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Memorandum

To: Valley Branch Watershed District (VBWD) Board of Managers
From: Meg Rattei, Senior Biologist
Subject: June 2017 Point-Intercept Plant Surveys at Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake
Date: October 5, 2017
Project: 23/820405.06
c: John Hanson, Susannah Torseth, Jeff Brower, Melissa Imse

This memorandum summarizes methods and results of the June 2017 point-intercept plant surveys at Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake. Tables and figures follow the discussion. Brief discussions of lake impairment, water quality, and the lakes' fisheries are also included.

Requested Manager Actions

1. Post this memorandum to the District's website and inform the following individuals that it has been posted:
    A. Brian Buchmayer and Bill Griggs of Friends of Long Lake
    B. Justin Bloyer of the Lake Jane Association and City of Lake Elmo council member
    C. Dr. John Hamerly and LeeAnn Leitch of the Lake Jane Association
    D. Link Lavey and Roger Johnson of the Lake DeMontreville/Olson Association
    E. Dave Carlson of the DeMontreville Olson Action (DOA) Weed Team Association and the Tri-Lakes Improvement Association
    F. Wendy Griffin and Dale Dorschner of the Lake Elmo Association
    G. Jeff Berg of the Lake Elmo Association and the VBWD Citizen Advisory Committee
    H. Rick Gelbmann and Jason Ziemer of the Silver Lake Improvement Association
    I. Keegan Lund, Kylie Cattoor, and Donna Perleberg of the Minnesota Department of Natural Resources (MnDNR)
2. Authorize technical support for Friends of Long Lake in 2018 to assist the organization with implementation of the Long Lake MnDNR-approved Lake Vegetation Management Plan. Technical support will include permitting, plant surveys, treatment design, and reporting.

Lake Impairment Standards

Until recently, lake impairment was determined using Minnesota Pollution Control Agency (MPCA) water quality or fish tissue standards published in Minnesota rules 7050. The MPCA would determine a lake impaired for water quality or fish consumption under the following conditions:

- **Water quality:** For a lake to be added to the impaired waters list, the most recent 10-year summer average for total phosphorus (causal variable) and either chlorophyll *a* or Secchi disc transparency (response variables) must be worse than the respective standards.
- **Fish consumption:** Fish tissues contain concentrations of dioxin, mercury, perfluorooctane sulfonate (PFOS), and/or polychlorinated biphenyls (PCBS) higher than impairment standards.

The MnDNR has recently developed two new biological tools to assist the MPCA with determining lake impairment: (1) the Fish Index of Biotic Integrity (IBI) and (2) a Lake Plant Eutrophication IBI. The Fish IBI has been used by the MnDNR since 2015 to assess whether lake waters are impaired for fish (i.e., do not support a lake's fish population). The MnDNR has applied the Fish IBI to recent fish survey data from Lake DeMontreville and Lake Elmo. Because the Fish IBI only applies to lakes with at least 100 acres in surface area, these are the only two VBWD lakes assessed with this tool.[1]

The Lake Plant Eutrophication IBI is used to measure the response of a lake plant community to eutrophication (excessive nutrients). Although it is not currently used to determine lake impairment, the MPCA intends to use this IBI to identify impaired lakes in the future.[2] The Lake Plant Eutrophication IBI includes two metrics to assess the viability of aquatic life. The first metric is taxa richness—the estimated number of taxa (species) in a lake. The second metric is floristic quality index (FQI). This metric distinguishes the quality of the plant community, which is a reflection of the quantity of nutrients in the lake. Because the Lake Plant Eutrophication IBI will be used by the MPCA in the future, Barr used it to assess Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake to determine whether plant communities were impaired. Taxa richness and FQI scores for the lakes were determined and then compared with MnDNR impairment thresholds: a minimum of 12 taxa (species) and an FQI score of at least 18.6.

[1] Bacigalupi, Jacquelyn. 2015. Fish-Based IBI Development for Minnesota Lakes & Use in the Watershed Assessment Process. October 15, 2015.
[2] Minnesota Department of Natural Resources. 2016. Lake Plant Eutrophication IBI, June 23, 2016: *An Assessment of Aquatic Plant Community Response to Anthropogenic Eutrophication.*

2017 Sample Methods

Matt Berg of Endangered Resource Services, LLC, conducted point-intercept plant surveys in six VBWD lakes on June 25 and June 27, 2017. He located equally spaced preset points in the field with a global positioning system (GPS) and took measurements at each point. His measurements included the following:

1. Individual species present
2. Overall density of plants, as measured by rake method
3. Density of individual species, as measured by rake method
4. Water depth
5. Dominant sediment type

Endangered Resource Services used a rake (pictured above) to collect plants for the plant surveys. Rake fullness is a measure of plant density.

Results

Long Lake

Long Lake has been treated with herbicide almost annually since 2011 to reduce EWM. The five herbicide treatments completed from 2011 to 2016 reduced the EWM area in Long Lake by more than two orders of magnitude—from 52 acres prior to the 2011 treatment to 0.33 acres after the 2016 treatment. Long Lake was not treated with herbicide in 2017 and EWM expanded by more than an order of magnitude—from 0.33 acres in 2016 to 5.58 acres in 2017 (Table 3).

Pictured above, EWM formed surface mats near the inlet of Long Lake in June 2017.

In 2017, the pond in Katherine Abbott Park, located north of Long Lake, was surveyed to determine whether the pond was a source of EWM for Long Lake. EWM was present in 98 percent of the pond in 2017, indicating the pond has likely been a source of EWM to Long Lake. Elimination of this source will be important in future Long Lake EWM management endeavors.

In 2017, EWM was present in 98 percent of the pond in Katherine Abbott Park, located north of Long Lake and pictured above.

The Long Lake plant community has improved substantially with treatment. Diversity more than doubled between 2010 and 2017 (Table 5). This is reflected by Simpson Diversity Index values; these values indicate that with treatment of the EWM, the

probability that two individual plants randomly selected from Long Lake will belong to different species has increased from 40 to 84 percent.

The 2017 Long Lake plant community does not meet the criteria of the MnDNR Lake Plant Eutrophication IBI. A total of 16 plant species were observed in Long Lake in 2017, 33 percent more than the impairment threshold of 12 species. However, the 2017 FQI score of 16.2 was 13 percent less than the impairment threshold of 18.6 (Table 6) and the lake would be considered impaired for plants. As mentioned previously, the plant IBI has not yet been used by the MPCA/MnDNR to determine impairment.

Lychnothamnus barbatus (bearded stonewort), a good plant, was observed in Long Lake for the first time in 2017 (Table 7). This species was not seen in North America until 2012 and few populations have been documented in the world. Paul Skawinski of the University of Wisconsin—Extension Lakes Program first found this species in Wisconsin. In Wisconsin, which now has 14 known populations of *Lychnothamnus barbatus,* the plant has been found in seepage lakes and impoundments from a few inches to about 6 meters deep. It occurs sparsely in some lakes and is dominant in others. Some of these lakes have public access and some do not. Thus, its habitat appears to be highly variable. Several of the lakes are man-made, so there is evidence that *Lychnothamnus barbatus* is moving. We do not know whether this movement is via humans, animals, or other mechanisms (Skawinski 2015).

***Lychnothamnus barbatus* (bearded stonewort), pictured above, was observed for the first time in Long Lake during June 2017.**

The first siting of *Lychnothamnus barbatus* in Minnesota occurred in Westwood Lake (Hennepin County) in 2015. In 2016, it was observed in neighboring Crane Lake (Hennepin County). Long Lake is the third lake in Minnesota and the first lake in Ramsey County to observe *Lychnothamnus barbatus*.

Lychnothamnus barbatus is in the family Characeae, a macroalgae (i.e., algae that can be seen with the naked eye) that resembles rooted aquatic plants. It was found at one location in Long Lake in 6.5 feet of water, was the only species in the location where it was found, and was growing adjacent to *Chara*, a species in the same family.

The native plant community was stable with no significant changes in frequency between 2016 and 2017. Filamentous algae significantly declined in frequency during 2017, which was a positive change for the lake.

Curly-leaf pondweed (CLP), an invasive species, is present in Long Lake but not problematic. In 2017, CLP was found in 17 percent of samples taken from the plant-growth area of the lake (Table 7). One other invasive species, reed canary grass, was also observed, but was not problematic (Table 7).

The MnDNR has not completed any fish surveys of Long Lake since 1999, and no surveys were completed by the VBWD prior to aquatic plant treatments. The VBWD has not received reports that the aquatic plant treatments have affected the fishery.

Long Lake has excellent water quality and is not impaired, as demonstrated by 10-year summer average (2007 through 2016) total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency level:

- **10-year summer average total phosphorus:** 21 µg/L (water quality standard is met when ≤40 µg/L)
- **10-year summer average chlorophyll *a*:** 6.2 µg/L (water quality standard is met when ≤14 µg/L)
- **10-year summer average Secchi disc transparency:** 3.1 meters (water quality standard is met when ≥ 1.4 meters)

Lake DeMontreville

Low-density EWM was first observed in the northern portion of Lake DeMontreville in June 2007. EWM extent and density remained relatively low for 5 years; however, between June 2012 and June 2013, EWM extent increased by an order of magnitude—from 5.4 to 51 acres. Since that time, the following treatment efforts have been made.

Pictured above, EWM canopied in 5 feet of water among white water lilies near the boat landing in May 2017.

- **2014:** In May 2014, EWM extent reached 53 acres. The Lake DeMontreville/Olson Association treated 4.3 acres with 2,4-D in early June, initially reducing the EWM extent to 27 acres. However, the EWM was burned (not killed) by the treatment, and the plant extent more than doubled during the remainder of the growing season.

- **2015:** The EWM extent was 58 acres when the Lake DeMontreville/Olson Association treated 14.3 acres with 2,4-D in May. Though the treatment initially reduced the EWM extent to 21 acres, herbicide residue samples collected indicated the dose was not lethal and Barr expected that EWM would likely rebound. By the end of the growing season EWM had nearly doubled, reaching 38 acres by May 2016 (Table 8).

- **2016:** The Lake DeMontreville/Olson Association treated 14.3 acres with 2,4-D. The treatment reduced the EWM from 38 acres in May to 19 acres in June and provided seasonal relief, but was not lethal. The VBWD contractor observed that deep water EWM plants in the eastern basin (4- to 6-foot plants in 15 feet of water) survived herbicide treatment more successfully in 2016 than in previous years. In the western/northwestern basin, EWM plants observed in June were

limited to young sprouts, 1- to 2-feet tall near shore among the white waterlilies. An August inspection by MnDNR documented the presence of EWM in all treated areas.

- **2017:** The Lake DeMontreville/Olson Association treated 16.1 acres with 2,4-D on June 1. In addition, some residents treated small areas near shore. The treatment reduced the EWM from 44 acres in May to 14 acres in June and provided seasonal relief, but was not lethal. The VBWD contractor observed surviving EWM re-growing from nearly dead stems.

The Lake DeMontreville plant community meets the criteria of the MnDNR Lake Plant Eutrophication IBI and is not impaired. A total of 22 plant species were observed by the VBWD contractor in Lake DeMontreville in 2017, which is nearly double the impairment threshold of 12 species. The 2017 FQI score of 25.5 was 37 percent higher than the impairment threshold of 18.6 (Table 10).

Significant changes in plant frequency of occurrence between 2016 and 2017 occurred for several species. Frequency reductions for high quality species such as *Potamogeton zosteriformis*, *Najas flexilis*, and *Potamogeton pusillus* are considered bad for the lake because these species provide food and cover for fish and food for waterfowl and other animals. Frequency increases for these valuable species are considered good for the lake. Frequency changes include:

- *Ceratophyllum demersum* (coontail) significantly decreased in frequency from 70 percent in 2016 to 53 percent in 2017 (Table 11). Frequency for this species has annually fluctuated since 2012, ranging from 38 percent to 70 percent. The 2017 change is consistent with its pattern of annual fluctuation and the value observed in 2017 was approximately mid-way in the frequency range observed since 2012.

- *Lemna trisulca* (forked duckweed) significantly decreased in frequency from 14 percent in 2016 to 5 percent in 2017 (Table 11). This reduction occurred concurrently with the appearance of three species of floating plants that were not present in 2016 – *Lemna minor* (small duckweed), *Spirodela polyrhiza* (large duckweed), and *Wolfia columbiana* (common watermeal). These species perform a similar function in the ecosystem as forked duckweed. The increased number of floating species in 2017 increased the lake's plant diversity (Table 9).

- *Potamogeton zosteriformis* (flat-stem pondweed) significantly decreased in frequency from 12 percent in 2016 to 2 percent in 2017 (Table 11). *Potamogeton zosteriformis* has nearly annually decreased in frequency since 2012, declining from 50 percent in 2012 to 2 percent in 2017 (Table 11).

- *Najas flexilis* (slender naiad) significantly decreased in frequency from 4 percent in 2016 to 0 percent in 2017 (Table 11).

- *Potamogeton pusillus* (small pondweed) significantly increased in frequency from 5 percent in 2016 to 13 percent in 2017. Prior to 2017, *Potamogeton pusillus* had annually declined in frequency during four consecutive years – from 41 percent in 2012 to 30 percent in 2013 to 25 percent in 2014 to 18 percent in 2015 to 5 percent in 2016 (Table 11). CLP, an invasive species, has annually been present in Lake DeMontreville since point intercept monitoring began in 2012, but has annually fluctuated in its frequency within the lake. CLP declined in frequency during 2012 through 2014 (from 49 percent in 2012 to 42 percent in 2013 to 10 percent in 2014), increased in frequency in 2015 (31 percent), declined in frequency in 2016 (2 percent) and increased in frequency in 2017 (17 percent). The significant increase in CLP from 2 percent in 2016 to 17 percent in 2017 (Table 11) was consistent with the annual variation in its frequency observed since 2012.

Two other invasive species, reed canary grass and hybrid cattail, were observed in 2017. A single siting of reed canary grass occurred at the southwest corner of the lake. A single siting of hybrid cattail occurred at the northwest corner of the lake. Because of the small area of infestation of each species, they are not presently considered problematic (Table 11). Changes in infestation area, however, should be closely monitored to determine if or when management may be needed.

