalent (Facility/Grazing Plans)	Dutch Hollow Brook	Increase number of plans implemented from current 15% (4 plans) to 55% (15 plans)	Variable	Variable	SWCD, NYSAGM, USDA-NRCS, Farmers	10 years	$60,500	Agricultural Nonpoint Source Abatement and Control Program, Climate Resilient

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Increase participation in Tier III AEM Program or Equivalent (Facility/ Grazing Plans) *(Continued)*	Headwaters - Owasco Inlet	Increase number of plans implemented from current 10% (4 plans) to 25% (9 plans)	Variable	Variable	SWCD, NYSAGM, USDA-NRCS, Farmers	10 years	$33,500	Farming, Environmental Quality Incentives Program, Eastern Finger Lakes Cover Crops, Great Lakes Basin Program for Soil Erosion and Sediment, Great Lakes River Basin Initiative, Agricultural Environmental Management Program
	Hemlock Creek-Owasco Inlet	Increase number of plans implemented from current 50% 11 plans) to 70% (22 plans)					$60,500	
	Mill Creek	Increase number of plans implemented from current 25% (6 plans) to 72% (23 plans)					$93,500	

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Increase participation in Tier III AEM Program or Equivalent (Facility/ Grazing Plans) *(Continued)*	Owasco Lake	Increase number of plans implemented from current 20% (7 plans) to 58% (28 plans)	Variable	Variable	SWCD, NYSAGM, USDA-NRCS, Farmers	10 years	$115,500	*(Above)*
Expand the use of riparian buffers on agricultural lands	Dutch Hollow Brook	Increase riparian buffers to 10% of total riparian zone (target total buffer area of 14 acres)	Variable, based on buffer width, soils, slope, vegetation, and other installed practices in BMP system within the buffer area Estimated reduction of upslope TP load: 42% for forested or grassed buffer (with minimum buffer width of 35 ft.)	Variable, based on buffer width, soils, slope, vegetation, and other installed practices in BMP system within the buffer area Estimated reduction of upslope TN load: 54% for forested and 38% for grassed buffer (with	Farmers, SWCD, NYSAGM	10 years	Variable, based on buffer width, vegetative cover, need for associated practices such as livestock exclusion, need to maintain sheet flow,	AEM Base Program, Ag Nonpoint Source Abatement and Control Program, Climate Resiliency Farming Program, Water Quality Improvement Program, Environmental Quality
	Headwaters - Owasco Inlet	Increase riparian buffers to 10% of total riparian zone (target total buffer area of 10 acres)						

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Expand the use of riparian buffers on agricultural lands *(Continued)*	Hemlock Creek-Owasco Inlet	Increase riparian buffers to 10% of total riparian zone (target total buffer area of 18 acres)	(Source: Chesapeake Bay Program, 2014)	minimum buffer width of 35 ft.) (Source: Chesapeake Bay Program, 2014)	Farmers, SWCD, NYSAGM	10 years	and other factors (Source: NYS Soil & Water Conserv Committee Ag Practices Handbook)	Incentives Program, Conservation Reserve Program, Conservation Stewardship Program, Agricultural Management Assistance Program, Agricultural Conservation Easement Program, Regional Conservation Partnership Program, FLLOWPA
	Mill Creek	Increase riparian buffers to 10% of total riparian zone (target total buffer area of 8 acres)						
	Owasco Lake	Increase riparian buffers to 10% of total riparian zone (target total buffer area of 19 acres)						

