VLAWMO

VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION

# Deep Lake Review, Ramsey County, MN

2024


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# 1 INTRODUCTION

## 1.1 INTRODUCTION

Deep Lake is located in the City of North Oaks, Ramsey County, and lies in the Vadnais Lake Area Water Management Organization (VLAWMO) watershed area. Deep Lake is 91 acres and has an average depth of 2 feet. Deep Lake's historic maximum depth is 11 feet. However, the 2018 bathymetry survey only detected a maximum depth of 6.8 feet. The lake has no public access. It is surrounded by private, low-density residential development, with no curb-and-gutter storm sewer system, resulting in low runoff into Deep Lake.

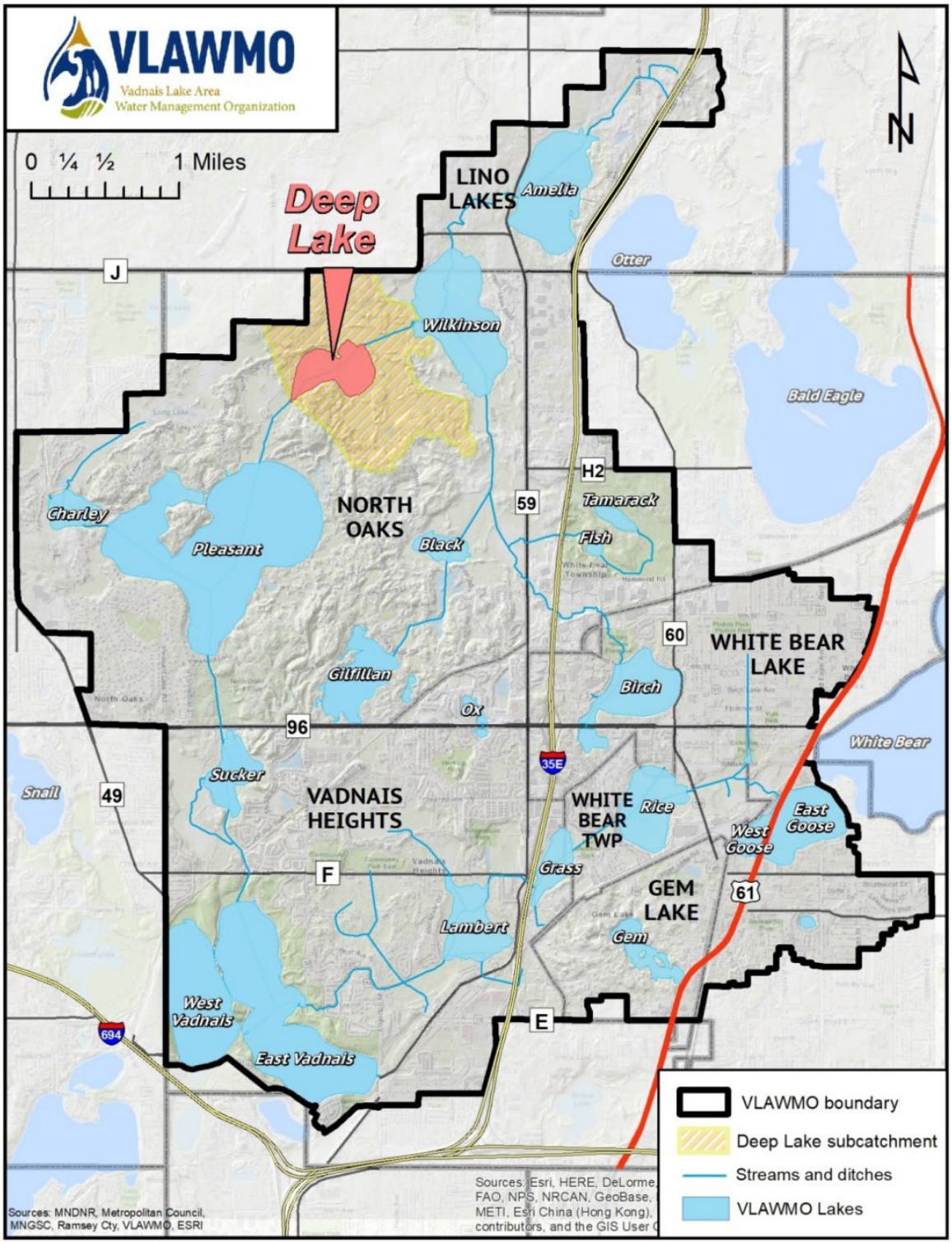
Deep Lake is in the middle of the North Oaks chain of lakes. This area drains roughly two-thirds of the watershed area of VLAWMO. Deep Lake is part of the St. Paul Regional Water Service (SPRWS) Centerville System that has not been utilized since 1992. The system used to provide water from Centerville Lake for St. Paul drinking water. Use of the Centerville System was discontinued because of poor water quality in Centerville Lake, aging infrastructure in the conduit network that was originally built in 1894 and reconstructed in 1907, and inadequate water availability to meet demand without large fluctuations in levels in Centerville Lake. A feasibility report was undertaken by the SPRWS to consider possible improvements and reutilization of the Centerville System in 2018. More information about that work can be found in the full report: Saint Paul Regional Water Service Centerville System Assessment (October 2018).

The North Oaks chain of lakes are utilized and largely managed by the St. Paul Regional Water Service (SPRWS) to move water from the Mississippi River to the McCarrons treatment facility where it is used as drinking water. On average, 20-25 million gallons of water is pumped each day into the system from the Mississippi River by the SPRWS to service over 430,000 customers. The amount of water pumped into the system varies according to seasonal demand. Although the Deep Lake Conduit is no longer is use, the Charley-Pleasant-Sucker-Vadnais chain of lakes are connected to Deep Lake. It is possible for backflow to enter Deep Lake. Dependent upon pumping rates from the St. Paul Regional Water Services (SPRWS), water can be inflowing to Deep Lake from Pleasant Lake through Deep Lake Channel, or outflowing south through the Channel and into Pleasant Lake. Any control efforts considered for Deep Lake need to include consideration for continual pumping of Mississippi River water and connection among the lakes.

Landscape characteristics and management actions play a role in the health of a water body. For a majority of lakes, water quality is affected mostly by the watershed surrounding the lake, but Deep Lake is unique in that most water input into the basin is dependent upon pumping rates. The Lake typically receives water from Wilkinson Lake upstream and exits the Lake south through Deep Lake Channel and flows downstream to Pleasant Lake. Due to fluctuating water levels that depend on SPRWS pumping rates, shoreline erosion tends to be a more unique issue on the North Oaks Chain of Lakes than would normally occur on most inland lakes. Restoration of Deep Lake Channel took place in fall 2015 to restore and stabilize areas that were affected by erosion. This presents a unique issue, but shoreline erosion and disturbances are being mitigated through numerous on-going shoreline restoration and stabilization projects.

*Deep Lake Channel Restoration, September 16th, 2015*

*Figure 1: Map of VLAWMO*



# 2 WATERSHED FEATURES

## 2.1 HISTORY

### *AERIAL PHOTO HISTORY*

*Figure 2: 1940 aerial photo of Deep Lake*

In 1940, residential development had not yet begun in the area. However, hydrology and hydraulics had been modified by the St. Paul Water Department in the late 1800s to provide water from Centerville Lake for St. Paul drinking water.

*Figure 3: 1953 aerial photo of Deep Lake*

In 1953, North Oaks was soon to be developed. In areas south and west of Deep Lake, most of the original James J. Hill farm and barn structures still existed. Trails and paths primarily used by the water utility are visible around Deep Lake.

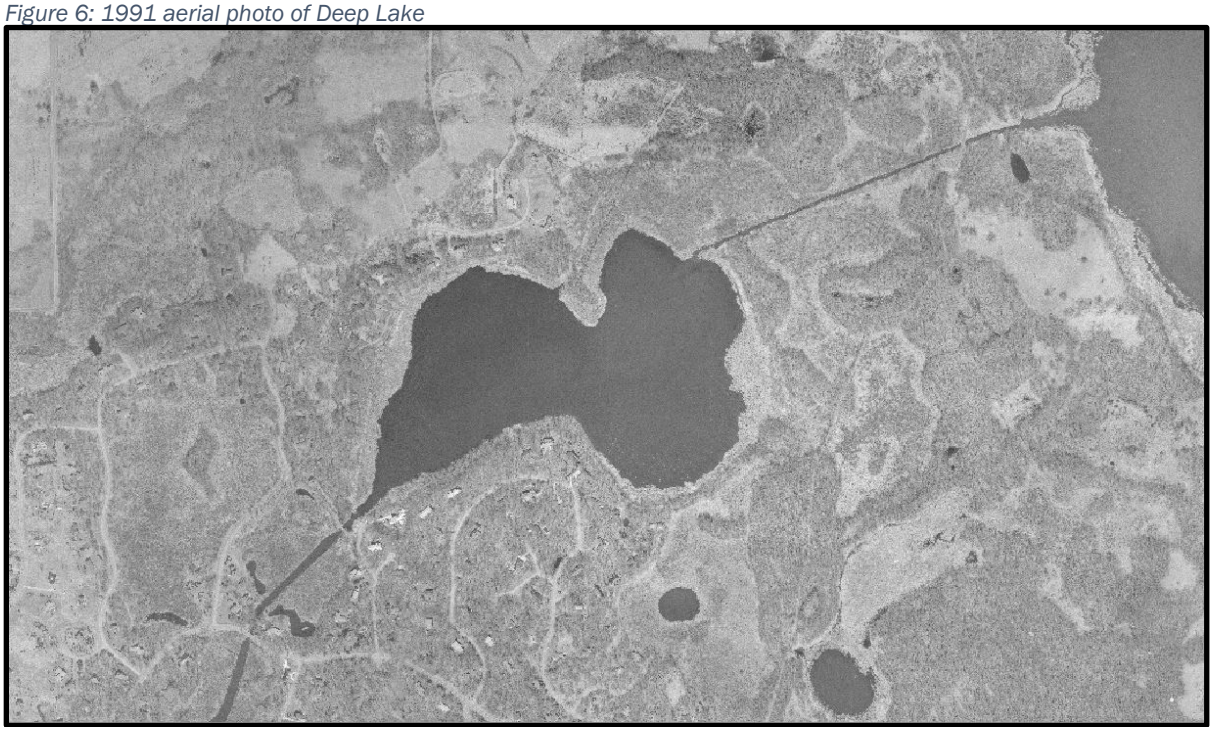
*Figure 4: 1974 aerial photo of Deep Lake*

In 1974, residential development of North Oaks is visible. Homes are present on the south shore of the lake. Development has begun on the south and west areas of the lake.