The MnDNR completed two fish surveys in Lake DeMontreville in 2011 and computed Fish IBI scores of 39 and 28 from those results. These scores are close to the shallow lakes impairment threshold of 36 (scores below 36 indicate fish impairment). The MnDNR is currently using these scores for information only.[3] MnDNR completed a fish survey in 2017, but did not compute Fish IBI due to staff limitations. The VBWD has not received any reports that the EWM herbicide treatments have affected the fishery.

Lake DeMontreville has excellent water quality and is not impaired, as demonstrated by 10-year summer average (2007 through 2016) total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency level:

- **10-year summer average total phosphorus:** 23 µg/L (shallow lakes water quality standard is met when $\leq$60 µg/L)
- **10-year summer average chlorophyll *a*:** 9.8 µg/L (shallow lakes water quality standard is met when $\leq$20 µg/L)
- **10-year summer average Secchi disc transparency:** 2.9 meters (shallow lakes water quality standard is met when $\geq$1.0 meters[4])

[3] Bacigalupi, Jacquelyn, MnDNR, Email to Meg Rattei on July 11, 2016.
[4] Metropolitan Council Environmental Services (MCES) Environmental Information Management Systems (EIMS). Retrieved from https://eims.metc.state.mn.us/ on August 25, 2017.

Lake Olson

EWM, first observed in Lake Olson in 2012, doubled in extent between June of 2013 and 2014 (from 2 acres to 4 acres). Although herbicide was applied to 4.7 acres in early June of 2014, EWM extent increased further (24 acres by late June of 2014 and 32 acres by May of 2015). Herbicide treatment of 7 acres in May of 2015 reduced EWM extent to 28 acres, partially mitigating the previous increase. After treatment, EWM extent again increased and nearly doubled between June of 2015 and May of 2016 (from 28 acres to 53 acres).

The Lake DeMontreville/Olson Association treated 6.85 acres with 2,4-D in May of 2016. The treatment provided seasonal relief, reducing EWM extent to 18 acres in June), but was not lethal. The EWM observed after the treatment was burned, slimy, and reduced, but the majority of the plants (not necessarily the stems) survived the treatment and commonly had 4 to 6 inches of new growth. An August inspection by MnDNR documented the presence of EWM in all treated areas. By May of 2017, EWM extent had increased to 44 acres.

The Lake DeMontreville/Olson Association treated 8.7 acres with 2,4-D on June 1, 2017. In addition, some residents treated small areas near shore. The treatment reduced the EWM from 44 acres in May to 21 acres in June and provided seasonal relief (Table 12).

In 2017, the VBWD contractor noted the potential presence of hybrid milfoil in Lake Olson. Hybrid milfoil is a cross between the native milfoil species (northern milfoil) and EWM. Although genetic testing is needed to verify hybrid milfoil, a tentative identification can be made by counting the leaflets and noting that the average number of leaflets is outside of the EWM range. The potential hybrid milfoil in Lake Olson noted more leaflets (mean 24) than is typically observed for EWM (12 to 21). Hybrid milfoil is more resistant to herbicide treatment than EWM and a lethal dose is typically higher for hybrid milfoil than EWM.

Pictured above, potential hybrid EWM observed in Lake Olson during June 2017.

The Lake Olson plant community meets the criteria of the MnDNR Lake Plant Eutrophication IBI and is not impaired. A total of 24 plant species were observed in 2017, which is double the impairment threshold of 12 species. The 2017 FQI score of 27.8 was 49 percent higher than the impairment threshold of 18.6 (Table 14).

Significant changes in plant frequency of occurrence between 2016 and 2017 occurred for three high quality species. Frequency reductions for these species are considered bad for the lake and frequency increases are considered good for the lake because they provide food and cover for fish and food for waterfowl and other animals. Frequency changes include:

- *Najas flexilis* (slender naiad) significantly decreased in frequency from 8 percent in 2016 to 2 percent in 2017.

- *Potamogeton illinoensis* (Illinois pondweed) significantly increased in frequency from 8 percent in 2016 to 17 percent in 2017 after nearly annually declining in frequency during 2012 through 2016, from 23 percent in 2012 to 8 percent in 2016. .

- *Najas guadalupensis* (southern naiad) significantly increased in frequency from 4 percent in 2016 to 14 percent in 2017. Najas guadalupensis was not observed in the lake during 2012 through 2013, noted at a frequency of 2 percent in 2014, and a frequency of 4 percent during 2015 and 2016. .

CLP, an invasive species, has annually been present in Lake Olson since point intercept monitoring began in 2012. CLP increased in frequency from 28 percent in 2012 to 43 percent in 2013 and then declined to a frequency of 3 percent in 2014. CLP has remained at a low frequency since 2014, ranging from 1 percent to 5 percent. CLP occurred at a frequency of 5 percent in 2017 (Table 15). Because CLP has remained at a low frequency for several years, it is not currently considered problematic. However, changes in the area of infestation should be monitored to determine if or when management may be needed.

Two other invasive species were also observed in Lake Olson during 2017: reed canary grass and yellow iris (Table 15).

Reed canary grass has annually been observed in Lake Olson at one location since point intercept surveys began in 2012 and was also observed at a second location in 2014 (Table 15). Since the reed canary grass infestation is small and hasn't spread during the past few years, it is not considered problematic. Changes in the area of infestation should be monitored to determine if or when management may be needed.

In 2017, yellow iris was observed at one location in the channel between Lake DeMontreville and Lake Olson (Table 15). This is the first siting of yellow iris in Lake Olson since point intercept monitoring began in 2012. Although not previously found in Lake Olson, yellow iris was observed in Lake DeMontreville during 2013 and 2015. The current Lake Olson yellow iris infestation is not considered problematic because it is very small. However, changes in yellow iris infestation area should be closely monitored to determine if or when management may be needed.

The most recent MNDNR fish survey of Lake Olson was completed in 2011. The VBWD has not completed any fish surveys and has not received reports that aquatic plant treatments have affected the fishery.

Lake Olson has excellent water quality and is not impaired, as demonstrated by 10-year summer average (2007 through 2016) total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency level:

- **10-year summer average total phosphorus:** 21 µg/L (shallow lakes water quality standard is met when ≤60 µg/L)
- **10-year summer average chlorophyll *a*:** 8.4 µg/L (shallow lakes water quality standard is met when ≤20 µg/L)
- **10-year summer average Secchi disc transparency:** 3.0 meters (shallow lakes water quality standard is met when ≥1.0 meters[5])

Lake Jane

In June of 2012, a few scattered EWM plants (about 0.1 acres in extent) were first observed by the VBWD contractor in Lake Jane near the east shore. From 2012 through 2015, EWM increased rapidly (2 acres in 2013, 24 acres in 2014, and 44 acres in 2015).

Pictured above, dead/dying EWM in Lake Jane during June 2017.

In May of 2015, the Lake Jane Association treated 7.9 acres of the lake with 2,4-D. While treatment reduced EWM extent to 31 acres, it only partially mitigated the growth that had occurred between June of 2014 and May of 2015. Herbicide residue samples collected 3 days after the treatment indicated the treatment dose was less than 20 percent of the lethal dose for EWM, suggesting the plant would likely rebound. As expected, EWM more than doubled in extent between June 2015 and June 2016 (increasing from 31 to 69 acres).

In June of 2017, the Lake Jane Association treated 11.1 acres of the lake with 2,4-D. In addition, some residents treated small areas near shore. Treatment reduced EWM extent by more than half (from 69 acres in June 2016 to 26 acres in June 2017). Residents indicated the treatment provided seasonal relief, but that the treatment was not lethal. A resident reported, "It appears in my diving that the crowns still survived."[6] The VBWD contractor noted that some plants that seemed to be killed by the herbicide treatment had surviving fragments growing off stems.[7]

In 2017, the VBWD contractor noted the potential presence of hybrid milfoil in Lake Jane. Hybrid milfoil is a cross between the native milfoil species (northern milfoil) and EWM. Although genetic testing is needed to verify hybrid milfoil, a tentative identification can be made by counting the leaflets and noting that the average number of leaflets is outside of the EWM range. The potential hybrid milfoil in Lake Jane noted

[5] Metropolitan Council Environmental Services (MCES) Environmental Information Management Systems (EIMS). Retrieved from https://eims.metc.state.mn.us/ on August 28, 2017.

[6] Hammerly, John. 2017. Personal communication (Email) on 8/28/2017.

[7] Berg, Matthew. 2017. Unpublished Field Notes from the June 27, 2017 Plant Survey of Lake Jane.

more leaflets (mean 26) than is typically observed for EWM (12 to 21). Hybrid milfoil is more resistant to herbicide treatment than EWM and a lethal dose is typically higher for hybrid milfoil than EWM.

The Lake Jane plant community meets the criteria of the MnDNR Lake Plant Eutrophication IBI and is not impaired. A total of 27 plant species were observed in Lake Jane in 2017, which is more than double the impairment threshold of 12 species. The 2017 FQI score of 30.8 was 66 percent higher than the impairment threshold of 18.6 (Table 18).

Significant changes in plant frequency of occurrence between 2016 and 2017 occurred for several species. Frequency reductions for high quality species such as *Potamogeton robbinsii and Najas guadalupensis* are considered bad for the lake because these species provide food and cover for fish and food for waterfowl and other animals. Frequency increases for these valuable species are considered good for the lake. Frequency changes include:

- *Potamogeton robbinsii* (fern pondweed) significantly decreased in frequency from 54 percent in 2016 to 33 percent in 2017. During 2012 through 2016, fern pondweed frequency did not change significantly, fluctuating between 53 percent and 66 percent.

- *Najas guadalupensis* (southern naiad) significantly decreased in frequency from 37 percent in 2016 to 20 percent in 2017. Southern naiad annually increased in frequency during 2013 through 2016 – from 5 percent in 2013 to 13 percent in 2014 to 17 percent in 2015 to 37 percent in 2016.

- Filamentous algae significantly decreased in frequency from 10 percent in 2016 to 2 percent in 2017. Filamentous algae frequency has ranged from 2 percent to 16 percent during the 2012 through 2017 period.

- *Elodea canadensis* (common waterweed) significantly increased in frequency from 46 percent in 2016 to 62 percent in 2017. Elodea has annually increased in frequency since 2013 – from 17 percent in 2013 to 27 percent in 2014 to 30 percent in 2015 to 46 percent in 2016 to 62 percent in 2017.

CLP, an invasive species, has annually been present in Lake Jane since point intercept monitoring began in 2012, but has annually fluctuated in its frequency within the lake. CLP declined in frequency during 2012 through 2014 (from 16 percent in 2012 to 12 percent in 2013 to 8 percent in 2014), increased in frequency during 2015 (11 percent) and 2016 (18 percent) and slightly decreased in frequency during 2017 (17 percent) (Table 19). CLP density in the lake is low, average of 1 on a scale of 1 to 4. Because CLP frequency declined in 2017 and density is low, management is not warranted at this time. Changes in the area of infestation should be monitored to determine if or when management may be needed.

Three additional invasive species were also observed in 2017: reed canary grass, purple loosestrife, and narrow-leaved cattail. Reed canary grass and purple loosestrife were sited at one location in the southwest

corner of the lake. Narrow-leaved cattail was sited at one location on the southeast side of the lake (Table 19). Because infestation areas are small, management is not currently warranted for these species. However, changes in the infestation areas should be monitored to determine if or when management may be needed

The most recent MnDNR fish survey of Lake Jane was completed in 2013. The VBWD has not completed any fish surveys or received any reports that the aquatic plant treatments have affected the fishery.

Lake Jane is listed as impaired for fish consumption because tissue from the lake's fish contains mercury concentrations that exceed the impairment standard. For this reason, the following fish consumption guidelines have been issued for the general population:

- Bluegill sunfish, all sizes—limit to 1 meal per week
- Bullhead, all sizes—limit to 1 meal per week
- Northern pike, shorter than 21 inches—limit to 1 meal per week
- Northern pike, 21 inches or longer—limit to 1 meal per month

The following fish consumption guidelines have been issued for pregnant women, women who may become pregnant, and children under age 15:

- Bluegill sunfish, all sizes—limit to 1 meal per week
- Bullhead, all sizes—limit to 1 meal per month
- Northern pike, shorter than 25 inches—limit to 1 meal per month
- Northern pike, 25 inches and longer—do not eat

Lake Jane has excellent water quality and is not impaired, as demonstrated by 10-year summer average (2007 through 2016) total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency level:

- **10-year summer average total phosphorus:** 15 µg/L (water quality standard is met when ≤40 µg/L)
- **10-year summer average chlorophyll *a*:** 3.0 µg/L (water quality standard is met when ≤14 µg/L)
- **10-year summer average Secchi disc transparency:** 4.4 meters (water quality standard is met when ≥1.4 meters[8])

[8] Metropolitan Council Environmental Services (MCES) Environmental Information Management Systems (EIMS). Retrieved from https://eims.metc.state.mn.us/ on August 28, 2017

Lake Elmo

During 2012 through 2017, EWM has dominated the Lake Elmo plant community in the 10 to 15 depth range with dense areas of growth that reached the surface. EWM increased from 51 acres in 2014, to 68 acres in 2015, to 80 acres in 2016 (Table 20). In 2017, EWM extent declined to 57 acres (Table 20).

The Lake Elmo Association has completed three small-scale EWM removal projects. During September 24 and 25, 2015, a dive team removed EWM from a small area (less than an acre) by hand. In July of 2016, about 10 acres of EWM at the north end of the lake were removed by mechanical harvesting. In July of 2017, about 4 acres of EWM on the east and northeast sides of the lake were removed by mechanical harvesting. The mechanical harvesting machine used in 2016 and 2017 pulled the plants up by their roots. In June of 2017, the VBWD contractor noted that the areas harvested on the north end of the lake in 2016 continue to be almost free of EWM.

The Lake Elmo plant community meets the criteria of the MnDNR Lake Plant Eutrophication IBI and is not impaired. A total of 29 plant species were observed by the VBWD contractor in Lake Elmo in 2017, more than double the impairment threshold of 12 species. The 2017 FQI score of 29.2 was 57 percent higher than the impairment threshold of 18.6 (Table 22).

The native plant community was stable with no significant changes in frequency between 2016 and 2017.

