Subject: Understanding 2019 Wenck Report: Green Lake Phosphorus Diagnostics Study
PLUS a collection of notes about Green Lake.
Compiled and summarized by Gordon Haubenschild for GLID Board in late 2019.
Retain for future reference.

GLID Board (ccing our Partners too) , Sharing my understanding and observations.
I write this stuff down so I can somewhat assimilate, comprehend, and look for positive items.
Then print it all out so I have a readable retrievable record. Yup, I may have some incorrect stuff, but it is a start.
I really do want your input/comments and recommendations. GLID needs to continue with proactive activities.
Please take some time to look at the all the reports and Lake Improvement plans to come to your conclusions.
But if you don't want to read a couple hundred of pages of reports, scan through my long summary below >>>

Did you know? Curley Leaf Pondweed was found in Green lake as far back as 1971.
Eurasian Watermilfoil was found in 2000.
CLP has expanded from 4% IN 2005 to 44% in 2018! So even with years of CLP treatment, explosion continues! WHY?? Treatment effectiveness not good enough using current DNR approved options... need to change something in treatment options?.. GLID Will explore use of Diquate. Our GLID CLP treatment is only for 15% of congested areas as approved by DNR... leaving other CLP to expand their areas. Also CLP treatment is highly weather dependent ,,, need to treat sooner before max growth to reduce the amount of dead weeds that increases nutrient load in the lake.

Green lake's Water quality has been monitored since 1988!!!!
And huge amount of effort and resources have been spent for assessment/improvement/monitoring and improvement plans in 1991, 1995, 1999, 2005, 2013, 2018 along with 3 year lake monitoring series with the last sequence 2016,2017, 2018. Some of the data is used for grants. Some positive actions were completed.
Then it seems that most of the reports/plans were forgotten.... not sure if any reports/plans had post-effectiveness reviews. I see some amazing valuable info in all the past reports.

You might want to read the recently published 2019 Wenck Report.
SWCD and GLID invested $6K in this Green Lake Phosphorus Diagnostics Study.
Tiffany summarized some of the content with her Oct 23 hour long presentation to GLID and guests with the united goal of improving Green Lake's water quality for continued pleasant recreational use and getting our lake off the Minnesota impaired waterbody list. Thank you again Tiffany. **Her 2020 Green Lake Improvement plan is found on the GLID website**, which could be viewed as an extension of the SWCD 2013-2018 detailed GLIP.

Green Lake's Partnership With the State
We're working with Isanti Soil and Water Conservation District, Isanti Zoning, Wyanette Township and Minnesota DNR for a better lake.

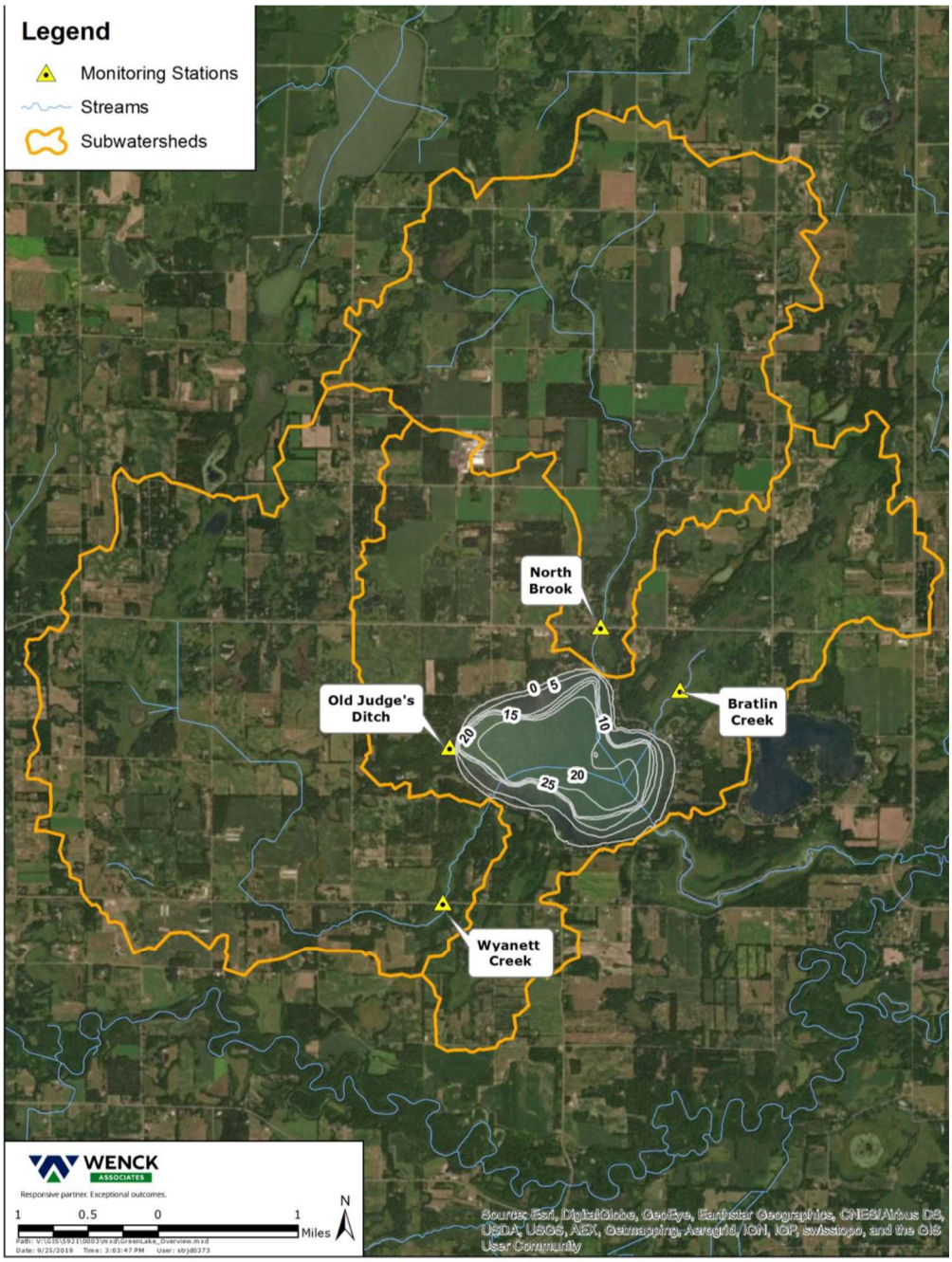
Isanti Soil and Water Conservation District (SWCD) commissioned a Green Lake Phosphorus Diagnostic Study that compiled data as far back as 1988 to the present. The results included a phosphorus trend line, nutrient budget charts, water clarity trends, and recommendations. The net net of the Wenck report was that Green Lake will continue to be a "nutrient rich" lake. Actions need to be taken to ensure the lake doesn't get worse. We must work on reducing nutrients generated by the

lake itself along with reducing added nutrients coming from lakeshores, septics, and surrounding watershed inlets. The 2019 Wenck Report "Green Lake Phosphorus Diagnostics Study" can be found on the GLID website.

