Cossayuna Lake
Watershed Management Review 2000 - 2016 and Action Plan Update

April 2018

Prepared by the Cossayuna Lake Improvement Association Watershed Management Team

Report prepared by the Lake Champlain - Lake George Regional Planning Board

Acknowledgements

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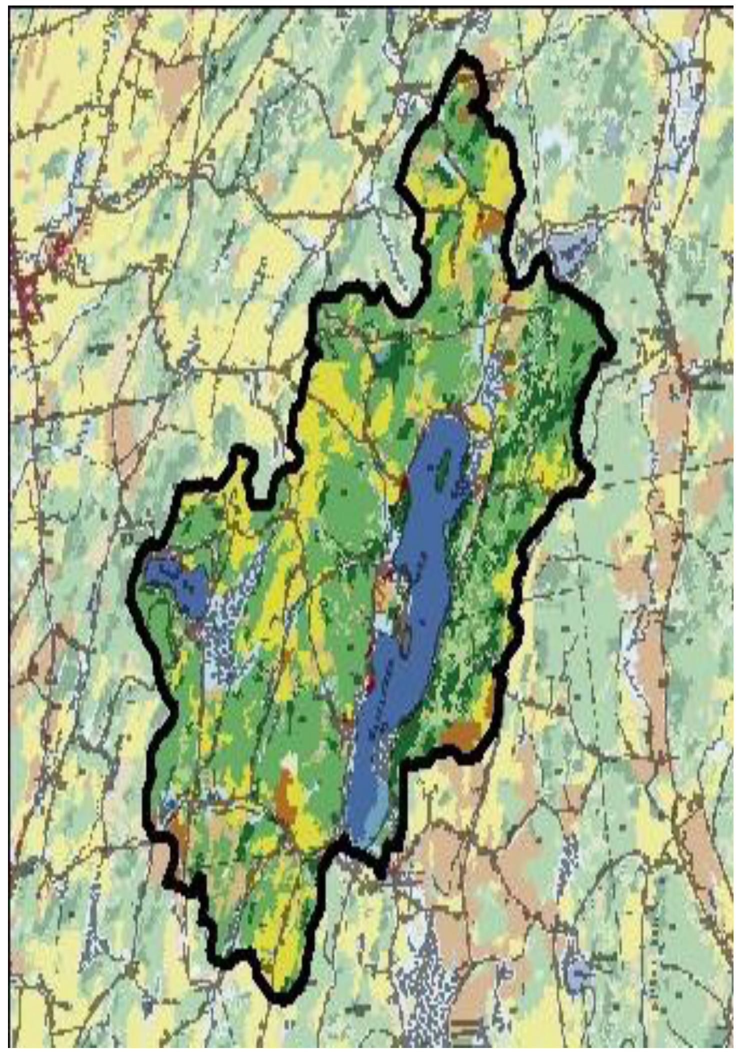
Cossayuna Lake at a Glance

Towns of Argyle and Greenwich, Washington County, NY

Lake Characteristics	
Surface Area	659 acres
Shoreline Length	8.1 miles
Max Depth	25 feet / 8 meters
Mean Depth	12 feet / 4 meters
Hydraulic retention time	0.8 years
Lake Designations	
Trophic Status	Meso-eutrophic
DEC Lake Classification	A
Dam Classification	A
PWL Assessment	Impaired
HABs Susceptibility	Frequent blooms, Moderate Susceptibility
Invasive Vulnerability	Invasives present, High Vulnerability
Watershed Characteristics	
Watershed Area	7652 acres
Watershed / Lake Ratio	11:1
Watershed Land Use	
Lakes and Wetlands	17%
Agriculture	21%
Forest, Shrubs and Grasses	56%
Residential	6%
Urban	0%



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1.0 Introduction

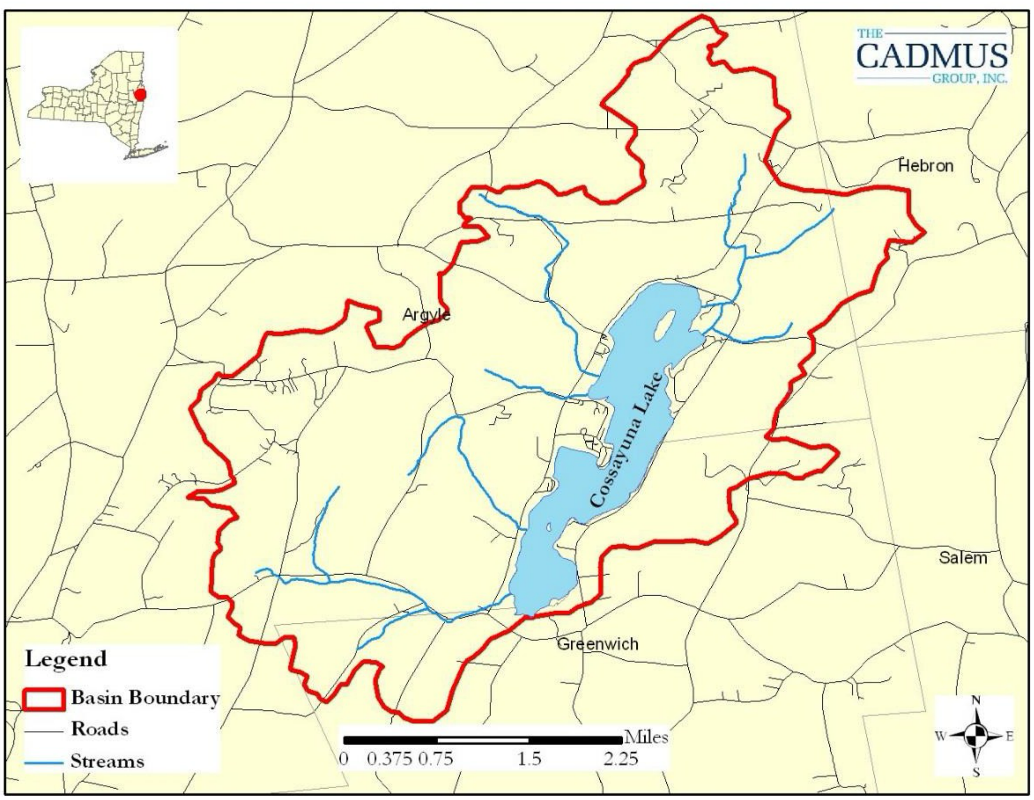
In 2008, the U.S. Environmental Protection Agency Region 2 and the New York State Department of Environmental Conservation (NYS DEC) ordered the creation of a Total Maximum Daily Load (TMDL) document to address phosphorus loading into Cossayuna Lake, which was prepared by The Cadmus Group. Much of the information contained herein is derived from that document and coupled with existing data collected through the efforts of the Cossayuna Lake Improvement Association. This 2018 document has been developed to provide a clear picture of the present status of Cossayuna Lake through the review of work that has been performed since 2000. It is also important to add that in 2016, the NYS DEC removed Cossayuna Lake from the state list of waterbodies requiring a TMDL.

1.1 Cossayuna Lake Watershed

Cossayuna Lake is located within central Washington County, NY. Its watershed is distributed among four townships: Argyle (85%), Greenwich (10%), Salem (4%) and Hebron (1%). The lake is part of the larger Upper Hudson River drainage basin with water that drain southward into the Upper Hudson River via Whittaker Creek, Carter Creek, and the Battenkill River (The LA Group, 2001). Cossayuna Lake has a direct drainage basin area of 6,841 acres (Figure 1) and a watershed elevation that ranges from 485 feet above mean sea level to 1,165 feet above mean sea level (The Cadmus Group, 2008).