CLP, an invasive species, has annually been present in Lake Elmo at a low frequency since point intercept monitoring began in 2012. CLP frequency of occurrence has ranged from 1 to 3 percent and was 3 percent in 2017. Since the CLP infestation is small and hasn't spread during the past few years, management is not currently warranted. Changes in the area of infestation should be monitored to determine if or when management may be needed.

The Lake Elmo cattail community, located along the western and southern shore of the lake, consists of two invasive species, hybrid cattail, and narrow-leaved cattail and both were present in 2017. The cattail community has remained relatively stable since 2012, ranging in frequency between 14 and 17 percent. In 2017, hybrid cattail occurred at a frequency of 1 percent and narrow-leaved cattail at a frequency of 13 percent. Because the cattail infestation hasn't spread during the past few years, management is not currently warranted. Changes in the area of infestation should be monitored to determine if or when management may be needed.

A fisheries survey of Lake Elmo was completed by the MnDNR in 2014 and used to compute a Fish IBI score of 53. This score is above the lake impairment threshold of 45, indicating that the Lake Elmo fishery is not impaired.

Lake Elmo is listed as impaired for fish consumption because tissue from the lake's fish contains mercury and perfluorooctane sulfonate (PFOS) concentrations that exceed the impairment standards. For this reason, the following fish consumption guidelines have been issued for the general population:

- Bluegill sunfish, all sizes—1 meal per month
- Bullhead, all sizes—1 meal per week
- Crappie, all sizes—1 meal per month
- Largemouth bass, all sizes—1 meal per month
- Northern pike, all sizes—1 meal per month
- Walleye, all sizes—1 meal per week
- Yellow perch—1 meal per month
- Carp and white sucker—no restrictions

The following fish consumption guidelines have been issued for pregnant women, women who may become pregnant, and children under age 15:

- Bluegill sunfish, all sizes—limit to 1 meal per month
- Bullhead, all sizes—limit to 1 meal per week
- Carp, all sizes—limit to 1 meal per week
- Crappie, all sizes—limit to 1 meal per month
- Largemouth bass—limit to 1 meal per month
- Northern pike—limit to 1 meal per month
- Walleye—limit to 1 meal per week
- Yellow perch—limit to 1 meal per month
- White sucker—no restrictions

Lake Elmo has excellent water quality and is not impaired, as demonstrated by 10-year summer average (2007 through 2016) total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency level:

- **10-year summer average total phosphorus:** 21 µg/L (water quality standard is met when $\leq$40 µg/L)
- **10-year summer average chlorophyll *a*:** 2.1 µg/L (water quality standard is met when $\leq$14 µg/L)
- **10-year summer average Secchi disc transparency:** 4.9 meters (water quality standard is met when $\geq$1.4 meters).

Silver Lake

Silver Lake has a long history of EWM and CLP management. EWM was first found in the lake in 1992 and chemical treatments to control dense mats of EWM were completed in the southern part of the lake during 1995 through 2006[9]. The treatments attained seasonal control of EWM, but aquatic plant surveys in 2006 documented that problematic growth of EWM and CLP continued despite the treatment efforts. EWM occurred at a frequency of 69 percent and CLP at a frequency of 21 percent in 2006. In 2007 through 2009, a series of lake-wide herbicide treatments aimed at controlling EWM and/or CLP were conducted by the Silver Lake Improvement Association. Because the treatments effectively reduced EWM and CLP, chemical treatments were not needed during 2010 and 2011. However, both EWM and CLP rebounded. Small scale chemical treatments have occurred annually since 2012 to attain seasonal control of EWM and/or CLP. Treatments during 2007-2017 include:

- May 8, 2007 – 50 acres were treated with triclopyr to control EWM and endothall to control CLP
- May 15, 2008 – 60 acres were treated with triclopyr to control EWM and endothall to control CLP
- April 29, 2009 – 60 acres were treated with endothall to control CLP
- August 1, 2012 – 4 acres were treated with 2,4-D to control EWM
- June 6, 2013 – 11 acres were treated with 2,4-D to control EWM and endothall to control CLP
- July 23, 2014 – 4 acres were treated with 2,4-D to control EWM
- May 15, 2015 – 7.7 acres were treated with 2,4-D to control EWM
- May 6, 2016 – 2.6 acres were treated with endothall to control CLP.
- May 15, 2017 – 3.2 acres were treated with endothall to control CLP
- June 10, 2017 – 2.74 acres were treated with 2,4-D to control EWM.

Despite the 2017 herbicide treatment, EWM significantly increased in frequency from 21 percent in 2016 to 31 percent in 2017.

In 2017, the VBWD contractor noted the potential presence of hybrid milfoil in Silver Lake. Hybrid milfoil is a cross between the native milfoil species (northern milfoil) and EWM. Although genetic testing is needed

[9] MnDNR. 2012. Silver Lake Fishery Survey: 07/24/2012.
http://www.dnr.state.mn.us/lakefind/showreport.html?downum=62000100
Retrieved 09/05/2017

to verify hybrid milfoil, a tentative identification can be made by counting the leaflets and noting that the average number of leaflets is outside of the EWM range. The potential hybrid milfoil in Silver Lake noted more leaflets (mean 24) than is typically observed for EWM (12 to 21). Hybrid milfoil is more resistant to herbicide treatment than EWM and a lethal dose is typically higher for hybrid milfoil than EWM.

Pictured above, potential hybrid milfoil with 24 leaflets collected from Silver Lake in June of 2017.

The 2017 Silver Lake plant community met the criteria of the MnDNR Lake Plant Eutrophication IBI and is not impaired. A total of 20 plant species were observed by the VBWD contractor in Silver Lake in 2017, which is 67 percent more than the impairment threshold of 12 species. The 2017 FQI score of 23.9 was 28 percent higher than the impairment threshold of 18.6 (Table 26).

Historically, the Silver Lake plant community has generally failed to meet the MnDNR Lake Plant Eutrophication IBI since 2007. Reportedly, the 2007 and 2008 treatments applied herbicide at excessive concentrations and significant damage to the native plant community resulted.[10] The data indicate the plant community met IBI criteria in 2006 and June of 2007, but did not meet IBI criteria during August 2007 through July 2012. Over time, the plant community has improved such that the Silver Lake IBI metrics (number of species and FQI) have consistently been relatively close to the respective impairment thresholds during the past five years and have met IBI criteria 60 percent of the time. The number of species observed in June of 2017 (20) was similar to 2006 pre-treatment conditions (19 species); the quality of the plant community in 2017, as determined from FQI (23.9), was slightly less than pre-treatment quality (2006 FQI was 25.7).

Significant changes in plant frequency of occurrence between 2016 and 2017 include:

- *Najas* significantly decreased in frequency from 9 percent in August of 2016 to 1 percent in June of 2017. This is likely an artificial decrease tied to the slow growth of this species which results in it becoming more common as the growing season progresses. Hence, the June 2017 VBWD data (early part of growing season) are not directly comparable to the August 2016 MnDNR data (later part of growing season) when *Najas* is more common (higher frequency). The 2007 through 2009 large scale herbicide treatments reduced *Najas* frequency in the lake from pre-treatment frequencies of 27 to 29 percent in 2006 to not observed in the lake during 2010 through 2012. Najas has consistently been observed in the lake since 2013. Frequencies have ranged from 1 to 9

[10] Lund, Keegan. 2014. Silver Lake, Ramsey County: 2013 Aquatic Vegetation Survey, Surveyed by the Invasive Species Program, MnDNR – Division of Ecological and Water Resources.

percent. Najas is a valuable plan that provides food and cover for fish and food for waterfowl and other animals.

- *Ceratophyllum demersum* (coontail) significantly decreased in frequency from 50 percent in August of 2016 to 26 percent in June of 2017. This decline was preceded by a decline after the 2007 through 2009 large scale herbicide treatments followed by an increase after the treatments. The large scale herbicide treatments reduced coontail from pre-treatment frequencies of 97 to 98 percent in 2006 to 3 percent in 2010. Coontail frequency then annually increased during 2013 through 2016 until a frequency of 50 percent was attained in 2016.

- *Lemna minor* (small duckweed) significantly increased in frequency from 0 percent in August of 2016 to 4 percent in June of 2017.

- Filamentous algae significantly increased in frequency from 0 percent in August of 2016 to 29 percent in June of 2017. The VBWD contractor noted that filamentous algae were common on EWM that was dead and dying from the June 10 treatment indicating nutrients from the decaying EWM fueled the growth of filamentous algae in the lake. Filamentous algae were not observed during the 2006 through 2016 Silver Lake plant surveys. The appearance of filamentous algae in 2017 was an undesirable change for the lake. Shade from filamentous algae at the lake's surface limits plant growth.

CLP has been managed in Silver Lake since 2007. Herbicide treatment to reduce CLP occurred in 2007, 2008, 2009, 2013, 2015, 2016, and 2017. Following the 2017 herbicide treatment, CLP was found at a frequency of 32 percent (Table 27), but the density was relatively low – average density of 1 on a scale of 1 to 4, which means that the sampling rake head was generally less than one third full of plants. A few patches of CLP, however, noted a high density; 3 of the 115 sampling locations observed patches of CLP with a density of 3 on a scale of 1 to 4, which means more than two thirds of the sampling rake head was full of plants. The high density patches were problematic, but occupied a relatively small area of the lake.

CLP significantly increased in frequency from 18 percent in August of 2016 to 32 percent in June of 2017. However, this increase is likely artificial and a reflection of its unusual growing cycle that includes annual senescence around July 1 and the start of a new growing season in late August. The data are consistent with our expectation that CLP occurs at a higher frequency in June, when growth is at its peak, than August at the start of a new growing season.

Two other invasive species, reed canary grass and narrow-leaved cattail, were each observed at one location in 2017. Because of the small infestation, management is not currently warranted. However, changes in the area of infestation should be monitored to determine if or when management may be needed.

The most recent MnDNR fish survey of Silver Lake was completed in 2012. The VBWD has not completed any fish surveys or received any reports that the aquatic plant treatments have affected the fishery.

The lake-wide chemical treatments during 2007 through 2008 reportedly applied herbicide at excessive concentrations and significant damage to the native plant community resulted.[10] A corresponding decline in water quality occurred. Prior to 2007, Silver Lake had excellent water quality and was not impaired as demonstrated by 10-year summer average (1997 through 2006) total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency level:

- **1997-2006 10-year summer average total phosphorus:** 31 µg/L (shallow lakes water quality standard is met when ≤60 µg/L)
- **1997-2006 10-year summer average chlorophyll *a*:** 6.8 µg/L (shallow lakes water quality standard is met when ≤20 µg/L)
- **1997-2006 10-year summer average Secchi disc transparency:** 2.8 meters (shallow lakes water quality impairment standard is met when ≥1.0 meters)

As noted previously, for a lake to be impaired, the most recent 10-year summer average for total phosphorus (causal variable) and either *chlorophyll a* or Secchi disc transparency (response variables) must be worse than the respective standards. Silver Lake was not impaired during 1997 through 2006 because the 10-year summer average total phosphorus and chlorophyll-*a* concentrations and Secchi disc level met the shallow lakes impairment standard. However, since 2007, Silver Lake has been impaired because it failed to meet the shallow lakes water quality standard as demonstrated by 10-year (2007 through 2016) summer average total phosphorus and chlorophyll-*a* concentrations and Secchi disc transparency level:

- **2007-2016 10-year summer average total phosphorus:** 83 µg/L (shallow lakes water quality standard is met when ≤60 µg/L)
- **2007-2016 10-year summer average chlorophyll *a*:** 25.0 µg/L (shallow lakes water quality standard is met when ≤20 µg/L)
- **2007-2016 10-year summer average Secchi disc transparency:** 1.2 meters (shallow lakes water quality standard is met when ≥1.0 meters)

The 10-year (2007 through 2016) summer average total phosphorus and chlorophyll *a* concentrations both failed to meet the shallow lakes impairment standard. As a result, Silver Lake could be added to the MPCA's list of impaired waters (303(d)) for eutrophication.

Summary

The MnDNR developed a Lake Plant Eutrophication IBI to measure the response of a lake plant community to eutrophication (excessive nutrients). The MPCA will use this IBI to identify lakes that are impaired (i.e., not supporting aquatic life due to stress from excessive nutrients). In 2017, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake met the criteria of the MnDNR Lake Plant Eutrophication IBI and are not impaired. Despite low nutrients/excellent water quality, Long Lake did not meet plant IBI criteria in 2017 and would be considered impaired for plants due to the poor quality of its plant community. The MPCA/MnDNR has not yet listed any lakes as impaired due to failing IBI scores.

Although Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake are infested with EWM, an aquatic invasive species (AIS), the degree of infestation and response to management efforts have varied.

- A multi-year herbicide treatment program in Long Lake reduced EWM from 52 acres in 2010 to 0.33 acres in 2016. The lake was not treated in 2017 and EWM expanded by more than an order of magnitude – from 0.33 acres in 2016 to 5.58 acres. The presence of EWM throughout the pond in Katherine Abbott Park, located north of Long Lake, was documented in 2017, indicating the pond has likely been a source of EWM to Long Lake. Elimination of this source will be important in future Long Lake EWM management endeavors. During the EWM reduction period, the native plant community responded positively, with increases in plant diversity. In 2017, *Lychnothamnus barbatus* (bearded stonewort), a good plant, was observed in Long Lake for the first time.

- EWM has expanded rapidly in Lake DeMontreville, Lake Olson, and Lake Jane since 2012, despite management efforts. Herbicide treatments were not lethal to EWM and only provided seasonal relief. In 2017, as in previous years, the VBWD contractor observed surviving EWM after herbicide treatment of the lakes.

- EWM in Lake Elmo expanded during 2014 through 2016, but declined in 2017. Small-scale EWM removal projects were completed during 2015 through 2017. The VBWD contractor noted the areas that had been harvested on the north end of the lake continue to be almost free of EWM.

- EWM in Silver Lake has been managed since 1995. Chemical treatments during 1995 through 2006 were not lethal to EWM and only provided seasonal relief. In 2007 through 2009, a series of lake-wide herbicide treatments aimed at controlling EWM and/or CLP were conducted. The treatments attained long-term control – no treatments were needed in 2010 and 2011. However, both EWM and CLP rebounded and small scale treatments to attain seasonal relief have occurred annually since 2012.

