Lake Iroquois Tributary Water Quality Monitoring

for
The Lake Iroquois Association
Support provided by the
Vermont Department of Environmental Conservation
LaRosa Partnership Grants Program
December 2017

Introduction

This is the fifth annual report of the Lake Iroquois Association (LIA) Tributary Monitoring Program (the "Program") supported by a LaRosa Environmental Partnership Grant. The Program began in 2011. The Program was managed by the Lake Iroquois Association, Inc., a Section 501(c)(3) environmental conservation organization focused on the water quality of Lake Iroquois in Vermont. Tributary monitoring was suspended from 2015-2016 while the LIA continued its work planning and assessing run-off mediation projects on the Lake's west shore, but was resumed in 2017. Design of the LaRosa project, including preparation of the initial proposal, handling of pre-log packets, bottle orders, field sampling, and delivery of samples to the laboratory was handled by one of its newest member on the LIA Board.

Description of the project waters

Lake Iroquois is the largest body of water in the LaPlatte River watershed. Formerly Hinesburg Pond, the Lake is a eutrophic kettle pond found in the Lake Champlain watershed and situated in a valley bracketed by Dow and Magee Hills to the east and Mount Prichard on the west. The Lake shares borders with the towns of Williston, Hinesburg and Richmond. The town of St. George also lies within the Lake's watershed. It is about 15 miles from Vermont's principal urban area of Burlington. The Lake was formed following the receding of the last ice coverage in Vermont about 15,000 years ago. Over the years, the Lake has naturally become more eutrophic, and has been the site of significant human development and use in the last 150 years. A dam constructed on the Lake's outlet in the mid-1800s was used to control the water supply to mills downstream in Hinesburg. These mills are no longer operational. Around the 1960s, the dam was intentionally cemented into its top position, retaining the pond at an artificially high level throughout the year. The outflow of the Lake is over the dam in the south end and forms Patrick Brook. This outlet stream flows into a lower pond in Hinesburg, eventually draining into the LaPlatte River and ultimately to Lake Champlain.

Ninety-one camps and homes are located on the lake shore. The four towns in the watershed formed the Lake Iroquois Recreation District, which operates a public beach on the north end of the Lake. The Vermont Fish & Wildlife Department maintains a public fishing access at the north end of the Lake. Some conserved land exists at the north end. Much of the remaining lake shore has been developed, with many summer camps and year-round residences built considerably close to the shoreline.

Goal of Monitoring Program

Present usage of the Lake, its persistently high water level, shoreline erosion, runoff from development and roads, outdated septic systems and other factors are suspected of accelerating the productivity and increasing nutrient concentrations within the Lake. Increasing nutrient loads in the Lake have impaired the water quality and public uses of Lake Iroquois and contribute to elevated nutrient levels in Lake Champlain. The Lake has a significant invasion of Eurasian water milfoil (*Myriophyllum spicatum*). In the fall of 2010 and again in 2011, blooms of blue-green algae (Cyanobacteria) occurred in the Lake. Assuming no change in current regulations, it is anticipated that changes in the watershed such as new development and increased motor boat usage in the Lake will continue unabated due to anticipated, population growth in proximity of the Lake, particularly Hinesburg. Without a continued, concentrated effort to identify and reduce major contributors to the Lake's nutrient load, its water quality could deteriorate rapidly.

Monitoring Process:

An earlier LIA watershed survey identified as many as 21 tributaries flowing into Lake Iroquois. Many of these tributaries flow intermittently during the period of the year when the lake is not frozen. A number of these tributaries formed artificially as a result of development around the Lake, including the construction of homes, roads, and parking areas. The 10 tributary sites are identified on the map in Appendix A and their locations are described in Appendix B. These sites were chosen to continue the monitoring that began in 2011, to provide additional data on the effect of remediation projects being undertaken on the west side of the Lake, and to provide general data on in-flows into the Lake. Site 6 was not chosen for sampling in 2017 due to nonexistent flows in prior years.

Lab tests were performed for chloride, total phosphorus, nitrogen, and turbidity.

During the period of May 15 through October 25, 2017, a volunteer sampled the 10 sites approximately every two weeks, including Site 11 located at the outlet of the Lake just below the dam.

Measurements of phosphorus at the Lake's outflow supplement in-lake measurements of phosphorus, chlorophyll and Secchi clarity taken as part of the Vermont Lay Monitoring Program ("LMP"). This outflow data is helpful in assessing the effectiveness of surface water remediation actions and identifying sources of phosphorus loading in the LaPlatte River.

Water Quality Monitoring Results

Graphic illustrations of the mean measured concentrations (with standard deviation) of chloride, total nitrogen, total phosphorus, and turbidity are provided in Excel spreadsheets submitted with this report. Concentrations of the analytes for each sampling event are included in the Excel spreadsheets as well.

The following observations were made following the 2017 testing:

CHLORIDES

The Vermont Water Quality standards (October 30, 2014) adopted a chloride chronic toxicity criterion of 230 mg/L (daily mean over four-day period), and 860 mg/L acute toxicity (one day mean). Chloride becomes toxic to aquatic life once levels approach 230 mg/L.