Project Description	HUC 12	Goal/ Target	Estimated Total Phosphorus Reduction	Estimated Total Nitrogen Reduction	Lead Organization	Time Frame	Estimated Cost	Potential/ Actual Funding Source
Support implementation of the Cayuga County Water Quality Management Agency Manure Management Guidelines	All	100% Adoption of Manure Management Guidelines by all Watershed Farmers	N/A	N/A	Agricultural support agencies, farming community	10 years	Variable	Variable
Water and Wastewater Infrastructure								
Replace inadequate septic systems as identified by the County Septic System Inspection with phosphorus removing technology	Owasco Lake	Modify 100% of septic systems within 100 ft of the shoreline by relocation or upgrade with phosphorus removal technology (251 systems)	106 lbs/year. 0.008 lbs. of P reduced to 0.002 lbs. of P in septic effluent per system Source: Owasco Lake MEANSS model	N/A	Homeowners, Cayuga County DOH	10 years	$20,000 per upgrade	NYS Septic System Replacement Fund
Investigate and identify opportunities for sewer extension in feasible areas of the lakeshore	All	Complete sewer extension feasibility studies in shoreline areas	Variable	Variable	Municipalities	10 years	$40,000 per study	USDA Rural Development, DOS, EFC

12.3 Technical and Financial Assistance

This plan relies primarily on voluntary implementation of BMPs on privately owned lands, actions by local government related to land use regulations and infrastructure management, and community partnerships leading conservation and education efforts. Various forms of technical and financial assistance are available to help implement recommendations of the Owasco Lake Watershed 9E Plan. State and federal resources, including cost-sharing and technical support, are summarized in **Table 19.**

Table 19: Key Programs and Resources to Support Recommendations

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
STATE				
NYS Dept of Agriculture and Markets (NYSAGM)	Agricultural Nonpoint Source Abatement and Control Program (AgNPS)	Financial assistance program for projects led by SWCDs that involve planning, designing, and implementing priority BMPs. The program also provides cost-share funding to farmers to implement BMPs.	Agricultural Nonpoint Source Reduction Strategies	https://www.nys-soilandwater.org/aem/nonpoint.html
	Agricultural Environmental Management (AEM) Program	SWCDs engage local partners such Cooperative Extension, NRCS, AEM Certified Planners, Certified Crop Advisors, USDA Technical Service Providers, and agri-businesses to assist farmers in farm planning to reduce runoff and erosion.	Agricultural Nonpoint Source Reduction Strategies	https://agriculture.ny.gov/soil-and-water/agricultural-environmental-management
	Community Resiliency Training Program	Provides community and municipality-based training events to increase resiliency to future flooding and outbreaks of harmful algal blooms in high-risk waterbodies.	Floodplain and Stormwater Management, Pollution Control	https://agriculture.ny.gov/soil-and-water/rfa-0210-community-resiliency-training-program
	County Agricultural and Farmland Protection Planning Grants	Financial assistance for the development of County Agricultural and Farmland Protection Plans and assist implementation of such plans.	Agricultural Practices and Management, Infrastructure & Development	https://agriculture.ny.gov/land-and-water/rfa-0262-county-agriculture-and-farmland-protection-planning-grants

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
NYS Dept of Agriculture and Markets (NYSAGM)	Climate Resilient Farming	Program grant funds are awarded through County SWCDs and are available for projects that mitigate the impact of agriculture on climate change, for greenhouse gas emissions reduction and carbon sequestration, in addition to enhancing the on-farm adaptation and resiliency to projected climate conditions due to heavy storm events, rainfall, and drought.	Agricultural Practices and Management, Floodplain and Stormwater Management, Pollution Control	https://agriculture.ny.gov/soil-and-water/climate-resilient-farming.
	Source Water Buffer Program	SWCDs are the only eligible applicants for this program; they apply to the program on behalf of interested farmers. Funds for purchase of conservation easements on agricultural lands to protect active sources of public drinking water and support, expand or enhance water quality protection, thereby preserving or establishing buffers for public drinking water supplies. To be eligible, the agricultural lands must be directly adjacent to drinking water sources, wetland areas adjacent to drinking water sources, within a wellhead protection area designated by the New York State DOH, and/or within the contributing area directly adjacent to an aquifer sinkhole.	Agricultural Practices, Easements	https://agriculture.ny.gov/soil-and-water/source-water-buffer-program

