

November 25, 2015

Ms. Joanna Bilotta, President
 Lake Shirley Improvement Corporation (LSIC)
 PO Box 567
 Shirley, MA 01464

Re: 2015 Year-End Report for the Aquatic Management Program at Lake Shirley

Dear Joanna:

This report provides an overview and summary of the 2015 Aquatic Management Program at Lake Shirley. As you know, this year’s activities also included re-permitting the treatment program and drawdown with the Lunenburg Conservation Commission. As a result of that process and at the request of the Conservation Commission and the LSIC, Aquatic Control Technology (ACT) performed the late summer survey using a quantitative methodology similar to that used in past third party surveys conducted by Geosyntec. A chronology of the 2015 program activities is as follows:

- ◆ Issuance of License to Apply Chemicals permit from MA DEPJune 19th
- ◆ Pre-treatment aquatic plant inspection with LSIC..... June 20th & July 2nd
- ◆ Reward (diquat) Herbicide treatment July 16th
- ◆ NOI submitted to the Lunenburg Conservation Commission July 20th
- ◆ Conservation Commission Hearings attended by ACT August 5th, 19th, Sept 2nd
- ◆ Monitoring of microscopic algae and Secchi Disk water clarity by LSICJuly-August
- ◆ Post-treatment, late summer plant inspection October 2nd
- ◆ Order of Conditions Issued October 7th

Pre-Treatment Surveys

Two pre-treatment surveys were performed this past summer on June 20th and July 2nd. The objective of these surveys was to document the density and distribution of plant species throughout the lake, prior to finalizing the recommended treatment plan. Our pre-treatment plant survey report and a map showing the area of herbicide treatment in 2015 are attached.

Continuing the trend observed over the last several years, invasive Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) growth was limited due to the on-going management program. Non-native, spiny naiad (*Najas minor*), native naiad (*Najas flexilis*) and tapegrass (*Vallisneria americana*) continue to be the most common nuisance vegetation and growth of these species was reaching problematic levels in many areas of the lake. All areas of milfoil/curlyleaf pondweed and areas of problematic spiny naiad and tapegrass were the target of this year’s herbicide treatment. Approximately 89 acres were designated for treatment, which is similar to last year (90-acres), slightly less than 2013 (~100 acres) but significantly more than in 2011-2012 due to the fact that high use areas of the lake with naiad and tapegrass are now included as target growth.

Herbicide Weed Treatment

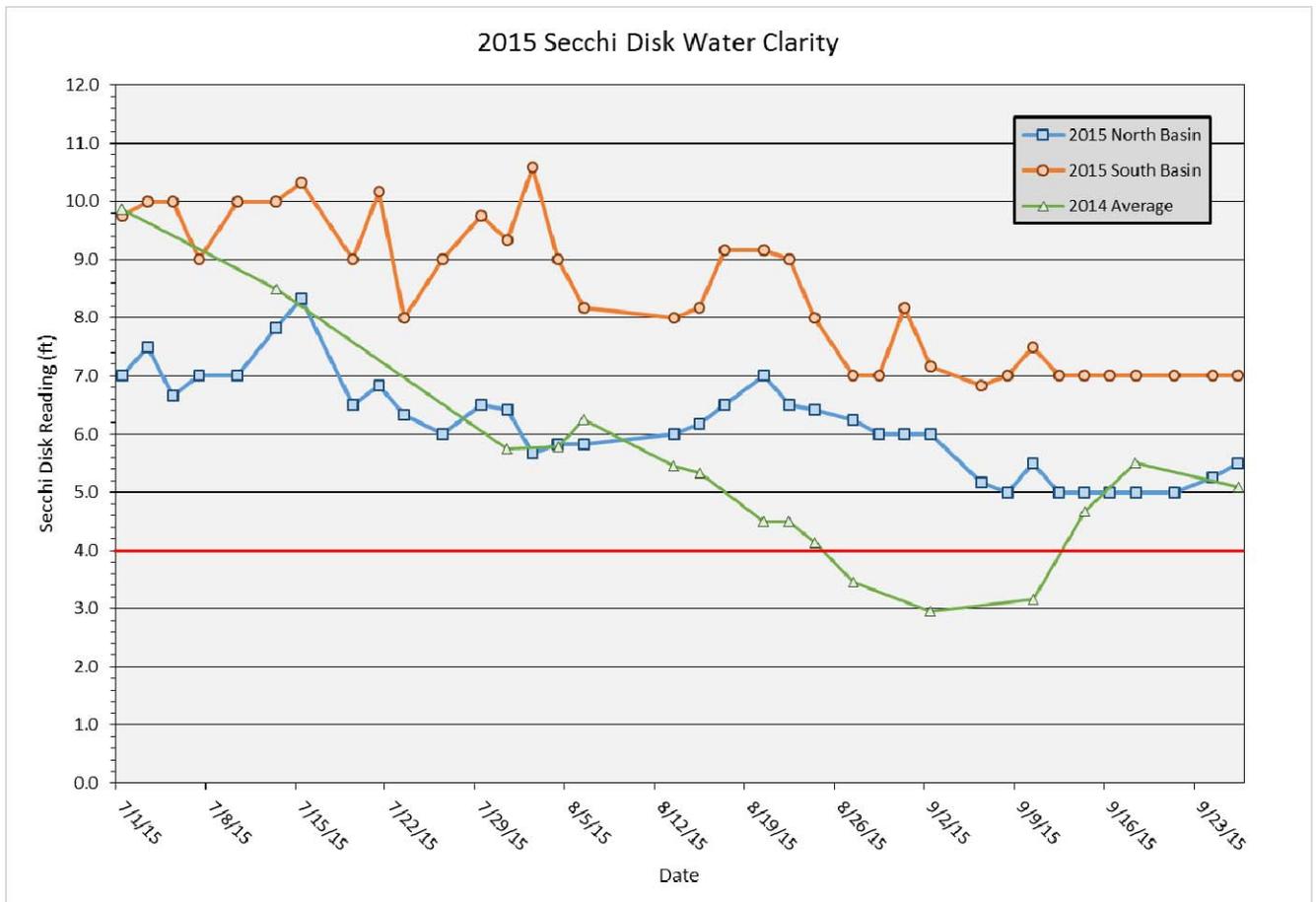
The 2015 Reward herbicide treatment was performed on July 16th following the treatment area designations presented in the pre-treatment report (See Figure 1). As with previous treatments, the lake community and the two towns were notified prior to treatment by LSIC. Several means of notification were utilized: placement of a

