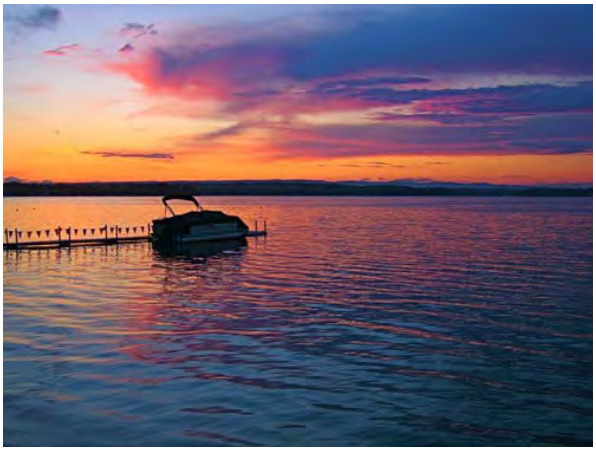
Land to Lakes Perspectives:
The Saratoga Lake 2021 Assessment



Saratoga Lake Protection and Improvement District (SLPID)

April 2022

Land to Lakes Perspectives: The Saratoga Lake 2021 Assessment

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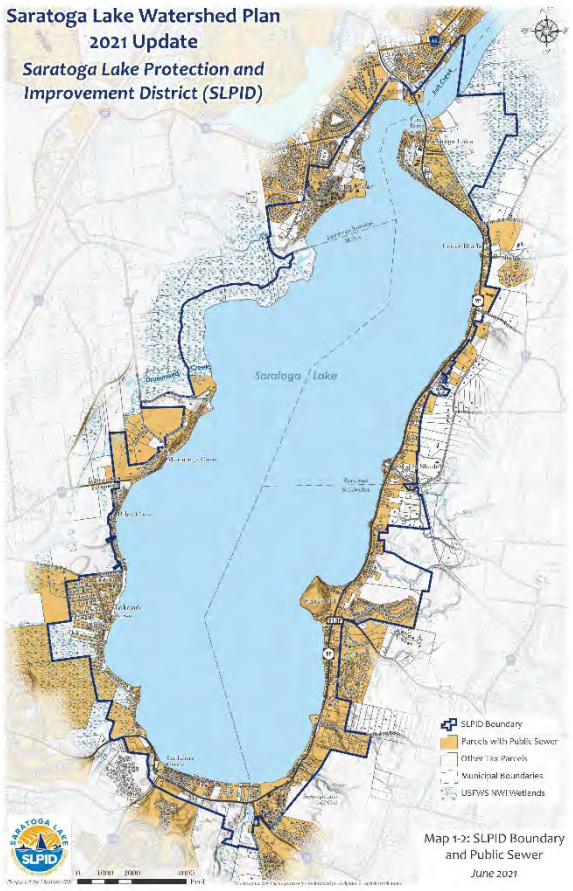
Executive Summary

PROJECT OVERVIEW

This document updates the *Land to Lake Perspectives: A Watershed Management Plan for Saratoga Lake* completed by SLPID in 2002. The 2021 assessment is a review of issues persisting from the 2002 report and expanding on developing issues over the past 19 years. The 2002 report was developed as a wider effort concentrating on the entire watershed. The "Watershed Management Plan for Saratoga Lake" (SLWMP 2002) was funded through the Environmental Protection Agency Wetlands State Development Program in 1999 and served as an update to the 1983 Lake Diagnostic Feasibility Study (Hardt, Hodgson and Mikol, 1983).

SLPID was established as a Special Purpose Tax District by the New York State Legislature in 1986 and founded following the development of a Phase 1 Diagnostic Feasibility Study in 1983 (Hardt, Hodgson and Mikol, 1983). Funded by the Environmental Protection Agency (EPA), this important study was completed on Saratoga Lake to identify the best method to manage the growth of Eurasian watermilfoil (EWM) which had spread throughout the Lake's shallow water zone.



This study focuses on the four communities that border Saratoga Lake that make up the sub-watershed, rather than the entire watershed. This will not only limit the expense of the update but enable it to concentrate on the immediate watershed and shoreline issues that persist. By involving the individual municipalities during the development of the update it is forecasted that the study's findings will be more relevant and have a greater positive long-term impact on Saratoga Lake.

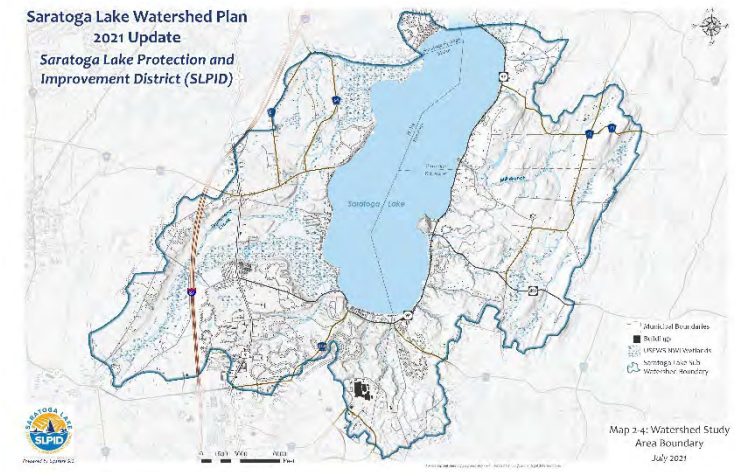
The update is guided and funded by SLPID with partners including the four lake municipalities, Saratoga County Planning, Saratoga County Soil & Water Conservation District, and Saratoga Lake Association.

This update covers the following topics:

- A general description of the whole watershed with existing information and data.
- A summary of water quality data brought forward from recent SLPID plans (SLPID, 2019), plus local comprehensive plans, local waterfront revitalization plans, and agricultural preservation plans.
- A summary of SLPID's long-term aquatic vegetation control efforts.
- A review and reporting of recreation trends on Saratoga Lake.
- A review of zoning and other regulations that impact land use.
- An analysis of issues in the watershed and how they are being addressed.
- Recommendations for policies, guidelines and regulations for the lake and watershed.

WATERSHED DESCRIPTION

The Saratoga Lake Watershed extends over 244 square miles covering approximately one-third of Saratoga County. The watershed includes parts of 11 townships, the Village of Ballston Spa, and the City of Saratoga Springs. Its point of origin is the Kayaderosseras Creek in the Town of Corinth and flows through the towns of Greenfield, Milton, and Malta before flowing into Saratoga Lake. The Saratoga Lake watershed is in turn a part of the Upper Hudson River Watershed which covers nearly 90 percent of Saratoga County.



The municipalities that have frontage on Saratoga Lake include the towns of Saratoga, Malta, Stillwater, and the City of Saratoga Springs. The boundary being used for this report is the Drummond Creek/Fish Creek Subwatershed. This subwatershed has the highest impact on stormwater runoff and the greatest potential for pollution to Saratoga Lake.

There are 14 direct tributaries to Saratoga Lake. The four significant in size and contribution to Saratoga Lake include: Kayaderosseras Creek, Mill Branch, Drummond Creek and Coffey Creek. Originating in the Town of Corinth, the Kayaderosseras is the largest tributary. There are 5 primary and 15 smaller tributaries associated with the Kayaderosseras. Fish Creek is the only outlet for Saratoga Lake. It originates at the 9P Bridge at the north end of the lake, flowing northeast eventually discharging into the Hudson River at Schuylerville.

SARATOGA LAKE CONDITIONS

Findings

The water quality of Saratoga Lake has significantly improved following the installation and operation of Sewer District #1 in 1978. Today's data indicates the lake's water quality improved from a dangerous eutrophic level in 1978 to a meso-eutrophic level 40 years later. Changes in water quality at Saratoga Lake tend to show Total phosphorous (TP) levels have been stable for many years. However, even with stable concentrations of TP, there is still sufficient levels of TP to drive changes in the lake. These changes are most pronounced in the probable increase in the internal loading of TP. Internal loading has increased since 1984 and the depth of anoxic waters have also increased since 2008. Lake modeling has confirmed that direct discharge sub-catchments may be causing an outsized contribution to nutrient loadings in Saratoga Lake. The recommendations outlined below are meant to address these challenges and further improve the water quality of Saratoga Lake.

Recommendations

1. Fish Creek Rehabilitation

The dam operator has accepted SLPID's proposal to examine Fish Creek and potentially modify operation of the dam to allow work for property owners on the Saratoga Lake shoreline or lower the lake prior to predicted storms to limit damage to infrastructure. The next step is to develop and outline of the permit process that identifies the key decision points by regulatory agencies and Federal Emergency Management Agency. The role of the Saratoga County Soil and Water Conservation District, Saratoga County Stormwater Coordination Office and Saratoga County Planning will need to be clarified. Information for the permit submittal will be identified. A decision maker list will be prepared, and representatives at all levels of government will be identified. This information will be used to create a request for proposal to select a firm qualified to prepare an application. The new bathymetric survey by CT Male will indicate benefits and feasibility of the project and will determine the feasibility of the project.

2. BioBase Mapping

Two of SLPID weed harvester have BioBase Lowrance mapping data loggers installed. The Lowrance system collects daily mapping of the travel courses of the harvesters. The data being collected includes bathymetric mapping estimates of plant biomass and the harvesting speed. The operators of the harvesters can see their individual pathways that they have completed and changes in the lake bottom profile. The key information for the Article 24 New York State Wetlands permit is to be able to show that harvesting in the wetlands is limited to under 50% of the wetland area. To date this information has been extracted by reviewing each day of harvesting and estimating the wetland position. It is recommended that each week a map be compiled into a single map of biomass which will reduce the costs related to data storage. The 2020 data will be combined into weekly maps and the 2021 data will be sorted.

3. Thermal Profile

A thermal profile in the deep-water area will be a research related effort. Two approaches are proposed to complete the work. The preferred method is to recruit a group to complete the work. A request for proposals will be issued to assist SLPID in installing a string of recording thermistors and managing data will be circulated in early 2022. Alternatively, SLPID will complete the work using available resources. A string of recording thermistors and recording dissolved oxygen probe should be set in the central deep-water area to continuously collect temperature to improve the detailed variation in the thermal profile of the lake from May to December. This will fill a gap on the duration of summer thermal stratification and DO depletion. During the winter, submersed temperature and DO recording devices can be left on the lake bottom attached to a pop-up buoy that will released and carry the recording devices to the surface once it receives a radio signal. This will provide information on bottom temperature and DO during the winter. During the same time, additional deepwater samples for nutrients can be collected to improve the estimation of internal loading.

4. Kayaderosseras Creek Flow

Watershed flow or hydrology estimates is a major source of error when assessing lake dynamics. Obtaining correct flow data is important to determining watershed nutrient loadings and lake water flow. There is a stilling well at Nelson Avenue Extension that was installed in 1970 to estimate the water flow in the Kayaderosseras Creek. An assessment of the stilling well is needed to see if it is still connected to the Kayaderosseras Creek. This can be done with dye and a compressor to clear pipes. If the stilling well is secure, a pressure gauge will need to be installed into the stilling well and calibrated. The Saratoga Stormwater Coordinator's office may assist in this project, and a surveyor may be required to re-establish the elevation of the stilling well.

5. Lake Water Flow

In the early 1970's, RPI constructed a 3-D physical model of Saratoga Lake to determine the flow of water from the Kayaderosseras Creek into the lake and out of Fish Creek. This 3D model demonstrated that water from the creek flowed south and exited by way of Fish Creek. SLPID should purchase recorders that use GPS to measure the flow and direction of the lake through inexpensive geographic position recorders used to track equipment or trailers and then be downloaded to a map.

6. PCR Coliform Testing

PCR coliform testing uses genetic material found in a water sample to identify if the coliforms are from humans, cows, horses, dogs, or birds. It is recommended the tests would be completed on Sucker Brook, Kayaderosseras Creek, and some of the other short-run streams to identify locations for additional study or remedial efforts.

7. Harmful Algal Blooms (HABs)

HAB sampling has been conducted as part of the CSLAP program. However, the program is expected to stop or be greatly reduced after 2022. In cooperation with existing HAB sampling conducted by NYSDEC and NYSDOH, SLPID should continue to participate in sampling efforts. If HAB conditions occur with greater frequency, or as more public beaches are developed, more

HAB sampling may be warranted. Such a plan may incorporate nearshore and offshore HAB testing, organized surveillance, and additional water quality testing. Additional actions include the recent purchase of a Turner handheld fluorometer which will measure the concentration of chlorophyll that is specific to HAB bloom species. This will aid in the determination of whether a bloom is cyanobacteria or green algae. At the same time, kits should be purchased to detect and measure the amount of cyanobacteria toxins to better evaluate bloom conditions. The common method to test for algae toxins using a kit that is an immunoassay. Qualitative test strips are also available for detection of HABs toxins. A laboratory is needed to complete the testing by use of the kit. Investigate whether Saratoga County will support this type of testing to use on multiple lakes, or if the county will support a demonstration project for Saratoga Lake in 2022.

AQUATIC PLANT MANAGEMENT

Findings

Aquatic invasive species are an ongoing problem on Saratoga Lake. Their presence can lead to habitat degradation and loss of wildlife. Along with loss of recreational opportunities and income, aquatic invasive species can damage drinking water and infrastructure. Therefore, there continues to be a need to manage both invasive and native aquatic plants. The existing Integrated Pest Management Plan for aquatic plant management will continue for Saratoga Lake. The program will need to be continually modified to respond to new invasive species and address updated control techniques. Biological controls may become available in the future to treat certain species and will be evaluated as needed.

Recommendations

1. Aquatic Plant Inventory

The rake toss aquatic plant survey should be continued on an annual basis. This survey identifies the need for herbicide and other treatments in 2023 and beyond. As a part of the 2022 survey, additional sampling should be completed around the bed of water star grass and eel grass to better map their location and density. SLPID should continue to fund and utilize comprehensive annual aquatic plant survey to identify locations for herbicide applications and identify emerging needs, as well as review and update procedures annually and adjust as needed, while increasing surveys of the lake for invasive species control and hand-pulls.

2. Harvesting Program

Continue to operate the mechanical harvesting program that now consists of three FX-11 Alphaboat harvesters and supporting equipment. The SLPID Weed Harvesting Program reduces weed abundance, clearing pathways to open water for recreation via cutting and/or scooping loose weeds reducing pollutant loads and nutrient enrichment. The operation of the harvesting program will be refined in 2022 but the plan includes beginning harvesting at the end of May or early June to limit disturbance of bass species tending their nest in shallow water. Continue to survey and hand harvest European Frogbit. Control water chestnut through a combination of complete plant removal by mechanical equipment, hand harvesting, and herbicides. Ongoing tasks include:

- Continue planning with the Quaker Springs Fire Dept. and the Town of Saratoga on sharing access at Fitch Road.
- Purchase new signage for equipment, first aid supplies, and complete safety manual. Keep communicating on options for dumping sites if needed and provide information to the Saratoga Lake Organic Compost Co. for a future business plan.
- Continue messaging outreach to the public to remove aquatic invasive species (AIS) on their own shoreline and in-between docks.

3. Rapid Response Program

SLPID should review and update the rapid response protocol in the event of introduction of a new aquatic invasive species (SLPID, 2019). Incorporate new groups involved in invasive controls and new techniques for invasive species control as they are approved. Keep a reserve in the budget each year in case of the discovery of a new invasive. Have a procedure in place for a rapid response plan and a list of pre-approved contractors for permits. Keep Lake stewards informed on AIS identification.

4. Herbicide Treatments

Continue to utilize herbicides as needed to control aquatic invasive species. Select herbicides based on target species, choose systemic mode of actions for longer control, limit impacts on non-target species. A Eurasian watermilfoil herbicide treatment will not be required in 2022. Water chestnuts will be controlled by mechanical removal using the Weedoo machine. Continue to conduct plant surveys annually and evaluate the need for herbicide use to control aquatic invasive species.

5. Draw Down

Continue to use drawdown of Saratoga Lake to limit plant growth in depths between 0-1 meter in water depth.

6. Unmanaged Invasive Species

Currently, emergent or wetland invasives, including purple loosestrife and Japanese Knotweed are not managed by SLPID and would require a management plan for their control. This could be done as a cooperative effort with riparian municipal governments and landowners but may require a different funding mechanism such as federal, state, and local grants. All control measures carried out by SLPID must be within the district.

LAKE USE REGULATIONS

<u>Findings</u>

Saratoga Lake is generally experiencing an increase in the number of docks and numbers of boats at individual properties that may lead to overuse of the lake. Many modest seasonal lakefront residences are being converted to larger homes creating more impervious surfaces, less green space, and increased uncontrolled/treated runoff. Correspondingly, the demand for docks, piers, boat lifts, mooring anchors, buoys, and swim floats is expected to increase. Boat sales have escalated in the last few years, and the 2020 Boat Census indicated that this trend is already translating into more boats on the lake. Airbnb's and the rental of residential dock space to non-

residents are popular trends that often create conflict between neighbors and a general loss of quality of life for all lake users.

Recommendations

1. **Managing Dock Structures**

Currently, there is no clear support from the four lakeside municipalities to approve a uniform set of dock regulations. SLPID developed a set of dock guidelines in 2012. These guidelines should be reviewed and simplified to reflect the present needs and interests of the riparian municipalities. However, as guidelines, these rules would have little impact on the dock environment since there would be no municipal regulatory oversight.

2. **Annual Dock Survey**

SLPID should continue to conduct an annual survey on the number, type, and length of docks throughout the lake. Also, monitor dock rental trends and identify issues with parking, neighbor conflicts, and boat congestion. To improve the annual boat count process, an aerial drone may be used to record images of the shoreline condition and clearly show the length of docks number and style of boats along the lake shore.

BOATING AND RECREATION

Findings

Based upon data collected annually on boating activity on Saratoga Lake since 2016 recreational boating appears to be stable and generally safe. There are times when the lake will seem too crowded, especially at peak times of the day for mooring and, when the weather changes rapidly, and all are heading for shore. In addition, there is the onshore capacity at local docks and marinas for many more boats to be out on the lake at one time. At-shore surveys show only about one-third of the boats are out on the lake at any one time. Should this factor change, it would dramatically alter the safety factor of recreational boating.

Recommendations

1. **Annual Boat Census**

Continue to conduct the annual boat census of active boats on the lake on a peak use day. Also continue to conduct an onshore boat count on a low use day.

2. **Marina Standards**

Communities around the lake should adopt marina standards that address parking, boat pump out facilities, dock length and placement, and quick launching as part of individual land use codes. SLPID should actively review and comment on future proposals for expansions of marinas during the local SEQRA process to assure that responsible and safe design standards for marinas are considered.

3. **Enforcement**

Marine patrol enforcement of existing laws and regulations governing Saratoga Lake is adequate given available resources. This is especially significant for enforcement of boat speed in no-wake

zones near the 9P Bridge and on Fish Creek. Continue to hold regular meetings between SLPID and the marine patrol throughout the summer season to review issues with boating on the lake. Continue to financially support the marine patrol in the SLPID budget to increased patrols during needed periods. Review existing 5mph buoy arrangement and make adjustments as required.

4. Boat Launch Management

Work with State Parks to continue the practice of bringing in a parking attendant on busy weekends and holidays to assist the lake stewards with the public and closing the launch when parking is full and/or the facility is too crowded. Patrol of the parking lot by various police agencies is important on weekends when the lot is at capacity, and there is the possibility of user conflicts.

EDUCATION AND STEWARDSHIP

Findings

SLPID has made significant outreach gains in the communities that surround Saratoga Lake. The issues around the lake have become more complicated, and the public's expectations have become more sophisticated. SLPID should develop a 5-year education plan that is responsive to the distributing information that will be essential to protecting the water quality of the lake long-term. Below are some recommendations that reflect near-future needs.

Recommendations

1. Boat Steward Program

Prevent new introductions of AIS by continuing to fund and operate a Lake Steward program at the NYS Boat launch and at other launching facilities as necessary. Increase hours for stewards, add extra stewards to come in earlier and later for the fishing tournaments and coverage at marinas.

2. Programming

To stay up to date in yearly changes and to provide proper training to the SLPID stewards, the Lake Administrator should collaborate, communicate, and participate with all agencies involved in steward training and lake management including NYS Parks, Recreation and Historic Preservation, NYSDEC Bureau of Invasive Species and Ecosystem Health, NY Natural Heritage Program, Capital Mohawk PRISM (Partnership in Regional Invasive Species Management), Saratoga County Soil & Water Conservation District, Saratoga County Cornell Cooperative Extension, Saratoga County Planning Department, NY Sea Grant, SUNY ESF, Adirondack Watershed Institute, Darrin Freshwater Institute, City of Saratoga Springs and towns of Saratoga, Stillwater, and Malta. Also continue collaboration and the sharing of steward information and data findings with other lakes in New York.

3. WISPA Data Management

The Lake Administrator should complete steward WISPA data information and review at the end of the season for submission to the State.

4. Education and Outreach

Develop a strategic plan for education and outreach that identifies specific initiatives, programs, and projects and funding needs over the next 5 years. Increase efforts on outreach education programs to the public and property owners on invasive species prevention and other issues. Extend outreach opportunities to Saratoga Lake Association and the local homeowner associations on the lake. Attend their meetings to pass on information about the lake. Provide a presence and role at the Saratoga County fair with Saratoga County Soil and Water District. Reach out, establish a good relationship, and coordinate activities with the fishing clubs that conduct tournaments on Saratoga Lake. Continue with yearly informational events at Browns Beach. Expand the "Take the Pledge" initiative and distribute the publication: *A Guide to Creating Vegetated Buffers for Lakefront Properties*.

5. Floating Classroom

Continue with the floating classroom program on AIS management, site stormwater management, lake ecology, and other topics of interest to the lake community. On lake experiences will need to meet requirements of NYS Navigation law and vessel requirements. Purchase a boat to accommodate the floating classrooms and also be utilized for water testing, lake surveys and other projects.

6. Demonstration Projects

SLPID should outline, fund, and implement a series of demonstration projects that are highly visible from the lake that feature examples of best practices for stormwater, natural shorelines, and erosion control measures.

7. Website, Newsletter, and Social Media Improvements

SLPID should post additional materials to the website including department reports, annual budgets, and news articles. Also expand on section that invites the viewer to the donation section. Expand the SLPID email notification list to effectively get the SLPID message out to the public on updates and projects. Increase SLPID's social media presence with live and more candid posts of SLPID's presence through regular, short messages. Continue developing and distributing 2-4 newsletters per year and expand the email notification list.

8. Grant Opportunities

SLPID should continue to seek grants to help fund special initiatives, projects, and programs. A long-term grant strategy should be developed that matches projects with potential grant programs and sets goals for setting aside required match money in future budgets.

LAND USE AND DEVELOPMENT

Findings

Waterfront zoning density ranges from one-third acre to nearly five acres. The three towns use maximum lot coverage to measure for the building envelope. Saratoga Springs is the only community whose approach to lot coverage requires a minimum area of permeable surface.

Overall standards are good for most uses. There are, however, no special rules for the regulation of marinas or residential docks on Saratoga Lake. Shoreline property standards for stormwater

management and erosion control should be developed and apply for projects that currently fall outside site plan review and other regulations.

Recommendations

1. **SLPID's Response to Development Projects**

SLPID is not structured to administer land use controls yet, to meet the objectives of the SLPID legislation, it is necessary for SLPID to work with the communities on land use decisions. SLPID will, at times, comment on specific development projects in the SLPID District or in areas that discharge to the Saratoga Lake. The comments will be limited to the criteria or topics found in Section 1 and 7 of the implementing legislation.

2. **Watershed Protection Group**

SLPID should continue to schedule and facilitate meetings with representatives from the four municipalities, Saratoga County Planning Department, Saratoga County Soil & Water Conservation District, and Cornell Cooperative Extension to address the potential opportunity to improve standards for stormwater management and erosion control on small lots around the lake, unify zoning districts, and fine tune land use controls around the lake.

3. **Stormwater Mitigation**

Discharge from the NYS Route 9P roadway enters streams and culverts by sheet flow or grates. Stormwater should be treated by catch basins with sumps to remove and collect sediments. SLPID with partners should consolidate inventories of stormwater discharge points engineering around Saratoga Lake. Recommendations should specify culvert repairs, modifications, and replacements, where necessary.

4. **Wetlands Restoration**

A longer-term program of rebuilding floodplains and wetlands in key areas will be needed to capture nutrients prior to entering the lake. Locations that involve wetlands that have been filled in or disturbed along roadsides are opportunities for wetland rehabilitations and the creation of stormwater forebays. A stormwater forebay is a location that captures sediments and then allows easy removal of sediments from the forebay reducing delta development in the lake. There are both larger and smaller opportunities for these projects around Saratoga Lake that need to be further assessed through joint efforts by SLPID, local municipalities, Saratoga County, New York State Department of Transportation, and private landowners.

5. **Demonstration Project**

Less traditional methods of nutrient remediation need to be explored including use of phosphorus absorbing materials such as Chitosan, or Biochar logs or anionic blocks. In each case the logs or blocks work best in slow-moving water. They have a useful life of months and therefore, must be replaced. Continue to investigate a feasible location for one or more demonstration projects to construct an artificial wetland, floating islands for water treatment, and green infrastructure projects to protect the lake from sediment and pollutants associated with stormwater discharges from local streams.

6. Critical Environmental Area

Investigate the potential for getting Saratoga Lake designated as a Critical Environmental Area. According to DEC, the CEA designation serves to alert project sponsors to the agency's concern for the resources or dangers contained within the CEA. Once a CEA has been designated, potential impacts on the characteristics of that CEA become relevant areas of concern that warrant specific, articulated consideration in determining the significance of any Type I or Unlisted actions that may affect the CEA.

7. Cooperation with Partners

The SLPID administrator should continue to meet with riparian municipal officials to discuss common interests and continue to participate in attending the Saratoga County Water Quality Committee.

8. Improve Waterfront Land Use Standards

Continue work with riparian municipalities and other partners to develop a uniform set of standards that only address land use situations that do not currently meet local or state thresholds for review. SLPID would continue to have no land use authority but act in a supporting role to the municipalities. Alternatively, the standards could simply be adopted individually in each municipality without the constraints of an overlay. The following concepts should be considered in the development of specific standards:
maximum impervious standards; green infrastructure; professional oversight; low impact design; preservation of the natural shoreline; limitations of retaining walls; stream buffers; minimization of land disturbance; and steep slopes protection.

WATERSHED MODELING

Findings

The section on Water Quality (3.4), describes the changes in water quality at Saratoga Lake that tend to show the lake Total phosphorous (TP) levels have been stable for many years. Even with stable TP, there is still sufficient levels to drive changes in the lake. These changes are most pronounced in the probable increase in the internal loading of TP. Internal loading has increased since 1984, and the depth of anoxic waters has also increased since 2008 (Figure 3-6, “Hypolimnion Water Depths with Depleted Dissolved Oxygen”).

To address internal loadings, there are methods to limit nutrient re-cycling by use of alum, Phoslock®, deep aerations, oxygen injections, and water circulation. All methods have their advantages and disadvantages. Selection of a method requires detailed water quality analysis, test or pilot projects, sediment testing, complex engineering for the selected system and permitting. The permitting process for alum and Phoslock is currently under review, and the process has not been set.

Traditional application of copper sulfate or hydrogen peroxide may be used to control HABs. Control by use of herbicides is difficult since the location extent and longevity of a bloom can’t be predicted. Also, responding in hours or days is a significant logistic problem. Experimental

controls are being explored in NYS by SUNY Environmental Science and Forestry, and Clarkson University, while at the same time United States Army Corps of Engineers is working in Florida. The HABs controls devices are built to be portable and use filtration, ozone, and hydrogen peroxide.

Recommendations

1. **Lake Modeling:** Direct discharge sub-catchments may be causing an outsized contribution to nutrient loadings in Saratoga Lake. Two efforts are underway and will continue in the coming years. A string of recording thermistors and possibly a recording dissolve oxygen probe should be set in the central deep-water area to continually monitor the thermal profile of the lake from May to December. This will fill a gap in the duration of summer thermal stratification and DO depletion. During the winter, a submersed temperature and DO recording device can be left on the lake bottom attached to a pop-up buoy that will be released and carry the recording devices to the surface once it receives a radio signal. This will provide information on bottom temperature and DO during the winter. During the period, additional deepwater samples for nutrients can be collected to improve the estimation of internal loading.

2. **Data:** Additional data is needed to improve predictive capability of watershed models at Saratoga Lake. There is a twofold difference in annual water flow in the watershed depending on the model used. Three tasks can be considered to improve model results:
   - Select and use different models and have work completed by an experienced team of modelers and hydrologists.
   - Re-install the water level recorder at the Nelson Avenue Extension bridge, install a rented velocity meter, and take new measurements of the channel. This will provide actual water flow estimates coming down Kayaderosseras Creek. This site is the discharged point for 87% of the watershed. The site does not include Lake Lonely, Spring Run, or Drummond Creek.
   - Collect water quality data and streamflow data at the short-run streams. This should include both dry and wet weather conditions. The short-run streams discharge to the lake by the way of culverts, so the flow can be estimated by water levels and pipe slope. Water levels are recorded by a pressure gauge. An automated sampler, which can be rented or purchased, is the best method of collection samples.

3. **HABs:** To address the issue of HABs, two actions can be taken:

- A Turner handheld fluorometer can be purchased to measure the concentration of chlorophyll specific to HABs bloom species. This will aid in the determination of whether a bloom is cyanobacteria or green algae.
- At the same time, kits can be purchased to detect and measure the amount of cyanobacteria toxins to better evaluate bloom conditions. This would not change bloom warning conditions or procedures.

4. **Nutrient Reduction:** Along with improving the knowledge base on Saratoga Lake nutrient loading and hydrology there are specific actions that are needed to reduce nutrient transport to the lake:
   - As recommended in the 2002 watershed plan, stream buffers are the best management approach that will protect both local stream water quality and the lake. At the same time, limiting runoff from lots that are being redeveloped on the lake shore is a certain method to lower discharges of sediment and nutrients to the lake.
   - Less traditional methods of nutrient remediation should be explored that include the use of phosphorus-absorbing materials such as Chitosan, Biochar logs or anionic blocks. In each case, the logs or blocks work best in slow-moving water. They have a useful life of only months and must be replaced on a regular basis.

5. **Forebay Projects:** A longer-term program of rebuilding floodplains and wetlands will be needed to capture nutrients prior to entering the lake. Large and small opportunities for forebay projects around the lake need to be further evaluated. Making these actions happen will require joint efforts by SLPID, local municipalities, Saratoga County, New York State Department of Transportation, and private landowners. They normally require a period of years to plan and complete.

6. **Catch Basins:** The NYS Route 9P roadway discharge enters streams and culverts by sheet flow or grates, and the stormwater is not treated by catch basins with sumps to remove and collect sediments. Adding catch basins will be difficult due to a limited right-of-way. However, the installation of catch basins should be explored as a part of improvement plans.

SECTION 1 PROJECT OVERVIEW

1.1 Project Description

This assessment updates the *Land to Lake Perspectives: A Watershed Management Plan for Saratoga Lake* completed by SLPID in 2002. The 2021 Assessment is intended to focus on a review of the issues that persist from the 2002 report and expanded with issues that have developed over the past 19 years. The 2002 report was developed as a wider effort concentrating on the entire watershed. It was funded through the Environmental Protection Agency Wetlands State Development Program in 1999 and served as an update to the 1983 Lake Diagnostic Feasibility Study (Hardt, Hodgson, and Mikol, 1983). Figure 1-1, "Regional Location," shows the relative location of Saratoga Lake to Saratoga County and New York State.

This study focuses on the four communities that border Saratoga Lake that make up the sub-watershed, rather than the entire watershed. This will not only limit the cost of the update but enable it to concentrate on the immediate watershed and shoreline issues that persist. By involving the individual municipalities throughout the development of the update it is forecasted that the study's findings will be more relevant and have a greater positive long-term impact on Saratoga Lake. See Figure 1-2, "Watershed Study Area Boundary," for the Drummond Creek sub-watershed area.

The update is guided and funded by SLPID with partners including the four lake municipalities, Saratoga County Planning, Saratoga County Soil & Water Conservation District, and Saratoga Lake Association.

This update covers the following topics:

- A general description of the whole watershed with existing information and data.
- A summary of water quality data brought forward from recent SLPID plans, plus local comprehensive plans, local waterfront revitalization plans, and agricultural preservation plans.
- A summary of SLPID's long-term aquatic vegetation control efforts.
- A review and reporting of recreation trends on Saratoga Lake.
- A review of zoning and other regulations that impact land use.
- An extensive detail of issues in the watershed and how they are being addressed.
- Recommendations for policies, guidelines and regulations for the lake and watershed.

1.2 Role of the Saratoga Lake Protection and Improvement District (SLPID)

SLPID was established as a Special Purpose Tax District by the New York State Legislature in 1986 as the result of the passage of Senate bill 7690 and Assembly bill 9211. SLPID was founded following the development of a Phase 1 Diagnostic Feasibility Study in 1983 (Hardt, Hodgson, and Mikol, 1983). Funded by the Environmental Protection Agency (EPA), this important study was completed on Saratoga Lake to identify the best method to manage the growth of Eurasian watermilfoil (EWM) which had spread throughout the lake shallow water zone.

The legislation describes the need for District as well as the benefits to be derived by its operation, organization, board membership, operational rules, and directive to own, operate and maintain aquatic plant harvesting equipment (section #7(c)). Along with this specific directive, Section 7 (p), "Take any and all other actions reasonably necessary and proper to further the purpose of the district".

This legislation set up a Board of Commissioners comprised of a representative from each municipality that fronts on the lake, plus an At-Large Commissioner. The Commissioners are all equal with a single vote during meetings to consider the business of the district. The slate of commissioners is selected by the Chair of the Saratoga County Board of Supervisors. After a commissioner's appointment is up or a resignation occurs, the Board of Supervisors selects the replacement.

The boundary of the SLPID District is mapped in Figure 1-3, "SLPID Boundary & Sewer District". The Sewer District 1 boundary is also overlaid on this map to show the difference between the SLPID boundary and the Sewer District boundary. Property owners in the SLPID boundary pay a special assessment tax to Saratoga County, which becomes SLPID's main funding source.

SLPID is responsible for the operation of the harvesting program and that has evolved into a large-scale effort to manage aquatic invasive species (AIS). To manage AIS, SLPID carries out the following programs and activities:

- ✓ Annual review of the integrated pest management strategy to control AIS.
- ✓ Funds the registration and use aquatic herbicides to manage AIS.
- ✓ Funds the mechanical removal of AIS and native aquatic plants when that is the best management tool.
- ✓ Funds annual aquatic plant surveys to support planning efforts.
- ✓ Funds the Lake Steward program and boat inspection program to limit the introduction of new AIS.
- ✓ Funds water quality testing.
- ✓ Operates a harvesting program to remove aquatic plants from in front of docks so that lake front owners can access and enjoy the lake.
- ✓ Purchases and maintains the needed equipment to operate the harvesting program.
- ✓ Works cooperatively with the lakefront municipalities on issues of common interest.
- ✓ Communicates with taxpayers and various other groups including Saratoga Lake Association, Saratoga Rowing Club, Saratoga County Water Quality Committee, Saratoga County Sheriff's Department, NYS Office of Parks Recreation and Historic Preservation, and NYS Department of Environmental Conservation.