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
NYS Dept of Environmental Conservation (NYSDEC)	Water Quality Improvement Project Program (WQIP)	For projects that reduce runoff, improve water quality, and restore habitat. Land acquisition of critical parcels is eligible for funding. Eligible applicants include municipalities, municipal corporations, and Soil and Water Conservation Districts. Not-for profit organizations are eligible to apply for grants for land acquisition in support of source water protection projects.	Infrastructure and Development, Pollution Control	https://www.dec.ny.gov/pubs/4774.html
	Climate Smart Communities (CSC) Grants	Provides 50/50 matching grants to municipalities for eligible climate mitigation and adaptation projects. This includes projects aimed at reducing flood-risk, increasing natural resiliency, extreme-event preparation, relocation or retrofit of critical infrastructure, and improving emergency preparedness.	Floodplain and Stormwater Management, Infrastructure and Development	https://climatesmart.ny.gov/
	Invasive Species Grant Program	Designed to support projects that target both aquatic and terrestrial invasive species. The program allows applications for two new categories: Lake Management Planning and Aquatic and Terrestrial Invasive Species Research.	Invasive Species	https://www.dec.ny.gov/animals/115742.html
	Trees for Tribs	The program's goal is to plant trees and shrubs along streams to create a forested riparian (streamside) buffer. Buffer in a bag provides organizations and private landowners free tree and shrub seedlings to help establish or improve a stream buffer on their property.	Floodplain and Stormwater Management	https://www.dec.ny.gov/animals/77710.html

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
NYS Dept of Environmental Conservation (NYSDEC)	Water Quality Management Planning Programs: Clean Water Act, Section 604(b) Funding	Funding is available to implement regional comprehensive water quality management planning activities, including tasks to determine the nature, extent and causes of point and nonpoint source water pollution problems, and to develop plans to resolve these problems.	Infrastructure and Development, Water and Wastewater Management, Pollution Control	https://www.dec.ny.gov/lands/53122.html
	Finger Lakes Lake Ontario Watershed Protection Alliance (FLLOWPA)	FLLOWPA receives an annual appropriation from the Environmental Protection Fund (EPF). FLLOWPA Counties then receive an annual allotment from this appropriation to implement water quality related programs and projects.	Installation and Implementation of Best Management Practices, Watershed Monitoring, Public Education and Outreach, Invasive Species and Technical Assistance	http://fllowpa.org/
NYSDEC, OPRHP, Empire State Development Corporation, NYSDOS, NYSAGM	Environmental Protection Fund	Funds capital projects that protect the environment and enhance communities. Eligible projects include conserving farmland, restoring habitat, controlling invasive species, upgrading municipal sewage treatment plants, cleaning up waterfront property and creating public parks, purchasing land for the NYS Forest Preserve, and restoring historic sites.	Invasive Species, Infrastructure and Development	https://www.dec.ny.gov/about/92815.html
NYSDEC, NY Sea Grant	NY's Great Lakes Basin Small Grants	Support stakeholder-driven efforts to restore and revitalize the state's Great Lakes region and demonstrate successful application of ecosystem-based management.	Floodplain and Stormwater Management, Invasive Species, Pollution Control	https://seagrant.sunysb.edu/articles/r/2768

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
NYSDEC / NYS Environmental Facilities Corporation (NYSEFC)	Clean Water State Revolving Fund	Provides interest-free or low-interest rate financing for wastewater and water quality improvement projects to municipalities. Eligible projects include construction or restoration of sewers and wastewater treatment facilities, stormwater management, landfill closures, as well as habitat restoration and protection projects.	Water and Wastewater Management, Floodplain and Stormwater Management, Infrastructure and Development	https://efc.ny.gov/cwsrf/
NYS Environmental Facilities Corporation (NYSEFC)	Drinking Water State Revolving Fund	Provides market-rate and below market-rate financing for the construction of eligible public water system projects for the protection of public health. Eligible projects include upgrade or replacement infrastructure needed to achieve or maintain compliance with federal or state health standards, and provide the public with safe, affordable drinking water.	Water & Wastewater Management	https://efc.ny.gov/dwsrf/