written notice in the newspaper(s); placement of large, printed signs at major road intersections/locations around the lake and posting of numerous 8.5 inch by 11 inch orange colored, printed signs around the lake shoreline and other means of communication/notification.

The treatment was performed by an airboat equipped with tank, pump, and sub-surface injection system. By injecting the diluted herbicide sub-surface, it eliminates the potential for aerial drift. GPS guidance was used to monitor the position of the airboat and its relation to the treatment areas. The treatment proceeded smoothly and without difficulty.

Algae & Water Clarity Monitoring

Following a difficult year in 2014 with algae blooms, the water clarity was monitored closely this year. The lake was very clear through the end of June so the Association only began recording clarity measurements beginning in July. The following graph shows the water clarity in the North and South Basin from July through the end of September.



The water clarity was much improved this year and the clarity in the North Basin never fell below the trigger level of 5-feet. When the water clarity dipped below 6-feet in early August, everyone was on “high-alert” and samples were collected for algal analysis on 8/2, 8/9 & 8/17. Those tests showed a mix of diatom, green and blue-green (cyanobacteria) algal types but the blue-green counts remained around 20,000-25,000 cells/ml through the end of August. The Association and ACT were prepared to conduct treatment with copper sulfate with any further decline in water clarity or increase in blue-green algae counts, but fortunately the lake hovered around this threshold for the remainder of the summer. The laboratory sheets for the August algae samples are attached.

Late Season Survey

As mentioned earlier, this year’s late season survey was conducted using a combination of ACT’s historical qualitative assessment and Geosyntec’s more quantitative methodology. The late season survey was performed on October 2nd. In addition to recording data on the general plant assemblage, point data was collected at 66 data points throughout the lake. At each point, data was collected on the species composition (species present), plant growth density and plant biomass. Figure 2 (attached) shows the location of data points in Lake Shirley. These are the same locations and point #'s used by Geosyntec in past reports.

Table 1 (below) shows the number of points exhibiting each category of plant density along with the average density index for each year of the survey (2002-2015).

Table 1: Plant Growth Density Estimates, 2002-2015

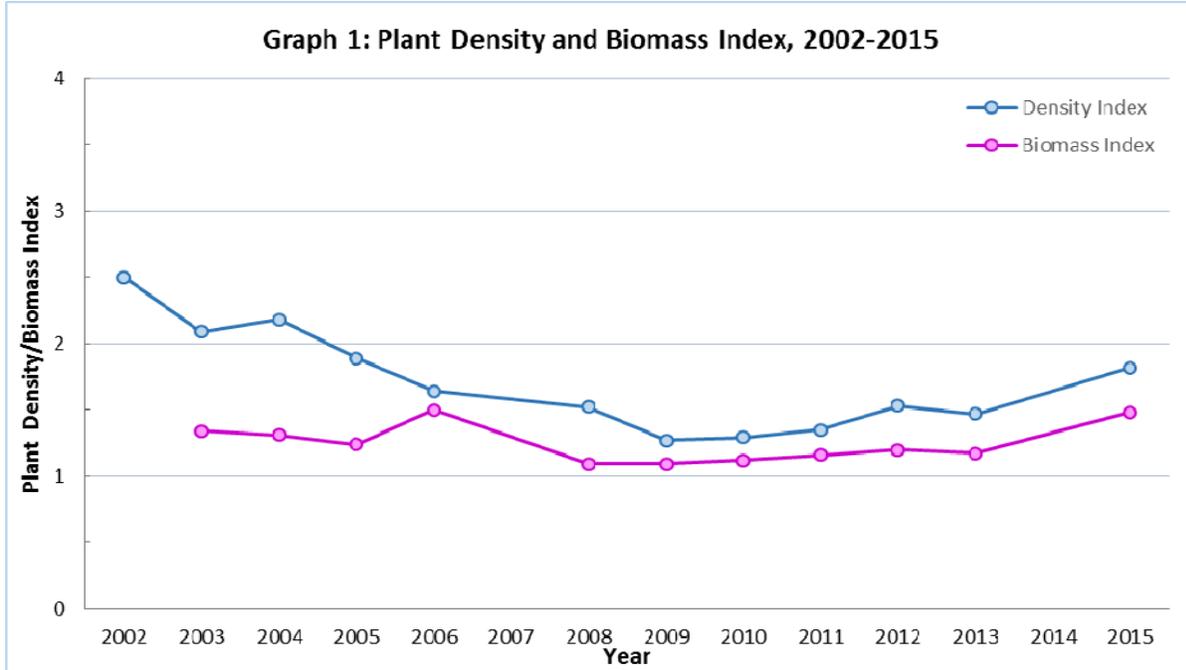
Density Rating	% of stations											
	2002 (n=64)	2003 (n=65)	2004 (n=66)	2005 (n=66)	2006 (n=66)	2008 (n=66)	2009 (n=66)	2010 (n=66)	2011 (n=66)	2012 (n=66)	2013 (n=66)	2015 (n=66)
1: Sparse 0-25%	14	11	17	27	45	59	79	77	77	65	65	32
2: Moderate 26-50%	36	72	58	61	42	33	17	17	14	20	23	50
3: Dense 51-75%	36	15	17	8	9	5	3	6	6	12	9	17
4: Very Dense 76-100%	14	3	9	5	2	3	2	0	3	3	3	2
Density Index	2.50	2.09	2.18	1.89	1.64	1.52	1.27	1.29	1.35	1.53	1.47	1.82

Table 2 (below) shows the number of points exhibiting each category of plant biomass, along with the average biomass index for each year of the survey.