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LAND TO LAKE PERSPECTIVES: THE SARATOGA LAKE 2021 ASSESSMENT

Saratoga Lake Protection and Improvement District (SLPID)

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Map 1-1: Regional Location

January 2022

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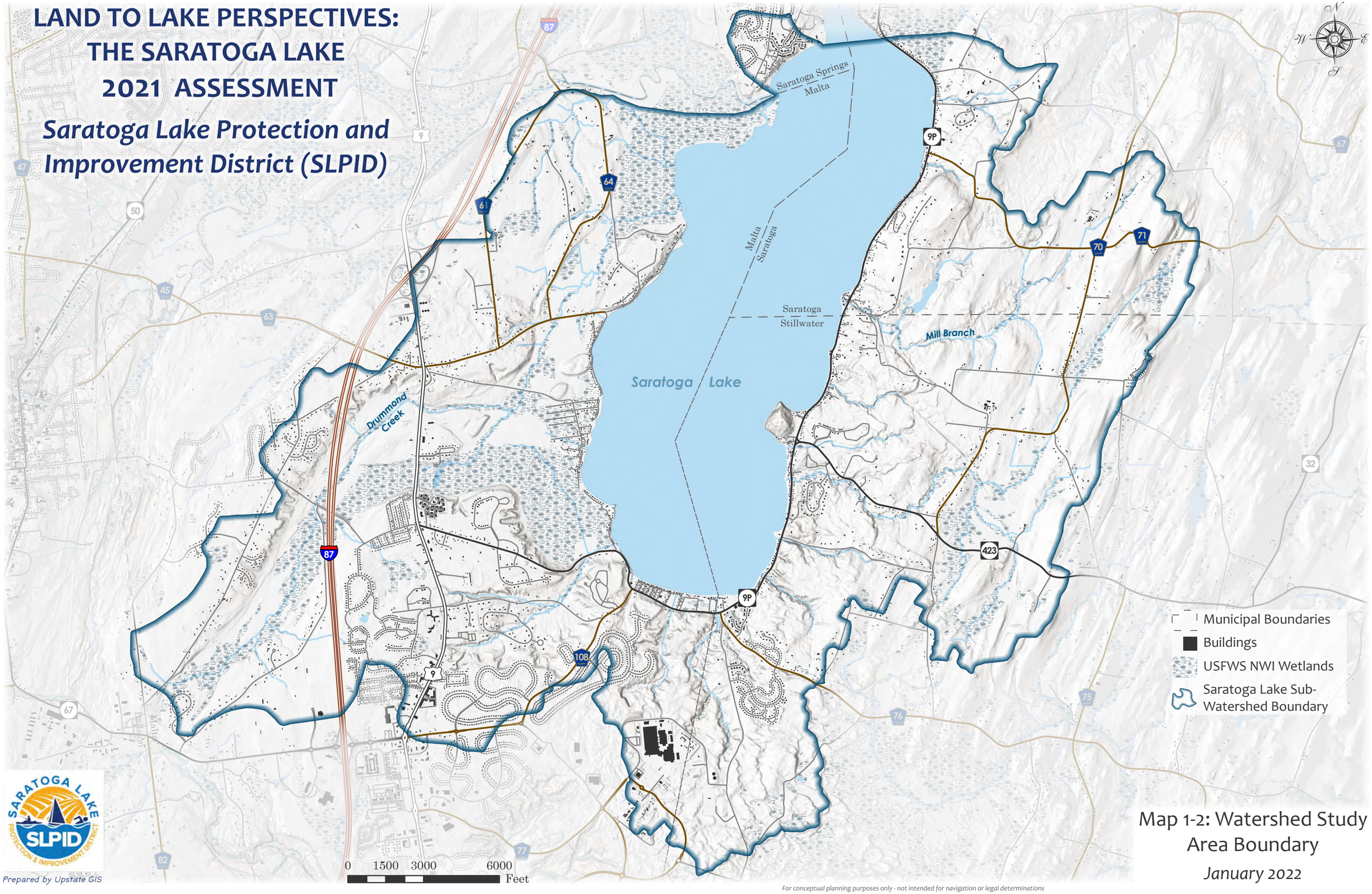
Saratoga Lake Protection and Improvement District (SLPID)



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Map 1-2: Watershed Study Area Boundary

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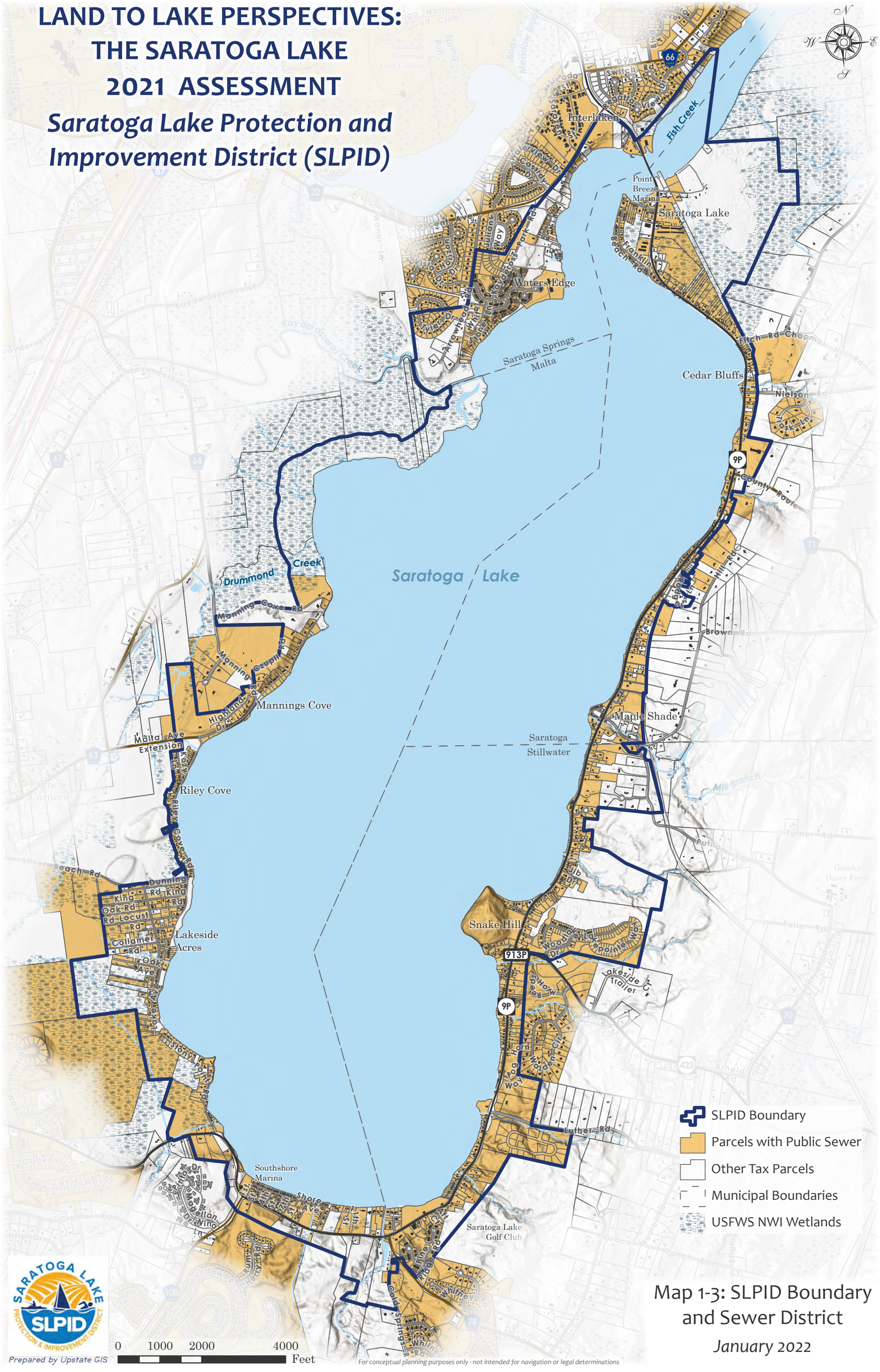
Saratoga Lake Protection and Improvement District (SLPID)



Map 1-3: SLPID Boundary and Sewer District

January 2022

SECTION 2 WATERSHED DESCRIPTION

2.1 Watershed Geography

The Saratoga Lake Watershed extends over 244 square miles covering approximately one-third of the Saratoga County. The watershed includes parts or all of 11 towns, the Village of Ballston Spa, and the City of Saratoga Springs. Its point of origin is the Kayaderosseras Creek in the Town of Corinth and flows through the towns of Greenfield, Milton, and Malta before flowing into Saratoga Lake. The Saratoga Lake watershed is in turn a part of the Upper Hudson River Watershed, which covers nearly 90 percent of Saratoga County. The entire watershed boundary is illustrated in Figure 2-1, "Saratoga Lake Watershed Boundary". Figure 2-2, "Saratoga Lake Regional Sub-Watersheds", illustrates the eight sub-watersheds that are part of the whole Saratoga Lake watershed area.

The municipalities that have frontage on Saratoga Lake include the towns of Saratoga, Malta, Stillwater, and the City of Saratoga Springs (riparian communities or municipalities). The boundary that is being used for this report is the Drummond and Fish Creek sub-watershed or sub-catchment. Runoff from this sub-watershed has immediate potential for pollution to Saratoga Lake.

2.2 Topography

The topography of the watershed is characterized by mostly flat and irregular terrain, steep slopes are found where local streams have down cut and created banks along their corridors. The highest elevation in the watershed is 1,997 feet in the Town of Corinth and the elevation of Saratoga Lake is 203 feet above sea level. Figure 2-3, "Slopes" illustrates the variety of terrain that influences the shape of the boundary in the riparian communities. There are numerous faults in the western and north-central section of the watershed that influence the drainage patterns of the tributary system for Saratoga Lake. The highest slopes in the sub-watershed area around Saratoga Lake can be found in the towns of Saratoga and Stillwater. These locations indicate the highest vulnerability for soil erodibility and runoff.

2.3 Soils

Soils vary greatly depending on the location in the watershed. The value of reviewing soil data is how they inform the developability of the land in terms of their erodibility and potential impact on water resources. Figure 2-4, "Soils" indicates that the areas in the sub-watershed range primarily from moderately to excessively drained. This generally means that the soil profile is mostly favorable for low runoff probability.

2.4 Climate

The Saratoga Lake watershed can be characterized as having warm, frequently humid summers and relatively cold winters. The climate is primarily controlled by the North Temperate Zone's prevailing westerly winds. Geographical influences on local weather are the result of the Adirondack Mountains to the northwest and the watershed's position in the Hudson Valley. On average, the watershed receives an average annual rainfall of approximately 45 inches and

snowfall of 63 inches. The average low of 37 degrees F occurs in January, and the average high of 83 degrees F occurs in July.

2.5 Vegetation

The Saratoga Lake watershed comprises a land use pattern characterized by lands converted from farms that are slowly converting over to forest lands as farms are abandoned. Much of the old forests and the new growth in these areas continue to be replaced by suburban residential and commercial development. Most of the forest cover consists of the northern segment of the eastern deciduous forest complex that includes hemlock, white pine, and northern hardwood components, including beech, sugar maple, basswood, yellow birch, black cherry, and red oak. Figure 2-5, "Land Cover," illustrates the general distribution of vegetation types within the whole watershed area. Forested areas are well distributed throughout, with the highest coverage in the west and northwest areas.

TABLE 2-1 LAND COVER ACREAGE

Type of Land Cover	Acres 2016
Agriculture	2,381
Open Space	1,427
Urban	1,406
Forest	6,015
Wetlands	2,947
Open Water	3,814
Totals	17,990

The terrestrial invasive species of concern in the watershed is the Hemlock Woolly Adelgid (HWA), an aphid-like insect native to Asia and was introduced to New York in the 1980's. HWA lives and feeds on hemlock trees and is spread by the wind, birds, humans and other animals. Hemlocks are considered a "keystone" species, meaning they play a critical ecological role. HWA- infested trees can take as few as two years after the time of infestation until death, although 10-12 years is more common. The eastern hemlock, *Tsuga canadensis*, has a significant presence in the watershed. Commonly found along streams, hemlock roots stabilize streambanks, preventing erosion and drastically reducing the amount of sediment and excess nutrients that enter the lake. HWA has been found in southern Saratoga County. *Cornell Cooperative Extension of Saratoga County* is involved in multiple efforts to manage and combat HWA infestation and save this critical tree species.

2.6 Lakes, Streams and Wetlands

The three major lakes in the watershed are Saratoga Lake, Loughberry Lake, and Lake Lonely. Saratoga Lake's characteristics will be described in the Sub-Watershed chapter. Figure 2-6, "Lakes, Streams and Wetlands," illustrates the location of these resources.

Loughberry Lake is approximately 75-acres and serves as the major water supply for the City of Saratoga Springs. Located in Saratoga Springs and the Town of Wilton, the lake was created in the mid-1800s. Lake Lonely is a natural 115-acre lake whose outlet flows into Kayaderosseras Creek to Saratoga Lake. At its deepest point Lake Lonely is 40 feet deep. Saratoga Lake has a north-south orientation with Fish Creek as the outlet in the north end. The main inflow into Saratoga Lake is Kayaderosseras Creek on the west shore. The lake is approximately 4.5 miles long and 1.5 miles across. It is 95 feet deep at its deepest point, located in the northeast portion of the lake. An in-depth discussion of the condition of Saratoga Lake is found in Section Three.

There are 14 direct tributaries to Saratoga Lake. The four that are significant in terms of size and contribution to Saratoga Lake include: Kayaderosseras Creek, Mill Branch, Drummond Creek and Coffey Creek. Originating in the Town of Corinth, the Kayaderosseras is the largest tributary. There are 5 primary and 15 smaller tributaries associated with the Kayaderosseras. Fish Creek is the only outlet for Saratoga Lake. It originates at the 9P Bridge at the north end of the lake flowing northeast eventually discharging into the Hudson River at Schuylerville.

Wetlands comprise the shoreline on either side of the Kayaderosseras Creek and Drummond Creek on the west side of Saratoga Lake. The major type of wetlands within Saratoga County are Palustrine distinguished by mostly vegetated areas including marshes, swamps, bogs, and small shallow ponds. Most of the remaining wetlands are lacustrine wetlands which include the shallow water zones of lakes and reservoirs. A very small percent of wetlands in the county are called riverine wetlands which are contained within a stream or river channel.

2.7 Population Profile

According to preliminary 2020 Census data, nearly two-thirds of all counties statewide saw significant population loss between 2010 and 2020. The Capital Region stands out as one of the few growth centers of upstate New York that bucked that trend at just under 7% growth, Saratoga County experienced the largest population growth in the region over the past 10 years.

Since 1980, the population of Saratoga County has increased by 53 percent, making it the second fastest growing county in the state for population over the past 40 years. Only one other New York County, Orange, had a greater percentage of population growth over the last 40 years.

Local officials and economic development experts attribute the increases to job growth in technology, health and pharmaceutical sectors in the region, convenient suburbs planted around I-87, and denser housing development, including multi-family and mixed-use buildings. The results are a stable workforce in the region. According to the U.S. Department of Agriculture, Saratoga County lost five percent of its farmland from 2012 to 2017. Other contributing factors are having the lowest property tax rate and the lowest county sales tax rate of any other county in New York State.

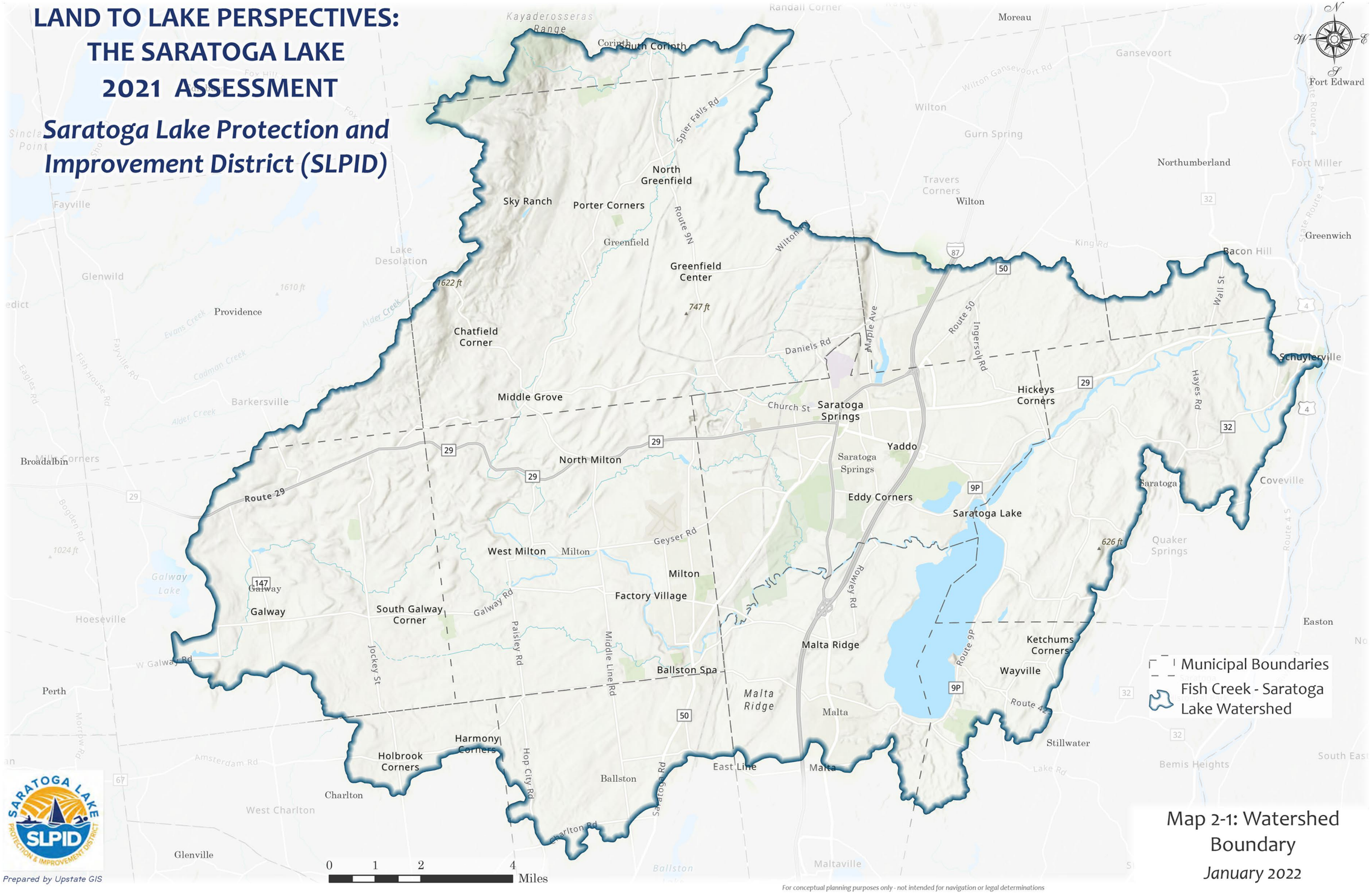
To assess what this means for the Saratoga Lake watershed, Table 2-2, “History of Watershed Population,” below assesses the details of the communities that make up the full Saratoga Lake watershed area. Population growth in the watershed area was about 6% since 2010 and 33% since 1980. The important thing to note is that the population that is exposed to recreation on the only large public access lake in Saratoga County is rising and is expected to continue to rise. This will likely result in more demand for real estate on Saratoga Lake, an increase in overall recreational demand for docking, and more recreational use.

TABLE 2-2 HISTORY OF WATERSHED POPULATION							
Municipality	**1980**	**1990**	**2000**	**2010**	**2020**	**2010 - 2020 Net Change**	**2010 - 2020 Percent Change**
Saratoga County	**153,759**	**181,276**	**200,635**	**219,607**	**235,509**	**15,902**	**6.75**
Ballston Spa	4,711	5,194	5,556	5,409	5,111	-298	-5.83
Ballston	7,714	8,078	8,729	9,776	11,831	2,055	17.37
Charlton	4,019	3,984	3,954	4,133	4,328	195	4.50
Corinth	5,216	5,935	5,985	6,531	6,429	-102	-1.59
Galway	3,018	3,266	3,589	3,545	3,546	1	-0.03
Greenfield	5,104	6,338	7,362	7,775	8,004	229	2.86
Malta	6,968	11,709	13,005	14,765	17,130	2,365	16.02
Milton	12,876	14,658	17,103	18,575	18,800	225	1.20
Northumberland	2,732	3,645	4,603	5,087	5,114	27	0.52
Providence	1,210	1,360	1,841	1,995	2,165	170	7.85
Saratoga	4,595	5,069	5,141	5,674	5,808	134	2.31
Saratoga Springs	23,906	25,001	26,186	26,586	28,491	1,905	6.69
Stillwater	6,316	7,233	7,522	8,287	8,764	477	5.44
Wilton	7,221	10,623	12,511	16,173	17,361	1,188	6.84
Watershed Total	**95,607**	**112,093**	**123,087**	**134,211**	**142,882**	**8,571**	**6.00**

Note: Numbers are representative of the whole municipality and not just the portion within the watershed boundary.
*2020 Census numbers are not finalized at this time. Source: Capital District Regional Planning Commission & US Census Bureau.

LAND TO LAKE PERSPECTIVES: THE SARATOGA LAKE 2021 ASSESSMENT

Saratoga Lake Protection and Improvement District (SLPID)



Map 2-1: Watershed Boundary

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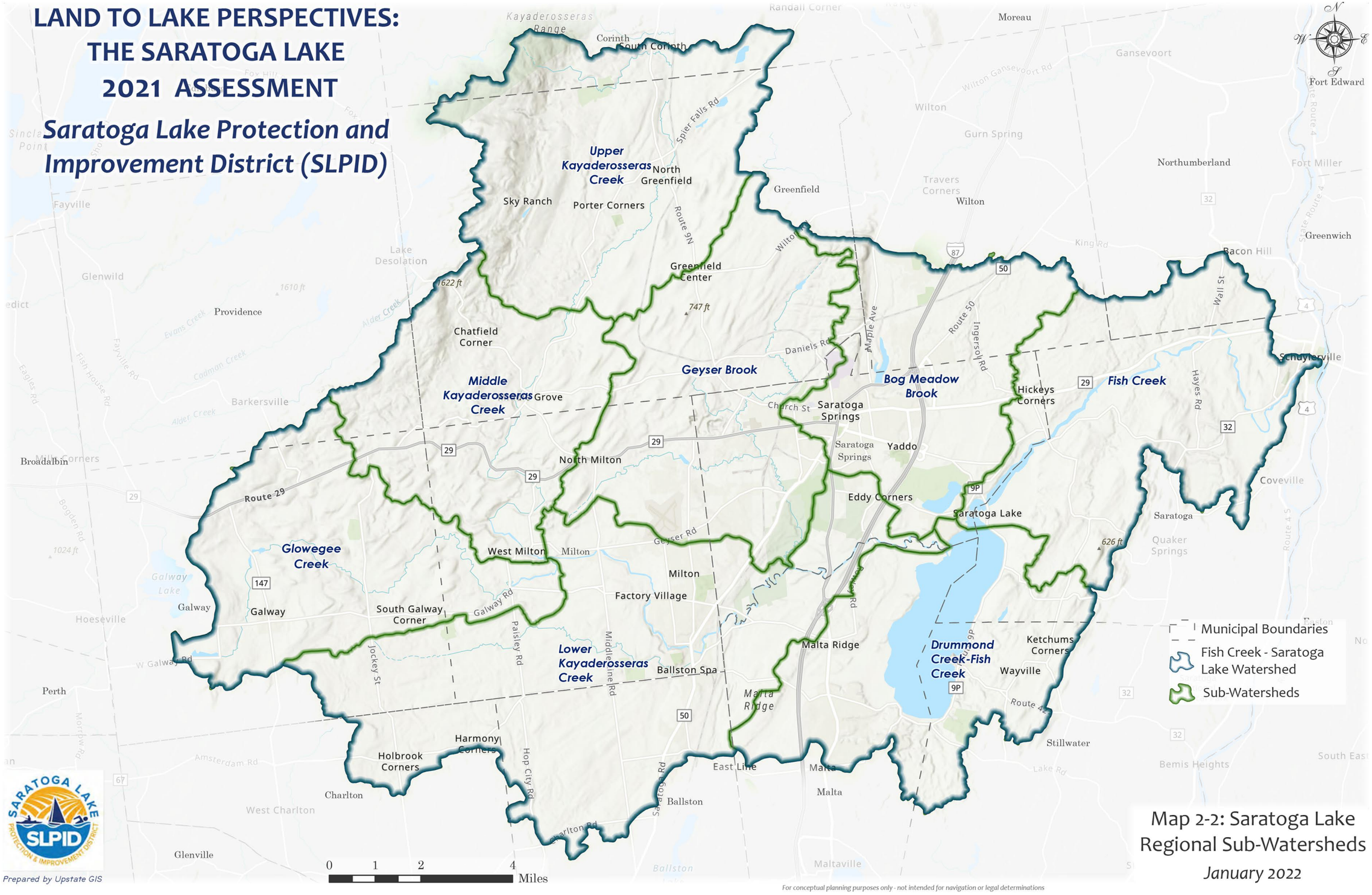
Saratoga Lake Protection and Improvement District (SLPID)



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Map 2-2: Saratoga Lake Regional Sub-Watersheds

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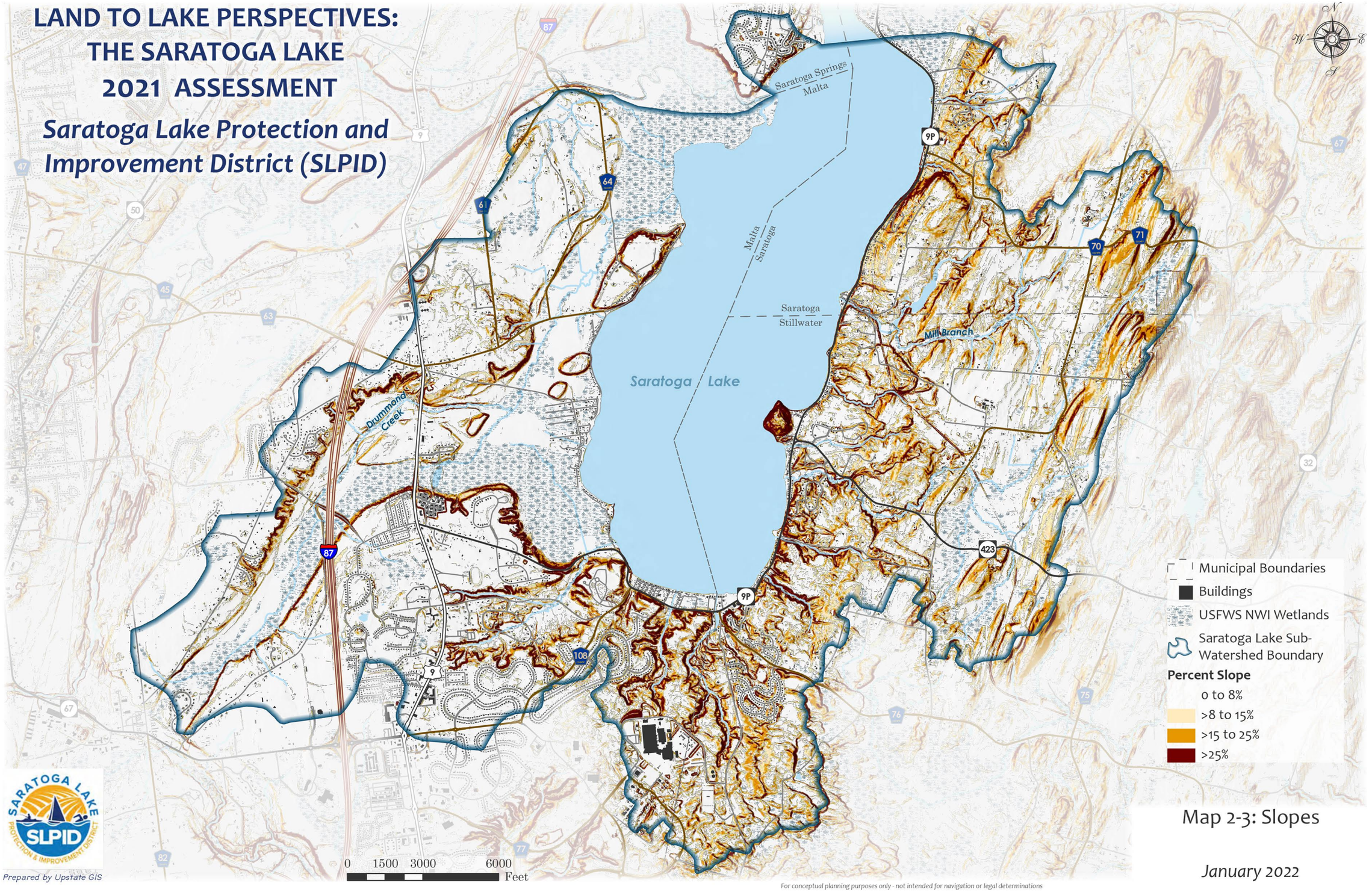
Saratoga Lake Protection and Improvement District (SLPID)



Map 2-3: Slopes

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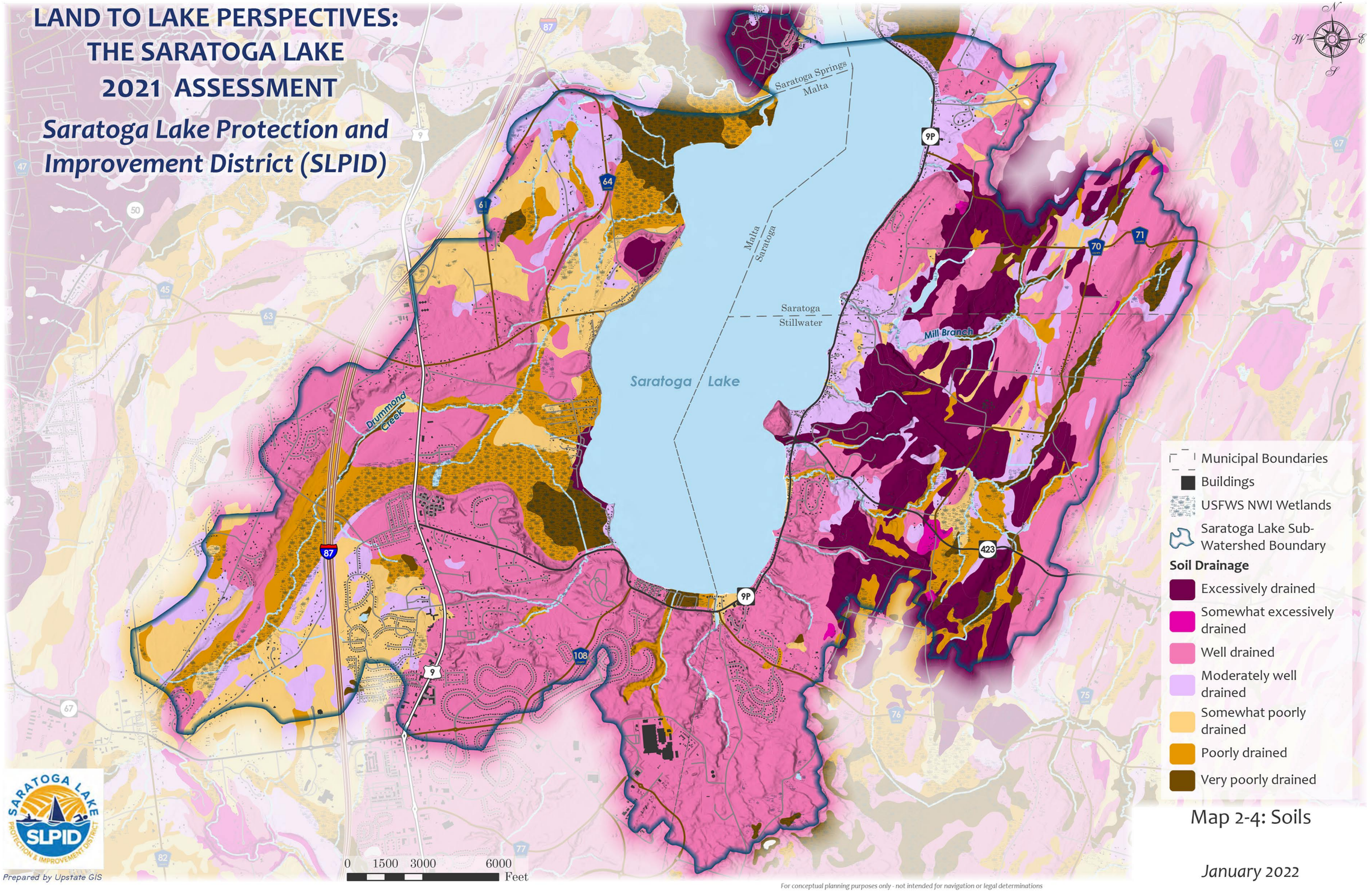

Map 2-4: Soils

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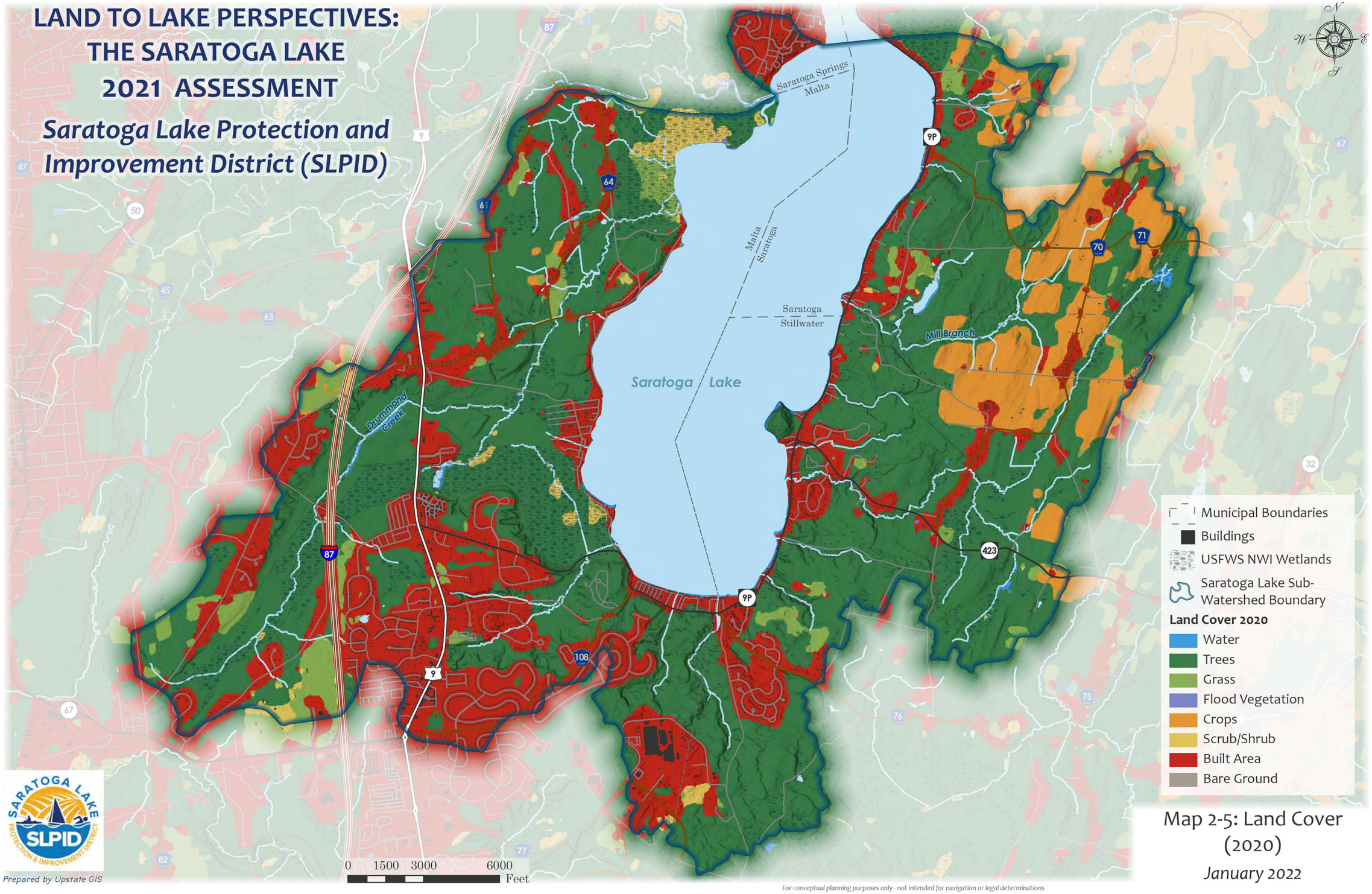