Chloride levels observed are well below the Vermont Water Quality Standards with no exceedances in 2017 **(Table 1.)**. Site 7, 8, and 10, showed the highest average chloride levels. Site 7 had the highest single chloride sample of 58.5 mg/L on September 28th. Site 2, 1, and 9 reflect the lowest average levels. Sites, 7, 8, and 4 reflect the highest multiple-year average chloride levels of all sites. Sample sites on the west and southern side of the Lake were notably higher. These sample sites receive runoff from developed areas including Pond Road, Pine Shore Road, and Southwest Shore Road. Site 7 collects runoff from Pond Road in addition to the private roads above (Dynamite Hill) and below the road (Pine Shore Road). The 2017 and multiple-year average chloride levels for Site 2 are the lowest, suggesting a correlation with the less developed watershed. Average chloride levels range from generally stable to a slight decline on some sites over multiple years of sampling.

Studies exist suggesting Eurasian water milfoil tolerates chloride better than native pond weeds. Perhaps techniques to reduce road salt usage on Pond Road could aid the efforts to control milfoil infestation in the Lake.

Table 1. Mean Total Chlorides in Lake Iroquois Tributaries (mg/L)

Sites	2011	2012	2013	2014	2017	Multi-Year Average
1	8.0	13.0	12.0	-	13.28	11.57
2	< 2	< 2	< 2	-	3.43	2.36
3	12.5	22.0	17.5	-	20.01	18.0
4	20.0	25.50	23.0	36.81	17.79	24.6
5	16.0	21.0	17.0	24.33	14.68	18.6
6	-	< 2	< 2	14.40	-	6.13
7	-	55.0	43.0	59.33	43.43	50.19
8	-	27.5	23.0	28.91	22.49	25.48
9	-	16.0	13.0	15.63	13.73	14.59
10	-	21.0	20.0	-	27.81	22.94
11	-	-	-	-	14.80	-

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PHOSPHORUS

The Total Phosphorus (TP) regulatory value for B(2) "Medium High Gradient" (MHG) streams is 15 µg/L under low, median monthly flow conditions. The nutrient criteria were derived to protect aquatic life from the detrimental effects of enrichment.

Nine of the 10 tributary sites monitored exceeded 15 µg/L of phosphorus at least once during the sampling season. Sites 3-5 and 8-11 experienced seasonal average phosphorous levels above the regulatory standard. Sites with the highest average phosphorus levels were 5, 10, 9, and 3 respectively. Sites with the lowest average phosphorous levels were 7, 1, and 2 **(Table 2)**. Site 5 had the single highest sample recorded at 351 µg/L while Site 7 had the lowest sample recorded at 5.75 µg/L.

Table 2. Phosphorus in Lake Iroquois Tributaries

Mean Total Phosphorus (µg/L) - Averages for sampling sites						
Sites	**2011**	**2012**	**2013**	**2014**	**2017**	**Multiple-Year Average**
1	18	24	16	15.2	11.2	16.9
2	20	17	13	14	11.3	15.06
3	71	44	42	33	22.2	42.44
4	47	13	15	11.5	20.8	21.46
5	34	20	31	23.5	94.7	40.64
6		26	24	13.6	DID NOT SAMPLE IN 2017	21.2
7		13	12	15.2	8.6	12.2
8		19	25	26.8	18.4	22.3
9		24	16	13.3	35.0	22.08
10		44	26	56	30.7	39.18
11	21*	18*	17*	14.3	16.5	15.4
	* LMP in-lake readings					

All Sites except Site 5 have experienced a general decline in phosphorous levels **(Figure 1)**. Site 5 experienced a significant spike in phosphorous, however, it is hoped that a road and stream rehabilitation project completed on Pine Shore Drive and the tributary leading to Site 5 will lead to reduction in sediment and phosphorous levels.

Based off review of precipitation data available for the area, it is worth noting spikes were observed in phosphorus levels corresponding with precipitation events. These spikes may also correlate with higher turbidity levels, suggesting that phosphorus sources are primarily from erosion from the landscape or within stream channels. Notably, Site 10, which has the third highest average phosphorus level by far, also reflects the highest average turbidity level. Evidence of recurring local disturbance within the roadway and stream just below the culvert was observed during multiple sampling events and may be contributing to higher suspended sediment and corresponding turbidity levels.