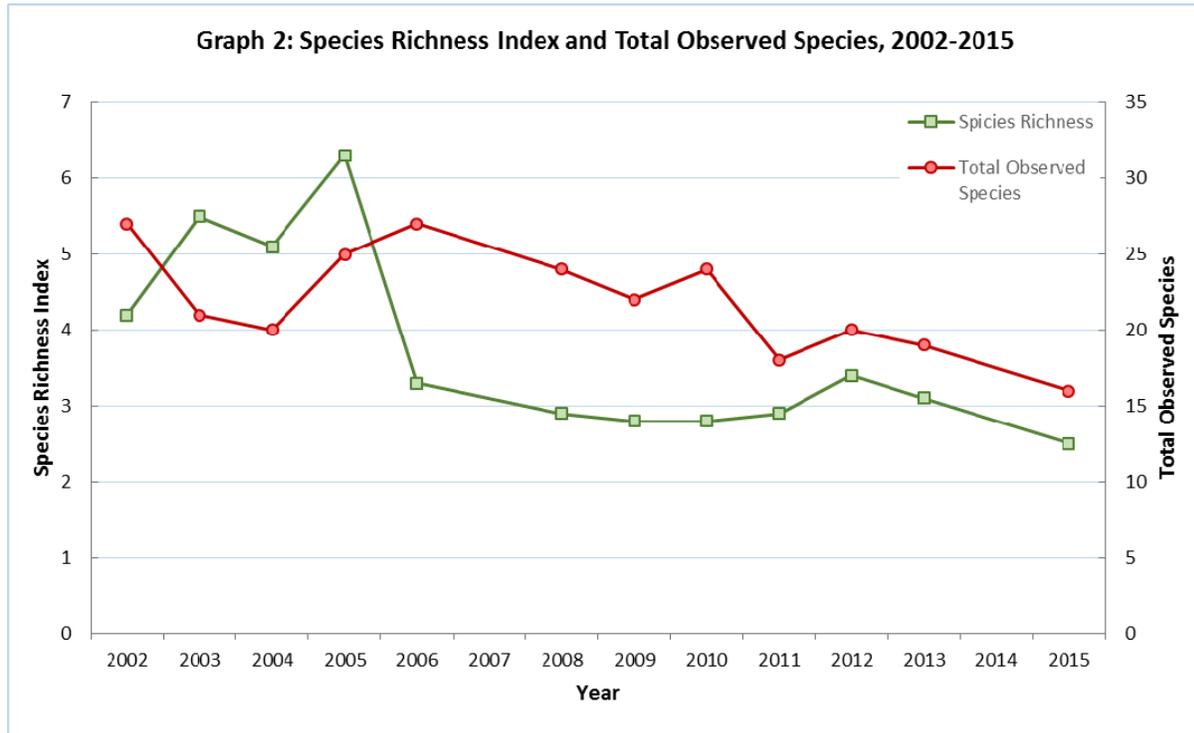
Table 2: Plant Biomass Estimates, 2003-2015

Biomass Rating	% of stations											
	2003 (n=65)	2004 (n=66)	2005 (n=66)	2006 (n=66)	2008 (n=66)	2009 (n=66)	2010 (n=66)	2011 (n=66)	2012 (n=66)	2013 (n=66)	2015 (n=66)	
1: Scattered plant growth; or primarily at lake bottom	69	80	77	59	91	92	91	88	82	88	73	
2: Less abundant growth, or in less than half of water column	29	12	21	33	9	6	6	8	17	5	21	
3: Substantial growth through majority of water column	2	6	2	6	0	2	3	5	2	8	6	
4: Abundant growth throughout water column to surface	0	2	0	2	0	0	0	0	0	0	0	
Biomass Index	1.34	1.31	1.24	1.50	1.09	1.09	1.12	1.16	1.20	1.17	1.48	

Both plant cover and biomass increased this year with the average plant cover index at 1.82 versus 1.47 in 2013 and the biomass index at 1.48 versus 1.17 in 2013. For plant cover, the major differences from 2013 occurred in the sparse and moderate categories with significantly more points showing moderate cover in 2015. The most notable change in the biomass data was an increase in the number of points showing “less abundant growth” versus “scattered growth”. The graph below shows the change in the average indexes over time.



Another useful metric is the species richness index (average number of species observed at each point) and the total number of species observed. The following graph shows these metrics over time.



Both the species richness and the total number of species recorded have decreased over time. In general, species with very low occurrence can be difficult to observe from year to year and partially account for the drop in the number of species observed. Additionally, bladderwort species (*Utricularia spp.*) were bulked together this year and one non-native species, curlyleaf pondweed, was not observed in this year's late season survey. The increased dominance of bushy pondweed and tapegrass over recent years is likely significant cause of the decrease in species richness.

The following are some general notes on this year's late season survey data. Historical data and comparisons can be found by referring to the information contained in the last Geosyntec report, issued on October 18th, 2013. The complete point data table from the 2015 survey is shown on the next page. Figure 3 shows the general vegetation assemblage in Lake Shirley at the time of the late season survey.

