

Sustainable Lake Management Plan Goose Lake



**Prepared by The
Vadnais Lake Area Water Management Organization**

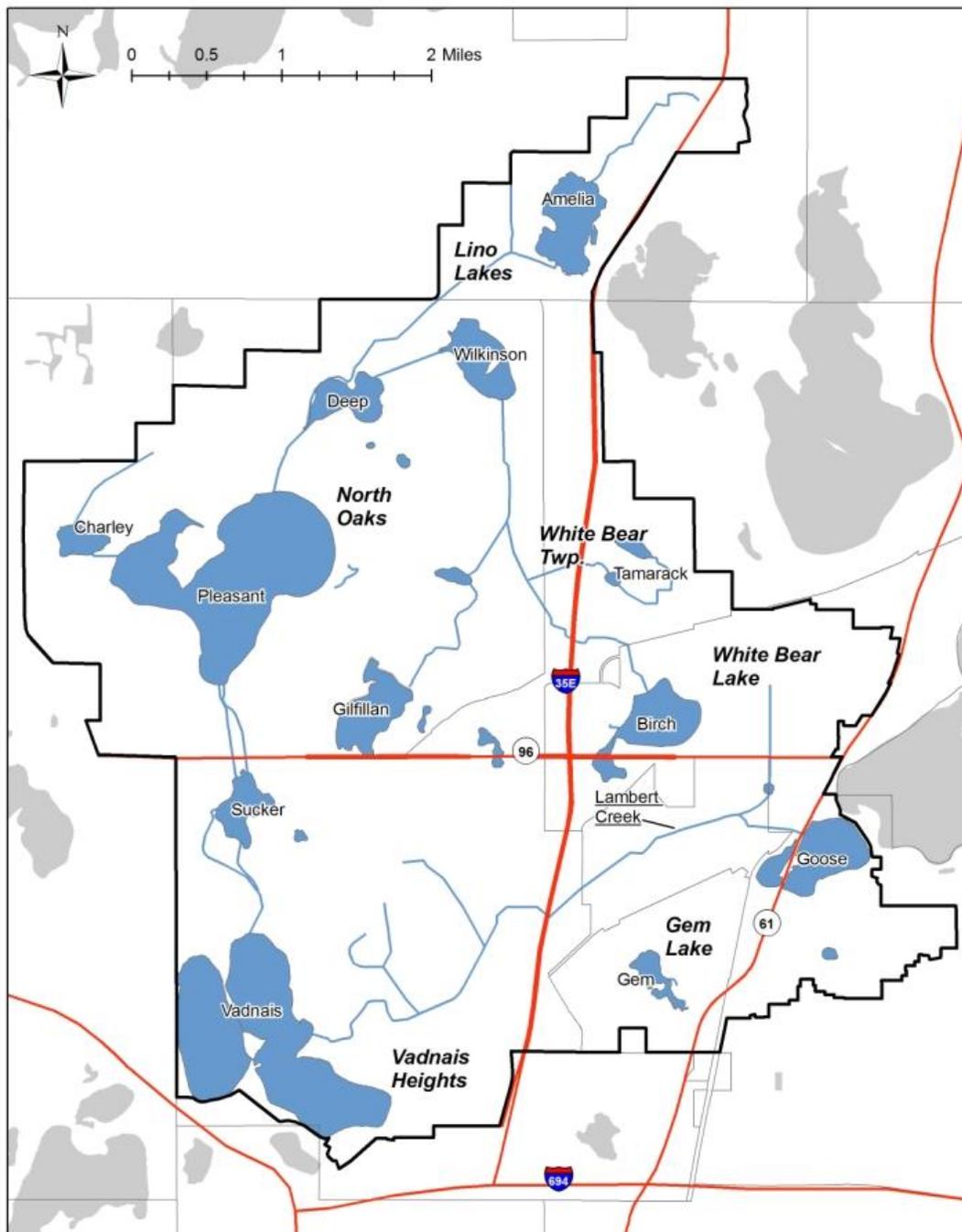
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Introduction

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 two basins and is connected by two 24 inch culverts running under Highway 61. West Goose is the smaller of the two basins at 27 acres. East Goose is the larger of the two basins at 113 acres. Goose Lake sits in a large 1124 acre sub watershed 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 is used to cool equipment at the Morning Star Plant and is then discharged into the lake. About 250,000 gallons of water a day is discharged into the lake from the Morningstar Plant. Even though these basins are connected there is a very noticeable difference in both water quality and biology between the two sides as described in this report.

[Location Map](#)



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 commercial buildings are located on the south end of the basin. Bald Eagles, Trumpeter Swans, ducks, and Geese are just some of the observed fauna. The studies for this report were conducted by VLAWMO, Ramsey Conservation District, Blue Water Science and Wenck Associates, Inc. All figures and tables were created by Wenck, VLAWMO, and Ramsey Conservation District unless otherwise noted. The studies and surveys are attached as Appendices. Homeowners have assisted VLAWMO with monitoring activities over the years. The Ski Otters, a ski team that uses the west basin for shows and practice, have been active stewards of the lake for many years. Partnership is the keystone of success for VLAWMO and this report is an excellent example of that cooperation.



Snapping turtle from west basin caught during fish survey



Fish sampled from the east basin, July 2012

Watershed Features

History

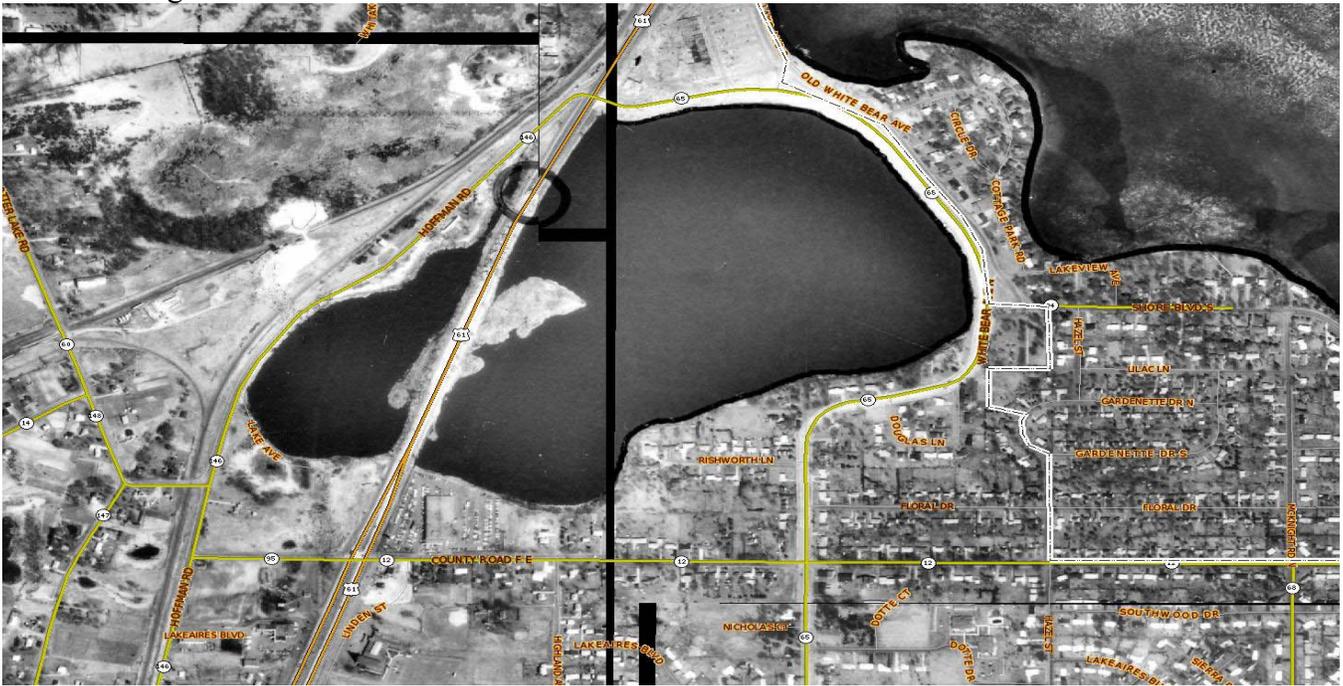
This is a **1940 aerial** photo of Goose Lake. There is little standing water in the photo, the “lake” looks to be more of a wetland/bog. First picture is of West Goose along Hoffman Rd 1941 after tornado.