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
NYS Environmental Facilities Corporation (NYSEFC)	Clean Water Infrastructure Act (CWIA) Grants	*Inter-Municipal Water Infrastructure Grant Program* funds municipalities, municipal corporations, and SWCDs for wastewater plant construction, retrofit of outdated stormwater management facilities, and installation of municipal sanitary sewer infrastructure. *Consolidated Animal Feeding Operation Waste Storage and Transfer Program Grant* funds SWCDs to implement comprehensive nutrient management plans through the completion of agricultural waste storage and transfer systems on larger livestock farms. *CWIA Source Water Protection Land Acquisition Grant Program* funds municipalities, municipal corporations, SWCDs and not-for-profits (land trusts) for land acquisition projects providing source water protection. This program is administered as an important part of the WQIP program.	Water and Wastewater Management, Agricultural Practices and Management, Infrastructure and Development, Pollution Control	https://efc.ny.gov/wiia
	Integrated Solutions Construction Grant Program	Provides funding for projects that incorporate green infrastructure into Clean Water State Revolving Fund (CWSRF) projects that remove stormwater from combined, sanitary, or storm sewers. This funding is available only in conjunction with CWSRF financing.	Floodplain and Stormwater Management, Water and Wastewater Management	https://www.epa.gov/enviro/igms-construction-grants-overview

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
NYS Environmental Facilities Corporation (NYSEFC)	Green Innovation Grant Program (GIGP)	Provides municipalities, state agencies, private entities, as well as SWCDs with funds to install transformative green stormwater infrastructure.	Floodplain and Stormwater Management, Infrastructure and Development	https://efc.ny.gov/gigp
	Wastewater Infrastructure Engineering Planning Grant	Available to municipalities with median household income equal to or less than $65,000 according to the United States Census. Priority is usually given to smaller grants to support initial engineering reports and plans for wastewater treatment repairs.	Water and Wastewater Management	https://efc.ny.gov/EPG/
	Septic Replacement Fund	Provides participating counties with funds to reimburse a property owner for up to 50% of the costs (up to a max of $10,000) of their eligible septic system project. Eligible projects include replacement of a cesspool with a septic system; installation, replacement or upgrade of a septic system or components; installation of enhance treatment technologies.	Water and Wastewater Management	Septic System Replacement Fund | Environmental Facilities Corporation (ny.gov)
NYS Environmental Facilities Corporation (NYSEFC) and USFWS	Clean Vessel Assistance Program (CVAP)	A reimbursement grant program that aids marinas in the installation, renovation, and replacement of pump-out stations for the removal and disposal of recreational boater septic waste.	Pollution Control	Clean Vessel Assistance Program | Environmental Facilities Corporation (ny.gov)
NYS Dept of State (NYSDOS)	Local Waterfront Revitalization Program (LWRP)	Matching grant program that funds planning, design, and implementation to revitalize communities and waterfronts including water quality related projects.	Floodplain and Stormwater Management, Infrastructure and Development, Water Quality Research, Planning and Monitoring	https://dos.ny.gov/local-waterfront-revitalization-program