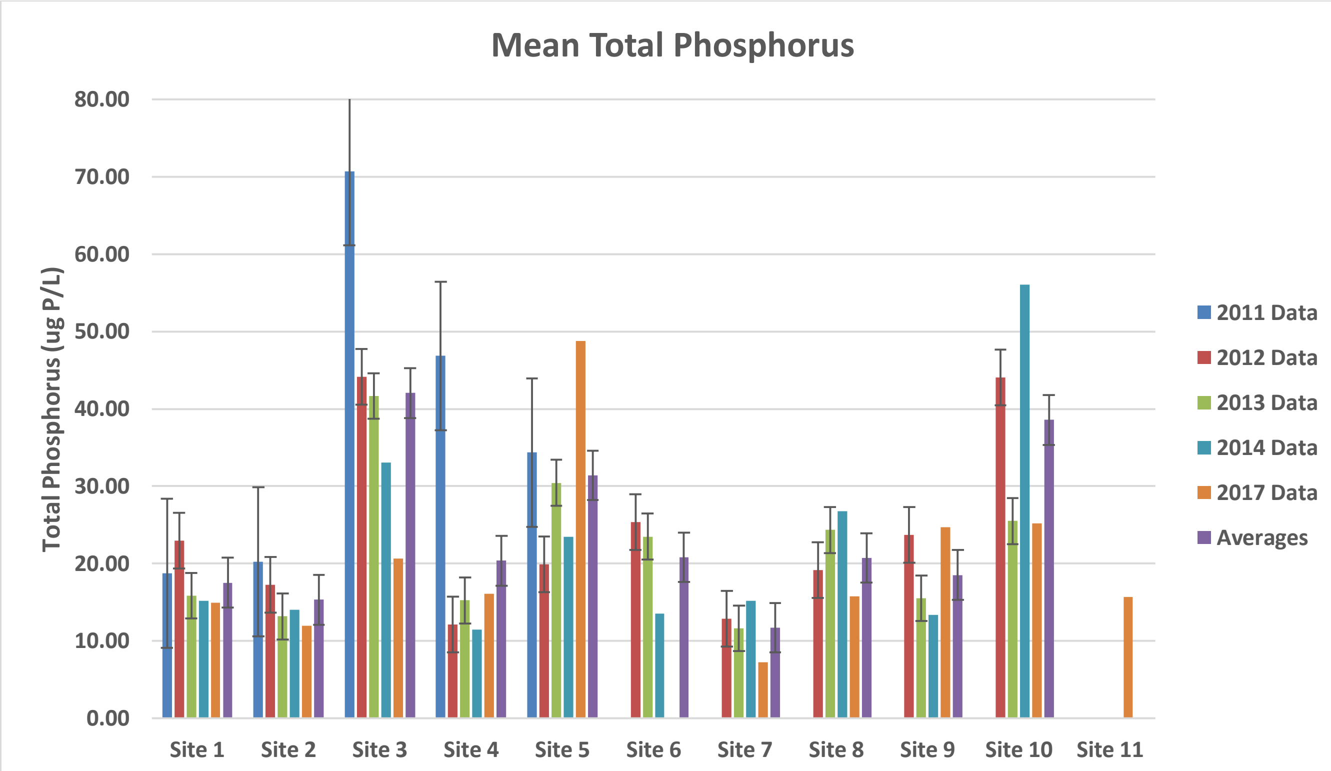


Figure 1. Average phosphorus levels for the sampling year for each site (2011 to 2017)

TURBIDITY

The Vermont Water Quality Standard for turbidity in Class B(2) streams is 25 NTUs (Nephelometric Turbidity Units). Three streams - Site 5, 9, and 10 - exceeded the Vermont Water Quality Standard of 25 NTUs for turbidity on four occasions. These Sites also reflect the highest average turbidity levels, although it must be stated there were one-time notable spikes on June 29th which skewed these averages considerably higher. The three Sites reflecting the lowest average turbidity levels were 7, 3, and 2 **(Table 3 and Figure 2)**. The highest single turbidity sample recorded was 107.4 NTUs at Site 10 following this same rain event. The lowest single turbidity recorded was 0.30 NTUs at Site 2. All Sites reflect turbidity averages well below the State regulatory standard.

Table 3. Turbidity in Lake Iroquois Tributaries

Turbidity (NTUs)						
Site	**2011**	**2012**	**2013**	**2014**	**2017**	**Multiple-Year Average**
1	1.75	2.3	1.1	1.30	1.32	1.55
2	1.1	1.25	0.4	0.79	1.06	0.92
3	2.4	1.7	1.1	1.31	0.81	1.46
4	4.1	1.25	0.6	1.40	1.89	1.85
5	5.1	6.1	4.25	11.61	8.93	7.20
6		0.9	2.75	1.70	N/A	1.78
7		2.0	1.4	0.67	0.74	1.20
8		4.25	1.1	4.45	1.58	2.85
9		2.75	0.7	2.07	9.89	3.85
10		3.5	0.75	1.71	9.79	3.94
11				1.09	1.78	1.44