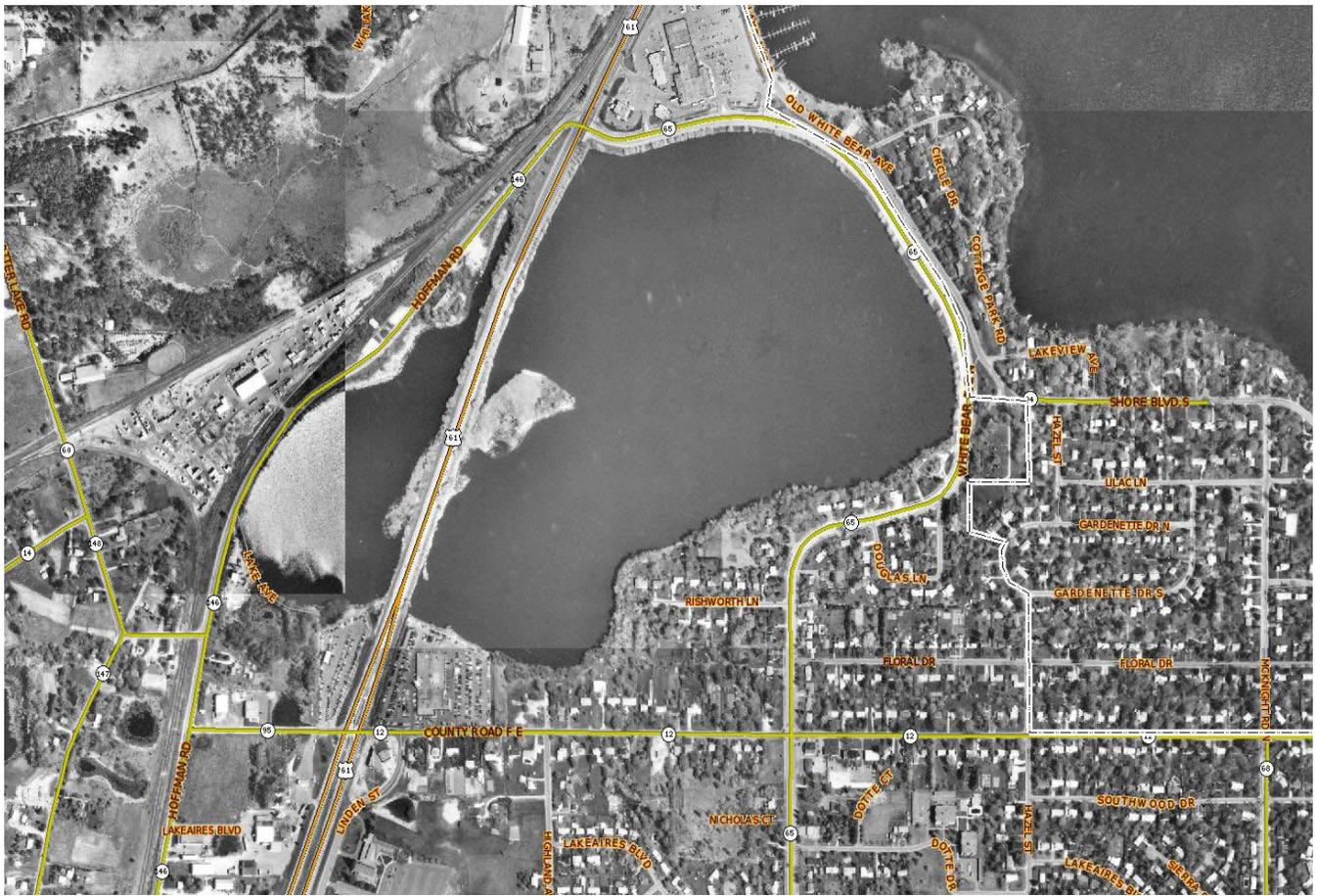
Here is the **1953 aerial** photo. Goose was dredged some time during the 1940's early 1950's. Highway 61 was also built in the early 1950's separating Goose lake into the two basins.



