VLAWMO

VADNAIS LAKE AREA WATER MANAGEMENT ORGANIZATION

# East and West Goose Lake Review, Ramsey County, MN

2024

Vadnais Lake Area Water Management Organization
800 County Road E East
Vadnais Heights, MN 55127
651-204-6070
www.vlawmo.org

# TABLE OF CONTENTS



FULL REPORTS (BELOW) INDICATED IN APPENDIX AVAILABLE ON VLAWMO WEBSITE -> GOOSE LAKE AND UNDER RESOURCES -> REPORTS

AQUATIC VEGETATION AND LAKE CONTOUR SURVEY REPORT (2014, 2019 BY RCSWCD)
EAST GOOSE PHYTOPLANKTON REPORT (2021-2023 BY BARR ENGINEERING)
FISH SURVEY (2012, 2017, 2019 BY BLUE WATER SCIENCE)
RETROFIT REPORT (2011 BY RCSWCD)
TOTAL MAXIMUM DAILY LOAD REPORT (2013)
EARLY BMP PROJECT INVESTIGATION (2020 BY BARR)

ALUM FEASIBILITY INVESTIGATIONS:
INTERNAL P LOADING AND SEDIMENT FRACTIONATION WEST GOOSE (2010 BY ERDC)
INTERNAL P LOADING AND SEDIMENT FRACTIONATION EAST GOOSE (2014 BY WENCK)
EAST GOOSE EQUILIBRIUM EXCHANGES OF SOLUBLE P (2015 BY WENCK)
EAST AND WEST GOOSE AND WILKINSON LAKE ALUM FEASIBILITY (2017 BY BARR)
EAST AND WEST GOOSE AND OAK KNOLL POND ALUM FEASIBILITY (2018 BY BARR)

# 1 INTRODUCTION

## 1.1 INTRODUCTION

Goose Lake is located in the City of White Bear Lake and lies within the Vadnais Lake Area Water Management Organization (VLAWMO). Goose is a shallow lake with a maximum depth of about 8 feet. The 140-acre lake is separated into 2 basins and is connected by2, 24-inch culverts running under Highway 61. West Goose is the smaller of the 2 basins at 27 acres. East Goose is the larger of the 2 basins at 113 acres. Goose Lake sits in a large 1124-acre subwatershed and receives a lot of runoff from storm events and snow melt. There is a weir/outlet on the north end of West Goose which drains the basin into Lambert Creek. A constant flow of ground water enters West Goose on the south end of the basin; this water was used to cool equipment at the Morning Star Plant in the past, and that water was then discharged into the lake. However, that use is no longer active. About 250,000 gallons of water a day was discharged into the lake from the Morningstar Plant.

The East basin of Goose Lake is surrounded by private homes along the east side with townhomes and a car dealership to the south. The West basin has no private homes. A bar/motel is located on the north end, and commercials buildings are located on the south end of the basin. Bald Eagles, ducks, and geese are some of the observed fauna. The studies for this report were conducted by VLAWMO, Ramsey Conservation District (now RCSWCD), Blue Water Science, Wenck Associates, Inc., and Barr Engineering.

# 1 INTRODUCTION

**Figure 1:** East and West Goose Lake, location in the watershed, at the headwaters of Lambert Creek which flows into East Vadnais Lake.

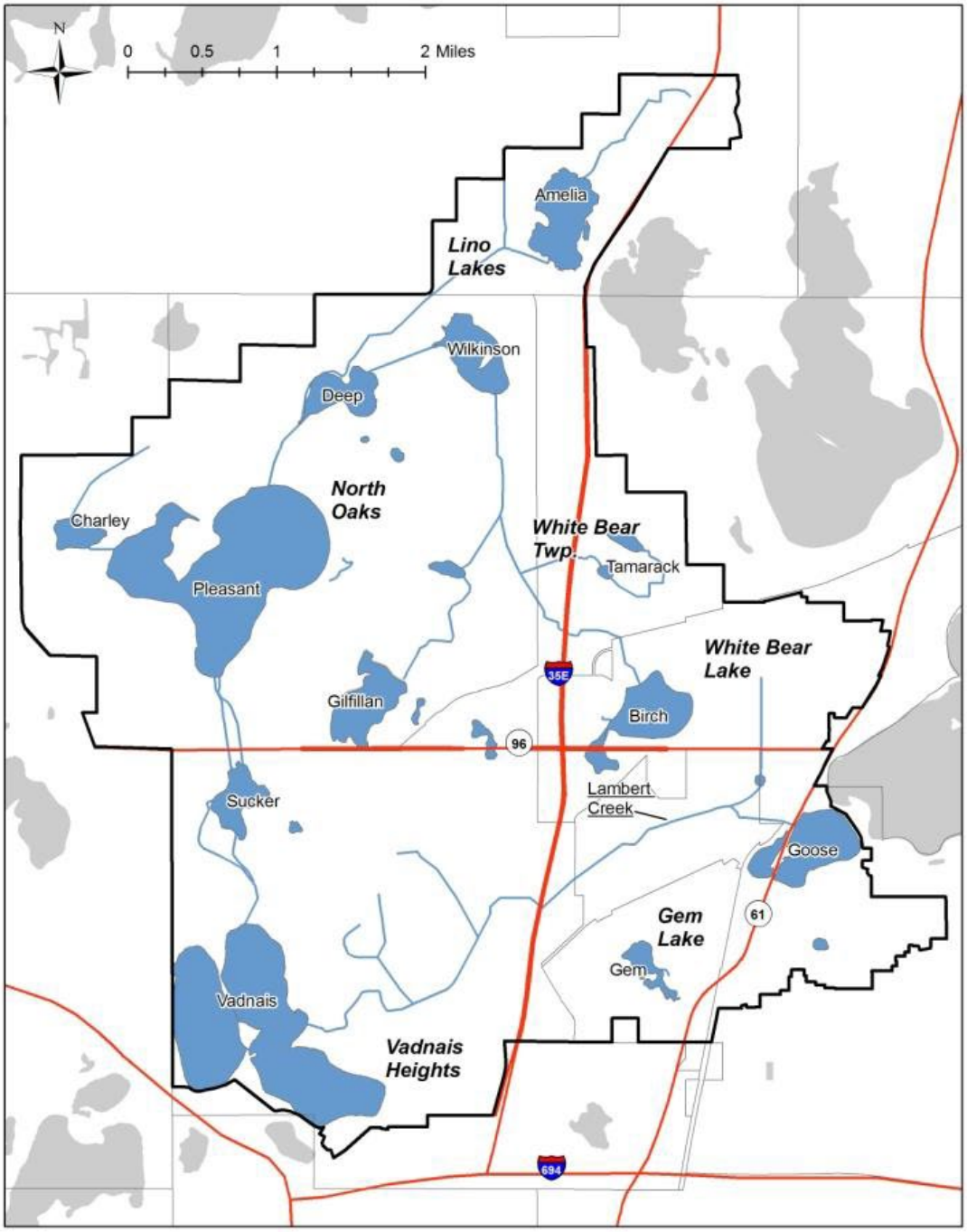


Figure 2: Aerial view of East and West Goose Lakes. Both lakes are impaired for nutrients. Annual phytoplankton surveys show above-CDC recommended levels for potentially harmful blue-green algae (2021-2023).

# 2 WATERSHED FEATURES

## 2.1 AERIAL PHOTO HISTORY

### History

Figure 3: Aerial photo of Goose Lake from 1940. There is little standing water in the photo, the lake area appears to be more of a wetland/bog than an open-water lake.

Figure 4: This photo was from 1941. It was taken of West Goose along Hoffman Road after tornado.

Figure 5: 1953 aerial photo: Goose was dredged some time during the 1940s/early 1950s. Highway 61 was also built in the early1950s, which separated Goose Lake into East and West Goose Lakes.

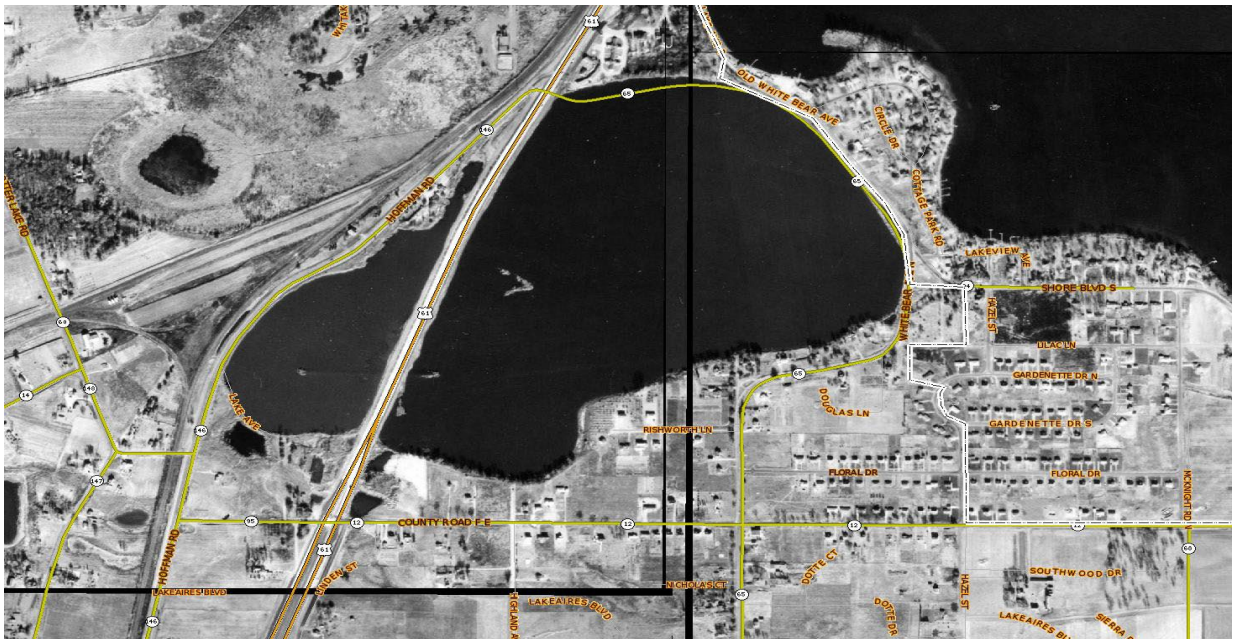


Figure 6: By 1974, more development is occurring around Goose Lake. White Bear Lake Sewage Plant discharged into the north end of the East basin.