*Figure 5: 1985 aerial photo of Deep Lake*

In 1985, residential development is present to the south and west of the lake. New development is underway on the north shore.

*Figure 6: 1991 aerial photo of Deep Lake*



In 1991, the first-phase residential development is complete around the lake and in the subwatershed.

*Figure 7: 2006 aerial photo of Deep Lake*

In 2006, a few more houses are present in the north neighborhood of Deep Lake. It is not visible in this image, but the nearby Rapp Farm residential development has begun.

*Figure 8: 2009 aerial photo of Deep Lake*

In 2009, little has changed since the 2006 aerial.

*Figure 9: 2011 aerial photo of Deep Lake*

In 2011, little has changed since the 2009 aerial.

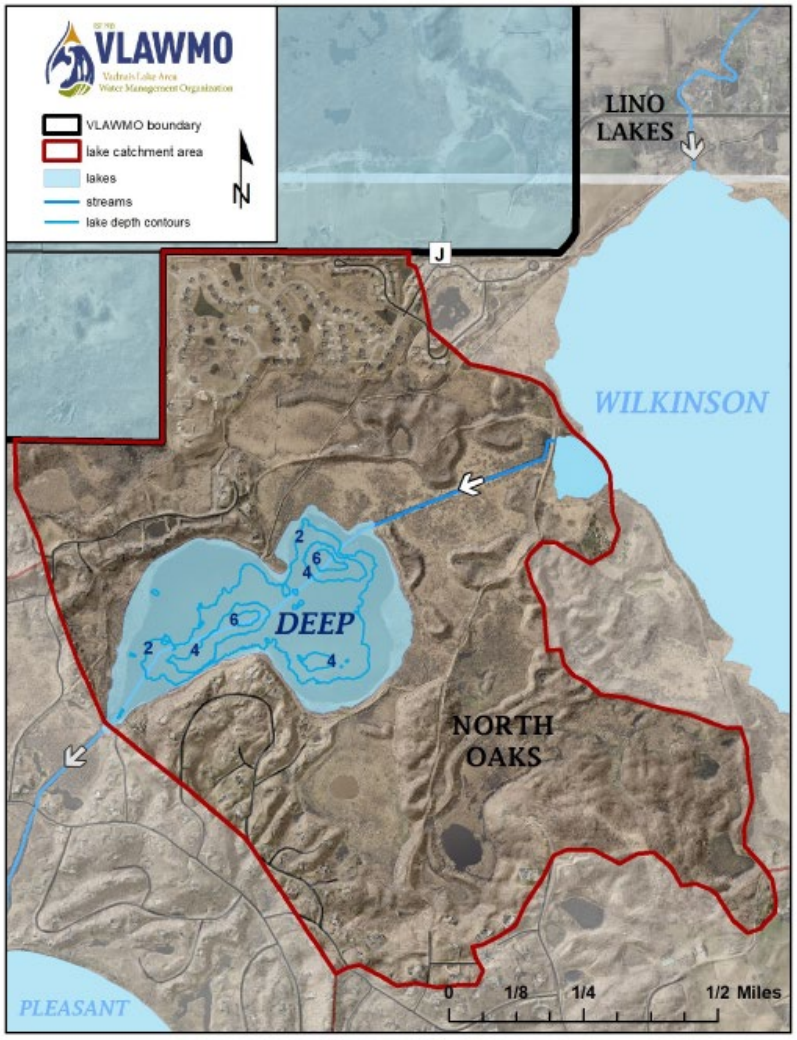
*Figure 10: 2015 aerial photo of Deep Lake*

In 2015, the Rapp Farm development has expanded to its furthest southern extent and is visible in the central top section of the aerial. The Rapp Farm development does not directly contribute runoff into Deep Lake, but it does lie within the lake's subwatershed area.

## 2.2 DEEP LAKE DRAINAGE AREA

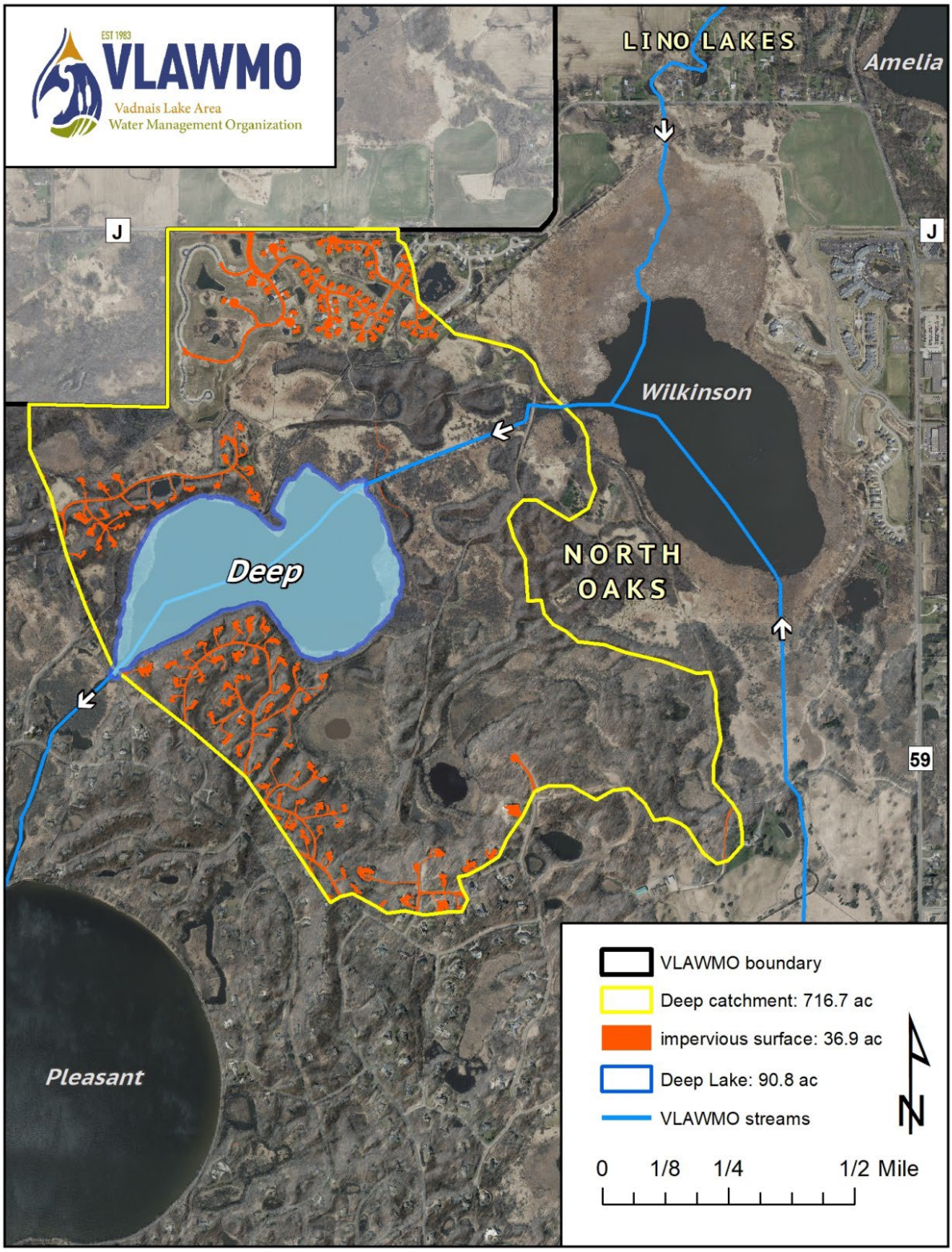
Deep Lake receives direct inflow via Deep Lake Channel that flows west from Wilkinson Lake. The subwatershed drainage area surrounding the Lake is comprised of an area of 695 acres; Deep Lake itself is nearly 91 acres. A **subwatershed** is an area of land that drains locally to a central location.

Figure 11: Deep Lake Drainage Area




Deep Lake is bordered by low-density residential housing on the north, west, and southern shores. Most of these houses are fairly larger, single-family homes, with large yards and mixed open space. These yards, combined with streets that do not have curb and gutter, result in low direct stormwater runoff from development into the basin. In the northernmost part of the Deep Lake drainage, the Rapp Farm neighborhood was developed in the late 2000s. Part of this development is in the Wilkinson Lake drainage; most is in the Deep Lake drainage. Rapp Farm is composed of low-density, more traditional homes, with curb and gutter that drains into stormwater treatment ponds and includes emergency overflows into surrounding wetlands. Due to distance, buffering, and pretreatment, very little stormwater from this neighborhood flows into Deep Lake. The east shore of Deep Lake consists primarily of an undisturbed conservation easement with the Minnesota Land Trust that is managed by the North Oaks Company.