CLP, an AIS, is found in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake. A few dense patches in Silver Lake are problematic, but most of the CLP in Silver Lake is at low density and not problematic. CLP is not problematic in the other five VBWD lakes.

Five additional AIS are present in VBWD lakes, but none are problematic.

- Reed canary grass is found in Lake Jane, Lake Olson, Lake DeMontreville, Silver Lake, and Long Lake.
- Purple loosestrife is found in Lake Jane
- Narrow-leaved cattail is found in Lake Elmo, Lake Jane, and Silver Lake
- Hybrid cattail is found in Lake Elmo and Lake DeMontreville
- Yellow iris is found in Lake Olson

The MNDR has raised concerns that aquatic plant treatments might affect the fishery. However, the VBWD has not received any reports that the aquatic plant treatments have affected the fishery in any way.

From 1997 through 2012, the MNDNR developed Fish IBI tools to assess whether lakes support healthy fish populations. The MNDNR has used the Fish IBI since 2015 to characterize lakes as impaired (not supporting aquatic life), or not impaired (supporting aquatic life). The Fish IBI only applies to lakes that have at least 100 acres of surface area (in the VBWD, only Lake DeMontreville and Lake Elmo).

The MnDNR completed two fish surveys in Lake DeMontreville in 2011 and computed Fish IBI scores of 39 and 28 from those results. These scores are close to the shallow lakes impairment threshold of 36 (scores below 36 indicate fish impairment). The MnDNR is currently using these scores for information only. The MnDNR completed a fish survey in 2017, but did not compute Fish IBI due to staff limitations.

A fisheries survey of Lake Elmo was completed by the MnDNR in 2014 and used to compute a Fish IBI score of 53. This score is above the lake impairment threshold of 45, indicating that the Lake Elmo fishery is not impaired.

Both Lake Elmo and Lake Jane have restrictions on fish consumption because tissue from fish in those lakes has failed to meet MPCA standards (mercury standards for Lake Jane and both mercury and PFO standards for Lake Elmo).

Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo have excellent water quality and are not impaired. 10-year summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency levels from 2007 through 2016 met the MPCA lake water quality standards.

Prior to 2007, Silver Lake had excellent water quality and was not impaired. 10-year summer average total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency levels from 1997 through 2006 met the MPCA lake water quality standards. The lake-wide chemical treatments during 2007 through 2008 reportedly applied herbicide at excessive concentrations and significant damage to the native plant community resulted.[10] A corresponding decline in water quality occurred and the lake has been impaired since 2007. 10-year average total phosphorus and chlorophyll *a* concentrations from 2007 through 2016 failed to meet the MPCA lake water quality standards. As a result, Silver Lake could be added to the MPCA's list of impaired waters (303(d)) for eutrophication.

Description of Tables

- **Table 1** summarizes the results of the 2017 aquatic plant surveys of six VBWD lakes. The following data are presented:
  - **Number of species**—the number of different plant species that were either collected on the rake or observed in the lake (e.g., water lilies or cattail beds not collected on the rake but observed). This number includes both invasive and native species.
  - **Number of native species**—the number of native plant species that were either collected on the rake or observed in the lake.
  - **Number of native species collected on rake**—only native plants collected on the rake were used for this statistic.
  - **Number of invasive species**—the number of invasive plant species that were either collected on the rake or observed in the lake.
  - **Maximum depth of plant growth**—the maximum depth that plants were found in the lake.
  - **Frequency of occurrence**—the frequency with which plants were found in water shallower than the maximum depth of plant growth.
  - **Average rake fullness**—the density of plant growth, as measured by rake fullness on a scale of 1 to 4, where:
    - 1 = less than 1/3 of the rake head full of plants.
    - 2 = from 1/3 to 2/3 of the rake head full of plants.
    - 3 = more than 2/3 of the rake head full of plants.
    - 4 = rake head is full, with plants overtopping.
  - **Simpson Diversity Index Value**—index used to measure plant diversity, which assesses the overall health of the lake's plant communities. The index, with scores ranging from 0 to 1, considers both the number of species present and the evenness of species distribution. The scores represent the probability that two individual plants randomly selected from the lake will belong to different species. A high score indicates a more diverse plant community—a higher probability that two randomly selected plants will represent different species.
- **Table 2** summarizes invasive species data from the six VBWD lakes surveyed in 2017. The table shows the frequency of occurrence for species collected on the rake and includes species that were observed but not collected on the rake.
- **Tables 3, 4, 8, 12, 16, 20, and 24** summarize Eurasian watermilfoil (EWM) extent for the period of record for Long Lake, Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, and Lake

Elmo, and for 2017 for Silver Lake. EWM extent is shown as acres of EWM in the lake and as a percent of the plant-growth area.

- **Tables 5, 9, 13, 17, and 21, and 25** summarize Simpson Diversity Index values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, and Lake Elmo and for 2017 in Silver Lake.

- **Tables 6, 10, 14, 18, 22, and 26** summarize MNDNR Lake Eutrophication Plant IBI values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

- **Tables 7, 11, 15, 19, 23, and 27** show species frequency for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Table 1 Valley Branch Watershed District: Lake Plant Survey Summary Statistics (June 2017)

Lake	Number of Species*	Number of Native Species*	Number of Native Species Collected on Rake*	Number of Invasive Species	Maximum Depth of Plant Growth (feet)	Frequency of Occurrence (%)	Average Rake Fullness	Simpson Diversity Index Value
Elmo	32	28	19	4	23.0	92	2.70	0.91
Jane	30	25	21	5	22.50	98	2.06	0.89
Olson	28	24	19	4	20.5	93	2.07	0.86
DeMontreville	25	21	18	4	20.5	96	2.09	0.87
Silver	23	19	12	4	10.5	69	2.44	0.82
Long	18	15	14	3	21.5	58	2.44	0.84

*Filamentous algae, aquatic moss, and liverworts were not included in number of species.

Table 2 2017 Valley Branch Watershed District: June Invasive Species Summary
Frequency of Occurrence at Sites Shallower than Maximum Depth of Plant Growth (Percent or Observed*)

Lake	*Myriophyllum spicatum* (Eurasian watermilfoil)	*Potamogeton crispus* (curly-leaf pondweed)	*Phalaris arundinacea* (reed canary grass)	*Lythrum salicaria* (purple loosestrife)	*Typha angustifolia* (narrow-leaved cattail)	*Typha glauca* (hybrid cattail)	*Iris pseudacorus* (Yellow iris)
Elmo	32	3			13	1	
Jane	24	17	Observed	Observed	Observed		
Olson	25	5	Observed				Observed
DeMontreville	14	17	Observed			Observed	
Silver	31	32	Observed		1		
Long	14	17	Observed				

*Observed in the lake but not collected on the rake.

Table 3 Long Lake acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.011800)

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/15/2010	52.31	53.71	97.39%
8/1/2011	4.89	22.67	21.56%
4/29/2012	2.44	31.47	7.74%
6/18/2012	7.24	21.06	34.39%
5/16/2013 (Partial Survey)	14.28	--	--
6/24/2013	7.88	50.43	15.62%
5/24/2014	9.75	39.94	24.41%
6/25/2014	4.77	47.68	10.00%
5/9/2015	5.5	52.81	10.41%
6/22/2015	0.40	54.72	0.73%
5/1/2016	3.78	50.34	7.51%
6/27/2016	0.33	51.94	0.64%
6/27/2017	5.58	50.24	11.10%

Table 4 Long Lake – Katherine Abbott Pond acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/27/2017	2.88	2.93	98.32

Table 5 Simpson Diversity Index Values for Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	Diversity
2010	June	15	0.40
2011	August	1	0.80
2012	June	18	0.85
2013	June	24	0.81
2014	June	25	0.83
2015	June	22	0.77
2016	June	27	0.78
2017	June	27	0.84

Table 6 MNDNR Plant IBI: Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Long Lake Species Richness**	Percent Difference between MNDNR Criterion and Long Lake Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Long Lake FQI**	Percent Difference between MNDNR Criterion and Long Lake FQI	Does Long Lake Meet MNDNR Plant IBI Criteria?
2010	June	15	≥12	14	17	≥18.6	21.3	15	Yes
2011	August	1	≥12	13	8	≥18.6	18.9	2	Yes
2012	June	18	≥12	13	8	≥18.6	18.9	2	Yes
2013	June	24	≥12	12	0	≥18.6	17.6	-5	No
2014	June	25	≥12	12	0	≥18.6	17.0	-9	No
2015	June	22	≥12	16	33	≥18.6	20.0	8	Yes
2016	June	27	≥12	17	42	≥18.6	21.8	17	Yes
2017	June	27	≥12	16	33	≥18.6	16.2	-13	No

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 7 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Free-float	Free-float	Free-float	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Upland
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	**Eudicot**
			Native	**Non-Native**	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native		Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Hybrid		**Non-Native**
			Myriophyllum sibiricum	*Myriophyllum spicatum*	*Ceratophyllum demersum*	*Ranunculus aquatilis*	*Utricularia vulgaris*	*Elodea canadensis*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton pusillus*	*Potamogeton sp.*	*Potamogeton nodosus*	*Stuckenia pectinata*	*Najas flexilis*	*Nitella spp.*	*Lychnothamnus bgarbatus*	*Chara spp.*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Filamentous Algae	Aquatic Moss	*Bolboschoenus fluviatilis*	*Eleocharis acicularis*	*Phalaris arundinacea*	*Schoenoplectus acutus*	*Sparganium eurycarpum*	*Typha glauca*	*Typha sp.*	*Salix spp.*
2010	06	15	1	92					8		6			P			2				2	2	1					P	1	2	P		1	1
2011	08	1		29	5		P		2		2		2				16			8	P	11			15	3	P	5	P	2				
2012	06	18		29	9				21		41		5				26	2		17	2	5			16		2	2	2	2		2		
2013	06	24		19	5				3		25		5				7			11	2	1			20		1	1	P	1		P		
2014	06	25		10	10			2	2		11		14				1			20		2			17		1	2	P	1		P		
2015	06	22		1	6			26	1		6		8		P	P	1	1		26	1			1	25		P	1	P	P		P		
2016	06	27		1	10	3		31	2		10		4		1		1	1		29	1	1	P		37		P	1	P	P		P		
2017	06	27		14	13	3		28	2	1	17	P	1		2			5	1	31	2	2	2	2	20				P					

*P = Present—Observed but not collected on the sampling rake

Table 8 Lake DeMontreville acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010100)

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	5.39	137.07	3.93%
6/24/2013	50.88	144.45	35.22%
5/24/2014	53.08	143.93	36.88%
6/28/2014	26.75	146.94	18.20%
5/10/2015	58.01	149.40	38.83%
6/21/2015	20.60	157.29	13.10%
5/1/2016	38.28	156.25	24.50%
6/26/2016	19.04	147.06	12.95%
5/21/2017	44.27	144.49	30.64
6/25/2017	14.15	146.42	9.66

Table 9 Simpson Diversity Index Values for Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	Diversity
2012	June	18	0.89
2013	June	24	0.90
2014	June	28	0.90
2015	June	21	0.90
2016	June	26	0.86
2017	June	25	0.87

Table 10 MNDNR Plant IBI: Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake DeMontreville Species Richness**	Percent Difference between MNDNR Criterion and Lake DeMontreville Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake DeMontreville FQI**	Percent Difference between MNDNR Criterion and Lake DeMontreville FQI	Does Lake DeMontreville Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	22	83	≥18.6	26.4	42	Yes
2013	June	24	≥12	24	100	≥18.6	27.6	48	Yes
2014	June	28	≥12	22	83	≥18.6	27.9	50	Yes
2015	June	21	≥12	24	100	≥18.6	28.6	54	Yes
2016	June	26	≥12	19	58	≥18.6	24.6	32	Yes
2017	June	25	≥12	22	83	≥18.6	25.5	37	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 11 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	*Ceratophyllum demersum*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*	*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Stuckenia pectinata*	*Najas flexilis*	*Najas s guadalupensis*	*Vallisneria americana*	*Chara sp.*	*Nitella sp.*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	*Wolffia columbiana*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous Algae	Aquatic moss	*Eleocharis acicularis*	*Eleocharis palustris*	*Lythrum salicaria*	*Iris Pseudacorus*	*Phalaris arundinacea*	*Schoenoplectus acutus*	*Schoenoplectus tabernaemontani*	*Typha angustifolia*	*Typha latifolia*	*Typha glauca*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Free-float	Free-float	Free-float	Float-leaf	Float-leaf	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	**Dicot**	**Dicot**			Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	**Non-Native**	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	**Non-Native**	Native	Native	**Non-Native**	Native	Native	**Non-Native**
2012	06	18	38	4	5	4	8	5		4	49		9	41	12	50		2		4	6	11		22		1	3		6	1	1	P	P		1		P	P	P	1
2013	06	24	50	33	12	5	22	7		3	42	1	7	30	26	48	2	2		2	5	3	1	28	1		4	P	33			P		P	P			P	P	1
2014	06	28	61	19	13	3	32	7		3	10	1	7	25	19	39		4	1	7	10	3		17			3	P	14	3	1	P			1					1
2015	06	21	61	17	1	5	30	2	1	6	31		6	18	17	45		6	8	12	13	6		15			3	P	27	6	2	P		P	P	P	P			1
2016	06	26	70	16		3	68	4			2		6	5	4	12		4	18	14	30	11		14			5	1	39	1			P		P	P	P			1
2017	06	25	53	14		5	64	1		1	17		3	13	4	2			17	18	35	10	3	5	3	2	3	P	31	6		P			P	P				P

*P = Present—Observed but not collected on the sampling rake

Table 12 Lake Olson acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010300)

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	2.17	88.03	2.46%
6/24/2013	3.55	89.01	3.99%
5/24/2014	22.96	87.11	26.36%
6/28/2014	23.96	89.02	26.92%
5/9/2015	31.77	89.26	35.59%
6/21/2015	28.13	87.02	32.33%
5/1/2016	53.49	89.26	59.93%
6/26/2016	17.56	89.26	19.67%
5/21/2017	43.61	89.26	48.86
6/25/2017	21.03	88.80	23.68

Table 13 Simpson Diversity Index Values for Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	Diversity
2012	June	18	0.92
2013	June	24	0.91
2014	June	28	0.90
2015	June	21	0.90
2016	June	26	0.85
2017	June	25	0.86