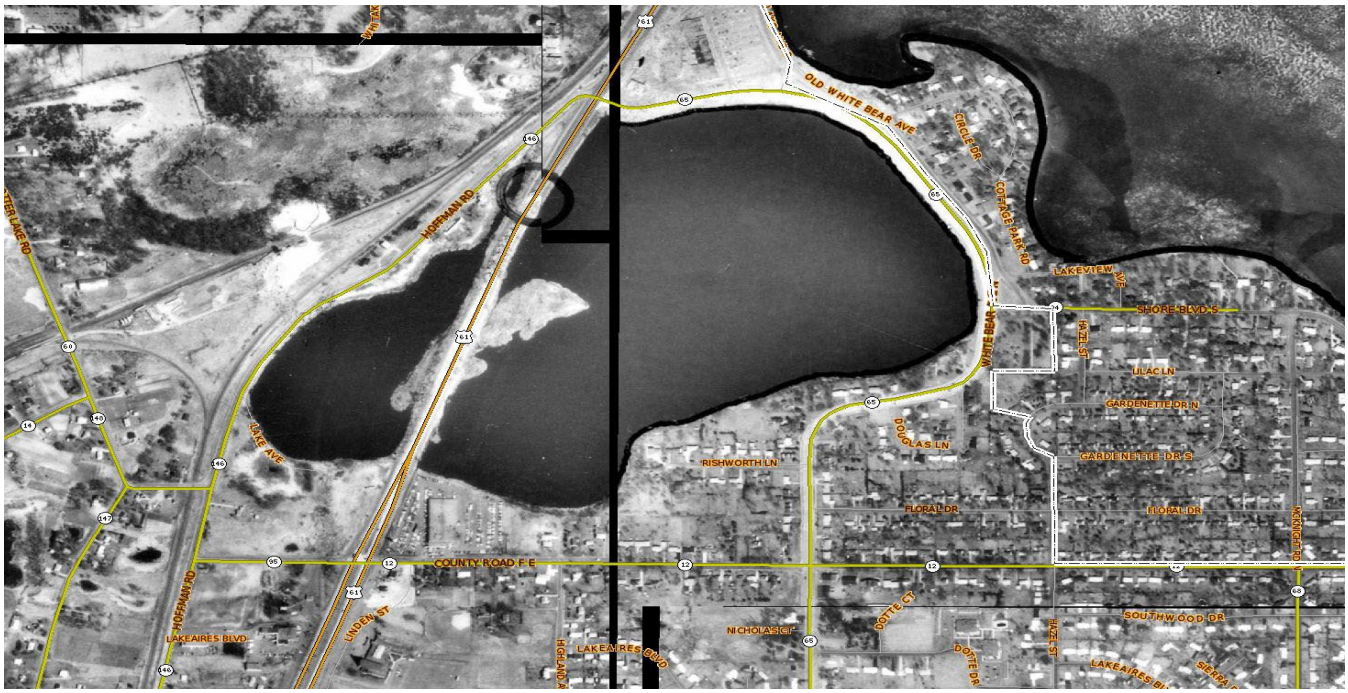



Figure 7: By 1985, the Morningstar Plant is visible on the south end of West Goose Lake. Cooling water is likely being discharged into the basin.

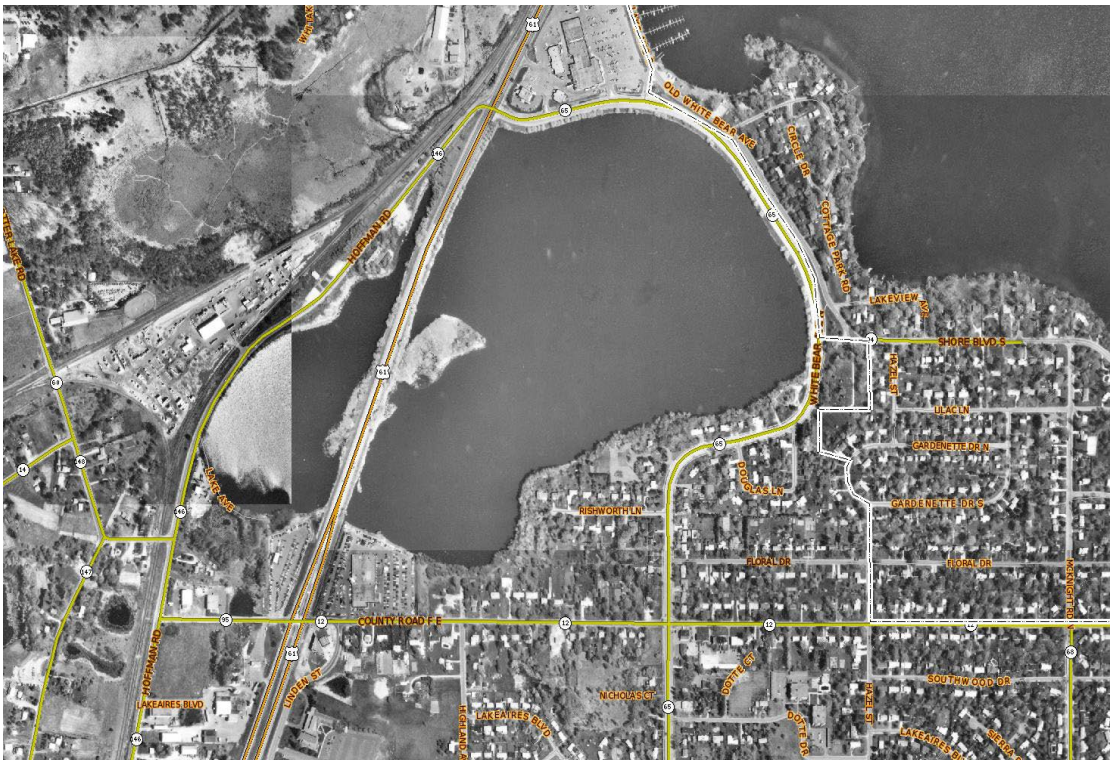
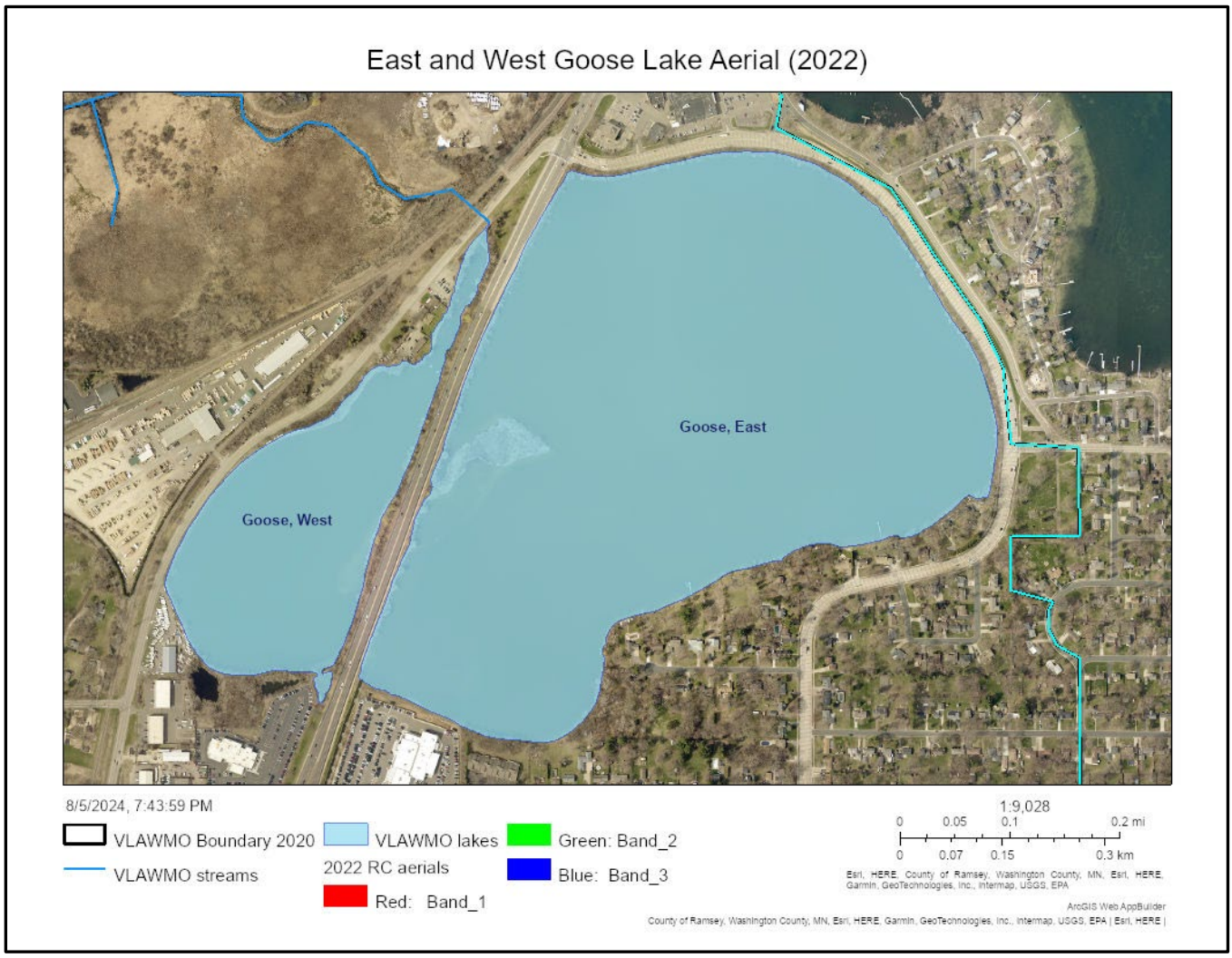


Figure 8: By 2006, the dark green color of the lake is apparent, as a result of high chlorophyll levels.