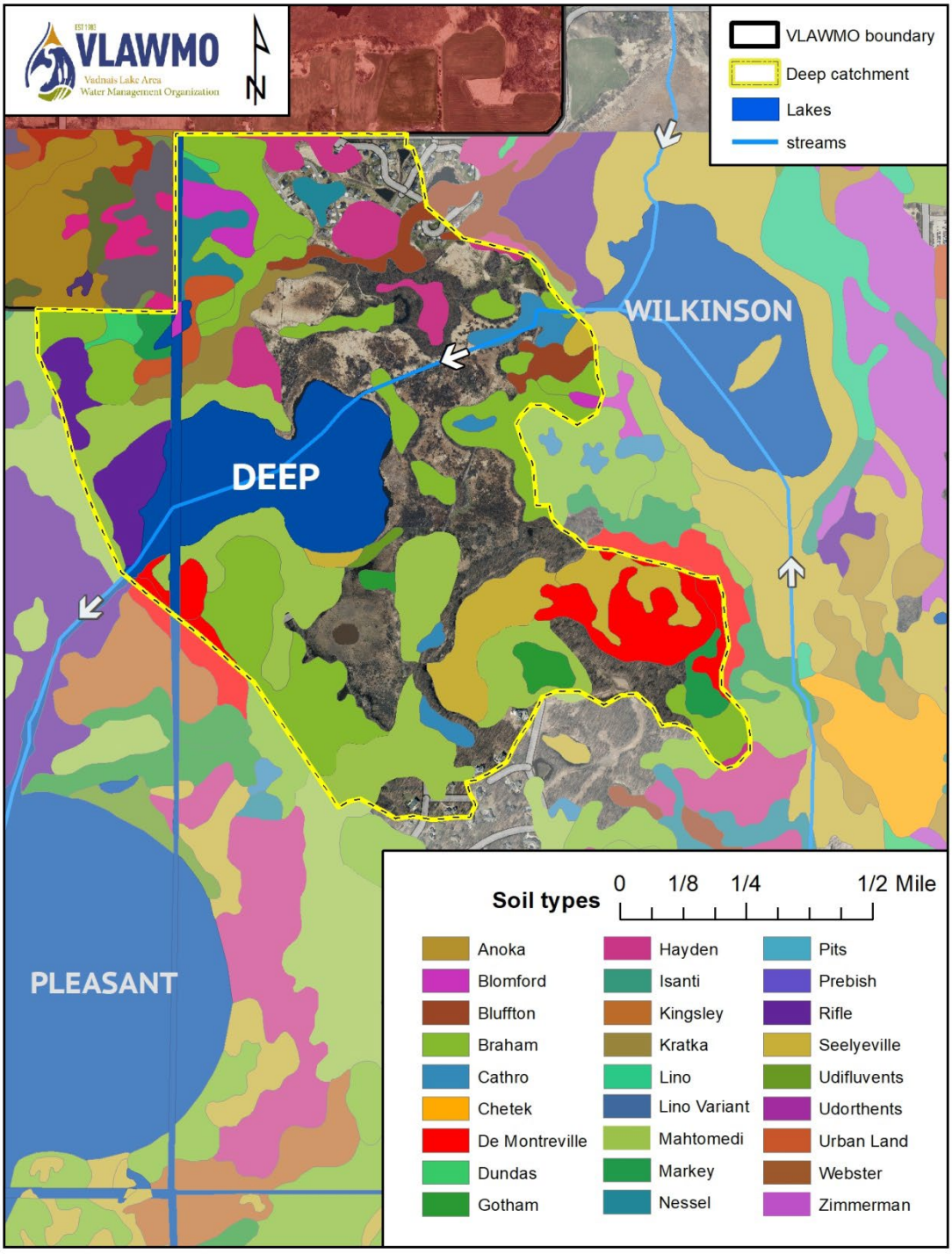
*Figure 11: Impervious Surfaces in the Deep Lake Drainage*



## 2.3 DEEP LAKE SOILS

Compared to other lake subwatershed areas in VLAWMO, Deep Lake has a lower diversity of soil types in its drainage. The majority of these soils are combinations of fine sands and loams, which are fairly well-drained. The soils in wetlands around Deep are thicker, poorly drained, mucky soils, which are common in wetlands and bogs.

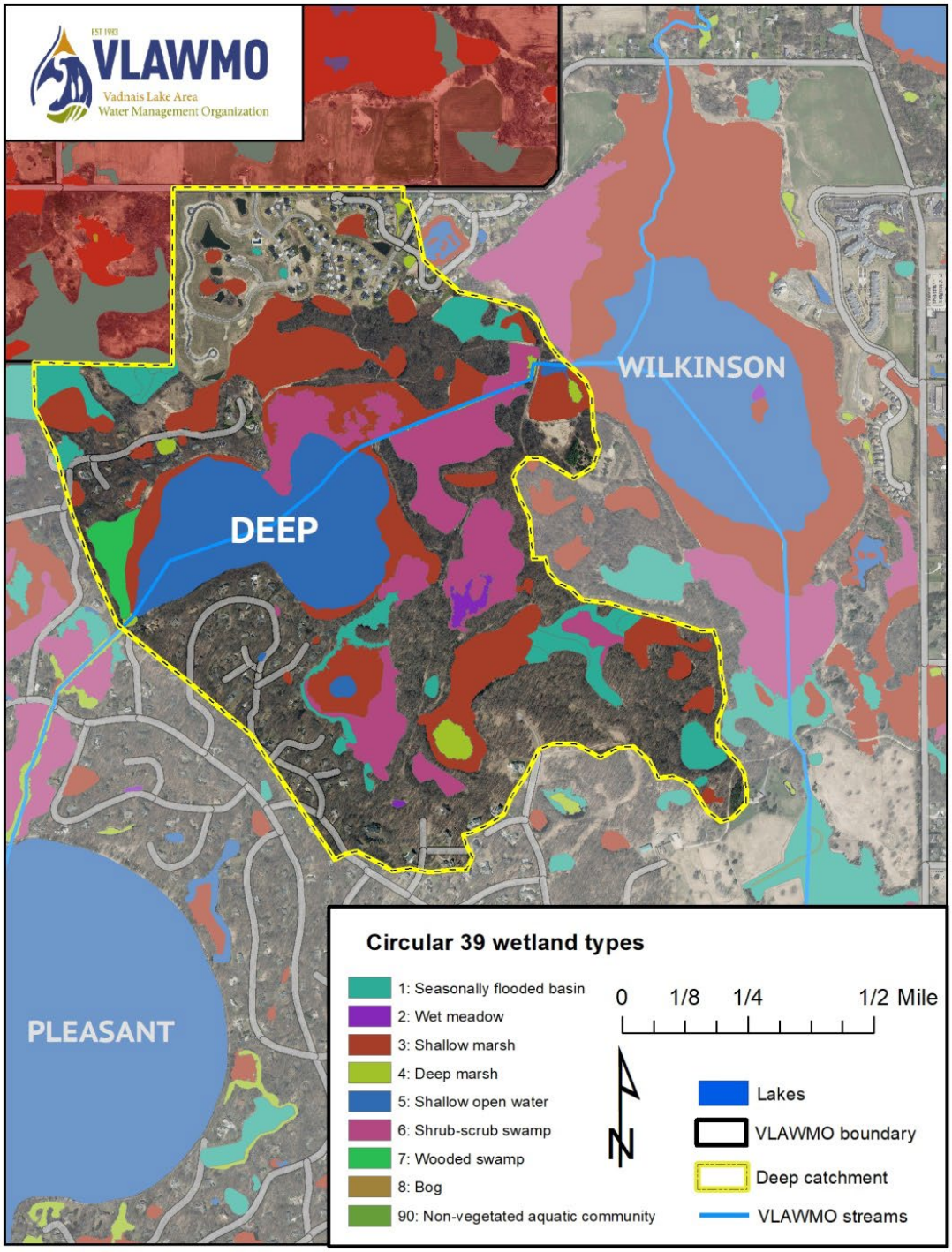
*Figure 12: Deep Lake Drainage Soils*



## 2.4 DEEP LAKE WETLANDS

As a shallow lake, Deep has many surrounding wetlands along with shallow marsh (type 3) and shrub-scrub (type 6) wetland fringes. The surrounding area is also a majority of type 3 and type 6 wetlands with sparse seasonally flooded basins and wet meadows.

*Figure 13: Deep Lake Drainage Wetlands*



# 2 WATERSHED FEATURES

About 2/3 of the shoreline of Deep Lake is classified as Northern Mixed Cattail Marsh (MRn83) (Figure 15), (MN DNR, 2014). The remaining 1/3 of the shoreline is in the more developed and higher-elevation southern/southwestern perimeter of the lake. Wetlands in the Deep Lake Drainage are less disturbed than would typically be found in other developed areas because of the low-density development. Deep Lake wetlands provide habitat for native wildlife.

Within the US Fish & Wildlife Service's National Wetland Inventory (Cowardin Classification System), there are three predominant classifications around Deep Lake: PEM1C, PEM1F, and PSS1C, which correspond to Shallow Marsh and Shrub Wetland (Figure 16). PEM1C and PEM1F refer to palustrine, emergent, persistent marshes that are seasonally flooded (1C) or semi-permanently flooded (1F), whereas PSS1C is identified as a palustrine scrub-shrub, broad-leaved deciduous wetland that is seasonally flooded. PEM1C covers the northwest shoreline, PSS1C covers the northern shoreline to the east, and PEM1F covers the eastern and southeast shoreline. These three areas that immediately border the lake add up to 26.24 acres, or 106,190 square meters.

More detailed information is included in the Deep Lake Shoreline Vegetation Survey included in the Appendix.