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
NYS Dept of Transportation (NYSDOT)	Transportation Alternatives Program	Provides funding for roadway improvements and culvert and bridge replacements, as well as pedestrian and bicycle paths.	Infrastructure and Development	https://www.dot.ny.gov/TAP-CMAQ
NYS Office of Parks, Recreation and Historic Preservation (NYSOPHRP)	Environmental Protection Fund Municipal Grants Program	Provides funding for acquisition, preservation, planning, development, and improvement of parks, historic properties, and heritage areas. Funding is available through the following grant categories: Park Acquisition, Development and Planning Program; Historic Property Acquisition, Preservation and Planning Program; Heritage Areas System Acquisition, Development and Planning Program.	Infrastructure and Development	https://parks.ny.gov/grants/grant-programs.aspx
NYS Office of Homes and Community Renewal	Community Development Block Grant (CDBG) Program – Small Cities	Funds may be utilized to address construction or renovation of various infrastructure projects such as water, wastewater and solid waste facilities, streets, and flood control projects.	Water and Wastewater Management, Floodplain and Stormwater Management, Infrastructure and Development	Community Development Block Grant | Homes and Community Renewal (ny.gov)
FEDERAL				
Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program	Helps communities implement hazard mitigation measures to protect against life and property damages.	Floodplain and Stormwater Management	https://www.fema.gov/grants/mitigation/hazard-mitigation
US Dept of Agriculture, Farm Service Agency (FSA)	Conservation Reserve Program (CRP)	A voluntary program for agricultural landowners that provides farmers with annual rental payments and cost-share assistance to establish long-term, resource covers on eligible farmland.	Agricultural Nonpoint Source Reduction Strategies	https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
	Conservation Reserve Enhancement Program (CREP)	In exchange for removing environmentally sensitive land from production and introducing conservation practices, farmers, ranchers, and agricultural landowners are paid an annual rental rate and incentive payments.	Agricultural Nonpoint Source Reduction Strategies	https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-enhancement/index
	Farmable Wetlands Program	Voluntary program designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow.	Agricultural Practices & Management, Floodplain & Stormwater Management	Farmable Wetlands Program (usda.gov)
US Dept of Agriculture, Natural Resources Conservation Service (USDA-NRCS)	Agricultural Conservation Easement Program (ACEP)	Provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.	Agricultural Practices & Management, Floodplain & Stormwater Management	Agricultural Conservation Easement Program | NRCS New York (usda.gov)
US Dept of Agriculture, Natural Resources Conservation Service (USDA-NRCS)	Agricultural Management Assistance (AMA) Program	Provides financial and technical assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations.	Agricultural Practices & Management. Pollution Control	Agricultural Management Assistance Program | Benefits.gov
	Conservation Stewardship Program (CSP)	Voluntary program that provides financial and technical assistance to implement conservation practices on agricultural and forested lands.	Agricultural Practices & Management, Forestry Management	Conservation Stewardship Program | NRCS (usda.gov)

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
US Dept of Agriculture, Natural Resources Conservation Service (USDA-NRCS)	Environmental Quality Incentives Program (EQIP)	Voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources on agricultural land.	Agricultural Practices & Management, Forestry Management	Environmental Quality Incentives Program | NRCS (usda.gov)
US Dept of Agriculture, Rural Development	Water & Waste Disposal Loan & Grant Program	Provides funding for clean and reliable drinking water systems, sanitary sewage disposal, sanitary solid waste disposal, and storm water drainage to households and businesses in eligible rural areas.	Water and Wastewater Management	https://www.rd.usda.gov/programs-services/water-environmental-programs/water-waste-disposal-loan-grant-program
	Community Facilities Direct Loan & Grant Program	Provides funding to develop essential community facilities in rural areas.	Water and Wastewater Management	https://www.rd.usda.gov/programs-services/community-facilities/community-facilities-direct-loan-grant-program
US Environmental Protection Agency (USEPA) and US Forest Service	Great Lakes Restoration Initiative	Funding focused on toxic substances and Areas of Concern, invasive species, nonpoint source pollution impacts on nearshore health, habitats and species, and foundations for future restoration in the Great Lakes watershed.	Floodplain and Stormwater Management, Infrastructure and Development, Invasive Species	https://www.epa.gov/great-lakes-funding/great-lakes-restoration-initiative-glri