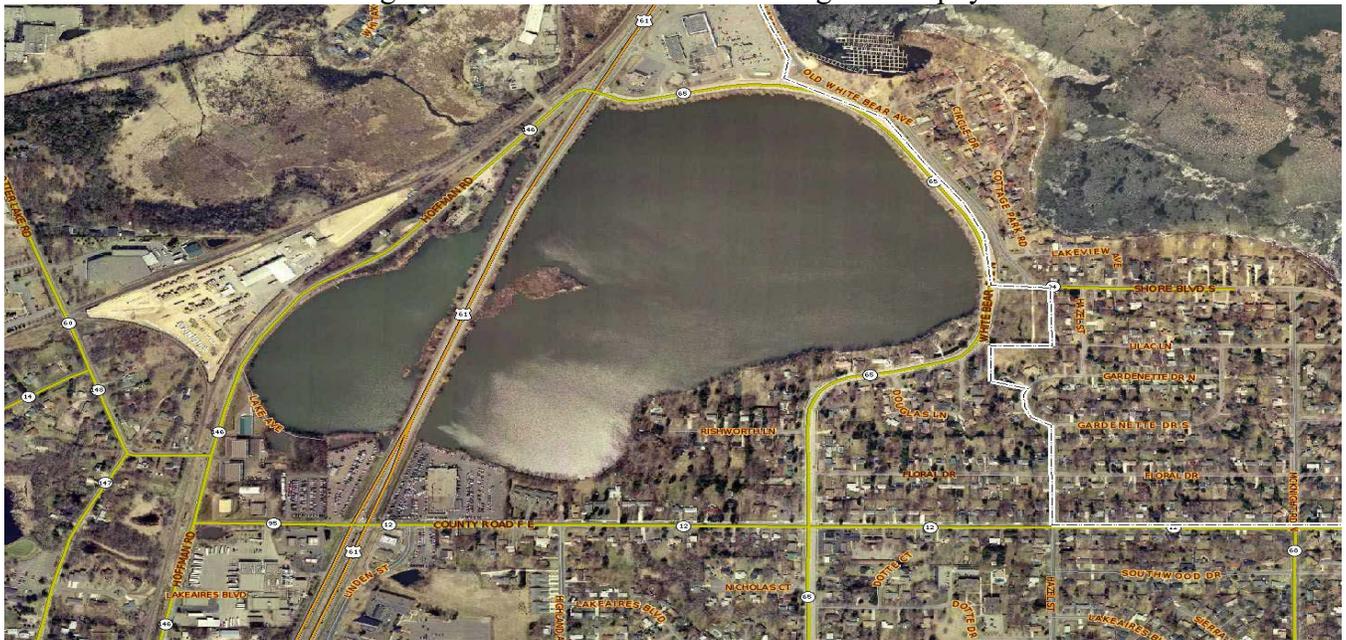
This is the **1974 aerial**. More structures are appearing around Goose lake. White Bear Lake Sewage Plant discharged into the north end of the East basin



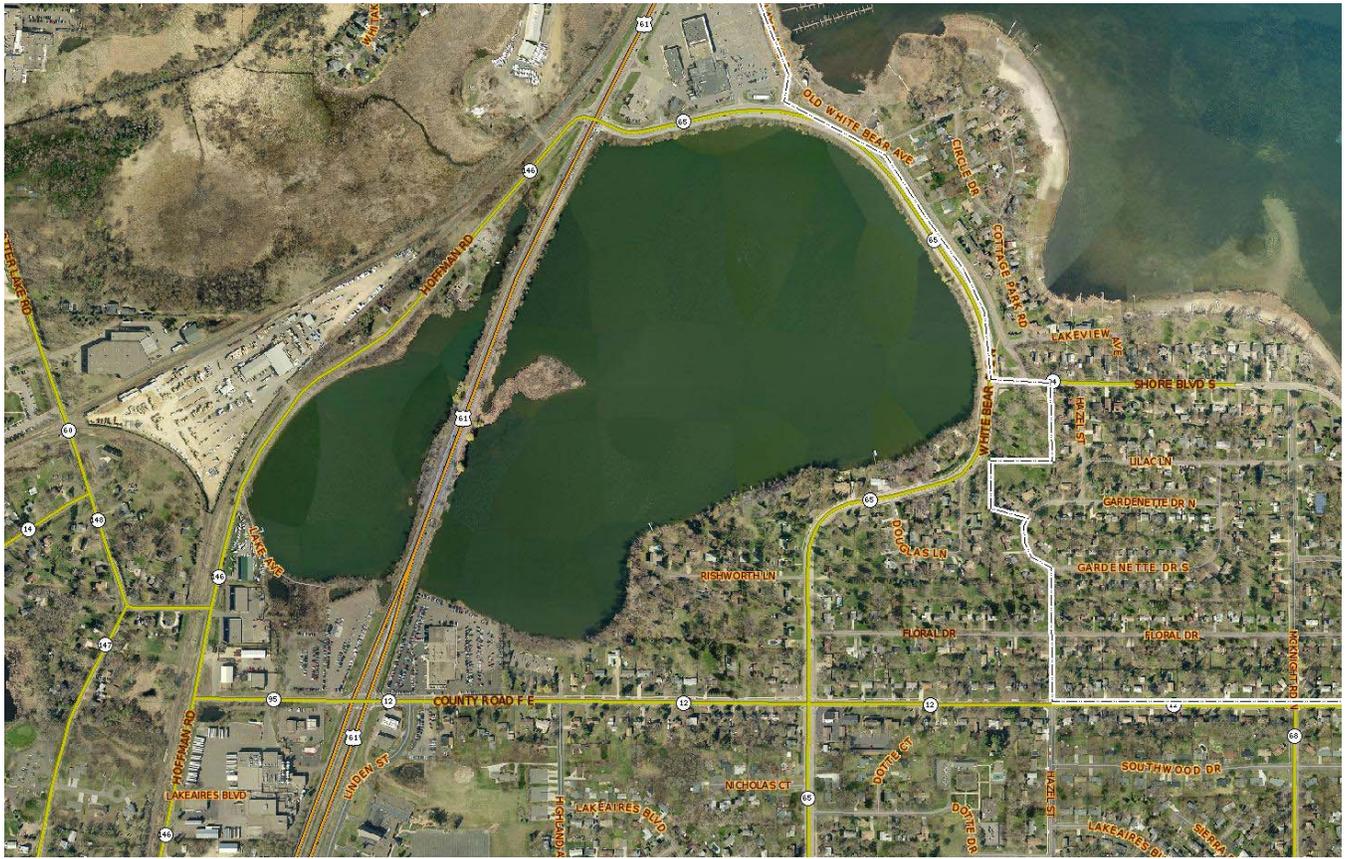
1985 aerial. The Morningstar Plant is now visible on the south end of West Goose Lake. Cooling water is likely being discharged into the basin.



2006 aerial. You can see the green color of the lake from the high chlorophyll levels.