Table 14 MNDNR Plant IBI: Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Olson Species Richness**	Percent Difference between MNDNR Criterion and Lake Olson Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Olson FQI**	Percent Difference between MNDNR Criterion and Lake Olson FQI	Does Lake Olson Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	21	75	≥18.6	25.6	38	Yes
2013	June	24	≥12	21	75	≥18.6	25.3	36	Yes
2014	June	28	≥12	23	92	≥18.6	27.1	46	Yes
2015	June	21	≥12	25	108	≥18.6	29.2	57	Yes
2016	June	26	≥12	23	92	≥18.6	27.1	46	Yes
2017	June	25	≥12	24	100	≥18.6	27.8	49	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 15 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	*Ceratophyllum demersum*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*		*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton illinoensis*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas guadalupensis*	*Stuckenia pectinata*	*Vallisneria americana*	Chara sp.	*Nitella sp*	*Lemna trisulca*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous algae	Aquatic moss	*Calamagrostis canadensis*	*Eleocharis acicularis*	*Eleocharis palustris*	*Iris virginica*	*Iris pseudacorus*	*Phalaris arundinacea*	*Sagittaria cristata*	Sagittaria graminea	Schoenoplectus acutus	Schoenoplectus Tabernaemontani	Typha angustifolia
			Submersed	Submersed	Submersed	Submersed	Submersed		Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Float-leaf	Float-leaf	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**		Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot		Monocot	Monocot	**Dicot**	**Dicot**			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	**Non-Native**	Native	Native	Native		Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**
			Ceratophyllum demersum	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*		*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton illinoensis*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas guadalupensis*	*Stuckenia pectinata*	*Vallisneria americana*	Chara sp.	*Nitella sp*	*Lemna trisulca*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous algae	Aquatic moss	*Calamagrostis canadensis*	*Eleocharis acicularis*	*Eleocharis palustris*	*Iris virginica*	*Iris pseudacorus*	*Phalaris arundinacea*	*Sagittaria cristata*	Sagittaria graminea	Schoenoplectus acutus	Schoenoplectus Tabernaemontani	Typha angustifolia
2012	06	18	27	3	12	4	11		16		10	28	23		30	10	19	3			2	25	12	15	1	P	7	18		4	1			1				1	P
2013	06	24	38	5	10	3	11		12		7	43	17		25	7	21	13		P		10	6	20	1		8	14		3	1			P				1	P
2014	06	28	57	28	8	2	23		24	1	1	3	13		22	10	17	11	2	P	3	25	4	19	1		19	13		1	1			P				P	P
2015	06	21	37	28	2	P	23		6		3	5	13	1	6	21	15	8	4	P	5	38	7	11	1		9	15		4	1	P		P	P			P	P
2016	06	26	50	19		3	67		4			1	8	P	3	8	6	8	4	1	6	53	9	8	1	P	23	13	P	5	P			P		2		P	P
2017	06	27	58	25		2	58		1		2	5	17	P	2	10	3	2	14	1	10	55	9	3	1	P	18	8	P	2			P	P		2	P	P	

*P = Present—Observed but not collected on the sampling rake

Table 16 Lake Jane acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010400)

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	0.10	118.54	0.08%
6/28/2013	1.68	121.82	1.38%
6/27/2014	24.08	112.61	21.38%
5/9/2015	44.16	125.08	35.31%
6/21/2015	31.01	126.77	24.46%
6/27/2016	68.71	131.23	52.36%
6/27/2017	26.26	126.40	20.77

Table 17 Simpson Diversity Index Values for Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	Diversity
2012	June	18	0.92
2013	June	28	0.91
2014	June	27	0.92
2015	June	21	0.92
2016	June	27	0.90
2017	June	27	0.89

Table 18 MNDNR Plant IBI: Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Jane Species Richness**	Percent Difference between MNDNR Criterion and Lake Jane Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Jane FQI**	Percent Difference between MNDNR Criterion and Lake Jane FQI	Does Lake Jane Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	28	133	≥18.6	31.6	70	Yes
2013	June	28	≥12	31	158	≥18.6	33.1	78	Yes
2014	June	27	≥12	29	142	≥18.6	32.3	74	Yes
2015	June	21	≥12	26	117	≥18.6	30.8	66	Yes
2016	June	27	≥12	27	125	≥18.6	30.8	66	Yes
2017	June	27	≥12	27	125	≥18.6	30.8	66	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

To: VBWD Managers
From: Meg Rattei
Subject: June 2017 Point-Intercept Plant Surveys at Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake
Date: October 5, 2017
Page: 42
Project: 23820405
c: Susannah Torseth, Jeff Brower, Melissa Imse, John Hanson

Table 19 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Float-leaf	Float-leaf	Free-float	Free-float	Free-float	Free-float	Quillwort	Mosses	Algae	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Ceratophyllum demersum	*Bidens beckii*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Elodea canadensis*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton praelongus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Stuckenia pectinata*	*Najas flexilis*	*Najas guadalupensis*	*Vallisneria americana*	*Zannichellia palustris*	*Isoetes echinospora*	Chara sp.	*Nitella sp*	*Brasenia schreberi*	*Nymphaea odorata*	*Polygonum amphibium*	*Lemna minor*	*Lemna trisulca*	*Riccia fluitans*	*Wolffia columbiana*	Isoetes echinospora	Aquatic moss	Filamentous algae	*Carex pellita*	*Eleocharis acicularis*	*Eleocharis erythropoda*	*Iris virginica*	*Juncus articus variation balticus*	*Juncus canadensis*	*Juncus effusus*	*Juncus pelocarpus*	*Juncus pilocarpus f. submersus*	*Lythrum salicaria*	*Phalaris arundinacea*	*Sagittaria cristata*	*Schoenplectus tabernaemontani*	*Typha angustifolia*	*Typha X glauca*	*Polygonum amphibium*
2012	06	18	33		P	22	15	32	7	21	16	1	24		8	14	62	16	1	8	6	6			16		1	6	P	2	1		1					2		4				P	2		P	P	2	P	P	P	
2013	06	28	24		2	21	9	17	3	15	12		30		6	21	66	10	1	8	5	2	2	1	15	1	1	2		1	1	P	1					5		7	1		1				2	P	P	3	1	P		
2014	06	27	25		19	20	5	27	7	6	8	2	30	2	7	16	57	14	P	5	13	6	1	1	22		2	2			1			1				2	1	1	1		1	1	P			P	P	4	P		P	
2015	06	21	23	1	23	9	2	30		7	11	2	19	7	7	14	53	12	2	4	17	4			17	2	1	3			7			1	16		3							P	P	3	P	P		
2016	06	27	14		41	3	1	46	P	7	18		18	9	1	9	54	5	1	2	37	5	2	1	18	3		5	P						10	1	5	1	P	P	P				P	1	1	P	P		
2017	06	27	17		24		1	62	1	2	17		22	8		3	33	2	P	3	20	11			16	7	1	3			3			1	2		2	1		1	1			P	P	1	P	P		P

*P = Present—Observed but not collected on the sampling rake

Table 20 Lake Elmo acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010600)

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18–19/2012	71.09	112.68	63.09
6/28/2013	52.69	109.61	48.07
6/27/2014	50.58	112.42	44.99
6/21/2015	67.52	113.53	59.47
4/30/2016	58.77	123.62	47.54%
6/27/2016	78.58	123.31	63.73%
7/29/2016*	80.15	126.60	63.31%
6/27/2017	57.32	120.19	47.69

*July 29, 2016, data collected by the Lake Elmo Association

Table 21 Simpson Diversity Index Values for Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	Diversity
2012	June	18–19	0.91
2013	June	28	0.89
2014	June	27	0.88
2015	June	21	0.88
2016	June	27	0.89
2016	July	29	0.88
2017	June	27	0.91

July 29, 2016, data collected by the Lake Elmo Association

Table 22 MNDNR Plant IBI: Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Elmo Species Richness**	Percent Difference between MNDNR Criterion and Lake Elmo Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Elmo FQI**	Percent Difference between MNDNR Criterion and Lake Elmo FQI	Does Lake Elmo Meet MNDNR Plant IBI Criteria?
2012	June	18–19	≥12	31	158	≥18.6	31.1	67	Yes
2013	June	28	≥12	28	133	≥18.6	28.0	51	Yes
2014	June	27	≥12	25	108	≥18.6	25.4	37	Yes
2015	June	21	≥12	26	117	≥18.6	26.9	45	Yes
2016	June	27	≥12	26	117	≥18.6	26.9	45	Yes
2016	July	29	≥12	26	117	≥18.6	26.5	42	Yes
2017	June	27	≥12	29	142	≥18.6	29.2	57	Yes

* Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

To: VBWD Managers
From: Meg Rattei
Subject: June 2017 Point-Intercept Plant Surveys at Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake
Date: October 5, 2017

Project: 23820405
c: Susannah Torseth, Jeff Brower, Melissa Imse, John Hanson

Table 23 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	*Ceratophyllum demersum*	*Elodea canadensis*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Utricularia vulgaris*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton natans*	*Potamogeton praelongus*	*Potamogeton pusillus*	*Potamogeton richardsonii*	*Potamogeton strictifolius*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas guadalupensis*	*Stuckenia pectinata*	Chara sp.	*Nitella sp*	*Nymphaea odorata*	*Polygonum amphibium*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Filamentous algae	*Riccia fluitans*	*Ricciocarpus natans*	*Carex comosa*	*Carex pellita*	*Carex scoparia*	*Eleocharis acicularis*	*Eleocharis erythropoda*	*Eleocharis palustris*	*Equisetum fluviatile*	*Iris virginica*	*Phalaris arundinacea*	*Phragmites australis*	*Polygonum amphibium*	*Schoenplectus acutus*	*Schoenoplectus pungens*	*Schoenoplectus Tabernaemontani*	*Sparganium eurycarpum*	*Typha angustifolia*	*Typha glauca*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Float-leaf	Free-float	Free-float	Free-float	Free-float	Algae	Liverwort	Liverwort	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot		**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot				Monocot	Monocot	Monocot	Monocot	Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	**Non-Native**
2012	06	18-19	29	8	44	1	7	1		P	3	P	P	13	12		1	P	1	7	1	28	5	37	1	12	P	1				5			P			3	1	3	P		4			4	P	5	P	17	
2013	06	28	26	3	37	P	4	1			P		1	7	9		P	P		3	1	21	1	33	1	13		4				8		P	P	1	1		1	P	P	1	1	1		3	P	4	P	16	
2014	06	27	43	5	34		1	P			P		P	4	9			P		4	4	18	1	31		9	P	1		1		14			P	1	P		1	P	P		3	P		5	P	3			16
2015	06	21	41	3	45	P	3	1	1	P	P			4	13		1			7		12	3	35		13	P	5		7		11	3					3	P	P	P	P	P		3	P	3		17	
2016	06	27	43	8	43		6	P	3	P	1			9	10		1			6	P	23	1	34		18	P	4	1	3		8		1					P	P		1	P		5	P	P		15	1
2016	07	29	40	8	39		3	P	3	P	P			11	10	P				4	1	28	3	29		11	P	3		1		3						1	P	P			P		5	P	3		1	15
2017	06	27	42	6	32		9	3	1	P	3			13	10	1	P			4		29	6	21	1	14		4	4	5	4	4	P					1			P			P	P	3	P	P		13	1

*P = Present—Observed but not collected on the sampling rake

July 29, 2016, data collected by the Lake Elmo Association

Table 24 Silver Lake acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 62.000100)

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/25/2017	30.43	69.78	43.61

Table 25 Simpson Diversity Index Values for Silver Lake, Ramsey County, MN (DOW 62.000100)

Year	Month	Day	Diversity
2017	June	25	0.82

Table 26 MNDNR Plant IBI: Silver Lake, Ramsey County, MN (DOW 62.000100)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Silver Lake Species Richness**	Percent Difference between MNDNR Criterion and Silver Lake Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Silver Lake FQI**	Percent Difference between MNDNR Criterion and Silver Lake FQI	Does Silver Lake Meet MNDNR Plant IBI Criteria?
2006	June	7	≥12	19	58	≥18.6	25.7	38	Yes
2006	July	27	≥12	15	25	≥18.6	22.0	18	Yes
2007	June	11	≥12	13	8	≥18.6	19.4	4	Yes
2007	August	13	≥12	12	0	≥18.6	18.5	-1	No
2008	June	23	≥12	9	-25	≥18.6	16.7	-10	No
2008	August	24	≥12	7	-42	≥18.6	15.1	-19	No
2009	June	2	≥12	10	-17	≥18.6	12.4	-33	No
2009	August	9	≥12	8	-33	≥18.6	13.8	-26	No
2010	June	16	≥12	7	-42	≥18.6	12.1	-35	No
2010	August	6	≥12	9	-25	≥18.6	14.0	-25	No
2011	August	1	≥12	11	-8	≥18.6	16.6	-11	No
2012	July	20	≥12	8	-33	≥18.6	14.1	-24	No
2013	August	13	≥12	13	8	≥18.6	18.6	0	Yes
2014	August	5	≥12	11	-8	≥18.6	15.7	-16	No
2015	August	20	≥12	14	17	≥18.6	19.0	2	Yes
2016	August	16	≥12	11	-8	≥18.6	16.0	-14	No
2017	June	25	≥12	20	67	≥18.6	23.9	29	Yes

* Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)
**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

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Table 27 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Silver Lake, Washington County, MN (DOW 62.000100)