Figure 9: By 2012, high chlorophyll levels remain apparent, as indicated by the green water color compared to that of White Bear Lake to the northeast.

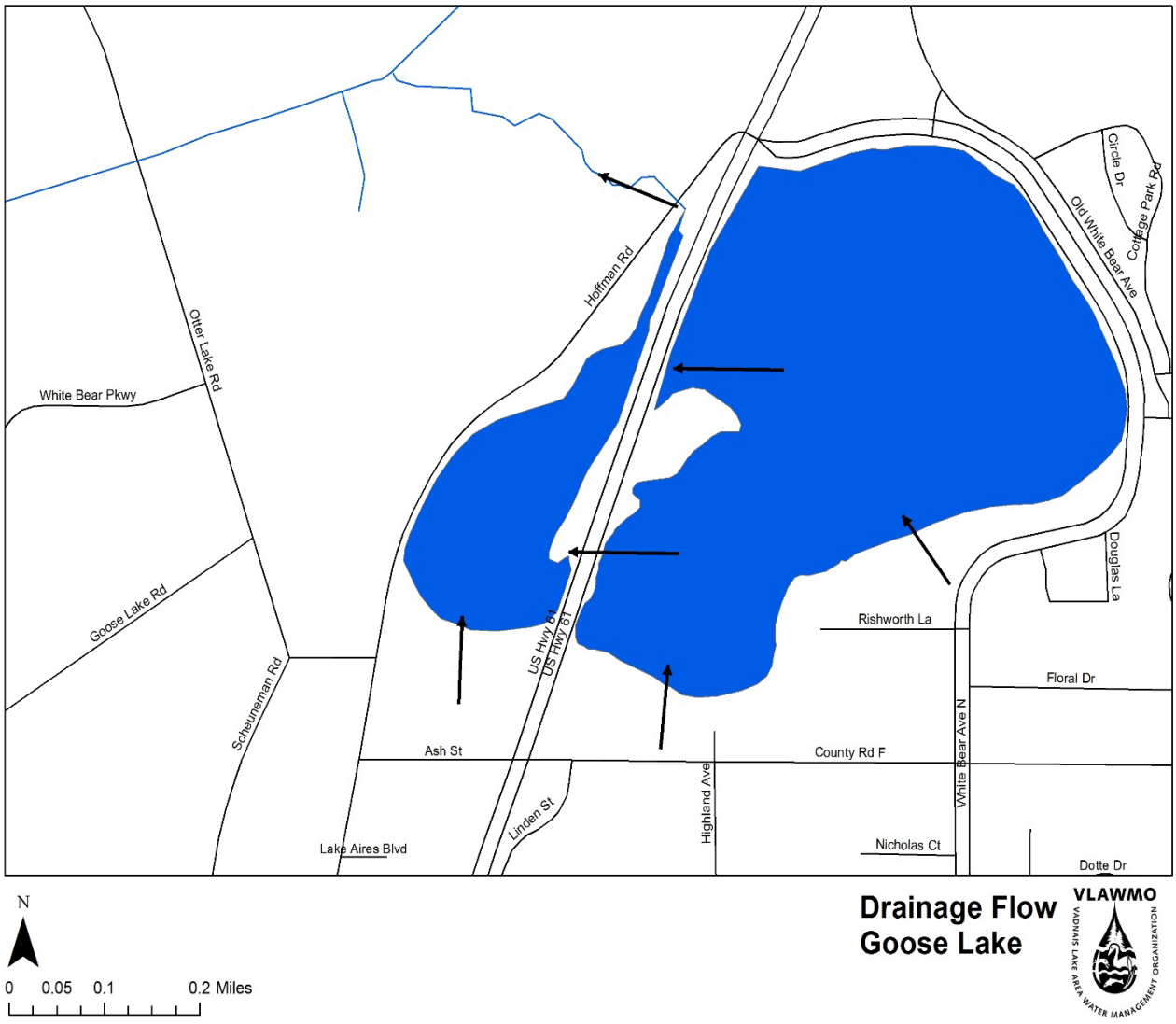
Figure 10: 2022 aerial photo



## 2.2 GOOSE LAKE DRAINAGE AREA

The drainage area into Goose Lake is approximately 1124 acres and is about 8 times larger than the surface area of Goose Lake, which is 140 acres. This is a large drainage area to Goose Lake which can be a negative aspect for the lake. Large drainage areas are more likely to wash pollutants into the lake and usually result in poorer water quality. Water enters the lake primarily through rain events, snow melt and ground water. The VLAWMO Total Maximum Daily Load (TMDL) study prepared by Wenck and the Ramsey Conservation District Lambert Creek Retrofit report includes more detail on the groundwater and watershed effects on Goose Lake.

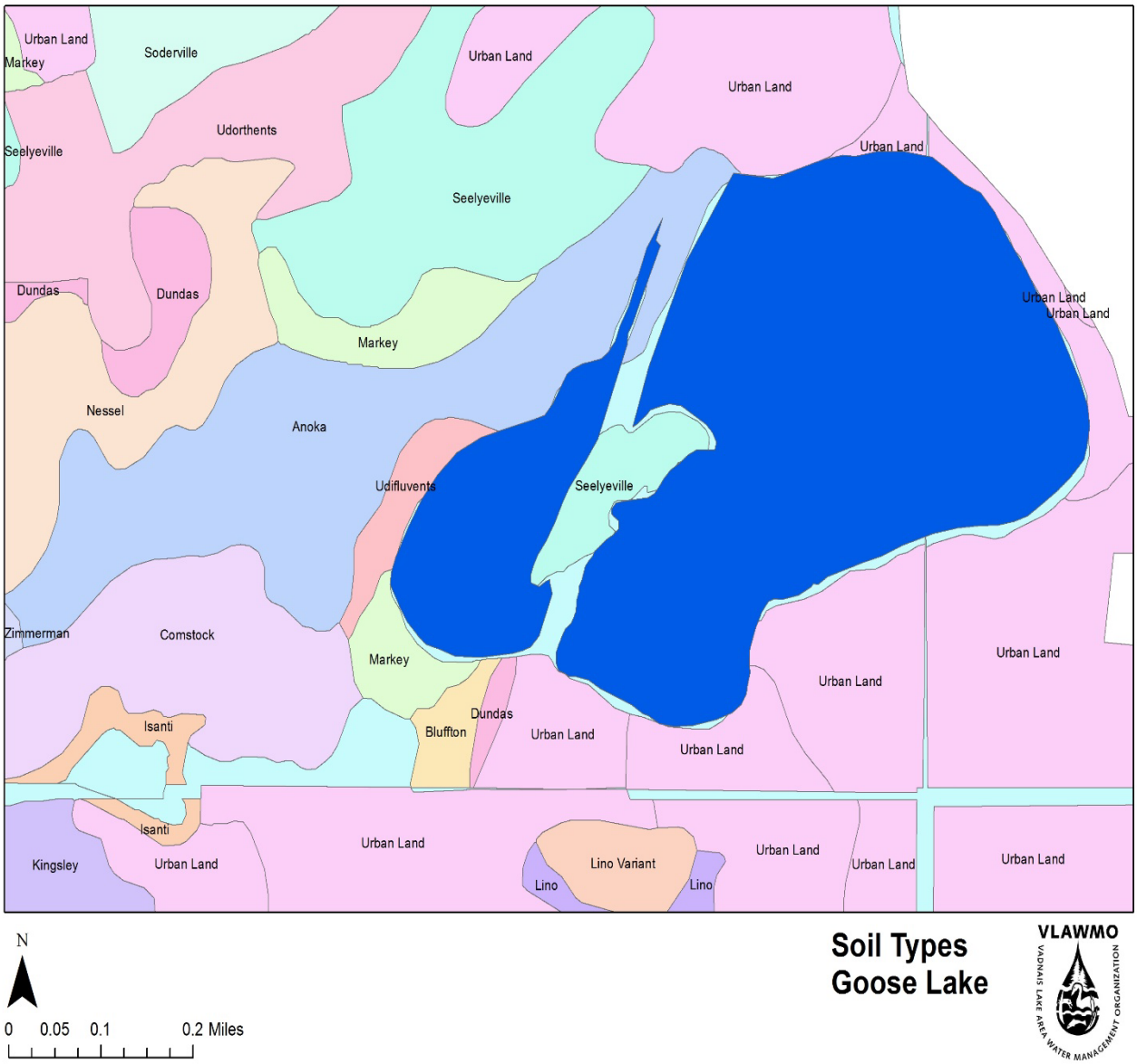
**Figure 11:** Goose Lake Subwatershed



## 2.3 GOOSE LAKE SOILS

Soils within the Goose Lake subwatershed are dominated by Hayden fine sandy loam. This soil tends to drain well, allowing water to filter into the ground. However, with urban development, much of the soil has been compacted, moved, and covered over, thus pushing rain water into storm sewer systems or away from the lake. Additionally, a survey was conducted to examine the sediment of the lake bottom and address the possible effects of internal phosphorus loading. Detailed results are addressed in the VLAWMO TMDL and the ERDC report. The sediments suggest internal loading due to above normal phosphorus levels in the sediment.

