GLEASON LAKE MANAGEMENT PLAN

GLEASON LAKE IMPROVEMENT ASSOCIATION

August 2003

EMMONS & OLIVIER RESOURCES

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Prepared for the Gleason Lake Improvement Association

August 2003

Matching Grant Funds Provided by the Minnesota Board of Water and Soil Resources, Minnehaha Creek Watershed District, City of Plymouth, U.S. Army Corps of Engineers, Gleason Lake Improvement Association

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Guidance for development of the Plan was provided by Peter Palm (GLIA President) and Lee Keeley (GLIA Vice President). Preparation of the Plan by EOR staff was managed by Gary Oberts, with contributions made by Marcey Westrick, Melissa Arikian, Tony DeMars, Andrea Plevan and Andy Smith. Steve McComas of Blue Water Science, Inc. contributed many of the in-lake study elements. John Skogerboe of the U.S. Army Corps of Engineers contributed macrophyte data from his on-going study in the north bay. The Minnehaha Creek Watershed District provided findings from its Hydrologic, Hydraulic and Pollutant Loading Study (HHPLS), and the City of Plymouth contributed engineering information.

RECOMMENDATIONS

The following recommendations are made to the Gleason Lake Improvement Association:

1. Management efforts for the improvement of Gleason Lake should focus on the reduction of phosphorus. Management practices effective at reducing phosphorus will be similarly effective for other pollutants of concern, like sediment and heavy metals.

2. Efforts to control internal phosphorus loads via chemical treatment are not needed at this time because it is unlikely that any direct lake improvement would result.

3. Any manipulation of the macrophyte population should be carefully considered for the secondary impacts that could result. It is recommended that coontail removal be done only on a local scale.

4. Adopting a Gleason Lake interim (ten-year) water quality goal of 80 µg/L (mean summer surface water level) TP, and a long-term goal of 50 µg/L would be consistent with the MCWD's Hydrologic, Hydraulic and Pollutant Loading Study (HHPLS) Regional Team 3. To achieve the interim goal, a watershed load reduction program that reduces external TP load to the lake by 24% (156 pounds) should be pursued.

5. General practice BMPs that should be used throughout the watershed include: runoff management from all new development and re-development; surface water planning that adheres to the City and Watershed District water management plans; use of technical guidance documents that provide information on installation, use and maintenance of BMPs; and rehabilitation of aging ponds that do not still conform to their design configuration. Upkeep on these ponds could be improved through an "Adopt-a-Pond" program initiated by the MCWD, GLIA and the Cities. Additional cooperative pilot projects similar to the zero runoff, natural vegetation treatment demonstration site constructed at the Luce Line parking lot during the preparation of the GLMP should be pursued.

6. Specific BMPs are recommended to improve the reach of stream from Pond #3 (see Figure 3.4.1 and Table 3.4.1) in GLC-3 to Pond #7 in GLC-6, including:

- Dredge Pond #3 to regain its design configuration;
- Enlarge Pond #2 to increase its effectiveness at controlling runoff at the juncture of two channel segments;
- Dredge Pond #6 to regain its design configuration;
- Repair the erosion around Berm #2;
- Repair and stabilize the erosive channel in Erosive Reach E3;
- Enlarge Pond #7 and incorporate it into a detention/wetland treatment system that more effectively treats input at the bottom of GLC-1 through 6;

- Treat runoff from about 15 acres of the Wayzata Central Middle School paved parking lot, building roofs and roadways through a system of vegetated pre-treatment swales, forebays and native wetlands; and
- Restore the original design conditions of small ponds in GLC-7.

7. Two lakeshore erosion sites (L1 and L2) on the south end of the lake should be repaired and stabilized.

8. A piscivore dominated fishery should be maintained. A stocking program for largemouth bass may have some recreational potential for anglers, but the northern pike population is dominant at this time and is in good condition.

9. Aquatic plants will help keep water clear. A robust native plant community currently in place produces water clarity that is better than predicted based on phosphorus concentrations. Although coontail can grow to nuisance conditions, the best way to control the excessive growth is through lake nutrient reduction that would best occur at a watershed level. Harvesting or the use of herbicides will give temporary relief, but coontail will return quickly if the nutrient levels remain high.

10. Eurasian watermilfoil does not warrant active management at this time, but should be monitored on an annual basis.

11. Winter aeration is important to maintain the fish community and the potential for biomanipulation effects. It should be maintained.

12. Future monitoring efforts should include collection and analysis of a lake sediment core. The objective would be to get insight into predevelopment lake conditions, for example, to see if Gleason Lake has always been weedy.

13. The MCWD Gleason Creek water quality monitoring station should be re-located from below the lake outlet to upstream of the lake. The improvements made to the lake and its watershed should be monitored for effectiveness, with specific emphasis on wetland and restored pond performance.

14. The Plan implementation monitoring program itemized in Table 6.1 should be instituted.

15. A lakeshore landscaping demonstration project should be undertaken to show the benefits of a vegetated shoreline, and the DNR CD "Restore Your Shore" should be made available as an educational tool to lake homeowners and associations.

CHAPTER 1. GLEASON LAKE SETTING

1.1. WATERSHED

Gleason Lake is a relatively shallow lake in an urban setting, with a watershed size that has been artificially increased over the years beyond its natural boundaries through the installation of storm sewers. It is not uncommon for this type of lake to exhibit poor water quality, as reflected in the phosphorus concentrations for Gleason Lake. However, water clarity measurements indicate a better than expected transparency based on phosphorus. Reasons for this disparity are explained within this Management Plan.

Gleason Lake and its watershed area are located primarily in the City of Plymouth (~95%), but with small areas also in Wayzata and Minnetonka (Figure 1.1.1). There have been numerous opinions on the actual area of the Lake, varying from 131 acres (Engstrom and Wright, 1998) to 156 acres (MCWD). In some respects this variation can be expected due to the variation in the amount of rainfall in any given year, and the fact that these numbers relied upon manual measurements using a planimeter. This Management Plan carefully measured the area of the Lake (Figure 1.1.2 and Table 1.1.1) using the latest geographic information system (GIS) capabilities and determined an area of 160.2 acres, with an additional 13.9 acres of attached wetland (cattail) area, for a total "wet covered" area of 174.1 acres. Clean-Flo, in one of its aerator design memos, noted an area of 177 acres covering the lake and the adjacent wetlands.

1.2. LAKE

The Lake itself is comprised of a north bay (about 31 acres) and a main lake (about 129.2 acres). MCWD reports that the maximum depth of the Lake is 16 feet, with a mean depth of 7.7 feet (Figure 1.1.3) and a volume of 1,201 acre-feet (about 390 million gallons). Using the same mean depth, the adjusted volume based on the GIS-based area in Table 1.1.1 would be 1233.5 acre-feet (about 402 million gallons). The length of lakeshore is close to 3.9 miles (DNR Fisheries has previously reported a shoreline of 4.01 miles).

The drainage area bringing water to Gleason Lake covers a total of 2,450 additional acres in sub-basins GLC-1 through 9 (Figure 1.1.1). Sub-basins GLC 10 and 11 (72.3 acres) drain downstream of the outflow of Gleason Lake and do not contribute to the Lake, but rather drain directly to Lake Minnetonka's Wayzata Bay. Previous reports have stated that a drainage area of approximately 3,000 acres exists for Gleason Lake. The exact coverage used for this statement is not clear, but for the GLMP, the sub-basin areas determined for the MCWD Hydrologic, Hydraulic and Pollutant Loading Study (HHPLS) are used.

Much additional physical information on the watershed is contained in the *Lake Management Plan - Data Summary* (EOR, 2002), delivered to the GLIA under separate cover. The *Data Summary* contains maps on bedrock geology, land use, soils, and topography.

Table 1.1.1. Lake-Related Data.

Feature	Measure
North Bay	
- littoral area*	30.98 acres
- total lake area	30.98 acres
- wetland	3.49 acres
- shoreline	1.04 miles (5,492 ft.)
Main Lake	
- littoral area	125 acres
- total lake area	129.22
- wetland	10.43 acres
- shoreline	2.85 miles (15,049 ft.)
Total water area for Gleason Lake	160.2 acres
Total wetland surrounding Lake	13.92 acres
Total “wet” area	174.1 acres
Total shoreline of Lake (water area only)	3.89 miles (20,541 ft.)