Funding Source	Program	Description	Related Owasco Lake Watershed Recommendations	Website/Link for Additional Information
US Fish and Wildlife Service (USFWS)	Partners for Fish and Wildlife Program	Assists landowners with technical and financial assistance to help protect, enhance, and restore wildlife habitat on privately owned lands. Activities include restoring wetlands, grasslands, in-stream habitats, stream banks, riparian, and floodplain areas.	Floodplain and Stormwater Management, Infrastructure and Development	https://www.fws.gov/program/partners-fish-and-wildlife
US Fish and Wildlife Service (USFWS)	National Fish Passage Program	Restore aquatic organism passage at man-made barriers including dams and culverts; priorities include projects restoring habitat to freshwater mussels, brook trout, lake sturgeon, Atlantic salmon, and American eel.	Infrastructure and Development	https://www.fws.gov/program/national-fish-passage
US Environmental Protection Agency (USEPA)	Clean Water Act Section 319 Nonpoint Source Management Program	Funding to support a variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects.	Water Quality Research, Planning and Monitoring, Pollution Control; Collaboration, Partnerships and Outreach	https://www.epa.gov/nps/319-grant-program-states-and-territories
	USEPA Environmental Education Grants	Supports environmental education projects and promote environmental awareness and stewardship.	Collaboration, Partnerships, and Outreach	https://www.epa.gov/education/grants
LOCAL				
Municipalities	Municipal budgets	Provide labor and equipment from Departments of Highways and/or Public Works to do tasks such as clean debris from streams, culverts, storm drains, etc.	All	

12.4 Evaluation of Plan and Plan Updates

As outlined in the 2016 Plan, the OLWMC is the organization tasked with tracking progress toward implementation of the recommended actions and conditions of the lake and watershed. This institutional structure continues to be an effective avenue for collaborative efforts and communication. Adaptive management is a critical feature of the 9E Plan. Continued monitoring of water quality, habitat conditions, and hydrology will inform the Council of emerging issues and the need for additional actions. Monitoring efforts and plan updates shall be reviewed and approved by NYSDEC and NYSDOS as required, guided by a QAPP, and all analyses will be performed by an ELAP-certified laboratory.

The modeling efforts that underlie this 9E Plan are based on data and information collected between 2016 and 2021. The lake and watershed are not static, nor are the modeling tools. CCDP&ED will serve as the repository of the SWAT model files and will periodically update the analyses as land cover and management practices change, additional site-specific data become available (including weather, hydrology, and tributary water quality data), and the SWAT model framework evolves.

Reviewing and, if warranted, updating the 9E Plan on a ten-year cycle is recommended. This interval is comparable to recommended best practices for community comprehensive plans. Moreover, the lake's water residence time and the influence of weather conditions on nonpoint source phosphorus inputs support the need for tracking over a multi-year time frame. The OLWMC may consider other triggering events as they schedule periodic updates. Such events may include changes in regulatory policies, emerging contaminants, revised lake level management approaches, new technologies for nutrient inactivation or cyanobacteria, innovative management practices, expanded monitoring data, major changes in land use or land cover, updated modeling tools, and others.

12.4.1 Evaluation Criteria

Both quantitative and qualitative metrics will be used to track implementation of the recommended actions, and the extent to which Owasco Lake supports its best uses for water supply, aquatic habitat, salmonid fishery, and contact recreation. Examples of primary and secondary metrics are listed below.