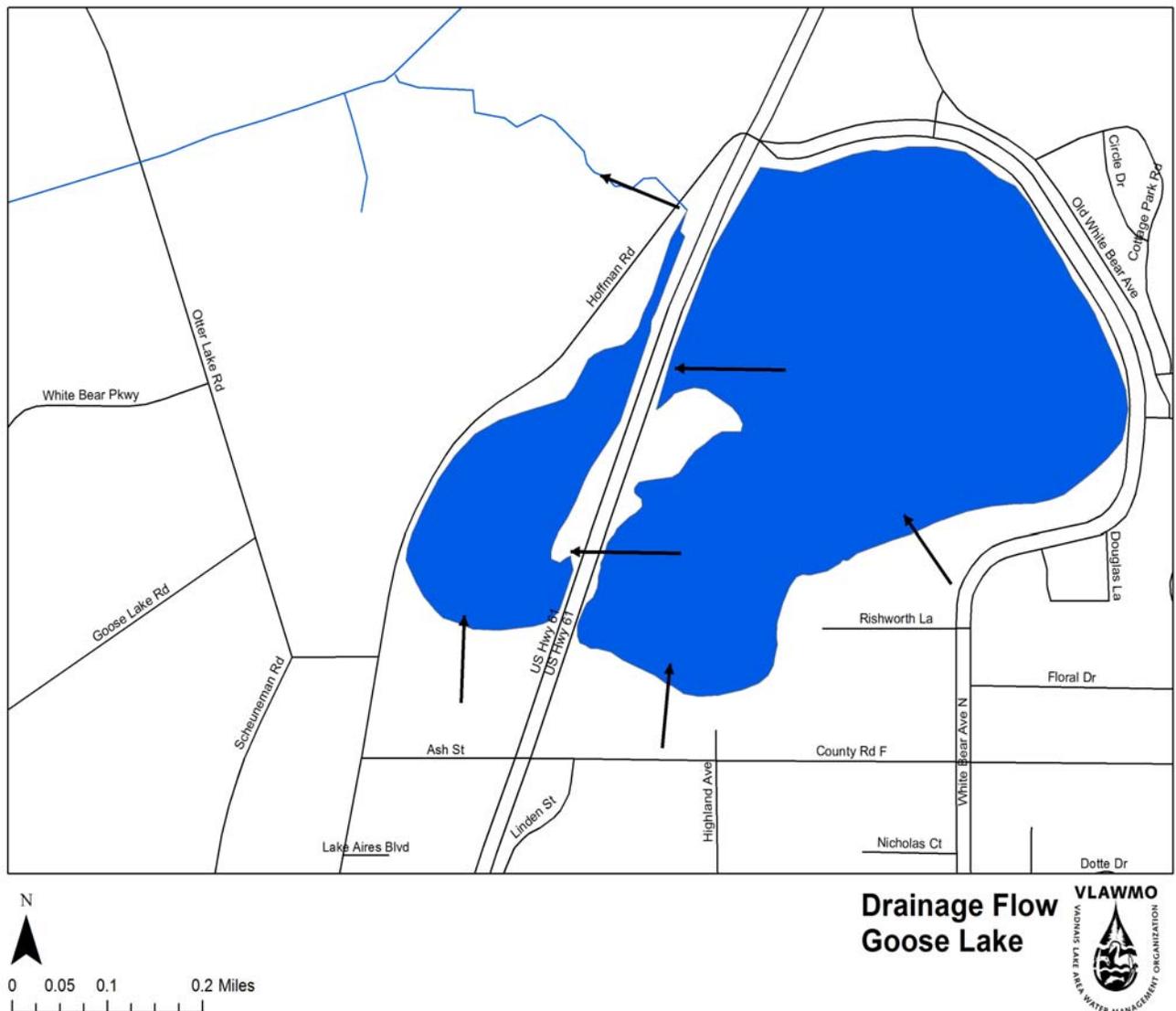


2012 aerial. Aerial color is brighter than the one above, but still shows the high chlorophyll level indicated by the green water color compared to that of White Bear Lake to the north east. .



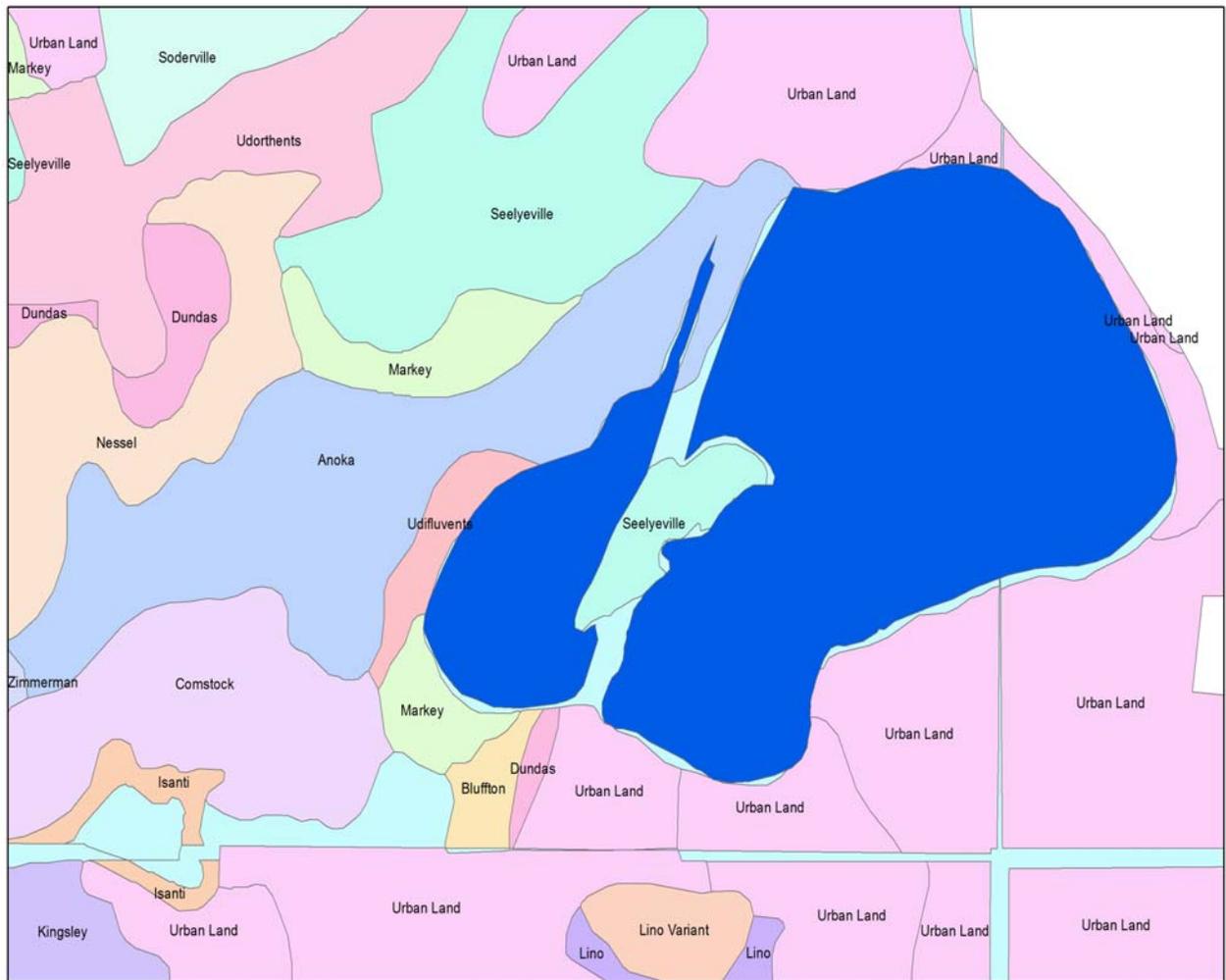
Drainage area

It is important to understand where water flows into and out of a waterbody in order to ascertain the potential inputs of pollutants. 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 (appendix A & B) goes into more detail on the ground water and watershed effects on Goose Lake.



Soils

Soils within the Goose Lake sub watershed is 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 (Appendix A) and the ERDC report (appendix D). The sediments raise no major concerns but do suggest an internal loading possibility due to the above normal phosphorus levels in the sediment. The rough fish present in the lake can stir up this sediment, releasing the nutrients trapped in it causing the high nutrient levels we see in the lake today. A fish survey was done on Goose Lake summer of 2012 by Blue Water Science (Appendix C).