Map 2-5: Land Cover (2020)

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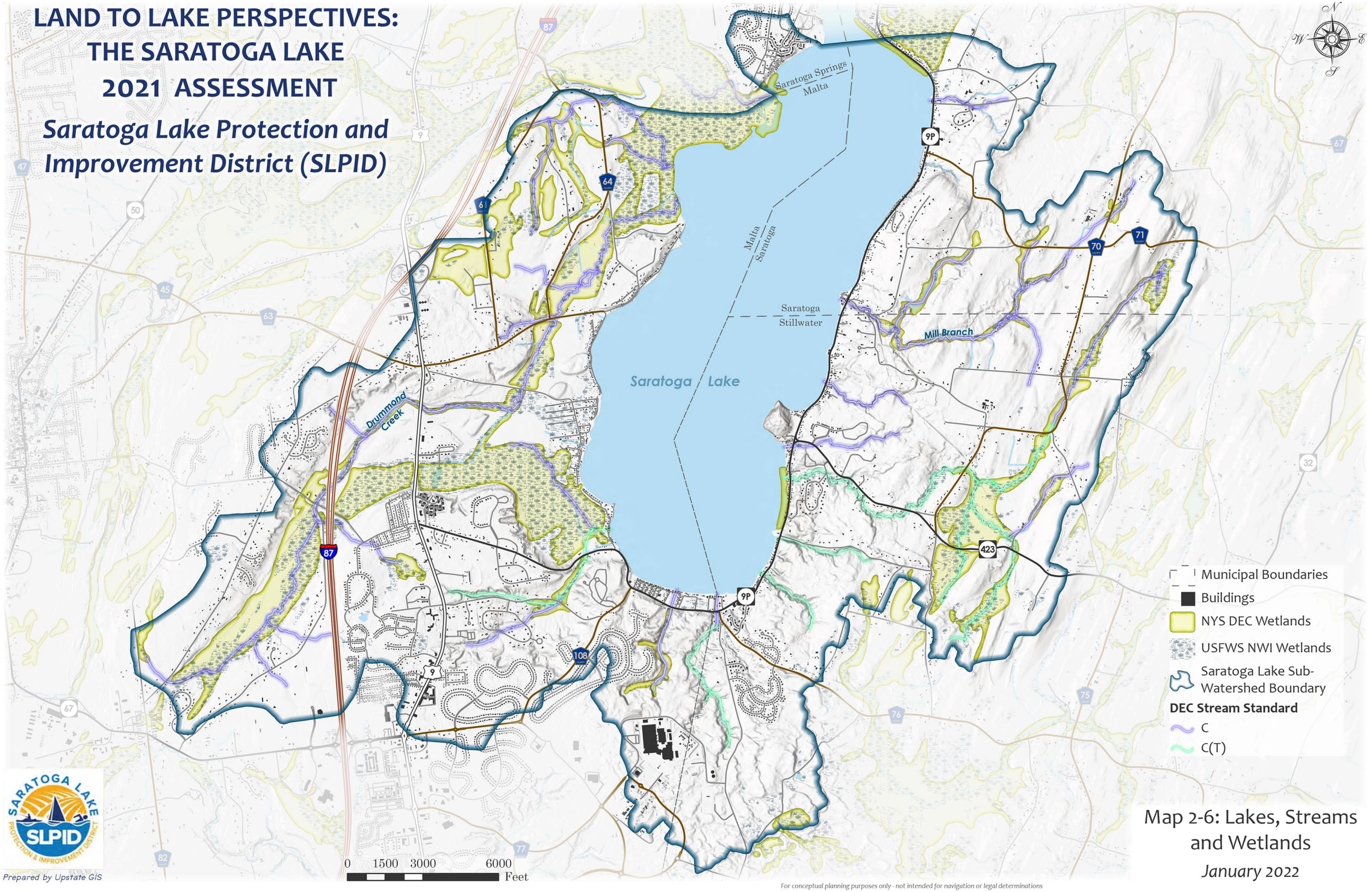

Map 2-6: Lakes, Streams and Wetlands

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SECTION 3 SARATOGA LAKE CONDITIONS

3.1 PHYSICAL CHARACTERISTICS

Saratoga Lake is a natural, glacier-formed lake with a north-south orientation typical of large basins formed by the retreating continental glaciers. Table 3-1, "Characteristics of Saratoga Lake," lists the major characteristics of the lake. Saratoga Lake has 14 tributaries that account for surface-fed waters from its 245 square mile drainage basin. The largest stream to discharge to the lake is the Kayaderosseras Creek. The lake has one outlet, Fish Creek, which drains from the lake's northeast end. Water levels in Saratoga Lake are regulated by a water level control structure located on the Fish Creek outlet, approximately 6.2 miles downstream from the Route 9P Bridge.

TABLE 3-1 CHARACTERISTICS OF SARATOGA LAKE	
Mean Length	4.5 miles
Mean Width	1.5 miles
Maximum Depth	96 feet (29 meters)
Mean Depth	26 feet (7.9meters)
Area	6.01 square miles 4,006 acres
Volume	31,250,000,000 gallons
Watershed	210.04 square miles
Watershed to Lake Ratio	34.9:1

Saratoga Lake is a mesotrophic to eutrophic lake that supports a healthy warm-water fishery. The aquatic plant community is diverse and has at least 25 plant species that are frequently found in the lake. The lake has an extensive shallow water zone that extends to a depth of eight feet and covers 800 acres.

Saratoga Lake is comprised of one large basin, with two deep holes, one in the northern end of the lake 29m (95 feet deep), and the other near the southern end that is 14 m (50 feet deep). Figure 3-1, "Bathymetry," illustrates the smaller south hole found just west of Snake Hill along the eastern shoreline. The mean depth of the lake is 8m (26 feet).

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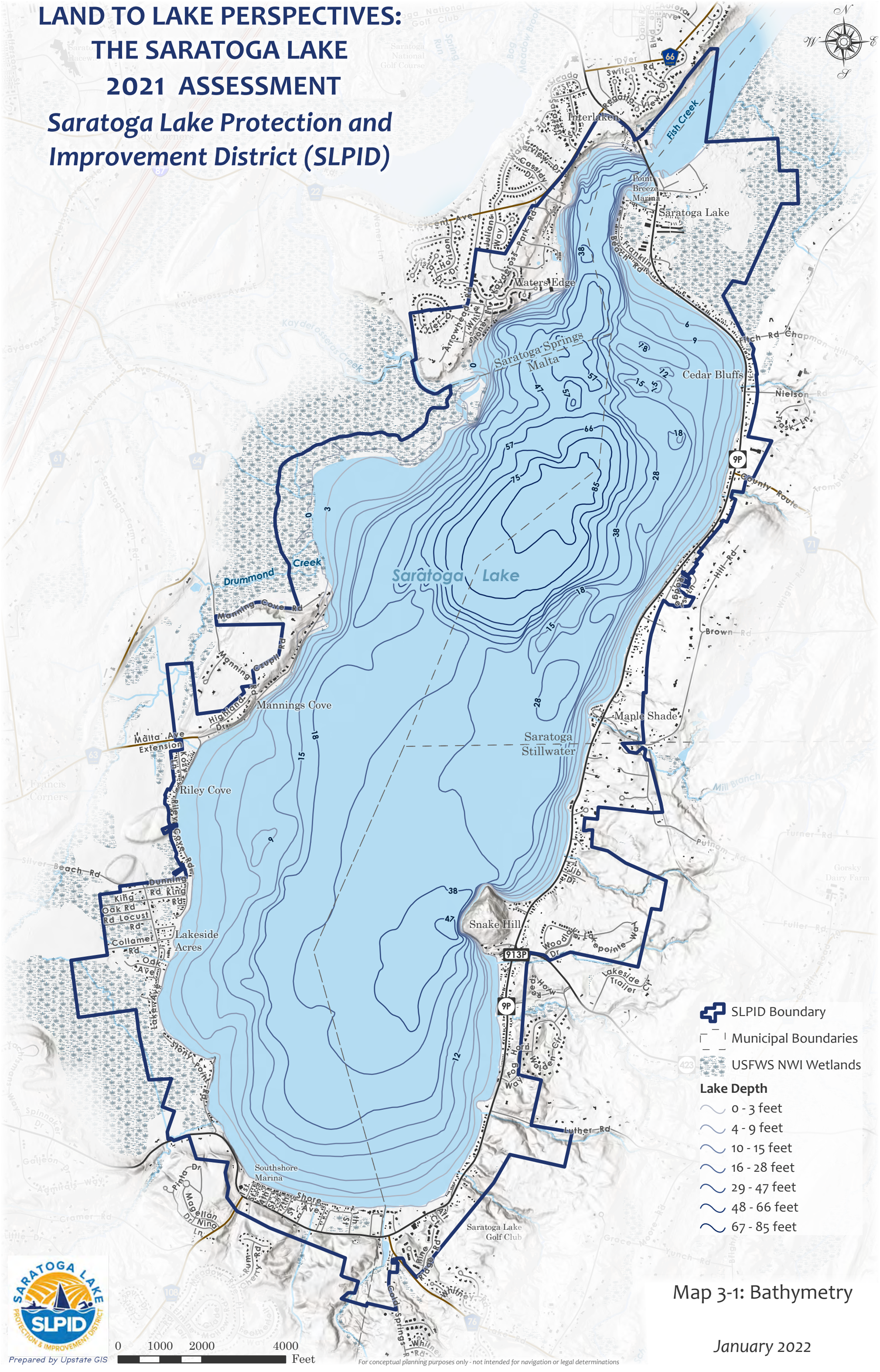
Saratoga Lake Protection and Improvement District (SLPID)



Map 3-1: Bathymetry

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The shoreline is 23 miles long, with most of it developed with seasonal and year-round residences, manmade private dock structures, sea walls, and beach areas. The shoreline areas adjacent to the Kayaderosseras Creek Inlet, Manning Cove and Snake Hill remain largely undeveloped.

The main public access to the lake is the Saratoga Lake State Boat Launch operated by the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP). There is additional public access along Kayaderosseras Creek and Fish Creek via upstream canoe and kayak access areas. Public access also includes eight marinas, and most of which offer day use launch and parking spaces and rent seasonal dockage. A former marina is now operated as a club with season long dock rental. The Town of Stillwater operates a public beach facility known as Brown's Beach. The Saratoga Lake Sailing Club and rowing clubs also have access to the lake, and several restaurants offer either boat access or marina facilities with dock space.

3.2 General Water Quality Standards

According to the Lake George Association website, there are many measurements that can be used to determine water quality including water clarity, total phosphorus, chlorophyll A, dissolved oxygen, chlorides, calcium, total coliform, and E. coli. The most common measurements are those used to determine trophic state: water clarity, total phosphorus, and chlorophyll *a*.

Water clarity, or transparency, is measured with using a Secchi Disk. This measurement indicates algae growth, weed growth and suspended material in a water body. Water clarity is the most important factor in public perception of water quality. In general:

- Unproductive lakes (with little nutrients) have a clarity of greater than 5 m
- Moderately productive lakes have a clarity of 2 – 5 m
- Productive lakes have a clarity of less than 2 m

New York does not have a state water quality standard for clarity. However, the NYS Department of Health does require 1.2 meters (4 feet) of clarity to operate a swimming beach. The long-term Secchi depth in Saratoga Lake for the years 1993-2020 is 3.3 m.

Phosphorus is usually the nutrient that controls (limits) algae growth. It is usually measured as Total Phosphorus (referred to as "TP"). There is no NYS water quality standard for phosphorus. However, there are State Guidance Values (ppb stands for parts per billion and is equivalent with ug/l – which stands for micrograms per liter).

- Highly productive lakes have readings of 20 ppb or higher
- Moderately productive lakes have readings of 10-20 ppb
- Unproductive lakes have readings lower than 10 ppb

The long-term surface TP for the period of 1993-2020 is 0.0185 mg/l or 18.5 ppb.

Chlorophyll *a* is found in all green plants, so it is used to measure algae in the water, or lake productivity.

- Highly unproductive or oligotrophic lakes: Chlorophyll *a* Levels < 2 µg/l. These lakes have rare algal blooms although some may suffer from growths of benthic (bottom-attached) algae.

- Moderately productive or mesotrophic lakes: Chlorophyll *a* level of between 2 – 8 µg/l. These lakes have occasional algal blooms (generally not blue-green algae and sporadically throughout the summer).
- Highly productive or eutrophic lakes: Chlorophyll *a* Levels > 8 µg/l: frequent and persistent algal blooms (often blue-green algae and particularly late in the summer). The long-term Chlorophyll *a* at the surface of lake for the period of 1993-2020 is 6.2 ppb.

3.3 Saratoga Lake Studies

The earliest study recorded for Saratoga Lake was ordered by Governor Theodore Roosevelt dates in 1899. The goal of the project was to complete a study of the Kayaderosseras Creek and Saratoga Lake to determine sources that were contributing to the poor water quality of the lake. This executive order observed that the upstream owners blamed pollution on the shoreline hotels around the lake, while lakefront owners identified pollution sources as the villages and factories along the Kayaderosseras Creek. This study resulted in mandating construction of the first sewage treatment plants in Ballston Spa and Saratoga Springs, as well as the control of waste discharges by the textile and leather industries.

The first extensive study of the Upper Hudson River and its tributaries was conducted in 1932 by the Conservation Department, the New York State Department of Environmental Conservation's (NYSDEC's) predecessor agency. Based on the results of a single water quality sampling in July, deepwater areas in Saratoga Lake revealed very low levels of dissolved oxygen.

From 1972-1974, the USEPA (USEPA, 1974) conducted a study on the water quality of Saratoga Lake. These studies occurred immediately prior to the formation of the Saratoga County Sewer District #1. From 1981-1982, chemical, biological, and physical monitoring of Saratoga Lake was conducted under EPA's "Clean Lakes Program" (Hardt, Hodgson and Mikol, 1983). As part of these studies, NYSDEC directed in-lake feasibility and pilot studies, including the evaluation and selection of weed control methods and identifying associated environmental impacts. The ***1983 Diagnostic Feasibility Study for Saratoga Lake*** (Hardt, Hodgson and Mikol, 1983) represented all these studies from the 1980s. It contained important findings since the data covers both the pre- and post-implementation of the Saratoga County Sewer District in 1977. Since the 1983 Study, the problem of EWM has been the focus of lake management and, in 1986 the SLPID Tax District was formed to manage the EWM problem and manage other lake and watershed issues.

In 2000, Fredrick W. Hardt prepared the ***Saratoga Lake Historical Water Quality Review Data Tabulation 1972-2000*** for the City of Saratoga Springs as part of the Saratoga Lake Water Source Development DEIS.

SLPID has been an active participant in the ***Citizens Statewide Lake Assessment Program (CSLAP),*** a volunteer lake-monitoring program managed jointly by the DEC and the NYS Federation of Lake Associations. SLPID collected data for the following years: 1993-1997, 2005-2011, 2013, and 2016-2021. Under this program, trained volunteers collected water samples, and conducted water quality measurements every other week over a fifteen-week period starting in May and ending in October. During the initial five-year study, CSLAP drafted a broad summary

of the major lake problems and discussed recommendations for lake management. SLPID rejoined CSLAP in 2005 and, over the last few years has been supplementing CSLAP's data with dissolved oxygen readings.

Land To Lake Perspectives:* A *Watershed Management Plan for Saratoga Lake (SLWMP 2002) was funded and developed through the Environmental Protection Agency (EPA) Wetlands State Development Program in 1999. The Watershed Plan updated the 1983 Lake Diagnostic Feasibility Study and focused on alternative methods to control Eurasian watermilfoil (EWM) and non-native plant growth. This plan addressed the introduction of a small-scale bio-control project using the EWM weevil to combat EWM, and Sonar, a chemical agent to control invasive aquatic species. The Sonar® demonstration studies were funded through SLPID due to the importance and priority of determining methods that would be useful in the long-term management of EWM in Saratoga Lake.

In 2004, SLPID commissioned Aquatic Control Technology, Inc. to research and prepare the ***2004 Long-Term Aquatic Vegetation Management Plan*** to develop an integrated approach to EWM control by utilizing a combination of mechanical harvesting, lake drawdown and herbicide applications to decrease the areal extent of EWM, a key recommendation from the 2002 Watershed Management Plan. The Long-Term Aquatic Vegetation Management Plan, funded directly from the SLPID budget, concluded that an application of Sonar to the entire lake would be a viable option for the control of EWM, while harvesting methods should still be utilized to control weeds throughout the lake. A comprehensive survey of the EWM beds was subsequently conducted and reported in the 2005 EWM Inspection Report.

The ***2006 Draft and Final Environmental Impact Statement (EIS) for the Sequential Whole Lake Treatment of Saratoga Lake*** provided the basis for obtaining the permits required to treat Saratoga Lake with herbicides to control EWM.

In 2019, SLPID completed the ***Draft and Final Supplemental Generic Environmental Impact Statement (SGEIS) for the Saratoga Lake Aquatic Invasive Species 2019 Long-Term Management Plan***. This was an update of the *2006 Draft and Final Environmental Impact Statement (EIS).* The SGEIS recommended a continued integrated management plan for the control of non-native plants by the combined use of herbicides and drawdown, mechanical harvesting, and hand harvesting to manage the density of all aquatic plants.

3.4 Water Quality

Known as the "Jewel of Saratoga County," Saratoga Lake encompasses a 300 square mile watershed (larger than that of Lake George) and is classified as a Class A lake for water quality in New York State. As with any body of water, native aquatic plants and weeds are vital to the lake's health and ecosystem. Unfortunately, the health of these vital ecosystems is under attack.

The water quality of Saratoga Lake has significantly improved following the installation and operation of Sewer District #1 in 1978. It was predicted that the diversion of wastewater from a portion of the Saratoga Lake watershed would reduce the loading of phosphorus. However, the

amount of improvement was unknown (Federal Water Pollution Control 1969). Today's data indicates the lake's water quality shifting from a dangerous eutrophic level in 1978 to a mesotrophic level 40 years later.

The lake's Secchi depth in 1974 was 2.5 meters (8.2 feet, and total phosphorus was 0.031 mg/l. The long-term Secchi depth between the years 1993 to 2017 improved to 3.3 m and total phosphorus improved to a lower concentration 0.0185mg/l (18.5ppb). These parameters indicate that the lake is mesotrophic as described in Section 3.2. Over the long-term, Saratoga Lake has a pH level of neutral to alkaline, and moderate levels of conductivity. These are the expected results for a lake containing limestone and has natural springs which introduce ions into the water. There are short-term, localized Harmful Algal Blooms (HAB) blooms with generally low levels of toxins. There was a decrease in chlorophyll *a* in the water due to the introduction of zebra mussels sometime before 1997, which also resulted in increased water clarity. Even though water quality has improved, it is subject to short-term upsets or changes associated with large storms that cause large runoff events and possibly internal nutrient loading.

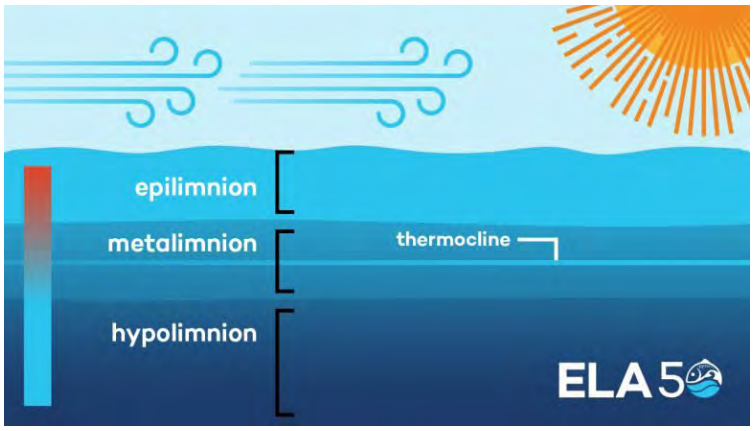
Dissolved Oxygen and Temperature

SLPID has monitored dissolved oxygen temperature profiles in concert with the New York State Citizen Lake Assessment Program (CSLAP) water quality monitoring program. The designated CSLAP site and temperature profiles were taken in the northern deepwater area in the central portion of the lake from 2005 - 2014. The water depth at the northern and central deep-water site is 27-30 meters (approximately 95 feet deep).

From 2015 to 2021 the CSLAP sampling site was moved to the southern 15 m deep water location just south of Snake Hill. In 2000 and 2004, Adirondack Ecologists (AE) completed DO temperature profiles in both the north and south deepwater locations (AE, 2002 and AE, 2004). The Saratoga Lake Diagnostic Feasibility Study (Hardt, Hodgson and Mikol, 1983) also completed DO temperature profiles. The 1974 USEPA study only monitored DO and temperature using a 5m interval survey. Dissolved oxygen (DO) is the amount of oxygen that is present in the water. The DO must be above 4 ppm to support most fish species. Since colder water contains more DO, there is a direct relationship between dissolved oxygen and water temperature. Water exists as a solid, liquid and a gas, which makes it unique. Water density changes with temperature and water is less dense as a solid at 0 °C (32°F) than when it is at temperatures above and below 4.0° C, water is most dense at 4.0°C(39°F).

Following ice-off temperature, the vertical profile is the same from top to bottom. As the air temperature warms, temperatures slowly increase at the lake's surface. This continues during the entire spring and summer. In June, the zone of water known as the metalimnion experiences rapid water temperature changes resulting in a thermocline formation. The thermocline is the zone where there is a dramatic change in water temperature of over 1°C per meter (Wetzel, 1975). The thermocline will become deeper as the summer progresses, to a depth of around 8-20m or more. The water below the thermocline will not circulate until fall turn-over when the lake cools to the deepwater temperature. At that point, the lake is in the isothermal stage and will then re-mix or turnover. The deepwater is isolated from the atmospheric air and is cut off

from oxygen. Within the metalimnion, the water does not mix with the water above epilimnion or the water below hypolimnion (deep water zone).



Source: International Institute of Sustainable Development

The concentration of DO is an indicator of the complex chemistry of the deep-water zones related to phosphorus and iron. Dissolved oxygen is typically depleted in the deep-water holes in July and August. This occurs after thermal stratification has become strong due to dramatic temperature changes in the metalimnion. As oxygen is depleted, phosphorus is released from sediments and, when the lake - mixes or overturns in September or October, this nutrient input will cause or sustain late-season algal blooms. As the lake warms, the area of oxygen depletion grows, and more phosphorus is re-generated.

To illustrate the changes in DO, a temperatures series of graphs have been prepared for both the north and south deepwater zones. The time series includes the months of July and August in 2004 (AE, 2004). Figure 3-2 displays the data for August 29, 2004, for the North Deepwater; Figure 3-3 displays the data for August 27, 2010, for the North Deepwater; Figure 3-4 displays the data for August 24, 2015, for the South Deepwater; and Figure 3-5 displays the data for July 29, 2020, for the North Deepwater site (SLPID).

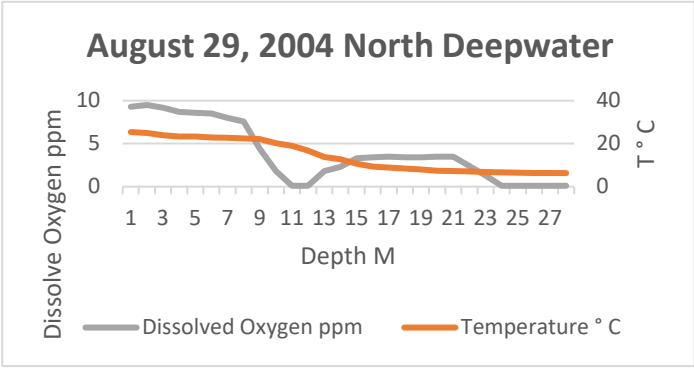


FIGURE 3-2

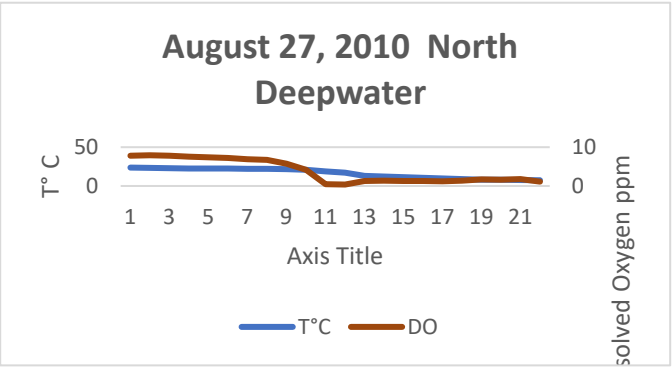


FIGURE 3-3

The dissolved oxygen and temperature are plotted against depth on the horizontal axis. The metalimnion is clear on each graph as the steep slope of the temperature line. Figures 3-3 and 3-4 indicate that the dissolved oxygen is depleted in the metalimnion zone. This occurs when decomposition of trapped material is actively taking place and the metalimnion is not mixing with the surface water. This demonstrates that stratification is stable and prolonged.

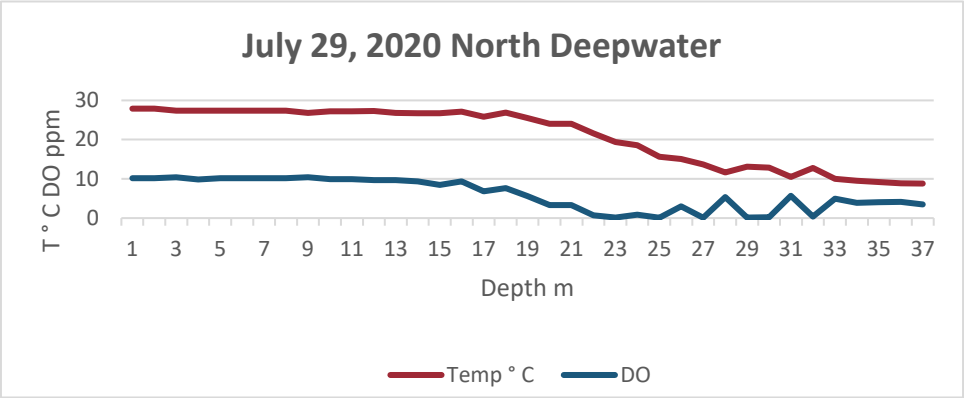


FIGURE 3-4

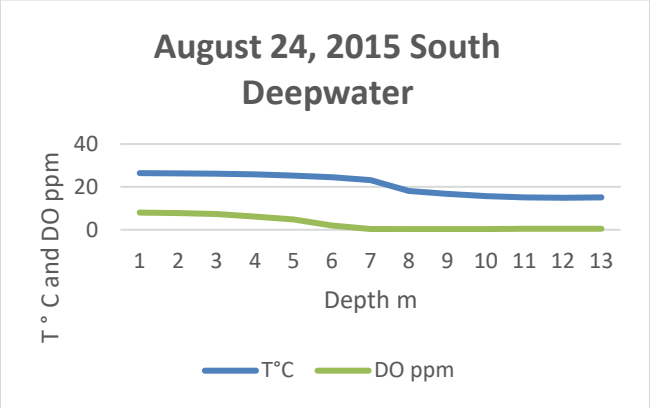


FIGURE 3-5

Figure 3-4 indicates the metalimnion in the North Deepwater is between 17-27m and the thermocline was at a depth of 20m. Figure 3-5 shows the temperature and dissolved oxygen profile in the south deepwater area near Snake Hill. The metalimnion is at a depth of 7-8.5 m and the thermocline is in the same depth range. Each of the above figures show that dissolved oxygen is depleted by July or August below the thermocline.

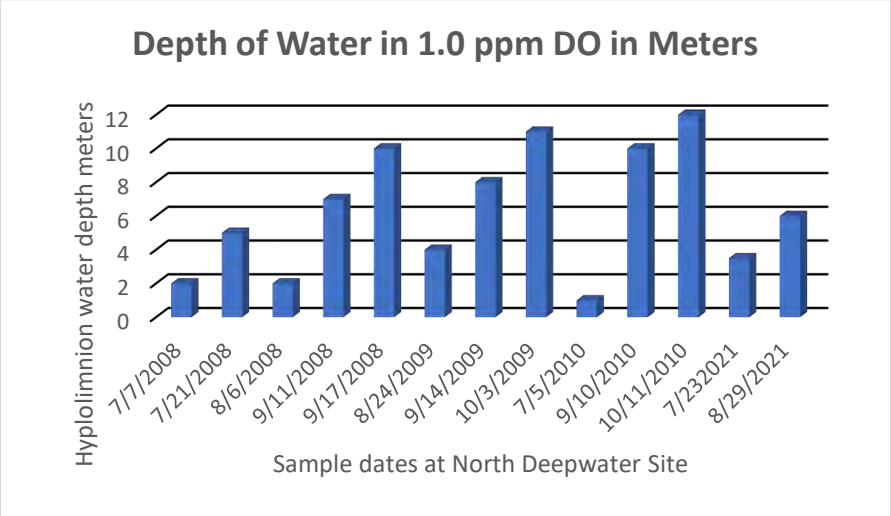


FIGURE 3-6 HYPOLIMNION WATER DEPTHS WITH DEPLETED DISSOLVED OXYGEN

Figure 3-6, "Hypolimnion Water Depths with Depleted Dissolved Oxygen," illustrates the changes in the volume of water that is depleted each year and how it changes during the season. Variability between samples may have resulted from slightly different sample locations in the deep-water zone. Oxygen stress begins in July and becomes extensive in August or September when 10m or more of the water column may be depleted of oxygen. The depth of oxygen depletion is similar in each year.

pH and Conductivity

The pH is the measurement of acidity of water and is controlled by dissolved minerals, gases, and inputs of acidic or alkaline compounds. Neutral pH is 7.0, acidic pH is below 7.0 and alkaline pH is above 7.0. Natural lakes influenced by dissolved gasses and most minerals or compounds should have a pH of 6.5 to 8.3. This is the normal range of pH dominated by bicarbonate equilibrium. When surface water has a pH of over 8.3, it is outside the bicarbonate equilibrium. In surface water, this occurs during period of high photosynthetic activity. Saratoga Lake pH ranges between 6.14 and 8.82 due to the predominance of limestone in the watershed. The average pH was 7.89 in the surface water for the period of 1993- 1997 and 2013, and 2015-2020 (CSLAP). In 2020, the CSLAP reports began reporting the medians rather than the average. The advantage of a median is that it represents the central value of the test parameter and is less influenced by extreme values. The ten-year median pH was 7.7.

Conductivity is a general measurement of all dissolved salts in the water. Typically, spikes of conductivity levels in the spring are due to road runoff. The lake returns to normal values for the rest of the year. The lowest conductivity values are found in lakes with the least concentration of dissolved ions and are often called soft water lakes. Hard water lakes have higher levels of dissolved ions and have higher conductivity. Conductivity in Saratoga Lake between 1993 and 2017 ranged from 101-333μmhos/cm. The average conductivity has been 285μmhos/cm which is similar to the values found in the Finger Lakes. These values are expected due to similarities in geology and surrounding land uses. In 1972, the conductivity was 235 μmhos/cm, in 2009 it was

314 μmhos/cm, and in 2017, 364.8 μmhos/cm which is consistent with the statewide trend of increasing conductivity. The long-term average is 285μmhos/cm (CSLAP, 2017). These rising values indicate that urban runoff is an escalating problem for Saratoga Lake.

Secchi Depth, Total Phosphorus, Total Nitrogen and Chlorophyll a

The indicators of eutrophication will be reviewed in this section. Indicators include Secchi depth, total phosphorus, total nitrogen, and chlorophyll *a*. Each parameter is related to eutrophication, a natural process of change in lakes that results from increased nutrient levels in the water. All lakes respond differently to the addition of nutrients. Responses range from the chemical state of the nutrients, availability of other nutrients, water temperature, amount of sunlight, thermal structure of the lake, whether nutrients are introduced incrementally or are the result of large storms, plant and fish life in the lake, and other factors.

Phosphorus and nitrogen are both plant nutrients that influence the growth of rooted plants, algae, and cyanobacteria (formerly identified as blue green algae). Nutrients are measured in different ways depending on how each compound is found in nature. The most frequently method of measurement is total phosphorus and total nitrogen which both convert all the various forms of phosphorus and nitrogen into a single measured quantity.

All the water quality parameters do contribute to the clarity of the water in the lake. Secchi depth is a direct measurement of water clarity that is determined by the depth at which an 8-inch black and white disk can no longer be seen as it is lowered into a lake or pond. Secchi depth and Chlorophyll *a* are both measurements that are related to the volume of algae and cyanobacteria in the water.

In 1932, the average Secchi depth near Snake Hill was 4.77 m based on four measurements ranging from 3.50 to 6.00 (Hardt, Hodgson, and Mikol et al. 1983). In 1972, it was 2.29 m, and in 2009, it was 4.16 m (8 measurements ranging from 3.05-5.50 m). The 1993-2020 average is 3.3 m, with a range of 1.20 m to 7.1 m. Secchi depth indicates the impact of in-basin sewage discharges and poorer water quality that occurred prior to the late 1970's. Improved water clarity in the data is a result of the implementation of the Saratoga County Sewer System that collected and diverted sewage to the treatment plant in the Town of Stillwater located near the City of Mechanicville. Water quality in Saratoga Lake has improved overall but it is subject to short-term upsets or changes associated with large storms, large runoff events and potentially internal nutrient-loading. Overall, the Secchi depth at Saratoga Lake is slightly greater than other Class A drinking water supply lakes in the Mohawk Region (Kishbaugh, 2010).

The introduction of zebra mussels around 1995 into Saratoga Lake had a positive impact on water clarity by removing large amounts of algae from the water by their filter-feeding of the free-floating algae, which is measured by Chl *a*. It normally takes two or more years for zebra mussel population to increase sufficiently to cause a change in Chl *a*, however, the water chemistry of Saratoga Lake is very favorable for zebra mussel growth.
However, the introduction of zebra mussels also increased the amount of sunlight entering the water column. This in turn has the potential to increase the growth rate of EWM. While increased

water clarity is a benefit for recreation and native plant species, it did change the EWM distribution in the lake by allowing the plant to inhabit deeper waters. This shift to deeper water is a trend that can be seen in the various Saratoga Lake Aquatic Plant Surveys (DFWI).