Existing land use and land cover in the Cossayuna Lake watershed has been determined utilizing digital aerial photography and geographic information system (GIS) datasets from the 2001 National Land Cover Dataset (Homer, et.al., 2004).

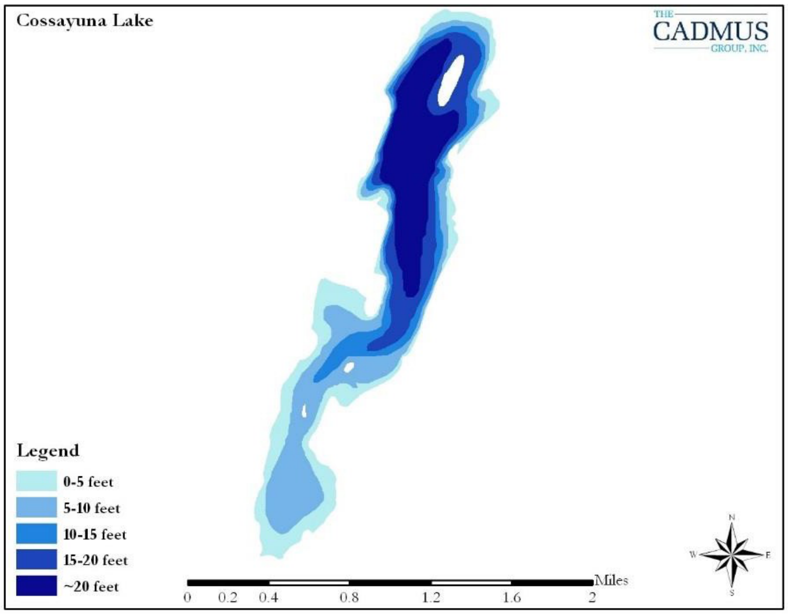
Figure 1. Cossayuna Lake Direct Drainage Basin. Figure provided by The Cadmus Group.



1.2 Lake Morphometry

Cossayuna Lake is a 649 acre waterbody that is at an elevation of approximately 485 feet above mean sea level. It has a maximum depth of 25 feet, with a mean depth of 12 feet. The hydraulic retention time, which indicates the average length of time water will stay within the lake, is 0.8 years. Figure 2 is a bathymetric map for the lake based on a lake contour map developed by the NYS DEC. The deeper parts of the lake can be found within the northern section of the lake, while the southern section of the lake is fairly shallow.

Figure 2. Bathymetric Map of Cossayuna Lake. Figure provided by The Cadmus Group.



1.3 Lake Classifications

The NYS DEC has given Cossayuna Lake, based on its Title 6 Regulations, an “A” classification, which means the best usage of the water is as a source for drinking, culinary or food processing purposes, primary and secondary contact recreation and fishing (including propagation and survival). With additional treatment, these waters can meet NYS DOH drinking water standards (NYS DEC, 2014).

2.0 Water Quality Analysis

2.1 Citizens Statewide Lake Assessment Program

The Cossayuna Lake Improvement Association has been active in the New York Citizens Statewide Lake Assessment Program (CSLAP) since 1992. Information collected from this program includes an array of chemical water quality parameters, which are utilized to make informed lake management decisions.

Water quality values from the 2016 sampling season can be seen in Table 1. Sampling results highlighted in the light red color indicate a sampling result above acceptable levels. For the Total Phosphorus (TP) parameter, heightened readings indicate eutrophic conditions within the lake. For the Chlorophyll *a* (Chl. a) parameter, results indicate conditions conducive to harmful algal blooms. The "seasonal change" category shows the current year variability.

Table 1. 2016 CSLAP water quality sampling data results. Shaded red cells indicate eutrophic conditions, while green shaded cells indicate improved long-term water quality trends.

Open Water Indicators	2016 Sampling Results								Seasonal change	Long Term Avg	Long Term Trend
	6/3	6/16	7/1	7/25	8/8	8/22	9/12	9/26			
Clarity (m)	4.3	3.8	4.4	3.6	2.8	2.6	3.0	2.3		2.1	↑↑
TP (mg/l)	0.009	0.018	0.010	0.018	0.018	0.021	0.030	0.026		0.028	↓
Deep TP (mg/l)	0.013	0.015	0.015	0.030	0.029	0.059	0.021	0.026		0.038	↓↓
TN (mg/l)	0.342	0.439	0.381	0.442	0.461	0.450	0.633	0.594		0.527	no
N:P Ratio	37	25	38	25	26	22	21	23		19	no
Chl.a (ug/l)	0.6	0.9	1.2	4.2	14.2	7.4	36.0	0.7		18.8	↓↓
pH	7.7	7.6	8.1	7.7	7.5	6.8	8.0	7.6		8.0	↓↓
Cond (umho/cm)	218	182	202	210	153	165	179	195		185	↓
Upper Temp (degC)	23	23	28	26	26	25	24	20		23	↑
Deep Temp (degC)	21	19	21	24	24	24	22	20		22	no
BG Chl.a (ug/l)	0	0	0	0	4	5	7	13		5	no
HABs reported	no	no	no	no	no	no	no	no			

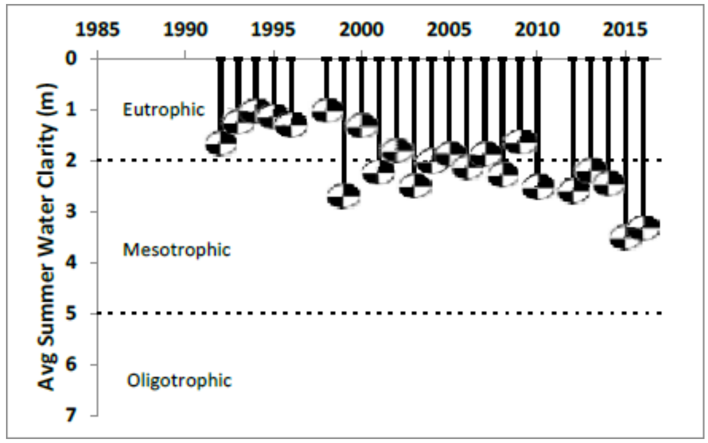
2.2 Long Term Trend Analysis

Water quality parameter information collected through CSLAP has provided an array of information that has been analyzed to create a long-term trend analysis for the lake. To obtain a copy of the full CSLAP reports, please visit www.cossayunalake.com.

2.2.1. Clarity

Clarity, or the transparency of water in a lake, is measured utilizing a secchi disk reading. Transparency of water can be reduced by the presence of a large amount of algae or suspended inorganic materials, such as sediment. Long term monitoring of the clarity of Cossayuna Lake (Figure 3) has shown that since 1992, the clarity of the water in the lake has been steadily increasing. This is a good indication that the quality of the water in Cossayuna Lake is becoming better, as the reading show the lake in a eutrophic state at the beginning of the program with a clarity of less than two meters, to a mesotrophic state in more recent years with a clarity of almost 4 meters.