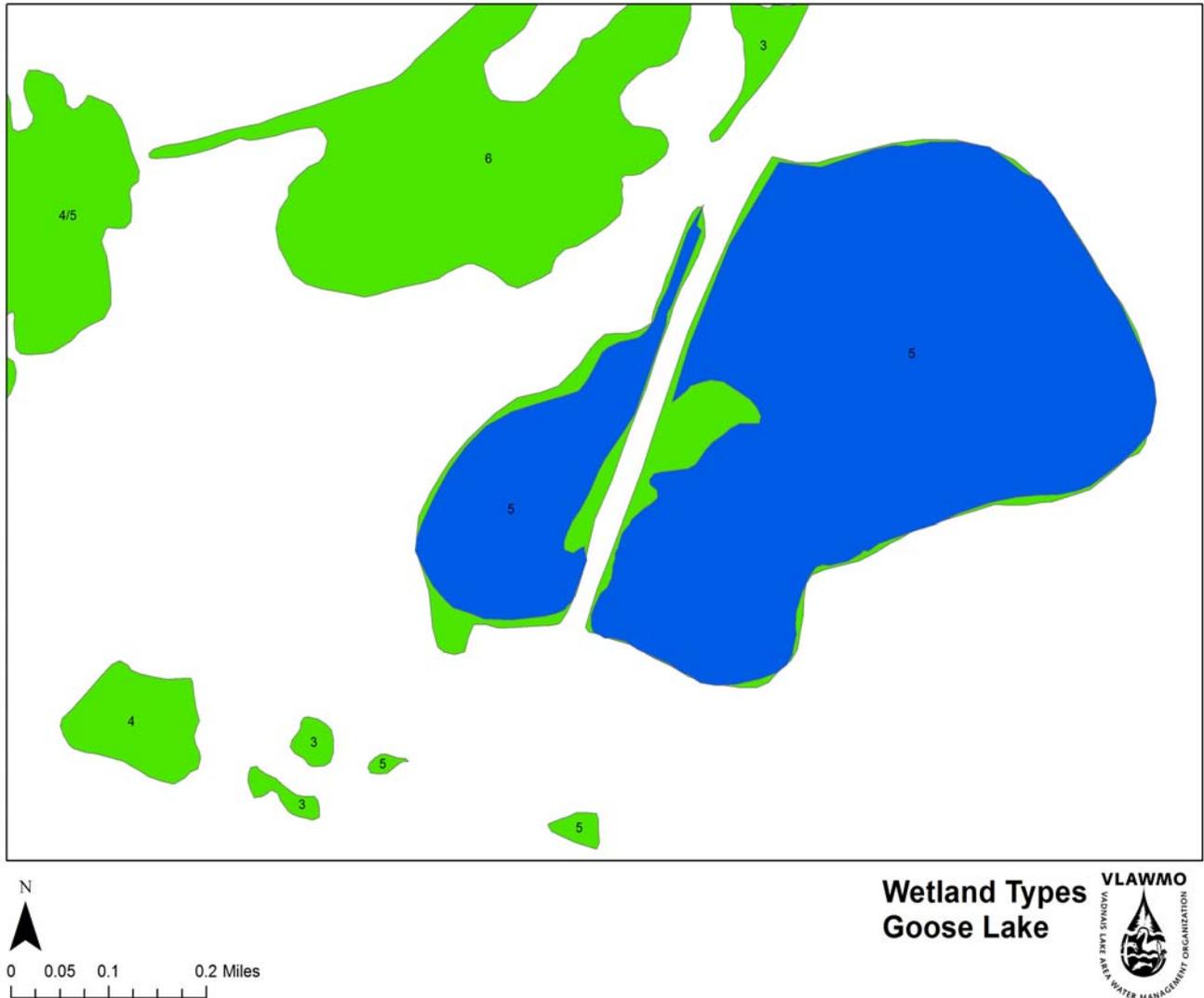


**Soil Types
Goose Lake**



Wetlands / Watershed

There are few wetlands around Goose Lake. With the large size of the sub watershed 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 an implementation plan to address the impairments. Wetlands are numbered on the map and the key is below.