*Littoral area is the lake surface area where the water depth is 15 feet (~4.6 meters) or less.

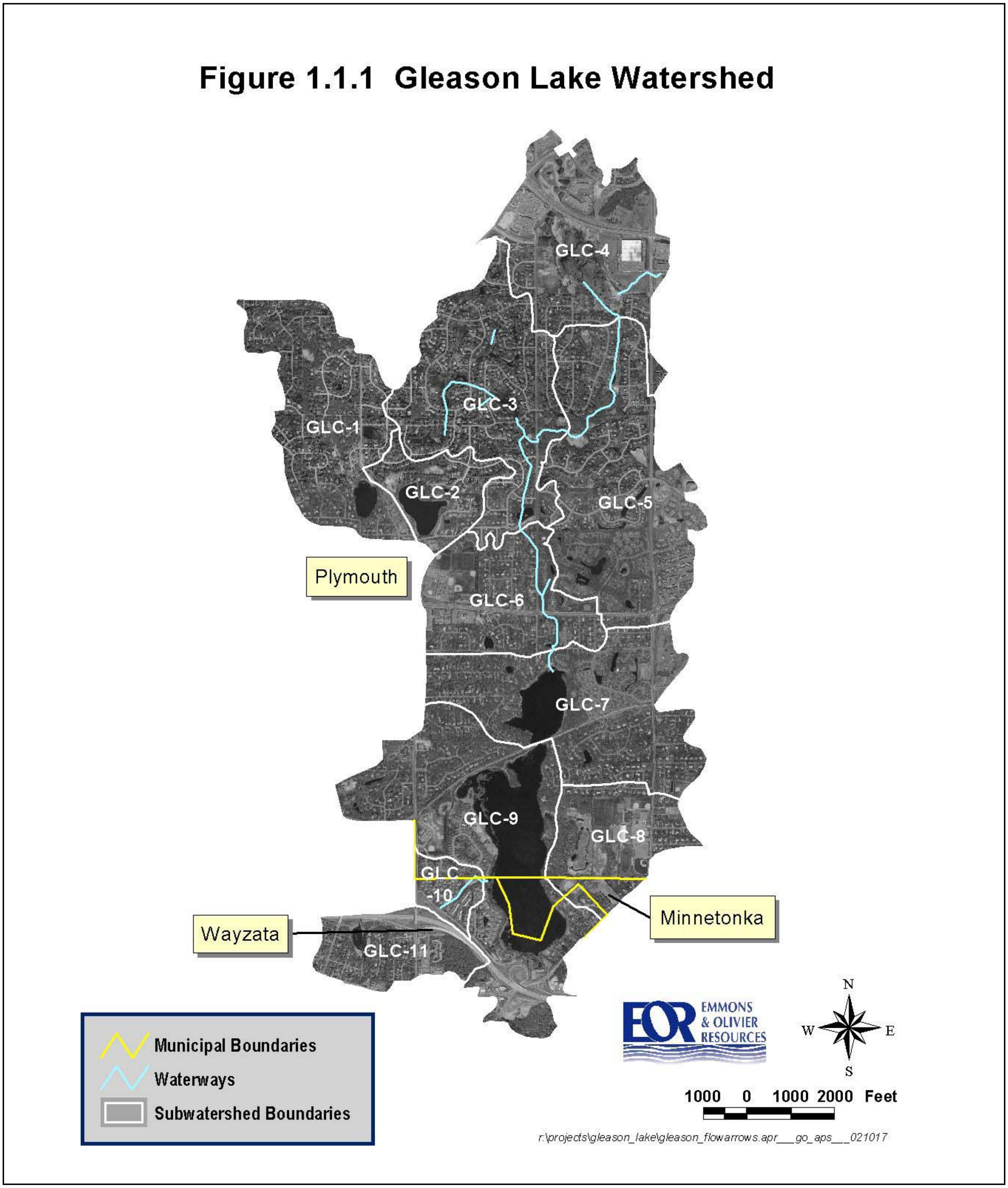
Figure 1.1.1 Gleason Lake Watershed
GLC-4
GLC-3
GLC-1
GLC-2
GLC-5
Plymouth
GLC-6
GLC-7
GLC-9
GLC-8
GLC
-10
Minnetonka
Wayzata
GLC-11
Municipal Boundaries
Waterways
Subwatershed Boundaries
EMMONS
& OLIVIER
RESOURCES
N
W
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Figure 1.1.2. Gleason Lake Area Determination