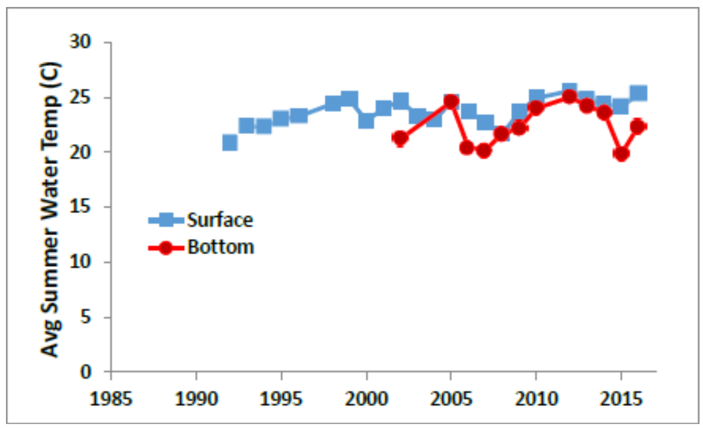
Figure 3. Long term monitoring secchi disk readings indicating clarity.



2.2.2 Temperature

Temperature of the water in the lake has a significant effect on the biological productivity of plants, as well as the survival requirements of certain species of fish. Warmer water can have an increased production of algae, and is a significant factor in the development of harmful algal blooms (HABs). Warmer water also has less dissolved oxygen within it, which can negatively affect trout species that require cold water with high levels of dissolved oxygen for maximum survival rates. The long term average water temperature trend in Cossayuna Lake shows a slight increase in temperature over the 14 year period (Figure 4). In the early 2000's, CSLAP volunteers also began taking deep water temperature samples, which indicate that the deep water temperature fluxes up and down with the surface water temperature.

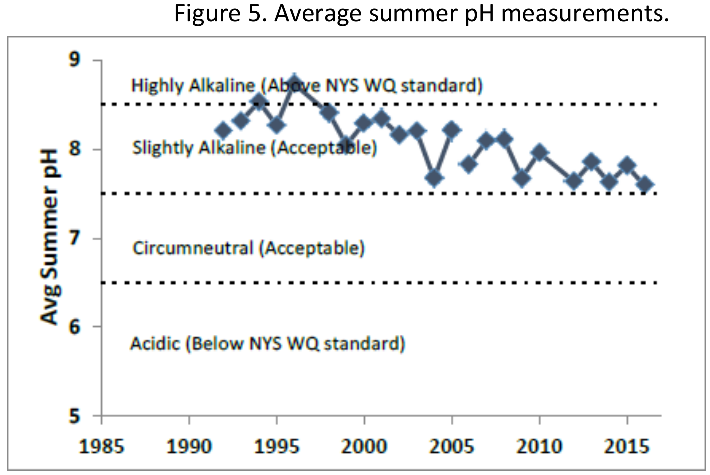
Figure 4. Average summer water temperature measurements.



2.2.3 pH

pH, which has a range from 0 – 14, is the measurement of how acidic water is. A pH reading from 0 – 6 is considered acid, a reading of 7 is considered neutral, and a reading of 8 – 14 is considered basic or alkaline. Many of the lakes within eastern New York State are slightly alkaline due to the abundance of limestone bedrock in the region. However, as illustrated in Figure 5, the alkalinity of the water in Cossayuna Lake was well above acceptable NYS water quality standards in the 1990's. This can be correlated with the heightened chlorophyll *a* readings during the same time period (Figure 7), as an

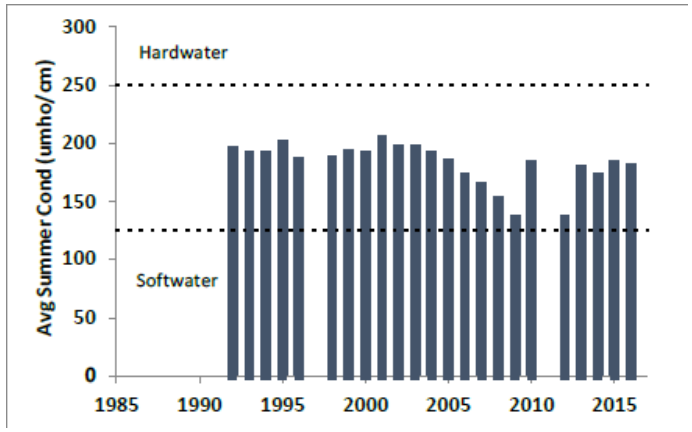
Figure 5. Average summer pH measurements.



increase in the amount of algae increases the amount of photosynthesis occurring, which decreased the amount of carbon dioxide (an acid) in the water, therefore creating a more alkaline lake.

2.2.4 Conductivity

Figure 6. Average summer conductivity measurements.

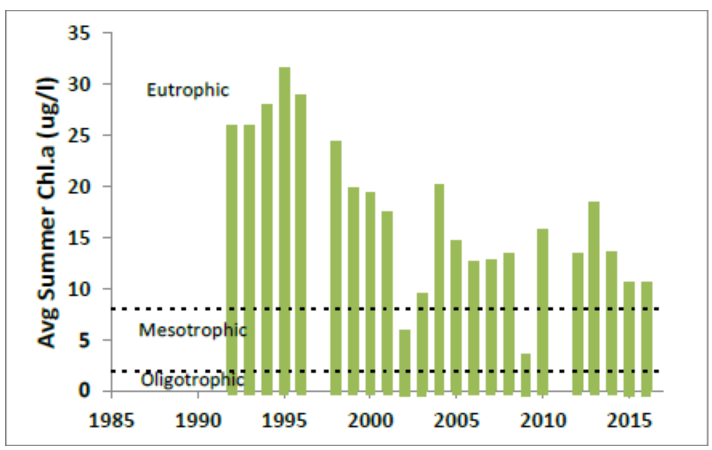


Conductivity measurements in a lake show the amount of charged particles within the water. This is an indication of whether the water is "soft," which means there are few charged particles (low conductivity), or "hard," which means there are many charged particles (high conductivity). Conductivity readings can also indirectly determine the amount of inorganic materials or total suspended solids (TSS), mostly referring to sediment, within the water column. Sediment loading into a waterbody, which will increase a conductivity reading, can have numerous negative effects, including reducing water clarity, filling in fish spawning beds, and bringing in nutrients adhered to the sediment particles. Long-term monitoring on Cossayuna Lake has shown a slight overall decrease in the conductivity readings taken from the lake (Figure 6). This could potentially be a result of shoreline erosion reduction efforts in the past decade.

2.2.5 Chlorophyll *a*

Chlorophyll *a* is used to measure the algae levels that are present in a lake. Algae are naturally present in every lake system, and are beneficial as a food source, however, excess algae can create a host of issues within a waterbody. As Figure 7 illustrates, the chlorophyll *a* content in the lake in the 1990's was well above acceptable levels, indicating that there was an abundance of algae production. This was most likely caused by a flux of nutrients entering the waterbody. As work to reduce nutrient input into the lake began and there was a noticeable decrease in the amount of phosphorus (Figure 8) and nitrogen (Figure 9) entering into the lake, there is also a decrease in the chlorophyll *a* measurements. This is a good sign that the work to reduce inputs into the lake is having a positive effect.

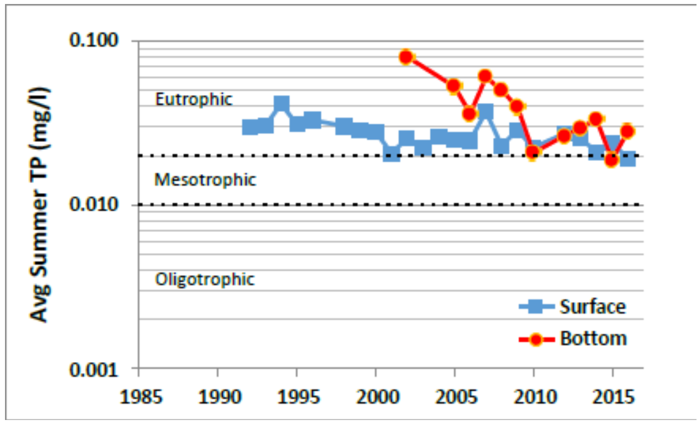
Figure 7. Average summer Chlorophyll *a* measurements.