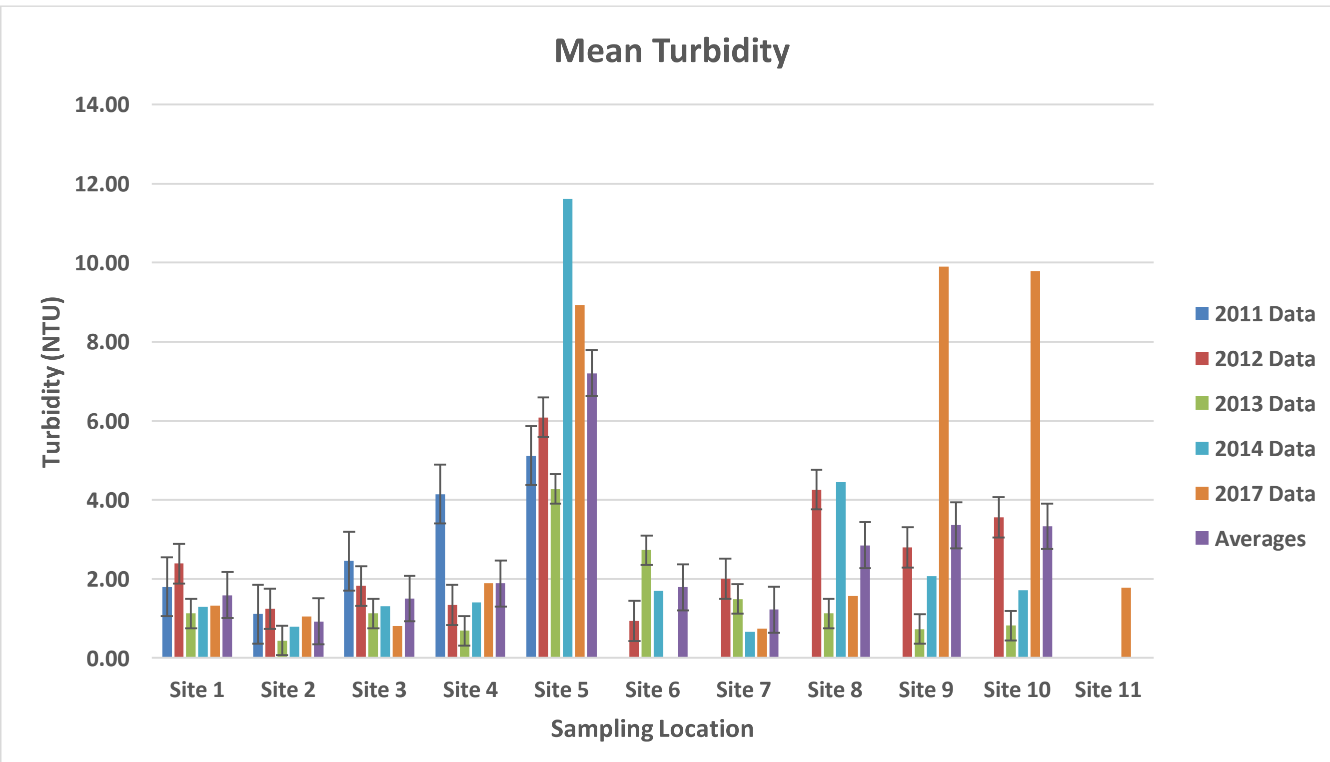


Figure 2. Average Turbidity values for the sampling year for each site (2011-2017)

NITROGEN

Nitrogen was included in this year's sampling effort and no Site exceeded the State standard of 5.0 mg/L. Site 11 had the highest average nitrogen levels of any Site followed by Sites 5, 10, and 7, respectively. Site 8 and Site 2 had the lowest average nitrogen levels of all the Sites. The highest single nitrogen sample recorded was 0.48 mg/L at Sites 7 and 10. Multiple Sites had low recordings of 0.10 mg/L.

Proposals for Future Actions: Based on test results of prior and current years, a number of grants were applied for in 2017 to further research nutrient level sources and rehabilitate areas around the Lake with sediment and erosion problems. The Lake Iroquois Association is hopeful these grants will gain approval in order to continue moving forward to reduce phosphorous and other pollutants of concern.

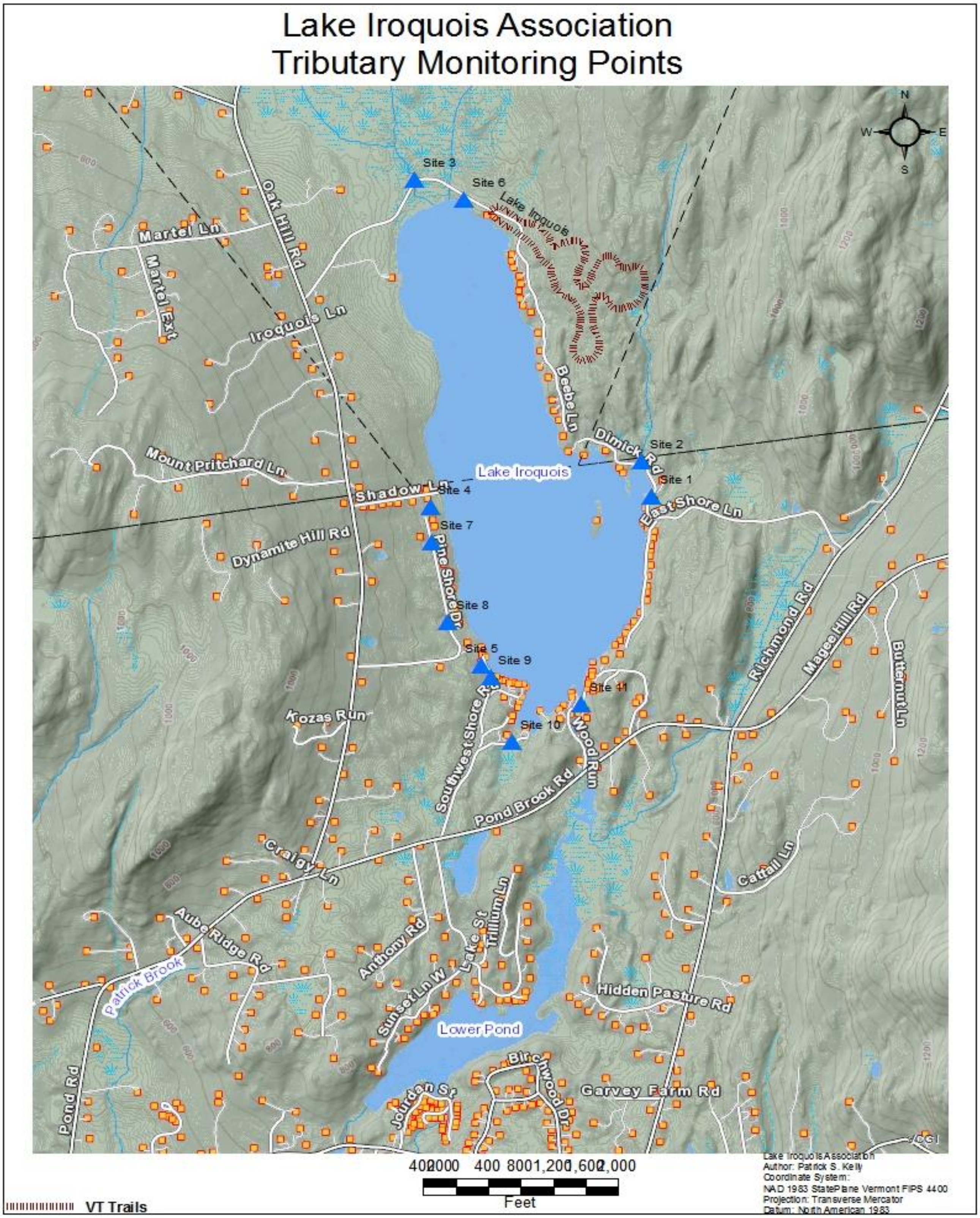
1. Monitor and review the upstream areas of tributary sites with highest phosphorus levels. The objectives and goals are:
    a. Assess validity of expanded monitoring efforts further upstream on sites with the highest phosphorus levels to bracket and pinpoint pollutant source(s).
    b. Determine the effectiveness of prior remediation actions taken to improve these Sites.
    c. Continue to identify problem areas and seek funding in order to implement remediation efforts.