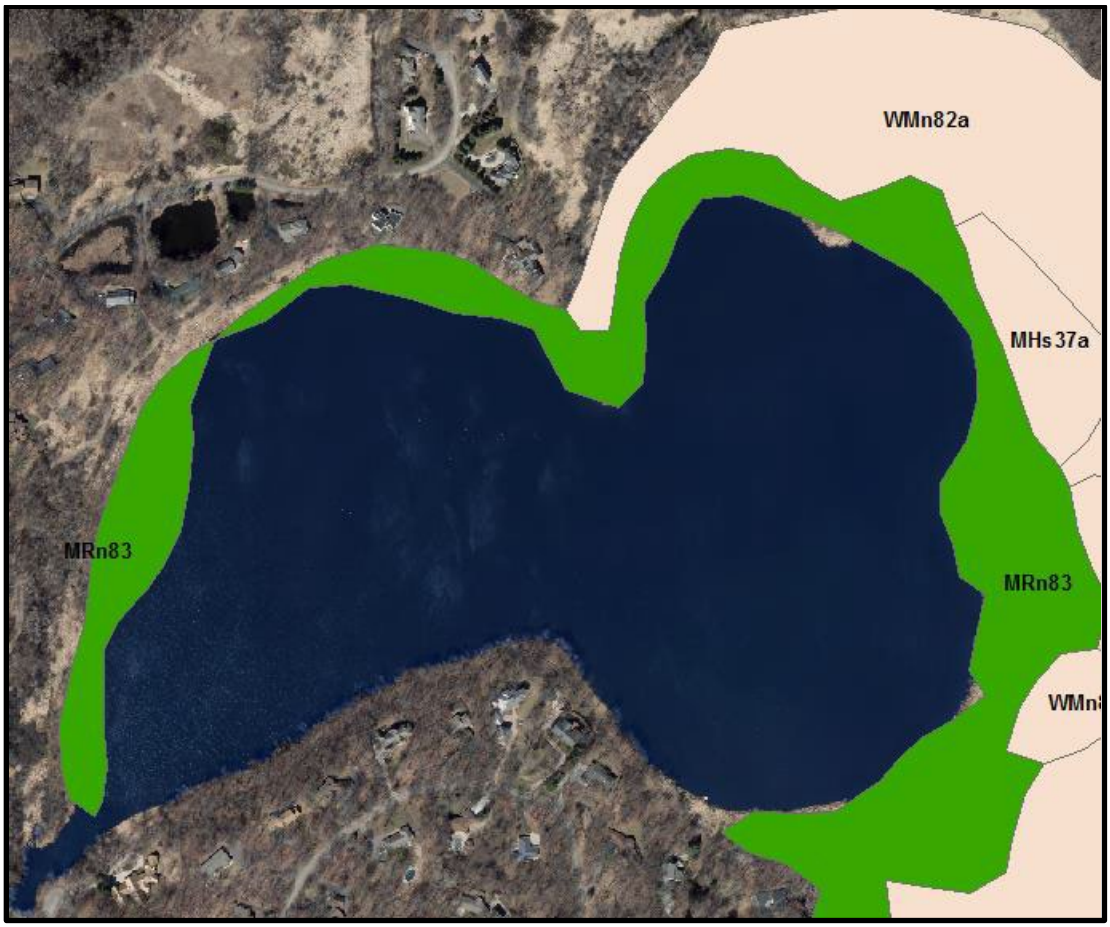



Figure 15: Deep Lake Shoreline Classification by Native Plant Community (left) as MRn83, or Northern Mixed Cattail Marsh, (Source: MNDNR Native Plant Community shapefile)