There is also a strong correlation between chlorophyll *a* levels and clarity, as the more algae present in the water column, the less clear the water will be. The long term monitoring trends show that as the chlorophyll *a* levels in Cossayuna Lake decrease, the clarity of the water increases (Figure 3). This is also an indication of an increase in the health of the waterbody.

2.2.6 Phosphorus

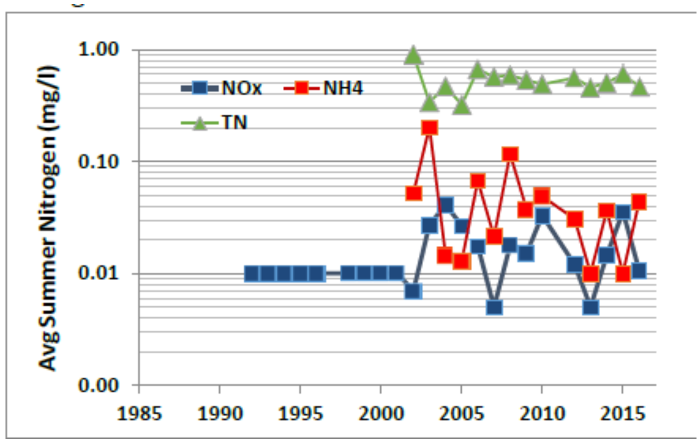
Figure 8. Average summer total surface and deep phosphorus measurements.



Phosphorus is considered a limiting nutrient within a fresh water system in New York State, meaning that it comes from very few sources within the environment and therefore the availability within a lake system is naturally low. Phosphorus is necessary for plant and algal growth, so its availability determines the amount of plant productivity. With an increase in phosphorus loading into a lake, which is usually as a result of human activity within a watershed, there will be an increase in plant and algal growth. Results from the long term monitoring program have shown that the phosphorus levels within Cossayuna Lake have decreased since the 1990's (Figure 8), certainly as a result of the creation and implementation of the TMDL document. However, current results are still indicating a mid-to-high amount of phosphorus within the lake, so more work will need to be done to continue to bring the phosphorus levels down as much as possible.

2.2.7 Nitrogen

Figure 9. Average summer nitrogen measurements.



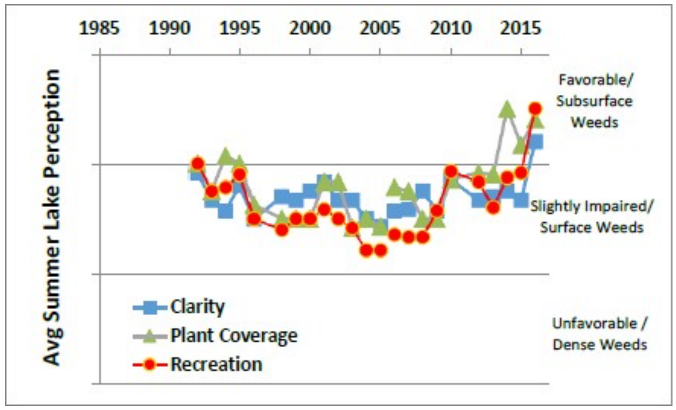
Nitrogen is also a nutrient, however, it is more naturally available within the environment, so it is not considered a limiting nutrient in the case of Cossayuna Lake. Measurements taken in the lake as part of the long-term monitoring program include Total Nitrogen (TN), Ammonium (NH4) and Nitrogen Oxide (NOx). Nitrogen concentrations in Cossayuna Lake have decreased slightly in the past 15 years, but not enough to correlate a long-term trend to (Figure 9).

2.2.8 Lake Perception

The long-term lake perception trends look at three qualitative factors; water clarity, plant coverage and recreation (Figure 10). In terms of water clarity, it is perceived by the CSLAP volunteers that the clarity of the water in the lake decreased from 2000 – 2010, but has been steadily increasing in recent years. The average lake perception readings also indicate that at the beginning of the assessment, recreation was slightly impaired, and dipped down towards unfavorable in the 2000's, only to increase up to a favorable perception in the past couple of years.

The final qualitative measure, plant coverage, has been assessed utilizing a scale of dense weeds (unfavorable), surface weeds (slightly impaired) and subsurface weeds (favorable). This scale indicates that an abundance of subsurface weeds shows a healthy plant community within the lake, versus an abundance of dense weeds, which indicates an unhealthy plant community. Since the beginning of the long-term monitoring program, the perception has indicated that there was an abundance of surface weeds, meaning that the plant community wasn't as healthy as it could be. However, in the past several years, the perception is that the plant community is becoming more favorable with an increased abundance of subsurface weeds. This is most likely due to the aquatic invasive species management efforts, which are discussed in more detail in Section 3.

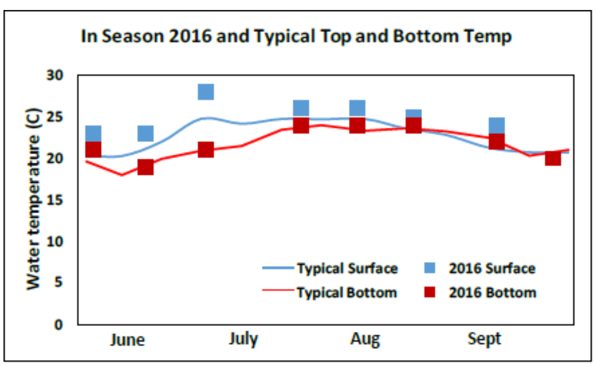
Figure 10. Average summer lake perception.

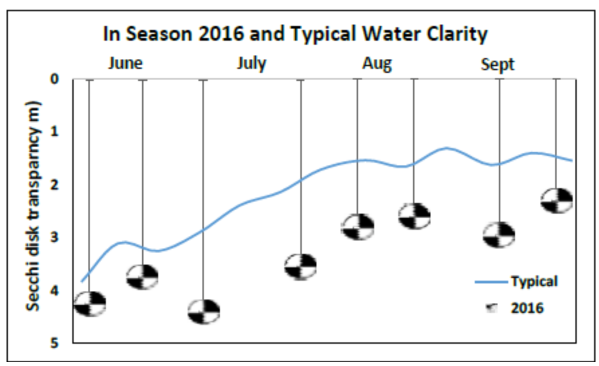


2.2.9 In-Season Variations

In an effort to better understand the fluctuations in water quality parameters through a season, CSLAP volunteers took secchi disk and temperature readings throughout the months of June, July, August and September in 2016. This information can be used to see what effect heavy recreational use in the summer months is potentially having on the quality of the lake water. As can be seen in Figure 11, the typical water clarity decreased from June to September in 2016, while the surface and deep water temperature readings indicate an increase in the hotter months of July and August.

Figure 11. 2016 in-season surface and deep water temperature and secchi disk readings.





3.0 Water Quality Concerns

The NYS DEC has classified Cossayuna Lake as having impaired uses, which, by NYS DEC definition, means that the lake has well documented water quality problems that require restoration measures in order for uses to be supported (NYS DEC, 2015). Figure 12 has been taken from the 2016 NYS DEC Waterbody Inventory/Priority Waterbodies List (PWL), which is a statewide list that provides water quality impairment information on waterbodies. Although Cossayuna Lake has been removed from the NYS DEC list of waterbodies requiring TMDLs, the lake is still listed as having impaired uses including recreation and habitat/hydrology, while aquatic life is categorized as stressed. The identified pollutants within the lake include algal and weed growth, nutrients (phosphorus), problem species and silt/sediment from habitat modification, failing on-site septic systems, agriculture and construction. Pathogens are listed as a possible pollutant due to the suspected failing on-site septic systems, however further testing will be needed to verify.