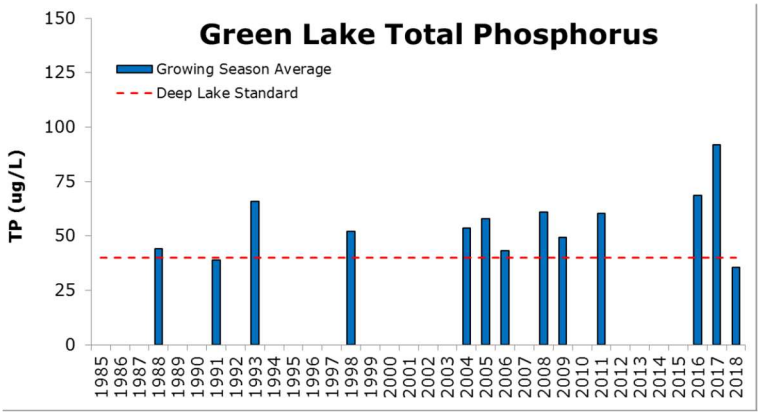
Green Lake's water comes from rainfall and watershed creeks/streams that flow into our basin. There are no springs feeding Green Lake. Hence, some portion of the nutrients that are in the surrounding watershed land find their way into our lake as runoff.

The past and present Green Lake Improvement Plans have all addressed ways to reduce the amount of nutrients in the runoff. Many Green Lake owners have engaged in this nutrient reduction process with best practices in shoreline management. Many have been part of shoreline restoration activities.

Isanti County SWCD will continue to address surrounding land areas that need improvements like ditch maintenance to catch and filter water-filled debris.

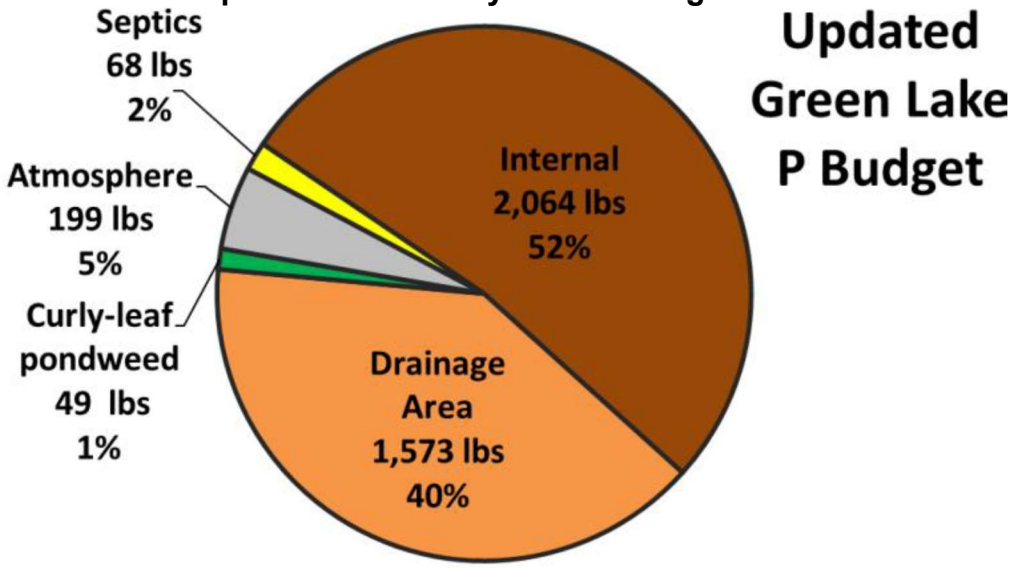


Net net from Wenck Report:
-There is a new nutrient Budget chart. Lots of recommendations. Interesting is the trend charts show higher than wanted TP and Chlorophyll rates but with a positive view showing only a slight increase trend line since 1988. Another positive is Green Lake water clarity (Secchi) measurements are better than deep lake standards with an average of 5-6 feet depending on the day of course! *(reference Attachment A; Green Lake Historic Water Quality)*



-No surprise, Wyanette Creek and North Brook continue to be huge TP contributors with *more of the same* recommendations for those area need to be fixed. There are positives and hope with GLIDs initiatives, but for sure, need forces greater than GLID to step in to change the watershed impact on Green Lake.

-Green Lake internal loading continues to generate the greatest amount of TP/nutrients. Moving forth on an alum treatment as a report recommendation to manage internal loading in Green Lake would likely cost between $1M-$2M. Gordon's limited view that there are unknown consequences and iffy long term remedy while high volume of nutrients continue to flow into our lake. Per Bald Eagle Lake experiences, may cause even greater weed growth, which could be problematic if they are not the good native short weeds.



-The report highlights Curlyleaf Pondweed as a contributor to the load equation. GLID can help by reducing AIS weed spread as planned for 2020, with the best option to get AIS weeds out of the lake. AIS weed growth has exploded in Green Lake since 2005.

Wenck report is a analysis of many previous reports. Green lake's Water quality has been monitored since 1988.
And huge amount off effort and resources have been spent for assessment/surveys/monitoring and improvement plans in 1991, 1995, 1999, 2005, 2013, 2018 along with 3 year lake monitoring series with the last sequence 2016,2017, 2018. Not sure of the total amount invested to get all the results.,, but A LOT!
Per Tiffany's charts, just from 2015 though 2020 plans. **$210,478 dollars have been spent on Green Lake, 70% from SWCD and 30% from GLID.** Of that, *$175,000 or **83% has been used for studies and monitoring*** and just recently, 17% or $35,000 for Lake shoreline restoration projects that actually reduced total phosphorus. The positive from all the study stuff, is the data provides an better understanding of the lake condition, the negative is most all of the huge impact recommendations couldn't get done.