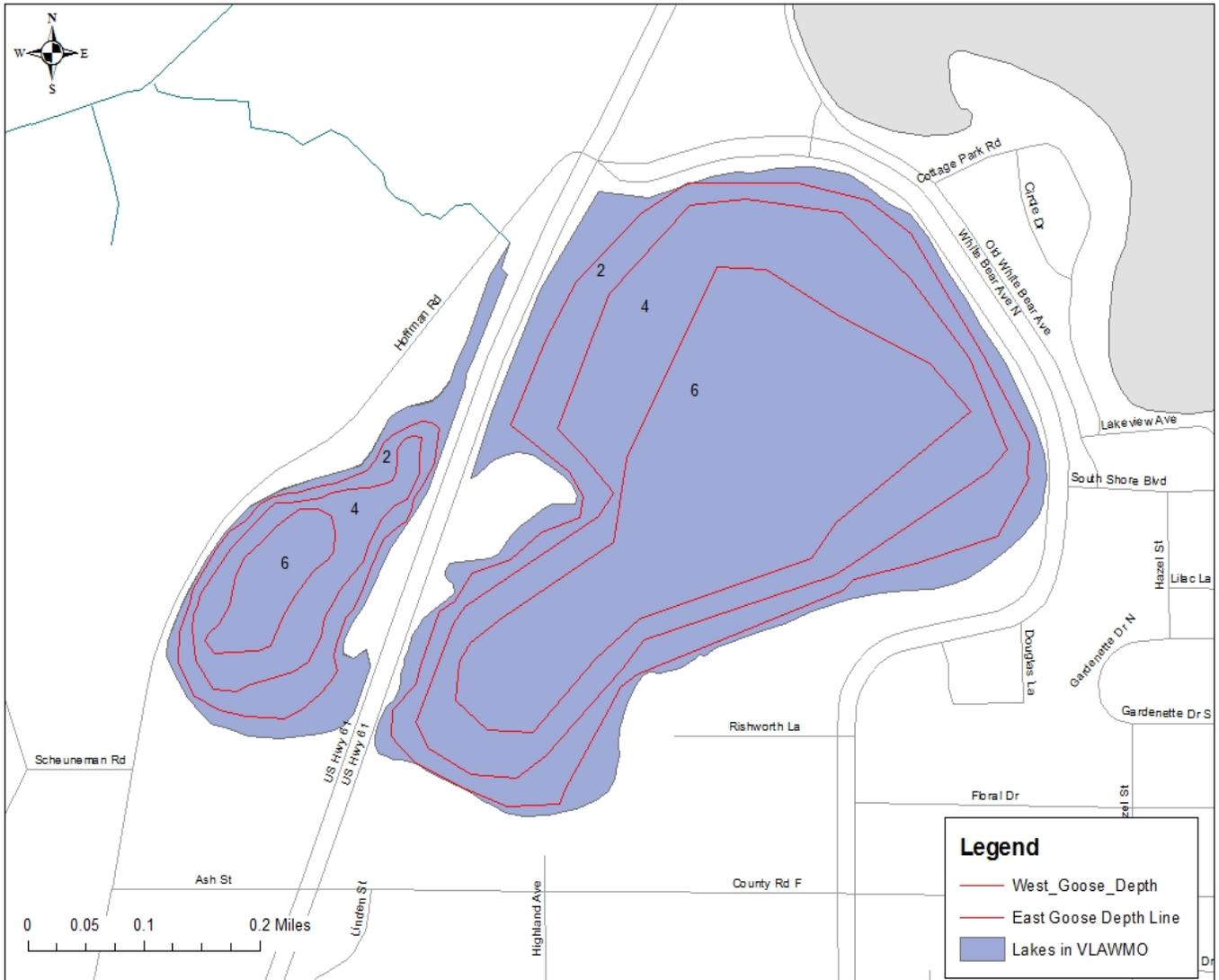


Wetland Types

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

A. Lake Depth

The summer of 2011 VLAWMO conducted a lake depth survey on both the East and West basins of 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 does monitor the lake level and it ranges between and elevation of 924-925 ft. Due to the weir structure out letting to Lambert Creek on the north end of the west basin and the inflow of groundwater from the Morning Star plant on the south end of the west basin water levels stay pretty constant throughout the year.



Appropriation Permit

The Minnesota Pollution Control Agency (PCA) provides and appropriations permit to the Morning Star plant which allows them to discharge groundwater into Goose Lake. The water must meet certain temperature and chemical/nutrient criteria set by the PCA. The PCA monitors this information quarterly. This information is on the PCA website. www.pca.state.mn.us

B. Lake Water Quality Summary

Goose Lake is very eutrophic as indicated by table on page 13. It is on the states impaired list for nutrients and is part of a TMDL study completed winter of 2014. Goose is above state standards for both phosphorus (TP) and chlorophyll (ChlA). Water quality data has been collected since 1997 and is shown below. Also included are the water quality comparisons of each basin. Overall, phosphorus and chlorophyll levels are very high for a shallow lake in this ecoregion. Water transparency is very poor. The high nutrients in the lake are a bit of a mystery considering the flushing it receives from the Morning Star Plant ground water, but it is a large urbanized watershed with a lot of runoff entering the lake. Runoff and internal loading most likely are causing the high nutrient levels.

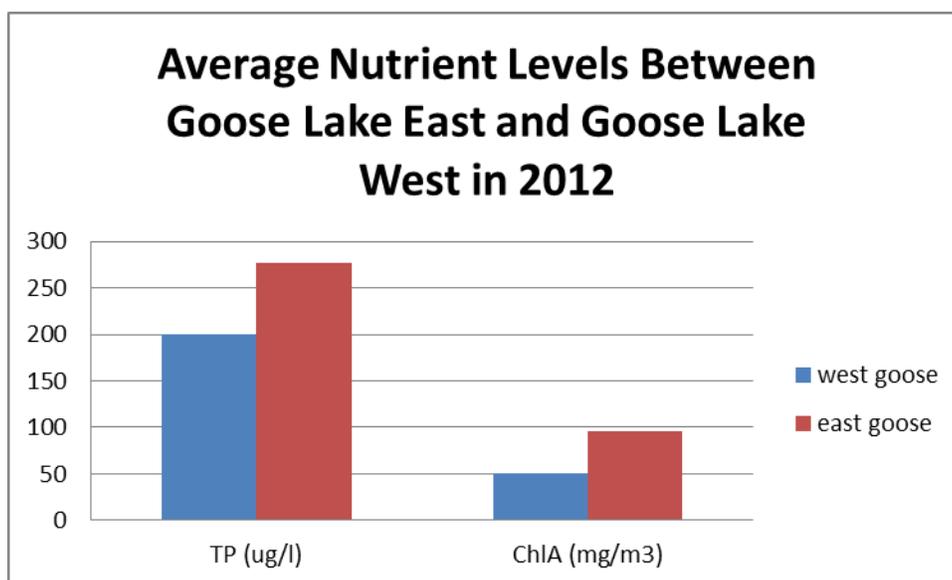
East Goose Lake Historical Avg TP/Chl A/SDT			
	TP (ug/L)	Chl A (mg/m3)	Secchi (m)
1997	21	134	0.4
1998	17	93	0.2
1999	475	56	0.3
2000	49	154	0.3
2001	603	28	0.3
2002	613	170	0.2
2003	342	66	0.3
2004	526	0	0
2005	407	38	0
2006	392	81	0
2007	260	97	0
2008	218	86	0.3
2009	237	121	0.3
2010	207	67	0.3
2011	164	48	0.3
2012	277	96	0.2

West Goose Lake Historical Avg TP/Chl A/SDT			
	TP (ug/L)	Chl A (mg/m3)	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

Numbers in red indicate above PCA Standard.

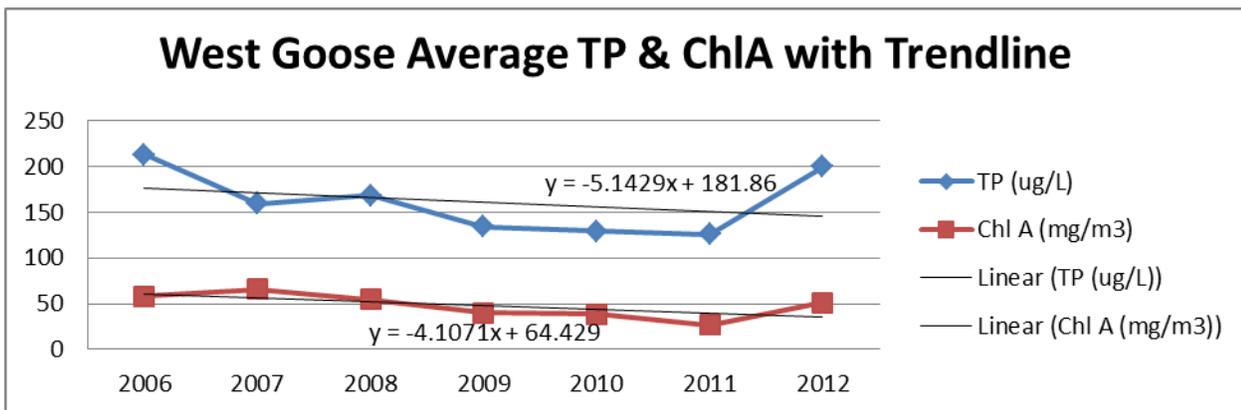
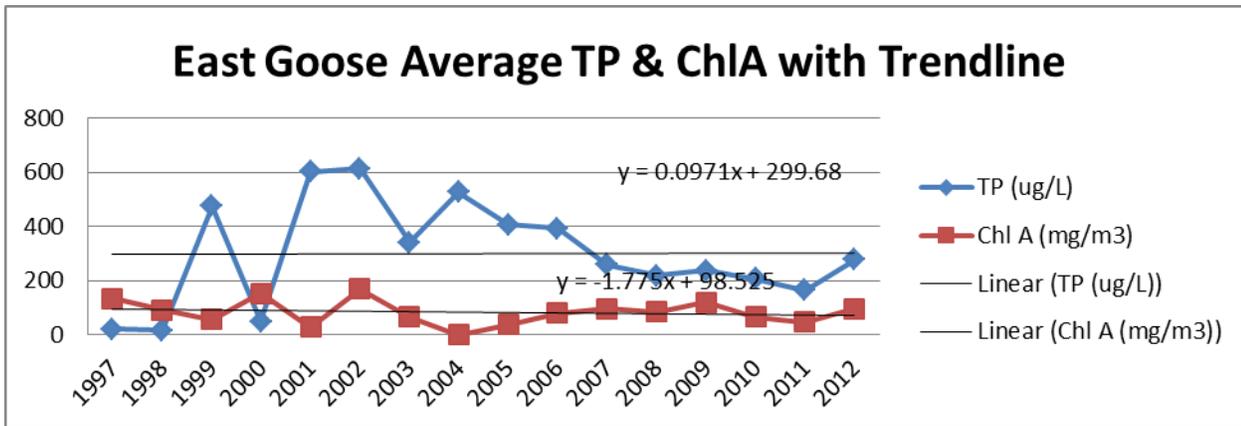
Standards Below