Figure 12. Cossayuna Lake listing on the 2016 NYS DEC Priority Waterbodies List. Courtesy of the NYS DEC.

Cossayuna Lake (1103-0002) — **Impaired Seg**

Waterbody Location Information — Revised: 12/06/2006

Water Index No:	H-301-17-P79			**Drain Basin:**	Upper Hudson River
Hydro Unit Code:	02020003/080	**Str Class:**	A		Upper Hudson-Hoosic
Waterbody Type:	Lake			**Reg/County:**	5/Washington Co. (58)
Waterbody Size:	659.3 Acres			**Quad Map:**	COSSAYUNA (I-27-1)
Seg Description:	entire lake				

Water Quality Problem/Issue Information (CAPS indicate MAJOR Use Impacts/Pollutants/Sources)

Use(s) Impacted	Severity	Problem Documentation
Aquatic Life	Stressed	Possible
RECREATION	Impaired	Known
HABITAT/HYDROLGY	Impaired	Known

Type of Pollutant(s)

Known: ALGAL/WEED GROWTH, NUTRIENTS (phosphorus), PROBLEM SPECIES, Silt/Sediment
Suspected: - - -
Possible: Pathogens

Source(s) of Pollutant(s)

Known: HABITAT MODIFICATION
Suspected: FAILING ON-SITE SYST, Agriculture, Construction
Possible: - - -

Figure 13 includes information from the NYS DEC PWL list, the Cossayuna Lake Improvement Association's 2016 CSLAP report, and the average values from past CSLAP data, to graphically illustrate the level of impairment for various uses in the lake. In summary, when comparing data from 2016 to prior years, the lake uses on Cossayuna Lake are becoming more supported. Cossayuna Lake is now characterized as a meso-eutrophic lake, which means that it moderately to highly productive, whereas in prior years it has been considered eutrophic.

Figure 13. Lake use score card illustrating level of supported uses. Data derived from the NYS DEC PWL list, 2016 CSLAP report and average historical CSLAP data.

Use	NYS DEC PWL Rating	Average CSLAP Rating	2016 CSLAP Rating	Primary Issues
Potable Water	●	■	◆	Algae Level
Swimming	◆	▲	●	Algal Blooms
Recreation	■	■	◆	Algae Level
Aquatic Life	◆	▲	●	Invasive Animals
Aesthetics	□	◆	▲	Algae Blooms
Habitat	□	◆	▲	Invasive Plants
Fish Consumption				Not applicable

● Supported/Good ▲ Threatened/Fair ◆ Stressed/Poor

■ Impaired □ Unknown

It is because of the continued stressed and threatened lake uses that the Cossayuna Lake Improvement Association has been working diligently over the past several years to address pollutants and their sources. This section includes a more detailed discussion into each of the main water quality pollutants and their sources.

3.1 Phosphorus

As previously mentioned, Cossayuna Lake had a TMDL for phosphorus established in 2008, prepared by The Cadmus Group on behalf of the US Environmental Protection Agency and NYS DEC. Table 2, which was taken from the 2008 TMDL document, shows the mean annual total phosphorus load in pounds per year within the Cossayuna Lake watershed from 1990 – 2001 and 2002 – 2007. It indicates that the majority of phosphorus loading is a result of private septic systems and agricultural operations. Inputs from developed land increased within the time periods indicated, however, inputs are still much lower than the former inputs.

Table 2. Mean annual total phosphorus loading in pounds per year from 1990 – 2001 and 2002 – 2007. Table taken from the 2008 Cossayuna Lake TMDL report prepared by The Cadmus Group.

Source	Mean Annual Total Phosphorus Load (lbs/yr)	
	1990 – 2001	2002 – 2007
Hay/Pasture	645	436
Cropland	1,244	460
Forest	165	95
Wetlands	3	4
Developed Land	47	68
Stream Bank	1	2
Septic Systems	1,062	1,062
Groundwater	347	418
TOTAL	**3,515**	**2,544**

3.1.1. Stormwater

Stormwater runoff, or non-point source pollution, is one of the major inputs of phosphorus into a lake system. In an effort to reduce the amount of stormwater runoff entering into Cossayuna Lake, the Towns of Argyle and Greenwich, along with the Washington County Highway Department and Washington County Soil and Water Conservation District, have implemented many runoff reduction projects throughout the watershed. The main focus of these projects has been the reduction of sedimentation into the lake from tributaries and roadsides. These types of projects have been challenging due to the steep nature of the terrain surrounding the lake, which has limited the amount of area where best management practices can be installed. However, despite the challenges, several projects have been implemented to reduce stormwater runoff and the pollutants it carries from entering into Cossayuna Lake.

The first major project, which was the Cossayuna Lake Critical Area Stabilization on County Route 48, was completed in 1997 utilizing funds provided by the Lake Champlain – Lake George Regional Planning Board. This project addressed a slope failure on the western side of the road that was causing the road to fail and endangering two houses situated between the road and the lakeshore. The failure was approximately 250 feet long with 30% to a near vertical slope along its length. The remediation included cutting mature trees at the top of the slope to reduce weight, and then cut the slope back to 2:1 with a mid-slope bench and tile drainage. Tile line was also installed at the toe of the slope and culverts were replaced at the north and south ends of the project. The entire disturbed area was hydroseeded and low spreading conifers were planted for additional stabilization. After 20 years, the site is still well stabilized.

An additional project completed in 1997 was achieved utilizing Agricultural Non-Point Source Abatement funds awarded through the Washington County Soil and Water Conservation District. These funds were used to reduce sediment and nutrient laden runoff from a barnyard on the north end of Cossayuna Lake. Work on this project addressed several of the lake's pollutant loading concerns by relocating the barnyard and feedlot area, installation of a trench leachate collection and treatment system, installation of a milk house drain and wastewater filter field, and installation of clean water exclusion and wind breaking fencing. More recently, this farmstead has shifted its primary focus from a dairy farm to maple syrup production, so the former crop fields are now all in permanent sod for hay production or grazing.

In 2002, the NYS DEC awarded funds from their Water Quality Improvement Program (WQIP) grant to address sediment loading via roadside ditches on Street Road, Gordon Road and East Lake Road. Unfortunately, lack of cooperation from private landowners and permitting issues with the NYS DEC prohibited some of the originally proposed work from being completed, including sediment reduction work on a Class C tributary to the lake. However, in the end, over 2200 linear feet of roadside ditch on Gordon and Street Roads were modified in elevation, and stone check dams were installed to reduce the velocity of the stormwater flow in the ditches and promote sediment dropout.

In the future, additional items of concern identified in the greater watershed area inclusive of Summit Lake may be addressed through Agricultural Best Management practices or continuing education of land and homeowners =about small-scale green infrastructure projects, such as rain gardens and rain barrels, to reduce stormwater runoff from their properties.