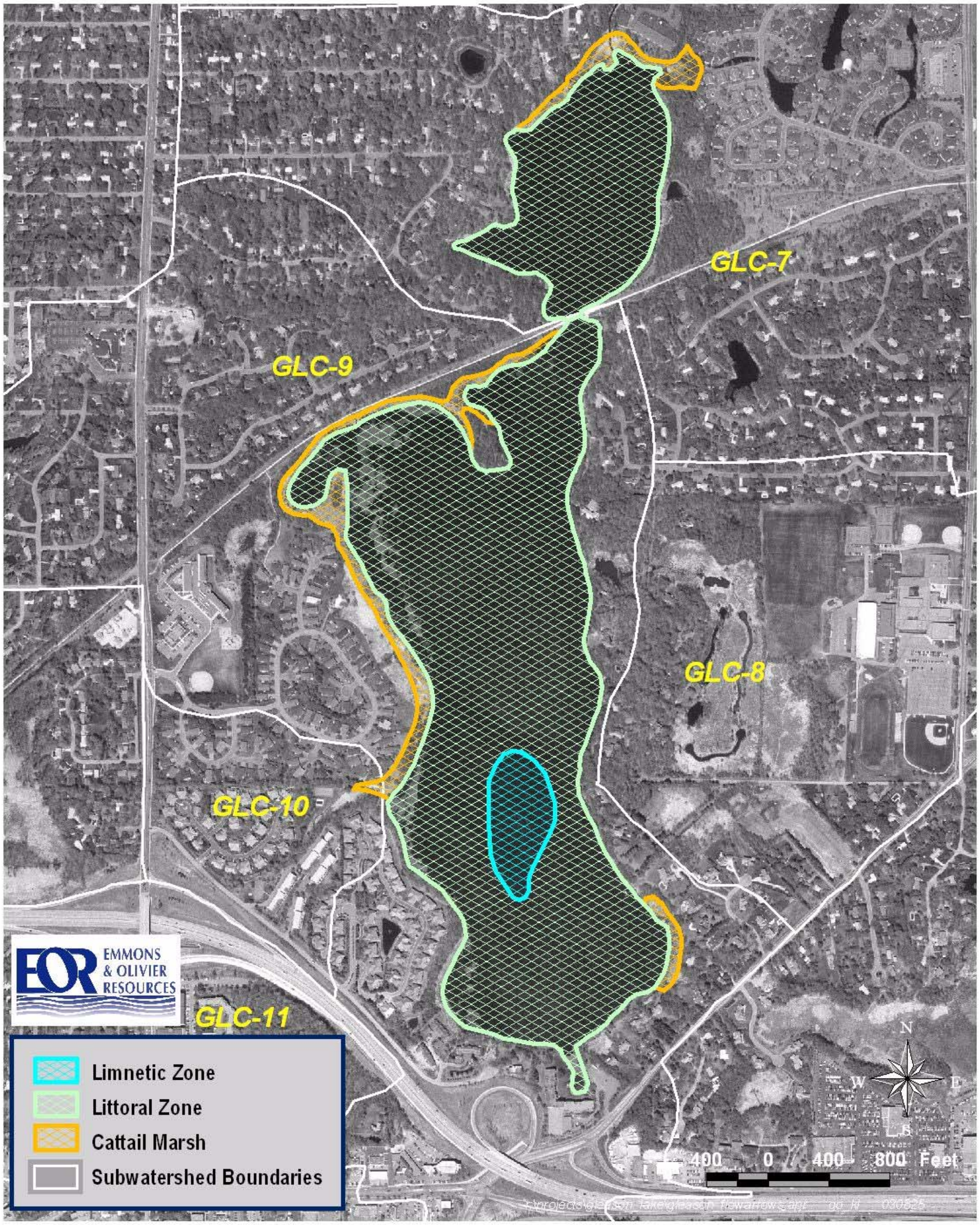
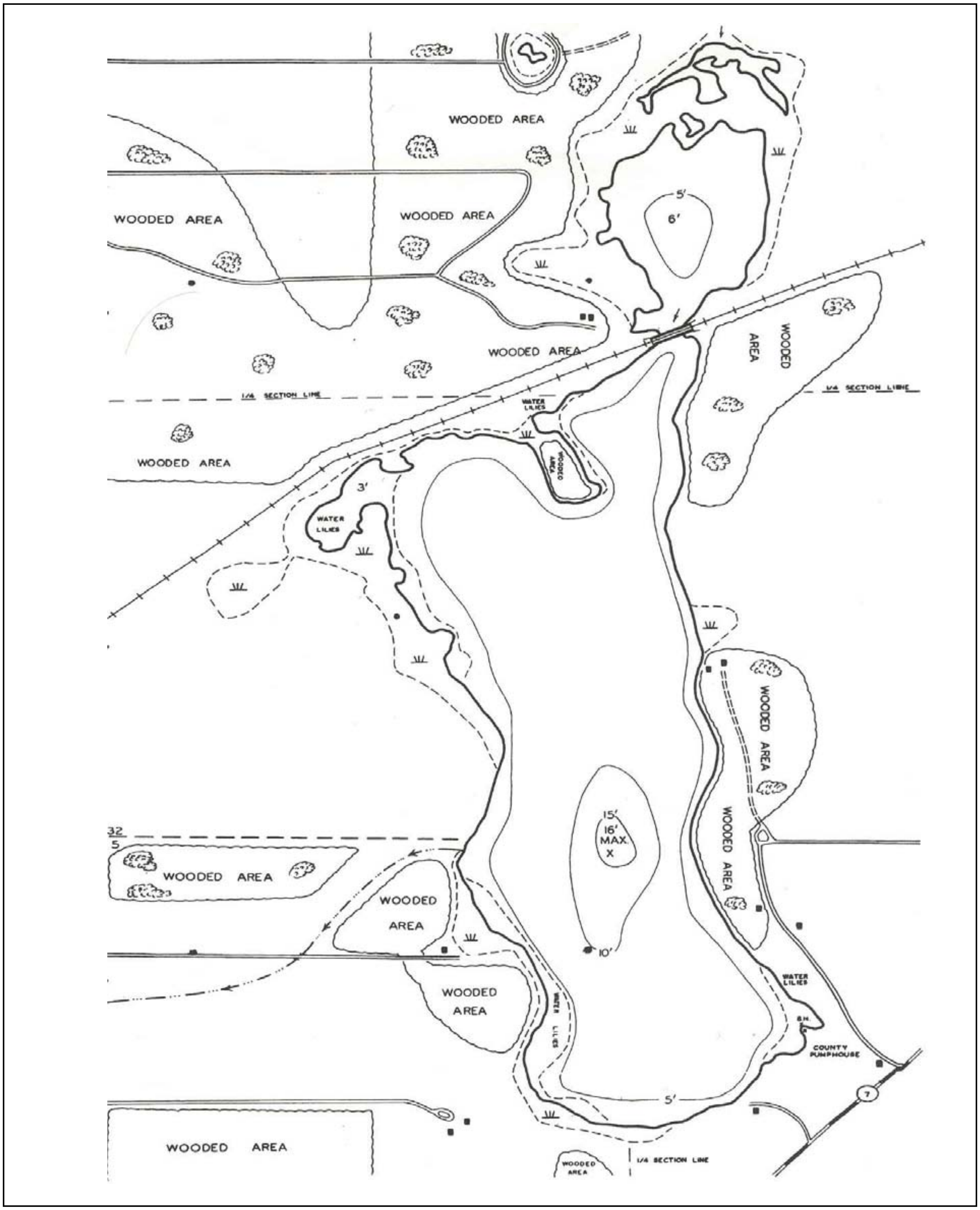


Figure 1.1.3. Gleason Lake Contour Map (DNR).



CHAPTER 2. COMMUNITY FOCUS

2.1. COMMUNITY EDUCATION AND OUTREACH

2.1.1 Development of a BMP Demonstration Site

Background

GLIA expressed an interest in cooperating with others (MCWD, City of Plymouth, DNR, Wayzata School District) on an educational demonstration site for the use of best management practices (BMPs) for lake protection. The intent is to use an urban BMP site to display in a well-traveled location one or more easily installed practices that demonstrate urban runoff pollution removal techniques.

The primary criteria for the pilot project are use of effective BMPs that display obvious pollution removal benefits, use of natural vegetation as part of the display, and visibility to a large number of people. The educational focus of the pilot site would be enhanced by locating it at or near one of the schools within the Gleason Lake watershed. The site selected is also intended to show how existing sites without any stormwater treatment facilities can be retrofit to incorporate good management.

Luce Line Zero Runoff Pilot Demonstration Site.

Signage will be displayed to explain the message of the pilot benefits.

Selection of Options

A preliminary evaluation of three site options recommended by a GLIA Board member (Lee Keeley) was conducted by EOR staff . EOR then met with Lee at each of the sites to explain some very basic concept ideas for each.

Gleason Lake Elementary School did not present a good opportunity for retrofitting a runoff solution. The school parking lot is shared with a commercial building. The drainage from most of the parking lot enters one of several storm sewer inlets and is routed off site. Roads and walkways alongside of the school drain to the rear of the school, but a nature area and gazebo presented physical obstacles to flow routing paths that could have been used. The value obtained by ripping out the nature area did not seem to exceed its value as an educational learning center, with access to an adjoining wetland.

Wayzata Central Middle School (Appendix A, Figure A1) presented many different elements that could be pieced together for a good pilot project. Essentially the entire site drains to the west and discharges to one of two wetland outlets. The entire parking lot drains to two inlets that connect to a pipe that drains untreated water directly to the wetland. The installation of a forebay at the point of discharge into a designed wetland treatment system would address this portion of the flow. The rest of the site, assumedly including the building rooftops, drain either to the two parking lot drains or down-gradient to another inlet that discharges north of the parking lot drain pipe. Additionally, overland runoff from the athletic fields and some parking lots, tennis fields and roads on the west and north sides of the school flows into the swale that leads from the second pipe to what would be the wetland treatment system. This swale could be planted in native vegetation to serve as a natural forebay area. This school project would be the best option from both a total runoff treatment and a proximity to a school standpoint. However, the public would likely not even know the project existed unless they visit the school or the athletic fields, so total visibility would be low. Because of the treatment potential that exists at the site, it is recommended as a high priority future project for the watershed.

Conversely, the Luce Line Trail DNR parking lot (Appendix A, Figure A2) is a high visibility site, with a moderate runoff treatment potential. This site was selected because it lends itself very well to retrofitting the parking lot with a filter and a vegetated infiltration system. The parking lot slopes to the southeast and to the northwest into low-lying areas extending along the parking lot. Between the lot and the two treatment areas, a vegetative and/or gravel filter could be installed to filter out solids. Since this parking area formerly was a sand and gravel mine, it is expected that water will readily infiltrate. Overflow, although not expected, could be routed to a City of Plymouth storm sewer that parallels the Luce Line Trail near the lot; this would be an option for consideration, if needed. Signage on the path leading from the lot to the Trail and on the Trail itself will pull trail users over to view the project. This site is also within walking distance of both Gleason Elementary and Wayzata Central Middle Schools. Because of the many benefits accruing from the Luce Line site, the Luce Line Pilot Project (LLPP) was chosen by GLIA representatives (Keeley and Palm) as the best option. Grant funds were sought and received from the Metropolitan Council, MCWD, City of Plymouth and Luce Line Trail Association, and the DNR allowed the site to be built on its land. The project was installed during the summer of 2003.