Figure 3-7, "Secchi Depth and Total Phosphorus," illustrates the data collected as a part of the CSLAP program. The graphs show the seasonal variability of the Secchi depth in a year and during the sampling period. The average Secchi depth for the period is 3.3 m. Chlorophyll *a* (Chl *a*) is measured in μg/l or ppb and is the amount of the photosynthetic pigment found in the water, which is an indication of the volume of algae in the water. The 1993-2020 range of values was 0.2-34 μg/l and the average were 7.83 μg/l. The highest value was measured in 1993 at 34 μg/l . The highest concentrations of Chlorophyll *a* normally occurs in September. In 1997 the Chl *a* value ranged from 1.43-7.14 μg/l with an average of 3.75 μg/l. It is believed that zebra mussels were introduced into the lake by the mid-1990s and normally the date cited is 1994 (SLWMP 2002). Between 1996 and 1997 the Chl *a* average went from 14.11 μg/l to 3.75 μg/l which does indicate the zebra mussel population was most likely had become well established (CSLAP,2009).

The deep-water site in the central lake measured Chl *a* at a depth of 1.5m from 1981-1988 at the average value was 7.6μg/l ranged between 4.33 and 14.05 μg/l (Hardt F. 2000). An average of 7.83 μg/l of Chl *a* places Saratoga Lake on the border of being mesotrophic and eutrophic trophic classification. This is an improvement of the condition of Saratoga Lake in the 1970's when the lake was classified as eutrophic.

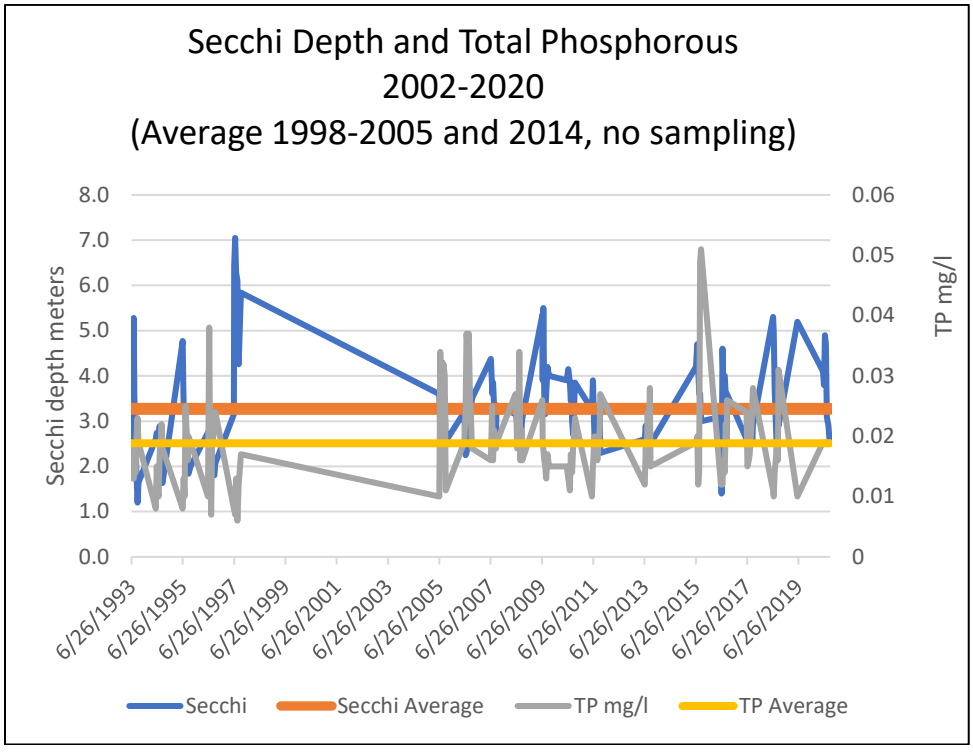


FIGURE 3-7 SECCHI DEPTH AND TOTAL PHOSPHORUS

Phosphorus (PO_4 total phosphorus, TP, measured as mg/l) is essential for plant growth and is the limiting nutrient in freshwater temperate lakes. When it becomes sufficiently available in the water column, algae blooms may occur. Between 1993 and 2020, the TP level in Saratoga Lake surface water ranged from 0. 006-0. 057 mg/l, with an average value of 0. 0185 mg/l.

Figure 3-8, "Total Phosphorous and Chlorophyll *a*," illustrates the variation in concentration of these two test parameters. Prior to sewage diversion the TP concentration in the surface water was 0. 031mg/l (USEPA,1974). This higher value was the result of continued use of in-basin wastewater treatment plant discharges at Saratoga Springs and Ballston Spa, and septic wastewater discharges into shallow wet soil around the lake. With the completion of much of the Saratoga County sewer project by 1978, these individual wastewater plants were all diverted.

Over the years, samples have been collected from the deepwater area of Saratoga Lake. In the deep water below the thermocline, oxygen becomes depleted due to decomposition and other biological activity. As oxygen levels become low at levels approaching zero, a chemical reaction occurs that causes the release of phosphorus from sediments. This phosphorus-enriched water will mix with upper water in the fall when the lake overturns (late September to mid-October). This may cause short-term algae blooms or non-perceptible changes in water quality to occur.
In the years 1993-2014 with a gap between 1998-2004, deep water TP samples were collected at the north sample site and the average value reported was 0.018 mg/l. Starting in 2015, the sample site was moved to the south deepwater area and the average value for 2015-2020 was 0.350 mg/l. The average TP concentration at both the north and south site is 0.189 mg/l. The long-term average of surface water TP is 0.0185, mg/l.

A series of samples was collected at the mouth of the Kayaderosseras in 1995 and 1994. The range of values was 0. 007-0.170 mg/l and the average were 0. 065 mg/l. These data show that regional inputs of TP are still contributing to the eutrophication of Saratoga Lake. The TP levels of Saratoga Lake are higher than the average values found in other Class A drinking water lakes in New York state. The average TP concentration in other Class A lakes is 0. 012 mg/l while at Saratoga Lake it is 0. 0185 mg/l (CSLAP2010a).

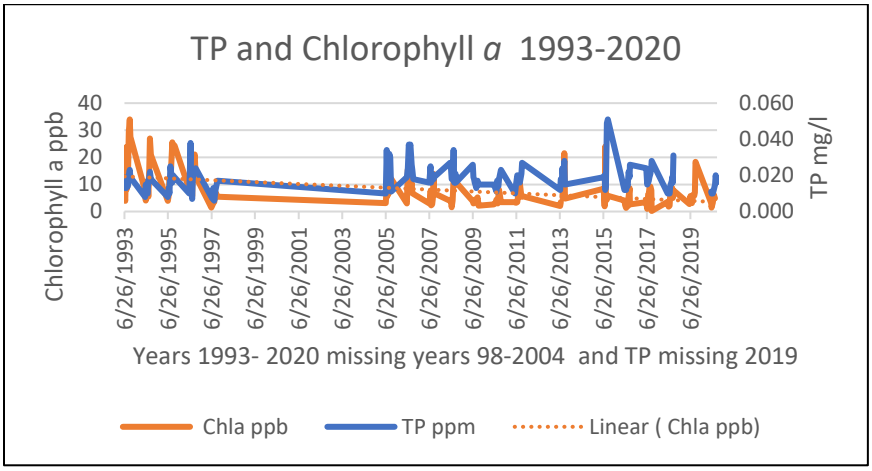


FIGURE 3-8 TOTAL PHOSPHOROUS AND CHLOROPHYLL *a* 1993-2020

Figure 3-8 illustrates the Chlorophyll *a* peak after a higher phosphorus level indicating phosphorus as the limiting nutrient during most of the year on Saratoga Lake. This is the most common situation for northern temperate lakes. Figure 3-8 includes a dotted trend line that shows a decrease in Chlorophyll *a* associated with the increase in zebra mussels.

Nitrogen is another nutrient that supports plant growth. Nitrogen is found in the aquatic environment as nitrate and ammonia and, infrequently as nitrite. A total nitrogen measurement digests the nitrogen compounds so that the measurement represents all nitrogen bearing compounds. Figure 3-9, "Total Nitrogen and Chlorophyll *a,"* illustrates the variation of these two parameters from 2005 -2020 in the surface water of Saratoga Lake.

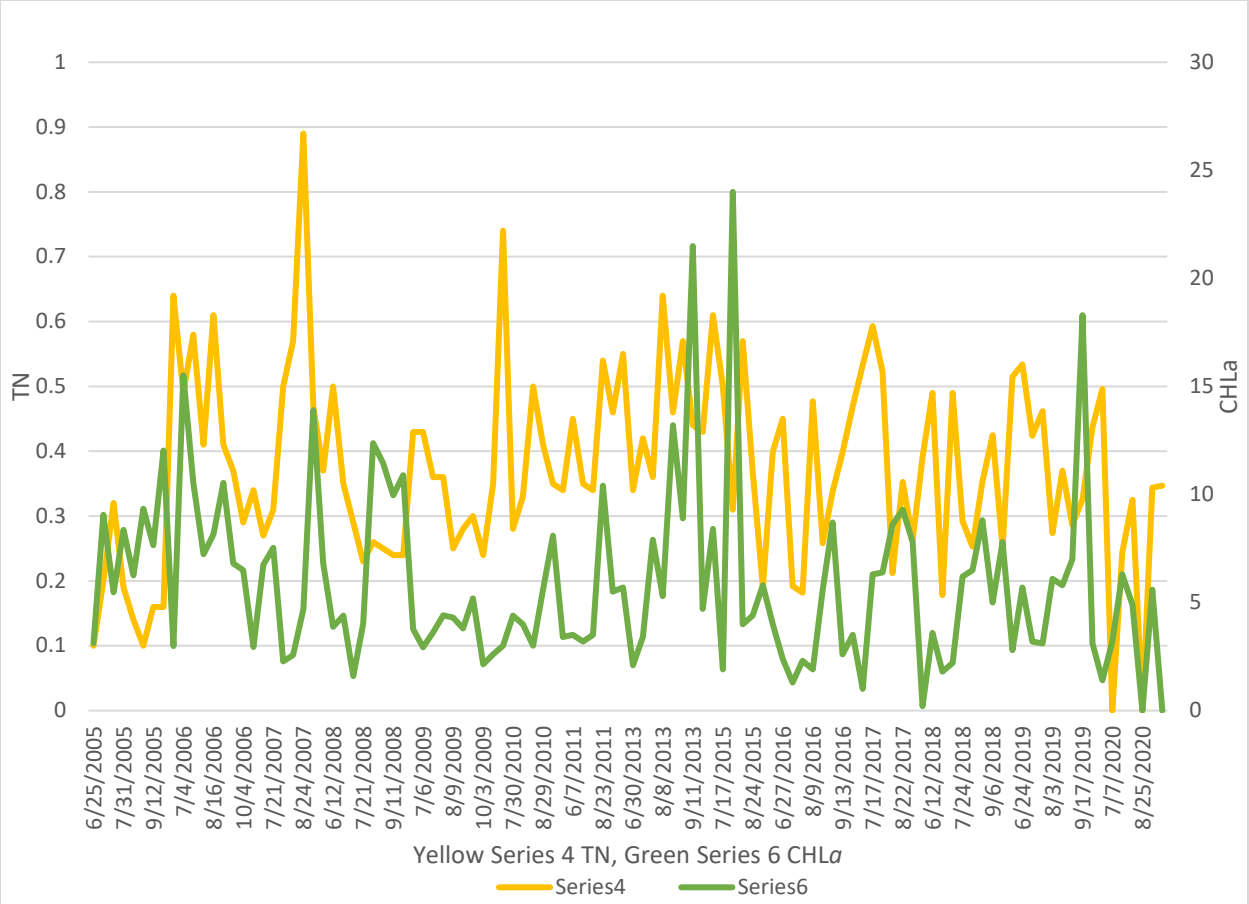


FIGURE 3-9 TOTAL NITROGEN AND CHLOROPHYLL *a*

The peaks of the Chlorophyll *a* occurs when the TN values are low as seen in 2005 and 2008. In 2013 there are simultaneous peaks of TN and Chlorophyll *a* that indicates a positive influence because of nitrogen there are brief periods when nitrogen will influence growth of algae.

3.5 Fisheries

Saratoga Lake is a highly productive fishery with a great diversity of game and non-game fishes. The fishery is primarily a warm water fishery dominated by largemouth bass, smallmouth bass, walleye, bluegill, yellow perch, pumpkinseed, chain pickerel, northern pike, bullhead, rock bass, and black crappie. The NYSDEC stocks approximately 13 million walleye fry in Saratoga Lake annually. Both NYSDEC and Saratoga County stock Saratoga Lake's largest tributary, Upper Kayaderosseras Creek, with brown, brook, and rainbow trout.

SUNY Cobleskill's Department of Fisheries and Wildlife conducted nighttime boat electrofishing on the northeast shoreline on September 17 and October 3, 2007, the entire lake shoreline in May, June and October 2008, and the entire lake shoreline again in June, July, and October 2009. The surveys were conducted to provide fisheries data associated with an herbicide treatment to control EWM (Cornwell and Poole 2009). Over the three years, these surveys logged over 16 hours of electrofishing "on-time," including 10 hours of game fish only collections and six hours of all fish collections, yielding data on 26 species of fish. Clear trends in these data are difficult to observe. Most gamefish and panfish catch rates remained remarkably consistent between 2007, 2008 and 2009.

Analyses of the northeast shore data show only a few trends:

- Bluegill catch rates on the northeast shore declined over the three-year period. This pattern in bluegill decline was also observed on the west shore. This observation is likely due to the decrease in EWM in the treatment area. Bluegills are known to use EWM monocultures as refuge from largemouth bass predation. Dominance of EWM generally leads to an increased abundance of small bluegill, since predatory gamefish cannot effectively forage for bluegills in the dense EWM beds.
- Declines in rock bass and pumpkinseed were observed in one-year post-treatment 2009 east shore collections. Catch rates for these two species were consistent in 2007 and 2008 and their steep decline (50%) in 2009 is noteworthy.
- Conversely, yellow perch increased in 2007, increased in 2008, and increased again in 2009 in northeast collections.
- West shore data demonstrate that largemouth bass was more abundant in the pre-treatment survey in June 2008 than in the same-year post-treatment survey in July 2009. This pattern did not continue with the northeast shoreline.

Comparisons with NYSDEC 1993 historical data show that SUNY surveys caught a similar suite of species 15 years later. SUNY surveys indicate that black crappie and golden shiner have declined while bluegill, log perch, and yellow bullhead are considerably more abundant. The NYSDEC completed fisheries survey in 1993, and 2015. The 2015 study (Fiorentio and P'Arco 2018) completed both electrofishing and net surveys on the lake. The largemouth bass population was well supported in the lake and harvest and recruitment was in balance. The catch per unit of effort was 25 while the state average is 17. There was a shift in population from 16–19-inch fish to 13-15-inch fish.

The same study stated that the smallmouth bass population was in good condition.

Saratoga Lake fisheries continues to provide good recreational opportunities, and the black bass fisheries is stable base on the catch per unit effort and weight ratio. The management action to control EWM, existing fishing pressure, and changes in the lake associated with zebra mussels all contribute to the changes in the character of fisheries (Fiorentio and P'Arco 2018).

In 2020, the NYSDEC began to complete fish inventories on Saratoga Lake researching crappy, and panfish (sunfish, Bluegills, and Pumpkinseed fish). The goal of the project was to locate specific spots for trap netting and to understand the species' size and population better to manage them more effectively. The crappie/panfish population is difficult to survey and it is necessary to use specific nets and targeted locations. DEC Fisheries intends to set trap and fyke nets at 3-5 locations along the shoreline to assess the status of the black crappie and sunfish populations in Saratoga Lake. The timing will ultimately be dependent on the temperature of the water, but DEC is aiming to net the crappies in mid-April and the sunfish in warmer temps in May. The traps will be set in shallow waters (3-6 feet) and marked with buoys. All fish will be identified, weighed, and measured then released unharmed. DEC will be conducting the actual survey in 2022.
The 2020 season was an off year for Saratoga Lake and many other lakes in the region due to changes in climate. The spring season began with a prolonged drought that continued into the fall. The water temperature was increasingly above normal. These two factors altered where the fish congregated and created a lower thermocline deeper in the water column.

Herbicide treatments and harvesting can also impact the fisheries for several years. Fish are sensitive to increased human impact, more boats, and more wave action. The 2020 season saw a dramatic increase in boating and fishing, which may have influenced the perception that there are fewer fish. The popularity and easy access to Saratoga Lake have increased the frequency of fishing derbies on the lake. These contests target the largest fish. Local and regional fishing derbies occur on most weekends in the summer and weeknight tournaments are often held mid-week.

3.6 Harmful Algae Blooms

Harmful algae blooms (HABs) are not a new occurrence, and prior to the lake wide sewer district, there were both green algae and blue green algae blooms commonly occurring in Saratoga Lake. A common cyanobacteria – *Anabaena* - was identified in the 1969 lake inventory. The cyanobacteria (blue-green algae) that make up these blooms may produce toxins that pose health risks to humans, pets, livestock, and wildlife that come in contact with the water.
Genera of cyanobacteria known to produce toxins include *Anabaena, Aphanizomenon, Cylindrospermopsis*, *Nodularia, Planktothrix* (*Oscillatoria*)*,* and *Microcystis* (Backer & McGillicuddy 2006). HABs can have the appearance of pea soup, a thick layer of green paint on the shoreline, or a floating scum that may be green, brown, or purplish. Exposure to cyanobacteria can occur through contact with contaminated water during swimming or other water-contact recreation, spray irrigation, or direct consumption. Animals are more likely than humans to be seriously poisoned because they often consume or swim in waters that humans

avoid due to foul smell, taste, or appearance. Dogs are known to have died from licking blue-green algae from their coats. Several dogs died after exposure to HABs in Lake Champlain during the summers of 1999 and 2000 (Watzin et al. 2002). Most HABs occur in late summer and early fall, but some may persist into late fall or winter (NALMS 2007).

Cyanobacteria maintain buoyancy by either gas vesicles or oil held within the cell. Buoyance is important to the cyanobacteria since it allows the cell to vary their position in the water column to capture sufficient light to complete metabolic functions. On a day with wind the lake surface is mixed and once the wind stops mixing, the benefit of buoyancy takes over. Cells that are not buoyant may become trapped in water below with insufficient light available, and photosynthesis will stop. While the cyanobacteria with gas vesicles and polysaccharides will float to the lake surface and photosynthesis can restart. During daylight hours, cyanobacteria will rise in the water column and as they rise, clumps will form (O'Neil J.M. et.al. 2012) and contributes to formation of layers of scum. This is important since the amount of photosynthesis fills the gas vesicle. While the water is calm, cells will cluster, further aiding buoyancy even at the expense of shading (Visser P.M. et.al. 2005). As the cells compete for nutrients of nitrogen, phosphorus, and carbon to drive photosynthesis, each respective nutrient may become limiting including nitrogen. The cyanobacterium has an ability to fix nitrogen, but it comes at a high energy cost that may not be sustained in bloom conditions (Chorus I. and M. Welker, 2021). Both short-term and long-term blooms will be driven by nutrients in the water the relationship of nutrients varies, therefore the nutrient ratios are not reliable predictor of bloom conditions (O'Neil J.M et.al. 2012).

Harmful Algae Bloom Studies in Saratoga Lake

The New York State Department of Health, in collaboration with NYSDEC and CSLAP, has analyzed samples from many lakes, including Saratoga Lake, for levels of microcystin, a toxin produced by cyanobacteria. This is part of a 5-year agreement between NYSDOH and the Centers for Disease Control with the aim of documenting HAB occurrence and any potentially related illnesses, improving the ability of NYSDOH to analyze cyanobacterial toxins and ultimately to reduce exposure to HABs.

Sampling for HABs parameters for Fluoroprobe, toxin testing, and microscope identification of various species has been occurring since 2009. As part of the CSLAP, a pre-screening testing for plant pigments related to HAB has been completed over the last six years. The toxin levels in the three samples from Saratoga Lake that were analyzed were not high enough to cause concern. However, there can be an interplay between HABs and aquatic herbicide treatments in that exposure to some herbicides can be lethal to cyanobacteria, leading to release of toxins into the water. Given that Saratoga Lake is popular for water-contact recreation, monitoring for HABs and their toxins may be advisable. Microcystin monitoring can be completed by immunoassay, and it may be feasible to have test kits available to test algae blooms when they are found. The Fluoroprobe detects a specific protein found in blue green algae. The fluorescence method uses a filter that is prepared in the field by the CSLAP volunteers.

Microcystin and Anatoxin are two common toxins that are associated with blue green algae. Table 3-2, "Saratoga Lake Water Samples for Chlorophyll Microcystin, and Anatoxin (units µg/l)," provides a summary of results from 2013 to 2020. The inshore concentration of cyanobacteria is

always greater than the offshore site. The same is true for the toxins Microcystin, and Anatoxins the offshore site is rarely above 1 µg/l while the inshore can be 50 to 100 times greater.

In 2009, three water samples collected in Saratoga Lake as part of the CSLAP were analyzed for the cyanobacterial toxin microcystin-LR. The results from the three samples are as follows: 8/24/2009 - 0. 22µg/l; 9/21/2009-0. 07 µg/l; 10/03/2009 - 0. 05 µg/l. The shoreline FP-BGA criteria level of 25-30 µg/l has been exceeded four times during the 16 samplings in 2016 and 2017. At the same time, samples did not exceed threshold levels five different times. Shoreline HABs are typically short-term and isolated to small areas. Saratoga Lake was on the HABs notice listing in 2013, 2015, 2016, 2017, and 2018. Table 3-3, "Reported HABs in Saratoga County 2012-2018," compares Saratoga Lake to other nearby lakes reporting HABs.

NYSDOH requires a public bathing beach to have a permit. The beach operator is required to close the facility when visual inspection indicates there may be a HAB event. Once closed, the beach can only be re-opened following a test to confirm that Microcystin is below 4 *u*g/l (4 ppb).

Ballston and Saratoga Lake are a part of the CSLAP lake monitoring program that includes HABs monitoring by Fluoroprobe for chlorophyll, toxin testing and microscope identification of major species. The reports from Moreau and Round Lake are based on visual observation of HABs blooms. At Saratoga Lake the high toxin incidences have all occurred in shore and water quality samples are not collected in the shallow water zone. Bloom sampling has decreased since the adoption of a visual standard for HABs conditions. There have been occasions when HABs have occurred in shallow areas that would have warranted public beach closures. None of the blooms observed on Saratoga Lake have lasted for more than a few hours and Saratoga Lake is not currently experiencing unusual or pro-long HABs bloom conditions, until October 2021. In October 2021, while the lake was still stratified, there was a HABs bloom that covered a narrow band of water and encircled most of the Saratoga Lake for a period of three days.

TABLE 3-2 SARATOGA LAKE WATER SAMPLES FOR CHLOROPHYLL MICROCYSTIN, AND ANATOXIN (UNITS µG/L)								
Parameter	**HAB Criteria *u*g/l**	**2013 Mean /Range**	**2015 Mean /Range**	**2016 Mean /Range**	**2017 Mean /Range**	**2018 Mean /Range**	**2019 Mean/ Range**	**2020 Mean/ Range**
Shoreline FP-BGA *u*g/l	25-30	410 3.2-1,213	278.3 0. 8-1,213	23.6 0-118.7	5.0 0-633	6.2 0.5-49,536	101.8	No samples
Microcystin *u*g/l	20	74.1 0. 3-220. 4	50. 2 0-389	ND ND	8.1 ND-58	600 ND-2400	13.3	No Samples
Anatoxin *u*g/l	none	ND ND	ND ND	ND ND	NA ND-0. 16	ND	ND	No Samples
Offshore FP-BG Chl-a *u*g/l	none	3 1-10	1 0-10	0. 89 0-2	2.1 0. 1-4.7	2.5 1-6	1.4 1-2	1.6 0.1-3.4
Offshore Chl a *u*g/l	none	8.44 1.43-34.4	2 1-12	3.6 1.3-8.7	3.2 1-9.3	5.2 1.8-8.8	6.5 2.8-18.3	4.0 1.4-6.3

There is good information in the data provided, however, that the frequency and intensity of HABs in Saratoga Lake has increased in the last 5 years. Based on the DEC HAB website, there were 6 confirmed HAB reports on Saratoga Lake as of October 6, 2021.

TABLE 3-3 REPORTED HABS IN SARATOGA COUNTY 2012-2018									
Waterbody	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Ballston Lake	C	C	C	-	-	C	-	S	No sample
Moreau Lake	-	-	-	-	-	-	S	?	No report
Round Lake	-	-	-	-	C	C		/	No report
Saratoga Lake	-	HT	-	HT	C	HT	C	No sample	No Sample

Note: C-Confirmed Bloom; S-Suspected Bloom; HT-Confirmed with High Toxins Bloom.

Statewide HAB Research and Findings

In 2017 and 2018, Governor Andrew Cuomo started a HABs initiative to review the possible causes of HAB's conditions on NYS lakes. This work was started following persistent HABs on both large and small Finger Lakes, including Skaneateles Lake, a part of the City of Syracuse water supply. HABs also repeatedly occur in small lakes in the Hudson River Valley, and urban lakes. There has been a steady increase in the HABs reported and examined by the NYSDEC since 2012.

The HABs Initiative recognized that the problem was complex and would not be solved by short-term actions. A research guide statement was released in 2021 to direct future efforts in NYS to better understand HABs, causes, method to control, dynamics of watershed nutrients, location and shape of the lake, plant nutrients, cyanotoxin production, impact of warmer lake temperature, zebra mussels related changes, and physiological factors of cyanobacteria that include the ability to fix nitrogen, rapidly uptake nutrients, and buoyance control (NYSDEC 2021).

At Saratoga Lake the HABs blooms have been small isolated and short lived until October 2021. Over a three-day period when the lake was still stratified, there were shoreline blooms along half of the lake shore. This was the largest bloom seen on the lake since the early 1970's. A prior large bloom occurred after hurricane Irene. Management of HABs will require a multilevel effort that limits discharge of nutrients from the watershed including nitrogen compounds, preserving natural shoreline so that water can freely move, avoid using fertilizers, and prevent the introduction of other filter feeding mollusks (NYSDEC, 2021). Further studies are underway to better understand the dynamics of HABs, including work by the USGS to assign nation level experts on HABs to the NYS USGS, NYS DEC and NYSDOH.

The HABs Initiative focuses on four criteria that were determined to be strongly related to the presence of HABs:

- Increase in TP above average levels - for every 0. 01 ppb increase of TP above average increases the probability of HABs by 10% to 18%.
- Presence of zebra or quagga mussels increase the probability 18%-66%.
- Lakes with long fetches - for every mile of increased length, the probability of HABs is increased by 20%.
- Lakes with northwest orientation along their longest fetch increase the probability of HABs by 10-56% (www.dec.ny. gov/chemical/113733.html).

Saratoga Lake and the Great Lakes HABs were common prior to the sewer diversion and advanced secondary treatment system development in the 1970's and 1980's. On the Great Lakes, HABs began to re-occur in the mid 1990's and these blooms were related to zebra, quagga mussels. Recently, HABs on the Great Lakes have become persistent and widespread. Part of the mechanism is the selective feeding by zebra mussels. It has been determined that zebra mussel will reject some, but not all Microcystin when feeding. This causes other blue green algae and green algae to be a food source for the mussels while concentrating Microcystin, which is not consumed by the mussels (Vanderploeg, H. et. al. 2017). A review of CSLAP lakes in the Mohawk Region determined a relationship between zebra mussels and HAB conditions (NYSDEC 2017). The zebra mussel does influence the density or prevalence of Microcystin lakes. However, it is still to be determined as to how this influences the extent and cycle of HAB's.

Peroxide and copper-based herbicides can be used to treat HABs, however, the pesticide application process needs notice prior to application along with identification of the treatment area. HAB blooms tend to be short-lived and in limited areas making it difficult to treat in a timely fashion due to the need to schedule and permit herbicide applications months in advance. If the HABs become more widespread, then a generic treatment process could potentially be developed, but even with rapid mobilization, it may be difficult to suppress a HABs event.

3.7 Hydrology and Lake Levels

Hydrology is the flow pattern of water in a system. The focus of hydrology in lakes is to determine the lake detention time since the lengths of time that water remains in the lake impacts the growth of algae which establishes the lake's ecological balance. Hydrology also evaluates the changes in water levels as a result of water input. A lake has a watershed that delivers water to

the lake as runoff which may be immediate for water falling along the shoreline or hours or days depending on the size and shape of the watershed.

Saratoga Lake of today is not a natural lake in that a portion of the lake was flooded by the construction of dams on Fish Creek. There was a dam that served a lumber mill operated by the Schuyler Family along Fish Creek near the last dam in the Village of Victory. The dam that changed water levels at the Saratoga Lake dam was constructed in 1828 by Phillip J. Schuyler (1789-1835) at Winnie Reef. Some of the land on Saratoga Lake may have been flooded by a dam build in Grangeville by Jesse Toll in 1800 (Starr T, 2010).

From 1972-1974, a study of the overall hydrology was completed to estimate the detention time in the lake (Connor, 1974 and Bloomfield, 1980). To complete this study, temporary water level recorders were placed in Kayaderosseras Creek, and data was collected from existing gauges on the Glowegee Creek and on Fish Creek at the hydroelectric dam. The study found that 97.5% of water that enters the lake is by the way of runoff. Approximately 1.5% is from direct precipitation and 1.0% is ground water recharge. During the 1972-1974 study, both the Saratoga Springs and Ballston wastewater treatment plants still discharged into the watershed. The estimated flow from the Saratoga Springs wastewater treatment facility was between 5.5-8.0 million gallons a day or 7.7- 12.4 cfs (Connor, 1974). An estimate for the Ballston Spa wastewater plant was not provided. The Ballston Spa wastewater plant discharged directly into the Kayaderosseras Creek below what is now Kelly Park.

After the need for hydropower was no longer required to operate the mills in Victory, the water canals and outlet structures were modified to produce electricity. At some point, the dam became the property of Niagara Mohawk Power Corporation which was incorporated in the early 1960's resulting in the consolidation of numerous independent power companies and hydroelectric facilities. The dam passed through a number of owners and is now operated by Enel Green Power North America, a large international energy company. In 1983, a study of methods to control EWM was completed (Hardt, Hodgson and Mikol, 1983) and that work recommended use of annual draw down to control EWM in the shallow water zone. An agreement was completed with NMPC that set operating levels of the lake. This agreement set out the summer level of the lake as 203-204 ft. elevation. The lake was to be drawn down in the fall to a level of 201. This agreement is still in place however, there is a general modification in the operation of the dam to hold water levels slightly higher in October. The lake levels are now held to an elevation of 202-203 msl until the *Head of the Fish* regatta is completed in mid-October. Operation of the dam is fully under the control of Enel who is the current owner, and subject to the agreed upon contract.
In 2008, a study of the Fish Creek was completed by CT Male and funded by the SLA and SLPID. https://slpid.digitaltowpath.org:10231/content/Generic/View/5:field=documents;/content/Documents/File/17.pdf

The work was supervised by the Saratoga Lake Association. The purpose of the study was to determine if Fish Creek was capable of efficiently discharging water from Saratoga Lake. In the late 1970's, observations were made that deltas had formed at the various locations along Fish

Creek and that these deltas may impede flow. A computer model of Fish Creek was developed using standard HEC (Hydrograph Engineering Calculation) developed by the United States Army Corps of Engineers (ACOE) for estimation of river flow. The evaluation included various alternatives for the operation of the outlet at the Winnie Reef dam.

The CT Male study determined that the characteristics of Fish Creek were adequate to efficiently move the water from Saratoga Lake out along the Fish Creek to the Hudson River. The normal operation of the dam is to regulate water levels by removal of flash boards or logs. The log system consists of eight, eleven-foot-wide log weirs each containing four twelve-inch-thick logs. To regulate the discharge of the dam and lake elevation, logs are removed by a winch from each of the eleven weirs. This system regulates the lake level between elevations of 198.9-202.9 msl. The dam also has three mechanical gates that are lifted from the top, which lets water out at the 196.2+ msl. This gate system operates at elevation of 196.2-204.2 msl.

The capacity of the log weir to release water is less than that of the gate system. Table 2 in the CT Male report provides the results of seven different test runs of the HEC model. For each test, the model was set to assess the amount of time to decrease the lake level by one foot without new water inputs. Test one, with the gates all open and all logs out, it took 45 hours to decrease the lake level one foot. In model test three, with all gates open and all logs in place, it took 46 hours to decrease the lake surface by one foot. This shows that the gates will release more water under most conditions. It is recognized that during periods of excessively high water more water could be released from Fish Creek and the lake by operation of the gates (CT Male, 2010).

The bottom profile and stream width of Fish Creek was evaluated in the same study. There was a segment of Fish Creek 17,000 feet down stream of the 9P Bridge that showed some restriction in flow. In this area the stream channel is reduced from 270 feet wide to 190 feet wide and a depth of less than five feet. A portion of Fish Creek in this section are above the dam sill elevation of 196.2 msl. This does limit the discharge of Fish Creek to a small degree however, this restriction may be overcome by use of the dam gates.

SLPID funds the operation of the lake water level gage by the United States Geological Survey, and the data is collected and displayed on the USGS automatically. Water levels are updated every 15 minutes. The USGS website supports graphic display of the data.

3.8 Stormwater Discharge Points

In the 2002 watershed plan, 26 discharge points consisting of culverts and streams were identified. There have been additional efforts to locate discharge locations by the Lake stewards and in the towns. Figure 3-10, “Points of Runoff Locations,” identifies the water inflow points and potential runoff locations as mapped by the Lake Stewards in 2020. This map offers a good starting point for additional investigation and mitigation of issues with runoff.

The Towns are required to have an inventory of discharge location as a part of their Municipal Separate Storm Sewer System (MS-4) permits that are issued by the New York State Department of Environmental Conservation to the Towns and Saratoga County. In Saratoga County, the

stormwater management plans are compiled and administered by the Saratoga County Stormwater Coordinator.

SLPID has begun the process of collecting the available information and preparing sub-catch maps for each of the discharge points in the sub-watershed. Along with mapping the sub-catchment area soils, vegetation cover and slopes maps will be prepared or refined. This effort will identify the most critical problem areas. The Town of Stillwater has completed a stormwater management plan that addresses the Town's portion of the Saratoga Lake Watershed. The Plan provides a regional, watershed-wide understanding of the cause and effect of stormwater runoff and the need to manage water quality on a broad scale. The secondary objective is to continue the watershed-wide discussion concerning stormwater issues throughout the Saratoga Lake watershed.

LAND TO LAKE PERSPECTIVES: THE SARATOGA LAKE 2021 ASSESSMENT

Saratoga Lake Protection and Improvement District (SLPID)

Saratoga Lake

Interlaken

Waters Edge

Saratoga Springs

Malta

Cedar Bluffs

Point Breeze Marina

Fish Creek

Drummond Creek

Manning Cove Rd

Mannings Cove

Riley Cove

Lakeside Acres

Snake Hill

Maple Shade

Saratoga Stillwater

Southshore Marina

Saratoga Lake Golf Club

SLPID Boundary

Other Tax Parcels

Municipal Boundaries

USFWS NWI Wetlands

Culverts, streams and other outflows

0 1000 2000 4000 Feet

Prepared by Upstate GIS

For conceptual planning purposes only - not intended for navigation or legal determinations

Map 3-10: Points of Runoff Locations

January 2022

3.9 Findings and Recommendations

Findings

The Saratoga Lake watershed is diverse and complicated. Stormwater runoff originates throughout many land uses, from high-density urbanized cities to large-scale agricultural operations. Saratoga Lake provides year- round recreation and is a major economic resource for all local communities. Changes in water quality at Saratoga Lake show that the Total phosphorous (TP) levels have been stable for many years. However, even with stable concentrations of TP there is still sufficient levels of TP to drive changes in the lake. These changes are most pronounced in the probable increase in the internal loading of TP. Internal loading has increased since 1984 and the depth of anoxic waters have also increased since 2008.