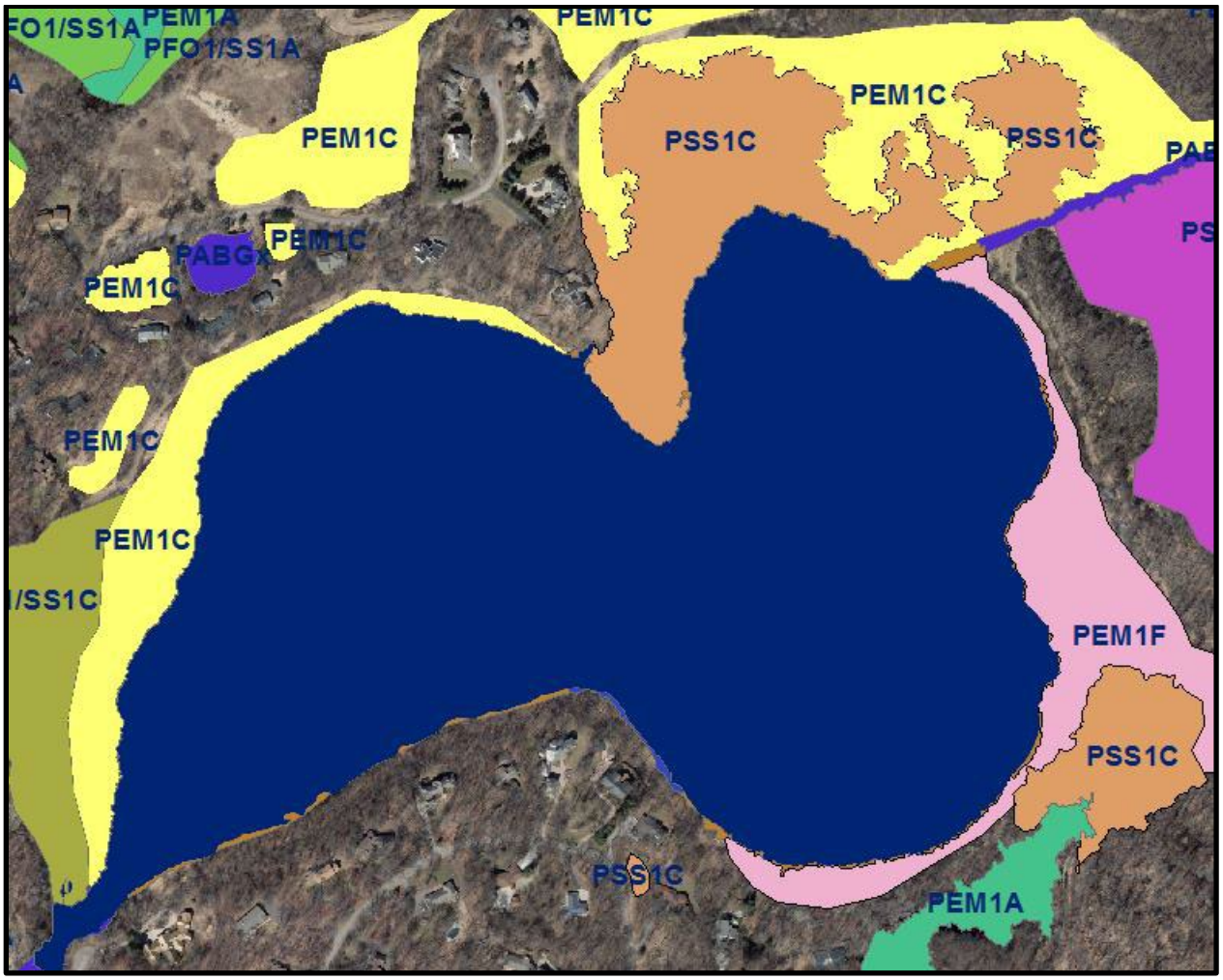


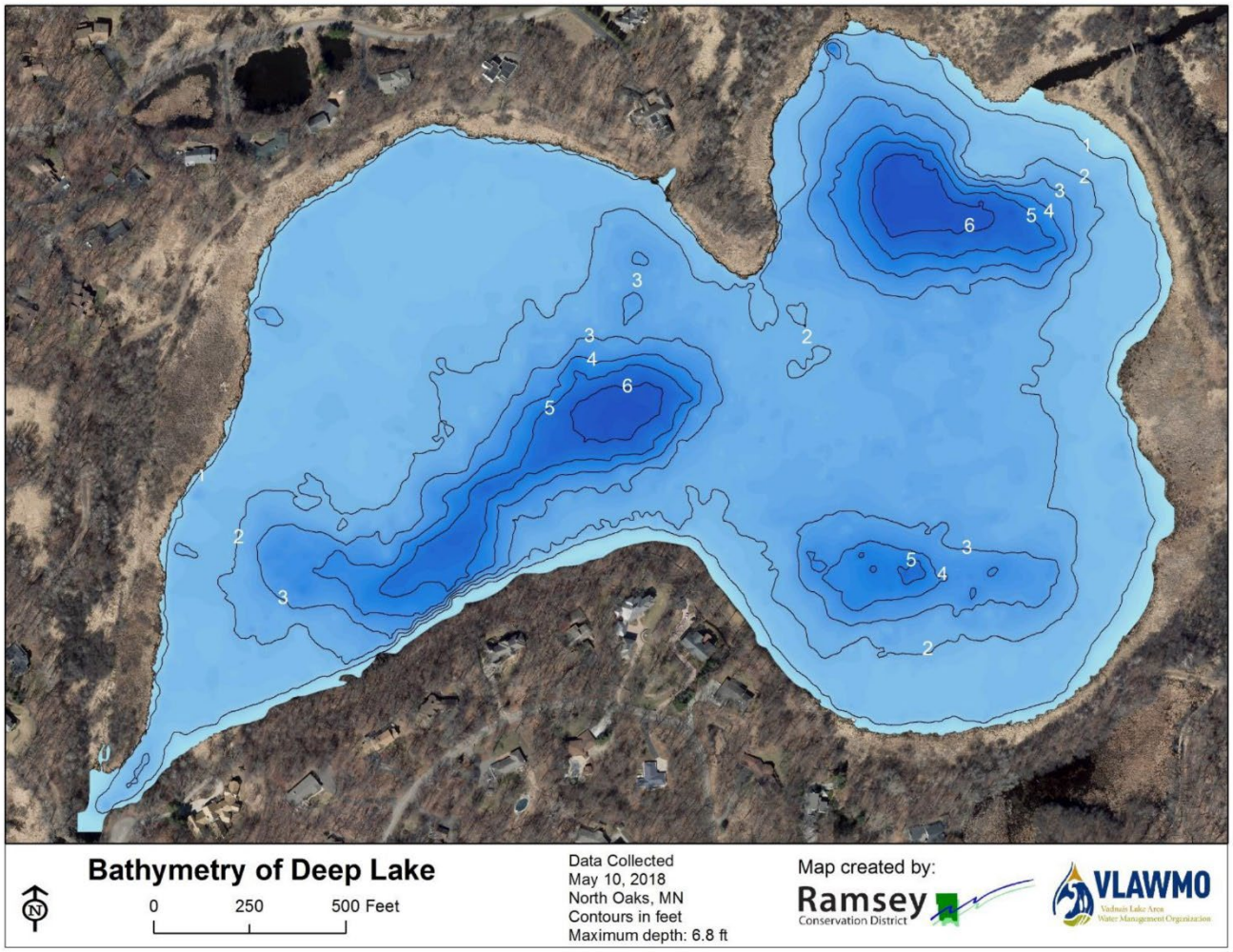

Figure 16: Deep Lake Shoreline Wetland Classification by National Wetland Inventory as three major wetland types: PEM1C, PEM1F, and PSS1C (Source: Wetlands_NWI2010 shapefile from Ramsey County).

# 3 LAKE FEATURES

## 3.1 DEEP LAKE DEPTH

A bathymetry survey was completed by Ramsey Conservation District (now Ramsey Soil and Water Conservation) in May 2018 to develop a map of the bottom of Deep Lake and determine depths. Deep Lake has a maximum depth of 6 feet. It generally follows a typical lake bottom shape, with shallower areas along the outer portions of the lake and deeper sections towards the middle. Deep Lake has 3 deeper pockets, 1 in each of the 3 lobes of the lake.

*Figure 14: Deep Lake Depth Map*

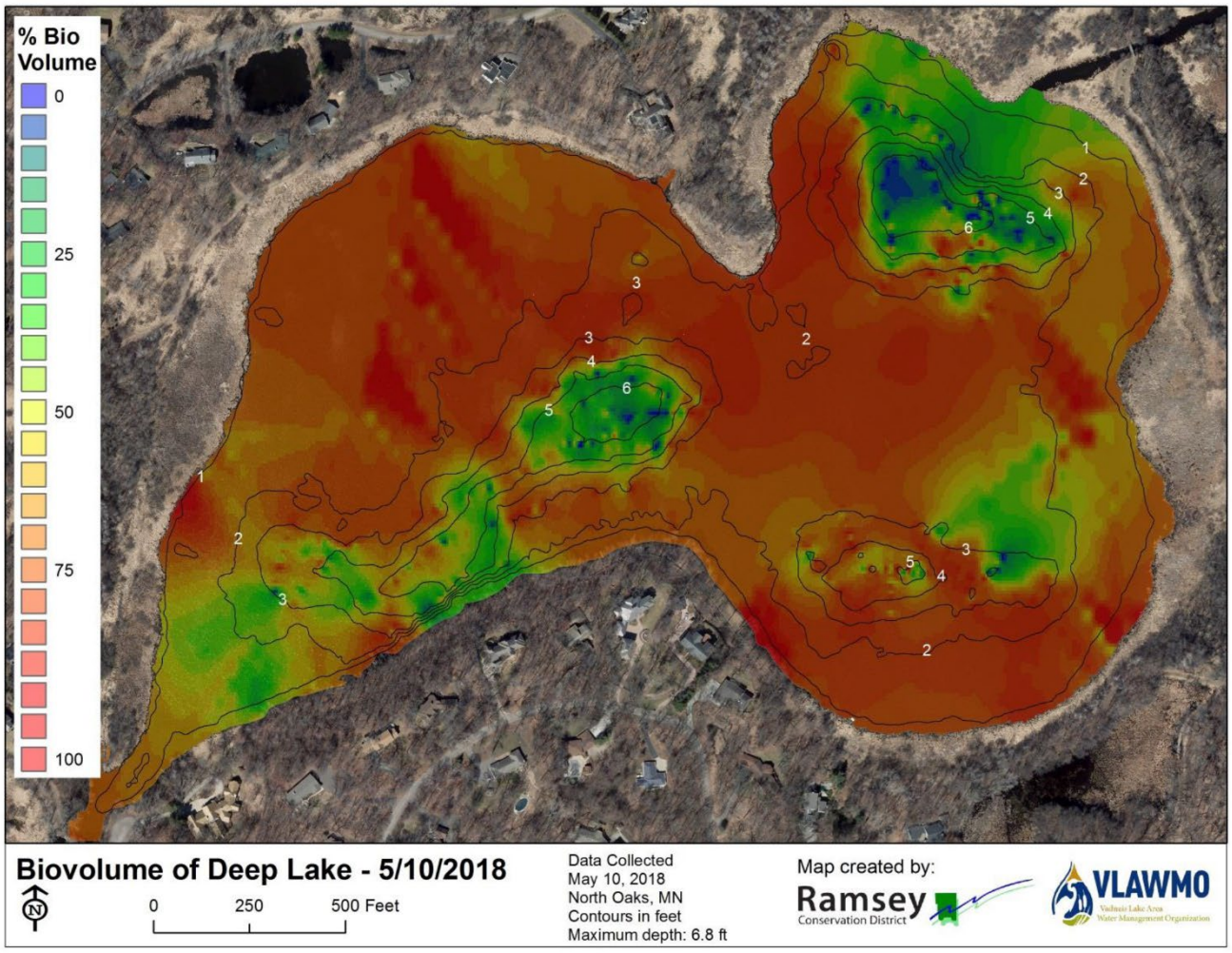


## 3.2 DEEP LAKE BIOVOLUME AND AQUATIC VEGETATION

### Biovolume

The Ramsey Conservation District (now Ramsey Soil and Water Conservation) conducted a biovolume and aquatic vegetation survey in August 2018. Biovolume measures the density of plant life within the lake. Blue signifies 0% plant life, and red signifies 100% plant life. At depths greater than 4-6 feet, there is commonly no plant life in Minnesota lakes. Plant growth is limited because the sun does not penetrate the water column below those depths enough to allow photosynthesis to occur. Deep Lake has abundant plant life throughout the lake, and there are only small pockets at the 6-foot depth where there is no vegetation (Figure 15).

*Figure 158: Deep Lake Biovolume*



## Aquatic Vegetation

Ramsey Conservation District (now Ramsey Soil and Water Conservation) conducted an assessment of the types and abundance of aquatic plants in August 2018. Vegetation was documented at 46 of the 48 survey points. Thirteen plant species were documented.