Potential Funding Sources for Other Projects

The original concept of building a pilot BMP demonstration site was to show the public the benefits of urban runoff BMPs on water quality. The thought was to undertake the effort as a partnership among many parties interested in the concept. The Minnehaha Creek Watershed District, one of the potential funding partners, has a memorial grant program in honor of Cynthia Krieg. This grant program is dedicated to environmental education endeavors similar to the BMP demonstration pilot. This fund was the driving force behind the idea of developing a pilot site with high public visibility. An application for the LLPP was successfully submitted, but additional funds were needed because of the limit on the total Krieg Funds.

Implementation funds for other projects, such as the Wayzata Central Middle School runoff control, could be sought in the future. Additional sources of funds that should be considered include:

- Metropolitan Council's MetroEnvironment Partnership (MEP) grant program - This program focuses on both educational and structural solutions to nonpoint source pollution problems. This fund was chosen as the best option for funding the Luce Line Pilot Project, and a grant request was successfully submitted. This source of funding is currently in the last year of existence. However, a possible future water quality improvement funding program could develop.

- City of Plymouth surface water management funds - Although no formal grant program exists for large-scale projects, the City has a small projects grant fund that can be used as a cost-share for other grants. The City contributed both cash and in-kind services to the LLPP.

- U.S. EPA Section 319 (Clean Water Act)/MPCA Clean Water Partnership grant program - This cooperative Federal/State grant program addresses nonpoint sources of pollution. A substantial lead time is needed within which to get a project initiated and funded.

- Minnehaha Creek Watershed District - Other funds dedicated to special projects that address a problem and educate residents of the District are possible from the District, but any request would need to fit into its annual budgeting cycle.

- Minnesota Board of Soil and Water Resources (BWSR) Challenge Grant - BWSR grants are issued to undertake innovative watershed management designed to reduce adverse nonpoint source impacts. However, the future of this program, in light of the State's budget problems is questionable.

- DNR Greenways - This state program focuses on creating management plans for high quality natural areas and could be considered as a future possibility for funds.

2.1.2. Community Contacts

The original workplan for the GLMP called for a community meeting to be held to present the findings of the Management Plan. After some discussion, the GLIA decided that the pilot demonstration project and a series of newsletters, combined with the educational brochure (Section 2.2 below) would provide more efficient communication with the public. Findings resulting from the GLMP effort will be incorporated into the GLIA newsletter. The pilot demonstration project provides several opportunities for volunteer work during construction and planting, and a public open house will be held in September after completion. Information on the pilot project will also be included in the educational brochure. School groups will be notified of the opportunity for environmental education associated with the pilot site.

One of the ideas to emerge in the management section of the Plan is the involvement of local neighborhoods in the proper maintenance of the many ponds located in the watershed. The "Adopt-a-Pond" program would organize neighbors to make sure that their local pond functions effectively. Program participants would be trained to maintain the ponds through such measures as skimming duckweed and algae, litter pick up, small-scale erosion repair, outlet debris removal and sediment delta removal. They would also be asked to visually monitor the ponds and quickly notify the proper personnel if a problem arises. The "Adopt-a-Pond" program would be applied to both newly dredged or re-configured ponds, as well as older ponds that are awaiting renewal or are found to be functioning properly with their current configuration.

One other element that merits mention is the need to get the word out to neighborhoods, condominium associations, commercial centers and new developers to practice good house-keeping. Sweeping mowed grass and fertilizer from the street, cleaning-up litter in parking lots, picking up pet waste and practicing good erosion control on new construction sites are all examples of how the community can participate in good watershed management.

2.2. EDUCATIONAL BROCHURE

The stated intent in the workplan of preparing an educational brochure is to present the findings of the GLMP to the public in an informative and educational manner. The brochure is expected to contain key information about Gleason Lake and its watershed, maps identifying areas of concern, and recommended activities residents can perform to ensure the sustainability of the lake. A directive from GLIA requested that the GLMP contain recommended content of the brochure, but suggested that the brochure itself be coordinated by the Association in the same manner as the "The Gleason Lake Connection" brochure.

The "Connection" brochure was an excellent starting point to educate residents of the entire watershed about the lake. It talked about the Lake in terms of residents' yards and explained how the watershed, Gleason Lake and Lake Minnetonka are connected. Supplementing on this good start should include the introduction of the findings and recommendations of this Plan in an equally understandable manner.

Appendix B includes a number of different possible items that could be adapted for a new brochure. First is a list of "TEN STEPS TO CLEAN WATER - THINGS YOU CAN DO!" that could supplement the current brochure, although the theme is essentially the same. The "Ten Steps" in the appendix incorporates some of the findings, and orients the actions based on those.

Appendix B also includes a graphic of the relationship of biomanipulation to overall lake health, and the way in which macrophytes alter lake quality. This should help to explain why it is that major manipulation of a lake is not always the way to improve it.

The next elements in Appendix B are graphic depictions of BMP groups or suites that could be put into a brochure as examples of available management techniques. These graphics were used during the MCWD H&H public input process to show participants suites of BMPs commonly used to address nonpoint source pollution. The pictures helped participants envisage solutions. Selections are contained for using BMPs focused on development, natural, surface water management, channel stabilization and shoreland management techniques. Finally, some web-site links are added for those interested in finding new source of information or delving further into nonpoint source runoff control. Perhaps references to electronic or paper BMP manuals could be added, if GLIA sees an opportunity to enhance knowledge without overwhelming the reader.

The major educational points that need to be made for the Lake and watershed are: the source of the phosphorus to the Lake has to be reduced before the Lake can improve; the weeds, although a nuisance, are naturally occurring and do benefit the Lake by holding down algal growth and by providing good fish habitat; ponds and wetland treatment that have been used since the area was originally developed have filled in and become largely ineffective; and the aerator provided the biggest benefit from winter-only operation to prevent fish kills.