General Notes

- Overall plant cover and biomass increased in 2015 however the total number of species observed dropped from 19 to 16 and the average species richness dropped from 3.1 to 2.5.
- The dominant plant in the lake continues to be bushy pondweed followed by tapegrass (wild celery).
- Non-native European naiad, which was co-dominant with the native naiad prior to this year's herbicide treatment showed a significant reduction from pre-treatment density and as compared to the 2013 survey.
- The number of stations dominated by non-native species (fanwort and European naiad) increased to 9 as compared to 6 in 2013.
- Only four species were observed at 20% or more of the stations in 2015. Two of these species were non-native.
- The number of stations where fanwort was observed decreased from 25 to 19 this year, but the number stations where fanwort was dominant increased from 3 to 6.
- Bushy Pondweed and tapegrass (wild celery) were observed at a similar number of points to 2013 but the number of stations where these plants were dominant increased significantly.
- Curlyleaf pondweed was not observed during the late season survey this year.
- Fanwort growth was observed mostly in water depths greater than 5-6 feet as the winter lake level drawdowns typically provide good control of fanwort in the shallower (less than ~ 6 ft.) near-shore areas.
- Herbicide treatment is working well to minimize the presence of non-native curlyleaf pondweed, Eurasian watermilfoil and European naiad as well as maintain non-problematic levels native vegetation in high-use areas of the lake.

Anticipated Management in 2016

Based on the results of the 2015 late season plant survey, we anticipate seeing continued, minimal growth of watermilfoil and curly-leaf pondweed this coming summer. Observations also indicate that the treatments are producing a desired decrease in the proportion of non-native European naiad while maintaining an extensive and non-problematic growth of native naiad. This minimal growth of early season non-native growth allows us to delay the herbicide treatment until somewhat later in June so that the naiad and tapegrass are also at the right growth stage to be targeted.

Reward herbicide alone will provide good control of milfoil, curlyleaf pondweed and naiad. Tapegrass is sometimes more difficult to control and, if needed, we will apply a combination of Reward and a copper based herbicide (Nautique) or algaecide (Captain/copper sulfate) to increase effectiveness and produce more desirable results.

If desired and approved by the LSIC, areas of fanwort could be treated with the Clipper (flumioxazin) herbicide, which was registered by the State in 2013. Unlike Sonar (fluridone) which has been discussed in the past, Clipper works quickly and can be used effectively to spot-treat relatively small areas of fanwort. The timing for treatment of the fanwort will most likely coincide with the treatment of the other target plants so that everything can be done in one visit. The on-going issue with the use of Clipper is that under current regulations, the same areas of the lake can only be treated once every 4 years unless it's in the immediate vicinity of a high-use area such as a beach or boat launch. While it's possible this condition may be lifted in the future, for it will be necessary to either rotate the areas treated with Clipper or treat subsections of larger areas of fanwort over the course of multiple years.

In order to use Clipper and other forms of copper besides copper sulfate, approval for use of the new products must be sought from the Shirley Conservation Commissions. The Order of Conditions from the Town of Lunenburg allows the use of alternate products pending approval of annual treatment plans.

As in the past, early summer plant surveys will be used to gauge the amount of nuisance plant growth and establish areas of the lake which warrant treatment, either with Reward/Copper for milfoil, curlyleaf pondweed, naiad and tapegrass growth and, if proposed, Clipper for fanwort. Based on discussions during the permitting process and the new Order of Conditions issued by the Lunenburg Conservation Commission, we expect that the more quantitative methodology will need to be conducted moving forward for the pre-treatment survey as well and that the data collected will assist with prioritizing treatment areas with LSIC. While all areas of non-native growth should be treated (with the likely exception of fanwort), we anticipate working with the LSIC and the Lunenburg Conservation Commission to establish thresholds for treatment of native vegetation in order to try and reduce the total area treated annually. The multiple inspections and surveys continue to work well to monitor the lake's plant community and to guide the aquatic management program.

Monitoring of water clarity and algal populations (as necessary) provides timely information to guide algaecide treatments should such treatments be warranted. It continues to be of paramount importance to ensure that the water clarity monitoring is conducted on a regular basis (weekly or bi-weekly depending on general observation) from May-October and that results are provided to ACT and other project partners so that algaecide treatments are scheduled in a timely manner. Should treatment of the algae be required in 2016, copper sulfate is again proposed for use.

We recommend LSIC continue to pursue an integrated approach of in-lake management, utilizing drawdown and herbicide/algaecide treatment as required and appropriate. Naturally, watershed management and public education are also very important and should be continued as well. The work that LSIC is doing with Water Resource Services and Dr. Ken Wagner is a great step forward in this regard. As discussed over the summer and as required by the Lunenburg OOC, the LSIC needs to prepare a comprehensive Lake Management Plan over the winter and before any treatments are conducted in 2016. ACT is certainly willing to assist with the plan development in any capacity the Association chases.

We hope this report will be of help to LSIC in planning for 2016 and beyond. If you have any questions regarding this report, please feel free to contact me. We look forward to working you again in the year ahead.