3.2 Aquatic Invasive Species

Over the years, several aquatic plant surveys have been completed on Cossayuna Lake. The first was performed by W.C. Muenscher in 1933. In this survey, 33 species of aquatic plants were observed. A similar survey was conducted in 1998 and reported a total of 15 species in the lake (Eichler, Howe and Boylen, 1998). The most recent survey was completed in October of 2016 by the Darrin Freshwater Institute (Eichler, 2016). In this survey, entitled *Report on Aquatic Vegetation of Cossayuna Lake*, a total of 22 species were observed, with 20 collected in the point intercept survey. Of the species observed, one group is classified as macroscopic alga, or charophytes (*Chara/Nitella*), three are floating-leafed species (*Nuphar, Nymphaea,* and *Trapa*), three are floating species (*Lemna* and *Spirodela*), six are emergent species (*Eleocharis, Sparganium, Polygonum, Scirpus, Typha* and *Pontederia*), and the remaining nine are submersed species. A native plant, Coontail (*Ceratophyllum demersum* L.), dominated the plant community throughout the littoral zone. The high diversity of plants suggests a healthy aquatic plant population at the present time. It is also important to note that none of the species identified in the 2016 survey are listed on the New York State Rare Plant list (Young, 2010).

When the data from all the reports is combined, there are a total of 40 species that have been observed in the lake over the past 85 years (Table 3). Of these 40 species, seven are newly reported species within the 2016 report, two of which are known aquatic invasive species, brittle naiad and waterchestnut.

In additional to the brittle naiad and waterchestnut, Cossayuna Lake has three more aquatic invasive species; Eurasian watermilfoil (EWM), curly leaf pondweed (CLP), and zebra mussels. Within the 2016 survey it is noted that there was a limited occurrence of CLP plants found, which can most likely be attributed to the timing of the survey, which was in September, rather than the actual abundance of the species. CLP generally reaches peak abundance in June and July, and then undergoes senescence. The abundance of waterchestnut found in the survey indicates that the hand-harvesting efforts performed by the lake association members may have kept the population in check since its discovery in 2014. The single sighting of brittle naiad represents the first indication of this invasive in the lake.

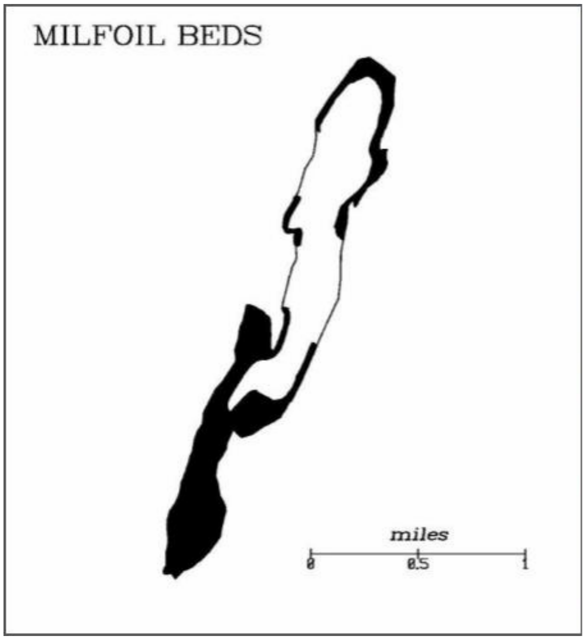
Figure 14 shows the distribution of EWM beds within Cossayuna Lake in 1998 and in 2016. In 1998, EWM beds were abundant within the lake, covering the entire southern portion and much of the littoral zone in the northern portion of the lake. In the survey that was completed in 2016, a total of five sparse beds were found in the northern portion of the lake and a total of 12 sparse beds were found in the

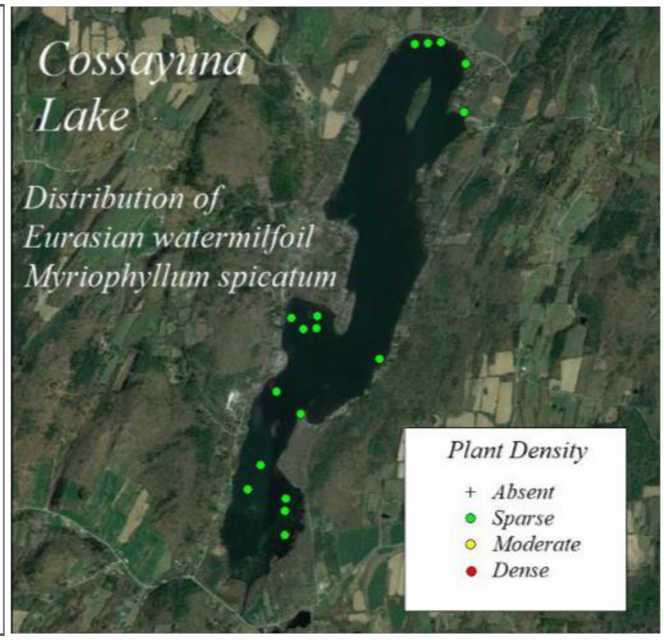
Table 3. List of all of the identified aquatic plant species within Cossayuna Lake from four plant surveys.

Scientific Name	Common Name	Present at Time of Survey			
		1932	1992	1998	2016
Brasenia schreberi	water shield	x			
Chara/Nitella	Muskgrass				x
Ceratophyllum demersum	Coontail	x	x	x	x
Eleocharis sp.	spikerush	x			x
Elodea canadensis	waterwort	x	x	x	x
Isoetes echinospora	quillwort	x			
Lemna minor	duckweed			x	x
Lemna trisulca	duckweed				x
Megalodonta (Bidens) beckii	water marigold	x			
Myriophyllum spicatum	Eurasian watermilfoil		x	x	x
Najas flexilis	bushy pondweed	x		x	
Najas guadalupensis	southern naiad				x
Najas minor	brittle naiad				x
Nuphar variegata	yellow water lily	x	x	x	x
Nymphaea odorata	white water lily	x		x	x
Polygonum amphibium	smartweed				x
Pontederia cordata	pickerelweed	x			x
Potamogeton amplifolius	broad-leaf pondweed	x			
Potamogeton crispus	curly-leaf pondweed	x	x	x	x
Potamogeton dimorphus	spiral pondweed	x			
Potamogeton epihydrus	Nutall’s pondweed	x			
Potamogeton freisii	Fries’ pondweed	x			
Potamogeton gramineus	variable pondweed	x			
Potamogeton natans	floating-leaf pondweed	x			x
Stuckenia pectinata	Sago pondweed	x			
Potamogeton praelongus	white-stem pondweed	x			
Potamogeton pusillus	little pondweed	x		x	
Potamogeton richardsonii	Richardson’s pondweed	x			
Potamogeton robbinsii	Robbin’s pondweed	x		x	
Potamogeton zosteriformes	flat-stem pondweed			x	
Ranunculus sp.	white water crowsfoot	x			
Scirpus sp.	spike rush				x
Sparganium eurycarpum	giant bur-reed	x			x
Spirodela polyrhiza	giant duckweed				x
Trapa natans	waterchestnut				x
Typha sp.	cattail			x	x
Utricularia vulgaris	giant bladderwort	x			
Vallisneria americana	duck celery	x		x	x
Zosterella (Heteranthera) dubia	water stargrass	x		x	x

southern portion of the lake. Within this survey, there were no moderate or dense beds of EWM found. For the full reports, please visit www.cossayunalake.com.

Figure 14. Eurasian watermilfoil (EWM) distribution maps from 1998 Eichler, Howe and Boylen report (left) and 2016 Eichler report (right). On the map on the left, EWM beds are shaded in black. On the map on the right, EWM beds are indicated by green dots.