CHAPTER 3. TECHNICAL BASIS

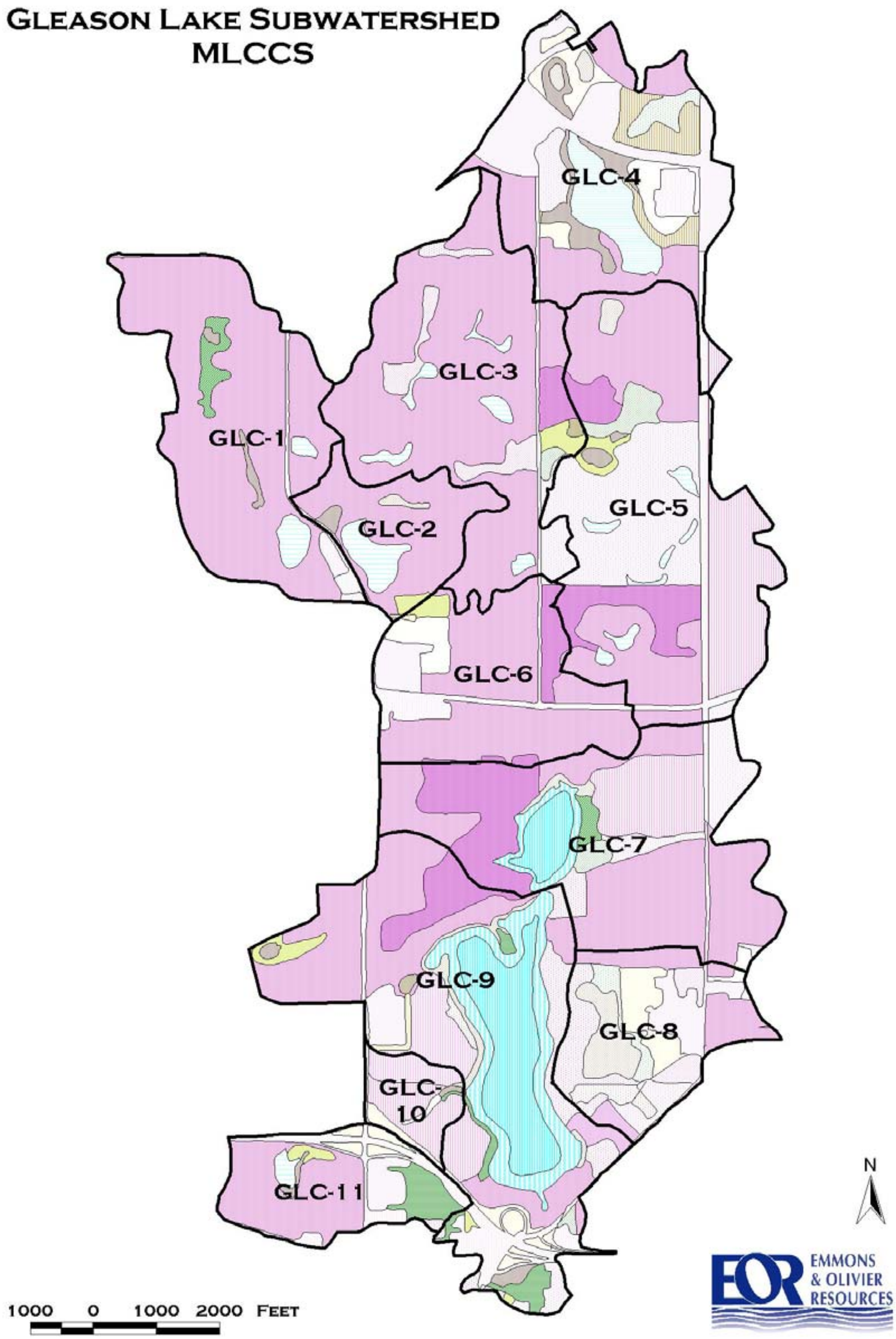
3.1. LAND COVER MAPPING

Part of the work program for the Minnehaha Creek Watershed District HHPLS included assembling land cover under the format developed for the DNR's Minnesota Land Cover Classification System (MLCCS). The MLCCS is a standardized method for mapping and defining land cover types in both rural and urban settings. Detailed ecological information is gathered through the use of stereoscopic infrared aerial photo pairs, with field verification. Land cover types are then mapped using a Geographic Information System (GIS). The detailed GIS data associated with all of the mapped cover types provides valuable information about each mapped unit. Accurate and efficient use of the MLCCS requires trained GIS operators and skilled natural resource professionals.

MLCCS codes are represented by five digit numbers. Each number represents one level in the hierarchical classification system. Level one, or the first digit, differentiates between major differences in land cover, such as artificial surfaces and forests. Level two then differentiates forest types, for example, into coniferous and deciduous. Levels three, four and five further differentiate the land cover subtypes providing detailed information, such as percent of impervious for developed areas and vegetation species composition for natural areas.

Figure 3.1.1 shows the MLCCS categories for the entire area draining to Gleason Lake. This information is presented as level five. The 34 cover types shown in the figure provide the basis for moving forward on consideration of BMP implementation and land alterations that could benefit water quality.

Figure 3.1.1. Gleason Lake Subwatershed Land Cover



Minnesota Land Cover Classification System
- Gleason Lake Subwatershed -

11220	11% to 25% impervious cover with deciduous trees
11230	26% to 50% impervious cover with deciduous trees
13110	4% to 10% impervious cover with perennial grasses and sparse trees
13120	11% to 25% impervious cover with perennial grasses and sparse trees
13130	26% to 50% impervious cover with perennial grasses and sparse trees
13140	51% to 75% impervious cover with perennial grasses and sparse trees
13210	4% to 10% impervious cover with perennial grasses
13220	11% to 25% impervious cover with perennial grasses
13230	26% to 50% impervious cover with perennial grasses
13240	51% to 75% impervious cover with perennial grasses
14110	76% to 90% impervious cover
14120	91% to 100% impervious cover
21110	Upland soils with planted, maintained, or cultivated coniferous trees
23210	Upland soils with planted or maintained grasses
23211	Short grasses on upland soils
23220	Hydric soils with planted or maintained grasses
24210	Upland soils - close grown cropland
32110	Oak forest
32150	Maple-basswood forest
32170	Boxelder - green ash disturbed native forest
32220	Lowland hardwood forest
42130	Disturbed deciduous woodland
61220	Medium-tall grass non-native dominated grassland
61510	Cattail marsh - seasonally flooded
61530	Seasonally flooded non-native dominated emergent vegetation
61610	Cattail marsh
61630	Semipermanently flooded non-native dominated vegetation
61710	Cattail marsh - intermittently exposed
61730	Intermittently exposed non-native dominated vegetation
62140	Grassland with sparse deciduous trees - non-native dominated vegetation
92100	Limnetic open water
92500	Littoral open water
93200	Permanently flooded aquatic bed
93300	Open water

3.2. WATERSHED AND IN-LAKE MODELING

Watershed runoff and in-lake modeling was conducted for Gleason Lake and the area draining to it as part of the MCWD Hydrologic, Hydraulic and Pollutant Loading Study (HHPLS). This section of the report summarizes those findings and the implications they have for improving the quality of Gleason Lake.

Watershed Runoff Modeling

Runoff quantities for each of the sub-basins comprising the Gleason Lake watershed (see Figure 1.1.1) were modeled using the XP-SWMM framework developed for the HHPLS. The sub-basins are presented schematically, as handled in the runoff model, in Figure 3.2.1. Note that sub-basins GLC-10 and -11 are not included in subsequent runoff and modeling analyses because they do not discharge into Gleason Lake, but rather enter the drainage system between the Gleason Lake outlet and Lake Minnetonka.

Each drainage feature (ex. channel, culvert, storm sewer inlet) within the watershed is presented as a node in the XP-SWMM modeling framework. The network of nodes occurs within the sub-basin framework shown in Figure 3.2.1. Water that falls on the surface of the watershed is routed down through the drainage network toward the Lake. Because the basin is nearly fully developed, the increase in runoff by the year 2020 is not expected to rise under the current development scenario.

The second part of the runoff modeling is the assignment of water quality parameters to the runoff. Loading coefficients are based upon the land use generating the runoff, combined with the land cover as documented under the HHPLS. The method used for determining land cover is the MLCCS, as described in Chapter 3.1 and displayed in Figure 3.1.1.

Under the HHPLS effort, water quality loads for total phosphorus (TP), total nitrogen (TN) and total suspended solids (TSS) were tabulated under both existing and 2020 conditions (Table 3.2.1), and plotted in Figure 3.2.2 (a-c). Of these constituents, TP is the most critical to the overall quality of Gleason Lake. Most lakes in Minnesota are "phosphorus-limited", meaning the supply of phosphorus is the most limited, commonly sampled nutrient needed by the lake to sustain biological activity. When TP is in short supply, the lake will remain relatively algae free. However, when TP is plentiful, algal growth abounds. Tracking the presence of TP, therefore, allows some management assumptions to be made

Figure 3.2.2 (a) is a graphic presentation of the load of TP washing-off of each of the sub-basins. The change in tone from light to dark indicates an enrichment of annual TP load, or mass measured in pounds per acre, in the runoff.

Figure 3.2.1. Sub-Basin Drainage Within the Gleason Lake Watershed.