Sincerely,

AQUATIC CONTROL TECHNOLOGY



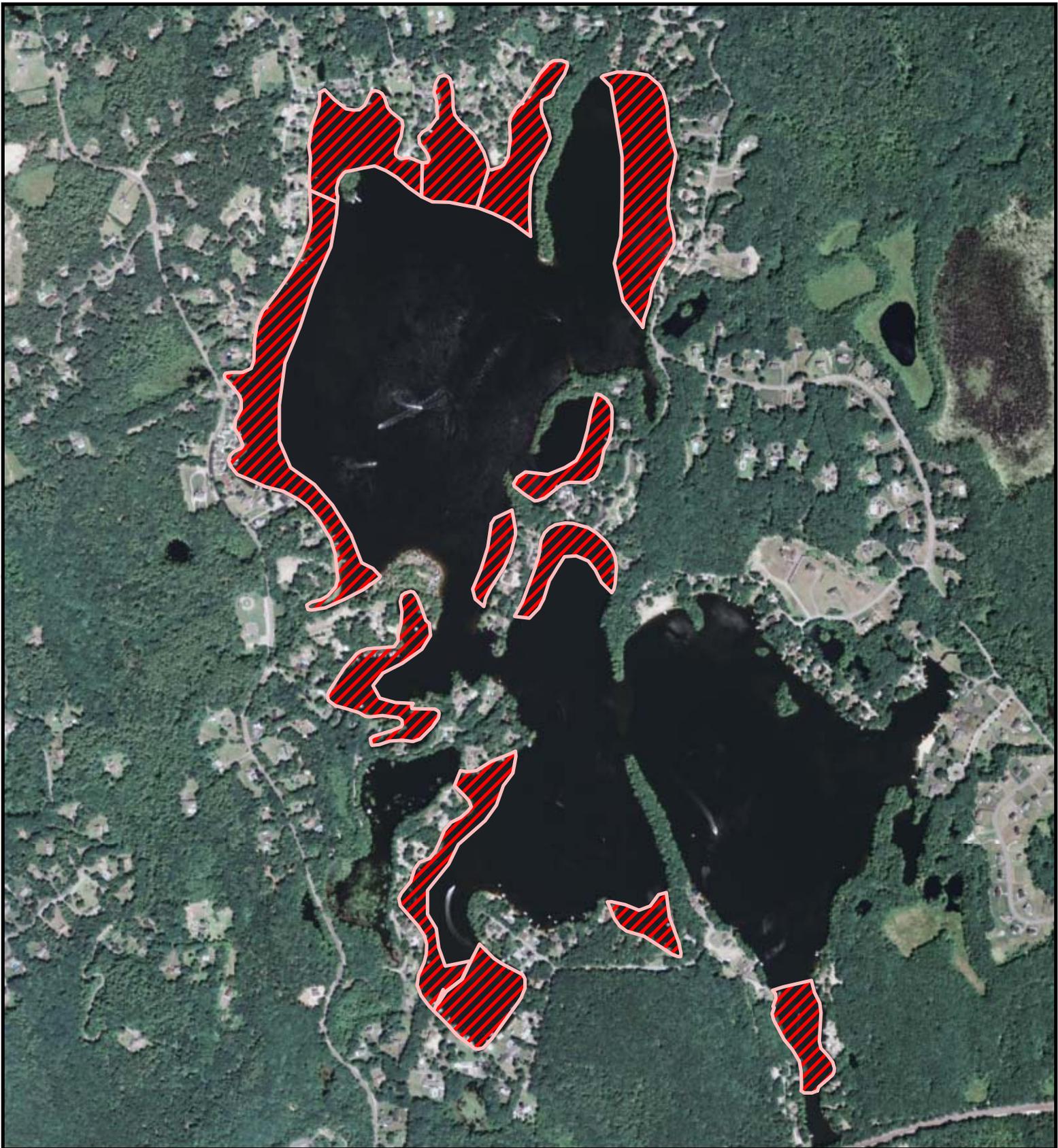
Dominic Meringolo
Senior Environmental Engineer/Regional Manager

2015 Year-End Report



ATTACHMENTS

- Figures
 - Figure 1 - 2015 Treatment Areas
 - Figure 2 - Late Season Survey Points
 - Figure 3 - Late Season Aquatic Vegetation Assemblage
- 2015 Pre-Treatment Report
- Algal Analysis - Laboratory Reports



Lake Shirley

Lunenburg/Shirley, MA

2015

Treatment Area

FIGURE:	SURVEY DATE:	MAP DATE:
1	6/20 & 7/2/15	7/6/15



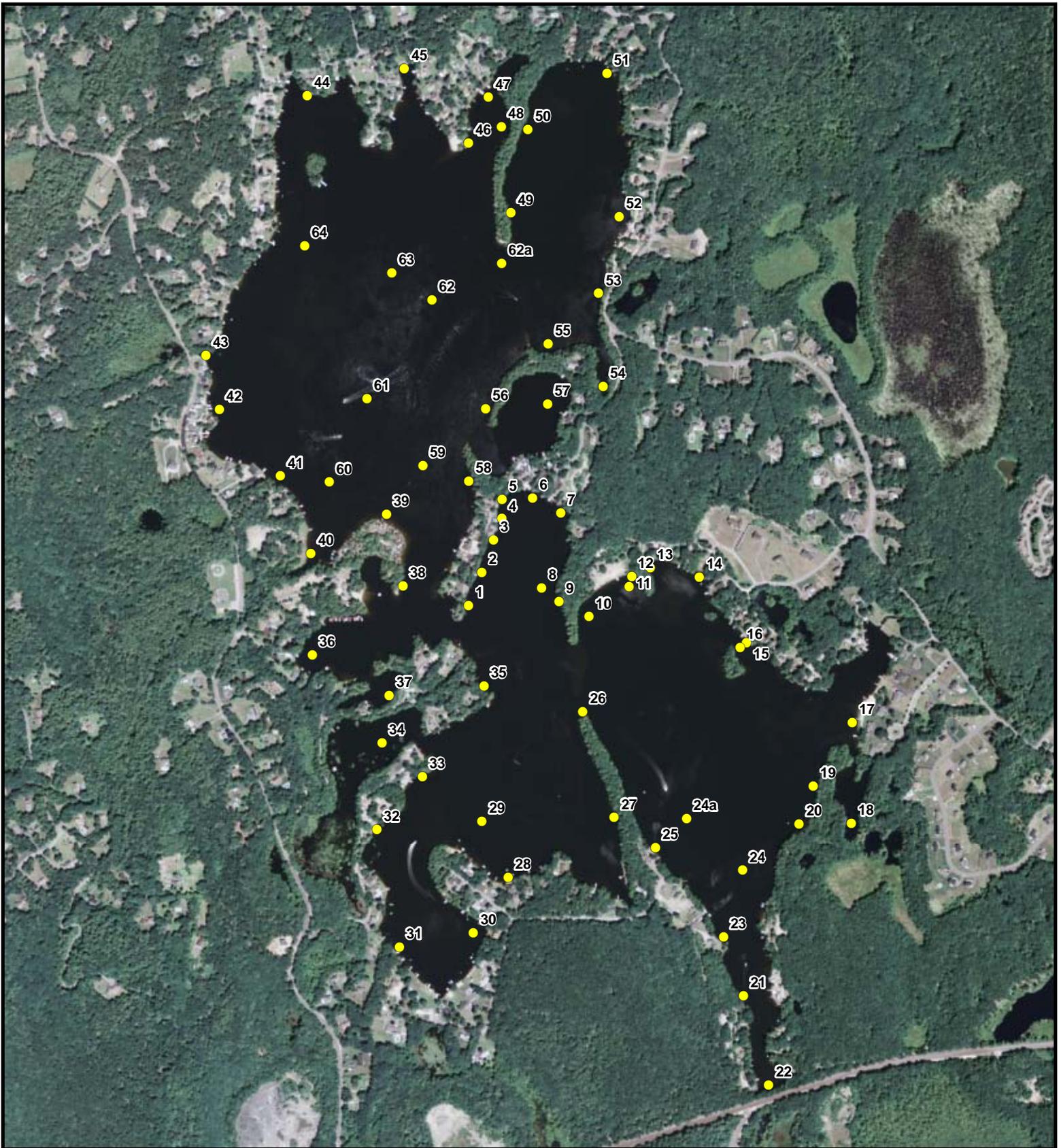
Proposed 2015 Treatment Areas - 89 acres