2. Pursue educational outreach efforts to encourage and assist in better property management practices, especially riparian buffers. This effort may serve to reduce phosphorus pollution coming from developed properties. Helping homeowners manage stormwater runoff from private roads would also aid in cleaning up the Lake.
3. Seek assistance from the Vermont DEC to strengthen working relationships with other watershed groups, particularly the LaPlatte Watershed Partnership and Lewis Creek Association.
4. Resume tributary monitoring in May 2018, including outflow monitoring with changes as suggested above.
5. Seek to diversify and expand funding resources.
6. Consider more sophisticated equipment and studies that support increased knowledge of the watershed. Examples include a full-time stream gage at the Lake outlet, a continuous water quality monitoring instrument, and sample discharge monitoring equipment.

Conclusion: Lake Iroquois is part of the greater LaPlatte River watershed of Lake Champlain. Relative to concentrations of total phosphorus, total nitrogen, and chloride measured over the 20+ year period of the Lake Champlain Long Term Monitoring Program, the monitoring results for the Lake Iroquois tributary monitoring are on par or are better than the average concentrations observed in the LaPlatte River. This is not too surprising given the relatively small size of the Lake Iroquois watershed. Chloride levels at all sites meet the Vermont Water Quality Standards, although are higher on the west side where a busy Town road is located. An increased number of sampling locations experienced phosphorus levels that do not meet Vermont Water Quality Standards of 15 µg/L. Turbidity values were still relatively low but did seem to correlate with elevated phosphorous levels.

The Lake Iroquois Tributary Monitoring Program has identified tributaries in this watershed for which management actions could be directed to improve the water quality in Lake Iroquois, the LaPlatte River, and ultimately Lake Champlain. The LIA intends to move forward to achieve some or all of the action items listed above. LIA hopes to use the monitoring data as part of an ongoing effort to educate lake residents and users about the effect of human actions on water quality and to assess the effects of remedial actions and better practices on water quality.

Appendix A: Maps of Lake Iroquois Water Quality Monitoring



Appendix B Description of Sampling Locations

Site 1: This stream originates from Magee Hill. The stream crosses under Richmond Road (a paved, well-traveled public road running from Hinesburg to Richmond) and passes through culverts under East Shore Road and Dimick Road before entering the Lake on its east shore. Through historic observation, this is the largest tributary of Lake Iroquois and it is known to generally flow continuously through the season. The sampling location was approximately 10 meters from the Lake. The stream is contained in a mostly rocky-bottomed bed before entering the Lake.

Site 2: This stream enters the east side of the Lake after passing under Dimick Road. The stream flows into a marshy area next to the Lake. The sampling location was a culvert at Dimick Road that is approximately 30 meters above the stream entrance to the Lake. This stream is believed to drain a largely wooded area to the east of the Lake and is not known to pass under any regularly used public or paved roads.

Site 3: This stream may be considered the inlet to the Lake as a principle contributor. This tributary drains a large, low-lying area on the north side of the Lake. This northern portion of the Lake contains a wetland and would be a larger marsh if it were not for the dam on the Lake's southern outlet, which keeps the Lake's water level artificially higher than the natural level of the pond. There are several smaller streams that converge upstream of the sampling site. In August 2013 we took phosphorus samples from two of these smaller streams, identified as sites 3A and 3B. The stream passes under the well-travelled Beebe Lane and also drains sparsely developed areas in Williston north of the Lake. The watershed area extends north of South Road in Williston. Further survey work was been done in an attempt to determine the principal sources of phosphorus at this site.

Site 4: This stream originates on Mount Pritchard and descends in a line perpendicular to the Lake's western shore. The stream bed is partly man-made as a result of development, and runs parallel to Shadow Lane, a dirt road running directly down the hillside perpendicular to the Lake shore. The stream crosses the well-travelled, paved Pond Road. This Site is impacted by remediation work, including the construction of retention ponds, undertaken at the end of the 2012 sampling season and extending into summer and fall 2013. Sampling in 2014 suggests that the remediation work on this stream may not have the desired effect of reducing phosphorus loading.