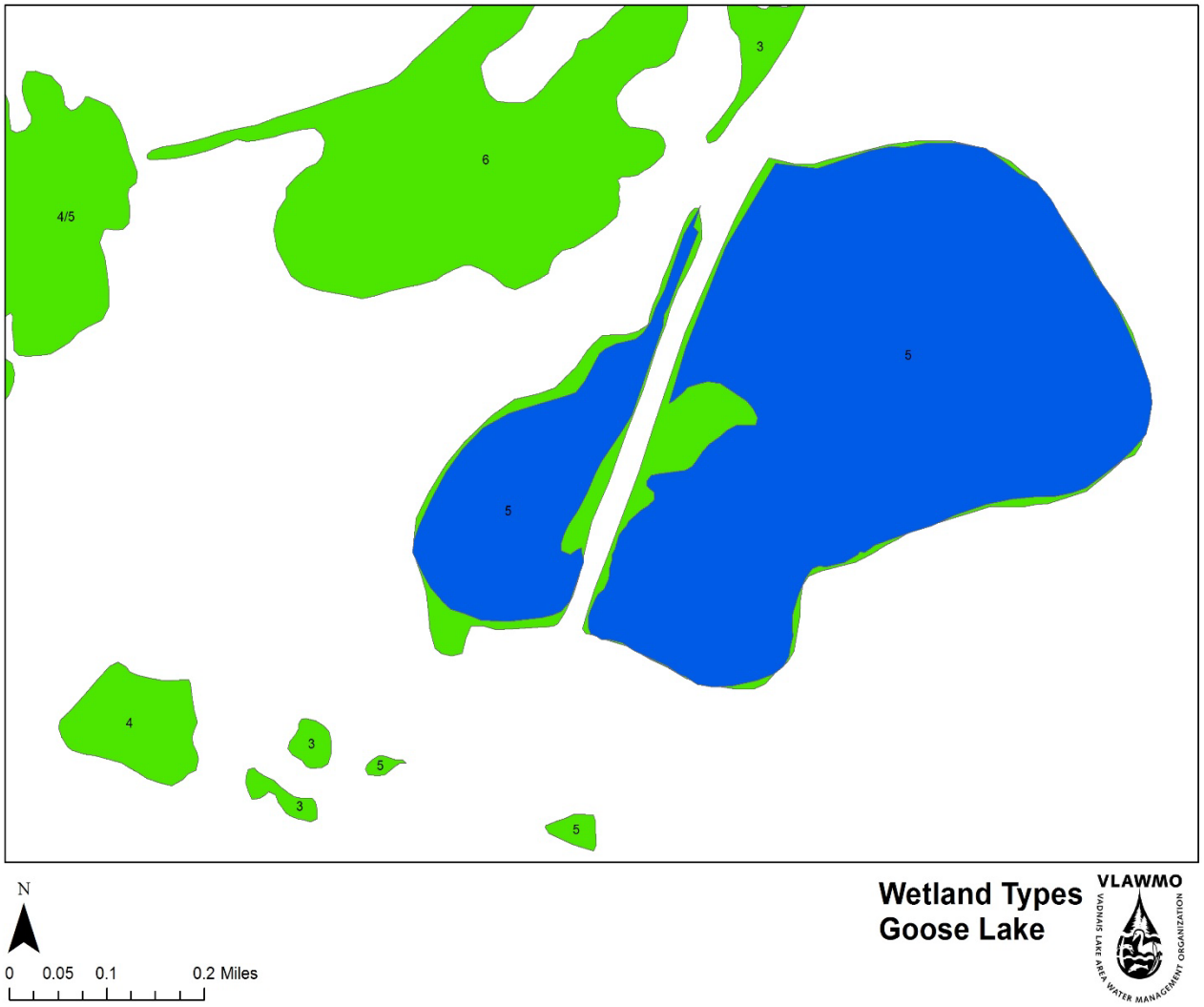
**Figure 12**: Goose Lake area soils



## 2.4 GOOSE LAKE WETLANDS

There are few wetlands around Goose Lake. With the large size of the subwatershed surrounding the lake and the high urbanization of the area there is very little relief from rain events in terms of runoff protection and buffers around the lake. This is likely one of many factors affecting the water quality in the lake. The VLAWMO TMDL goes into great detail on the impairment issues in Goose Lake and also provides and implementation plan to address the impairments Wetlands are numbered on the map and the key is below.

**Figure 13**: National Wetland Inventory (2015) wetland areas in and around Goose Lake, Circular 39 Classification System




**Wetland Types**

1 – Seasonally Flooded
2 – Wet Meadow
3 – Shallow Marsh
4 – Deep marsh
5 – Shallow Open Water

# 3 LAKE FEATURES

## LAKE FEATURES

During the summer of 2011, VLAWMO conducted a lake depth survey on East and West Goose Lake. Both basins are bowl shaped with max depth of 6-8 ft. The official ordinary high-water level (OHW) for Goose Lake set by the DNR is 925.3ft. VLAWMO monitors the lake level, and it ranges between and elevation of 924-925 ft. The weir structure outlets to Lambert Creek on the north end of the west basin.

## 3.1 LAKE DEPTH

A bathymetry survey was completed by RCSWCD on East Goose Lake on June 6, 2014, to determine lake depths. The deepest location detected by sonar was 2.11 m (6.9 ft), and the average was 1.57 m (5.2 ft).

Figure 14: East Goose Lake depths with 1-foot contours (2014)

## 3.2 BIOVOLUME AND AQUATIC VEGETATION

RCSWCD conducted a biovolume and aquatic vegetation survey on June 6, 2014, and on June, 13, 2019. in Goose Lake. 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 into the water column below those depths enough to allow photosynthesis to occur.

The Ski Otters waterski team has conducted mechanical and chemical removals in West Goose Lake targeting Curly-leaf pondweed, beginning in 2014. Permitting is done through the MN DNR for this removal work.

Due to the limited plant growth and observations of frequent blue-green algae blooms, VLAWMO has been working with Barr Engineering to conduct algal monitoring during the growing season. Algal monitoring began in 2021 and are ongoing as of 2024. Algal counts annually exceed CDC recommendations for human and pet health, When exceedance occurs, VLAWMO posts a notice on the website, as does the City of White Bear Lake.

In 2014: Data was collected at 94 points. Aquatic macrophytes were found at 24 points. Canada Waterweed (*Elodea canadensis*) and invasive Curly-leaf pondweed (*Potomogeton crispus*) were the most common species. Also present was Leafy pondweed (*Potamogeton foliosus*.). The Secchi disk reading was 0.3 m (.98 ft). The high turbidiy and algae levels in the lake appeared to be limiting plant growth, which is why plants were not more widespread in this shallow lake.

Figure 15: Point intercept locations. Green dots show locations where vegetation was detected.