There are methods available to address internal loadings, including limiting nutrient re-cycling through the use of alum, Phoslock®, deep aerations, oxygen injections, and water circulation. All methods have their advantages and disadvantages. Selection of a method requires detail water quality analysis, test or pilot projects, sediment testing, complex engineering for the selected system, and permitting. The permitting process for alum and Phoslock is under review, and the process has not been set.

Traditional application of copper sulfate or hydrogen peroxide maybe used to control HABs. Control by using of herbicides is difficult since the location extent and longevity of a bloom can't be predicted. Also, responding in hours or days is a significant logistic problem. Experimental controls are being explored in NYS by SUNY Environmental Science and Forestry, and Clarkson University and the Army Corps of Engineers is working in Florida.

Lake modeling has confirmed that direct discharge sub-catchments may be causing an out sized contribution to nutrient loadings in Saratoga Lake.

<u>Recommendations</u>

1. **Fish Creek Rehabilitation**

The dam operator has accepted SLPID's proposal to examine Fish Creek and potentially modify operation of the dam to allow work for property owners on the Saratoga Lake shoreline or lower the lake prior to predicted storms to limit damage to infrastructure. The next step is to develop and outline of the permit process that identifies the key decision points by regulatory agencies and Federal Emergency Management Agency. The role of the Saratoga County Soil and Water Conservation District, Saratoga County Stormwater Coordination Office and Saratoga County Planning will need to be clarified. Information for the permit submittal will be identified. A decision maker list will be prepared, and representatives at all levels of government will be identified. This information will be used to create a request for proposal to select a firm qualified to prepare an application. The new bathymetric survey by CT Male will indicate benefits and feasibility of the project and will determine the feasibility of the project.

2. **BioBase Mapping**

Two of SLPID weed harvester have BioBase Lowrance mapping data loggers installed. The Lowrance system collects daily mapping of the travel courses of the harvesters. The data being

collected includes bathymetric mapping estimates of plant biomass and the harvesting speed. The operators of the harvesters can see their individual pathways that they have completed and changes in the lake bottom profile. The key information for the Article 24 New York State Wetlands permit is to be able to show that harvesting in the wetlands is limited to under 50% of the wetland area. To date this information has been extracted by reviewing each day of harvesting and estimating the wetland position. It is recommended that each week a map be compiled into a single map of biomass which will reduce the costs related to data storage. The 2020 data will be combined into weekly maps and the 2021 data will be sorted.

3. Thermal Profile

A thermal profile in the deep-water area will be a research related effort. Two approaches are proposed to complete the work. The preferred method is to recruit a group to complete the work. A request for proposals will be issued to assist SLPID in installing a string of recording thermistors and managing data will be circulated in early 2022. Alternatively, SLPID will complete the work using available resources. A string of recording thermistors and recording dissolved oxygen probe should be set in the central deep-water area to continuously collect temperature to improve the detailed variation in the thermal profile of the lake from May to December. This will fill a gap on the duration of summer thermal stratification and DO depletion. During the winter, submersed temperature and DO recording devices can be left on the lake bottom attached to a pop-up buoy that will released and carry the recording devices to the surface once it receives a radio signal. This will provide information on bottom temperature and DO during the winter. During the same time, additional deepwater samples for nutrients can be collected to improve the estimation of internal loading.

4. Kayaderosseras Creek Flow

Watershed flow or hydrology estimates is a major source of error when assessing lake dynamics. Obtaining correct flow data is important to determining watershed nutrient loadings and lake water flow. There is a stilling well at Nelson Avenue Extension that was installed in 1970 to estimate the water flow in the Kayaderosseras Creek. An assessment of the stilling well is needed to see if it is still connected to the Kayaderosseras Creek. This can be done with dye and a compressor to clear pipes. If the stilling well is secure, a pressure gauge will need to be installed into the stilling well and calibrated. The Saratoga Stormwater Coordinator's office may assist in this project, and a surveyor may be required to re-establish the elevation of the stilling well.

5. Lake Water Flow

In the early 1970's, RPI constructed a 3-D physical model of Saratoga Lake to determine the flow of water from the Kayaderosseras Creek into the lake and out of Fish Creek. This 3D model demonstrated that water from the creek flowed south and exited by way of Fish Creek. SLPID should purchase recorders that use GPS to measure the flow and direction of the lake through inexpensive geographic position recorders used to track equipment or trailers and then be downloaded to a map.

6. PCR Coliform Testing

PCR coliform testing uses genetic material found in a water sample to identify if the coliforms are from humans, cows, horses, dogs, or birds. It is recommended the tests would be completed on Sucker Brook, Kayaderosseras Creek, and some of the other short-run streams to identify locations for additional study or remedial efforts.

7. Harmful Algal Blooms (HABs)

HAB sampling has been conducted as part of the CSLAP program. However, the program is expected to stop or be greatly reduced after 2022. In cooperation with existing HAB sampling conducted by NYSDEC and NYSDOH, SLPID should continue to participate in sampling efforts. If HAB conditions occur with greater frequency, or as more public beaches are developed, more HAB sampling may be warranted. Such a plan may incorporate nearshore and offshore HAB testing, organized surveillance, and additional water quality testing. Additional actions include the recent purchase of a Turner handheld fluorometer which will measure the concentration of chlorophyll that is specific to HAB bloom species. This will aid in the determination of whether a bloom is cyanobacteria or green algae. At the same time, kits should be purchased to detect and measure the amount of cyanobacteria toxins to better evaluate bloom conditions. The common method to test for algae toxins using a kit that is an immunoassay. Qualitative test strips are also available for detection of HABs toxins. A laboratory is needed to complete the testing by use of the kit. Investigate whether Saratoga County will support this type of testing to use on multiple lakes, or if the county will support a demonstration project for Saratoga Lake in 2022.

SECTION 4 AQUATIC PLANT MANAGEMENT

4.1 Aquatic Macrophytes and Invasive Species

Aquatic plants are a critical element in the natural ecology of lakes and serve many functions within a lake, including soil and sediment stabilization, habitat for young fish, amphibians, aquatic insects that provide forage for larger fish, shading of the lake bottom, produce oxygen, absorb wave energy, and intercept ground water (NYSFOLA, 2009). Aquatic plants are rarely consumed by fish, but the growth on the plants known as epiphytes, is a portion of the diet of small fish or insects. At the same time, invasive plants may interfere with these benefits if the plants become too dense and crowd out the native species that have evolved together over the last 15,000 years. The SGEIS (SLPID, 2019) includes a summary of the plants that have been found in Saratoga Lake based on the past and current aquatic plant surveys. There were brief surveys of aquatic plants in 1932 and 1969. Starting in 1982, the Rensselaer Freshwater Institute (FWI), now known as the Darrin Freshwater Institute (DFWI), have completed surveys of the aquatic plants on Saratoga Lake. Beginning in 2006, aquatic plant surveys have been completed annually to support the ongoing herbicide and aquatic plant management actions at Saratoga Lake. The more recent plant surveys are found on *SLPID.org* website, while the old surveys are on file at the Rensselaer Polytechnic Institute Folsom Library that can be found on the DFWI web site.

This section focuses on the invasive species, management efforts by SLPID to address growth of aquatic plant community, and positive changes in the aquatic plant community resulting from the management of invasive species.

The predominance of Eurasian watermilfoil (EWM), *Myriophyllum spicatum,* was the primary cause for the formation of SLPID. EWM was not found in a plant survey conducted by NYSDEC in 1969, yet it was abundant in 1982 (SDEIS, 2019). It is estimated that EWM entered Saratoga Lake sometime during the mid-1970's (Eichler and Boylen, 2004). EWM was first identified in the state in in 1880 in Dryden Lake in Tompkins County.
https://nas.er.usgs.gov/queries/CollectionInfo.aspx?SpeciesID=237&State=NY&YearFrom=1880&YearTo=1880

Potamogeton crispus (Curly leaf pondweed (CLP)) was found in NYS in 1879 and in Saratoga Lake in 1932 during the aquatic plant survey. Curly leaf pondweed starts growing in the early spring following ice off and may reach the lake surface by late May. This early growth is usually followed by a die-back that occurs at the end of June. The plant may also re-grow following this die back. The growth character of the CLP somewhat limits the interference with recreational activities. The largest area of coverage by CLP has been at the south end of the lake.
https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1134
CLP has controlled by both mechanical harvesting and aquatic herbicide applications. The most successful control effort occurred in 2019 following large-scale applications covering 147 or more acres.

Waterchestnut (*Trappa natans)* is an annual plant that reproduces mainly by seed (BugwoodWiki, 2010, Gleason & Cronquist 1991). When germinating on the lake bottom, it grows a root and sends up 10 to 15 stems that end in a rosette of floating leaves. The petioles (stems) of these leaves are swollen with spongy tissue containing air, which gives them buoyancy. Below the

rosettes, the submersed stems bear featherlike leaves that are attached in whorls. The nodes that produce these leaves can be an inch or more apart, and the stem of the plant can be up to 16 feet long, allowing it to grow in relatively deep water for a rooted plant with floating leaves. However, water chestnut prefers water between 1 and 6 feet deep.

The floating rosettes may break free of the stem and be dispersed, taking root elsewhere. The rosettes may cover the surface of the water in such density that they adversely affect other submersed plants by shading. Flowers are produced in the floating rosette from mid-July until the killing frost. Each flower produces one fruit, which has four sharp-pointed horns. The fruits sink to the bottom and germinate in the spring but are reported to remain dormant up to 12 years. The stems and rosettes of the plants die in the fall, and the seeds are the only form in which water chestnut over-winters. The key to success in controlling the water chestnut is to harvest the plant while the nut is still attached so that new plants will not grow in the following season.

European frogbit (*Hydrocharis morsus-ranae)* has been found in Saratoga Lake at the headwall of the State Boat Launch and at the Saratoga Marina Dock Club on the west side of Fish Creek.

To understand the impacts of the management actions on the aquatic plant community, percent frequency, a measure of number of samples containing an individual species, will be used. Table 4-1, "*Percent Frequency of Select Aquatic Plants"*, illustrates the changes in the number of times that a plant is found during sampling. If a plant is found in 10 of the 100 samples taken, it has a percent frequency of 10%.

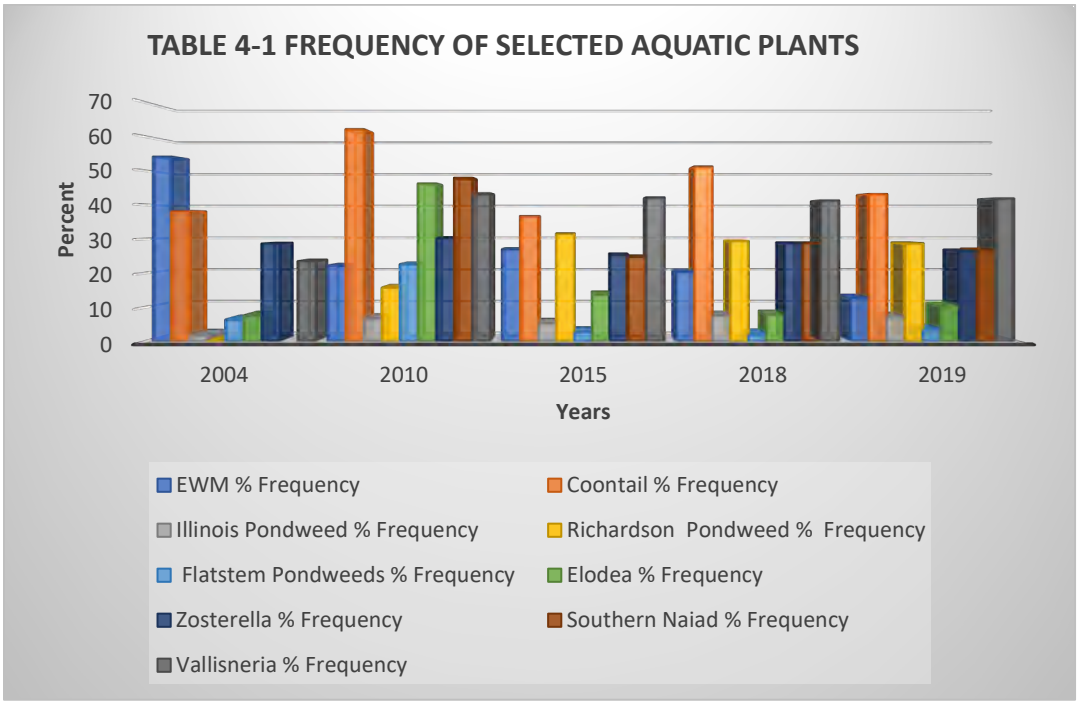


Table 4-1 shows the decrease in the frequency of the occurrence of EWM following the 2007-2009 segmented whole lake treatment and corresponding re-emergence of native species including the pondweeds. The 2010 samples show the increase in Elodea, Zosterella, and Southern Naiad. Between 2010 and 2015, various pondweeds began to become more common. Eventually Richardson and Flatstem pondweeds are now found in over 20% of the samples (Eichler and Boylen 2004, 2010, 2015, 2018, and 2019).

There has been noticeable growth and spread of *Zosterella dubia* water star grass into dense thick beds on the lake near Franklin Beach, along NYS Route 9P and in Manning's Cove. This demonstrates that the management plan to use herbicides that are systemic in action against invasive species can be used in a manner to limit non-target species damage. These actions have successfully restored the aquatic plant community on Saratoga Lake.

The harvesting program contributed to the successful management of the aquatic invasive plants since harvesting re-shaped the community. In 1982, there were 13 submerged species and 14 years later, after ten years of harvesting, submerged species increased to 19. The submersed species have been between 18-22 species (SLPID 2019).

4.2 Aquatic Plant Management

The SGEIS covers the aquatic plant management program for Saratoga Lake (2019 SLPID). That plan is based on Integrated Pest Management (IPM) which utilizes multiple control methods to address aquatic invasive species. Table 4-2, "Summary of Herbicide Application Treatments," shows the history of past herbicide applications completed on Saratoga Lake. The IPM effort is a year-round project to assess invasive species, plan treatments, complete treatments, plan and manage harvesting efforts, and deploy lake stewards. Figure 4-1, "2020 Treatment Areas and Sample Locations," shows the two areas in the lake – one on the north end and the other in the south end- that were treated with herbicide in 2020.

TABLE 4-2 SUMMARY OF HERBICIDE APPLICATION TREATMENTS			
Year	**Treatment Area Size & Location**	**Herbicide Product**	**Treatment Outcome**
2007	158 acres South End	Sonar® PR & Q (Fluridone pellets)	Very successful for control of EWM; control lasted three years.
2008	292 acres Northeast & East Shore	Renovate® OTF (Triclopyr granular)	Successful very good control of EWM; some drift to the east due to high winds; no non-target damage species.
2009	285 acres Northeast & West Shore	Renovate® OTF	Successful control of EWM in the application area; limited control of EWM on rock bar.
2010	50 acres Spot Treatments	Renovate® OTF	Good control in herbicide application zone; limited fringe area control of EWM.
2011	100 acres Northeast and Southeast Shore	Renovate® 3 (Triclopyr liquid & Aquathol K (Endothall liquid)	Acceptable control of EWM in the NE treatment area except in the deep-water area near channel; good control of EWM in the southeast zones; combined herbicide treatment with Clearcast recommended.
2012	100 acres Southeast Shore	Renovate® OTF & Clearcast® 2.7G (Imazamox gran,)	Good control of target species; larger treatment area improved control.
2013	172 acres Northeast & Northwest Shore	Renovate® OTF	Acceptable control of EWM in the treatment zone except for deep water area, that has imbedded EWM turion; high rainfall events may have contributed to dilution
2014	48 acres South End & Northwest Shore	Renovate® OTF (Triclopyr granular) & Aquathol K (endothall liquid) & Clearcast® (imazamox liquid)	Acceptable control with Renovate Aquathol combination, but dilution seem to impact the level of control; CLP was controlled with Clearcast.
2015	50 acres Southeast shore	Sonar One	Acceptable control in treatment area; evidence of control in 2016 and 2017.
2016	None	-	Only scattered EWM plants found in 2015 DFWI inventory.
2017	146.1 acres South end	Combined treatment Aquathol & Navigate	No explosive growth of EWM without treatment in 2016; good control of EWM with combined herbicides and large area.
2018	54.5 acres Kayaderosseras Creek outlet & Franklin Beach	Clearcast & Renovate	Good control of CLP; good control of EWM except in the deep-water portion of the treatment zone.
2019	5 acres Kayaderosseras Creek outlet	Clearcast®	Complete control of Curly leaf pond weed and EWM with limited impacts to non-target
2020	54.47 acres Franklin Beach 147.29 acres South end	ProcellaCOR at Franklin Beach Aquathol South end	Complete control of Curly leaf pond weed and EWM with limited impacts to non-target species.
2021	32 acres Kayaderosseras Creek Outlet	ProcellaCOR EC	Very good control of EWM. No plants found in post aquatic plant survey.

From 1986 to 2006, EWM was the focus of the harvesting program. The successful use of herbicides to control EWM began in 2007-2009 with a segmented whole lake treatment. The use of herbicides to manage invasives has brought about multiple seasons of invasive control.

The general schedule for planning aquatic plant management begins in August with the comprehensive plant survey. The results of that survey are received by November. The need for herbicide treatments to address aquatic invasive plants is made, and the cost for treatment is obtained in the months of November through January. Permits from NYSDEC are submitted by March. Herbicide treatments normally occur between mid-May to mid-June, depending on the herbicide being applied and the target species. Water chestnut herbicide treatments normally occur in July (SLPID, 2019). To control EWM and CLP, herbicides have been used due to the plants' biology and coverage area.

Water chestnut, a species that is prone to nuisance levels of growth, was also reported in 1994, 2004, 2007, and 2010. Water chestnut has been the subject of ongoing management efforts of limited herbicide applications, mechanical removal, and hand harvesting. During 1990's – 2000 there was a well-organized hand harvesting effort by the Saratoga Lake Association that kept control of the water chestnut, and the effort eventually stopped. A limited number of specimens of water chestnut were observed on the delta of Kayaderosseras Creek near the "ditch" area, a small finger of the lake located just north of Manning's Cove. The density of water chestnut had become so great in the ditch that chemical control was considered, and a permit was obtained in 2002. The treatment was not completed since the extent of the plant had declined greatly. Water chestnuts are predominately found in Fish Creek near the Fish Creek Marina.

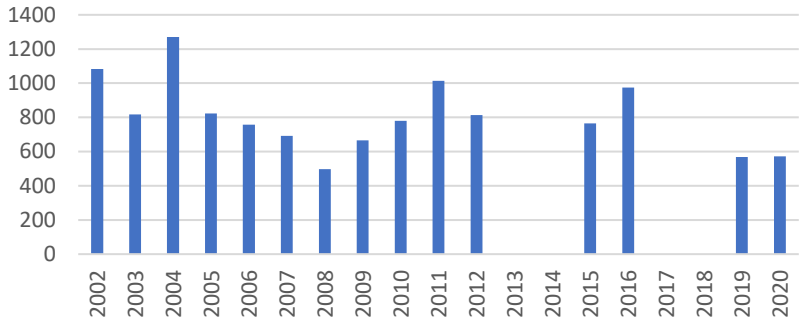
By 2012, water chestnut was found at the mouth of Kayaderosseras Creek, in Fish Creek, north side of Manning's Cove, north of Waters Edge and at the State boat launch and in Fish Creek. Navigate ® was applied in 2017 and 2018, while Clearcast® was applied in 2014 and 2019 to control water chestnut in the area around Kayaderosseras Creek outlet. Mechanical removal by floating excavation equipment has been used in various years, including 2020 and 2021.

To date, the control method for European Frogbit has been hand harvesting and this will continue to be the treatment of choice. New sites need to be reported to SLPID to record locations and complete removal by hand. Plant debris will be disposed of as solid waste materials. In the future, should chemical control be necessary, Renovate® and Clearcast® are the selected permitted herbicides for control of this species.

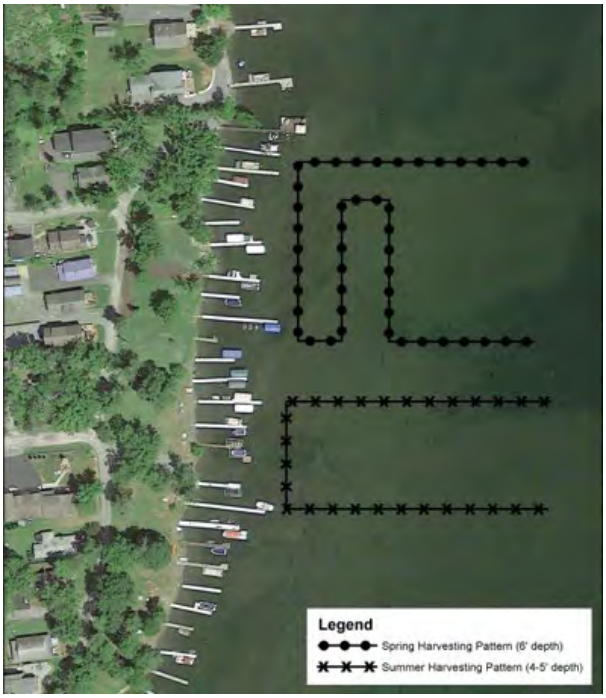
In August 2021, SLPID took possession of a third FX-11 harvester conveyor, and a second truck to haul weeds. The harvesters are used to cut and remove dense beds of native species that interfere with boating access to and from the shore. This goal represents a shift from the start of the harvesting program in 1986 through 2007, when the harvesting program targeted EWM with the goal of removing as much as possible during each season.

Harvesting loads are measured by the number of truckloads of plant material that were removed from the lake. Table 4-3, "Truckloads of Aquatic Plant Materials Harvested at Saratoga Lake 2002-2020," illustrates the amount of aquatic plant material removed from the lake for that period. During this period the trucks have had a 300 cubic foot (CF) grain box therefore it is a consistent method to count the amount of material. Harvester's hoppers have varied from 300 CF to 1000 CF. In 2011, the higher number of loads was caused by clean up following hurricane's Irene and Lee. Even during the period of 1986-2007 it was impossible to remove the entire EWM coverage of the lake and the approach was limited to providing access to from docks to deepwater areas.

TABLE 4-3 TRUCKLOADS OF AQUATIC PLANTS HARVESTED AT SARATOGA LAKE 2002-2020



The change in plant dominance from EWM that grows rapidly in the spring to a native plant community that grows rapidly after June changes the harvesting activity. While this allows a later start in the harvesting operations, it does push work into the later season. Highest plant density is reached in August.



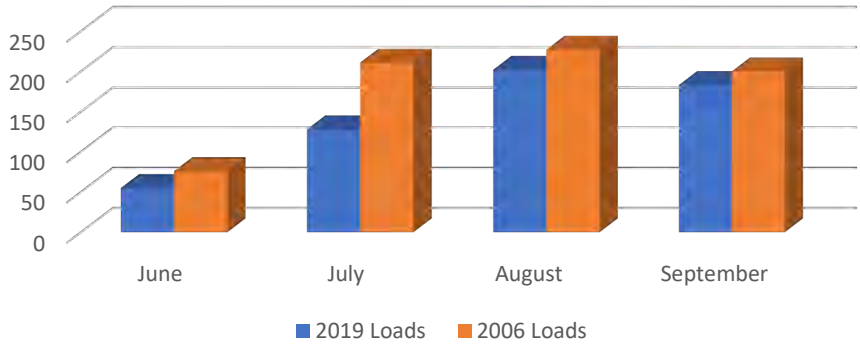
Harvesting Zones

Table 4-4, "Truckloads of Aquatic Plant Material Harvested," shows the number of loads removed in 2006 and 2019. In 2006, EWM was still the dominate plant, while in 2019, it no longer holds that distinction. The plot shows that more loads were taken out in June and July in 2006 than in 2019, partly due to the more rapid growth of EWM. The current harvesting goal is to provide access from clusters of docks and in the general area of the end of docks. This goal allows the harvesting to occur in the area where it is needed while leaving other locations unharvested to provide fish habitat. The harvesters are large so harvesting between docks is avoided. When the harvester is skimming debris the cutterhead is only a foot or so below the water surface, preventing damage to the equipment by underwater obstacles.

During 2020 and 2021, the harvesters were deployed to skim off loose floating mats of aquatic plants that interfere with lake access and boating. Both eel grass and star grass have been the dominate plants in the floating mats. In 2022, the operation of the harvesting program will be

refined, but the fundamental goal is to clear paths in aquatic plant beds so that multiple docks and riparian owners will be able to use their docks and the area around the docks will continue.

TABLE 4-4 TRUCKLOADS OF AQUATIC PLANTS HARVESTED BY MONTH



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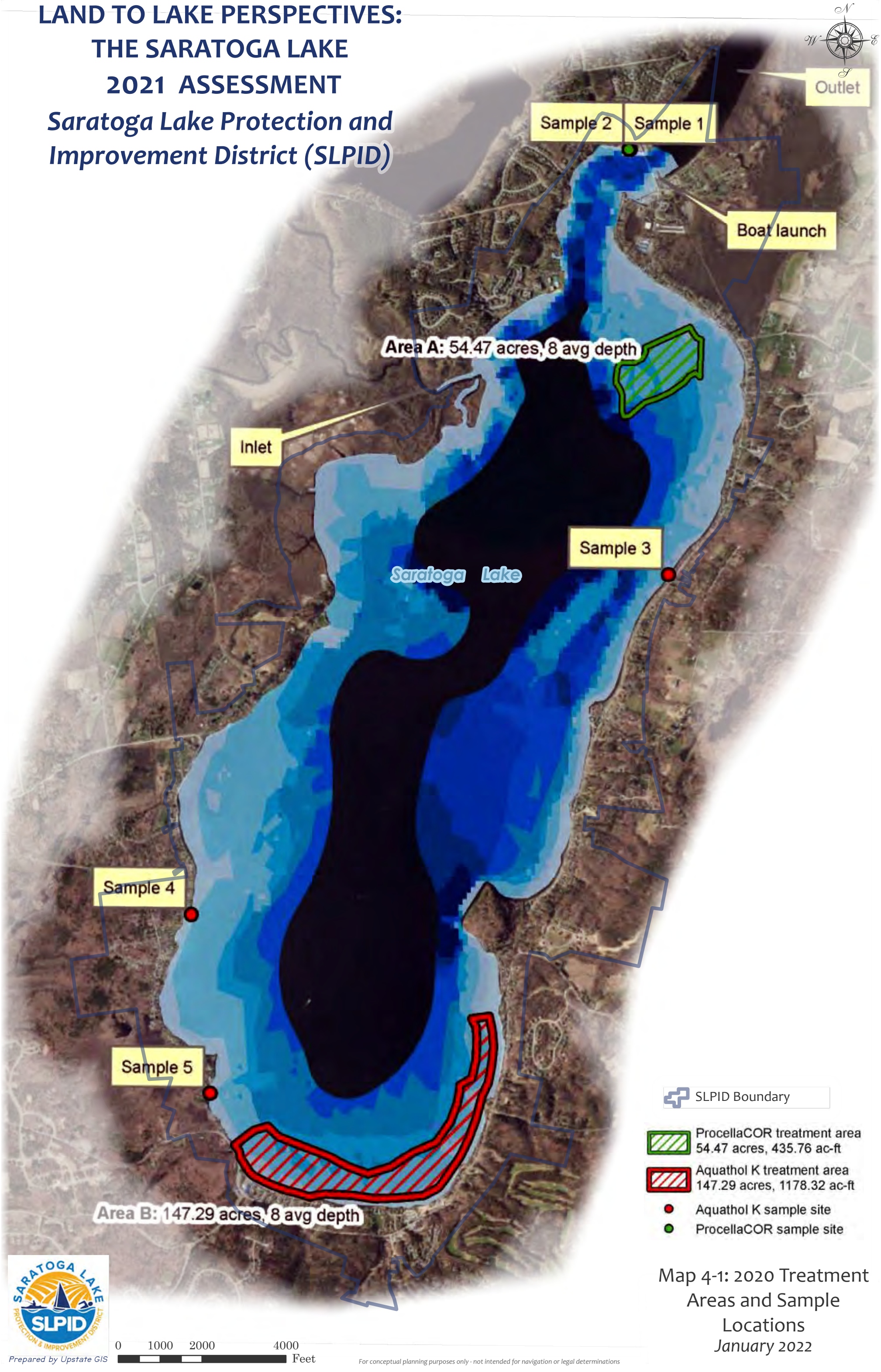

Map 4-1: 2020 Treatment Areas and Sample Locations

January 2022

4.3 Findings and Recommendations

Findings

Aquatic invasive species are an ongoing problem on Saratoga Lake. Their presence can lead to habitat degradation and loss of wildlife. Along with loss of recreational opportunities and income, aquatic invasive species can damage drinking water and infrastructure. For example, zebra mussels, an aquatic invasive found in Saratoga Lake, can grow on infrastructure systems such as water intake pipes, irrigation pipes, and power plants. Zebra mussels also accumulate toxins in their tissues which are passed along the food chain to people who fish off the lake. Thus, aquatic invasive species pose health concerns for both people and the wildlife ecosystem.

In the United States, an estimated $120 billion annually is put into efforts to control and mitigate damage of invasive species. Unfortunately, as the climate warms, this number is expected to increase as aquatic invasive species become more prevalent and wreak more havoc. Many aquatic invasive species cannot survive cold winters. Thus, the ecosystem regulates invasive populations via a natural change in temperature. However, due to anthropogenic climate change, lakes in upstate New York are not getting as cold as they used to during the winter. This is problematic across the state. Large lakes in New York, such as Lake George and Lake Champlain, are freezing over less frequently. This not only means a longer life span for existing invaders, but warmer winters mean new invasive species will tend to migrate northward. A comprehensive strategy needs to be expanded to a trend towards milder winters to manage aquatic invasive species.

Therefore, there continues to be a need to manage both invasive and native aquatic plant plants according to the existing Integrated Pest Management Plan for aquatic plant management. The program will need to be continually modified to responsibly respond to new invasive species and improved control techniques. Biological controls may become available in the future to treat certain species and will be evaluated as needed.

Recommendations

1. **Aquatic Plant Inventory**

The rake toss aquatic plant survey should be continued on an annual basis. This survey identifies the need for herbicide and other treatments in 2023 and beyond. As a part of the 2022 survey, additional sampling should be completed around the bed of water star grass and eel grass to better map their location and density. SLPID should continue to fund and utilize comprehensive annual aquatic plant survey to identify locations for herbicide applications and identify emerging needs, as well as review and update procedures annually and adjust as needed, while increasing surveys of the lake for invasive species control and hand-pulls.

2. **Harvesting Program**

Continue to operate the mechanical harvesting program that now consists of three FX-11 Alphaboat harvesters and supporting equipment. The SLPID Weed Harvesting Program reduces weed abundance, clearing pathways to open water for recreation via cutting and/or scooping loose weeds reducing pollutant loads and nutrient enrichment. The operation of the harvesting program will be refined in 2022 but the plan includes beginning harvesting at the end of May or early June to limit disturbance of bass species tending their nest in shallow water. Continue to

survey and hand harvest European Frogbit. Control water chestnut through a combination of complete plant removal by mechanical equipment, hand harvesting, and herbicides. Ongoing tasks include:

- Continue planning with the Quaker Springs Fire Dept. and the Town of Saratoga on sharing access at Fitch Road.
- Purchase new signage for equipment, first aid supplies, and complete safety manual. Keep communicating on options for dumping sites if needed and provide information to the Saratoga Lake Organic Compost Co. for a future business plan.
- Continue messaging outreach to the public to remove aquatic invasive species (AIS) on their own shoreline and in-between docks.

3. Rapid Response Program

SLPID should review and update the rapid response protocol that identifies the procedures to occur in the event of introduction of a new aquatic invasive species. Incorporate new groups involved in invasive controls and new techniques for invasive species control as they are approved. Keep a reserve in the budget each year in case of the discovery of a new invasive. Have a procedure in place for a rapid response plan and a list of pre-approved contractors for permits. Keep Lake stewards informed on AIS identification.

4. Herbicide Treatments

Continue to utilize herbicides as needed to control aquatic invasive species. Select herbicides based on target species, choose systemic mode of actions for longer control, limit impacts on non-target species. A Eurasian watermilfoil herbicide treatment will not be required in 2022. Water chestnuts will be controlled by mechanical removal using the Weedoo machine. Continue to conduct plant surveys annually and evaluate the need for herbicide use to control aquatic invasive species.

5. Draw Down

Continue to use drawdown of Saratoga Lake to limit plant growth in depths between 0-1 meter in water depth.

6. Unmanaged Invasive Species

Currently, emergent or wetland invasives, including purple loosestrife and Japanese Knotweed are not managed by SLPID and would require a management plan for their control. This could be done as a cooperative effort with riparian municipal governments and landowners but may require a different funding mechanism such as federal, state, and local grants. All control measures carried out by SLPID must be within the district.

SECTION 5 LAKE USE REGULATIONS

5.1 Introduction

Saratoga Lake has a mostly sensitive shoreline with little natural protection, such as a rocky or well-forested/vegetated shoreline. In addition to the lake, many streams and wetlands along the shoreline contribute significant natural resource value to the lake. This condition makes it important to maintain the natural shoreline to the greatest extent possible. Adding fill or dredging material from the lake can yield significant negative impacts to fish nests and small animal and amphibian passage between the water and the shore. In addition, erosion and sedimentation can result in serious and long-lasting environmental damage.

To ensure the shoreline is kept in its natural condition to the greatest extent possible, the NYS Department of Environmental Conservation established a permit process to guide property owners who desire to add fill to their individual shorelines. The permit process contains standards that are designed to protect the natural environment, animal habitat, fisheries, and general water quality of the lake. In addition, a federal permit may be required from the US Army Corps of Engineers. Federal permit requirements kick in when the amount of fill requested reaches a certain threshold. The determination of whether additional permits, including a federal permit is required, occurs during the general permit process, which requires the applicant to complete a Joint Application Form that is sent to both DEC and ACOE.

A landowner who wants to excavate or place fill in navigable waters of Saratoga Lake, including adjacent and contiguous marshes and wetlands, is required to obtain a Protection of Waters Permit from NYSDEC before any work is started. Projects will require either a minor or major permit from DEC. Generally, Minor projects have shorter review time frames and require less public review. Minor Excavation or Placement of Fill in Navigable Waters projects include:

- Fill of less than 100 cubic yards.
- Maintenance dredging occurring at least once every 10 years.
- Excavation of an area of 5,000 square feet or less.
- Installation of riprap of less than 100 linear feet for each parcel of land.
- Repair or replacement, in-kind and in-place, of existing structures.

For information on submitting a permit consult the following website: https://www.dec.ny.gov/permits/6230.html

5.2 Saratoga Lake Regulations

Boat speed is the only on-lake regulation and is strictly enforced by the Saratoga County Marine Patrol. Speed in the channel 1,200 feet either side Route 9P bridge is limited to 5mph. Figure 5-1, “Saratoga Lake Speed Limits and Buoy Distribution,” illustrates how the speed zone is delineated with channel buoys. There is a No Wake Zone within 200 feet from shore, the end of docks, and in the vicinity of other boats. On most other lakes the No Wake Zone is 100 feet from the shoreline or docks. The Navigation Law restricts the overall speed limit on Saratoga Lake to 45mph during the daytime hours and 25mph from ½ hour after sunset to ½ hour before sunrise.