Year	Month	Day	Surveyor	*Ceratophyllum demersum*	*Elodea canadensis*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Ranunculus sp.*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton praelongus*	*Potamogeton pusillus*	*Potamogeton nodosus*	*Potamogeton richardsonii*	*Potamogeton robbinsii*	*Potamogeton sp.*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas sp.*	*Stuckenia pectinata*	Chara sp.	*Nitella*	*Chara and Nitella*	*Nymphaea odorata*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Filamentous algae	*Eleocharis acicularis*	*Eleocharis sp.*	*Iris virginica*	*Phalaris arundinacea*	*Typha angustifolia*	*Typha sp.*
				Submersed	Submersed	Submersed	Submersed	Submersed		Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Free-float	Free-float	Free-float	Free-float	Free-float	Algae	Emergent		Emergent	Emergent	Emergent	Emergent
				Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot		Monocot		Monocot	Monocot	Monocot	Monocot
				Native	Native	**Non-Native**	Native	Native		Native	Native	**Non-Native**	Native	Native	Native	Native			Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native		Native	**Non-Native**	**Non-Native**		Native
2006	06	7	VBWD	98	51	69	3		6	10	13	21		1			1	1	1	22	27			1	2		3		14					1				
2006	07	27	VBWD	97	41	43	10		1	13	10	1						1		1	29			3	1		2		9									
2007	06	11	Fortin	81	56	48	3				6	2							12		11				1		2	1	28									1
2007	08	13	Fortin	96	32	8						1							5		7								34									
2008	6	23	U of M	54	17					1				1							1			4			3		14				1					
2008	8	24	U of M	11	12					2	1			3							1			3			5		5				3					
2009	6	2	U of M	3	29					2		1												26	1		4	1	1				1					1
2009	8	9	U of M	1	44	1				6				1							1			40			8	1					3					1
2010	6	16	MnDNR		22	6		1			1	62											9	55														
2010	8	6	MnDNR	3	25	16				4	1	1			2								3	34														
2011	8	1	MnDNR	2	13	43	4			3		6	10	2									2	21			6											3
2012	7	20	MnDNR		4	71	9					8	1	1									1	24			3											1
2013	8	13	MnDNR	12	2	13	23					3	2	1							2		2	2	37		9						2					

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Year	Month	Day	Surveyor	*Ceratophyllum demersum*	*Elodea canadensis*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Ranunculus sp.*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton praelongus*	*Potamogeton pusillus*	*Potamogeton nodosus*	*Potamogeton richardsonii*	*Potamogeton robbinsii*	*Potamogeton sp.*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas sp.*	*Stuckenia pectinata*	Chara sp.	*Nitella*	*Chara and Nitella*	*Nymphaea odorata*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Filamentous algae	*Eleocharis acicularis*	*Eleocharis sp.*	*Iris virginica*	*Phalaris arundinacea*	*Typha angustifolia*	*Typha sp.*
				Submersed	Submersed	Submersed	Submersed	Submersed		Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Free-float	Free-float	Free-float	Free-float	Algae	Emergent		Emergent	Emergent	Emergent	Emergent
				Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			**Dicot**	Monocot	Monocot	Monocot	Monocot		Monocot		Monocot	Monocot	Monocot	Monocot
				Native	Native	**Non-Native**	Native	Native		Native	Native	**Non-Native**	Native	Native	Native	Native			Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native		Native		Native	**Non-Native**	**Non-Native**	
				Ceratophyllum demersum	*Elodea canadensis*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Ranunculus sp.*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton praelongus*	*Potamogeton pusillus*	*Potamogeton nodosus*	*Potamogeton richardsonii*	*Potamogeton robbinsii*	*Potamogeton sp.*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas sp.*	*Stuckenia pectinata*	Chara sp.	*Nitella*	*Chara and Nitella*	*Nymphaea odorata*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Filamentous algae	*Eleocharis acicularis*	*Eleocharis sp.*	*Iris virginica*	*Phalaris arundinacea*	*Typha angustifolia*	*Typha sp.*
2014	8	5	MnDNR	24	2	71				1		44			15						5	5			50		6					1					
2015	8	20	MnDNR	38	2	8	1	1		7		2	6							1		5				46	8					1					
2016	8	9	MnDNR	50	3	21				4		18		1								9	3			32	9					2					
2017	06	25	VBWD	26	3	31		P		P		32	P	P	1	P				1	1		P	40			5	4	1	3	2	29	2		P	P	1	

*P = Present—Observed but not collected on the sampling rake

Description of Figures

- **Figures 1, 2, 4, 6, 8, 9, and 10** show EWM extent in Long Lake, Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake in June of 2017.
- **Figures 3, 5, and 7** show the 2017 herbicide treatment areas for Lake DeMontreville, Lake Olson, and Lake Jane.
- **Figure 11** shows the 2006-2017 Eurasian Watermilfoil Frequency of Occurrence in the Vegetated Depth Range of Plants in Silver Lake.

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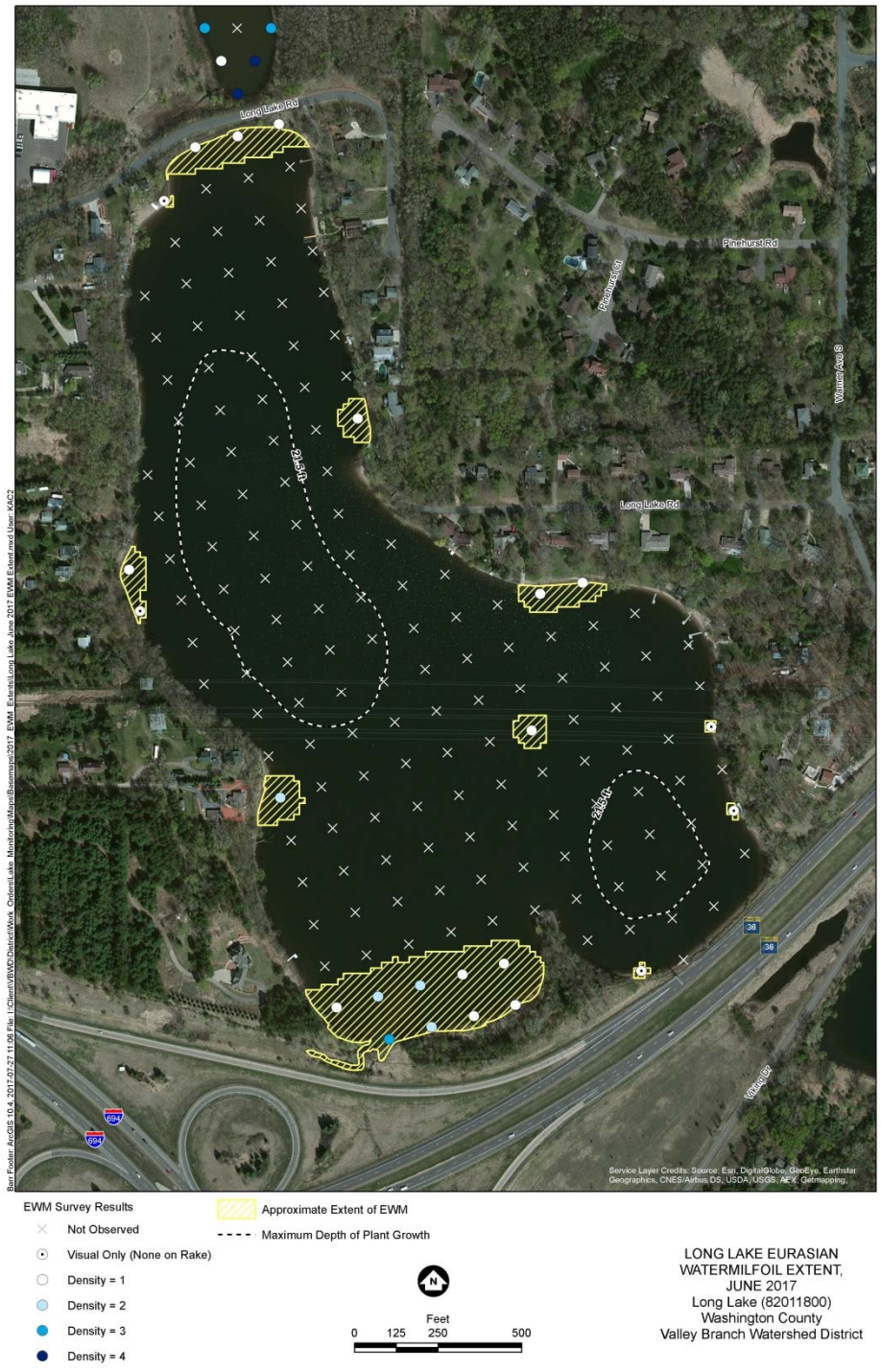

Figure 1 2017 Long Lake Eurasian Watermilfoil Extent

Figure 2 2017 Long Lake-Katherine Abbott Pond Eurasian Watermilfoil Extent

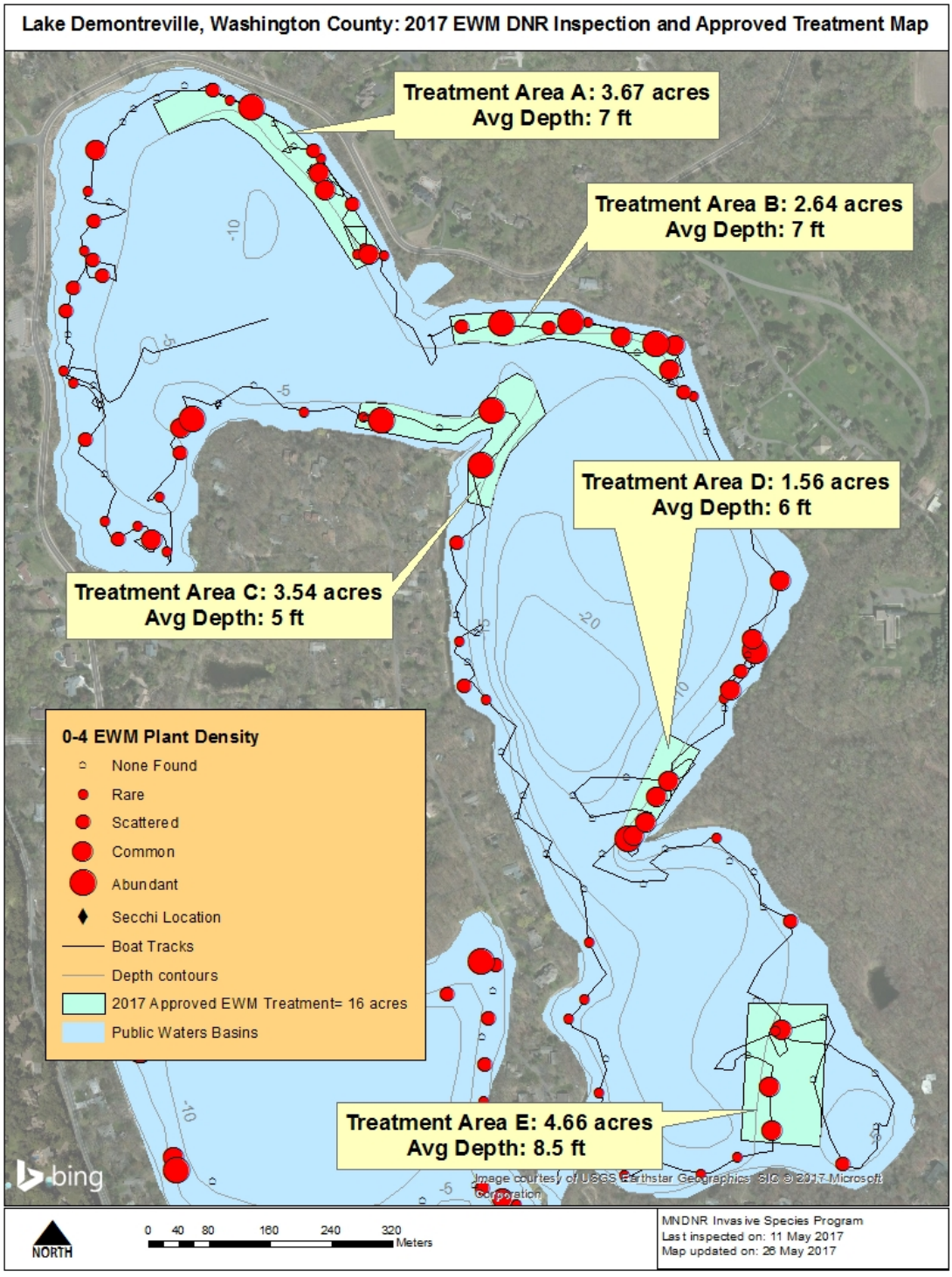

Figure 3 2017 Lake DeMontreville Eurasian Watermilfoil Treatment Areas (Map Prepared by Minnesota Department of Natural Resources)