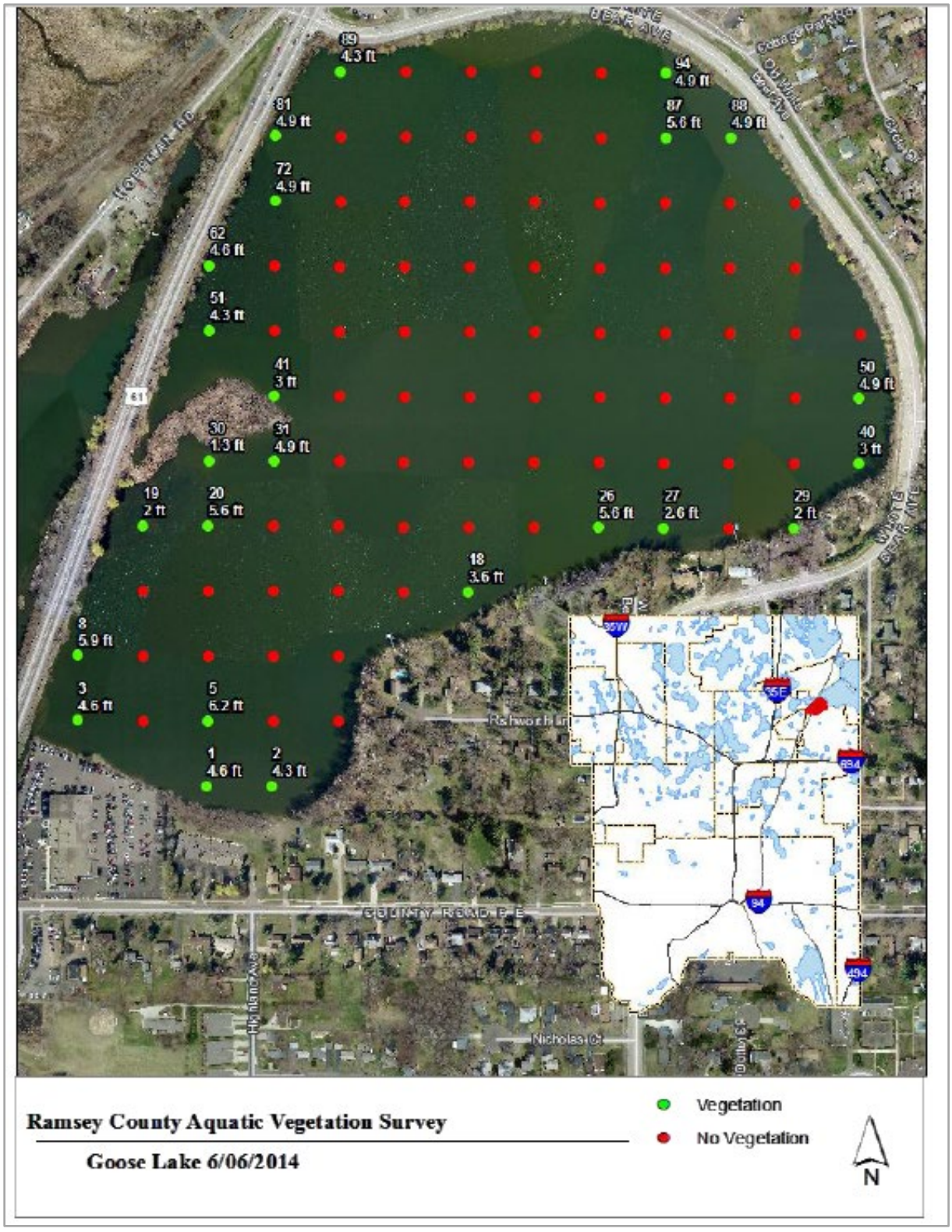
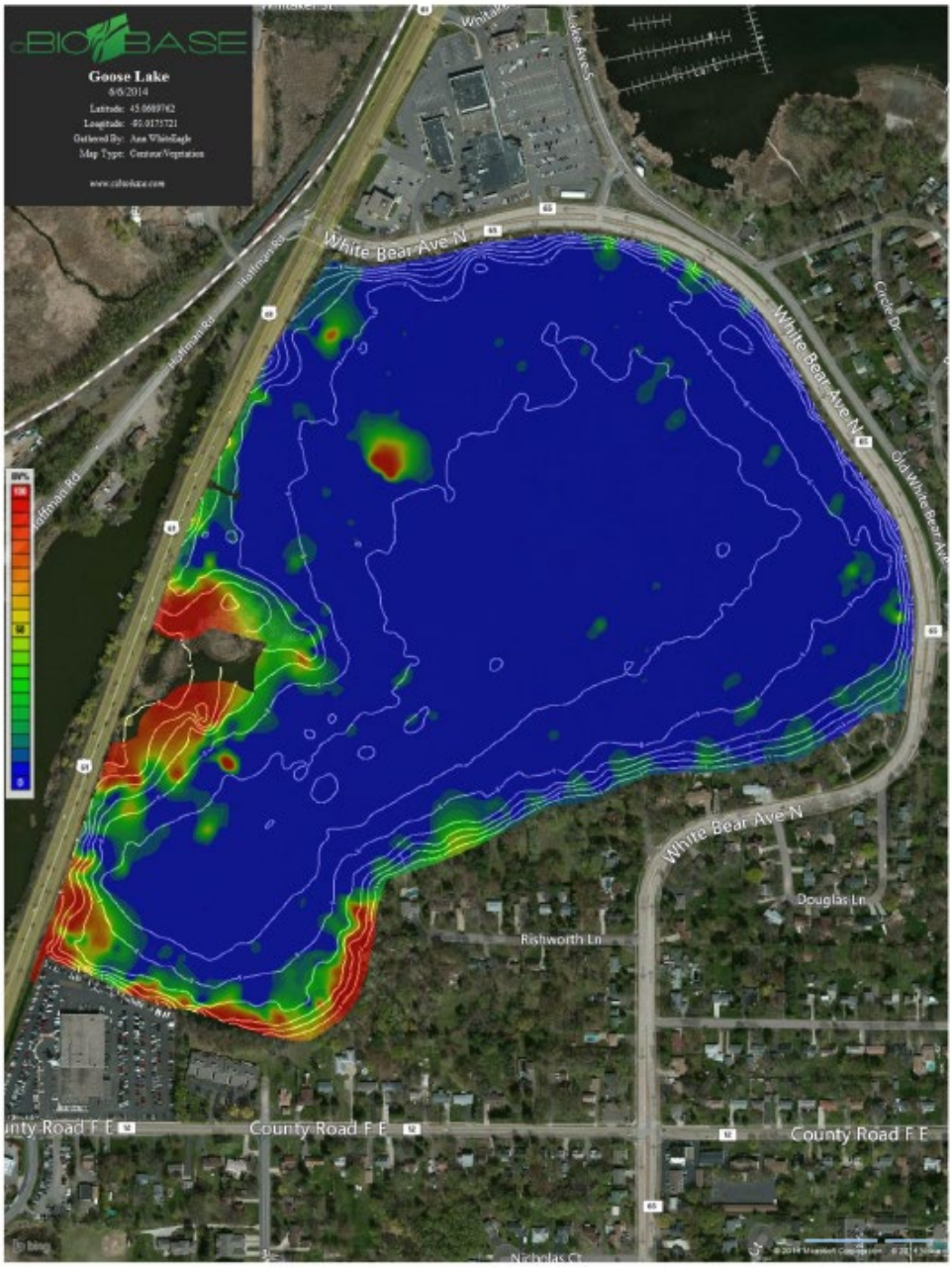


Figure 16: Biovolume map for East Goose Lake 2014. Plant growth is restricted to only the shallowest areas, likely due to dominance in the system by algae.



In 2019: Sampling occurred at 116 geo-referenced points 70 meters apart. Aquatic macrophytes were found at 10 of 116 points surveyed, all of which were located in West Goose Lake. The most prevalent species was invasive Curly-leaf pondweed (*Potamogeton crispus*), which had 100% occurrence, meaning that it was found at all 10 points where macrophytes were detected on West Goose Lake. Leafy pondweed (*Potamogeton foliosus*), Sago pondweed (*Stuckenia pectinata*), and Canada waterweed (*Elodea canadensis*) were also present in 1 to 3 points each. Algae present included Filamentous algae (*Spirogyra sp./Cladophora*), Blue-green algae (*Cyanobacteria*), and Muskgrass (*Chara*). The secchi disk reading was 1.0 ft (0.30m) in East Goose Lake and 1.5 ft (0.46 m) in West Goose Lake. The high turbidiy and algae levels in the lake appeared to be limiting plant growth, which is why plants were not more widespread in this shallow lake.

**Figure 17**: Macrophyte sampling with RCSWCD and VLAWMO staff.

Figure 2. Left: Green color of lake water on East Goose Lake – secchi disk visibility was 1 ft. No macrophytes were present at the 94 surveyed points.

Right: Blue-green algae and curly-leaf pondweed along the southern border of West Goose Lake. Secchi disk visibility was 1.5 ft, and macrophytes were found at 10 out of 22 surveyed points.

Figure 18: Point intercept locations. Green dots show locations where vegetation was detected.