Site 5: This is a low volume site on the Lake's west side impacted significantly by development. This stream crosses Pond Road via a culvert. The stream bed has been altered by development, and like Site 4, it drains an area descending directly to the west side of the Lake. Remediation efforts to improve culverts and to build a retention pond were undertaken during the summer of 2012. The retention pond filled more quickly than anticipated. Accumulated sediment was removed in fall 2013. This site, in addition to Sites 4 and 8, was dry for three or four of the sampling dates.

Site 6: This is an intermittent drainage area at the north end of the Lake. This may drain a portion of the parking area of the public beach. It had zero flow in 8 of the 14 sampling dates in 2013. In 2014, two samples were taken here. NOTE: This Site was not sampled in 2017.

Site 7: A stream on the west side conveying water across Pond Road. The stream is impacted by runoff from developed areas uphill and to the west of Pond Road. The stream passes under Pine Shore Road prior to entering the Lake.

Site 8: A stream on the west side that passes under Pine Shore Road.

Site 9: A stream that drains an area on the southwest side of the Lake along and under Old Pump Road.

Site 10: This stream drains an area southwest of the Lake which may include some agricultural use. The stream enters a swampy area south of Pike Point Road prior to passing under a culvert at Pike Point Road and entering the Lake.

Site 11: This site is the outlet of the Lake. Samples were taken just below the dam in the stream that drains the Lake.

Appendix B Table 1: Site ID and location

Location ID	Location Name	Latitude	Longitude
505512	Site 1	44.369204	-73.077965
505513	Site 2	44.370476	-73.078435
507884	Site 3 Lake Iroquois Inlet	44.380389	-73.089219
505515	Site 4		
505511	Site 5	44.368760	-73.088387
507885	Site 6	44.363178	-73.085965
507888	Site 7	44.379700	-73.086900
507889	Site 8	44.367512	-73.088308
507891	Site 9	44.364721	-73.087516
507883	Site 10	44.362749	-73.085478
510232	Site 11 Lake Iroquois Outlet	44.360489	-73.084446

Appendix C. Quality Assurance

Quality Assurance: Participation in a project of this nature was new in 2011 to everyone on the LIA Board as well as the other individuals recruited as volunteers for sampling under the Program. The 2012 and 2013 Programs built on the experience among the volunteers in the sampling protocols for the in-lake Lay Monitoring Program (LMP) of the Vermont Department of Environmental Conservation (VT DEC) and in prior LaRosa Program sampling. Training for the Program included a spring training session in April at the VT DEC lab located at the University of Vermont. Renewed sampling in 2017 was handled by a first-year volunteer.

The Quality Assurance Project Plan (QAPP) was developed based on the "Generic QAPP" template provided by VT DEC and the earlier QAPP developed for the Program. The Program relies wholly on volunteer staffing. Volunteers for the Program are personally dedicated to the Program goals and have been receptive to learning proper sampling techniques, storage of samples and delivery to the lab. Renewed sampling in 2017 was handled by a first-year volunteer.

The Program QAPP was not discussed in detail with the VTDEC Project Contact or with other professionals associated with the Program. The initial QAPP was revised in January, 2013 to reflect the change in sampling Site 6. The actual Site 6 as used in the Program has been properly described in Section 10 of the QAPP, including a recorded latitude/longitude of site 6 and the other sampling sites.

Our volunteers are committed to continually expanding the knowledge of the LIA Board and all Program volunteers concerning quality assurance of the sampling undertaken in the Program. The addition of site 11, the elimination of nitrogen sampling, and the limitation of chloride sampling in 2014 were discussed with the LaRosa Program Director. Also discussed was the suspension of sampling in 2015. A decision was reached that the sampling data from 2011-2014 could be effectively used as a baseline to measure the effectiveness of future projects anticipated by the LIA to improve water quality in the Lake tributaries. Sampling resumed again in 2017.

Appendix C Table 1: Quality assurance measures for total phosphorus, nitrogen, turbidity and chlorides

Note: Due to miscommunication with the lab, duplicate samples collected were not processed by the lab.

Date	Phosphorus (µg/L) Sample	Duplicate	Nitrogen	Turbidity	Chloride	Relative Percent Difference Between Duplicate Pairs (RPD) (Phosphorous)
					Mean	

Appendix C Quality Assurance

Note: Due to miscommunication with the lab, duplicate samples collected were not processed by the lab.

QAPP – Summary of steps need for data analysis

1) To screen for contamination, the average blank concentration, by parameter, should be calculated. This average value should be as close as practical to the Reporting Limit listed in Table 1 (NOTE: No blanks were run the entirety of this sampling effort).

2) To assess the precision of results, the Mean Relative Percent Difference (RPD) between field duplicate samples should be calculated. The average RPD should be less than or equal to the Estimated Precision listed in Table 1 . This simple measure is calculated as follows (see also figure 1):

$RPD_{field\ duplicate\ pair\ 1}$ = absolute value ($sample_1$ - $sample_2$) / average ($sample_1$ and $sample_2$); and, the Mean RPD for "n" duplicate pair = average ($RPD_{pair\ 1}$ + $RPD_{pair\ 2}$ + ... + $RPD_{pair\ n}$)

3) Reconciliation with Project Quality Objectives (PQOs)

As indicated above, mean blank concentrations and mean relative percent differences will be compared to data quality objectives established in Table 2 below.