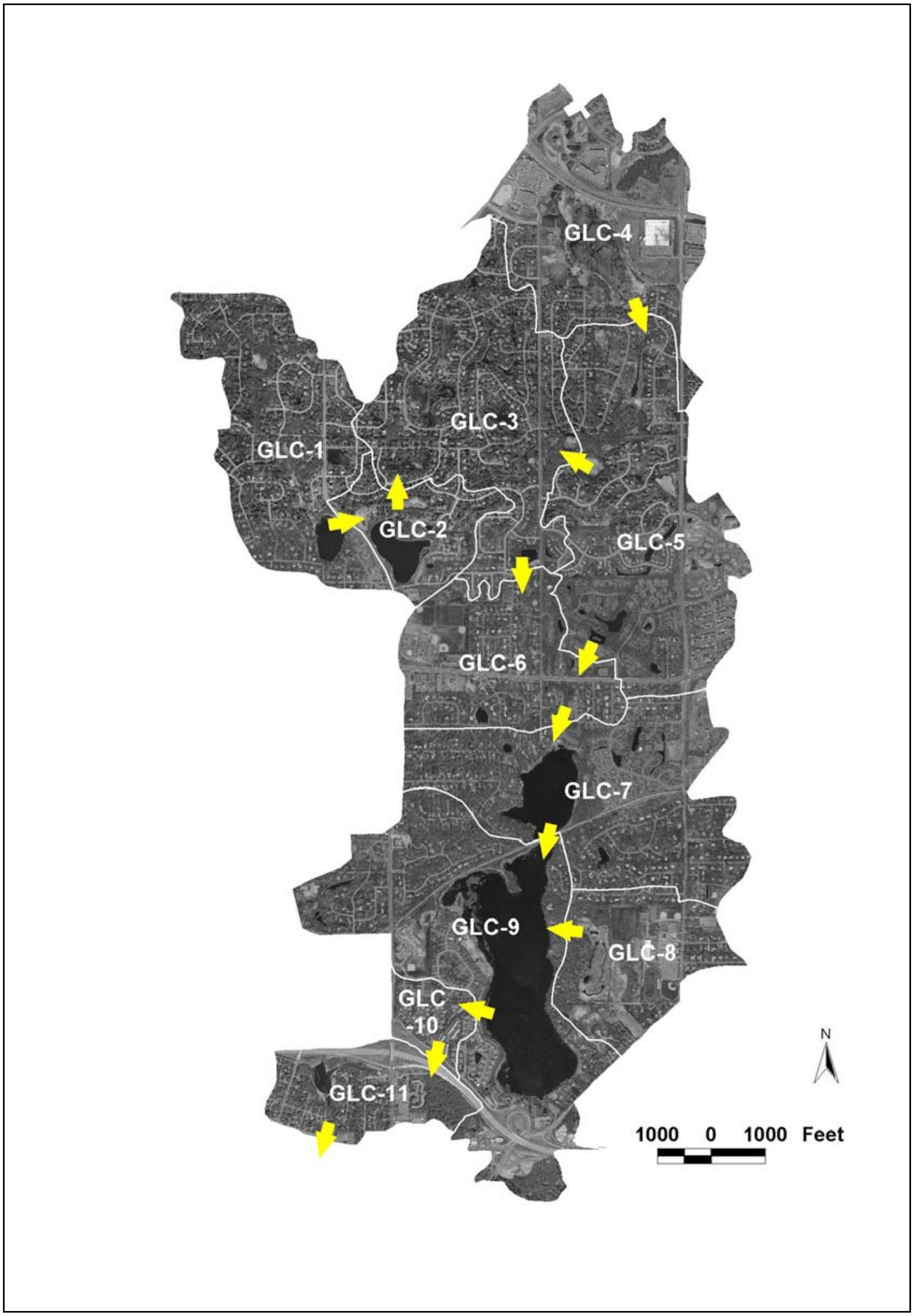


Table 3.2.1. Sub-Basin TN, TSS and TP Loads for Gleason Lake Subwatershed.

		TN					
		Existing			2020		
		Volume	Load	Load	Volume	Load	Load
Sub-Basin	Acres	(acre-feet)	(lbs/yr)	(lbs/ac-yr)	(acre-feet)	(lbs/yr)	(lbs/ac-yr)
GLC-1	283.2	104.6	762.7	2.7	105.1	761.2	2.7
GLC-2	101.4	41.2	235.9	2.3	41.2	246.9	2.4
GLC-3	341.5	115.8	842.4	2.5	116.1	852.9	2.5
GLC-4	303.7	135.2	686.0	2.3	160.1	860.0	2.8
GLC-5	406.4	143.9	1008.4	2.5	144.6	1039.3	2.6
GLC-6	205.9	79.2	553.2	2.7	79.7	580.9	2.8
GLC-7	345.1	135.6	873.2	2.5	137.6	911.1	2.6
GLC-8	157.7	39.3	226.3	1.4	40.3	267.5	1.7
GLC-9	460.1	228.1	980.2	2.1	232.7	1069.0	2.3
Total	2605.0	1022.9	6168.4	2.4	1057.4	6588.6	2.5

		TSS					
		Existing			2020		
		Volume	Load	Load	Volume	Load	Load
Sub-Basin	Acres	(acre-feet)	(lbs/yr)	(lbs/ac-yr)	(acre-feet)	(lbs/yr)	(lbs/ac-yr)
GLC-1	283.2	104.6	26562	94	105.1	28115	99
GLC-2	101.4	41.2	8118	80	41.2	8339	82
GLC-3	341.5	115.8	27754	81	116.1	30213	88
GLC-4	303.7	135.2	31543	104	160.1	44161	145
GLC-5	406.4	143.9	39090	96	144.6	42407	104
GLC-6	205.9	79.2	21312	103	79.7	24857	121
GLC-7	345.1	135.6	31453	91	137.6	33965	98
GLC-8	157.7	39.3	8638	55	40.3	11534	73
GLC-9	460.1	228.1	34283	75	232.7	38491	84
Total	2605.0	1022.9	228754	88	1057.4	262082	101

		TP					
		Existing			2020		
		Volume	Load	Load	Volume	Load	Load
Sub-Basin	Acres	(acre-feet)	(lbs/yr)	(lbs/ac-yr)	(acre-feet)	(lbs/yr)	(lbs/ac-yr)
GLC-1	283.2	104.6	113.2	0.40	105.1	109.0	0.38
GLC-2	101.4	41.2	33.0	0.33	41.2	32.5	0.32
GLC-3	341.5	115.8	124.4	0.36	116.1	122.5	0.36
GLC-4	303.7	135.2	89.8	0.30	160.1	109.7	0.36
GLC-5	406.4	143.9	137.9	0.34	144.6	133.7	0.33
GLC-6	205.9	79.2	82.6	0.40	79.7	82.1	0.40
GLC-7	345.1	135.6	120.5	0.35	137.6	120.1	0.35
GLC-8	157.7	39.3	35.1	0.22	40.3	37.7	0.24
GLC-9	460.1	228.1	118.0	0.26	232.7	127.4	0.28
Total	2605.0	1022.9	854.4	0.3	1057.4	874.7	0.34

It is important to note the distinction between the wash-off load represented in Figure 3.2.2 and the actual load reaching a receiving water. The loads in the figure are subjected to several physical, biological and chemical processes before they actually enter a receiving water body. Processes such as settling, algal uptake, and organic complexation all work to reduce the total load of phosphorus as it flows through the watershed. The next sub-section addresses the need to adjust wash-off loads to account for changes as the load is routed through the various sub-basins.

Figure 3.2.2 (a). Modeled Phosphorus Loads (lbs/ac-yr) for the Gleason Lake Watershed.