3.2.2 Herbicide Treatments

The Cossayuna Lake Improvement Association has been managing EWM and CLP populations with herbicides on and off for several years (Table 4). All of these treatments have been privately funded through the efforts of the Association. Chemical treatments were started in 2001 and continued through 2009, until a three year hiatus was taken on the treatments. In this time, property owners noticed a significant degradation of the lake as the EWM and CLP abundance flourished. Since treatments began again in 2013, property owners are finding, through visual perception surveys, that the abundance of EWM and CLP is reducing, while the populations of native aquatic plants are now flourishing. Funding for a plant study is currently being pursued to better quantify the return of the native plants for comparison to previous plant studies. This will help the Association determine if the current management strategies are indeed improving the health of plant life in the lake, and how to proceed with aquatic invasive species management into the future.

3.2.3. Harvesting

The Cossayuna Lake Improvement Association owns an aquatic weed harvester with a 7-foot cutting bar that is operated 40 hours a week during the summer months by a full-time operator. Additionally, a part-time truck driver is employed to help unload the harvested weeds and dispose of them in a nearby land reclamation project. This program is funded by the two towns; $3000 from the Town of Greenwich and $7350 from the Town of Argyle, based on the amount of shoreline within each Town; and $6000 from the Association and participating lakeshore owners. Washington County does not provide any funding to the weed harvesting program.

Table 4. Type, amount, cost, and total acres treated with herbicides per year for aquatic invasive plant control on Cossayuna Lake from 2000 – 2016.

Year	Acres Treated	Chemicals Used	Amount Applied per acre	Cost
2016	73.1	Navigate	42 lbs	$28,767
		Aquathol K	up to 3.5 gallons	
2015	94	Sculpin G	16.35 pounds	$33,600
		Aquathol K	up to 1 gallon	
2014	120	Sculpin G	16.35 pounds	$40,967
		Aquathol K	0.45 gallons	
2013	120	Sculpin G (2, 4-D)	130.9 pounds	$46,350
2012	no treatment			
2011	no treatment			
2010	no treatment			
2009	25.3	Aqua Kleen (2, 4-D)	100 pounds	$13,500
2008	28.5	Aqua Kleen (2, 4-D)	100 pounds	$12,716
2007	28.5	Aqua Kleen (2, 4-D)	100 pounds	$12,722
2006	27.2	Aqua Kleen (2, 4-D)	100 pounds	$11,791
2005	28.9	Aqua Kleen	100 pounds	$11,316
2004	28	Aqua Kleen	100 pounds	$10,673
2003	23.5	Aqua Kleen	100 pounds	$9,121
2002	26	Navigate (2, 4-D)	100 pounds	$11,791
2001	26	Unknown	100 pounds	$8,662
2000	no treatment			

Table 5. Number of truckloads of aquatic weeds harvested from Cossayuna Lake from 2000 – 2016. Estimated tonnage calculated based on the assumption of 2.5 tons per truckload.

Year	**Total Truckloads of Aquatic Weeds Removed**	**Estimated Tonnage of Aquatic Weeds Removed**
2016	321	802
2015	285	712
2014	254	635
2013	222	555
2012	296	740
2011	403	1007
2010	400	1000
2009	234	585
2008	350	875
2007	340	850
2006	186	465
2005	283	707
2004	391	977
2003	402	1005
2002	410	1025
2001	378	945
2000	386	965

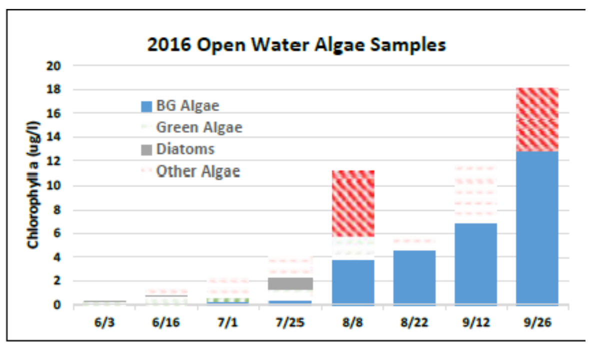
Tonnage of plants removed has been estimated utilizing the number of truckloads removed at 2.5 tons per truckload (Table 5). Little correlation can be made between the loads removed and the positive effect removing the weeds has on the lake, due to the variability of weather and funding shortages. It is also important to note that in 2006 the weed harvester broke down, which resulted in the significantly lower number of truckloads of weeds taken out of the lake in that year. Because of this breakdown, the Association purchased a new harvester in 2007. However, even with constraints, a total of 5,541 truckloads of aquatic weeds were removed from Cossayuna Lake from 2000 – 2016. This equates to an estimated 13,850 tons.

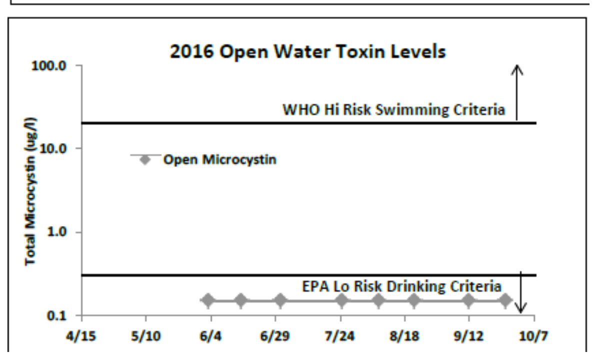
3.3 On-Site Septic Systems

Information on the composition of septic systems within the watershed was collected from town documents ranging from 2000 – 2015. Data showed that in that time period in Argyle, 33 new systems were installed, 18 systems were repaired, and ten were changed to a holding tank with an alarm. In Greenwich, during the same time period, six new systems were installed, four systems were repaired, one system was replaced and four were replaced with a holding tank with an alarm. In total, 76 out of the 440 properties within one-mile of the lake addressed structural issues with their septic systems over the past 15 years. It is important to note that none of this information includes the number of systems that were pumped or inspected, so it is difficult to discern the maintenance levels of individual systems.

On-site septic system issues can only be meaningfully address through local or state legislation. The first step a municipality can take is to require a septic system inspection upon sale or transfer of property. This would, at the very least, assist local code enforcement in identifying failing systems not only for the protection of the lake, but for the protection of the new owner.

Figure 15. 2016 Open water algae sampling and open water toxin level results.





3.4 Algal Blooms and HABs

Cossayuna Lake has periodically exhibited large shoreline blue-green algae (cyanobacteria) blooms comprised of multiple species, with some elevated toxin levels. Although total blue-green algae levels rise in the open water during the typical summer months, open water blooms are uncommon and toxin levels are low. It is not known if these blooms have affected water intakes, but drinking water users should be aware of this potential risk.

Figure 15 shows the results of open water algae sampling and open water algae toxin levels for 2016. Results show that the amount of algae increased as the summer progressed, more specifically the amount of blue-green algae. An abnormally high-temperature September may have resulted in the increase of algae growth in that month. However, the increase in algae, especially blue-green, did not result in toxin levels reaching above the EPA Lo Risk Drinking Criteria.