Our recent Limnopro and Wenck study investments used much of the previous monitoring reports. All leveraged Models using data then providing recommendations and also calling for more monitoring studies.
Note, Limnopro reports calculates much high amounts of TP load, using same SWCD data.
The 2020 Green Lake Improvement Plan proposal used those recommendations highlighting what GLID can do with some potential/possible actions SWCD and Isanti County to dos.

2019 Wenck Report: Green Lake Phosphorus Diagnostics Study
The SWCD contracted with Wenck Associates, Inc. (Wenck) to review the newly collected data, compare these data to the original TMDL study, and provide further recommendations to reduce phosphorus loading to the lake. This technical memorandum presents the results

of this work which includes the following components:
π Review historic and recently collected data
π Update lake phosphorus budget and model using new data
π Establish phosphorus goals and reductions based on new data
π Recommended strategies

Observations:
> I was really impressed with Wenck's use of previous collected reports and monitoring data.
The Wenck Report has incorporated Green Lake data starting in 1988!!

> Wenck Report showed both the Rum River Watershed HSPF model and their own updated model TP load results:
- One showing Existing TP Load 4,712 pounds per year
- **New model indicating TP Load of 3,954 pounds per year**

The largest source of TP load is coming from the lake itself with 2,064 pounds/year.
In comparison, a 1995 diagnostic study of Green Lake by Water Research and Management, Inc. estimated that total phosphorus loading to the lake is 3584 lbs per year. So no new news since then.

Wenck used the updated lake response model to estimate TP load reductions (all sources) needed to meet Green Lake's 40 µg/L water quality goal. **The updated model suggests TP loading to Green Lake will need to be reduced by approximately 2,142 pounds/year (54%) in order to meet this goal**. Wenck reviewed each phosphorus loading source to Green Lake and performed a series of load reduction scenarios to determine which source(s) could be reduced to achieve the TP load reduction target/goal. But seems to fail to factor in Feldspar Drive in the TP data modelling,, but maybe adjusted for it in their models.

What seems to be missing is the Green Lake outflow of water and nutrients via the Green Lake Brook.
That outflow is flushing some of the TP and other stuff into the Rum River Watershed.
During highwater times, there is huge amount of water going out over the 2007 installed flood gates.
And when the Rum River is low, the gates open, and Green Lake water continues to find its way out, although at a slower flow rate. That is all goodness for Green Lake.

However, it is reasonable to state that nutrient/TP inflow along with internal loading is greater that nutrient outflow, which is the bummer situation causing our current situation, hence the increase TP trend line.

The largest source of TP load is coming from the lake itself with a modeled number of 2,064 pounds/year.
The Wenck lake response model suggests internal loading in Green Lake would need to be reduced by
approximately 74% (1,525 pounds/year) to meet State water quality standards if the 613 pounds/year watershed load reduction scenario is achieved. chemical treatments, such as aluminum sulfate (alum), can reduce phosphorus release from lake sediments by approximately 90% (or greater) if designed and dosed
correctly. **An alum treatment** to manage internal loading in Green Lake
would likely cost between $0.75M-$2.00M depending on the size of the treatment area and the amount of alum needed. In order to refine these cost estimates, Wencks recommends that an internal load $17K feasibility study be conducted for Green Lake in which sediment cores are collected at a minimum of five sites and analyzed in the laboratory.

> Green Lake Owners septic systems checks for "failers" are always good and should be done. Locating and replacing leaky septic systems near the lake is important. Leaky septic systems can be a source of phosphorus and coliform to the lake, depending upon the severity of the leak, proximity to the lake, and soil characteristics between the leaky septic system and the lake.
But Wenck models based on Isanti County numbers, suggest Green Lake septics may not a significant source to the TP loading problem. If everything is fixed, may result in a TP load reduction of approximately 4 pounds/year (<1% of target/goal).

> **Focus needs to be on what TP and nutrients flow into Green Lake.**
Per the reports, That accounts for 40% or 1,573 pounds of TP/year.
(note: Limnopro report projects 2,700 lbs/year)
The solution still remains that surrounding watershed needs to be 'fixed' to reduce nutrient filled runoff into the lake, which has been happening for years, but potentially with more concentrated amount of nutrients? Isanti county is in the process of creating a ditch maintenance program, it will be important that the SWCD is involved such that they can recommend best management practices (BMPs) if ditch is going to be maintained. North Brook is set to be inspected in 2020, Wyanett ditch 2023. This practice goes hand-in-hand with increase water retention in North Brook and Wyanett Creek.

SWCD Agricultural Best Practices with North Brook & Wyanett Focus:
2017 North Brook and Wyanett Creek Subwatershed Assessment: The SWCD has initiated an agricultural outreach program to increase the number of ag practices being implemented. This program is starting from square one and will take some time.

> GLID's lake shoreline restoration projects should continue to help reduce TP flow into the lake.
Per the 2014 Green Lake Subwatershed Retrofit Analysis, if 30 property owners participate, with collective 1920 feet shoreline, there could be a 13.3% TP reduction in those areas, hence reducing TP into Green Lake by 4-6 pounds/year. All proposed candidates should be mapped against the recommend fix areas found on pages 64-69.