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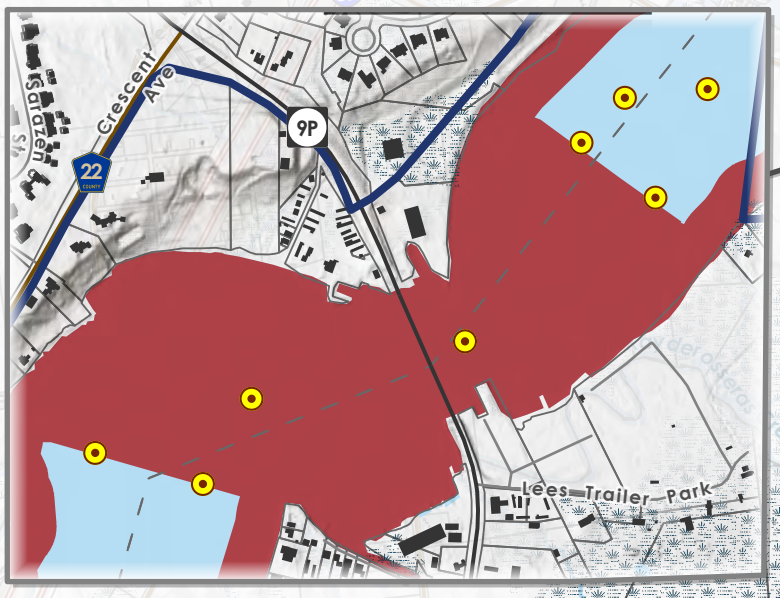

Saratoga Lake

Fish Creek

Interlaken

Point Breeze Marina

Waters Edge

Saratoga Springs

Malta

Cedar Bluffs

Nielson Rd

Chapman Hill Rd

Creek

Drummond

Manning Cove Rd

Mannings Cove

Malta Ave Extension

Riley Cove

Dunning Rd

King Rd

Oak Rd

Locust Rd

Collamer Rd

Lakeside Acres

Snake Hill

Maple Shade

Saratoga Stillwater

Brown Rd

Turner Rd

Putnam Rd

Fuller Rd

Luther Rd

Southshore Marina

Saratoga Lake Golf Club

Francis Corners

Gorsky Dairy Farm

- SLPID Boundary
- Tax Parcels
- Municipal Boundaries
- USFWS NWI Wetlands
- 5 MPH Buoys
- 5 MPH Zone (200' from shore and as designated near outlet)
- 45 MPH Zone (25 MPH 1/2-hr after sunset to 1/2-hr before sunrise)

0 1000 2000 4000 Feet

Prepared by Upstate GIS

For conceptual planning purposes only - not intended for navigation or legal determinations

Map 5-1: Saratoga Lake Speed Limits and Buoy Distribution

January 2022

5.3 Docks, Boats, and Marinas

There are presently no rules in place regulating the number, length, width, type, shape, or use of docks on Saratoga Lake in any of the four communities that border the lake. Lake residents believe flexibility is needed regarding the size and number of docks. Narrow lots, low water depth, and the presence of aquatic vegetation all serve to create limitations on the placement of these structures on the lake. NYS law provides riparian owners use of the waterfront if they do not interfere or prohibit other riparian owners' rights to maintain the water in its natural flow or existence. Each riparian owner has the burden of balancing his use with other riparian owners' uses. Figure 5-2, "Waterfront Public and Commercial Access," illustrates that marinas are primarily clustered at the north end of Saratoga Lake.

Structures that fall below or outside the parameters of the regulatory jurisdiction of OGS or DEC, are not regulated except through Chapter 791 of the Laws of 1992, amending Article 42 of the Executive Law (Waterfront Revitalization and Coastal Resources Act) which now provides local governments with the clear authority to comprehensively manage activities in near shore areas by developing comprehensive harbor management plans and adopting local laws and ordinances to implement these plans.

With this understanding, in 2012, SLPID put forth a proposal to the four municipalities to adopt a uniform set of standards for docks. The dock regulations provided a limitation to the number of docks related to the amount of an individual's shoreline and a simple set of standards for the construction of docks, moorings, and marinas. The proposal also suggested creating a mandatory fee and sticker program for motorboats. The fee was aimed primarily at non-resident boats. Funds generated from this program would be used for programs to preserve the resources of the Lake and the safety of its users. A draft law was developed to introduce the public to the idea, provide an understanding for why regulations and fees are necessary, and to find out whether there is public support for this concept.

A presentation was held at a joint public meeting with the Saratoga Lake Association and Saratoga Lake Protection and Improvement District on July 19, 2012. Feedback at that meeting did not support the dock regulations or boat fees and they were not moved forward. However, there was strong support to move the dock regulations forward as guidelines rather than regulations. See more information at: https://slpid.org/guidelines-for-docks/

To date, none of the four municipalities have adopted the guidelines. According to the NYS Office of General Services (OGS), Saratoga Lake is not "sovereign owned" because of the 1708 Kayaderosseras Patent from Queen Anne. OGS does not therefore claim authority, nor do they require project review or underwater land leases on Saratoga Lake. NYS DEC is the main agency that oversees dock construction over underwater lands not owned by the state. Projects that are exempt include the construction, reconstruction, or repair of a docking facility for five or less boats in a perimeter area of less than 4,000 square feet, including all relating water surface area. These usually involve marina facilities since most dock facilities on Saratoga Lake would fall well under these criteria and therefore would be exempt. However, if a dock project involves fill below

the mean high water, it is regulated as a disturbance under NYS DEC Article 15, Protection of Waters, and requires a permit.

The New York State Office of Parks, Recreation and Historic Preservation has jurisdiction over floating objects in navigable waters of the state, outside the Adirondack and Catskill Parks. The following regulations apply to Saratoga Lake:

- A revocable permit is required for the placement of mooring buoys, bathing beach markers, swimming floats, speed zone markers, or any other floating object having no navigational significance.
- Adjacent upland owners may place one mooring buoy and one swimming float of not more than one hundred square feet of surface area, in the waters adjacent to and within the boundaries of their shoreline, provided however, that no floating object and no vessel or part thereof which is secured to a mooring buoy shall at any time extend more than one hundred feet from shore and further provided that no floating object may be placed in a navigable channel or in any location in which it will interfere with free and safe navigation or free access to another person's property.

The US Army Corps of Engineers developed a set of guidelines (not regulatory policy) in 1991 to minimize the impacts to navigation. These guidelines can be adopted into local ordinances (they have not in Saratoga Lake). These guidelines include:

- Prohibiting structures that extend into traditional navigation ways.
- Allowing replacement structures that do not extend beyond the length of the existing one.
- Limiting the length of structures to less than 25% of the width of the waterway.
- Discouraging the placement of a structure within 25-feet of riparian lines.
- Establish a minimum of 50 feet between docks.
- Recommendation that moorings be located as close as practicable to an applicant's property.

5.4 State and Federal Wetland Regulations

To ensure the shoreline is kept in its natural condition to the greatest extent possible the NYS Department of Environmental Conservation established a permit process to guide property owners who desire to add fill to their individual shorelines. The permit process contains standards that are designed to protect the natural environment, animal habitat, fisheries, and general water quality of the lake.

A federal permit may also be required from the US Army Corps of Engineers. Federal permit requirements kick in when the amount of fill requested reaches a certain threshold. The determination of whether additional permits, including a federal permit is required, occurs during the general permit process, which requires the applicant to complete a Joint Application Form that is sent to both DEC and ACOE.

A landowner who wants to excavate or place fill in navigable waters of Saratoga Lake, including adjacent and contiguous marshes and wetlands, is required to obtain a Protection of Waters Permit from NYSDEC before any work is started. Projects will require either a minor or major

permit from DEC. Generally, Minor projects have shorter review time frames and require less public review. Minor Excavation or Placement of Fill in Navigable Waters projects include:

- Fill of less than 100 cubic yards.
- Maintenance dredging occurring at least once every 10 years.
- Excavation of an area of 5,000 square feet or less.
- Installation of riprap of less than 100 linear feet for each parcel of land.
- Repair or replacement, in-kind and in-place, of existing structures.

The following website should be consulted for information on submitting a permit: https://www.dec.ny.gov/permits/6230.html. Contact the NYSDEC Region 5 office in Warrensburg with questions about completing the application form and other required information for applications.

5.5 Findings and Recommendations

Findings

Saratoga Lake is generally experiencing an increase in the number of docks and numbers of boats at individual properties that may lead to overuse of the lake. Many modest seasonal lakefront residences are being converted to larger homes creating more impervious surfaces, less green space, and increased uncontrolled/treated runoff. Correspondingly, the demand for docks, piers, boat lifts, mooring anchors, buoys, and swim floats is expected to increase. Boat sales have escalated in the last few years, and the 2020 Boat Census indicated that this trend is already translating into more boats on the lake. Airbnb's and the rental of residential dock space to non-residents are popular trends that often create conflict between neighbors and a general loss of quality of life for all lake users.

Much of the issue with dock length is unavoidable. The lakeshore typically consists of narrow lots, and low water depth occurs out to one-hundred feet or more from shore. These limitations, plus the presence of dense aquatic vegetation, all serve to create restraints on the placement of docks on the shoreline. The impacts from conflicts often result in a decrease in the overall quality of recreational experience for both visitors and residents. A counter point of view is that there is no need to regulate docks because there are relatively few problems with the size, length, and use of docks in the current environment. The Lake's depth widely varies, and residents need the greatest amount of flexibility in design for both docks and swim floats.

Recommendations

1. **Managing Dock Structures**

Currently, there is no clear support from the four lakeside municipalities to approve a uniform set of dock regulations. SLPID developed a set of dock guidelines in 2012. These guidelines should be reviewed and simplified to reflect the present needs and interests of the riparian municipalities. However, as guidelines, these rules would have little impact on the dock environment since there would be no municipal regulatory oversight.

2. **Annual Dock Survey**

SLPID should continue to conduct an annual survey on the number, type, and length of docks throughout the lake. Also, monitor dock rental trends and identify issues with parking, neighbor

conflicts, and boat congestion. To improve the annual boat count process, an aerial drone may be used to record images of the shoreline condition and clearly show the length of docks number and style of boats along the lake shore.

3. Annual Boat Survey

SLPID should continue to conduct an annual boat count of recreational activities on the lake during the summer.

SECTION 6 BOATING AND RECREATION

6.1 Recreational Boating

Saratoga Lake is a recreational resource used by thousands of sport fishermen and recreational boaters each year. Saratoga Lake is a prime destination because it is located just east of the Adirondack Northway, and only 25 miles from the Capital District, which represents 800,000 people. The lake is also the focal point for residents in Saratoga County itself.

According to the 2020 Census, the Saratoga County experienced the fifth largest percent increase in county population from 2010 to 2020. On the local level, the Town of Malta's population grew by 16% or 2,356 people, the Town of Saratoga's grew by 2.4% or 134 people, the Town of Stillwater's grew by 8.9% or 735 people, and Saratoga Springs grew by .2% or 1,905 people. More people mean more boats. NYSOPRHP reports there were 13,918 boats registered in Saratoga County in 2020 (2020 Recreational Boating Report). In 1999 there were a total of 13,693 registered boats, indicating the number of registered boats has remained remarkedly stable over the last 20 years. The numbers do not consider boats using the lake that are registered in other parts of the state or from other states.

One of the reasons there is a robust recreational boating community on Saratoga Lake is that there is abundant public access. The primary public access is the Saratoga Lake State Boat Launch operated by New York State Parks (NYSOPRHP). Lake access is also available at eight marinas, most of which offer day use launch, plus parking spaces and rent seasonal dockage. The Saratoga Lake Sailing Club and several rowing clubs also have access to the lake, plus several restaurants offer either boat access or marina facilities and dock space. There are also three dedicated canoe and kayak access points along Kayaderosseras Creek and Fish Creek.

SLPID Lake Stewards are stationed at the State Boat Launch with the primary focus of surveying the boat traffic and inspecting and removing any aquatic invasive species before boats enter Saratoga Lake. Many of these boats are used in other lakes and streams providing the opportunity for plant and animal aquatic invasive species from those waterbodies to be introduced to Saratoga Lake or for them to be spread from Saratoga Lake to other water bodies.

For many years, SLPID has fielded complaints from the public about the condition of Saratoga Lake and the quality of their boating experience. During the summer of 2018, the Stewards collected data on launch users. While this activity was entirely voluntary on the part of participants, most were willing to take the survey.

Activity at the State Boat Launch has more than doubled since records have been kept (1996). State boat launch statistics show an increase from 32,413 people admitted to the boat launch in 1996, when fees were first collected at the facility, to 75,545 in 2010, with a peak of 109,089 in 2007 (numbers have not been recorded since 2016). The average yearly attendance in the period 2001-2010 was 78,080. Note that not all of those entering the boat launch were engaged directly in boating; some were spectators for events, such as rowing regattas. Also, the state shifted to an automated parking fee collection system, therefore user numbers are not reliable after that

point. The most recent exit survey occurred at the Saratoga Lake State Boat Launch over a period of 9 days in July 2020. Approximately 174 boaters volunteered to take extra time to answer a total of 6 questions about their time on the lake that day. Most of the take-away's were very encouraging:

- About 50% of all boaters were out on the lake for 3-4 hours and 27% were out 4 or more hours.
- The main boating activity (54%) was fishing followed by general boating at 36%.
- Most people had no problem utilizing the launch.
- Only 5% of boaters encountered weed issues.
- Nearly 80% of boaters reported a "great" boating experience. Only 2% expressed having a poor experience.
- Of the 32 individuals that responded to issues they encountered on the lake, 22 identified fishing as an issue. Many expressed frustrations with too few fish to catch and were concerned that the decrease in weeds may be a related issue.

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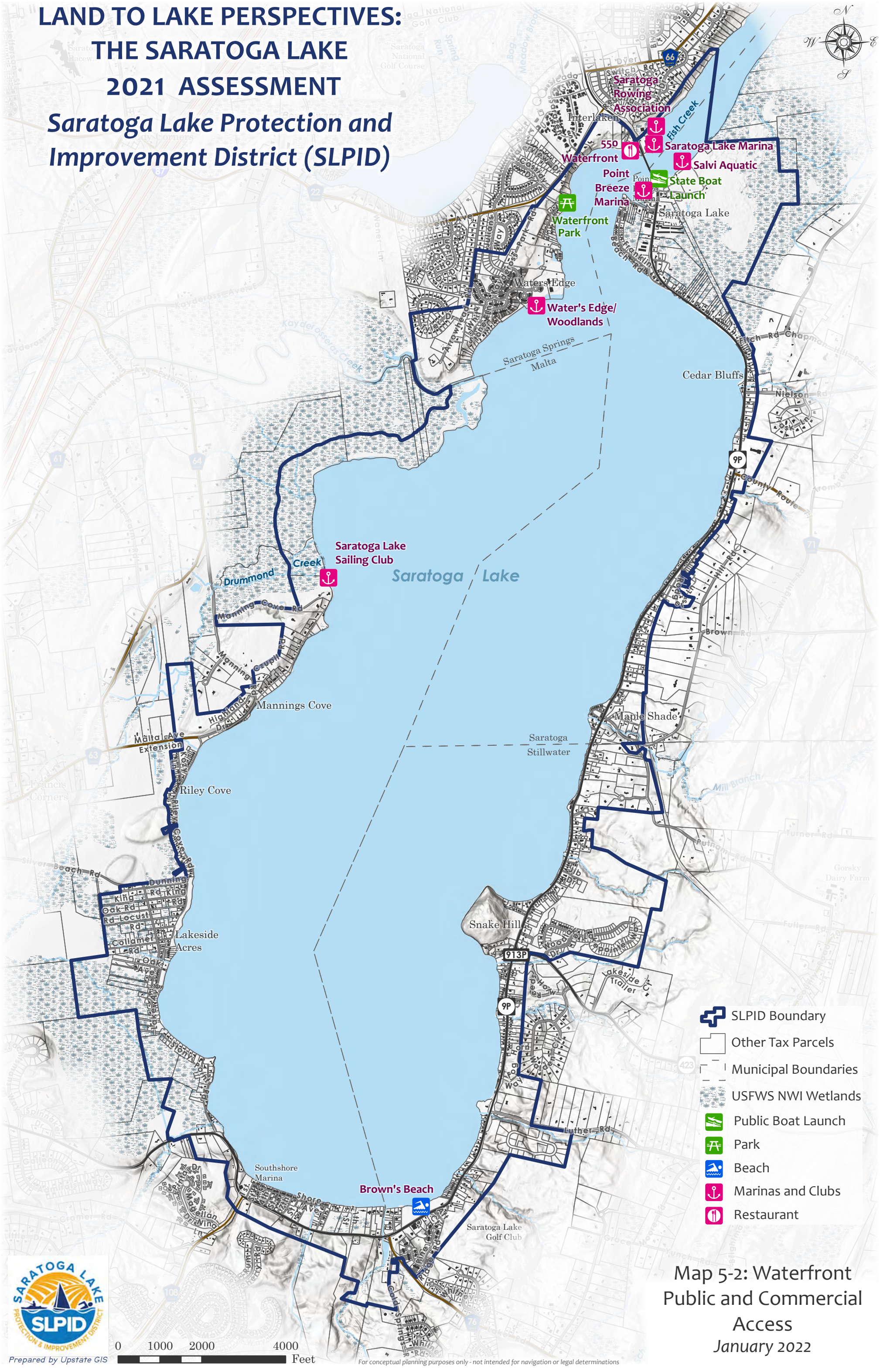


Map 5-2: Waterfront Public and Commercial Access

January 2022

6.2 At-Dock and On-Land Boat Counts

In 2000, SLPID began a boat count of the number of boats that are inactive and docked in the water or dry-docked at both commercial marinas and residential properties. On weekdays the counts are conducted when boat traffic is light, with most resident boats inactive. The information presented in Table 6-1, "At Dock and On-Land Boat Count Survey 2020/2021," estimates there were 2,262 "resident motorboats" on Saratoga Lake in 2021. This represents an increase of 336 motorboats. Approximately 50% were located at commercial marinas and 50% at private properties. About 1,333 non-motorized boats were counted, 49% of which are located at private residences. 54% of the non-motorized boats are kayaks, up from 45% in 2020.

TABLE 6-1 AT-DOCK AND ON-LAND 2020/2021 BOAT COUNT SUMMARY

	Commercial		Private		Total	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**
Motorized Boats	***1,014***	***1,126***	***912***	***1,136***	***1,926***	***2,262***
Motorboats	985	1,072	686	759	1,671	1,831
Jet Skis	29	54	226	377	255	431
Non-Motorized Boats	***356***	***679***	***533***	***654***	***889***	***1,333***
Kayaks	130	345	272	380	402	725
Canoes	20	61	56	49	76	110
Sailboats	122	150	27	37	149	187
Other Small Craft	84	123	178	188	262	311

Most of the motorboats at marinas are kept at Point Breeze Marina, South Shore Marina, Lee's Campground, and Brown's Beach Marina. Most of the kayaks are rentals at The Kayak Shak. As expected, most sailboats (127) are kept at Saratoga Lake Sailing Club.

6.3 On-Lake Boating Annual Census

SLPID has been actively monitoring the number and type of boats actively using Saratoga Lake since 2016. The 2021 lake wide boat census was conducted on Saratoga Lake on Sunday, August 29, 2021, from 1:00 -2:30 pm in sunny 72-degree weather with a light breeze. Past boat counts had been conducted on a fair-weather weekend day in July before track season started. This year the weather did not cooperate, and the boat census had to be scheduled in August. Table 6-2, "On-Lake Boat Count," shows the numbers for the last three seasons.

For consistent counting purposes, the lake was divided into 7 geographic zones. Boats were counted by category: active, anchored, and non-motorized. Boats moored or parked at docks were not counted as part of this effort. However, an independent count of boats "at-dock" or stored in boat yards was conducted.

The boat census yielded a total of 255 boats active on the lake between 1 and 2pm. This count includes approximately 49 boats moored at Manning's Cove/Sandy Bay and 10 moored at Sandy Point. This number is 272 less boats than counted in 2020. However, the 2020 annual boat count showed an increase of 185 boats (54% increase) over the 2019 boat count. Most of the increase

was in the overall number of boats anchored in Manning Cove (Sandy Bay) or Stoney Point. The increase was also due to many more kayaks and paddleboards in the Fish Creek area. This significant increase could be explained by a combination of very warm and sunny weather, and the pandemic, which has given some people more time for leisure activities with appropriate social distancing. The increase was also due to the availability of more kayaks and paddleboards rentals in the Fish Creek area.

TABLE 6-2 ON – LAKE BOAT COUNT			
	2021	**2020**	**2019**
Total Actively Moving Boats	***198***	***252***	***219***
Jet Skis	15	35	31
Motorboats	168	166	152
Non-Powered Boats	12	51	36
Anchored Boats	***60***	***275***	***122***
Total Boats	***255***	***527***	***342***

As shown in Table 6-3, "Total Boat Count Comparison 2016-2021," the average number of boats during the six-year period of 2016-2021 was 362 boats, therefore 2020 indicates a significant increase and 2021 a significant decrease over the typical year.

TABLE 6-3 TOTAL BOAT COUNT COMPARISON 2016-2021						
2016	**2017**	**2018**	**2019**	**2020**	**2021**	**6 – Year Average**
342	368	338	342	527	255	362

Table 6-4, "On Lake Boat Count Summary Comparison 2016-2021," provides a detailed summary of where boats congregated on Saratoga Lake. The most significant finding relates to two specific areas of the lake- the Sandy Bay area where boats individually moor and raft together, and the area of the 9P Bridge. At its highest use, the area between Kayaderosseras Creek south to Riley Cove (mostly Sandy Bay) has seen up to 137 boats at one time (2020 boat count).

Congestion in the vicinity of the 9P Bridge is common during times of high boat activity on weekends. It is not unusual to have several boats in a holding pattern on the north side of the bridge with boats trying to launch and leave both the State Boat Launch and the Saratoga Marina launch. This situation is made more complex with a large increase in SUPs and kayaks in the Fish Creek approach on the north and south side of the bridge. The area near and under the bridge is narrow and extremely limited and made more problematic by other motorized and non-motorized trying to pass under the bridge.

TABLE 6-4 ON-LAKE BOAT COUNT SUMMARY COMPARISON 2016 – 2021

	Active Boats						Anchored Boats						Non-Motorized					
ZONE	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Browns Beach to Snake Hill	12	15	15	19	16	24	1	12	13	5	7	0	11	10	1	1	13	1
Snake Hill to Maple Shade	57	4	12	24	9	20	0	9	12	6	43	1	16	20	1	13	1	0
Maple Shade to Cedar Bluffs	14	13	6	12	9	17	1	5	0	3	8	0	1	5	1	0	0	0
Cedar Bluffs and Kayaderosseras Creek to 9P Bridge	31	31	57	55	27	70	1	5	3	1	9	0	14	31	6	15	3	5
9P Bridge to SLPID Boundary	5	19	10	27	67	17	1	0	8	0	13	0	0	12	4	6	14	4
Kayaderosseras Creek to Riley Cove	37	16	16	22	39	6	88	71	101	88	137	49	3	25	14	0	5	0
Riley Cove to Stony Point	25	14	33	23	34	29	14	39	19	19	58	10	10	12	10	2	15	2
TOTAL	181	112	149	183	201	183	106	141	152	122	275	60	55	115	37	37	51	12

6.4 Boating Safety

Saratoga Lake is regularly patrolled by the Saratoga County Sheriff's Department Marine Division and supplemented on weekends with NYS Police marine patrol units. The Sheriff's Office enforces the boating laws of the state and county and provides education on how to practice safe boating by always providing personal flotation devices, PFDs, for all boat occupants. It is the responsibility of boat operators to exercise caution and control when operating motorized vessels and boaters are reminded that all motorized boats must be registered with the NYS Department of Motor Vehicles. The Saratoga County Sheriff's Department reported a total of 6 boating incidences on Saratoga Lake in the last 5 years. This does not include incidences reported by the NYS Police and the NYS Park Police.

Fish Creek

The area of the bridge represents the epicenter for boat activity on Saratoga Lake since it is anchored by the State Boat Launch and supported by commercial docking for over 700 boats. This is a critical pinch point where boats from the marinas of Fish Creek and the State Boat Launch converge and move out into Saratoga Lake under the 9P Bridge, where they encounter more boating activity generated from several other active marinas on the south side.

The cause of the many recent complaints and concerns may be explained by recent expansions and other improvements at several nearby marinas. In addition, the State Boat Launch has realized an increase in usage regularly reaching its maximum capacity throughout the 2020 summer months. The number of kayaks and paddleboards has risen significantly which has resulted in congestion around the area of the 9P Bridge and a concern for safety going forward.

To respond to this concern, SLPID is investigating the potential for widening the navigational channel at the 9P Bridge. In 2019, the buoys were positioned to mark the described boundary of the 5mph zone as defined in local laws of the Town of Saratoga and the City of Saratoga Springs. These boundaries were reviewed by Saratoga County Sheriff's Department and Saratoga Rowing Association/Club. SLPID made some adjustments to the 5mph buoy locations. SLPID is further considering whether the navigational channel can be adjusted to permit and direct non-motorized boats into the two side channels when going under the bridge. Also, SLPID has requested that both Saratoga Marina Boat Club and 550 Union Avenue re-arrange their docks so that there is more space on the east side to allow non-motorized boats to pass in between the marked navigation channel and docks. In this area boats leaving their docks were backing out into a limited amount of space or fairway between docks and channels. Operators have agreed to adjust dock arrangements and post signage to warn boaters to be aware of non-power boaters in the area.

SLPID conducted a one-day study on July 19, 2020, to observe that boat traffic in the region between Stafford's Bridge and the 9P Bridge. The drone company, *Hand and Frame Creative*, was hired to gather video and aerial photographs of the area over a half-hour period when boat traffic was at the highest level of the day. The photos were able to show all the marinas in the north end in the vicinity of the 9P Bridge giving good data for use and occupancy, parking, and numbers of boats out on the lake at one time.

There are five marinas between the area of the 9P Bridge and Stafford's Bridge. These marinas support docking for approximately 706 boats. Approximately 223 boats were out of their slips between 1:00 and 1:30 p.m. This represents that approximately 32% of all boats docked at marinas (assumes 100% slip occupancy at all five marinas) and can be assumed to be the maximum since it was a beautiful weekend summer day. A summary of the resources of the five marinas and State Boat Launch are provided in Table 6-5, "Summary of Marina, Docks and Boat Information".

Additional boats were generated at the State Boat Launch. According to the records of the SLPID boat stewards, there were a total of 222 boats checked in by the Stewards on July 19. These included 161 motorboats, 55 PWCSs, and 6 kayaks. This count did not include the estimated 25 boats that did not elect to stop at the boat inspection checkpoint.

One of the elements to consider for future seasons is the potential for a significant increase in the number of boats using Saratoga Lake at the same time. As noted in the above discussion, only 32% of the boats currently leasing slips at the five marinas observed were out on the day of the boat count. The number of boats remaining in commercial marina slips was approximately 483.

This means there is the potential to nearly double (92% increase) the number of boats that were out on Saratoga Lake on the day of the 2019 boat count. However, the NYS Boat Launch has limited parking which limits the number of boats that can access the lake at any one time. Even a modest increase in the number of active boats on the lake would effectively decrease Saratoga Lake's carrying capacity and potentially result in congestion and safety concerns.

TABLE 6-5 SUMMARY OF MARINA DOCKS AND BOATS INFORMATION

MARINAS	# DOCKS, BOAT SLIPS, AMENTITIES	# BOATS OUT ON LAKE	% BOATS OUT ON LAKE	# PARKING SPACES
Saratoga Marina Dock Club	9 dock complexes 147 slips launch 2 tour boats rental boats (future)	54	37%	70+
Saratoga Lake State Boat Launch	boat launch only boat inspection & wash station	-	-	59 trailers plus 5 handicap, 10 cars plus 2 handicap cars
Lee's Park	8 dock complexes 192 slips 1 launch with dock boat rentals, pontoon boat tour, hydro hover board, jet ski rental	73	38%	65+
Point Breeze Marina	7 dock complexes 172 slips 1 launch & gas dock Boat sales & rentals	54	31%	53+
550 Waterfront	3 dock complexes 96 slips (potential expansion to 139) restaurant boat rentals	22	23%	141+
Fish Creek Marina	7 dock complexes 101 slips kayak rentals restaurant	20	20%	52+

Notes: Numbers are estimated from aerial photos. Assumes all marina dock spaces are rented. The number of boat slips and parking spaces at marinas are estimated based on aerial photos taken on July 19, 2020.

6.5 Carrying Capacity of Saratoga Lake

Saratoga Lake is a finite resource that is in high demand. As residential development and public access increase, boating and other on-lake recreational activities increase as well. This increased use, coupled with increases in boat size and speed, has made lake over-crowding an issue for many lakes. Balancing lake use with ecological, economical, and aesthetic impacts is paramount in arriving at balanced and sustainable use levels.

Many factors influence the estimation of a lake's recreational carrying capacity. These include the physical characteristics of the lake including size, shape, depth, shoreline development, the lake's use characteristics (the number of lakeside homes, number of moored and off-lake boats, number of access sites and density of their use, etc.); environmental impacts to the aquatic plant community or lake sediment; area of the lake available for boating; boat density; and most importantly aesthetic preferences.

Saratoga Lake has approximately 4,000 acres of surface water. An estimated 800 acres can be subtracted out where it is either too shallow or too weedy for boats to navigate freely, and areas where boat speed is restricted. Subtracting this acreage out leaves roughly 3,200 acres that could conservatively be considered navigable. Utilizing a factor of 12 acres per boat to determine safe carrying capacity (a typical average that considers all boat activities), a maximum total of 267 boats on the lake at any one time is recommended. This calculation includes boats that are actively cruising. Anchored boats are generally left out of the equation since they are not using up a lot of lake surface real estate. Kayaks and other small boats are also omitted since they are mostly clustered in the speed restricted zones or near the shoreline.

TABLE 6-6 MOTORBOAT CARRYING CAPACITY ON SARATOGA LAKE 2016-2021
(Based on 3,200 acres lake surface)

	Active Motorboats Only	Acres Per Boat
2016	181	18
2017	112	28
2018	149	21
2019	183	18
2020	201	16
2021	183	18
6-Year Average	168	19

Recreational boating is dynamic, and activity is weather dependent, has timing constraints related to fishing or the type of boating activities, types of boats, and skill of boaters. During each of the survey years, when considering all boats on the lake, Saratoga Lake reaches carrying capacity during mid-day when the weather is good. The lower number of recreational boaters found on the lake in 2021 when the air temperature was lower shows the importance of weather. When the lake is crowded, resident boaters owning docks will choose not to use their watercrafts. Visiting boaters may choose to limit their activity on the lake by anchoring or leaving the lake after a short period of time as seen in the one past survey.

An analysis of boat traffic on the lake on 8/29/21 yielded a total of 183 active non-rafting motorboats and jet skis on the Saratoga Lake. Applying 3,200 acres of usable lake surface area yields a general boat density of approximately 18 acres per boat. While this is within the comfortable carrying capacity of Saratoga Lake, there are times when the lake will seem too

crowded, especially at peak times of the day for rafting and when the weather changes rapidly, and all are heading for shore. Table 6-6," Motorboat Carrying Capacity on Saratoga Lake," shows total number of active motorboats for 2016-2021.

6.6 Economic Impact of Recreational Boating

The presence of dense beds of EWM just offshore can result in the fouling of boat propellers, deterrence of sportsmen from fishing in those areas, and the inability to swim or otherwise enjoy the lake in those areas dominated by EWM. At Saratoga Lake, EWM has been controlled, and there are now occasional locations of dense mats of water star grass and eel grass that interfere with boating. The native plant community does not heavily restrict the movements of recreational boaters. The impact from dense beds of aquatic vegetation reduces the amount of lake surface for boaters to use creating the potential for a greater concentration of boats in limited areas. The impact of aquatic vegetation on economics has been quantified in a study of Houghton Lake in Michigan (Deamud et al. 2004). The study identified the economic effects on the local economy from the 2002 Sonar® treatment targeting EWM. The selected methodology for measuring these impacts was a written survey supplemented and supported by personal interviews. The result was a correlation between reduced EWM populations and improved economic impact. In addition, respondents believed that the benefits realized following the Sonar® treatment was well worth the costs incurred through special assessments.

Measuring economics related to fisheries, recreation, water quality, and ecology is complicated. Markets and values are difficult to define and measure. Human perceptions of their environment are different among lake user groups. Research suggests there is a direct relationship between the quality of the recreational experience and the number of times a visitor will recreate, and how much they are willing to spend in that location.

The economic impact from boaters on Saratoga Lake is significant to the local economy. Additional economic benefits are also realized from secondary impacts or "ripple effects" resulting from the original purchase of sales and services. Recreational activities that involve potentially significant expenditures tend to decrease when overall spending decreases.

6.7 Findings and Recommendations

Findings

Based upon data collected annually on boating activity on Saratoga Lake since 2016 recreational boating appears to be stable and generally safe. There are times when the lake will seem too crowded, especially at peak times of the day for mooring and, when the weather changes rapidly, and all are heading for shore. In addition, there is the onshore capacity at local docks and marinas for many more boats to be out on the lake at one time. At-shore surveys show only about one-third of the boats are out on the lake at any one time. Should this factor change, it would dramatically alter the safety factor of recreational boating.

Recommendations

1. **Annual Boat Census**

Continue to conduct the annual boat census of active boats on the lake on a peak use day. Also continue to conduct an onshore boat count on a low use day.

1. **Marina Standards**

Communities around the lake should adopt marina standards that address parking, boat pump out facilities, dock length and placement, and quick launching as part of individual land use codes. SLPID should actively review and comment on future proposals for expansions of marinas during the local SEQRA process to assure that responsible and safe design standards for marinas are considered.

2. **Enforcement**

Marine patrol enforcement of existing laws and regulations governing Saratoga Lake is adequate given available resources. This is especially significant for enforcement of boat speed in no-wake zones near the 9P Bridge and on Fish Creek. Continue to hold regular meetings between SLPID and the marine patrol throughout the summer season to review issues with boating on the lake. Continue to financially support the marine patrol in the SLPID budget to increased patrols during needed periods. Review existing 5mph buoy arrangement and make adjustments as required.

3. **Boat Launch Management**

Work with State Parks to continue the practice of bringing in a parking attendant on busy weekends and holidays to assist the lake stewards with the public and closing the launch when parking is full and/or the facility is too crowded. Patrol of the parking lot by various police agencies is important on weekends when the lot is at capacity, and there is the possibility of user conflicts.

SECTION 7 EDUCATION AND STEWARDSHIP

7.1 Education and Outreach Program

SLPID has a long-established and successful program of community outreach for their education programs. Outreach goes well beyond commissioners and the lake administrator fielding questions, concerns and complaints from both residents and visitors about various lake issues. Outreach efforts are proactive. SLPID has an up-to-date website, annual newsletters, lake community workshops, "Take the Pledge" program, floating classroom, and in-school education programs. In addition, SLPID provides critical information on the condition of the dam and monitors lake levels, boating safety, and weed harvesting trends. SLPID also conducts weekly water quality testing, lake surveys, various lake studies, yearly boat counts, watercraft inspections, and operates the boat wash station at the State Boat Launch.

With these efforts in place (and the establishment of the county sewer district around the lake in 1981) invasives are decreasing and Saratoga Lake has improved from a Class D in 1986 to its status of Class A. According to NYSDEC, the best usages of Class A waters are a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. This is evident in the outstanding diversity of wildlife in Saratoga Lake, which has experienced a healthy increase in fish, turtles, birds, bald eagles, osprey, and loons.
Outreach and education efforts are only successful with the active cooperation and participation of partners. The main partnerships include: The Saratoga Lake Association; Saratoga Lake businesses, towns of Saratoga, Stillwater, Malta, and city of Saratoga Springs; Saratoga County Planning Department; Saratoga County Soil & Water Conservation District; Cornell Cooperative Extension's Stormwater Management Coordinator; Adirondack Watershed Institute; and Darrin Freshwater Institute.