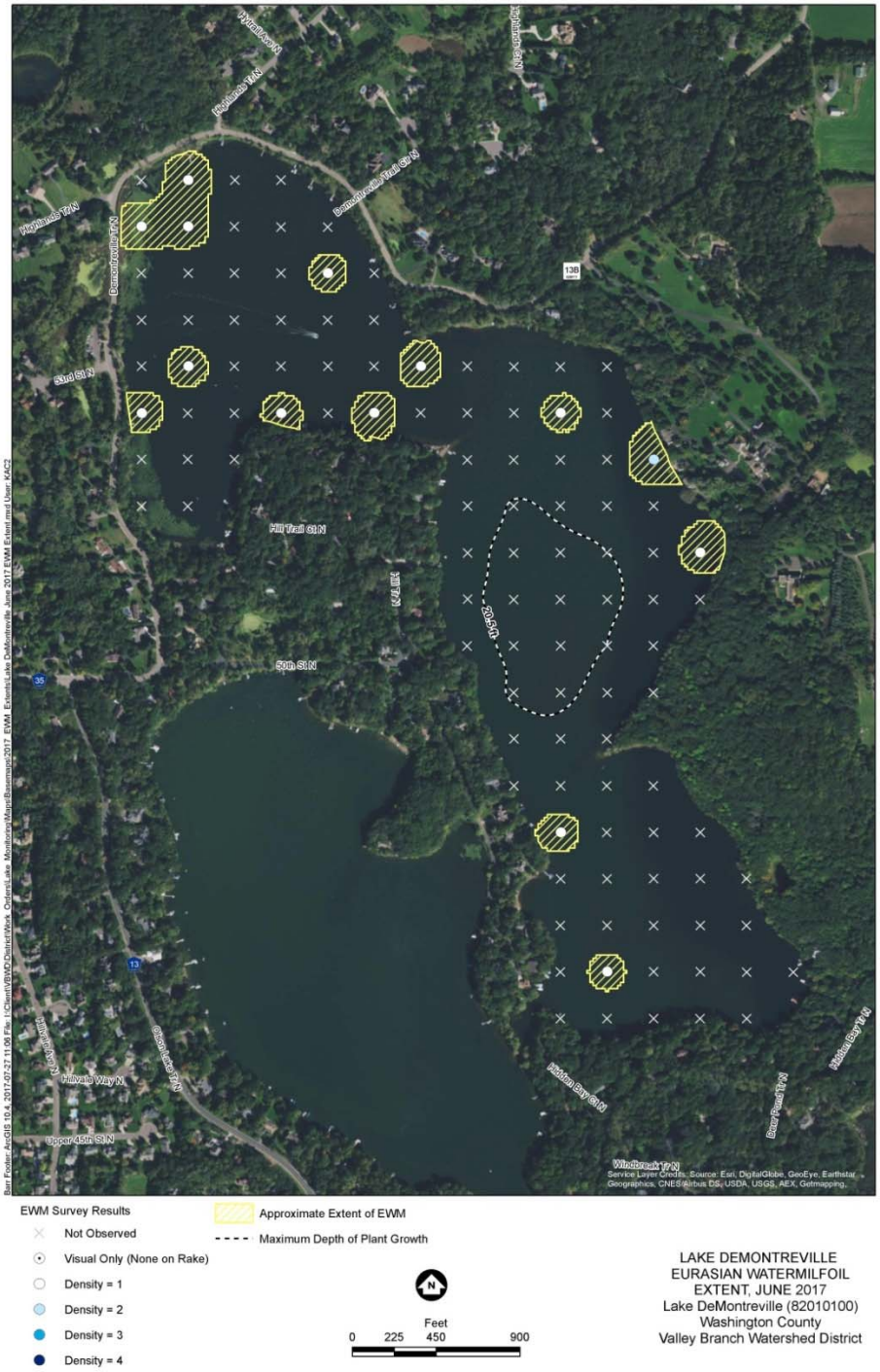

Figure 4 June 2017 Lake DeMontreville Eurasian Watermilfoil Extent

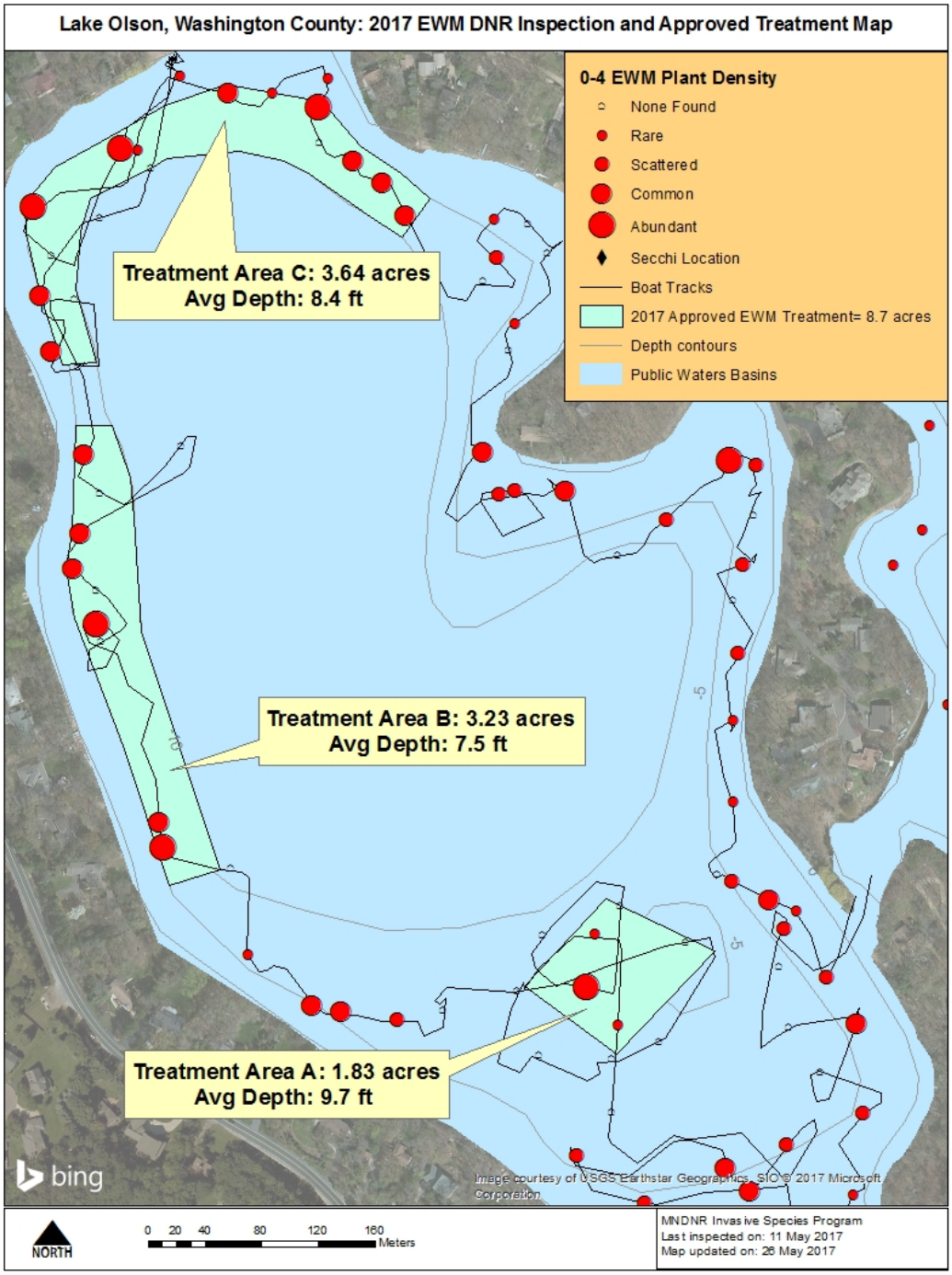

Figure 5 2017 Lake Olson Eurasian Watermilfoil Treatment Areas (Map Prepared by Minnesota Department of Natural Resources)

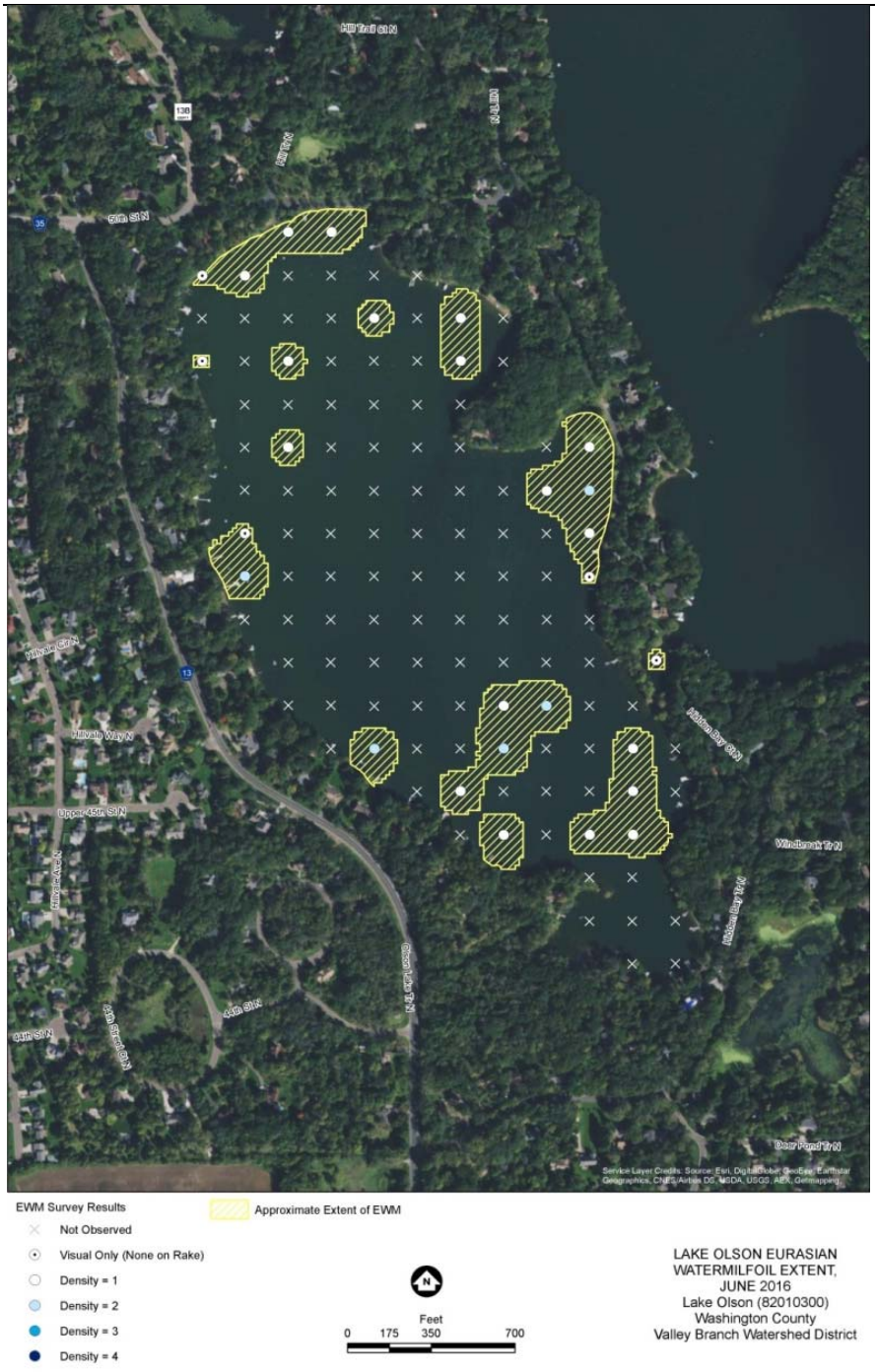

Figure 6 June 2017 Lake Olson Eurasian Watermilfoil Extent

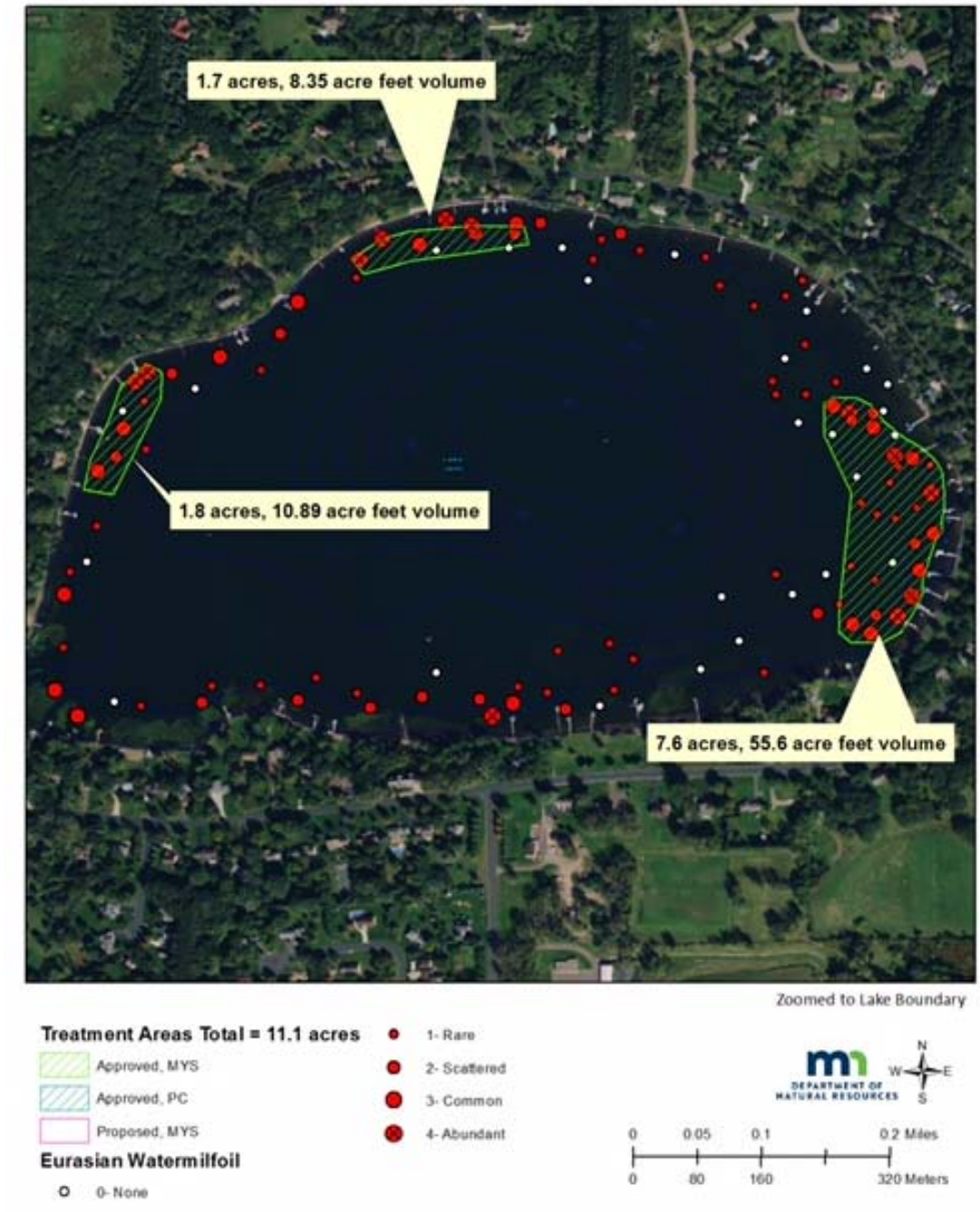

Figure 7 2017 Lake Jane Eurasian Watermilfoil Treatment Areas (Map Prepared by Minnesota Department of Natural Resources)