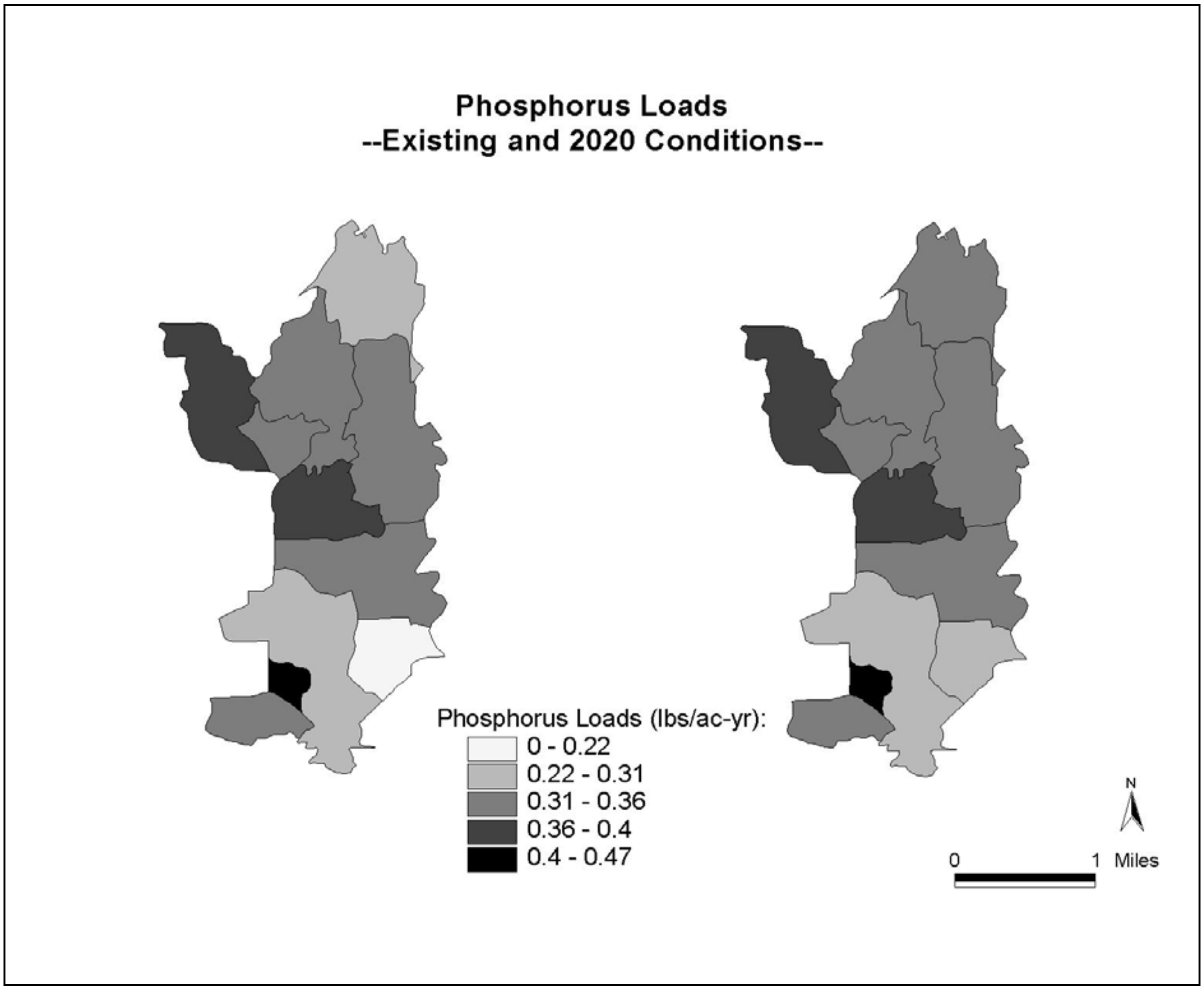


Figure 3.2.2 (b). Modeled Total Nitrogen (TN) Loads (lbs/ac-yr) for the Gleason Lake Subwatershed.

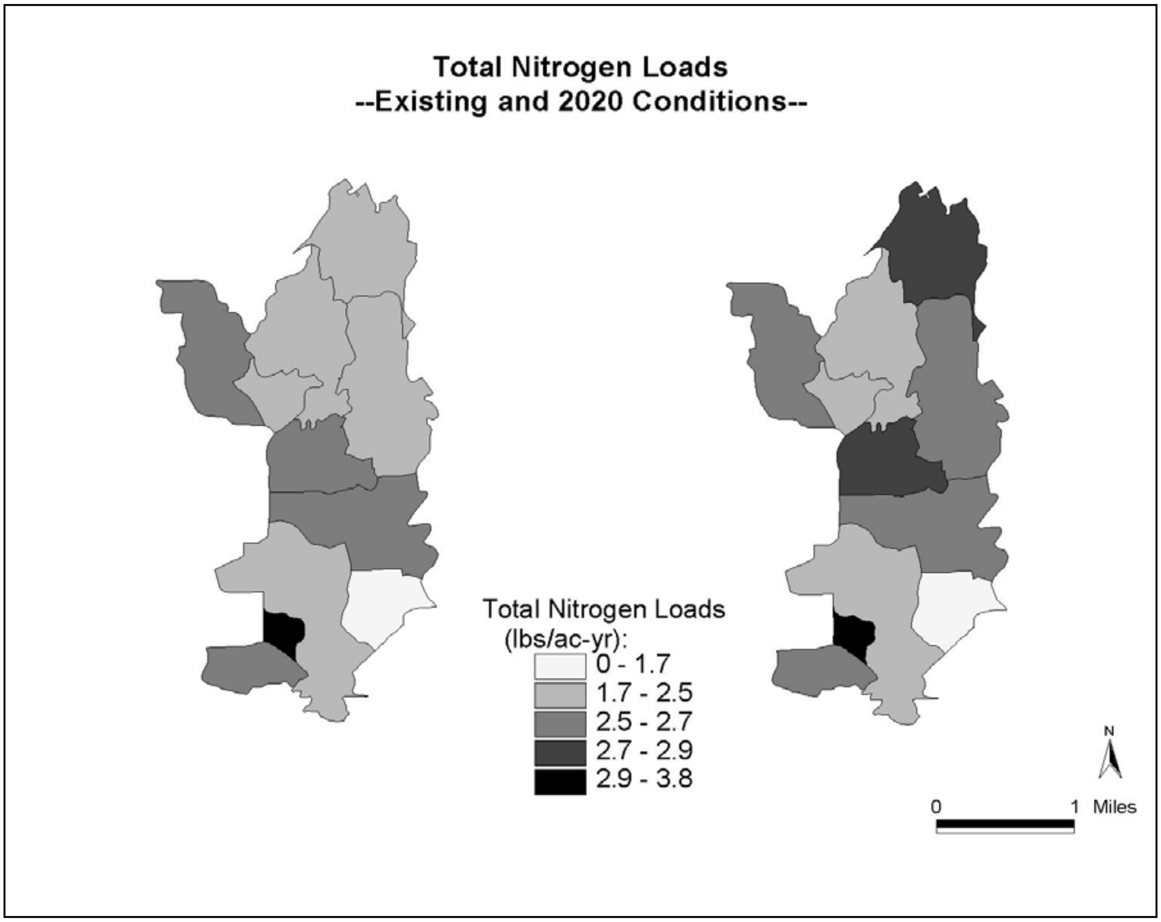
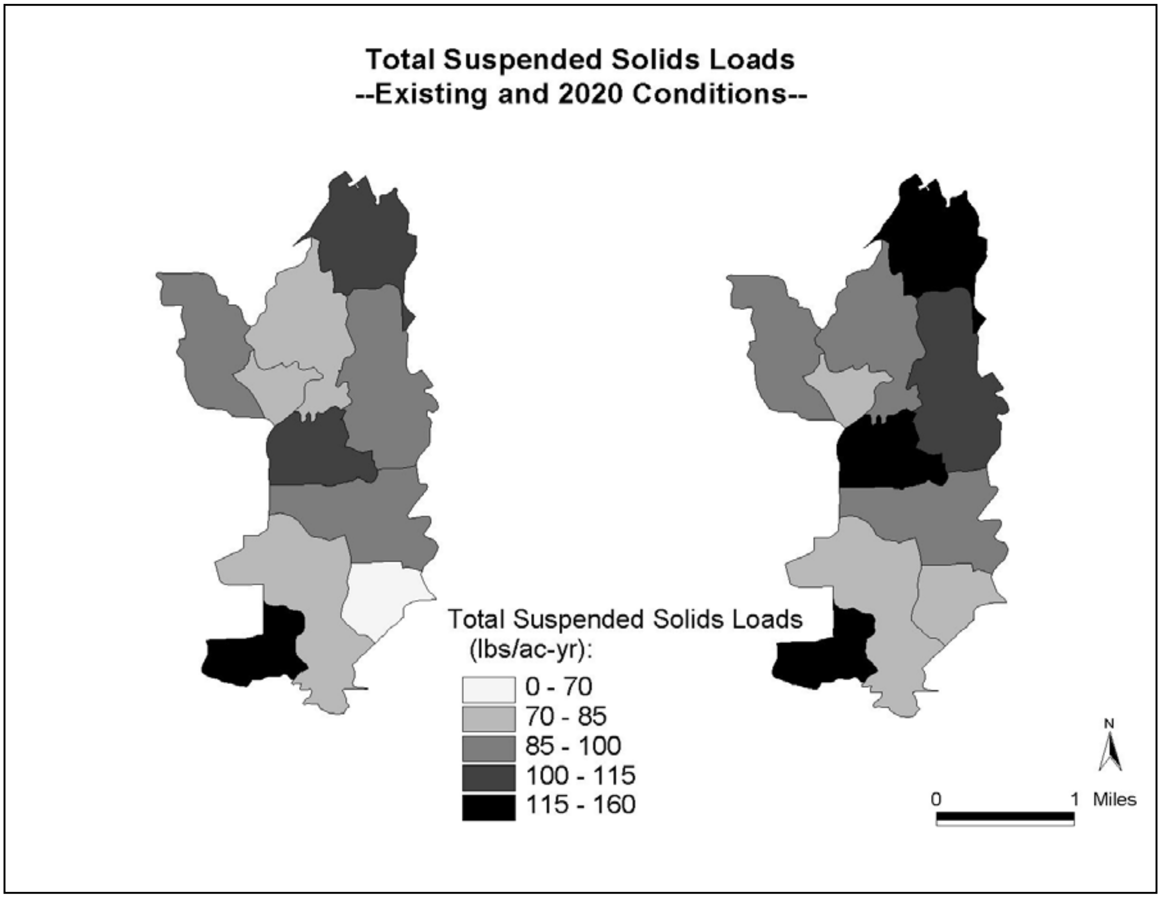


Figure 3.2.2 (c). Modeled Total Suspended Solids (TSS) Loads (lbs/ac-yr) for the Gleason Lake Watershed.