Some of the most important SLPID outreach efforts are described below.

Take the Pledge!

"Take the Pledge" is a program designed to encourage property owners within the Saratoga Lake watershed to commit to a group of actions that will demonstrate that collective small efforts can have a significant impact on the biodiversity and health of the lake. Simple changes in managing the stormwater and land disturbances on individual properties will help limit algal growth and harmful algal blooms, sediment run-off, bacteria, pathogens, and harmful impacts to aquatic life and wildlife. The Pledge includes the following landowner promises:

- *Minimize Runoff* by incorporating "soft-scaping" and buffers around the lakefront and any slope or hillside that has a chance to runoff into the watershed.
- *Say No to Fertilizers* by looking for alternatives to fertilizers and only using fertilizers after getting a soil test done at the county Cooperative Extension office to ensure that you are only using the minimum amount of fertilizer. Do not apply lawn fertilizer within 20 feet of any water body unless there is at least a 10-foot buffer of shrubs, trees, or other plants between the area you are fertilizing, and never apply before a storm.

- *Stop Pollution* by not throwing leaves, lawn debris/clippings, or animal feces into the lake.
- *Say No to Pesticides* and harmful cleaning agents and other chemicals. The bugs you see in and around the lake are also an important part of the ecosystem. Dangerous pesticides and lawn chemicals can be toxic to aquatic life and promote the growth of algae and weeds. Wash cars and boats well away from the lake.

Floating Classroom

SLPID offers a "floating classroom" in collaboration with the Adirondack Watershed Institute during the state's annual Aquatic Invasive Species Awareness Week. The floating classroom program was established in 2014 to educate school groups and the public about the local waters and various natural science topics. This interaction on the lake is often the first learning opportunity for a lot of local children. The classroom is a hybrid program that combines on-the-water instruction with shoreline activities. Participants are given the opportunity to learn about, and actively participate in different aspects of lake water quality sampling procedures. Common components of the classroom curriculum include sampling for aquatic invasives, pH, dissolved oxygen, and water temperature. SLPID also offers a smaller floating classroom on aquatic invasive species identification and reporting. These classrooms are offered to the public and guided by staff from the Capital District Mohawk Prism and SLPID.

A Guide to Creating Vegetated Buffers for Lakefront Properties

With partners from the Saratoga County/CCE Stormwater Management Program, Saratoga County Soil & Water Conservation District, and Saratoga Lake Association, SLPID developed and distributed a guide to implementing best management practices along shoreline lots. This handbook provides practical solutions for planning and planting homeowners' shoreline areas. Including buffers, or areas of vegetation situated between the urbanized environment and the water, traps sediment, excess nutrients, and other pollutants, prevents erosion, and helps to stabilize sloped areas and the shoreline. While the primary focus of this handbook is lakefront areas, the same principles apply to all waterfronts throughout a watershed.

7.2 Watercraft Inspection Steward Program (WISPA)

Watercraft inspection programs have existed in New York since as early as 2000 in the Adirondack region, at Upper St. Regis Lake and St. Regis Mountain through the Paul Smith's College and Adirondack Watershed Institute. This program, along with others, has since expanded to cover most of the boat launches throughout the Adirondack Park. The Watercraft Inspection Steward Program Application (WISPA) was developed to coordinate real-time data collected from stewards at launches across NY and store it in a single online database. Multiple partner organizations are currently participating in this program.

SLPID has funded and participated in a lake steward program since 2008. Originally the program started as a simple boat inspection program with boat steward's main task as inspecting watercraft for invasive aquatic species and removing all aquatic life from the watercraft by hand or by decontamination at the boat wash decontamination unit. This program has greatly expanded over the years and SLPID now participates in the WISPA program. The program, located at the State Boat Launch, currently provides boat and trailer inspections, conducts visitor surveys and provides extensive education to the boating public. The educational program is designed to implement control measures to prevent or eliminate the re-introduction or importation of aquatic invasive species. This program includes signage, educational materials, and one on one outreach efforts at the State Boat Launch. These interactions include handing out educational literature, quick visual inspection of boats, and encouraging a positive attitude toward invasive control.

The SLPID team also regularly take water samples from multiple parts of the lake. They prepare individual samples and send them to a lab for analysis. SLPID's stewards also participate in hand pulling water chestnuts and monitoring other aquatic invasives.

Watercraft inspection consists of visually inspecting all areas of boating and recreational equipment (i.e., boat, trailer, motor, live well, anchor, swim fins, scuba gear, etc.) that have contact with or hold water; removing all visible plants, animals, and mud; and draining water from all compartments and containers. These practices reduce the risk of movement of all plant and animal organisms from one body of water to another. The inspection season begins on Memorial Day through September. Stewards are

stationed at the Saratoga Lake State Boat Launch from 7:30 AM to 7:00 PM throughout the week and weekend and at local marinas when staff is available.

Boat stewards are required to complete a survey on each inspected watercraft. Some questions include what waterbody the watercraft has been in last, if the boater is aware of preventing the spread of invasive species, and if there are any organisms detected during the inspection. If an invasive species is identified a boat wash is recommended to the boat owner. Decontamination at Saratoga Lake uses both heated high- and low-pressure water to remove any microorganisms from the watercraft. Water is pumped directly from a well, using no chemicals and captured to prevent any run-off back into the lake.

7.3 WISPA 2020 Summary Report

During the summer of 2021, the lake stewards collected data from 13,646 boats. Most of the boats were registered in New York State, but the remainder came from 19 other states, including all the states bordering New York, as well as ones as far away as Florida, Montana, Arizona, North Carolina, Texas, and Wisconsin. The peak week for boat launches was Saturday and Sundays June 25th through July 1st.

Below are some summary statistics from the *Report for 2020 Watercraft Inspections – SLPID.* Tables 7-1 through 7-4 provide the detailed responses from the surveys.

- Total number of boaters surveyed: 29,088
- Total number of watercraft: 13,646
- Motorized watercraft: 11,898 (87.2% of total watercraft)
- Non-motorized watercraft: 1,748 (12.8% of total watercraft)
- Number of reported invasive species detections: 1,543
- Number of surveys by launch: State Boat Launch: 11974; South Shore Marina: 615
- Types of watercraft observed: 10,232 motorboats
- 11,544 vessels (92% were listed as registered in New York and 8% in other states and unregistered/unknown/unanswered)
- Primary activities were listed as recreation (65%), fishing (31%), and other (4%).
- Most non-resident boats arrive from the Essex, Warren, Washington County region
- One out of four boats (25%) had debris or organisms detected
- Nearly one-half of all invasive species found were Eel Grass and Water Celery
- Eurasian watermilfoil was 7th on the list with just over 5% of samples found

Eel Grass

TABLE 7-1 TOTAL WATERCRAFT OBSERVED AT BOAT LAUNCH 2021		
Type	**Count**	**Percent**
Barges	2	0%
Canoes	158	1.2%
Docks	1	0%
Kayaks	1,364	10%
Motorboats	10,232	75%
PWCs	1,664	12.2%
Rowboats	37	0.3%
Sailboats	59	0.4%
SUPs	123	0.9%
Windsurfers	6	0%

Table 7-2 NUMBER OF BOATS LAUNCHED AT SARATOGA LAKE FROM PREVIOUS LAKES AND RIVERS			
Place	**Number**	**Name of Waterbody Region**	**Number**
New York	1,315	Lake George	26,206
Vermont	13	Great Sacandaga Lake	31,268
Connecticut	11	Mohawk River	110
Massachusetts	10	Hudson River	100
New Jersey	7	Round Lake	83
Florida	3	Schroon Lake	83
New Hampshire	3	Hudson River	64
Pennsylvania	3	Lake Champlain	53
Kentucky	1	Ballston Lake	31,067
Maryland	1	Other or Unspecified	27

TABLE 7-3 LAUNCH NUMBERS BY NEXT DESTINATION	
Type	**Count**
Saratoga Lake	2,129
Unknown	285
Lake George	69
Hudson River	36
Sacandaga Lake	36
Sacandaga Lake	23
Lake Champlain	19
Mohawk River	18

TABLE 7-4 TOTAL WATERCRAFT OBSERVED AT BOAT LAUNCH 2021		
Species	**Count**	**Percent**
Eel Grass/Water Celery	2599	49.3%
Zebra Mussel	775	14.7%
Coontail	417	7.9%
Native Pondweed	398	7.6%
Curly Leaf Pondweed	350	6.6%
Elodea	310	5.9%
Eurasian Watermilfoil	275	5.2%
Variable-leaf Milfoil	109	2.1%
Water Chestnut	19	0.4%
Native Lily	8	0.2%
Lemna-spp (duckweed)	4	0%
Unidentified Snail Species	1	0%

7.4 Findings and Recommendations

Findings

SLPID has made significant outreach gains in the communities that surround Saratoga Lake. The issues around the lake have become more complicated, and the public's expectations have become more sophisticated. SLPID should develop a 5-year education plan that is responsive to the distributing information that will be essential to protecting the water quality of the lake long-term. Below are some recommendations that reflect near-future needs.

Recommendations

1. **Boat Steward Program**

Prevent new introductions of AIS by continuing to fund and operate a Lake Steward program at the NYS Boat launch and at other launching facilities as necessary. Increase hours for stewards, add extra stewards to come in earlier and later for the fishing tournaments and coverage at marinas.

2. **Programming**

To stay up to date in yearly changes and to provide proper training to the SLPID stewards, the Lake Administrator should collaborate, communicate, and participate with all agencies involved in steward training and lake management including NYS Parks, Recreation and Historic Preservation, NYSDEC Bureau of Invasive Species and Ecosystem Health, NY Natural Heritage Program, Capital Mohawk PRISM (Partnership in Regional Invasive Species Management), Saratoga County Soil & Water Conservation District, Saratoga County Cornell Cooperative Extension, Saratoga County Planning Department, NY Sea Grant, SUNY ESF, Adirondack Watershed Institute, Darrin Freshwater Institute, City of Saratoga Springs and towns of Saratoga, Stillwater, and Malta. Also continue collaboration and the sharing of steward information and data findings with other lakes in New York.

3. **WISPA Data Management**

The Lake Administrator should complete steward WISPA data information and review at the end of the season for submission to the State.

4. Education and Outreach

Develop a strategic plan for education and outreach that identifies specific initiatives, programs, and projects and funding needs over the next 5 years. Increase efforts on outreach education programs to the public and property owners on invasive species prevention and other issues. Extend outreach opportunities to Saratoga Lake Association and the local homeowner associations on the lake. Attend their meetings to pass on information about the lake. Provide a presence and role at the Saratoga County fair with Saratoga County Soil and Water District. Reach out, establish a good relationship, and coordinate activities with the fishing clubs that conduct tournaments on Saratoga Lake. Continue with yearly informational events at Browns Beach. Expand the "Take the Pledge" initiative and distribute the publication: *A Guide to Creating Vegetated Buffers for Lakefront Properties*.

5. Floating Classroom

Continue with the floating classroom programs on AIS identification, lake ecology, erosion, natural shorelines, and related topics. On lake experiences will need to meet requirements of NYS Navigation law and vessel requirements. Purchase a boat to accommodate the floating classrooms and also be utilized for water testing, lake surveys and other projects.

6. Demonstration Projects

SLPID should outline, fund, and implement a series of demonstration projects that are highly visible from the lake that feature examples of best practices for stormwater, natural shorelines, and erosion control measures.

7. Website, Newsletter, and Social Media Improvements

SLPID should post additional materials to the website including educational messages, department reports, annual budgets, news articles, and expand on the section that invites the viewer to the donation section. Expand the SLPID email notification list to effectively get the SLPID message out to the public on updates and projects. Increase SLPID's social media presence with live and more candid posts of SLPID's presence through regular, short messages. Continue developing and distributing 2-4 newsletters per year and expand the email notification list.

8. Grant Opportunities

SLPID should continue to seek grants to help fund special initiatives, projects, and programs. A long-term grant strategy should be developed that matches projects with potential grant programs and sets goals for setting aside required match money in future budgets.

SECTION 8 LAND USE AND DEVELOPMENT

8.1 Introduction

The Saratoga Lake Protection & Improvement District (SLPID) Board continues to explore ways to improve the overall water quality of Saratoga Lake. The mission to improve water quality has traditionally been limited to in-lake measures. The Board is now exploring measures to address on-land pollution from stormwater runoff and land disturbances by proposing the municipalities in the SLPID District adopt an overlay district to be known as the Saratoga Lake Overlay Protection District (SLOPD). This law would superimpose an overlay district over the individual zoning maps of the Towns of Saratoga, Malta, Stillwater, and City of Saratoga Springs. It would provide a unified set of standards designed to increase the overall protection of Saratoga Lake and its environment. Individually, they would ratify as part of their zoning code and be responsible for regulating and enforcing the standards. SLPID would continue to have no land use authority but would act in a supporting role to the municipalities.

An overlay district is a district of any shape or size that is superimposed over the underlying "base" zoning district(s) to protect a resource, address a special problem, or guide development within a special area. The overlay district essentially adds a layer of safeguards, standards or incentives that may not have been considered for the base zoning uses. The base zoning requirements still apply but overlay district standards apply in cases where the base and overlay requirements conflict. These requirements are based on ensuring that all development is done in a way that protects the waterfront for public use while protecting private and public property to the extent possible.

This overlay district aims to protect and improve the water quality of Saratoga Lake by preserving the natural shoreline, preventing erosion, and manage stormwater that is not regulated under current DEC mandates. Land development activities, loss of native vegetation, and associated increases in site impervious cover often alter the hydrologic response of local watersheds and increase stormwater runoff rates and volumes, create flooding, stream channel erosion, sediment transport and deposition, and increase pollution rates.

The four municipalities address environmental protection in individual ways and at different levels. However, there are gaps in land use regulations for stormwater management, erosion control, and stream and wetland protection which can introduce pollution in the lake and the destruction of natural environments. These gaps are often found in projects that fall outside the regulatory network of standards and practices outlined in individual ordinances. Many projects propose land disturbances that are less than one acre and are not therefore regulated under the Municipal Separate Storm Sewer System (MS4) Program. These individual landscape alterations can have a negative impact next to neighboring properties. The cumulative impact of many uncontrolled land disturbances can have a dramatic long-term impact on the lake's water quality.

The foundation of the SLIPD includes the following reasoning:

- Land development activities, loss of native vegetation, and associated increases in site impervious cover often increase stormwater runoff rates and volumes, flooding, stream channel erosion, pollution rates, and sediment transport and deposition.

- Whereas the surface cover provided by roots, leaves, and other plant matter slows the velocity of water, thereby reducing its sediment-carrying capability, the clearing and grading during construction and other land development activities increases soil erosion and adds to the loss of native vegetation necessary for viable land and water habitats.

- Pollutants of concern having a negative impact on water quality are known to originate from construction activities, land development, from other land alteration activities, poorly performing or failing septic systems, and from the use of substances necessary for domestic, commercial, agricultural, and industrial activities.

- Increased runoff negatively impacts receiving waters by changing the physical, biological, and chemical composition of water resulting in unhealthy environments for aquatic life, other desirable species, and humans.

8.2 Land Use Regulations by Municipality

An assessment of local zoning along the Saratoga Lake waterfront is presented in Table 8-1, "Municipal Shoreline Land Use Profiles". This includes the City of Saratoga Springs, and towns of Saratoga, Stillwater, and Malta. Zoning on the lake is primarily residential with some limited commercial zones found in the City of Saratoga Springs and Town of Saratoga.

Marinas are permitted in two zoning districts in the City of Saratoga Springs and one zoning district in the Town of Saratoga. All other marinas and commercial operations are pre-existing, non-conforming uses or are part of planned unit developments. None of the lakeshore communities have special use or site planning rules related to marinas. Building setbacks from Saratoga Lake are not clearly defined in any of the riparian communities.
The Town of Stillwater currently allows bed and breakfasts, restaurants, and taverns in the Resort Residential Zone for commercial uses. The use of "marina and other waterfront-related use" was added to the use table in 2018 when the Hudson River Local Waterfront Revitalization Plan was completed. The Town's intent is to review this set of uses for the Saratoga Lake area in the upcoming zoning changes as recommended in the Saratoga Lake LWRP. Marina uses currently existing in the RRD zone are pre-existing.

Opportunities exist to unify zoning districts and fine-tune land controls around the lake. A comprehensive effort should also be made to remediate sources of sediments, contaminated runoff, and loss of natural shoreline. A consistent regulatory approach is needed to address the general degradation of local water quality along the lakeshore. All residential and commercial waterfront development or redevelopment should be subjected to a uniform set of standards that address stormwater management, erosion control, and shoreline protection. This would include projects that fall outside the site plan review process and would require a special permit.

The standards and limitations for a special permit are yet to be determined and part of this ongoing discussion process. Also, the natural erosion of streams east of Route 9P continue to discharge to Saratoga Lake largely untreated. The opportunity exists through this effort to make recommendations to address this issue.

Table 8-1, "Municipal Shoreline Land Use Profiles," shows the general status of land use plans, regulations, standards, and guidelines in the four municipalities that share Saratoga Lake lakefront. It has been developed to illustrate the differences in how each community approaches land use projects and to identify a model that could provide a unified set of regulations that would be adopted in each municipality. Figure 8-1, "Shoreline Zoning," illustrates the different types of zoning districts and associated density levels in the four municipalities. Table 8-2, "Density Regulations Per Municipality," indicates the Density Regulations by Municipality. This chart shows how the individual communities regulate maximum lot coverage and/or minimum area to remain permeable.

TABLE 8-1 MUNICIPAL SHORELINE LAND USE PROFILES

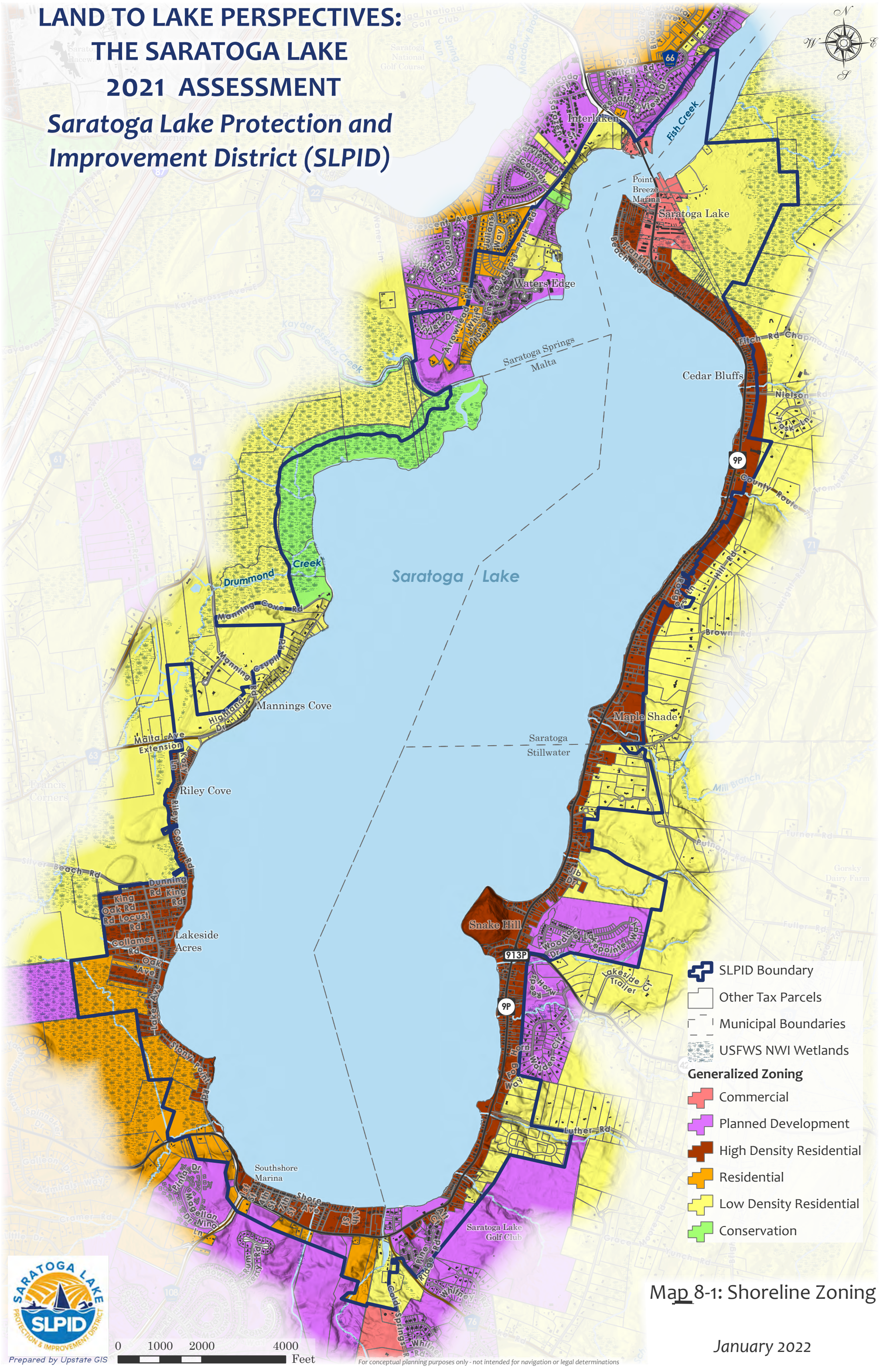
	Town of Saratoga	Town of Stillwater	Town of Malta	City of Saratoga Springs
Comprehensive Plan	The 2002 Comprehensive Land Use Plan is being updated in 2022. The Town of Saratoga Agriculture & Farmland Protection Plan was completed in 2019.	The Town of Stillwater Comprehensive Plan Update was completed in 2020.	Malta's 2005 Comprehensive Master Plan is in the process of being updated.	Last updated in 2015. An Urban and Community Forest Master Plan completed in 2013.
Local Waterfront Revitalization Program	The Town participated in the *Old Saratoga on the Hudson Waterfront Revitalization (*2007), a multi-municipal regional planning initiative involving the towns of Saratoga, Northumberland, Easton, and Greenwich plus the villages of Schuylerville and Victory.	*The Saratoga Lake Water Quality Study* is currently underway. It includes a 9.4 sq mile area and includes 11 sub-catchment areas. This was a recommendation of the *Saratoga Lake Waterfront Plan* and a Saratoga Lake LWRP stormwater management plan (2018) relating to the LWRP.	None	None
Zoning	Lake Residential Commercial Residential (CR) Conservancy	Residential Resort District (RRD) Planned Development Districts (PDD). The RRD Zone exists on the shoreline of the lake and east of Route 9P 500ft inland.		Facilitates its zoning laws through a Unified Development Ordinance (UDO). An update draft is presently under public review.
Lakeshore Zoning Districts	Lake Residential Commercial Residential (CR) Conservancy	Residential Resort District (RRD) Planned Development Districts (PDD) Low Density Residential (LDR)	Lake Conservancy Residential 8 Residential 6 Residential 4	Planned Unit Development (PUD), Suburban Residential 2, Rural Residential, Waterfront Related Business. A Water Protection Overlay District Is a special purpose district permit.
Site Plan Review	Required for special uses and supplemental uses.	Required for restaurants, vegetable stands, community uses, bed and breakfasts. The Town currently reviews all minor and major subdivisions with the Saratoga Lake area under more intensive stormwater regulations including but not limited to the use of additional ES&C practices during construction, the use of additional post construction BMPs, and the requirement of increased stormwater inspections during construction.	Required for commercial and multi-family projects.	Required as part of the UDO.
Stormwater Management	The Town will become a MS-4 community in 2022. Stormwater controls are currently required for projects that require site plan review.	Stormwater drainage plans shall be required as part of the site plan approval process, unless waived by the Planning Board. The stormwater drainage plan shall analyze the impacts of the project using a twenty-five-year return interval storm for residential projects and a fifty-year return interval storm for commercial projects and using the analysis procedures in Chapter 176, Subdivision of Land. Impacts on downstream properties shall be analyzed as part of the plan. All stormwater management plans shall be designed so that post-development runoff is equal to or less than predevelopment runoff unless this requirement is waived by the Planning Board. All development sites of 1-acre or more are subject to NYS DEC SPDES General Permit for Stormwater Discharges from Construction Activity GP-0-20-001. The Town requires ES&C plans for all development regardless of size in the Lake area and may require a full SWPPP on site under 1-acre depending on grade and potential of erosion. Stormwater is managed through the Municipal Separate Storm Sewer System (MS4) Program._The Town administers a comprehensive Stormwater Management Program (SWMP) designed to address a wide array of stormwater pollution issues and concerns. The core of this Program centers around (6) Minimum Control Measures (MCM's) intended to reduce "non-point" sources of stormwater pollution through education, regulation, and enhanced management practices.	Considered a small MS4 and is currently covered under the state permit. Permits require the development of a program that satisfies the six minimum control measures (MCM) set forth in the program and described in the permit. Stormwater management plans are required for: *Construction activities* involving soil disturbances of one (1) or more acres; including disturbances of less than one acre that are part of a *larger common plan of development or sale* that will ultimately disturb one or more acres of land; and *Construction activities* involving soil disturbances of less than one (1) acre where the Town's Stormwater Management Officer has determined that the land development activity is in proximity to, or presents a threat to, a surface water, wetland, or stormwater conveyance or treatment area.	Managed through the Municipal Separate Storm Sewer System (MS4) Program. The City administers a comprehensive Stormwater Management Program (SWMP) designed to address a wide array of stormwater pollution issues and concerns. The core of this Program centers around (6) Minimum Control Measures (MCM's) intended to reduce "non-point" sources of stormwater pollution through education, regulation, and enhanced management practices. Pollutants of Concern (POC) have been identified by the NYS-DEC as having the potential to impair local waters, notably Lake Lonely and two of its' main tributaries, Spring Run and Bog Meadow Brook.

		All site plans and major subdivisions of 1 acre or more are required to comply with the NYS DEC SPDES General Permit for Stormwater Discharges from Construction Activity GP-0-20-001.		
Sediment and Erosion Control	The Town has a Steep Slopes, Erosion and Sediment Control regulation that applies to all development requiring a permit from the Town. The purpose of these control measures is to limit erosion, reduce sediment transport, and prevent the introduction of man-made pollutants in the Town's water drainage and reservoir systems. The standards vary but the primary approaches used are to limit clear cutting of forests and provide natural buffer zones within reasonable distances of the shores of Saratoga Lake, major streams, wetlands, and the Hudson River. All projects under municipal review must comply.	Regulations under site plan review generally apply to construction disturbance on slopes of 10% or more for driveways and 15% or more for individual lots. The law includes a provision for the prohibition on the operation of failed wastewater systems. Applicants must conform to the published Guidelines for Erosion and Sediment Control in Urban Areas of New York State, by the United States Department of Agriculture Soil Conservation Service or local standards if they are more restrictive.	Requires site plans that disturb one-acre or more to show wetlands and water courses. Saratoga Lake is not defined as a sensitive resource.	Projects reviewed by planning and zoning or jurisdictional by NYS are subject to these rules.
Steep Slopes	Steep slopes and stream protection standards are required for construction on classified or significant streams.	Covered under stream corridor protection.	Covered under stream corridor protection.	Article 9-On-Site Development Standards contains development regulations that apply to a lot outside of the standards set within each district. Steep slope preservation is a new standard that applies during site plan review. Slopes are categorized as steep slopes (15% to 25%) and very steep slopes (25% to 35%). Standards that limit disturbance are based on the type of slope.
Shoreline Setback	There are no shoreline setback limits. Minimum setbacks are 25-40 feet depending on whether it is a front or rear setback.	10 feet from the mean high-water mark of Saratoga Lake and 20 feet from the road on which the property abuts. Flood hazard protection includes protection of designated flood hazard areas.	Streams under Class A-D require a 100-foot setback while other water courses require a 50-foot setback for any building construction. This rule does not cover Saratoga Lake.	Section 7.1.E designates 100 feet for water courses and includes Class 1 & 2 wetlands. Saratoga Lake is not specifically designated.
Maximum Building Lot Coverage	Maximum building coverage is 35% in the Lake Residential District and the Lake Commercial District, and 10% in the Conservancy District.	*Building Lot Coverage:* Maximum coverage is 40% in the Residential Resort District. Lot Coverage is defined as "All areas covered by buildings, pavement or other permanent impermeable surfaces, but not including stored merchandise such as cars and manufactured housing. The definition includes the term "impervious area."	*Building Lot Coverage*: Building coverage 30% for R-4 and 18% for R-6 and R-8 districts.	30% (UR2); *Minimum % Remain Permeable*: 25%
Shoreline Setback	There are no shoreline setback limits. Minimum setbacks are 25-40 feet depending on whether it is a front or rear setback.	*Shoreline Setback:* 10 feet from the mean high-water mark of Saratoga Lake and 20 feet from the road on which the property abuts. Flood hazard protection includes protection of designated flood hazard areas.	*Shoreline Setback:* Streams under Class A-D require a 100-foot setback while other water courses require a 50-foot setback for any building construction. This rule does not cover Saratoga Lake.	On designated water courses the setback is 100 feet. It includes Class 1 & 2 wetlands. Saratoga Lake is not designated.
Stream Corridor Protection	Steep slopes and stream protection standards are required for construction on classified or significant streams. Standards include a 50-foot buffer zone and limits on clearing.	*Stream Corridor Protection:* No stream in the sub-watershed area is protected by regulation.	*Stream Corridor Protection:* A Stream Buffers and Steep Slopes provision requires a buffer of 100 feet on each side of any NY State Department of Environmental Conservation classified stream, Class D or higher, and a buffer of 50 feet on each side of any unclassified perennial stream. Cutting of trees and other vegetation within stream buffers is generally prohibited.	Yes, through section 7.1.E and the Site Plan Review law.
Cluster Subdivision Provisions	A Conservation Subdivision Design law is long established as the preferred method of subdivision for all projects that propose more than four residential lots on 10 acres or more in the Rural District,	*Cluster Subdivision Provisions:* The Cluster and Conservation Subdivision law provides that clustering is optional for minor and major subdivisions in the Residential Resort District. The Saratoga Lake WRP recommends the use of	*Cluster Subdivision Provisions:* The Open Space Development and Preservation law applies to any subdivision of land 20-acres or greater in the following zoning districts: R-1, R-5, and R-6.	Article IV-Conservation Subdivision Regulations applies to all properties within the RR and SR-1 Districts, for all proposed subdivisions within RR and SR Districts,

	Rural District 2, and Rural Residential Zoning Districts.	Cluster Subdivision around Saratoga Lake.		conservation design subdivision is required.
Land Clearing and Tree Cutting	Land disturbance regulations are contained in the Steep Slopes, Erosion and Sediment Control section and apply to all projects requiring site plan review.	It is the purpose of this section to prevent the clear-cutting and grading of lots except in association with an approved site plan. No person may clear-cut or grade more than one acre within a five-year period in any business or industrial district, nor may a person clear-cut or grade more than two acres within a five-year period in any residential district, except for the RR and LDR Districts, without an approved site plan. No person may clear-cut or grade more than five acres in the RR and LDR Districts without an approved site plan. These regulations do not apply to timber harvesting or agricultural uses and associated activities.	No specific provisions related to land clearing and tree cutting.	Through Site Plan Review requires approval by the Planning Board prior to any clearing and grubbing of the project site. Within the Rural Residential-1 district any activity affecting 1.5 or more acres that changes the natural topography, removes, or disturbs topsoil, or removes more than 15% of trees over 4 inches in diameter at breast height requires a Land Disturbance Permit.
Docks and Marinas	There are no dock regulations for Saratoga Lake. Marinas are permitted only in the Lake Commercial District and require 1 acre of land and 35% maximum lot coverage for buildings. Marina parking is at the discretion of the Planning Board.	Docks and marinas (marina/waterfront-related use) are defined in the zoning code but there are no associated regulations related to docks or marinas. This Town's intent is to further review this use for the Saratoga Lake area in the upcoming zoning changes as recommended in the Saratoga Lake WRP. Marina uses currently existing in the RRD zone are pre-existing current zoning.	No specific provisions related to docks and marinas	No regulations for Saratoga Lake except through parking regulations. Only references to dock allowances are through existing PDDs.

LAND TO LAKE PERSPECTIVES: THE SARATOGA LAKE 2021 ASSESSMENT

Saratoga Lake Protection and Improvement District (SLPID)



Map 8-1: Shoreline Zoning

January 2022

TABLE 8-2 DENSITY REGULATIONS BY MUNICIPALITY			
Municipal Shoreline Zoning Districts	**Minimum Lot Size**	**Maximum Lot Coverage***	**Minimum Area To Remain Permeable**
City of Saratoga Springs			
Planned Unit	Variable	-	Variable
Development Suburban	20,000 SF either no central water	-	30%
Residential	supply or sewer	-	30%
	40,000 SF if without central water	-	80%
Rural Residential	supply and sewer	-	15%
Water Related Businesses	2 acres		
	20,000SF		
Town of Saratoga			
Lake Residential	15,000SF	35%	-
Commercial Residential	15,000SF	35%	-
Conservancy	80,000SF	10%	-
Town of Stillwater			
Residential Resort District	21,750 square feet/dwelling unit	40% Includes impermeable surface in the definition	60%
Planned Development Districts	Variable	Variable	
		40%	60%
Low Density Residential	1-acre with both public utilities, 1.5 with one public utility, and 2-acres without public utilities	Includes def of impermeable surface	
Town of Malta			
Lake Conservancy	-	-	-
Residential 8	200,000SF	18%	-
Residential 6	80,000SF	18%	-
Residential 4	15,000SF	30%	-

*Maximum Building Coverage

8.3 Summary of Findings and Recommendations

Findings

City of Saratoga Springs

Waterfront zoning density ranges from one-third acre to nearly five acres. The three towns use maximum lot coverage as a measure for the building envelope. Saratoga Springs is the only community whose approach to lot coverage is to require a minimum area of permeable surface. See Map 2-10 for the distribution of zoning districts on Saratoga Lake

Overall standards are good for most uses. There are no special rules for the regulation of marinas or residential docks on Saratoga Lake. Standards for shoreline properties for stormwater management and erosion control should be applicable for projects that require a permit but fall outside site plan review and other regulations. Saratoga Springs does not have a mechanism for permitting and inspecting dock space on residential or commercial parcels.

Town of Saratoga

Improvements could include adding provisions for percent of lot permeability. Presently the code only speaks to a maximum building coverage. Standards for shoreline properties for stormwater management and erosion control should be applicable for projects that require a permit but fall outside site plan review and other regulations. The Town does not have a mechanism for permitting and inspecting dock space on residential or commercial parcels.

Town of Malta

Improvements could include adding provisions for percent of lot permeability. Presently the code only speaks to lot building coverage. The Town does not have a mechanism for permitting and inspecting dock space on residential commercial parcels. Standards for shoreline properties for stormwater management and erosion control should be considered for projects that require a permit but fall outside site plan review.

Town of Stillwater

The Town requires ES&C plans for all development regardless of size in the Lake area and may require a full SWPPP on sites under 1-acre depending on grade and potential of erosion.

The Town does not have a mechanism for permitting and inspecting dock space on residential and commercial parcels.

Findings

Waterfront zoning density ranges from one-third acre to nearly five acres. The three towns use maximum lot coverage to measure for the building envelope. Saratoga Springs is the only community whose approach to lot coverage requires a minimum area of permeable surface.