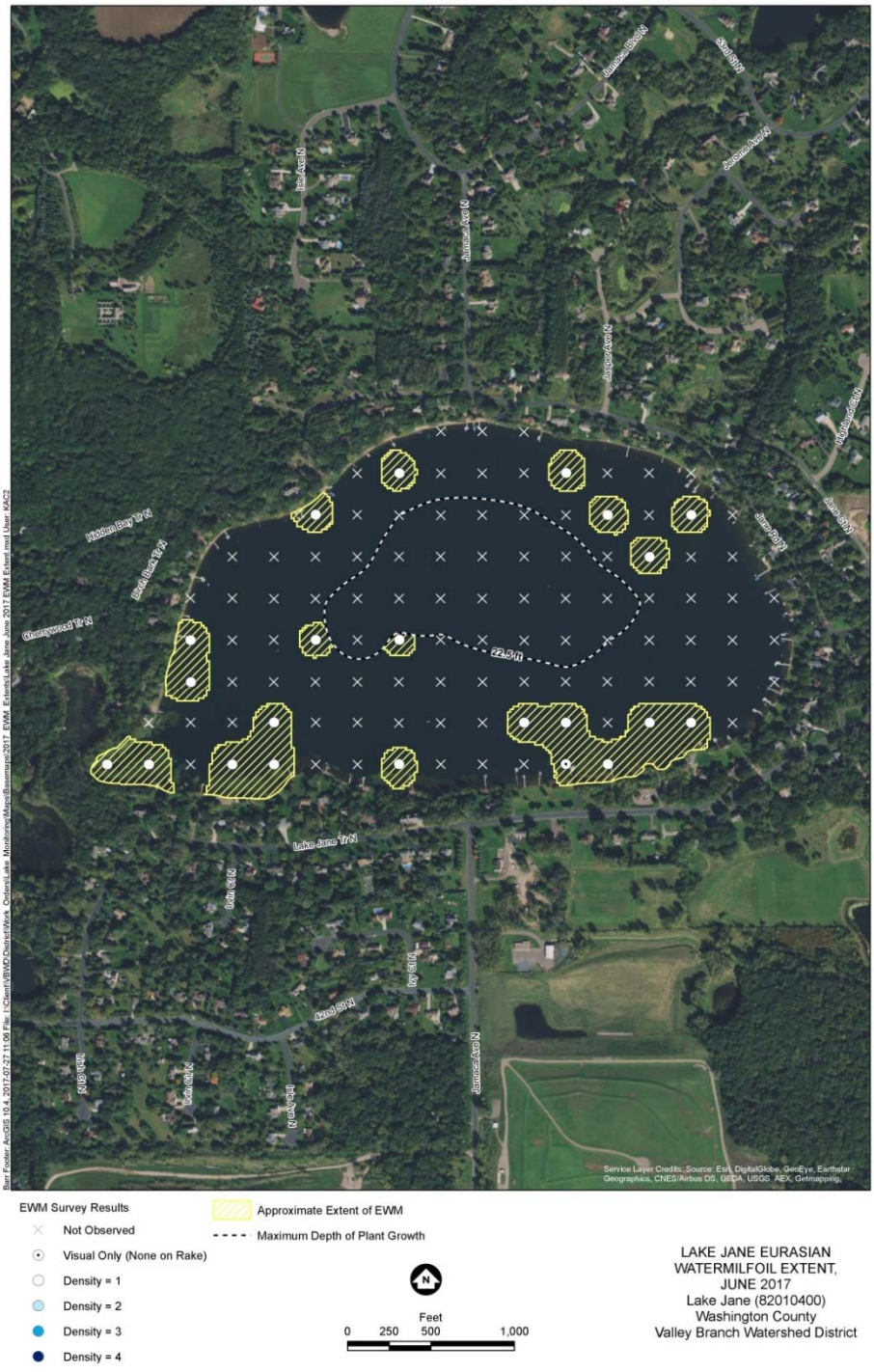

Figure 8 June 2017 Lake Jane Eurasian Watermilfoil Extent

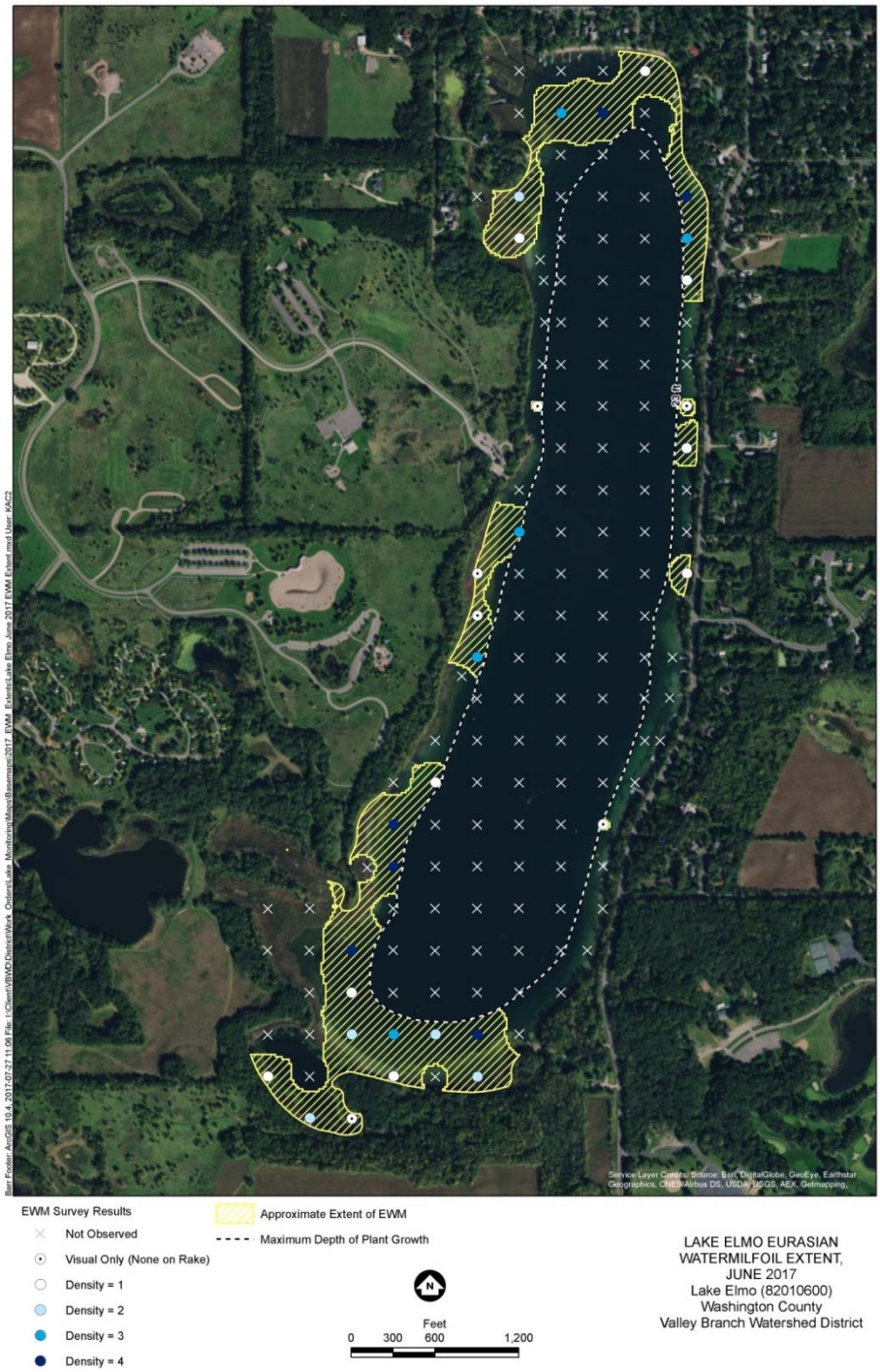

Figure 9 June 2017 Lake Elmo Eurasian Watermilfoil Extent

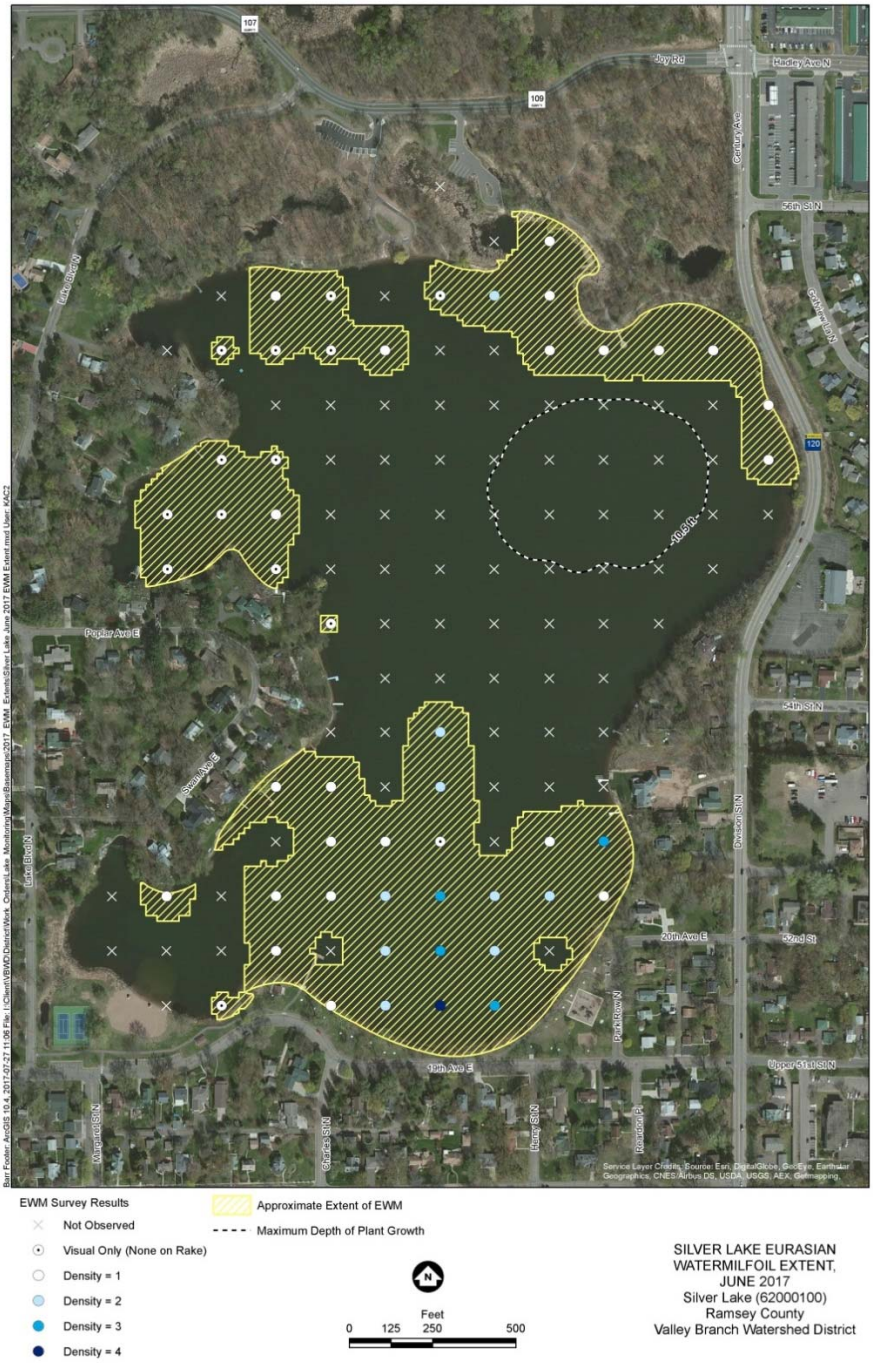

Figure 10 June 2017 Silver Lake Eurasian Watermilfoil Extent

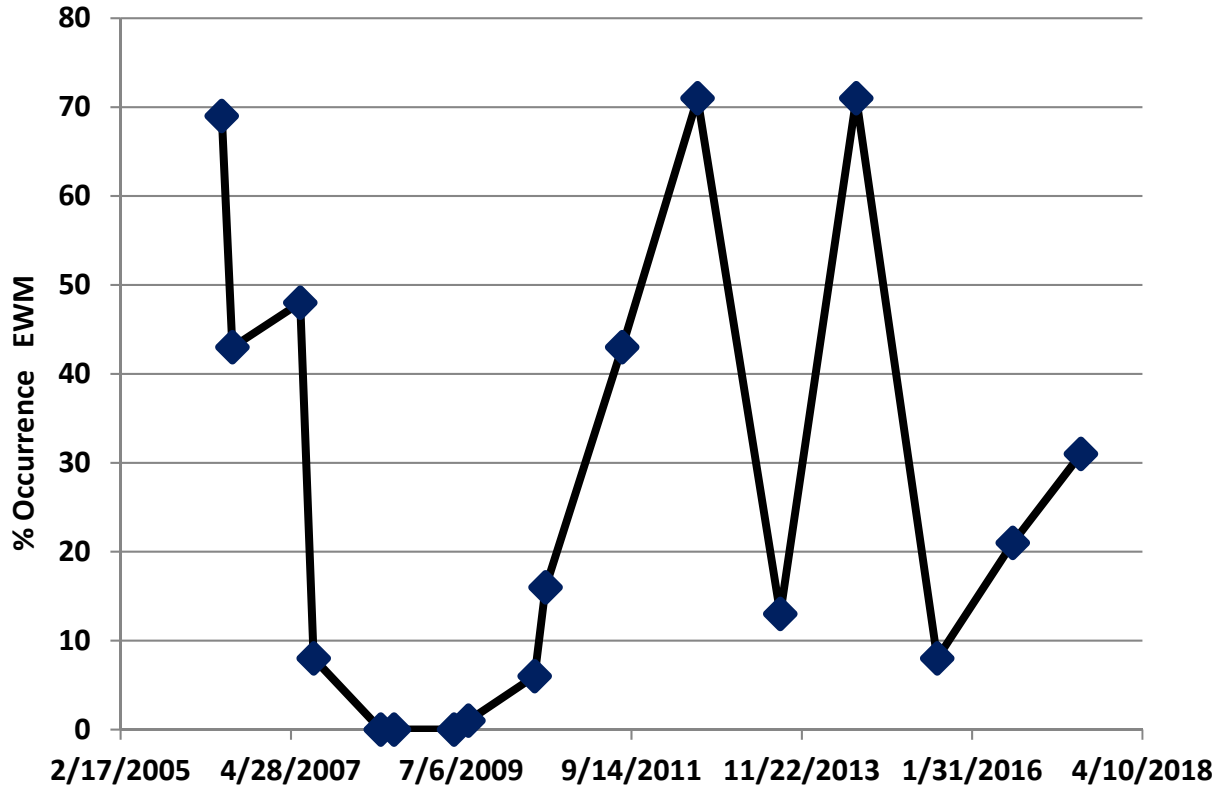

Figure 11 2006-2017 Eurasian Watermilfoil Frequency of Occurrence in Vegetated Depth Range of Plants in Silver Lake