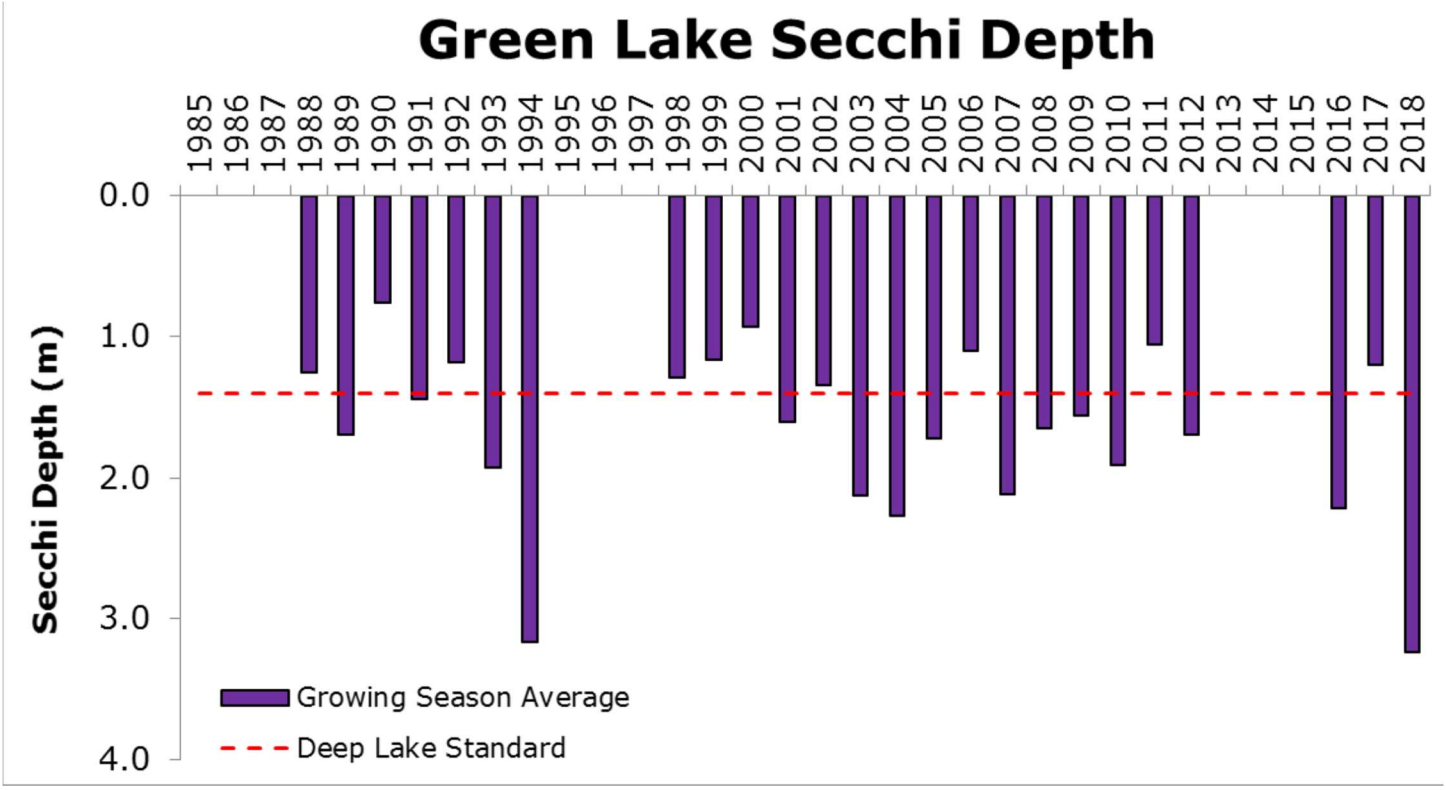
> Absolutely need to control/reduce the explosive AIS weed growth.
Our 2020 plans and partnership with DNR may help. Use of Diquat will be more effective, safer, and less chemicals going into the lake. Lake Restoration company is preparing to do 43.3 acres of herbicide treatment when the permits and time is right.
Getting AIS weeds out of the main lake via harvesting and around docks would also help reduce phosphorous amounts.

> Boat Inspections at the Public access may help if it keeps out new invasive species. Both don't have enough funds for constant monitoring. MN DNR is trying to raise awareness to boaters, but some just don't get it. The GLID Board voted to continue 2020 boat inspections as funds allow, hopefully with Isanti County Zoning assistance again.
Inspector Cost is about $20 per hour. We had $3800 set in previous years, buying 190 hours over 4 months. Need to provide tentative input to Stephine at Water Guards by YE so she can planned for the area lakes coverage. Update: Isanti Zoning to contribute $16K for 2020 public access boat inspections.

As mentioned before. So grateful for GLID, SWCD, Wyanette Township, and DNR endeavors to create, prioritize, then implement some parts of the numerous Green Lake Improvement plans. It is truly amazing the amount of time, talent, and treasure spent. Many positive changes have been made along with immense awareness of the challenges to clear up Green Lake water to a point that it can be taken off the impaired lakes list.
GLID Board and all users of Green Lake need to continue a proactive approach for its care and welfare.

Remember the goal is improve our lake for many future generations.

Once again, with Hope and Respect,
Gordon



Ok, at your fingertips is the Wenck Report and the 2020 Green Lake Improvement plan.
The other reading list of wonderfully detailed studies and best practices recommendations are on our GLID website (Thanks Mel!)

1- 2017 Green Lake Rural Stormwater Retrofit Analysis of North Brook and Wyanett Creek Prepared by: Isanti Soil and Water Conservation District- 129 pages of details

Executive Summary
This study provides recommendations for cost effectively improving treatment of stormwater from areas outside of the direct drainage area (considered rural) of Green Lake; more specifically, the two major inlets: Wyanett Creek and North Brook. This report provides sufficient detail to identify projects, rank projects by cost effectiveness at removing phosphorus and begin project planning. It includes project concepts and relative cost estimates for project selection

A variety of stormwater retrofit approaches were identified. They included:
- *Water and sediment control basins (WASCOB),*
- *Grassed waterways,*
- *Filter strips,*
- *Permanent vegetation,*
- *Wetland restorations.*

2- 2014 Green Lake Subwatershed Retrofit Analysis For Areas Draining Directly to the Lake Prepared by: Isanti Soil and Water Conservation District in partnership with the Metro Conservation Districts.

Funding provided by the Clean Water Fund

A variety of stormwater retrofit project types were identified. They included:

- *Residential curb-cut rain gardens,*
- *Diverting water to swales,*
- *Land purchase for protection from further development,*
- *Permeable pavement,*
- *Trench grate sediment traps,*
- *Hydrodynamic separators, and*
- *Lakeshore restorations.*

If the most cost effective practice were installed at each project site, 20.7 pounds of phosphorus would be prevented from reaching the lake. This would be a 23% reduction of the phosphorus from the study area. *Note that this is not a simple addition of all possible projects because in some cases there is more than one project option at a site.*

Funding limitations and landowner interest may make installing all projects difficult.

>>> Attention Dan Howard: This is the report that shows All 95 candidate lakeshore restorations Locations Dispersed around the lakeshore, see maps Property Ownership – were identified in fall 2013. Each is an average of 100 feet of lakefront that has less than a five foot wide vegetated buffer and/or active erosion. Pages 63-70. The top 15 locations were ID'd that could reduce phosphous by a lot!