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Lake Shirley

Lunenburg/Shirley, MA

Survey Points

● Survey points developed by Geosyntec

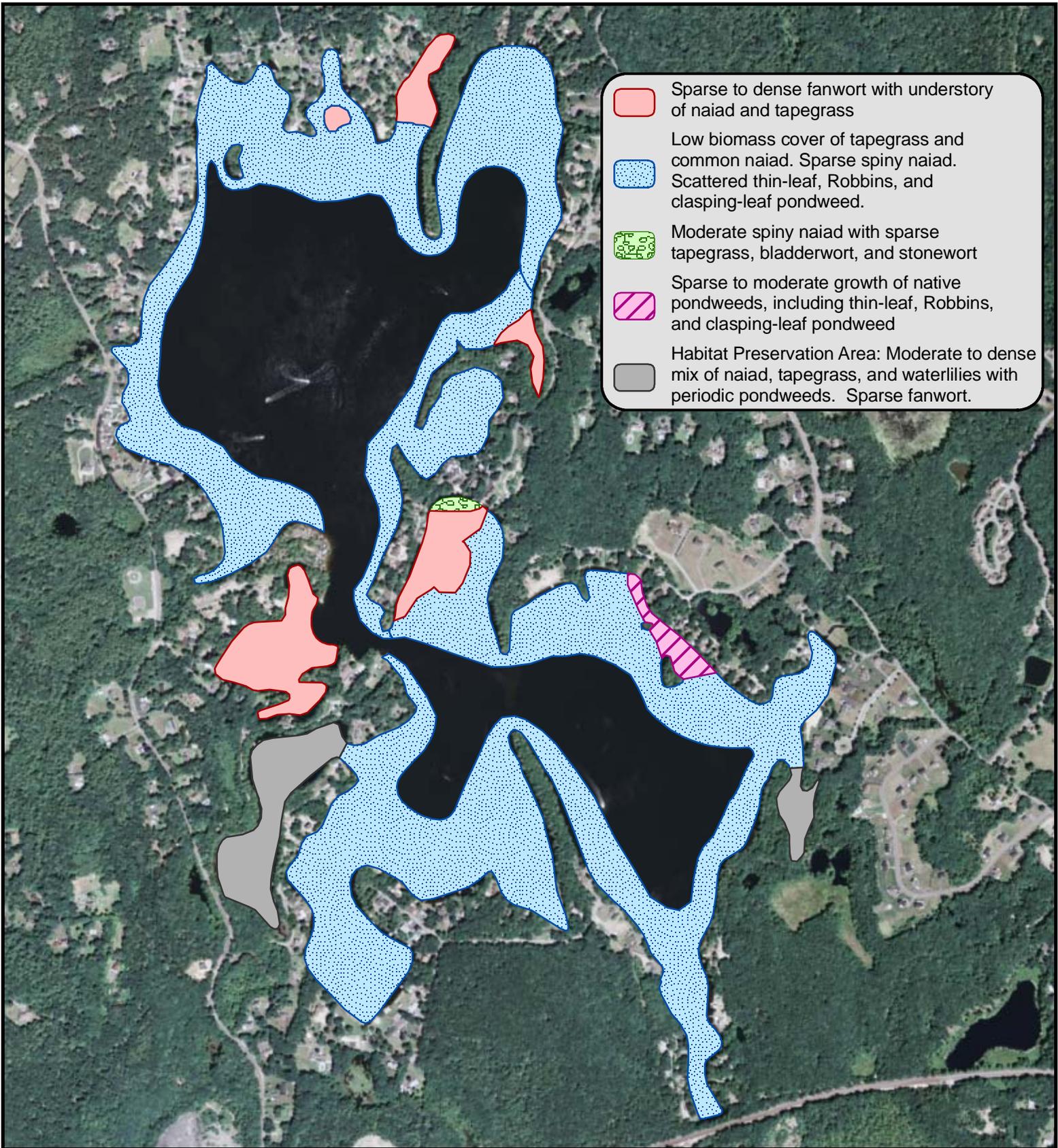


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FIGURE:	SURVEY DATE:	MAP DATE:
2	10/2/15	11/27/15



Lake Shirley

Lunenburg/Shirley, MA

2015 Post-treatment
Vegetation Assesmlage

FIGURE:	SURVEY DATE:	MAP DATE:
3	10/2/15	11/27/15



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Date: July 6, 2015

To: Joanna Bilotta; President, Lake Shirley Improvement Corporation

From: Gerry Smith, Aquatic Biologist & Dominic Meringolo, Environmental Engineer

Re: **Pre-Treatment Aquatic Plant Survey/Inspection and Management Recommendations –
Lake Shirley - 2015**

This memo summarizes the findings of Aquatic Plant Surveys/Inspections of Lake Shirley performed by Gerry Smith on June 20th and July 2nd. Jay Simoneau, from the Lake Association, once again accompanied me during the inspections as he has done in recent years.