*Figure 169: Deep Lake Aquatic Plant Survey Points*

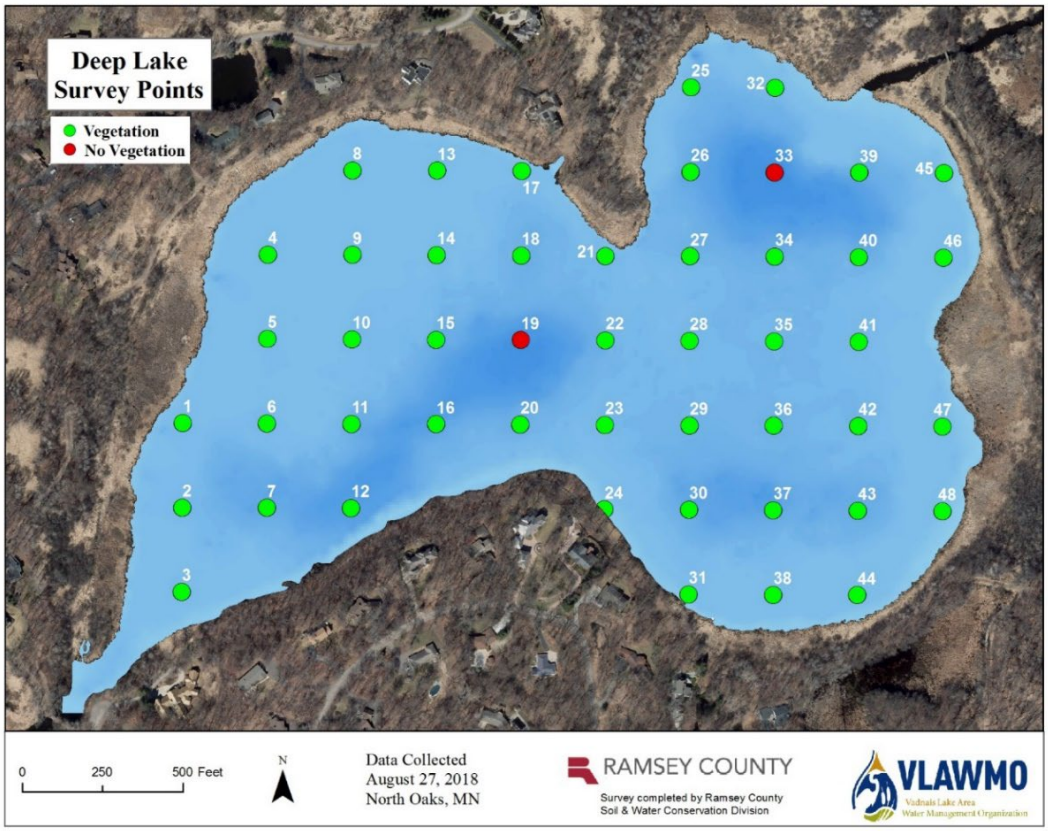



*Table 1: Aquatic Plant Survey Results*

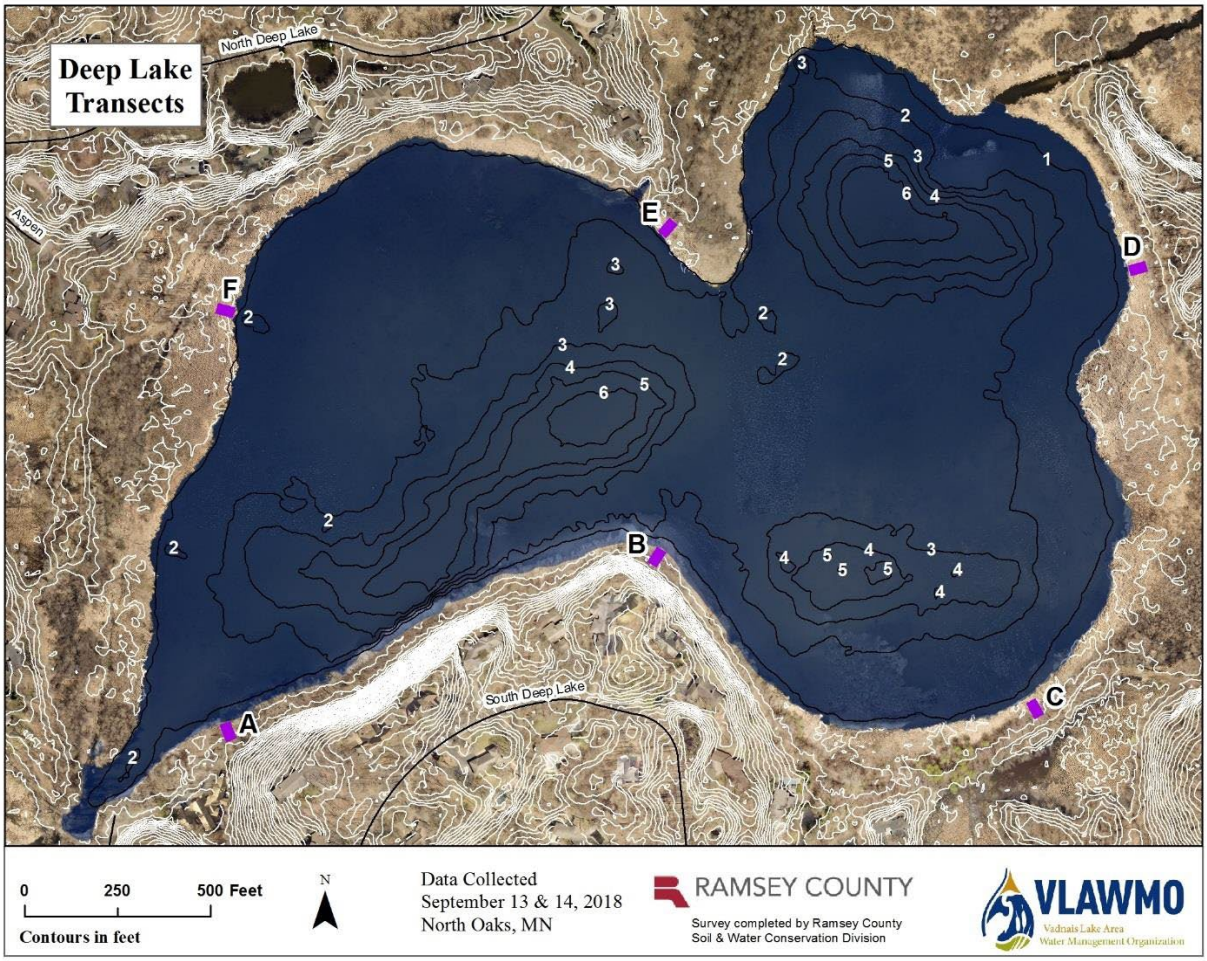
| Common Name | Scientific Name | Percent Occurrence | Native to MN? |
|---|---|---|---|
| Coontail | *Ceratphyllum demersum* | 98% | Yes |
| Watermeal | *Wolffia spp.* | 67% | Yes |
| Greater Duckweed | *Spirodela polyrhiza* | 67% | Yes |
| Lesser Duckweed | *Lemna minor* | 67% | Yes |
| Star Duckweed | *Lemna trisulca* | 50% | Yes |
| White Water Lily | *Nymphaea odorata* | 50% | Yes |
| Canada Waterweed | *Elodea Canadensis* | 37% | Yes |
| Filamentous Algae | *Spirogyra/Cladophora sp* | 43% | Yes |
| Slender Naiad | *Najas flexilis* | 17% | Yes |
| Flat-stem Pondweed | *Potamogeton zosteriformis* | 15% | Yes |
| *Curly Leaf Pondweed | *Potamogeton crispus* | 15% | No |
| Leafy Pondweed | *Potamogeton foliosus* | 9% | Yes |
| Southern Naiad | *Najas guadalupensis* | 9% | Yes |

*Curly Leaf Pondweed (CLP) is an aquatic invasive species (AIS) and of concern in Deep Lake. CLP can be a source of nutrient loading. This survey provides a reference condition for possible future management.

## 3.3 SHORELINE VEGETATION

Ramsey Conservation District assessed shoreline vegetation in September 2018 for abundance and diversity of terrestrial species.

*Figure 20: Deep Lake Transect Locations for Shoreline Vegetation*




A total of 52 species were documented, with Canada Bluejoint Grass (*Calamagrostis canadensis*) and Reed Canary Grass (*Phalaris arundinacea*) topping both the coverage list and the density list. The most widespread species across the lake included Lake Sedge (*Carex lacustris)* and Canada Bluejoint (*Calamagrostis canadensis*). Other common species included Reed Canary Grass (*Phalaris arundinacea*), Northern Marsh Fern (*Thelypteris palustris)*, Purple Loosestrife (*Lythrum salicaria*), Rice Cut Grass (Leersia oryzoides), Virginia Bugleweed (*Lycopus virginicus)*, Dwarf Clearweed (*Pilea Pumila*), Broad-leaf Arrowhead (*Sagittaria latifolia*), and Native Cattail (*Typha latifolia)*.

Species found in 3-4 quadrats included Bulblet-Bearing Water Hemlock (Cicuta bulbifera), Green Ash (*Fraxinus pennsylvanica)*, Sensitive Fern (*Onoclea sensibilis*), Common Buckthorn (*Thamnus cathartica*), and Virginia Creeper (*Parthenocissus quinquefolia*). The remaining 37 species were found in only 1 or 2 quadrats (8% or less of the sample area).

Indicator species that were found in the shoreline area, but not within quadrat areas, include Native Phragmites and Caterpillar Sedge (*Carex crinita*).

Six invasive species were documented as part of this survey (in red), listed from highest to lowest plant count below:

*Table 2: Shoreline Vegetation Invasive Species Documented*

| Scientific Name | Common Name | Total Plant Count |
|---|---|---|
| *Phalaris arundinacea* | Reed Canary Grass | 172 |
| *Rhamnus cathartica* | Common Buckthorn | 16 |
| *Lythrum salicaria* | Purple Loosestrife | 13 |
| *Lonicera Spp.* | Bush Honeysuckle | 3 |
| *Salix alba* | White Willow | 2 |
| *Robinia pseudoacacia* | Black Locust | 1 |

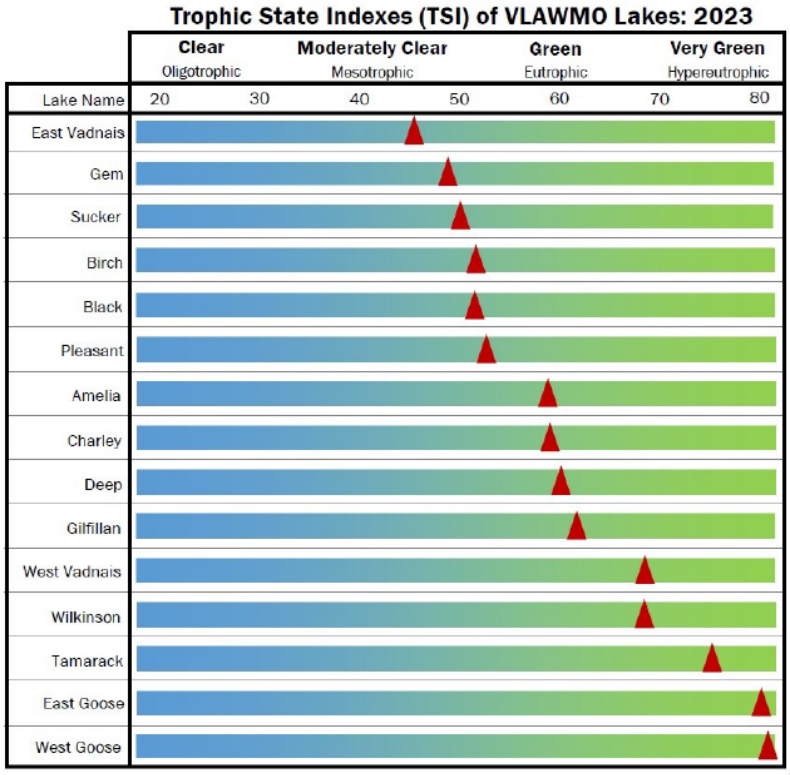
Reed Canary Grass is the single most prevalent invasive plant detected in this survey. It out-competes most native species, spreading through rhizomes and creating a thick mat at or directly below the soil surface. The MN Department of Natural Resources promotes a guide by Reinhardt and Galatowitsch (2000) for management of reed canary grass in wetland areas.