Action: Need to relook at those findings. for 2020, GLID has $15K to continue restorations. ***Per the report, if all 95 were completed, would reduce Total Phosphorous flow into Green Lake from those areas by 44%.*** *2014 Green Lake Subwatershed Retrofit Analysis report recommends lake owner-friendly cultural practices to be continued and increased, including Yard Care practices limiting fertilizer use, year waste disposal, and important, simply leaving un-mowed buffers in strategic areas.*

3- 2013-2018 Green Lake Improvement District Management Plan

The 2013 Green Lake Management Plan is proposed as a multi-step process that will be reviewed and evolve over time. In addition to organizing its future steps and recruiting volunteers the plan will require funding to accomplish its activities. The Green Lake Improvement District will be working closely with Isanti County Zoning and Isanti Soil and Water Conservation District to investigate funding sources and regulatory changes required to protect our valuable resources. It is meant to be a guide for future lake directors. It can be amended at any time to provide for opportunities and issues unforeseen.

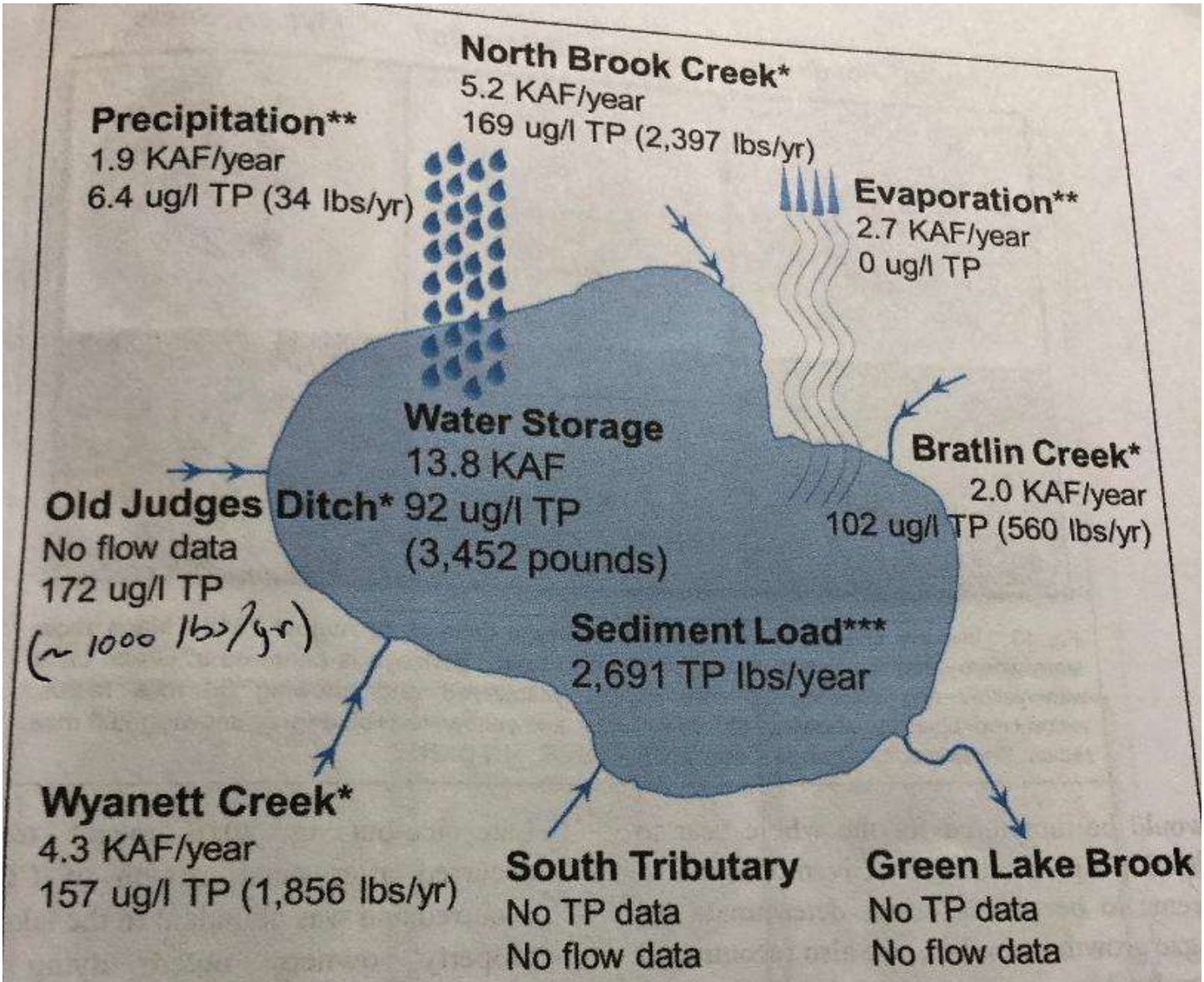
From the visioning session, strategies were established to manage the problems presented. Chapter Four contains a listing of the actions the Green Lake Improvement District intends to accomplish within the next five to ten years. Education of the residents within the lakeshed and users of the lake is central to all of the listed priority issues.

4- 2018 Green Lake Status Report done by Limnopro's Dr Dan

This lake status report will review issues of highest concern to most lake user groups but focus on the two issues that are a primarily concern in 2018, namely (1) clearing up water to a point that it can be taken off the impaired lakes list and (2) addressing the need and strategy for treating curlyleaf pondweed and Eurasian watermilfoil in the lake.

There are not enough data to determine nutrient sources to Green Lake (Fig. 12). The most important piece of missing data is outlet monitoring. Both discharge and total phosphorus measurements are required to balance the nutrient budget.

Note: Gordon's earlier nutrient budget swag was to better understand the equation CANNOT be used for any decisions, it represents an possible unbalance based on existing TP data and extrapolations.



***2015-2017 Tributary/Monitoring Study (Measured)**
****Miller et al. (2000)**
*****Nurberg modeled (1984)**

Fig. 12. Existing and missing water and nutrient data for constructing budgets on Green Lake in order to determine eutrophication mitigation strategies.

e criteria used by MPCA for Green d has a similar size to Green Lake surface area of 1,073 acres and n depth of 39 feet, draining a d of approximately 11,000 acres. was $1,732,100. This was funded he watershed district, Clean Water

There are not enough data to deter nutrient sources to Green Lake (Fig. 12) most important piece of missing data is monitoring. Both discharge and phosphorus measurements are requi balance the nutrient budget. Unless t high confidence that neither Old

Gordon’s preliminary follow-up swag nutrient budget analysis using Thomas' SWCD TP and flow data and DR Dan's GLID report:
NET NET:
1-All Green Lake most inlets have been monitored for 3 years- the missing one can be extrapolated
Net net - phosphorous from Wyanett Creek range of 154- 247ug/l adding TP 2000 lbs/year
- North Brook with TP range of 169 - 181ug/l adding TP approx 2400 lbs/year
- Old Judges Ditch @ 172ug/l with estimate adding TP 1000 lbs/year
- Bratlin Creek @ 102 ug/l adding 560 TP lbs/year low flow
- South Tributary -- low flow swag of 500 TP lbs/year
- Green Lake Sediment Load adds 2700 TP lbs/year! from dead weeds and etc
- Feldspar Drive reported as major TP contributor - my estimate adding at least 500 TP lbs/yr
- lake shore runoff and leaves adds much more too - hence need to restoration projects- est 1000 lbs

ADDING all Total Phosphorous amounts coming into lake - approx 12,000 lbs/year.
That's a lot! and does not include nitrogen or potash factors.