4.0 Stewardship Opportunities

For several years the Cossayuna Lake Improvement Association has been providing educational opportunities for area landowners on an array of topics. Some the these opportunities have included reducing fertilizer use or use of zero-phosphorus fertilizers, cleaning up pet waste, discouraging waterfowl congregation on the shoreline by restoring natural shoreline vegetation, septic system care and alternatives, use of composting toilets, porous pavement, water safety, boat cleaning, and plant identification. There are many additional individual stewardship activities that should be implemented within the Cossayuna Lake watershed to further improve the quality of water in the lake. These include, but are not limited to,

- **Stormwater.** *Plant a buffer along your shoreline*. Native plants can be grown to help reduce the velocity of stormwater entering into the lake, which will reduce shoreline erosion. Growing plants will also help take up nutrients within the stormwater, so fewer nutrients will be discharged into the lake.
- **Invasive Species.** *Perform Inspections*. All boats and trailers entering into Cossayuna Lake should be inspected for aquatic invasive species by a trained lake steward. The will help reduce the risk of new invasive species entering Cossayuna Lake.
- **Invasive Species.** *Monitor***.** Continued monitoring for invasive species is warranted because early detection of an aquatic invasive species increases the chance of best managing it.
- **Septic System.** *Pump your septic system*. For full time residences, this should be done every 3 – 5 years. For part-time residences, this should be done every 5 – 7 years.
- **Algae Blooms and HABs.** *Monitor***.** Continue monitoring for algal blooms and HABs.
- **Algae Blooms and HABs.** *Educate*. Continue educating visitors and homeowners, especially those that draw water from the lake, on the causes and effects of algae blooms and HABs.

More specific recommendations for each of these categories can be found in the next section.

5.0 Recommendations

5.1 Nutrient Loading and Erosion Recommendations

Recommendation	Involved Parties	Required Funding	Source of Funding	Timeframe	Preventative or Corrective
Stormwater					
Work with highway departments to reduce the quantity of salt/sand used in winter road maintenance activities	Washington Co. DPW Town highway departments Washington Co. SWCD LCLGRPB	Various	NYS DOS NYS DEC County Towns	Medium Term	P
Work with municipalities to post signage for reduced salt zones and educate public	Washington Co. DPW Town highway departments Washington Co. SWCD LCLGRPB	$0	N/A	Medium Term	P
Erosion					
Perform comprehensive lakeshore erosion assessment and produce report identifying areas for remediation	Washington Co. SWCD	$5,000	NYS DOS NYS DEC County Towns	Medium Term	P
Seek funding to implement projects identified in lakeshore erosion assessment	Washington County SWCD LCLGRPB	Various	NYS DOS NYS DEC County Towns Landowners	Long Term	P
Perform comprehensive culvert assessments in the watershed and produce report identifying replacement needs	Washington Co. SWCD Towns	$7,500	NYS DOS NYS DEC County Towns	Short Term	P
Seek funding to implement culvert replacements projects identified in report	Washington Co SWCD LCLGRPB	Various	NYS DOS NYS DEC County Towns	Long Term	P
Wetlands					
Identify wetland areas for enhanced conservation efforts	C.L.I.A.	$0	N/A	Long Term	P
Monitor beaver population in the lake and trap/remove as needed	C.L.I.A.	$80/year	C.L.I.A.	Continual	P

Recommendation	Involved Parties	Required Funding	Source of Funding	Timeframe	Preventative or Corrective
Septic Systems and Waste Facilities					
Assist property owners with locating septic systems	C.L.I.A.	$0	N/A	Continual	C
Create program to provide group rates for septic pumpouts	C.L.I.A.	$0	Homeowners	Continual	P
Work with Towns to update codes pertaining to onsite septic systems	C.L.I.A.	$0	N/A	Continual	P
Work with NYS DEC to ensure public bathroom facilities at the fishing access are properly maintained	C.L.I.A. NYS DEC	$0	N/A	Medium Term	P
Work with NYS DEC to install signage pertaining to litter laws	C.L.I.A.	$0	N/A	Short Term	P
Agriculture					
Update inventory of farms and operators	Washington Co. SWCD	$0	N/A	Short Term	P
Work with farms to implement best management practices for nutrient and sediment runoff reduction	Washington Co. SWCD	Various	NYSDAM NRCS	Long Term	P
Monitoring					
Perform DNA testing on water samples to determine if human waste is present	C.L.I.A. Consultant	$10,000	Unknown	Short Term	P
Continue CSLAP water monitoring program	C.L.I.A. NYSFOLA	$0	NYSFOLA	Continual	P
Replicate 1988 stream study to assess progress in nutrient reduction	C.L.I.A. Consultant	$5,000	C.L.I.A.	Short Term	P
Lake Level					
Drawdown the lake 20 inches in the winter to prevent erosion and spillway damage from ice	C.L.I.A. NYSFOLA	$0	N/A	Continual	P
Maintain historic summer lake level (6 inches above the bottom of the notch on top of the spillway)	C.L.I.A.	$0	N/A	Continual	P

5.2 Invasive Species Recommendations

Recommendation	Involved Parties	Required Funding	Source of Funding	Timeframe	Preventative or Corrective
Continue yearly management of EWM and CLP utilizing a prescribed herbicide cycle	C.L.I.A.	Various	C.L.I.A. Shoreline owners	Yearly	C
Evaluate effectiveness and longevity of herbicide treatment cycle	C.L.I.A.	$0	N/A	Medium Term	P
Continue open water EWM harvesting. Priority areas include those of high boat traffic and in the outlet channel.	C.L.I.A. Towns	$5,000	C.L.I.A. Towns	Yearly	C
Begin CLP harvesting in open waters	C.L.I.A. Towns	$5,000	C.L.I.A. Towns	Short Term	C
Continue dock weed harvesting program for homeowners. Program will run from May – September. Minimum of three cuts per season.	C.L.I.A. Municipalities	Various	Homeowners	Yearly	C
Investigate feasibility of a boat wash station at the boat launch	C.L.I.A.	$0	N/A	Short Term	P
Map extent of waterchestnut within the lake	C.L.I.A.	$0	N/A	Continuous	C
Utilize local youth groups (i.e. Boy Scouts) to hand harvest waterchestnut	C.L.I.A. Greenwich Boy Scouts	$0	N/A	Yearly	C
Establish five stations around the lake to monitor for small aquatic invasive species	C.L.I.A. Consultant	$5000	NYS DOS NYS DEC C.L.I.A.	Short Term	C
Replicate 1998 plant and small aquatic invasive species survey to assess progress of management activities	C.L.I.A. Towns	$3000	NYS DOS NYS DEC C.L.I.A. Towns	Short Term	P
Work with NYS DEC Fisheries to assess changes in fish population	C.L.I.A. NYS DEC	$0	N/A	Short Term	P
Perform a flow study to determine effects of herbicide treatments downstream of Cossayuna Lake	C.L.I.A. Consultant	$500	C.L.I.A.	Short Term	C

5.3 Education Recommendations

Recommendation	Involved Parties	Required Funding	Source of Funding	Timeframe	Preventative or Corrective
Install two buffer zones, one on a steep bank and one on a lawn, on C.L.I.A property	C.L.I.A.	$6,000	C.L.I.A. SCA grant Washington Co. SWCD	Short Term	P
Install permanent signage and provide education on buffers during workshops	C.L.I.A.	$1,500	C.L.I.A. SCA grant	Short Term	P
Create a "Best Buffer Zone" Contest to incentivize good shoreline stewardship	C.L.I.A.	$200	C.L.I.A.	Short Term	P
Provide "Homeowners Guides to a Healthy Lake" to property owners	C.L.I.A.	$0	LCLGRPB	Continual	P
Provide free plant identification services for residents	C.L.I.A.	$0	N/A	Continual	C
Provide information to residents to increase awareness of harmful algae blooms	C.L.I.A.	$0	N/A	Continual	C
Educate residents on the importance of wetlands and how to report disturbances	C.L.I.A.	$0	N/A	Long Term	P
Provide information to residents on septic system care and alternative technologies	C.L.I.A. LCLGRPB	$150	LCLGRPB	Short Term	P

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