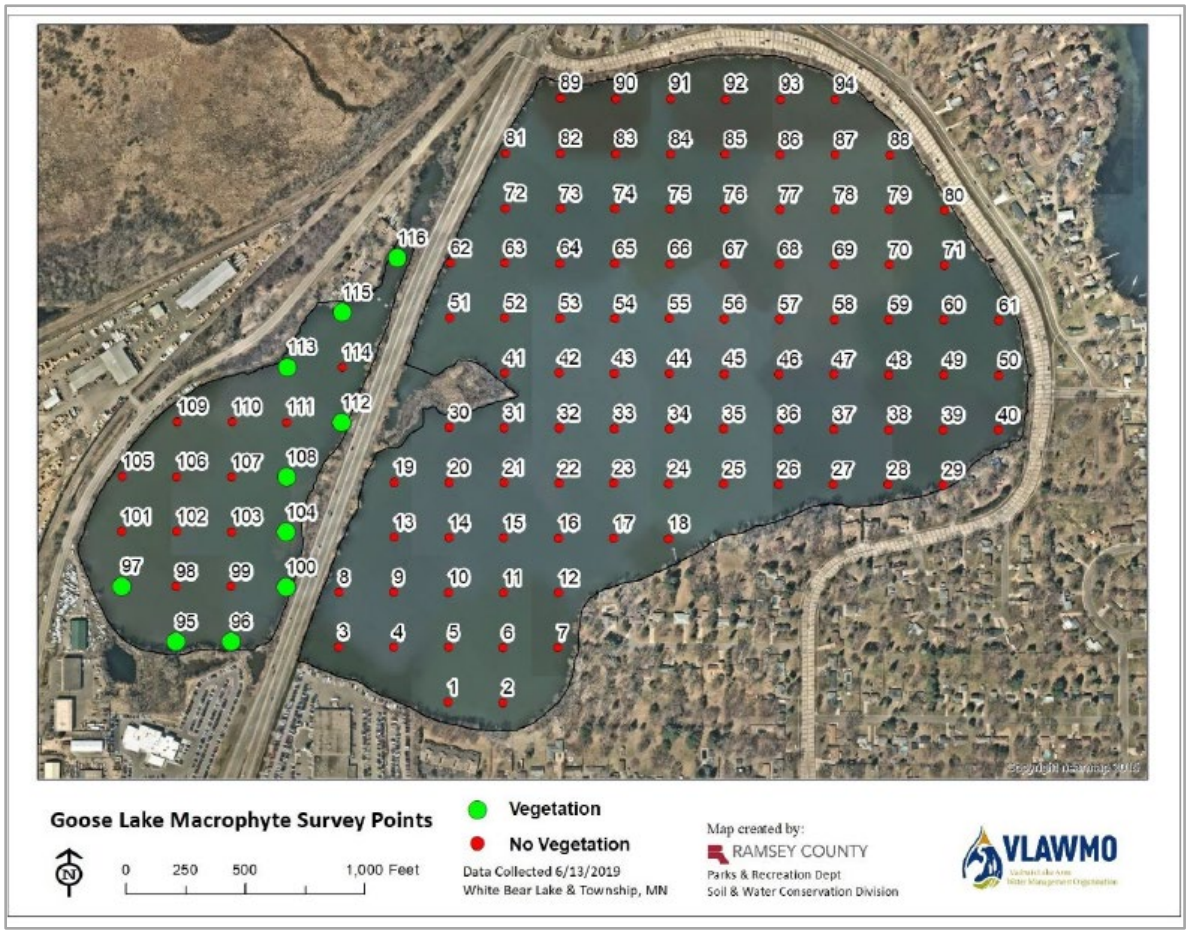
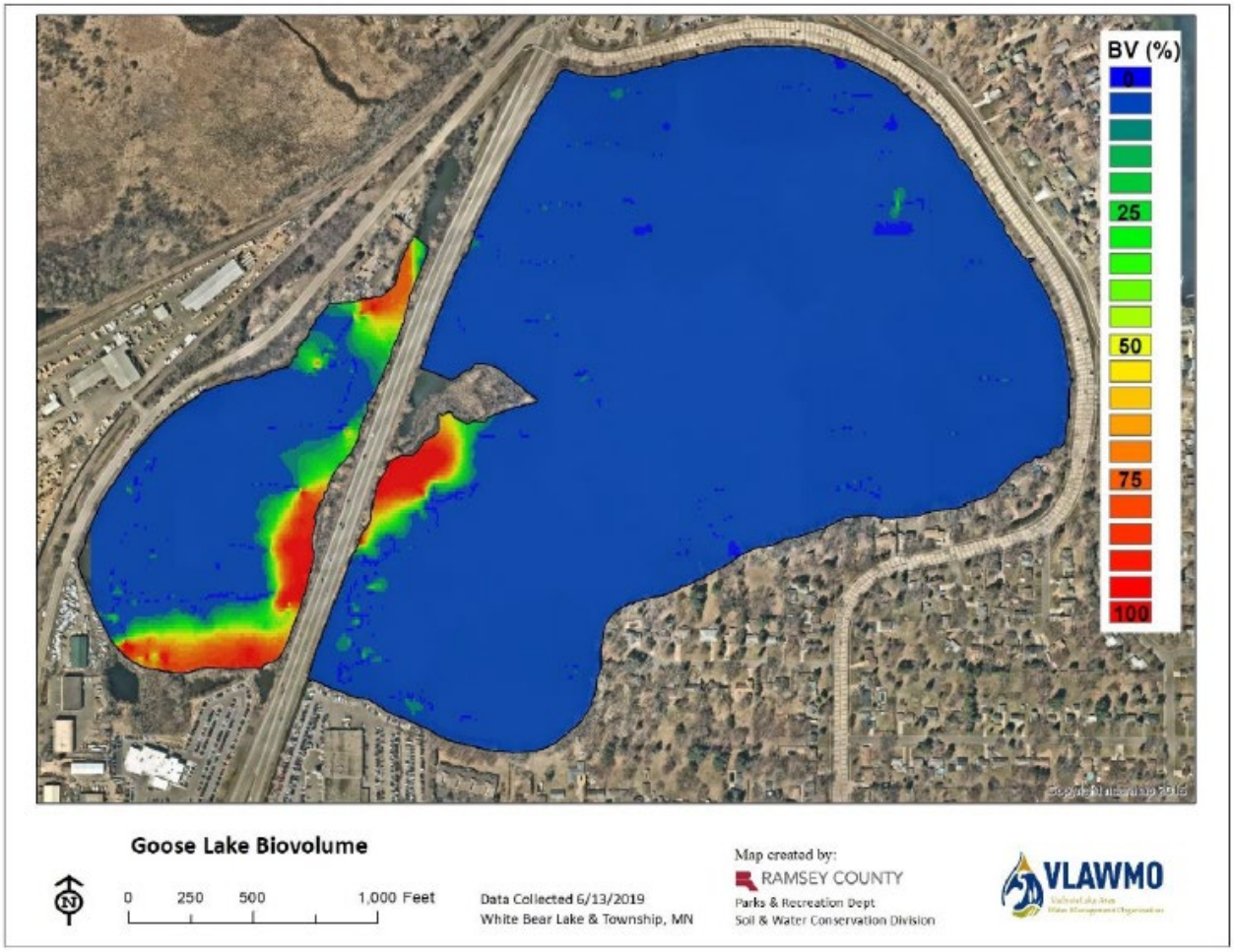


Figure 19: Biovolume map for East Goose Lake 2019. Plant growth is restricted to the shallowest areas, likely due to dominance in the system by algae.



## 3.3 FISH SURVEYS

MN DNR conducted a fish survey in 1986. Blue Water Science conducted fish surveys in 2012, 2017, and 2019.

In 2012, 6 standard trapnets were sampled for 2 days for a total of 12 lifts to survey fish in Goose Lake. The trapnet was a MnDNR-style with a 4x6 feet square frame with 2 funnel mouth openings and 50-feet lead. Net mesh size was 3/8 inch. Six standard trap nets were set on Monday morning July 16, 2012. Six nets were fished for the following 2 days (July 17, 18). A total of 10 fish species were sampled in Goose Lake on July 17-18, 2012. Bluegill sunfish were the most abundant species followed by black bullheads.

In 2017, the same protocol was used. Six standard trap nets were set on Wednesday morning September 6, 2017. Six nets were fished for the following 2 days (September 7 and 8). A total of 10 fish species were sampled in Goose Lake on September 7-8, 2017. Black crappies were the most abundant species followed by bluegill sunfish.

In 2019, the same protocol was used. Six standard trap nets were set on Monday morning September 23, 2019. Six nets were fished for the following 2 days (September 24 and 25). A total of 9 fish species were sampled in Goose Lake on September 24-25, 2019. Black bullheads were the most abundant species followed by bluegill sunfish.

### Comparison of 1986, 2012, 2017, and 2019 Fish Surveys

The first recorded Goose Lake fish survey occurred in 1986 and was conducted by the MN DNR. The 1986 results indicated a sparse fishery with moderate numbers of black bullheads and only 2 other species in low numbers (brown bullheads and white suckers). It is likely that winterkill was a frequent occurrence and limited fish numbers and reduced fish species. In 2012, fish were more abundant, especially in the East Goose basin. Black bullheads had a high density and may have been adversely impacting water quality. The VLAWMO sponsored bullhead removal by commercial fishermen and bullhead numbers were reduced based on the 2017 survey results. Black bullheads were not likely to be impacting water quality at this time. Also, in 2017, black crappies had a very high density whereas bluegill sunfish, yellow perch, and largemouth bass decreased compared to the 2012 survey. In 2019, black bullheads were the dominant fish and crappies declined compared to 2017 results. A partial winterkill may have occurred after the 2017 survey. In 2019, bullheads are abundant and predator fish are rare.

### Recommendations from fish surveys and bullhead removal

The trapnet survey in 2012 found the largemouth bass population had a high density and a size range from 6.5 to 16 inches indicating that several year classes of fish species were surviving over winter. Bluegills, yellow perch, and largemouth bass abundance (as fish/net) were above the typical MN DNR range for a lake like Goose. However bullheads were also abundant in 2012. The fish community changed based on findings from the 2017 survey. It appears commercial fishing successfully reduced bullhead densities. In somewhat of a surprise, black crappie numbers increased dramatically while largemouth bass, bluegill, and yellow perch numbers decreased. Black crappies were the top predator in Goose Lake in 2017. Largemouth bass were present and within a range typical for these types of shallow lakes.

In the 2019 fish survey, largemouth bass were absent and crappie numbers declined sharply

compared to 2017. Black bullhead abundance increased significantly. It appears a partial winterkill likely restructured the fish community by killing high oxygen-dependent species and favoring low oxygen tolerant species such as bullheads.

It is recommended that commercial bullhead removal be considered. The last time bullhead removal occurred, bullhead numbers declined and crappie numbers increased. Stocking bass may not be necessary since occasional winterkills seem to remove the bass and crappies may increase naturally without stocking and should exert predation on young bullheads.