A possible observation of Oriental Bittersweet (*Celastrus orbiculatus)* was noted along the pedestrian trail near transect C, but not within the survey area. VLAWMO staff and RCSWCD rechecked the site in the winter (January 2019) to check the vine when berries were present. At this site, the vine in question is native American Bittersweet (*Celastrus scandens*). However, Oriental Bittersweet has been documented in a number of sites nearby, including a new location that was documented along Pleasant Lake near the beach during the same visit. Vigilance is required to identify any new occurrences of Oriental Bittersweet and treat them before they become a problem.

## 3.4 WATER QUALITY SUMMARY

Deep Lake is shallow and falls in the green/eutrophic classification on the Trophic State Index (TSI) (shown below using the Carlson scale, MPCA). Deep Lake had recent scores of 60 (2022) and 60 (2023).

**Figure 21**: TSI scores for VLAWMO lakes




VLAWMO has collected water quality (WQ) data on Deep Lake since 1995. Regular, long-term uniform sampling was implemented in 2009 (Table 1). VLAWMO staff collects WQ data and water samples biweekly, May-September, for water clarity (secchi disk), nutrients (TP, Chl-a, SRP, nitrogens), and chemistry (temperature, conductivity, dissolved oxygen, and potential hydrogen [pH]). Total Phosphorus (TP) and Chlorophyll A (Chl-a) analyses are conducted by a contracted lab.

- TP is the primary cause of excessive plant and algae growth in lake systems. Phosphorus originates from a variety of sources, many of which are human related. Major sources include human and animal waste, soil erosion, detergents, septic systems, and stormwater runoff. Internal loading can also be present in a lake. Internal loading can result from P becoming re-suspended into the water column from the sediment. High amounts of P in sediments may occur as a result of historical land uses including, but not limited to, waste disposal into the lake.

- Chl-a is a green pigment in algae. Measuring Chl-a concentration gives an indication of algae abundance.

- The MN Pollution Control Agency (MPCA) has impairment standards for the levels of TP and Chl-a. For shallow lakes in Minnesota, the impaired water quality standard levels are: <60µg/L for TP, <20µg/L for Chl-a, and <230 mg/L for Chloride.

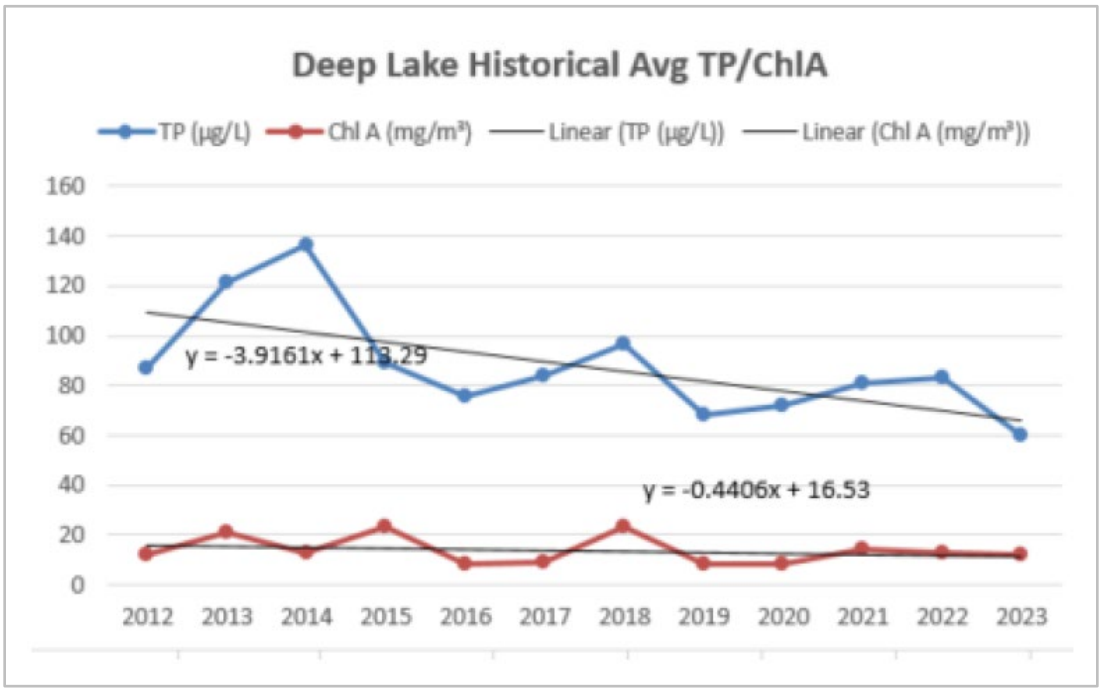
.

*Table 3: Deep Lake Monitoring Data 2009-2023*

| Deep Lake Historical Average TP/Chl-a/SDT/Chl | | | | |
|---|---|---|---|---|
| Year | TP (µg/L) | Chl-a (µg/L) | Secchi (m) | Chloride (mg/L) |
| 2009 | 112 | 21 | 1 | N/A |
| 2010 | 55 | 15 | 0.9 | 42 |
| 2011 | 95 | 12 | 1.2 | 45 |
| 2012 | 87 | 12 | 1 | 35 |
| 2013 | 121 | 21 | 1 | 44 |
| 2014 | 136 | 13 | 1.1 | 43 |
| 2015 | 89 | 23 | 1 | 35 |
| 2016 | 76 | 8 | 1.1 | 45 |
| 2017 | 84 | 9 | 1.1 | 41 |
| 2018 | 97 | 23 | 1.3 | 41 |
| 2019 | 68 | 8 | 1.4 | 44 |
| 2020 | 72 | 8 | 1.4 | 50 |
| 2021 | 81 | 14 | 1.2 | 60 |
| 2022 | 83 | 13 | 1.3 | 60 |
| 2023 | 60 | 12 | 0.9 | 54 |

Table 3: Deep Lake Chemistry. The numbers in red indicate parameters that exceed State Standards. The Trophic State Index (TSI) for Deep Lake indicates the basin's nutrient levels combined with clarity levels qualify it as hypereutrophic. Curly Leaf Pondweed, present in Deep, can exacerbate negative effects by contributing additional TP to the system.

Figure 22: Historical Water Quality Averages for TP/Chl-a with a linear trend through time.



# 4 MANAGEMENT ACTIONS

## 4.1 COMPLETED BPMS IN THE SUBWATERSHED

- A fish barrier was installed at the outlet of Wilkinson Lake by the North Oaks Company in 1994 to prevent common carp from migrating upstream from Deep Lake and the chain of lakes into Wilkinson. That was followed by a drawdown to remove carp from Wilkinson Lake.
- A shoreline restoration was completed on the south end of Deep Lake Channel in 2015 at the inlet to Pleasant Lake, though this restoration is not within Deep's catchment area.
- The Rapp Farm development included a stormwater system that exceeds development standards when it was constructed.
- Cost share grants: 2 rainbarrels, 1 native planting, and 1 raingarden.
- The carp removal project has been active from 2019-current and has been successful in removing thousands of pounds of carp and reducing the biomass in the Charley-Pleasant-Deep system of lakes.

## 4.2 Results of Stakeholder Survey

Surveys were mailed to 64 residents who live along the Deep Lakeshore or very close (e.g., across the street) on November 6, 2018. The original survey is included in the Appendix. Twenty-six surveys (41%) were returned to VLAWMO and analyzed. These responses help us better understand concerns and priorities of residents. They also serve as a baseline from which we will continue to engage with stakeholders and adaptively manage water and habitat quality in Deep Lake.

Stakeholders were asked how important a list of 12 possible lake issues were to them (Q1). The top 3 concerns identified were, in order of importance: habitat for wildlife, invasive plants, and nearby wetland health. Specific concerns mentioned in the comments section include a need for weed control especially along the north shore, purple loosestrife, and carp control. The graph below shows the full set of possible lake issues and importance assigned by stakeholders.

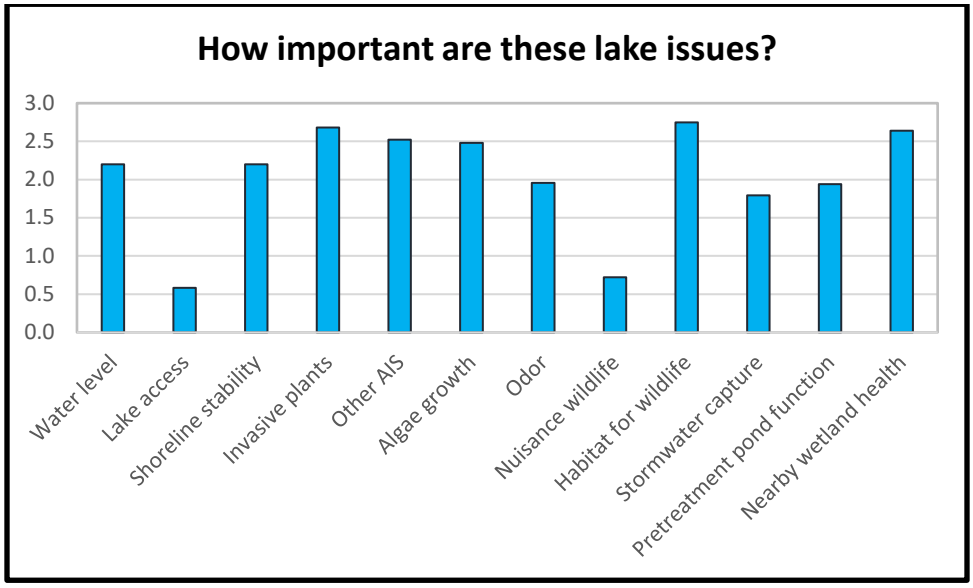



Figure 23: Survey Q1: How important are the following possible lake issues to you? (0 = Not Important, 1 = Fairly Important, 2 = Important, and 3 = Very Important).