Overall standards are good for most uses. There are, however, no special rules for the regulation of marinas or residential docks on Saratoga Lake. Shoreline property standards for stormwater management and erosion control should be developed and apply for projects that may not require a permit and fall outside site plan review and other regulations.

Recommendations

1. SLPID's Response to Development Projects

SLPID is not structured to administer land use controls yet, to meet the objectives of the SLPID legislation, it is necessary for SLPID to work with the communities on land use decisions. SLPID will, at times, comment on specific development projects in the District or in areas that discharge to the Saratoga Lake. The comments will be limited to the criteria or topics found in Section 1 and 7 of the implementing legislation.

2. Watershed Protection Group

SLPID should continue to schedule and facilitate meetings with representatives from the four municipalities, Saratoga County Planning Department, Saratoga County Soil & Water Conservation District, and Cornell Cooperative Extension to address the potential opportunity to improve standards for stormwater management and erosion control on small lots around the lake, unify zoning districts, and fine tune land use controls around the lake.

3. Stormwater Mitigation

Discharge from the NYS Route 9P roadway enters streams and culverts by sheet flow or grates. Stormwater should be treated by catch basins with sumps to remove and collect sediments. SLPID with partners should consolidate inventories of stormwater discharge points engineering around Saratoga Lake. Recommendations should specify culvert repairs, modifications, and replacements, where necessary.

4. Wetlands Restoration

A longer-term program of rebuilding floodplains and wetlands in key areas will be needed to capture nutrients prior to entering the lake. Locations that involve wetlands that have been filled in or disturbed along roadsides are opportunities for wetland rehabilitations and the creation of stormwater forebays. A stormwater forebay is a location that captures sediments and then allows easy removal of sediments from the forebay reducing delta development in the lake. There are both larger and smaller opportunities for these projects around Saratoga Lake that need to be further assessed through joint efforts by SLPID, local municipalities, Saratoga County, New York State Department of Transportation, and private landowners.

5. Demonstration Project

Less traditional methods of nutrient remediation need to be explored including use of phosphorus absorbing materials such as Chitosan, or Biochar logs or anionic blocks. In each case the logs or blocks work best in slow-moving water. They have a useful life of months and therefore, must be replaced. Continue to investigate a feasible location for one or more demonstration projects to construct an artificial wetland, floating islands for water treatment, and green infrastructure projects to protect the lake from sediment and pollutants associated with stormwater discharges from local streams.

6. Critical Environmental Area

Investigate the potential for getting Saratoga Lake designated as a Critical Environmental Area. According to DEC, the CEA designation serves to alert project sponsors to the agency's concern

for the resources or dangers contained within the CEA. Once a CEA has been designated, potential impacts on the characteristics of that CEA become relevant areas of concern that warrant specific, articulated consideration in determining the significance of any Type I or Unlisted actions that may affect the CEA.

7. Cooperation with Partners

The SLPID administrator should continue to meet with riparian municipal officials to discuss common interests and continue to participate in attending the Saratoga County Water Quality Committee.

8. Improve Waterfront Land Use Standards

Continue work with riparian municipalities and other partners to develop a uniform set of standards that only address land use situations that do not currently meet local or state thresholds for review. SLPID would continue to have no land use authority but act in a supporting role to the municipalities. Alternatively, the standards could simply be adopted individually in each municipality without the constraints of an overlay. The following concepts should be considered in the development of specific standards:

maximum impervious standards; green infrastructure; professional oversight; low impact design; preservation of the natural shoreline; limitations of retaining walls; stream buffers; minimization of land disturbance; and steep slopes protection.

SECTION 9 WATERSHED MODELING

9.1 Whole Watershed Model

Watershed models were developed after determining that the relationship of phosphorus to lake eutrophication could be expressed as a simple equation. This input-output or mass balance model is generally known as the Vollenweider model of eutrophication (Dillon, 1974).This equation includes the estimation of the settling rate of phosphorus, areal loading, and the flushing rate. By understanding that levels above 0.020 mg/l of total phosphorus may lead to the rapid and widespread growth of algae, the equation can then be used to estimate the safe loading rates for phosphorus.

More elaborate models for estimating phosphorus and other nutrient loadings can be achieved through mapping and an understanding of land use in the watershed. These models can predict the amount of phosphorus that will reach lake. However, they do not predict the dynamics of nutrients in the lake. Watershed models will identify if the lake is receiving an overload of nutrients. They rely upon regional and national estimates of water discharges, runoff nutrient concentrations, annual rainfall, and regional mapping of watershed characteristics.

To evaluate watershed loadings in Saratoga Lake, a model assembled by the Stroud Center for Watershed Science known as *Model My Watershed* was utilized. This model is found on the Wikiwatershed website (*Wikiwatershed.org*). The model allows the selection of specific watershed-based land use features based on the hydrographic unit codes (HUC). These include HUC land use from the National Land Cover Data Set, soils mapping from the Natural Resource Conservation Service, regional runoff estimates from the United State Geological Survey (USGS) and National Oceanographic and Atmospheric Administration (NOAA), and nutrient loadings based on the National Urban Runoff Program (NURP). The background calculations are from the general Watershed Loading Function Model, a comprehensive model. The model includes sub-routines that are specific to modeling efforts for the Chesapeake Bay area.

Model My Watershed includes mapping for the Hydrographic Unit Chart that breaks down watershed into various mapped units. The appropriate HUC will be mapped, and the model will gather the size of the watershed, annual rainfall, estimated annual flows, soils information, and land use for the selected watershed. Watersheds examined include Kayaderosseras Creek at the mouth of the creek on Saratoga Lake, Fish Creek at NYS 9P Bridge, Drummond Creek, and streams at Luther Road.

Table 9-1, “Nutrient Loading for Kayaderosseras Creek,” shows the results from the from the *Wikiwatershed* analysis for sediment, total nitrogen (TP), and total phosphorous (TP) levels entering Saratoga Lake from the watershed to the area that terminates at NYS Route 9P Bridge. This watershed total area is 138,068.40 acres, whereas the *Watershed Management Plan for Saratoga Lake* (2002) estimated the watershed as 144,963.63 acres. There is a large flat area in Wilton where the watershed boundary is poorly defined which likely accounts for the 6,895.23-acre difference.

TABLE 9-1 NUTRIENT LOADING FOR KAYADEROSSERAS CREEK			
	Sediment Sources	Total Nitrogen Sources	Total Phosphorus Sources
Total Loads (kg)	26,850,979.10	136,054.60	18,749.20
Loading Rates (kg/ha)	544.15	2.76	0.38
Mean Annual Concentration (mg/L)	159.03	0.81	0.11
Mean Low-Flow Concentration (mg/L)	382.40	2	0.43

Table 9-2 provides an estimated watershed loading but is not the actual estimated concentration of TN or TP in the lake. To validate the model, it must be compared to values found in Kayaderosseras Creek which was sampled as a part of the CSLAP program in months of September and October in 1994 and 1995 (CSLAP 2015). The range of the TP values was from 0.007-0.170 mg/l with an average of 0.065 mg/l and a median of 0.036. The model estimate is high but is within the range of values typically found on Kayaderosseras Creek. A second evaluation of the model used a steady state equation (Cooke D.G. et.al. 2005).

TABLE 9-2 STEADY STATE EQUATION MODEL
TP= L
Average depth (m) ($p + p^{0.5}$)
TP= 0.0291
8.3m ($2.8 + 2.8^{0.5}$)
TP= 0.02 mg/l and 0.0144 mg/l
L= loading estimate 0.0291 mg/l or 0.200 mg/l
p= flushing rate

The steady-state equation uses the estimated concentrations of TP found in Kayaderosseras Creek and correctly estimates the in-lake concentration. The model does produce representative results for Saratoga Lake. The Saratoga Lake watershed tends to have good soils that will allow water movement, and soils tend to be well-drained to moderately well-drained. The overall utility of the model is somewhat diminished since the individual sub-catchment watershed cannot be adjusted to account for the locations of the large wetlands along the Kayaderosseras Creek, and the wetlands that receive water from Spring Run. These large wetland communities (See Figure 2-7, “Lakes, Streams and Wetlands Map”) intercept a large volume of the nutrients that are associated with the developed areas in the watershed.

9.2 Sub-watershed Runoff Model

The *Wikiwatershed* site also has a runoff model that is based on the Technical Release (TR) #22 and #55 developed by the Natural Resource Conservation Service. These are the most common models to estimate stormwater runoff hydrology. The *Wikiwatershed* model allows the selection of rainfall volume and soil conditions for specific locations.

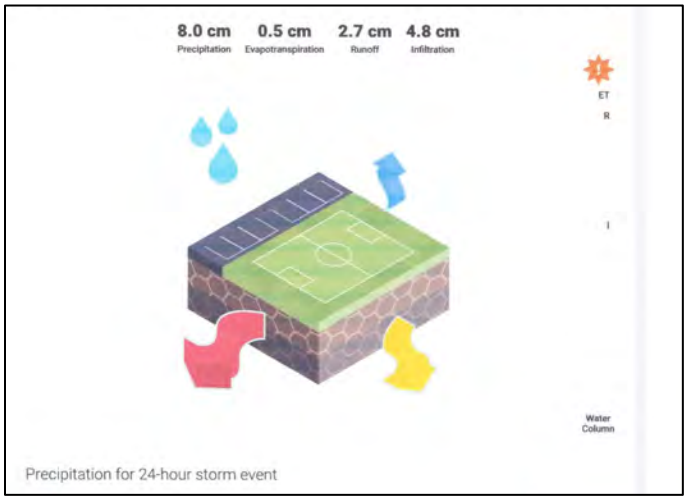
Two stormwater model runs were completed to show the differences in discharge associated with the changes in the percentage of impervious cover. The open developed area is illustrated below as a soccer field and has an impervious cover of under 20%. Runoff from developed open space might be found on a lot that is an acre with about 8,712 square feet of impervious surface.

The second illustration below depicts runoff from development in a low-intensity scenario showing an impervious surface of between 20%-49% or between 8,712 sf - 21,344 sf. This type of development intensity is similar to what would occur on a small lot in the lakeshore area.There is less evaporation, and infiltration and more runoff on a small intensely developed lot.

9.3 Tale of Two Watersheds

The Saratoga Lake watershed is complex, with important characteristics that delay impacts of development by having favorable soils in many developed areas, plus heavily developed watershed areas tend to discharge into wetland areas. The runoff from the intensely developed areas of Saratoga Springs discharges to Spring Run, a buried stream that begins in Congress Park and emerges above ground near High Street. From Spring Run, it eventually joins Bog Meadow in the Great Bear Swamp that surrounds Lake Lonely and occupies the east side of I-87 from just north of Exit 13 to the NYS Route 29 exit.

Table 9-3, “Land Use in Saratoga Lake and the Luther Road Stream Watershed,” illustrates the existing condition and modified condition to show the impact of land use changes.



EXAMPLES OF RUNOFF IMULATION FROM *MODEL MY WATERSHED* (WIKIWATERSHED.ORG)

TABLE 9-3 LAND USE IN SARATOGA LAKE AND THE LUTHER ROAD STREAM WATERSHED						
SL Land use, (NLCD Code)	**Saratoga Lake sq.km**	**Saratoga Lake Coverage %**	**Saratoga Lake Modification for Model Run**	**Luther Road Area sq.km**	**Luther Road Coverage %**	**Luther Road Modification**
Open water (11)	17.83	3.19		0.11	1.12	
Developed Open space (21)	49.27	8.82		0.75	7.44	
Developed low Intensity (22)	26.8	4.8		0.22	2.15	+ 0.5 sq.km
Developed medium Intensity (23)	9.1	1.63	+5 sq.km	0.02	0.17	
Developed High Intensity (24)	3.35	0.6	+ 5 sq.km	0	0	
Barren Rock or sand (31)	0.95	0.17		0.09	0.89	
Deciduous Forest (41)	121.72	21.79	- 10 sq.km	1.93	19.2	- 0.5 sq.km
Evergreen Forest (42)	103.09	18.45		1.05	10.48	
Mixed Forest (43)	51.32	9.18		1.89	18.81	
Shrub/Scrub (52)	2.45	0.44		0.05	0.54	
Grassland herbaceous	0.72	0.13		0	0	
Pasture/hay (81)	30.2	5.41		0.31	3.14	
Cultivated Crops (82)	34.08	6.1		1.38	13.71	
Woody wetland (90)	104.24	18.66		2.21	22.07	
Emergent marsh (95)	3.59	0.64		0.03	0.29	
Total	558.71	100		10.03	100	

The Stroud Center Watershed Model was used to identify nutrient loadings for two land use scenarios in each watershed. Both simulations ran the model without modification to loadings or nutrient captures for all test runs. Using the model without modification avoids possible over adjustments of factors that may be overly influenced by model users' best judgement. These model tests were completed to evaluate the difference in watershed loading from the entire Kayaderosseras Creek watershed verse loadings from a short-run direct discharge stream found at Luther Road.

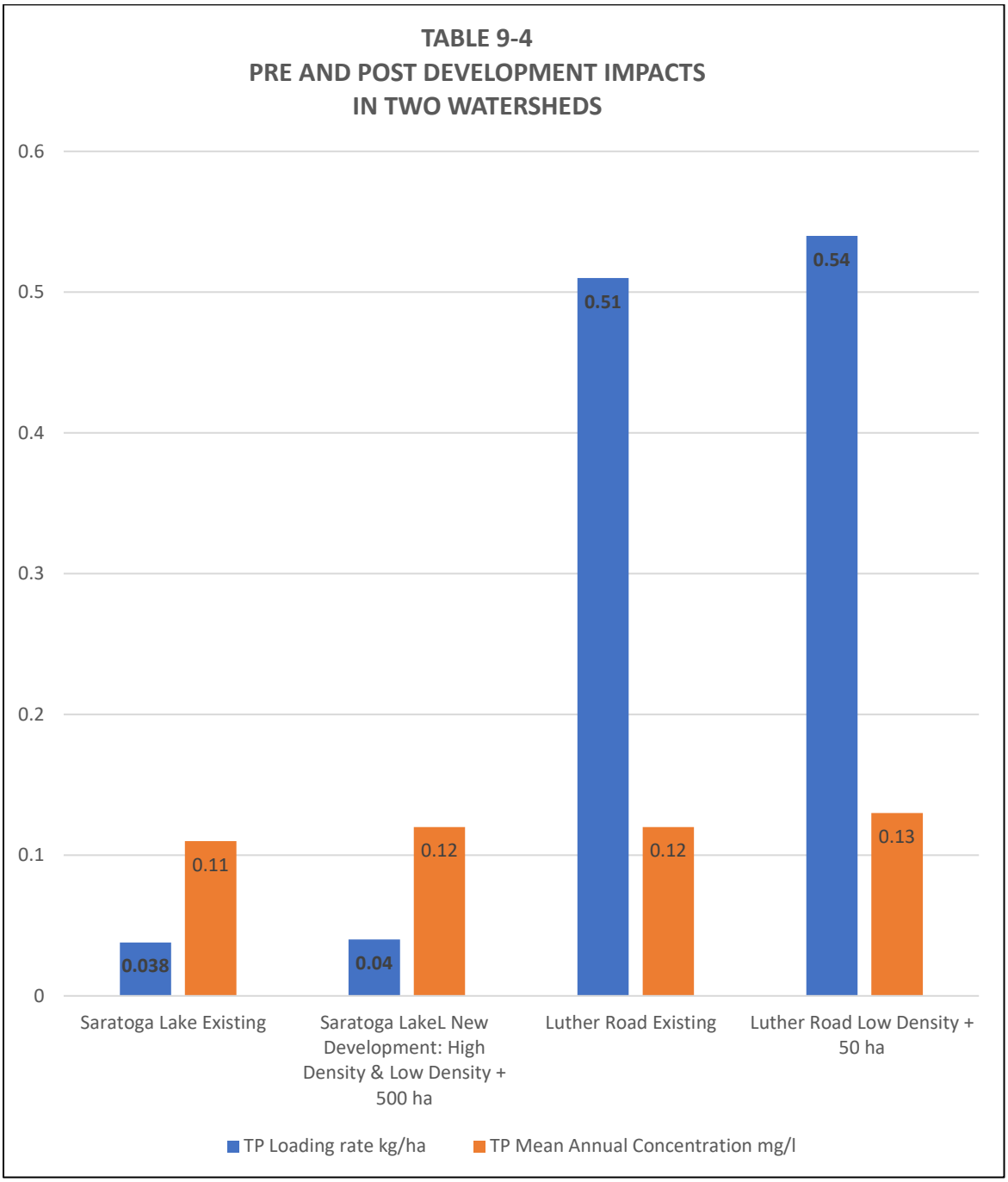
For the entire Saratoga Lake watershed, the model run used the existing conditions (pre-development). It then modified the land use by removing 10 sq. km from the deciduous forest and placing it into development medium intensity and development high intensity (post-development). Medium intensity development has 50-79% impervious surface, and high intensity development has 80-100% impervious surface (post development). The development would occur over an unknown period.

Using the same method, two simulations of the Luther Road stream watershed were completed for existing conditions (pre-development) and modified watershed (post-development). The modified model converted 0.5 sq. km of a deciduous forest to low intensity development. Low

intensity has 20-49% impervious surface. In each case, only land use was changed. The results of the simulations are illustrated in Table 9-4, "Pre and Post Development Impacts in Two Watersheds." Two columns on the table show the amount of nutrients that move from the tested watersheds to the lake. The blue columns are the loading rate as kg/ha, and the orange column is the estimated concentration found in the water under these conditions. For the total Saratoga Lake watershed with 100 sq km or 1000 ha of development changes are estimated to increase the amount of TP by 0.01 mg/*l*, a small, but measurable increase. This change in loading reflects the unique conditions in the Saratoga Lake watershed described above.

The second set of simulations was completed for a small sub-catchment watershed that discharges at Luther Road at an unnamed stream identified as 941-118 with limited wetland coverage. The loading rate for this watershed is much higher than the estimated loading rate for the entire watershed by a factor of almost 5. Yet, the concentration of TP is nearly the same as is found for the entire Saratoga Lake watershed. Again, there is an increase in the TP concentration even when the amount and intensity of development is much smaller in the post development condition.

Development pressures are different in all sub-catchments in the watershed. Impacts by land use conversion or re-development will be different depending on the location of development. The direct discharge sub-catchments of the Drummond Creek basin around the lake have the potential for more localized impacts and higher loadings of nutrients per unit area than development further up the watershed in the Kayaderosseras Creek sub-catchment. Large segments of the direct discharge watersheds are not served by Saratoga County Sewer District, which also contributes to nutrient loading. Further, it is logical that development on the immediate shoreline also has the potential for significant impacts to lake quality.



9.4 Internal Nutrient Loading

Lakes are water filled basins that receive surface water and groundwater inputs of both water and nutrients. Once in the basin, water and nutrients may escape by evaporation and discharge out of the lake by way of streams carrying both water and nutrients. In lakes, the nutrients are utilized by both rooted and free-floating aquatic plants (algae, and duckweed) to sustain the plant growth. The plants will then support zooplankton, fish, and aquatic plants, which provide fish habitat. Eventually, all the life forms die, and the plant or animal materials decompose, making

nutrients available to the system once again. This cycle is naturally occurring, yet it may become too energetic and begin to create periods of high nutrient loadings.

The cycle of decompositions occurs both in the presence of oxygen or aerobic decomposition, and without oxygen anaerobic decomposition. The area of active decomposition is in the lake bottom. In low nutrient or oligotrophic lakes, the process is mostly aerobic since there is a lack of material to be decomposed at any one time, and the bottom water is cold. In lakes with more nutrients, the decomposition process speeds up and depletes dissolved oxygen in the deep-water zones of a lake. When oxygen is depleted, it then creates bonds that hold phosphorous as a ferrous iron, manganous manganese, ammonium, and hydrogen sulfide gas (Nürnberg G.K., 2009). When phosphorous is released, it is in a soluble form and will be readily utilized by algae. In mesotrophic lakes such as Saratoga Lake, the amount of nutrient regeneration or internal load maybe small or insignificant in relation to the external load from the watershed. In eutrophic lakes, the same situation will occur. The amount of internal nutrient loading is heavily influenced by the volume of the deep-water zone, stability of thermal stratification, longevity of thermal stratification, lake temperature at the lake bottom, and lake flow.

A prior evaluation of internal loading was completed that concluded that the estimates could represent the internal load or could underestimate the internal load (Hardt, Hodgson, and Mikol, 1984). The internal loading estimate from 1984 was 1,420 kg P annually based on an area loading rate of 4.0-4.4 mg/sq.m/day, and by using deepwater TP concentration, the internal loading rate was 1,600 kg P annually. The following analysis reaches the same conclusion.

Two evaluations of the possible internal loadings are presented below. One uses the TP results collected by the CSLAP program, and the second using a representative estimate of the expected internal loading rate. A range of possible estimates is presented. To estimate internal loading, both the area and depth of anoxic water are required. In both cases, it is necessary to have the area and volume of the deepwater zones in Saratoga Lake. In Saratoga Lake, there are two deepwater areas one south of Snake Hill with a maximum depth of 18 m (60 ft), and the deeper area north of Snake Hill in the center of the lake with a depth of 28 m (95 ft). Area and depth of the lake bottom will use information from Aquatic Control Technology (ACT) (now Solitude), (ACT,2005).

The bathymetric data for lake volume was collected on two separate days in 2004. Collecting bathymetric data over a limited period should limit the variability caused by changes in lake levels. The other bathymetric maps for the lake use compiled data that has not been well tracked, so any information could vary by 0-3 inches or more. The two deepwater zones are added together based on the above identified table. The depth and duration of anoxic water was determined using the dissolved oxygen and temperature profiles collected as a part of the CSLAP program. Anoxic conditions by the end of the summer generally begin below a depth of 13m in the North or central deepwater area. This anoxic zone covers 3,180 acres (12,870,760 sq m) and 55,725 ac ft. (68,708,925 sq m). Anoxic conditions in the deepwater water area south of Snake Hill begins to occur below a depth of 8m. In late July, the data table does not separate two deepwater zones so estimates below will not account for all the anoxic water found in the lake.

Using a rate of 4.2 mg/ sq. m/day, and estimating the days of thermal stratifications that starts in mid- June and remains until the end of October for a total of 137 days:
4.2 mg/sq.m/day X 12,870,760 sq.m X 137 days/ 1,000,000= 7,405,835,304/1,000,000= 7,406 kg P. This loading is five time larger than the 1984 estimate and is caused by more anoxic water area and long period of stratification.

The second estimates use the measured concentration of TP in the deepwater zone and the volume of anoxic water. Three values are used to produce an estimated phosphorous loading from the deepwater anoxic zone. The first value is 0.0108 mg// from the north deepwater area measured during the years 2008- 2013. The next value is 0.350 mg// measured at the south deepwater area between 2015-2019. That last value is an average of all measurements 0.189 mg//. Each concentration is converted to kg/ cu.m and is then multiplied by the volume of water below 13m or 68,708,925 cu.m. The estimated annual load of phosphorous is based on the long-term average of 12,985 kg annually. Using the north deepwater value, it is 742 kg annually and with the south value, it is 24,048 kg annually.

A large portion of the internal load is discharged by the lake annually because of the Fish Creek discharge. The annual amount discharged is 368,530,704 cu.m multiplied by the average surface water TP concentration of 0.020 mg//. The net balance is between 5,165 -16,318 kg annually (internal load -discharge load). Recalculating the lake average TP value using the 5,165 kg annually, and in-lake TP concentration of 0.040 mg// is double the normal concentration found in the lake. However, loss from sedimentation or additions from rainfall have not been subtracted or added. The internal loading rate could therefore range from a little less than 5,168 to 7,406 kg annually. A final estimate of the internal load cannot be calculated since the annual flow calculations vary 168,804,636- 368,530,704 cu.m of water discharge annually.

9.5 Findings and Recommendations

Findings

The Saratoga Lake watershed is complex, with important characteristics that delay impacts of development by having favorable soils in many developed areas, plus heavily developed watershed areas tend to discharge into wetland areas. The runoff from the intensely developed areas of Saratoga Springs discharges to Spring Run, a buried stream that begins in Congress Park and emerges above ground near High Street. From Spring Run, it eventually joins Bog Meadow in the Great Bear Swamp that surrounds Lake Lonely and occupies the east side of I-87 from just north of Exit 13 to the NYS Route 29 exit. The recommendations below address alternative approaches to responding effectively to nutrient reduction in Saratoga Lake.

Recommendations

1. **Lake Modeling:** Direct discharge sub-catchments may be causing an outsized contribution to nutrient loadings in Saratoga Lake. Two efforts should be undertaken in the coming years. A string of recording thermistors and possibly a recording dissolve oxygen probe should be set in the central deep-water area to continually monitor the thermal profile of the lake from May to December. This will fill a gap in the duration of summer thermal

stratification and DO depletion. During the winter, a submersed temperature and DO recording device can be left on the lake bottom attached to a pop-up buoy that will be released and carry the recording devices to the surface once it receives a radio signal. This will provide information on bottom temperature and DO during the winter. During the period, additional deepwater samples for nutrients can be collected to improve the estimation of internal loading.

2. **Data:** Additional data is needed to improve predictive capability of watershed models at Saratoga Lake. There is a twofold difference in annual water flow in the watershed depending on the model used. Three tasks can be considered to improve model results:
   - Select and use different models and have work completed by an experienced team of modelers and hydrologists.
   - Re-install the water level recorder at the Nelson Avenue Extension bridge, install a rented velocity meter, and take new measurements of the channel. This will provide actual water flow estimates coming down Kayaderosseras Creek. This site is the discharged point for 87% of the watershed. The site does not include Lake Lonely, Spring Run, or Drummond Creek.
   - Collect water quality data and streamflow data at the short-run streams. This should include both dry and wet weather conditions. The short-run streams discharge to the lake by the way of culverts, so the flow can be estimated by water levels and pipe slope. Water levels are recorded by a pressure gauge. An automated sampler, which can be rented or purchased, is the best method of collection samples.

3. **HABs:** To address the issue of HABs, two actions can be taken:

- A Turner handheld fluorometer can be purchased to measure the concentration of chlorophyll specific to HABs bloom species. This will aid in the determination of whether a bloom is cyanobacteria or green algae.
- At the same time, kits can be purchased to detect and measure the amount of cyanobacteria toxins to better evaluate bloom conditions. This would not change bloom warning conditions or procedures.

4. **Nutrient Reduction:** Along with improving the knowledge base on Saratoga Lake nutrient loading and hydrology there are specific actions that are needed to reduce nutrient transport to the lake:
   - As recommended in the 2002 Watershed Management Plan, stream buffers are the best management approach that will protect both local stream water quality and the lake. At the same time, limiting runoff from lots that are being redeveloped on the lake shore is a certain method to lower discharges of sediment and nutrients to the lake.
   - Less traditional methods of nutrient remediation should be explored that include the use of phosphorus-absorbing materials such as Chitosan, Biochar logs or anionic blocks. In each case, the logs or blocks work best in slow-moving water. They have a useful life of only months and must be replaced on a regular basis.

5. **Forebay Projects:** A longer-term program of rebuilding floodplains and wetlands will be needed to capture nutrients prior to entering the lake. Large and small opportunities for forebay projects around the lake need to be further evaluated. Making these actions happen will require joint efforts by SLPID, local municipalities, Saratoga County, New York State Department of Transportation, and private landowners. They normally require a period of years to plan and complete.

6. **Catch Basins:** The NYS Route 9P roadway discharge enters streams and culverts by sheet flow or grates, and the stormwater is not treated by catch basins with sumps to remove and collect sediments. Adding catch basins will be difficult due to a limited right-of-way. However, the installation of catch basins should be explored as a part of improvement plans.

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SECTION 11 PUBLIC COMMENTS AND SLPID RESPONSES DOCUMENT TO THE FEBRUARY 2022 DRAFT

COMMENT #1:
Report lacks any time frame or implementation schedule. Other than the weed/invasives harvesting and treatment, the rest of the report reads more like a wish list than a plan or strategy that could be followed for implementation. Without any assigned responsibilities or accountability to implement or execute these recommendations, tough to see how this will have any tangible impact on the lake and the surrounding land. Someone or some entity must be given responsibility to actually do something other than harvest the weeds. Otherwise, this will lie dormant for another twenty years just like the original 2002 assessment. Nail down a few priority targets and push hard to see they get a strong recommendation for implementation.

RESPONSE
A good many of the recommendations in the 2002 Watershed Management Plan have been implemented. The Saratoga Lake 2021 Assessment provides a state of conditions at Saratoga Lake and a set of new recommendations for the SLPID Board to consider in the coming years. The document is meant to assist in decision making and the recommendations are a roadmap of actions that will be addressed in 2022 and beyond. Priorities will largely be driven by the availability of resources (money and manpower) available to implement the recommendations.

Items that can be directly impediment by SLPID are the immediate priorities. These items include working with the Saratoga County Stormwater Coordinator and Cornell Cooperative Extension on the development of rain gardens and vegetation buffers, and shoreline planting demonstrations and trainings. SLPID is working to identify two or more locations for demonstration projects. SLPID will also begin collecting additional water temperature data beginning in May and continuing year-round.

COMMENT #2:
The creation of a task force that would help in supporting the Harvesting Program, for example a group of businesses that can help put an annual water chestnut removal project together, with Kayak Shak being one of them. One other suggestion I have is to recommend a water adoption program where people are responsible for a small section of the lake, Fish Creek. Think of it as an adopt-a-highway program.

RESPONSE
SLPID needs the individual property owners to remove water chestnuts from their property. This work should be completed prior to the end of the first week of August. There is a need to continue hand harvesting of small patches of water chestnuts around the lake and this can be done as a volunteer effort. In the past, the Saratoga Lake Association organized a volunteer effort that focused on the removal of water chestnuts. The plant was nearly eliminated as a direct result of that effort. SLPID encourages the return of this group as well as the creation of a system of local lakefront landowners that will actively take responsibility for detection and removal of water chestnuts.

COMMENT #3:
Causes and sources of pollution have not been clearly identified. A quantified estimate of pollutant loads (TMDL) and related sources are essential and are often missing according to the EPA guide.

RESPONSE
Please see Section 9, "Watershed Modeling," which was added to the final report. To evaluate watershed loadings in Saratoga Lake, a model assembled by the Stroud Center for Watershed Science known as Model My Watershed was utilized. This model is found on the Wikiwatershed website (Wikiwatershed.org). The model allows the selection of specific watershed-based land use features based on the hydrographic unit codes (HUC). These include HUC land use from the National Land Cover Data Set, soils mapping from the Natural Resource Conservation Service, regional runoff estimates from the United State Geological Survey (USGS) and National Oceanographic and Atmospheric Administration (NOAA), and nutrient loadings based on the National Urban Runoff Program (NURP). The background calculations are from the general Watershed Loading Function Model, a comprehensive model. The model includes sub-routines that are specific to modeling efforts for the Chesapeake Bay area.

COMMENT #4:
Nothing in this document addresses road salt. The four municipalities and most importantly, the NYS DOT all apply road salt throughout the winter months. The runoff particularly from 9P which surrounds ¾'s of the shoreline, runs directly into the lake. As far as I know, only the Town of Malta is experimenting with the use of brine as an alternative to road salt for winter de-icing. SLPID should be encouraging the four municipalities as well as the DOT to explore mitigation measures in this critical area of impact to lake water quality.

RESPONSE
Please see explanations in Section 9. Both chloride and conductivity have increased in Saratoga Lake. This increase has been moderated by the annual flushing rate of the lake which is 108-130 days. The range of chloride in 1982 was 10.0-34.8 ppm with an average of 21.56 ppm in 1982 (Hardt, 2000). The current chloride concentration as a long-term median is 66 ppm. In 1982 the conductivity average was 317 umohs/cm and is now 439 umohs/cm. The season median in 2020 was 383 umohs/cm (decade median) and 296 umohs/cm as the long-term median (CSLAP 2020). The most important method to reduce salt use on local roads is better application equipment, maintaining the application equipment, better plow blades, and plow driver training. The simple act of replacing plow blades so that they remove the most snow with each pass reduces the need for salt treatment. Also, equipment that applies just the right amount of salt that can be controlled by the driver will reduce the amount of salt. Having the spinner with extension adjusted close to the road surface and using wetted salt helps to keep the salt on the road. The most effective incentive for the county and communities to reduce road salt use is that it saves money and the investment in improved equipment will be offset by savings in salt costs. Another consideration is to manage the messaging to motorists that towns are not required to have dry roads and some snow wet roads and driving at reduce speeds is a necessary action.

COMMENT #5:

Weed reduction continues to be the primary emphasis though pollutant/nutrient load has been mentioned. Most important for our Lake and probably the most difficult to address is determining how future growth can be managed to minimize adverse impacts. It's by complicated multiple municipal boundaries and SPLID's limitations to "in lake". The idea of an overlay district is a good one. But like the good ideas from the 2002 Watershed Plan if there is no way to implement and enforce this, it is likely to fail.

RESPONSE

Section 6 of the 2021 Assessment describes the current status of local land use control laws. SLPID the riparian communities and Saratoga County Planning and County departments have been meeting to identify the best method to improve development impacts from small lot development. SLPID is not in control of the implementation of the changes in the local laws, but SLPID will provide all the assistance that it can to the communities. SPLID encourages everyone that is concerned about Saratoga Lake and local land use controls to participate in local meetings and be respectful of the Boards' time and different opinions. We look forward to further refining priorities with the involved communities.

COMMENT #6:

Two primary regions where SLA (and any shoreline property owners) can provide additional support (both monetary and hands-on) to SLIPID's efforts:

1) Additional outreach in regard to runoff prevention. The SLA has provided support in this area already but more needs to be done and the health of the lake and future property values are at stake here.

2) The second is in terms of expanded oxygen and temperature monitoring using Hobo probes to better understand the stratification and mixing patterns of the lake. SLPID's reports talks about the installation of a profile string of these probes at the deep hole to monitor the seasonal development of temperature stratification and the loss of oxygen in the hypolimnion and lower metalimnion. Advocate for an additional string of hobos at the southern deep hole off Snake Hill. A better understanding of water movements and stratification effects on the lake environment would result from the installation of the profile strings and could further assess risks of future HABs.

RESPONSE

One of the primary recommendations in Education and Stewardship (Section 7) is to develop a strategic plan for education and outreach that identifies specific initiatives, programs, and projects and funding needs over the next 5 years. Increase efforts on outreach education programs to the public and property owners on invasive species prevention and other issues. Extend outreach opportunities to Saratoga Lake Association and the local homeowner associations on the lake. Attend their meetings to pass on information about the lake. Provide a presence and role at the Saratoga County fair with Saratoga County Soil and Water District. Reach out, establish a good relationship, and coordinate activities with the fishing clubs that conduct tournaments on Saratoga Lake. Continue with yearly informational events at Browns Beach.

Expand the "Take the Pledge" initiative and distribute the publication: *A Guide to Creating Vegetated Buffers for Lakefront Properties*. Please also see explanations in Section 9, "Watershed Modeling," which was added in the final document. Recommendations can be found on page 94.

COMMENT #7:

The Water Management Report is very thorough and in depth. I think it is essential that an organization like SLA be fully familiar and versed in its content to be of greater service to SPLID and the Lake community. To this end I was thinking of inviting the author(s), you, Kathy Simmons and perhaps others you deem key to a dinner meeting with the SLA board to review the salient aspects of the report.

RESPONSE

SLPID would be very interested on making a presentation to the SLA board. We look forward to meeting with you in the near future.

COMMENT #:

I thought the most recent report done by DEC in 2021 or 2020 showed a very healthy fish population. We may want to add that to the report on page 25 under Fisheries.

RESPONSE

This information has been added to the assessment. See Section 3.5.