Figure 20: Trapnet locations

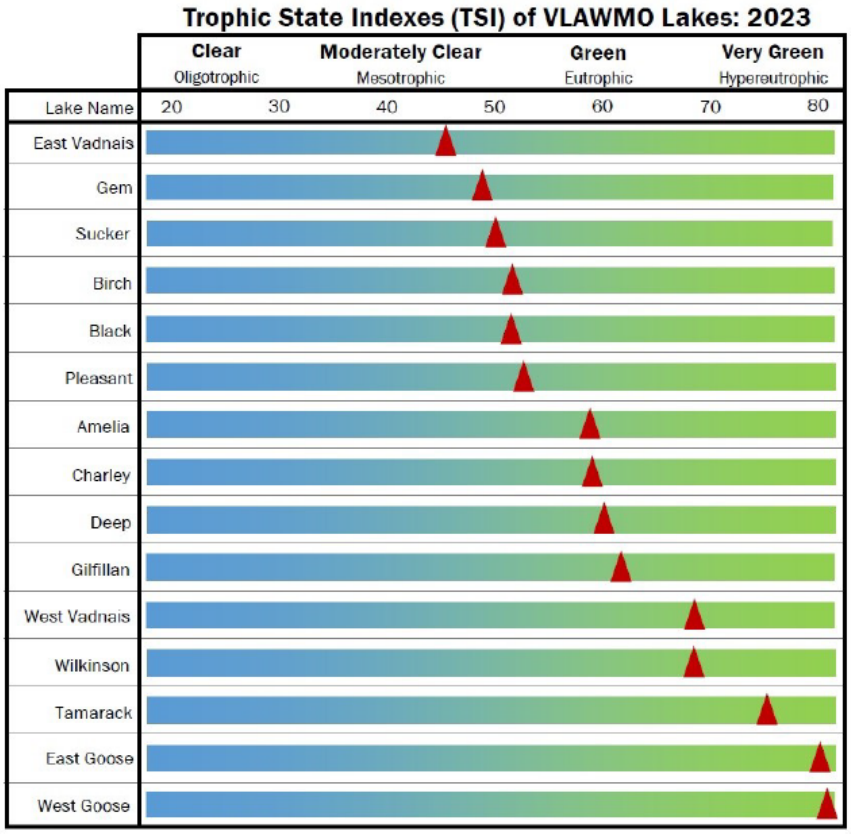

Figure 21: Photos from 2012 fish survey

| Snapping turtle from west basin caught during fish survey | Fish sampled from the east basin, July 2012 |
|---|---|
|  |  |

## 3.4 WATER QUALITY SUMMARY

East and West Goose Lakes are shallow and fall in the very green/hypereutrophic classification on the Trophic State Index (TSI) (shown below using the Carlson scale, MPCA). East Goose Lake had a score of 76 (2022) and 80 (2023). West Goose Lake had a score of 79 (2022) and 81 (2023). These lakes are consistently the most impaired lakes in the watershed.

**Figure 22**: TSI scores for VLAWMO lakes




VLAWMO has collected water quality (WQ) data on East Goose Lake since 1997 and West Goose Lake since 2006. VLAWMO staff collects WQ data and water samples biweekly, May-September, for water clarity (secchi disk), nutrients (TP, Chl-a, SRP, nitrogen), 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 resuspended 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.

- Red numbers indicate values that exceed MN State Standards.

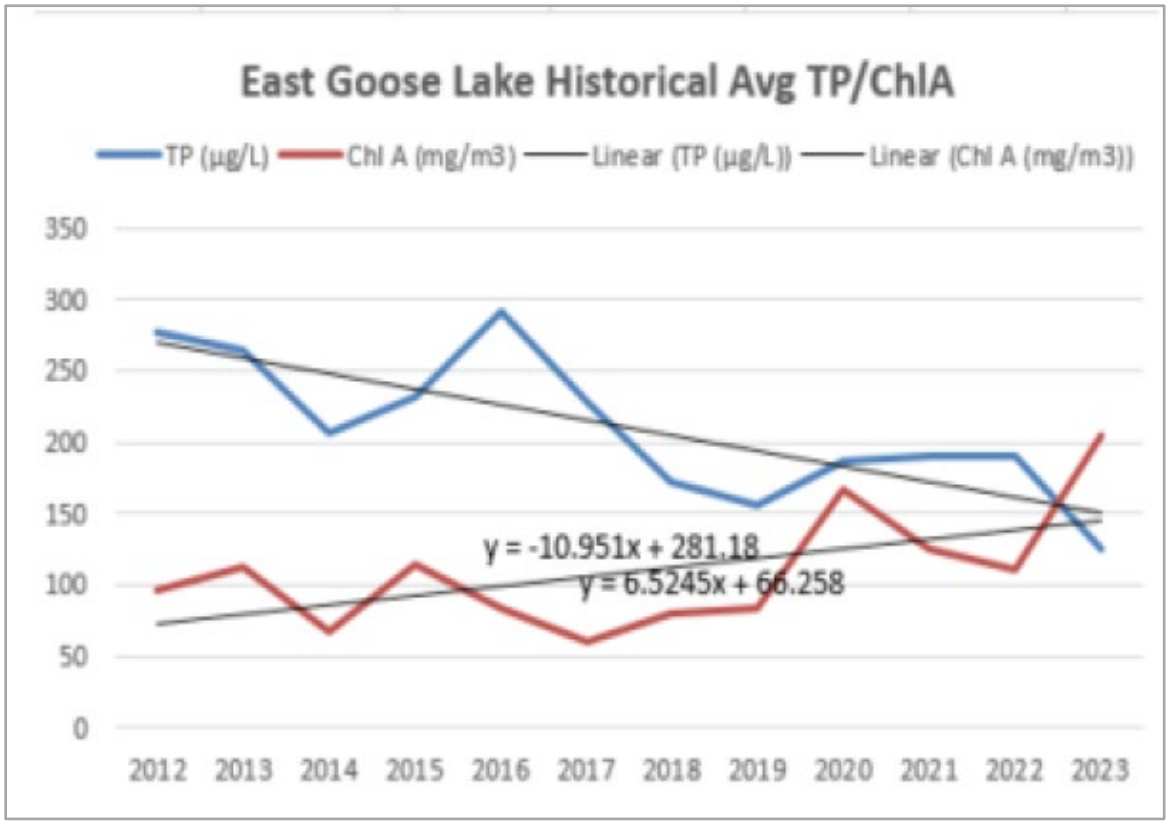
Table 1: East Goose Lake monitoring data

| East Goose Lake Historical Avg TP/Chl A/ SDT | | | |
|---|---|---|---|
| Year | TP (µg/L) | Chl A (µg/L) | Secchi (m) |
| 1997 | 21 | 134 | 0.4 |
| 1998 | 17 | 93 | 0.2 |
| 1999 | 475 | 56 | 0.3 |
| 2000 | 49 | 154 | 0.3 |
| 2001 | 603 | 28 | 0.3 |
| 2002 | 613 | 170 | 0.2 |
| 2003 | 342 | 66 | 0.3 |
| 2004 | 526 | 0 | 0 |
| 2005 | 407 | 38 | 0 |
| 2006 | 392 | 81 | 0 |
| 2007 | 260 | 97 | 0 |
| 2008 | 218 | 86 | 0.3 |
| 2009 | 237 | 121 | 0.3 |
| 2010 | 207 | 67 | 0.3 |
| 2011 | 164 | 48 | 0.3 |
| 2012 | 277 | 96 | 0.2 |
| 2013 | 265 | 112 | 0.5 |
| 2014 | 207 | 67 | 0.4 |
| 2015 | 231 | 115 | 0.6 |
| 2016 | 291 | 84 | 0.5 |
| 2017 | 228 | 60 | 0.7 |
| 2018 | 172 | 79 | 0.4 |
| 2019 | 155 | 84 | 0.4 |
| 2020 | 187 | 167 | 0.3 |
| 2021 | 191 | 125 | 0.3 |
| 2022 | 190 | 110 | 0.5 |
| 2023 | 126 | 205 | 0.2 |

Table 2: West Goose Lake monitoring data

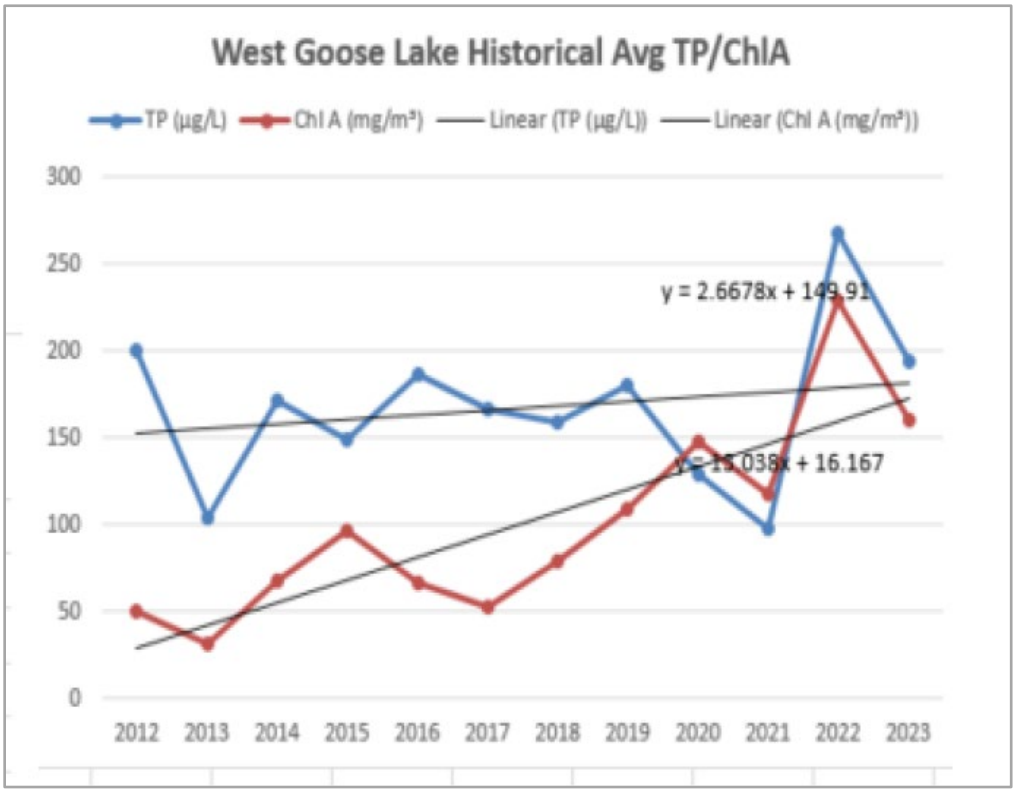
| West Goose Lake Historical Avg TP/Chl A/ SDT | | | |
|---|---|---|---|
| Year | TP (µg/L) | Chl A (µg/L) | Secchi (m) |
| 2006 | 213 | 58 | |
| 2007 | 159 | 66 | |
| 2008 | 168 | 55 | 0.3 |
| 2009 | 134 | 40 | 0.5 |
| 2010 | 129 | 39 | 0.5 |
| 2011 | 126 | 27 | 0.8 |
| 2012 | 200 | 51 | 0.7 |
| 2013 | 104 | 32 | 1 |
| 2014 | 172 | 68 | 0.5 |
| 2015 | 149 | 97 | 0.5 |
| 2016 | 187 | 67 | 0.4 |
| 2017 | 167 | 53 | 0.4 |
| 2018 | 159 | 79 | 0.4 |
| 2019 | 180 | 109 | 0.3 |
| 2020 | 129 | 148 | 0.3 |
| 2021 | 98 | 118 | 0.3 |
| 2022 | 268 | 229 | 0.6 |
| 2023 | 194 | 160 | 0.2 |

Figure 23: Water quality trends in East Goose Lake




.