Subtracting estimated TP flowing out via Green Lake Brook 60-70% into watershed OR being used
= approx 7,000 lbs (reference Dennis)

Gordon's SWAG Nutrient Budget shows a net 4,000 - 5,000 Total Phosphorus pounds per year load added to Green Lake! Which happens to be very close to the estimates from other reports!!!
If my estimates are off by a plus/minus 20% error factor,,, that still is a lot of added pounds of phosphorus per year to our Green Lake ....

Phosphorus fact: for every pound of phosphorus added or left in our Green Lake, another 500 pound batch of wet algae can be produced.

(as a reference point, we removed 8 tons of weeds via Harvester, removing 160 lbs of nutrients)

ACTION: if Green Lake Improvement plan can address and reduce at least two of the top TP inputs like Wyanette Creek and North Brook by 50% 70% with wetland restoration - that would be 2,220 - 3,000 lbs/year
ACTION: Need to address Feldspar lake access TP estimate and restoration
ACTION: Need to continue Green Lake Lakeshore Restoration projects - need grant money
ACTION: Better understand Nitrogen budget
ACTION: Explore ALUM use for selective deep water areas. approx 206 acrea or 25% of Green lake are deep enough with less oxygen that locked up phosphorus is released

One other new find for me was the 2013-2018 Green Lake Improvement Plan. I didn't know it existed,
It appears to be very complete filled with many action items.
attached below>>>
Action: Need to see how many action items were completed - and what more is needed
Action: Compare 2013-2018 plan to new proposed 2019 Green Lake Improvement plan
From monitoring data and observations, need to determine what improvements have happened and what are the next steps.

With Respect. Any errors or misunderstandings of the referenced data are my doing:)
Gordon H

References: All Isanti SWCD Tributary Monitoring Reports and Limnopro Reports on file.

Green Lake Facts

It's the largest and deepest lake in Isanti County

Green Lake is located in the west-central area of Isanti County and lies within Wyanett Township. Green Lake is an oval lake totaling almost 833 acres. The shoreline extends 4.4 miles, It is a shallow lake with forty-three percent of the total acreage fifteen feet or less in depth. The maximum depth of the lake is twenty-eight feet.

Green Lake water comes from only tributary inlets, no fresh water springs. The main inlets are Wyanett Creek, North Brook Creek, and three other smaller creeks. The main functioning outlet, Green Lake Brook, lies in section thirty-five of Wyanett Township. High water level is by a box culvert with timber flood water control flap gate located three miles downstream on MN Hwy 47 near County Road 39 turn off. Built in 2002, This ingenious flood control flap gate prevents Rum River flood waters from entering Green Lake, that would have added even more water and stuff in addition to the other inlets, causing major lakeshore flooding damaging the lakeshore and homes. The cool part of the system is that the automatic controls then lets out high Green Lake water once the river flooding stops. This allows tons of nutrients and sediment to flow out of Green Lake too. That’s good! During drought times, there is no dam mechanism to keep water in.

History & Purpose of the Green Lake Improvement District

Green Lake Improvement District (GLID) was incorporated as a non-profit organization on July 1, 2001. It functions with an elected board and exists as a local government body under Isanti County. Information is disseminated to lake property owners and the general public via emailings and through the web site: http://www.greenlakemnid.com/news.php.

The GLID was initially formed to take over the ownership and operation of a water control

structure at the confluence of Green Lake Brook and the Rum River. This mission has since been expanded to include the protection and improvement of Green Lake and its watershed.

Great Green Lake Fishing

Green lake is known for it's fishing, but it doesn't happen by itself.

Did you know our DNR has stocked our Green Lake with thousands and thousands of Walleye yearlings, fingerlings, and fry since 2009 and maybe earlier? Per the DNR reports, in 2018 they added 405 Walleye yearlings and 6,000 fingerlings. Another 2000 walleye in 2016 and even more in 2015! Complete data is found at https://www.dnr.state.mn.us/lakefind/showstocking.html?downum=30013600

Phosphorus Reduction Program for Green Lake

Isanti County Soil and Water Conservation is once again providing a $10,000 grant matched by GLIDs $5,000 to help. Green Lake landowners to restore their eroding or non-buffered shore line. 2020 nominations are now being accepted by Dan Howard.

Dan Howard:
763-286-1146
danhowardnow@gmail.com
Contact Dan for more information on how you can get involved at upcoming workshops/projects.

Check out : https://www.isantiswcd.org/images/0917Green_Lake_Restoration_project_summary_v1_002.compressed.pdf

Did you know the 2014 Green Lake Subwatershed Retrofit Analysis reported 95 sites that were candidates. Per the report, if all 95 were completed, would reduce Total Phosphorous flow into Green Lake from those areas would be reduced by a whopping 44%!

Again, all Green Lake residents are invited to get actively involved in your Lake Management Plans. You can make a positive difference!
Remember the quote; "Before you complain, have you volunteered yet?"

Green Lake Invasive Weed Treatments

For Green Lake and Homeowner dock areas, too!

We need to continue focusing on killing invasive weeds as soon as possible in the spring to reduce the growth and reduce the amount decomposing. We have received permission to use Diquat in 2020. This treatment will control both our Curly Leaf Pondweed and Eurasian Water Milfoil at the same time (2 for 1), saving thousands of dollars and reducing the amount of chemicals going into the lake. We will also focus on more weed harvesting.