- Total Phosphorus (TP) < 60 ug/l
- Chlorophyll a (ChlA) < 20 mg/m3
- Secchi Disk < 1.0 m



Phosphorus (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 wastes, soil erosion, detergents, septic systems, and runoff from yards and streets. The standard level set by the Minnesota Pollution Control Agency (MPCA) is less than 60 ug/L. **Goose Lake currently exceeds the MPCA standards.**

Chlorophyll A (ChlA) is a green pigment in algae. Measuring Chlorophyll A concentration gives an indication of how abundant algae are in a waterbody. The MPCA standard for Chlorophyll A is less than 20 mg/m3. **Goose Lake is well above the limits set by the MPCA.**



Both the east and west basin of Goose Lake show a flat or slightly declining trend in average nutrient levels over the years. Even though Goose Lake is very high in nutrients, this data shows that the basins are not getting worse on average over time.

2012 TSI Calculations (Carlson Trophic State Index)												
	ameli a	birch	black	charli e	deep	ge m	gilfilla n	goos e east	goos e west	tamarac k	west vadnai s	wilkinso n
TSIS	59	50	47	59	60	50	63	83	65	73		62
TSIP	57	53	54	66	69	58	65	85	81	74		71
TSIC	52	41	48	56	55	54	58	75	69	71		67
avg.	56	48	50	60	61	54	62	81	72	73		67

TSI < 40 Oligotrophic: relatively nutrient-poor, deep, clear lake with bottom waters high in dissolved oxygen, but some shallower lakes will become anoxic in the hypolimnion during the summer

TSI 40 - 50 Mesotrophic: moderately clear lake, but with an increasing probability of anoxia in hypolimnion during summer

TSI 50 - 70 Eutrophic: nutrient-rich, usually shallow, "green" lake with limited oxygen in the bottom water layer

TSI > 80 Hypereutrophic: very nutrient-rich lake characterized by frequent and severe nuisance algal blooms and low transparency

C. Lake Sediments

A study of Goose Lake sediment was conducted summer of 2010 by VLAWMO and Wenck. Results were analyzed by the Engineer Research and Development Center (ERDC). The detailed report can be seen in Appendix D. Only the west basin of Goose Lake was analyzed.

D. Aquatic Plant Status

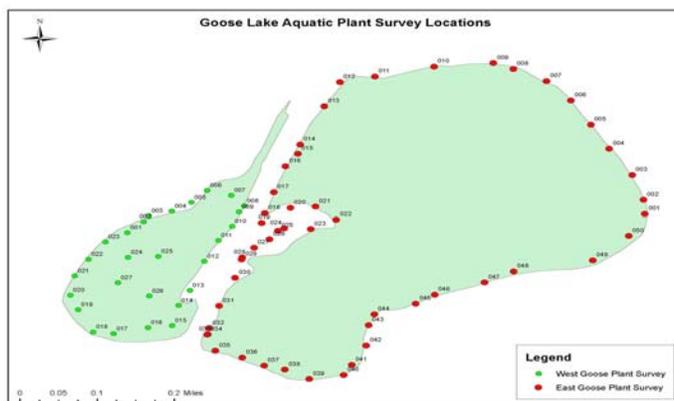
A late summer (August 2010) survey tracked the amount and location of aquatic plants in Goose Lake. The most abundant plant in the west basin was Elodea, a native plant, and it was found at nearly every site that was surveyed. The only other plant observed on the west basin was Narrow-leaf Pondweed and this was only present in a few locations. There were no invasive aquatic plants found during this survey, but curly leaf pondweed, an invasive, is present in the west basin. Due to the survey being conducted in the fall, and the life cycle of curly leaf pondweed, it was not present in the survey.

To our surprise, there were virtually no aquatic weeds present in the east basin of Goose Lake. Only 6 of the 50 sample sites had aquatic vegetation. Both of these basins have very low secchi readings and large population of rough fish. The drastic difference observed between these two basins could be explained by the ground water being pumped into the west basin, which is pretty isolated from the east basin and only connected by two 24inch culverts.

In the spring of 2014 Ramsey conservation District along with VLAWMO staff conducted a macrophyte survey on both the east and west basins of Goose lake (appendix E & F) using CI biobase technology. Bathymetry and biovolume were measured along with abundance of all aquatic species.

The invasive weed curly leaf pondweed was very abundant in the west basin and is spreading into the east basin around the culverts that connect the two basins under Hwy 61.