Appendix C Table 2 – Laboratory Analysis Protocols for Water Samples:

Parameter	Reporting Limit [A]	Accuracy[B] (% Recovery)	Estimated Precision for Field Duplicates [C] (RPD)	Laboratory Precision (RPD)	Analytical Method Reference[B]
Total and dissolved phosphorus	5 µg/l	85-115%	≤30%	15% [B]	*Standard Methods for the Examination of Water and Wastewater* (21st ed.) 4500-P H
Total Suspended Solids	1 mg/L	80-120%	≤15%	≤ 15%	*Standard Methods for the Examination of Water and Wastewater* (21st ed.) 2540D
Turbidity	0.2 NTU	N/A	≤ 15%	≤15%	EPA 180.1
Total nitrogen (persulfate digestion)	0.1 mg/L	85%-115%	≤20%	≤10%	*Standard Methods for the Examination of Water and Wastewater* (21st ed.) 4500-N C
Total NOx	0.05 mg/L	85%-110%	≤10%	≤5%	EPA 353.2

(A) - Reporting Limit is the minimum reported value (lowest standard in calibration curve or MDL x 3)
(B) - Section 5.0, Vermont Dept. of Conservation Laboratory QA Plan, 2008
(C) - Generated by the analysis of field duplicates
(D) - EPA's New England Regional Laboratory recommends that all samples resulting in Too Numerous To Count (TNTC) growth, defined as greater than 200 colonies on the membrane filter, be recorded as "TNTC."
(E) -As a quality control check on bacteria counts, if two or more analysts are available, each should count colonies on the same membrane plate for about 10% of the samples, and agree on the # of colonies within 10%.

Appendix C Table 3 – Project Completeness

Parameter	Number of Samples Anticipated	Number of Valid Samples Collected & Analyzed	*Percent Complete
Total Phosphorus	**120**	**106**	**88%**
Chloride	**120**	**106**	**88%**
Turbidity	**120**	**106**	**88%**
Nitrogen	**120**	**106**	**88%**

***Percent Complete = # of Valid Samples Collected and Analyzed / # of Samples Anticipated Analyzed / # of Samples Anticipated**

Calculating Relative Percent Difference

Data quality goals for precision are typically expressed as the **relative percent difference** (RPD). RPD is calculated using the following equation:

RPD = (Result 1 - Result 2) ÷ ((Result 1+ Result 2) ÷ 2) x 100

Take the absolute value of (Result 1 - Result 2) if Result 1 is less than Result 2.

Example:
Volunteers collected a field replicate sample from an agricultural stream in Addison County, which was analyzed for *E. coli* with the following results:

Result 1 = 248 cfu/100 mL
Result 2 = 238 cfu/100 mL

RPD = (248 - 238) ÷ ((248 + 238) ÷ 2) x 100 = 4.1%

This meets the field precision goal for *E. coli* set by the project of ± 30%.