DETAILS:

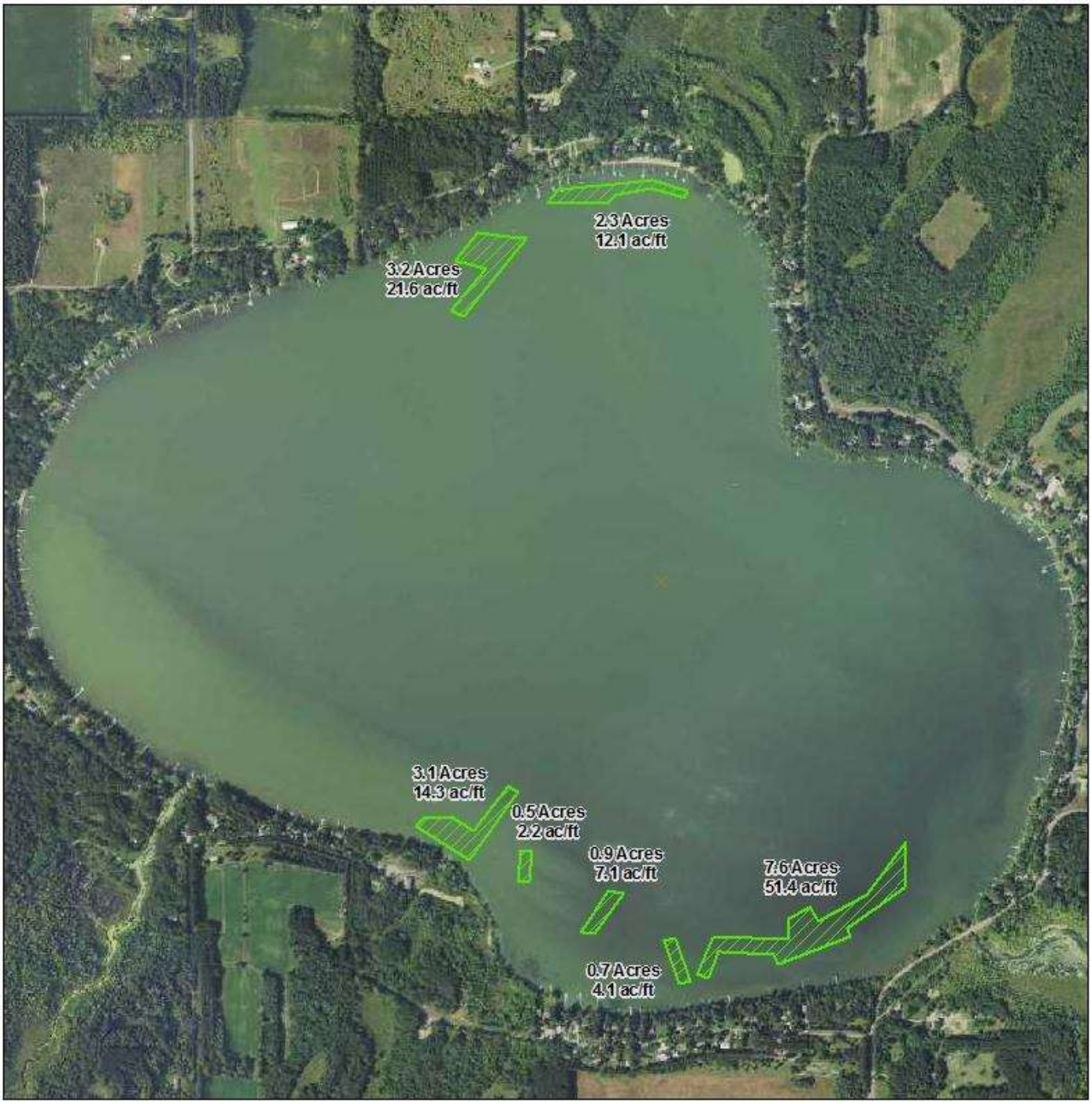
The GLID Board voted to do the right thing for the lake by working with the DNR to use the safer Diquat herbicide to help control both Curley Leaf Pondweed and Eurasian Water Milfoil, at the same time reducing chemical usage and saving a lot of money. The DNR will visit Green Lake after the ice is out (late April to early May) to determine if 50 acres can be treated using our DNR permits 2018-1015 and/or 2019-2498. Gordon has spent many hours with the DNR and SWCD to understand the many parameters and restrictions of AIS weed management. We are trying hard to balance the need for reduced weed infested lake waters with water quality, safety, less chemical usage, and fish habitat, knowing that doing nothing will result in a weed-clogged lake as part of nature's normal lake secession. More ideas will be gratefully accepted!

GLID chose Lake Restoration as our AIS weed management company based on their 3 year price lock, free post survey, and flexibility in treatment options. A Letter of Intent is to be sent.

Lake Restoration will also be available to lake homeowners. For $196 plus the $40 DNR permit fee, you can tackle your lakeshore weeds out to 100 feet! You should sign up before the end of March.

Call Lake Restoration at 763-428-9777

Green Eurasian watermilfoil Treatment Areas 2019



Green Eurasian watermilfoil Treatment Areas 2019

Zoomed to Lake Boundary
Volume Source: DNR Bathymetry

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DEPARTMENT OF NATURAL RESOURCES