Also in 2014 the Ski Otter's Ski Club began a weed harvesting program to help combat curly leaf pondweed on the west basin



East Goose Lake Aquatic Plant Survey 8/12/2010			West Goose Lake Aquatic Plant Survey 8/4/2010		
GPS Points	Prevalence on a Scale of (1-5)		GPS Points	Prevalence on a Scale of (1-5)	
	Elodea	Narrow-leaf pondweed		Elodea	Narrow-leaf pondweed
1	0	0	1	0	0
2	0	0	2	0	0
3	0	0	3	0	3
4	0	0	4	0	0
5	0	0	5	1	2
6	0	0	6	0	5
7	0	0	7	0	5
8	0	0	8	0	5
9	0	0	9	0	5
10	3 (dying)	0	10	0	5
11	0	0	11	0	5
12	0	0	12	0	5
13	0	0	13	0	1
14	0	0	14	0	5
15	Culvert 1		15	0	5
16	0	0	16	0	5
17	0	0	17	0	1
18	0	0	18	0	5
19	0	0	19	0	0
20	0	0	20	0	0
21	0	0	21	1	1
22	0	0	22	0	3
23	0	0	23	0	0
24	5	0	24	0	0
25	5	0	25	0	0
26	0	0	26	0	1
27	0	0	27	0	1
28	1	0			
29	0	0			
30	1	0			
31	1	0			
32	5	0			
33	Culvert 2				
34	0	5			
35	0	0			
36	0	0			
37	0	0			
38	0	0			
39	0	0			
40	0	0			
41	0	0			
42	0	0			
43	0	0			
44	0	0			
45	0	0			
46	0	0			
47	0	0			
48	0	0			
49	0	0			
50	0	0			

The Ski Otters ski team has also been chemically treating the weeds each year in the west basin. They treat early in the spring before the team begins their shows and training. This could be another reason VLAWMO did not survey any curly leaf pondweed during the vegetation survey.

E. Fishery Status

The only DNR fish survey on record is from 1986. White sucker and bullhead were the only fish sampled. In 2012 VLAWMO conducted a fish survey with Blue Water Science. VLAWMO was planning to kill the rough fish in the lake to help with the nutrient impairment. The water is very murky most likely due in part to the rough fish (bullhead), which stir up bottom sediment while foraging for food releasing phosphorus and other nutrients stored in the sediment causing high algae growth and destroying lake vegetation. The 2012 survey (Appendix C) determined that the fish population in Goose Lake was very healthy with great numbers of perch, largemouth bass, crappies and sunfish. There is no record of when or how these fish got into the lake but were introduced sometime after 1986. There was also a very large population of large bullhead in the lake, but very few to no small bullhead. The current game fish populations in the lake are doing a great job at keeping the first of the year bullhead numbers to a minimum, but the large bullhead were thriving. VLAWMO decided to harvest the remaining bullhead and removed approximately 16,000lbs of bullhead in 2013. With the removal of the large bullhead the current fishery in the lake should be able to maintain the remaining rough fish and in turn lake water quality should improve.

Fish Sampled for the 1986 Survey Year (DNR)

Species	Gear Used	Number of fish per net		Average Fish Weight (lbs)	Normal Range (lbs)
		Caught	Normal Range		
<i>Black Bullhead</i>	Gill net	80.0	30.3 - 150.6	0.30	0.2 - 0.4
<i>White Sucker</i>	Trap net	0.4	0.3 - 2.6	0.25	1.0 - 2.0
<i>Brown Bullhead</i>	Trap net	0.4	0.4 - 4.5	0.60	0.2 - 0.7
<i>Black Bullhead</i>	Trap net	47.6	11.5 - 132.6	0.26	0.2 - 0.4

Normal Ranges represent typical catches for lakes with similar physical and chemical characteristics.

Length of Selected Species Sampled for All Gear for the 1986 Survey Year

Species	Number of fish caught in each category (inches)								Total
	0-5	6-8	9-11	12-14	15-19	20-24	25-29	30+	
<i>Black Bullhead</i>	4	175	3	0	0	0	0	0	182
<i>Brown Bullhead</i>	0	0	1	1	0	0	0	0	2

4. Setting Water Quality Goals for Goose Lake

Goose Lake is very high in nutrient levels. The water quality is far higher than the MPCA nutrient criteria for shallow lakes for lakes within this ecoregion. The TMDL, retrofit study, fish survey and internal load study have given much information on why Goose Lake water quality is so poor and also possible steps to help improve water quality and overall aesthetics of the lake in the future. The table below along with the reports mentioned above should help greatly in moving forward with a cleaner healthier Goose lake.

5. Lake Management Plan for Protecting the Lake Environment

As stated previously in this report, Goose Lake’s water quality is very high in nutrients and above MPCA standards. This means that actions should be taken that could help reduce the poor water quality issues.

The table below lists various action items that will expand on the current knowledge of the lake and watershed and help to enhance the lake’s water quality. The table also lists who the lead for each item could be as well as a cost range for each item. One action item will not “fix” Goose Lake, but a combination of them can certainly help improve the lake conditions from the present state. These tables along with implementation plans in the appendix of this report have been created with watershed, stakeholder and lake resident feedback, comments and lake knowledge.

Weighted Priority 0 - 5 *	Action Item (Highest priority to lowest)	Description	Leader	Cost Estimate
				\$ = <\$1,000 \$\$ = \$1,000-\$2,500 \$\$\$ = \$2,500-\$5,000 \$\$\$\$ = \$5,000-\$25,000 \$\$\$\$\$ = \$25,000-\$100,000 \$\$\$\$\$\$ = >\$100,000
*****	Continued Lake Monitoring	Continue monitoring program of twice monthly lake sampling to measure nutrient levels, dissolved oxygen and temperature levels	VLAWMO	\$
****	Enhanced Monitoring	Target “hot spots” at lake inlets for nutrient loads	VLAWMO	\$\$\$
****	Weed Survey	Monitor current aquatic vegetation and monitor invasive curly leaf	VLAWMO	\$\$
****	Fish Survey	Document the type and amount of fish in Goose.	VLAWMO	\$\$
****	Reduce Phosphorus (P) Levels	Work with consultant to determine how to reduce P levels and implementation of those mechanisms: aerobic testing, consultant.	VLAWMO	\$\$\$ - \$\$\$\$
****	Education Efforts – newsletter	Include information for Homeowners and Ski Otters about shallow lake ecology as well as specifics for Goose Lake. Shoreline restoration workshop for interested residents	VLAWMO	\$
****	Aeration	Help to enhance wildlife and water quality	VLAWMO/ Stakeholders	\$\$\$\$
****	Fish Augmentation/removal	Work with DNR Fisheries to enhance the quantity and quality of fish in the lake	VLAWMO	\$\$\$\$
****	Weed/Algae Control	DNR, Blue Water Science or Wenck to help with control and harvesting options.	Homeowner s/Shi Otters	\$\$ - \$\$\$\$
****	Shoreline Restoration Projects/Erosion control	Partner with VLAWMO and City of WBL to enhance homeowner and public shorelines around lake.	VLAWMO/ City of WBL	\$\$\$\$

Appendix A

Vadnais Lake Area Total Maximum Daily Load (TMDL) and Protection Study
Wenck Associates, Inc.
By: Rebecca Kluckhohn, P.E.
August 2013

Appendix B

**Lambert Creek Retrofit ID and Design Project
Ramsey Conservation District
August 2011**

Appendix C

**Fish Survey of Goose Lake
Steve McComas
Blue Water Science
July 2012**

Appendix D

**Internal Phosphorus Loading and Sediment Phosphorus Fractionation
Engineer Research and Development Center
December 2010**

Appendix E

East Goose Lake Macrophyte Survey 2014

Appendix F

West Goose Lake Macrophyte Survey 2014