Primary Metrics

- Annual monitoring reports from CSLAP to evaluate trophic state indicator parameters and other ambient water quality standards related to aquatic habitat. **Summer average chlorophyll-a concentration at or below 4 µg/L as documented through CSLAP will be evidence of successful implementation of the 9E Plan.**

- Stream discharge, meteorological data, tributary water quality data, and land use/land cover data including adoption of BMPs will be used to update the SWAT model and estimate external TP loading. **Reduction in external loading of 30% as determined through continued evaluation and application of the SWAT model framework and/or other tools (e.g., STEPL for streambank stabilization) will be evidence of successful implementation of the 9E Plan.**

Secondary Metrics: Ongoing Monitoring and Partnerships

- SWCDs track projects related to BMPs on agricultural lands. Metrics to track progress with these voluntary incentive-based measures may include progress toward meeting the AEM strategic planning goals, number of grant awards, number of collaborating agricultural producers in each AEM tier, acres of cover crops planted, etc.
- SWCDs are also active partners on projects related to streambank stabilization, road ditch improvements, and other measures. Their annual reports will continue to be a source of data and information.
- The Cayuga County Health Department manages the septic inspection program in Cayuga County and oversees the installation of new and modified septic systems. Their analyses will continue to inform the community regarding wastewater infrastructure issues. Quantitative metrics from this program include number of failing septic systems and the number of septic systems replaced. The MEANNs estimation tool can be applied to estimate the phosphorus load reductions associated with septic system upgrades, relocation, and/or replacement.
- Data from Cayuga County Health Department regarding compliance with primary and secondary contact recreational standards such as beach closure days or other official public health notifications regarding contact recreation.
- CCDP&ED will continue to assess the effectiveness of the Owasco Flats project. This major effort to improve hydrologic resilience can help guide additional efforts in floodplain management.
- CCDP&ED will continue tracking local initiatives to incorporate water resource protection measures into land use regulations and guidelines.
- CCDP&ED will continue to map the extent of watershed lands under conservation protection with input from the Finger Lakes Land Trust, OLWMC, TNC, and others.
- CCDP&ED will continue to partner with the Finger Lakes Institute, the Finger Lakes PRISM, OWLA, and others to track invasive species detected and treated in the lake and watershed.
- OWLA and other partners will continue to document efforts in early detection and rapid response to hemlock wooly adelgid in critical areas.
- TNC and Evidn have an innovative program underway focused on identifying factors that affect behavior and encouraging increased awareness of the potential for meaningful change. The findings of the program may help local organizations improve outreach and messaging to individuals and local officials regarding long-term protection of the water resources.
- Annual water quality reports from the two water purveyors (City of Auburn and Town of Owasco) to document compliance of raw and finished water with public health standards for water supply.

Track and report the number of exceedances of maximum contaminant levels in finished water. Report the number of days with microcystin detections.

- Results of any upstream and downstream/before and after monitoring programs designed to evaluate effectiveness of installed BMPs. This encompasses road ditch improvement projects, streambank stabilization measures, agricultural BMPs (e.g., Tier 5 AEM efforts), and projects designed to reduce flood risk.

13 Conclusions

The Owasco Lake watershed provides a multitude of ecosystem services that benefit us all, as reflected in the 9E Plan's updated vision statement and goals. The lands and waters support food and fiber production, offer beautiful vistas and diverse recreational opportunities, provide habitat for a diverse assemblage of native species, and are a source of clean and abundant drinking water. In addition, the watershed lands and waters support power generation and waste assimilation for development activities.

Actions are needed to protect and preserve the watershed's ability to support these interrelated ecosystem services. The Owasco Lake Watershed Nine Element Plan for Phosphorus Reduction focuses on a key challenge facing many lakes and watersheds; the need to control phosphorus inputs. This 9E Plan analyzes phosphorus sources and locations, estimates current loadings, and uses mathematical tools to project the consequences of changing conditions. The findings support a series of recommended actions designed to reduce phosphorus inputs.

The analyses indicate that meeting the reduction target of an overall 30% reduction in external loading to Owasco Lake is both achievable and effective in meeting the community goals. Various landscape sources are the primary contributors of phosphorus to Owasco Lake. Therefore, managing these diffuse sources will require ongoing efforts of many parties: individual landowners, local leaders, farmers, foresters, and resource management agencies. Continued collaboration and partnerships are the key to protecting this resource for future generations.

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