Stakeholders were asked which activities they enjoy at Deep Lake and the quality of those activities at the lake (Q2-3). Activity choices included: aesthetics, wildlife viewing/birding, non-motorized boating, using trails, and outdoor grilling. Respondents were asked to choose all activities that apply. They identified trail use and wildlife viewing/birding as top activities and felt that resources are in good shape for those activities (2.7). Non-motorized boating ranked the lowest in current quality (1.9). Comments reflected that people feel water quality is declining in the lake and is affecting the activities that they value and that heavy buckthorn cover blocks their view in many places. Respondents added skiing and snowshoeing to activities they enjoy. These activities are useful to mention separately because they may require specific trail maintenance beyond what is done for walking trails. People also enjoy using the benches alongside the trails to relax and visit with others.

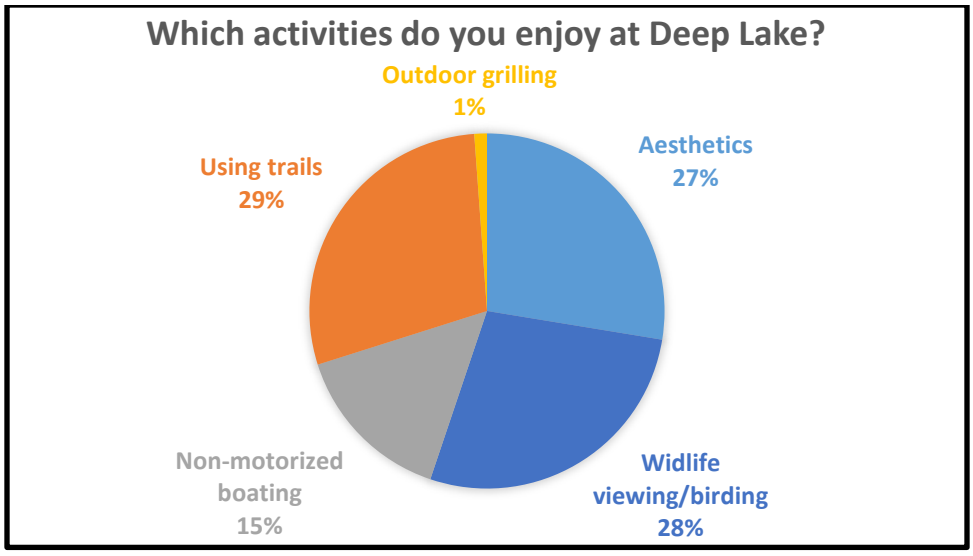



Figure 24: Survey Q2-3: Q2) Which activities do you enjoy at Deep Lake? (Check all that apply), and Q3) How do you feel about the current quality of Deep Lake for activities you enjoy? (1 = Poor, 2 = Average, and 3 = Excellent).

A more inclusive habitat-related theme of concerns was consistent throughout the survey. When asked which water-related priorities stakeholders feel are most important, they rated wetland conservation and invasive species as top concerns (Q4).

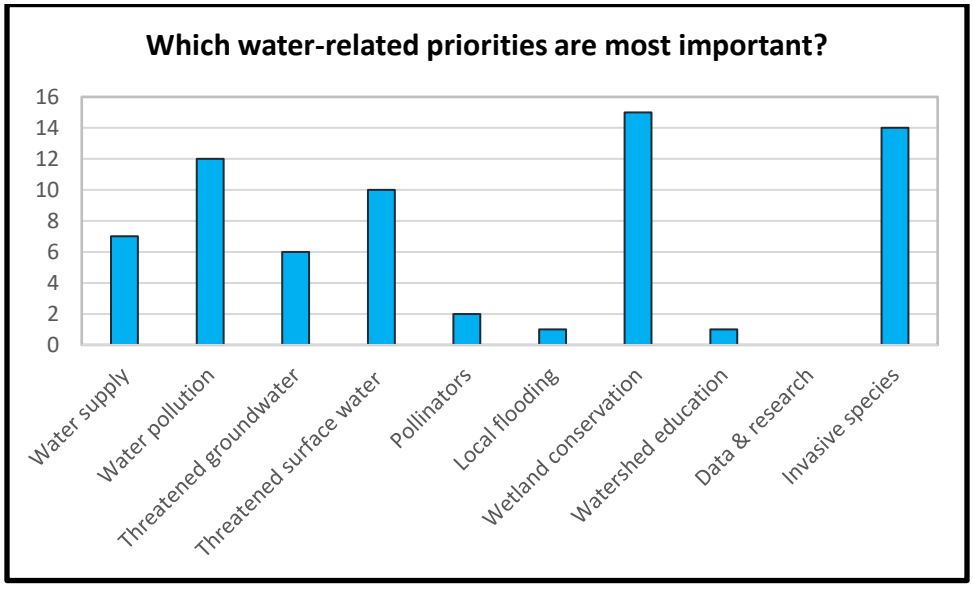



Figure 25: Survey Q4: Which water-related priorities are most important to you? (Check up to 3.)

Stakeholders identified wildlife habitat and scenery as top reasons why water quality is important to them (Q5). Respondents were invited to choose as many of the 6 choices as they felt applied. Many respondents chose all options; most respondents chose multiple options.

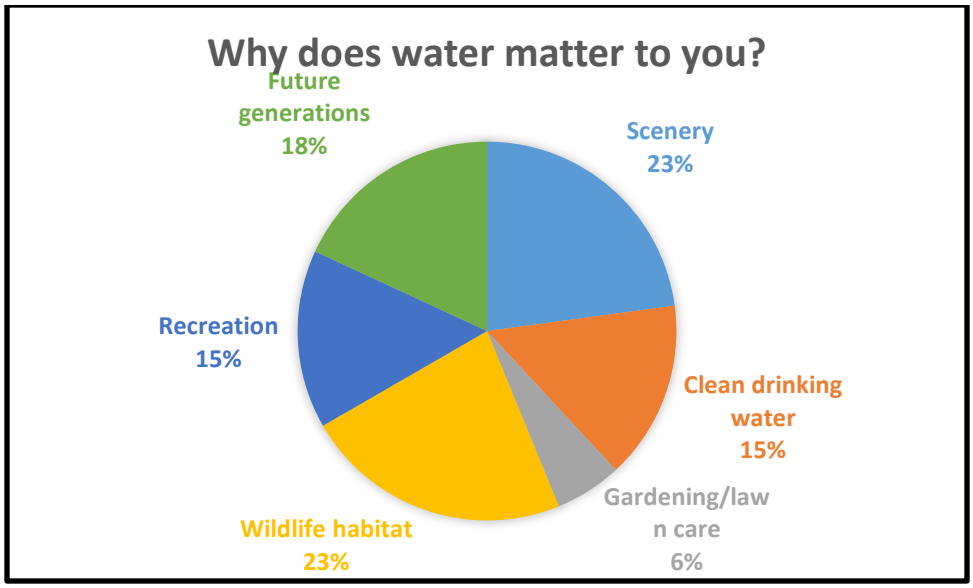



Figure 26: Survey Q5: Why does water matter to you? (Check all that apply).

Stakeholders identified how familiar and involved they currently are with local water issues (Q 6a-c). The majority of respondents felt they were familiar with local water issues at an average level (N = 12), that primary perceived barriers to involvement are time constraints and not enough experience, and that their current level of involvement is at a medium level and that they do their part within their normal routine (N = 9). The survey itself served as a form of communication and information. At the end of the survey, we provided website links and volunteer information. Surveys were returned with the bottom portion removed.

No new ideas were identified when stakeholders were asked about their highest priority for management (Q7). Responses included topics from Q1 and centered around improving water and habitat quality; and controlling weeds, carp, and algae. Strong affinity for Deep Lake was expressed. People indicated that they are interested in the lake staying natural and would like help improving water and habitat quality.

Additional concerns, comments, and questions by stakeholders include increasing weed and carp control efforts, and that: lake levels seem to fluctuate more than they did in the past, overall lake quality may be declining, buckthorn blocks in the view in places, the 630 acres of set aside conservation land should be used for everybody to enjoy, and trails should be managed. Respondents expressed concern about function of the Wilkinson weir system and wondered what happened with previously completed plans for management of Deep Lake 15+ years ago (Q8).

These topics, themes, and priorities will be part of an upcoming stakeholder meeting in 2019 and help to identify strategies and guide water-quality improvement in the watershed. One strategy that has been identified is a joint lake association for Charley, Deep, and Pleasant Lakes, which are all located in North Oaks, part of the SPRWS chain of lakes for drinking water delivery, and the focus of current SLMPs by VLAWMO.

## 4.3 RETROFIT RECOMMENDATIONS

In 2015, the Ramsey Conservation District completed a Retrofit Report for the Pleasant-Charley-Deep subwatershed, assessing possible areas and locations for implementing BMPs for improving water quality. The Report described the Lake's land catchment area as having a low base load risk for contributing external loading due to buffering capacity of preserved and undeveloped land, low density residential in the south, the newest residential area's distance from the lake and higher-than-standard stormwater treatment.

The Report identified 2 possible projects within the Deep Lake subwatershed. The first is a bank stabilization on the southwest shore of the Lake on Deep's "outlet bay" to stabilize and reduce shoreline erosion caused by fluctuating water levels. The second is an alum treatment to reduce internal nutrient loading that could help the Lake meet shallow water quality standards, as designated by the MPCA. These recommendations should be considered as management steps continue forward for Deep Lake.

Figure 27: BMP retrofit locations identified in the 2015 Pleasant-Charley-Deep Retrofit Report.