Figure 1. Calculating Relative Percent Difference

Appendix C Table 4. Raw data 2017

Row Labels	Red Text and red fill denote exceednace of Vermont Water Quality Standards. Yellow highlight denotes highest average of all Sites.												
Chloride (mg/L)	**15-May**	**30-May**	**18-Jun**	**29-Jun**	**16-Jul**	**30-Jul**	**13-Aug**	**30-Aug**	**14-Sep**	**28-Sep**	**15-Oct**	**25-Oct**	**Average**	**Std Dev**
Site 1	17.30	17.10	2.00	13.00	2.00	10.30	11.90	15.10	15.70	18.00	19.30	17.60	13.28	5.90
Site 2	2.00	2.00	11.00	2.00	10.10	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.43	3.33
Site 3	24.00	24.20	14.30	15.90	15.60	18.10	17.70	7.08	24.60	6.41	36.00	36.20	20.01	9.55
Site 4	19.70	24.90	24.10	17.10	18.90	20.50	22.90	0.00	19.50	0.00	21.70	24.20	17.79	8.64
Site 5	28.60	18.30	27.00	19.80	16.50	18.60	0.00	0.00	22.70	0.00	0.00	24.60	14.68	11.39
Site 6 - N/A													#DIV/0!	
Site 7	46.00	53.00	53.50	47.00	46.60	52.50	53.50	60.00	50.50	58.50	0.00	0.00	43.43	20.74
Site 8	29.20	30.80	27.00	26.80	23.79	29.10	0.00	0.00	29.80	0.00	36.00	37.40	22.49	14.06
Site 9	19.90	28.20	17.20	17.10	16.40	16.40	16.30	16.60	16.60	0.00	0.00	0.00	13.73	8.91
Site 10	29.20	29.20	29.00	27.80	26.85	27.00	27.20	25.90	25.60	27.80	29.60	28.60	27.81	1.33
Site 11	15.70	16.00	15.50	15.10	14.10	13.80	14.40	14.40	14.20	15.10	14.70	14.60	14.80	0.68
24-Hour Rainfall (Inches)	0.57	0.82	0.58	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29		
Phosphorus - Digested (µg/L)	**15-May**	**30-May**	**18-Jun**	**29-Jun**	**16-Jul**	**30-Jul**	**13-Aug**	**30-Aug**	**14-Sep**	**28-Sep**	**15-Oct**	**25-Oct**	**Average**	**Std Dev**
Site 1	14.10	9.23	10.50	13.90	10.40	7.33	12.90	11.50	10.80	58.70	9.40	10.60	14.95	13.92
Site 2	9.18	7.73	12.50	18.60	10.10	7.97	13.50	10.80	10.10	14.50	13.00	15.70	11.97	3.28
Site 3	21.50	19.70	25.40	20.80	22.10	14.70	18.70	34.80	16.90	17.10	15.90	19.90	20.63	5.36
Site 4	11.30	10.90	42.60	14.50	38.60	11.50	16.30	0.00	15.00	0.00	16.70	15.50	16.08	12.80
Site 5	13.00	9.73	14.90	351.00	152.00	27.60	0.00	0.00	8.01	0.00	0.00	8.59	48.74	104.09
Site 6 - N/A													#DIV/0!	#DIV/0!
Site 7	6.19	7.12	8.99	11.50	5.75	8.76	8.82	11.80	8.55	9.30	0.00	0.00	7.23	3.83
Site 8	14.80	14.90	17.00	36.80	16.70	10.30	0.00	0.00	11.60	0.00	15.00	52.40	15.79	15.32
Site 9	10.50	16.00	10.20	184.00	9.23	9.77	15.20	25.20	16.70	0.00	0.00	0.00	24.73	50.73
Site 10	16.60	18.30	21.80	134.00	13.30	11.50	15.40	15.00	11.10	15.80	14.00	15.00	25.15	34.40
Site 11	31.90	16.80	16.40	16.50	11.50	11.30	15.20	12.60	13.30	12.30	13.40	17.30	15.71	5.53
24-Hour Rainfall (Inches)	0.57	0.82	0.58	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29		
Turbidity (NTUs)	**15-May**	**30-May**	**18-Jun**	**29-Jun**	**16-Jul**	**30-Jul**	**13-Aug**	**30-Aug**	**14-Sep**	**28-Sep**	**15-Oct**	**25-Oct**	**Average**	**Std Dev**
Site 1	1.66	1.13	0.44	2.50	0.81	1.19	1.03	1.61	0.71	2.60	0.72	1.49	1.32	0.69
Site 2	0.30	0.44	1.41	2.45	0.77	0.36	0.79	1.42	0.32	3.30	0.56	0.54	1.06	0.95
Site 3	0.81	0.75	1.39	0.82	0.36	0.52	0.35	1.70	0.28	1.73	0.32	0.74	0.81	0.52
Site 4	0.54	0.65	8.78	0.74	1.44	1.15	0.42	0.00	2.68	0.00	4.05	2.18	1.89	2.48
Site 5	0.67	0.71	4.16	88.00	0.57	12.40	0.00	0.00	0.20	0.00	0.00	0.44	8.93	25.15
Site 6													#DIV/0!	#DIV/0!
Site 7	1.38	0.47	1.41	1.92	0.31	0.98	0.26	0.31	1.83	0.00	0.00	0.00	0.74	0.73
Site 8	1.75	1.42	6.73	5.84	0.46	0.64	0.00	0.00	0.26	0.00	0.42	1.39	1.58	2.29
Site 9	0.61	7.24	0.42	99.60	0.40	1.02	1.33	5.07	3.02	0.00	0.00	0.00	9.89	28.34
Site 10	0.61	0.89	0.52	107.40	0.56	0.37	0.65	1.70	0.54	1.07	1.29	1.85	9.79	30.74
Site 11	3.26	2.03	1.55	1.90	1.45	2.07	2.54	0.97	1.99	0.97	1.11	1.46	1.78	0.67
24-Hour Rainfall (Inches)	0.57	0.82	0.58	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29		
Nitrogen (mg/L)	**15-May**	**30-May**	**18-Jun**	**29-Jun**	**16-Jul**	**30-Jul**	**13-Aug**	**30-Aug**	**14-Sep**	**28-Sep**	**15-Oct**	**25-Oct**	**Average**	**Std Dev**
Site 1	0.20	0.13	0.10	0.12	0.10	0.10	0.19	0.18	0.15	0.16	0.10	0.10	0.14	0.04
Site 2	0.10	0.11	0.12	0.10	0.10	0.10	0.10	0.14	0.11	0.10	0.10	0.10	0.11	0.01
Site 3	0.40	0.10	0.36	0.35	0.38	0.30	0.40	0.29	0.38	0.21	0.38	0.39	0.33	0.09
Site 4	0.10	0.39	0.12	0.10	0.11	0.10	0.24	0.00	0.16	0.00	0.15	0.14	0.13	0.10
Site 5	0.22	0.10	0.28	0.88	0.28	0.45	0.00	0.00	0.48	0.00	0.00	0.13	0.24	0.27
Site 6													#DIV/0!	#DIV/0!
Site 7	0.20	0.18	0.15	0.14	0.10	0.13	0.47	0.41	0.25	0.48	0.00	0.00	0.21	0.16
Site 8	0.12	0.12	0.15	0.17	0.14	0.12	0.00	0.00	0.18	0.00	0.14	0.11	0.10	0.07
Site 9	0.10	0.31	0.10	0.37	0.10	0.10	0.18	0.16	0.14	0.00	0.00	0.00	0.13	0.12
Site 10	0.19	0.18	0.15	0.48	0.15	0.13	0.28	0.28	0.21	0.27	0.22	0.16	0.23	0.10
Site 11	0.29	0.25	0.24	0.22	0.21	0.22	0.40	0.34	0.29	0.30	0.29	0.36	0.28	0.06
24-Hour Rainfall (Inches)	0.57	0.82	0.58	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29		

*No discharge data collected in 2017