On June 20th, the weather during the start of our survey was good but deteriorated as the wind picked up and the skies darkened as the afternoon wore on. While we completed the shoreline survey in all three lake basins, a follow-up inspection was performed on July 2nd in order to check for nuisance weed growth throughout the middle portion of the northern lake basin in particular. We want to be sure that invasive watermilfoil and curlyleaf pondweed that formerly choked this area of the lake some years ago, does not again become widely established, thereby requiring chemical treatment of this relatively large area. The clarity of the water was fairly good at the time of our survey. Secchi Disk visibility in all three lake basins estimated to be in excess of seven feet.

The surveys were performed from a Pontoon Boat, while traveling around the entire shoreline and littoral (shallow water) zone of Lake Shirley. Given the overall shallow depth of the lake, additional transects were made across some of the coves and open-water portions of the lake in order to characterize the distribution of both invasive and native plants. A combination of survey techniques were utilized, including; visual observation and use of a “throw-rake”. Invasive watermilfoil, curlyleaf pondweed, spiny naiad and fanwort, along with the native but nuisance forming tapegrass/ wild celery as well as other non-nuisance, native aquatic plants, were noted and recorded.

The primary nuisance aquatic plants seen prior to treatment last year, were the invasive Spiny naiad along with native tapegrass or wild celery. These two plants are once again the primary species that will be targeted for treatment in 2015 although there was also an increased prevalence of the native bushy pondweed (*Najas flexilis*).

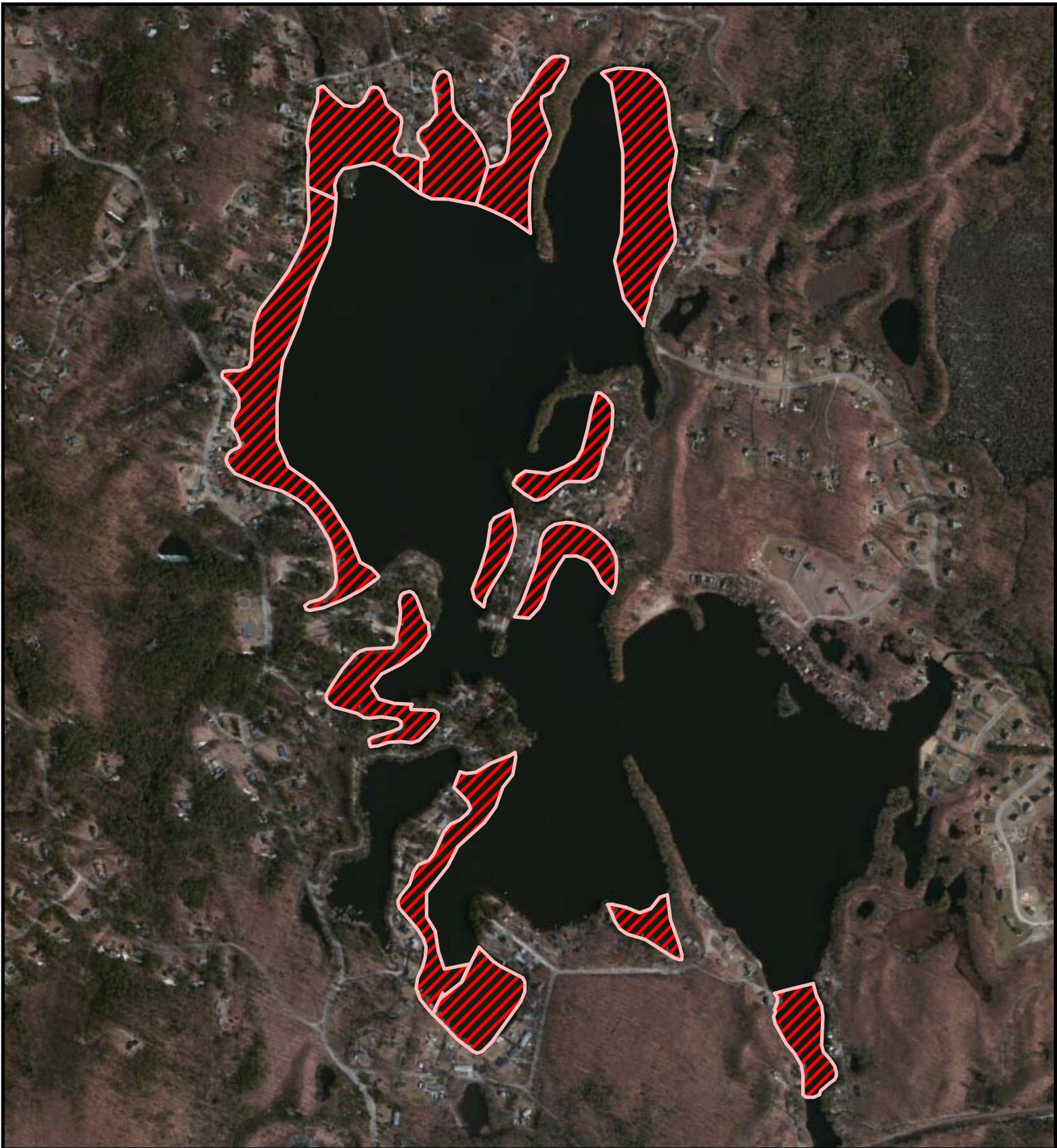
Some other native aquatic plants also observed during the survey, included, coontail, ribbon-leaf pondweed, bladderwort, sago pondweed, waterlilies and a macro-alga called muskgrass or chara.