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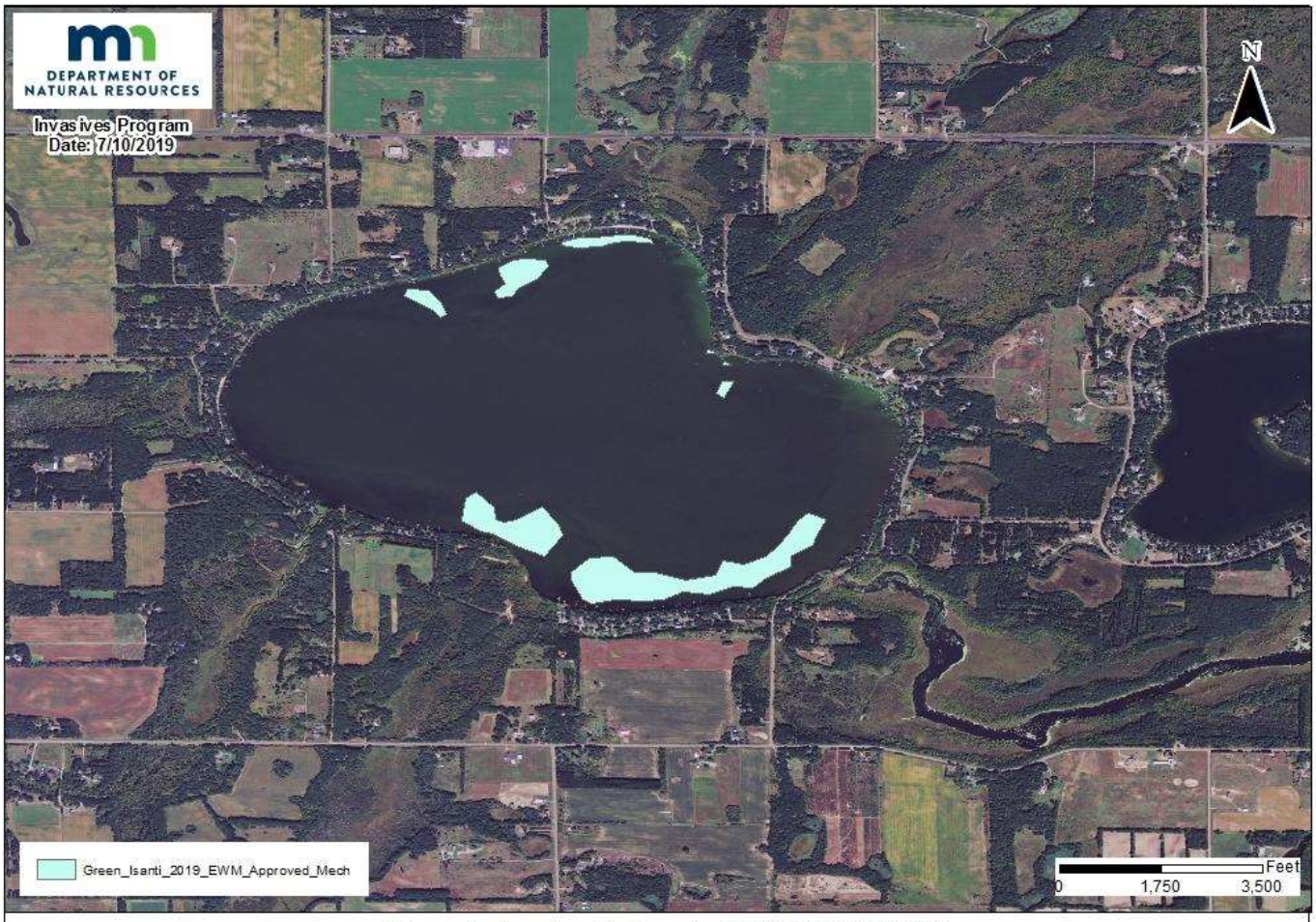
0 0.175 0.35 0.7 Km

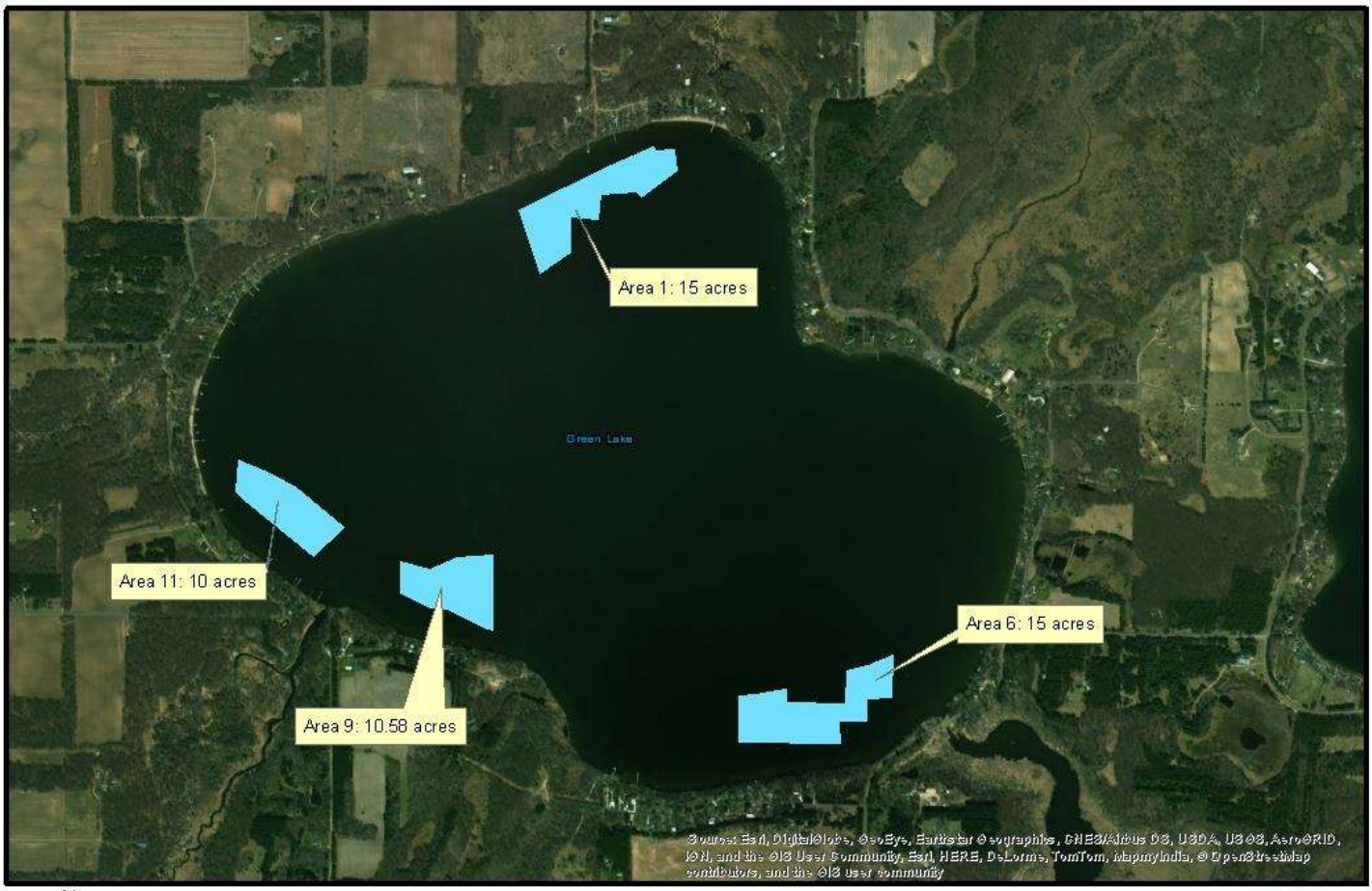
Treatment Areas

Approved



Green Lake, Isanti County (DOW#30013600)
Approved 2019 Mechanical Harvest EWM

Green Isanti CLP 2018



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Legend

Treatment sites totaling 50.58 acres