Figure 24: Water quality trends in West Goose Lake



# 4 MANAGEMENT ACTIONS

## 4.1 RETROFIT RECOMMENDATIONS

**Retrofit Report (2011)**

In 2011, the Ramsey Conservation District (RCD), now RCSWCD, completed a Retrofit Report for Goose Lake. This was part of a larger effort to assess the full watershed and subwatershed scales and identify optimal locations for BMPs.

33 catchments, and their existing stormwater management practices, were analyzed for annual pollutant loading. Stormwater practice options were compared, for each catchment, given their specific site constraints and characteristics. A stormwater practice was selected by weighing cost, ease of installation and maintenance and ability to serve multiple functions identified by VLAWMO. Nine of the 33 catchments were selected and modeled at various levels of treatment efficiencies. These catchments should be considered the "low-hanging-fruit" within the Lambert Creek Subwatershed.

Goose Lake Subwatershed section description

This catchment is comprised of primarily commercial and industrial land use and contributes an average of 1.03 Total Phosphorus (lb) per Acre per Year (TP/Acre/Yr). Analysis shows that this catchment contributes the most TP/Acre/Yr second to catchment 9-2 which empties into Goose Lake before entering Lambert Creek. This catchment drains through a series of storm sewer pipes that carry storm water south discharging into Lambert Creek near Centerville road and County road F.

Recommendation

Due to favorable soil types on site, a combination of bio-infiltration types is recommended for this catchment. Where soils are found to be less than favorable additional soil amendments or bio-retention cells should be utilized. The majority of these bio-infiltration cells will rely on newly poured curb cut inlets and sediment forebays for conveyance of street runoff to the treatment cell. Where elevations of the road and/or land behind the curb line are more than gradual, retaining walls will be necessary. The boulevards in this area are wide and ideal for adequately sized bio-infiltration cells, however, where space is limited, such as in boulevards where sidewalk and curb lines define the useable space, we recommend poured concrete wall retainment to form "box planters" along the streetscape.

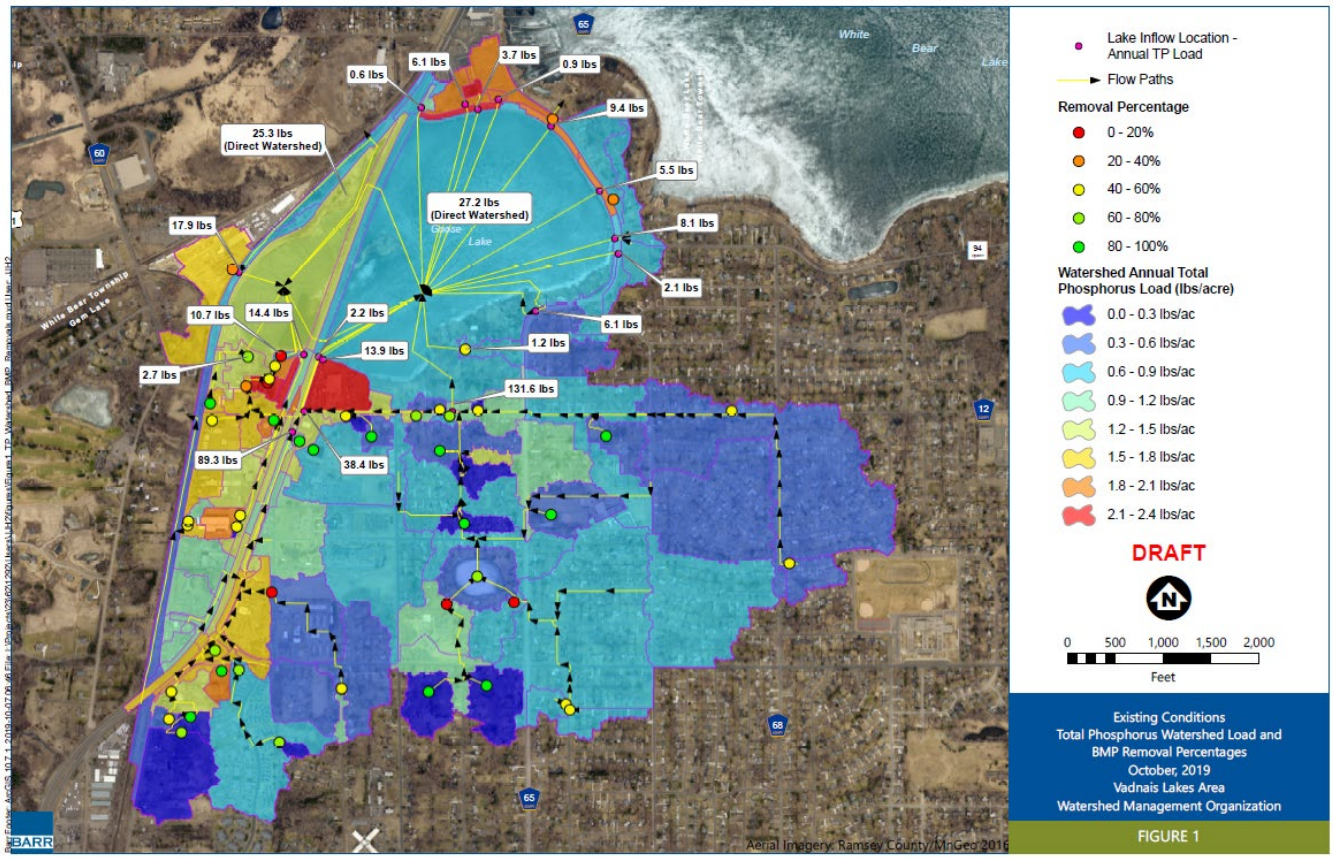
Alternate best management practices that could be placed within the catchment include porous asphalt strips and a detention basin. South within the catchment is municipal owned land where an extended detention basin could be constructed. Pond construction would be complex and include day lighting a portion of the storm sewer system to flow into this basin. The design criteria for a storm water pond, according to The Minnesota Stormwater Manual, states that the permanent pool volume for a stormwater pond should be sized 1800 cubic feet per acre draining to the pond and have the appropriately-sized live storage capacity which in conjunction could have the potential to remove 50% of the TP. Given the approximate watershed size flowing to this point estimated at 25 acres the permanent pool of the pond could be sized at 1666 cubic yards with a live storage area of approximately half of the permanent pool size estimated at 833 cubic yards.

Figure 25: Goose Lake Subwatershed: 3 subcatchments focused upon for recommended retrofits

### Retrofit Recommendations (2020)

In 2020, VLAWMO worked with Barr Engineering to identify possible retrofit locations to improve water quality in Goose Lake. Price estimates were provided as part of that effort but should no longer be considered current. Locations for possible BMPs are shown in the figure below. More information on these possible projects can be found in the document titled Early Project Feasibility Investigation by Barr (2020).

Figure 26: Barr Engineering map that shows potential locations for BMPs



### Potential for Alum Feasibilities

Five feasibility studies have been conducted to carefully analyze the potential for alum to improve water quality in East and West Goose Lake. No plans for an alum treatment are underway by VLAWMO at this time. The studies that have been completed include:

- INTERNAL P LOADING AND SEDIMENT FRACTIONATION WEST GOOSE (2010 BY ERDC)
- INTERNAL P LOADING AND SEDIMENT FRACTIONATION EAST GOOSE (2014 BY WENCK)
- EAST GOOSE EQUILIBRIUM EXCHANGES OF SOLUBLE P (2015 BY WENCK)
- EAST AND WEST GOOSE AND WILKINSON LAKE ALUM FEASIBILITY (2017 BY BARR)
- EAST AND WEST GOOSE AND OAK KNOLL POND ALUM FEASIBILITY (2018 BY BARR)

## 4.2 COMPLETED BMPS AND PROJECT PARTNERSHIPS IN THE SUBWATERSHED

Best Management Practices (BMPs) are implemented to improve and protect water quality. Common small-scale examples of BMPs include raingardens, infiltration basins, shoreline restorations, rain barrels, and native restorations and plantings. Larger BMPs include stormwater retention basins, iron-enhanced sand filters, weirs and stormwater conveyance retrofits, and in-lake treatments such an alum treatment, rough fish management, or aquatic vegetation management.

Completed BMPs for Goose Lake include:

- Rough fish removal in partnership with the district commercial fisher (2015)
- Maintenance-access boat ramp installed in partnership with the City of WBL (2021)
- Trial predator fish stocking in partnership with MN DNR (2021 and 2022); predator fish did not survey to be detected in follow-up annual surveys
- A demonstration spent-lime treatment in Oak Knoll Pond (2023-2024)

Figure 28: Spent lime demonstration project, which was completed during summer 2024

Figure 27: Completed Cost-share BMPs