A map of Proposed Treatment Areas is attached. The specific areas of treatment and total acreage are quite similar to the previous two years. Based upon our survey findings, we recommend chemical treatment of approximately 89 acres. The attached map represents invasive and nuisance plant cover in most treatment areas, of generally between > 10% and 100% and was judged during the survey to represent a probable impairment to the habitat and recreational uses of Lake Shirley come mid/late summer if control measures were not implemented. Management with “hand-pulling” or other non-

chemical techniques are either not cost/effective, practical or feasible over such large areas of abundant weed growth.

We are targeting chemical treatment of Lake Shirley for Thursday, July 16th. The lake will be closed to all water uses, including swimming, fishing and boating on the day of treatment only. There will be an additional restriction on water use for irrigation, watering livestock and drinking purposes for 5 days. We will be sending you a written "notice of treatment" for you to publish in the local paper(s) and will also mail you printed signs for you to post around the lake shoreline prior to treatment. We will again be chemically treating with Reward (diquat) at rate of 1-1.5 gal/acre which is substantially less than the maximum label rate of 2.0 gals/acre. Maximum USEPA label rate for Reward is 2.0 gals/acre. The Reward (diquat) may be tank-mixed with a low dose of copper based algaecide to enhance uptake and efficacy for control of the tapegrass/wild celery. We hope this information is helpful to LSIC.

Thank you.



Lake Shirley

Lunenburg/Shirley, MA

2015

Treatment Area

FIGURE:	SURVEY DATE:	MAP DATE:
1	6/20 & 7/2	7/6/15



Proposed 2015 Treatment Areas - 89 acres



 **AQUATIC CONTROL TECHNOLOGY, INC.**

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LSIC

Attn: LES SMITH
37 Flynn Road
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EMAIL ADDRESS:

lsmith@epsilonassociates.com

Table with report details: Report Date: 8/18/2015, Date Sampled: 8/02/2015, Laboratory ID#: 1563217-01, Date Received: 8/11/2015, Date Tested: 8/14/2015, Sample Site: SURFACE WATER: NORTH BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main data table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa with their respective counts.

Blue/Green Total: 21,000/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/11/2015

Approved by:

Signature of Alan C. [Name]

Laboratory Director



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Table with report details: Report Date: 8/18/2015, Date Sampled: 8/02/2015, Laboratory ID#: 1563217-02, Date Received: 8/11/2015, Date Tested: 8/14/2015, Sample Site: SURFACE WATER: MIDDLE BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main data table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa with their respective counts.

Blue/Green Total: 21,000/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/11/2015

Approved by:

Signature of Alan C. [Name]

Laboratory Director



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Table with report details: Report Date: 8/18/2015, Date Sampled: 8/02/2015, Laboratory ID#: 1563217-03, Date Received: 8/11/2015, Date Tested: 8/14/2015, Sample Site: SURFACE WATER: EAST BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa.

Blue/Green Total: 21,000/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/11/2015

Approved by:

Signature of Alan C. [Name]

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Table with report details: Report Date: 8/18/2015, Date Sampled: 8/09/2015, Laboratory ID#: 1563217-04, Date Received: 8/11/2015, Date Tested: 8/14/2015, Sample Site: SURFACE WATER: NORTH

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main data table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa with their respective counts.

Blue/Green Total: 23,000/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/11/2015

Approved by:

Signature of Alan C. [Name]

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Table with report details: Report Date: 8/18/2015, Date Sampled: 8/09/2015, Laboratory ID#: 1563217-05, Date Received: 8/11/2015, Date Tested: 8/14/2015, Sample Site: SURFACE WATER: MIDDLE BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main data table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa with their respective counts.

Blue/Green Total: 25,000/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/11/2015

Approved by:

Signature of Alan C. [Name]

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Table with report details: Report Date: 8/18/2015, Date Sampled: 8/09/2015, Laboratory ID#: 1563217-06, Date Received: 8/11/2015, Date Tested: 8/14/2015, Sample Site: SURFACE WATER: EAST BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa.

Blue/Green Total: 15,000/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/11/2015

Approved by:

Signature of Alan C. [Name]

Laboratory Director



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Table with report details: Report Date: 8/21/2015, Date Sampled: 8/17/2015, Laboratory ID#: 15633335-01, Date Received: 8/19/2015, Date Tested: 8/20/2015, Sample Site: SURFACE WATER: NORTH BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Large table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa.

Blue/Green Total: 0/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/19/2015

Approved by:

Signature of Alan C. [Name]

Laboratory Director



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Table with 4 columns: Report Date, Laboratory ID#, Date Sampled, Date Received, Date Tested, and Sample Site. Sample Site: SURFACE WATER: MIDDLE BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main data table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa.

Blue/Green Total: 0/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/19/2015

Approved by: [Signature]
Laboratory Director



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Table with report details: Report Date: 8/21/2015, Date Sampled: 8/17/2015, Laboratory ID#: 15633335-03, Date Received: 8/19/2015, Date Tested: 8/20/2015, Sample Site: SURFACE WATER: SOUTH BASIN

MICROSCOPIC EXAMINATION == Natural Units Count & Blue/Green Cell Counts

Main table with 4 columns: ORGANISM, #/ml, ORGANISM, #/ml, ORGANISM, Cell #/ml, ORGANISM, #/ml. Lists various organisms like Diatomaceae, Chlorophyceae, Cyanophyceae, and Protozoa.

Blue/Green Total: 0/ml

Comments: Results are based on sample, as submitted to Northeast Laboratories, Inc. on: 8/19/2015

Approved by:

Signature of Alan C. [Name]

Laboratory Director