Model Adjustments

As part of the MCWD HHPLS pollution load modeling, the TP load from each sub-basin draining to Gleason Lake was quantified for both existing and 2020 conditions (Table 3.2.1). These load numbers reflect the "wash-off" of total phosphorus from the land surface, not necessarily the amount that will reach a receiving water. Table 3.2.2 summarizes this information for TP, and shows an expected load wash-off increase of only 2.4% by 2020. This is reflective of the near fully developed nature of the watershed.

Table 3.2.2. Pre-BMP Modeled Loads

Sub Basin	TP Load (lbs.)	
	Current	2020
GLC-1	113.2	109.0
GLC-2	33.0	32.5
GLC-3	124.4	122.5
GLC-4	89.8	109.7
GLC-5	137.9	133.7
GLC-6	82.6	82.1
GLC-7	120.5	120.1
GLC-8	35.1	37.7
GLC-9	118.0	127.4
Total	854.5	874.7 (+2.4%)

* Sub-basins GLC-10 and 11 do not drain to Gleason Lake, but enter below the lake outlet into Lake Minnetonka

The "wash-off" load values shown in Table 3.2.2 have to be adjusted to account for reductions that occur as the runoff traverses the landscape. In doing so for the GLMP, the 2020 adjustments assumed the existing load reduction would remain constant. This is likely a conservative assumption, since improvements in development and retrofit runoff control techniques will improve with time. A good example of this is seen in the difference between development in the south part of the watershed versus the far north commercial area.

Figure 3.2.3 is a flow schematic that reflects the manner in which water flows from sub-basin to sub-basin. Table 3.2.3 reflects the flow pattern and the adjusted loads as water flows among the various sub-basins and into Gleason Lake. The narrative after the table explains the assumptions for adjustment. The adjusted load provides the baseline for BMP load reduction determination.

Figure 3.2.3. Gleason Lake Watershed Schematic.

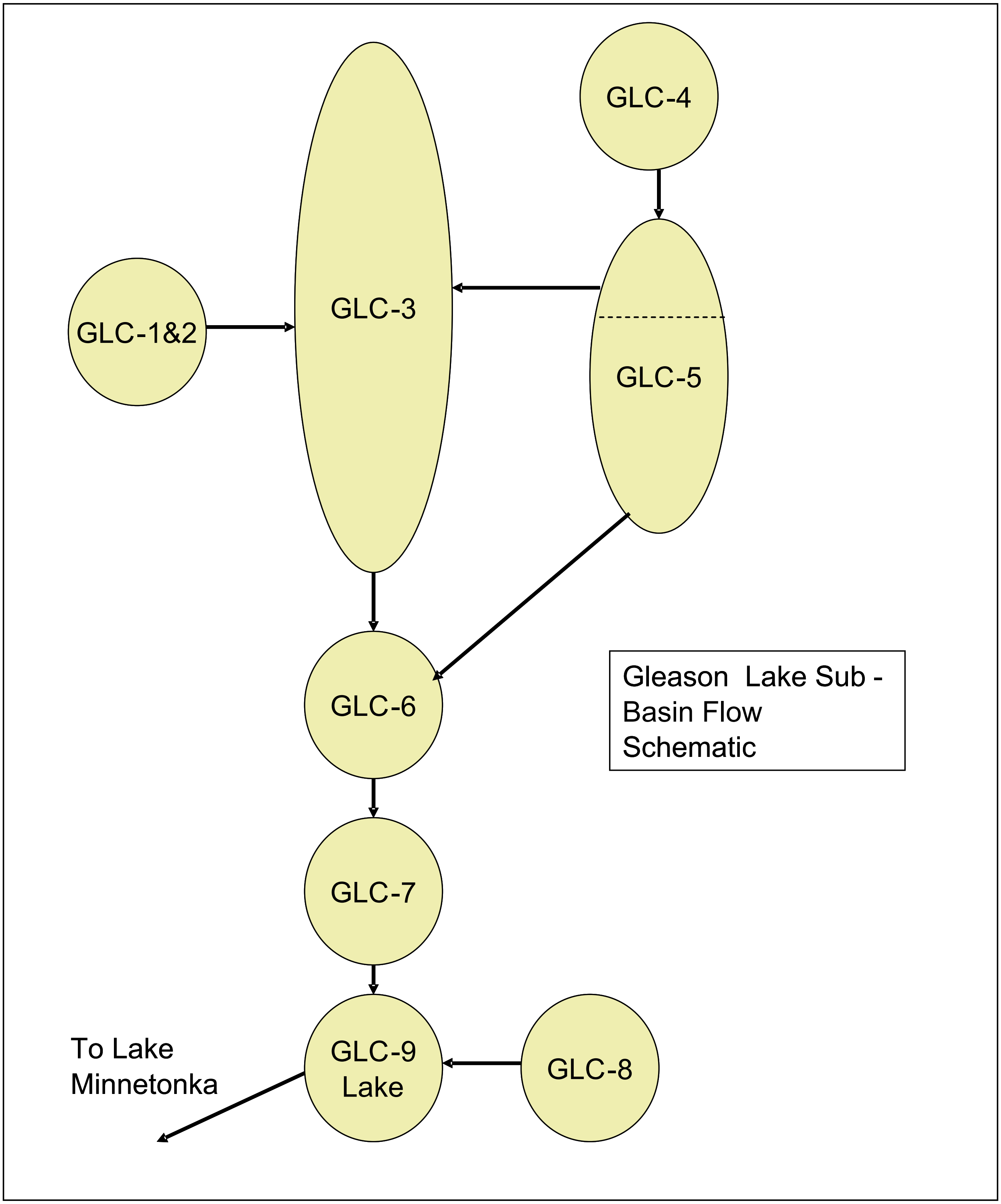


Table 3.2.3. Gleason Lake Sub-Basin Modeled and Adjusted TP Loads

Sub-Basin	TP Load (lbs.)	
	Current Modeled	Current Adjusted
GLC-1 and 2	146.2	48.8
GLC-4	89.8	44.9
GLC-1 through 4, and upper portion of 5	394.9	182.8
GLC-1 through 4, upper and lower portions of 5, and 6	580.9	385.7
GLC-1 through 7	701.4	500.2
GLC-1 through 8	736.5	531.8
GLC-1 through 9 (total)	854.5	649.8

Sub-Basin Model Adjustments

The information presented in Table 3.2.3 is reflective of the manner in which water flows through the watershed draining to Gleason Lake. The following descriptions explain the assumptions used in adjusting the wash-off load to the actual load leaving the sub-basin or collection of sub-basins.

GLC-1 and 2 - Flow from GCL-1 passes through Snyder Lake, where a load reduction of 49% was modeled. The settled flow then passes into GLC-2, and is further settled in Kreatz Lake, where the combined flow is predicted through modeling to lose another 46% of its TP load. These numbers were derived by the WiLMS lake loading model. The total existing to adjusted load reduction in GLC-1 and 2 is about 67% (97.4 lbs.). Of note, the location of Snyder Lake to the west of Kreatz Lake is the official City of Plymouth designation. Both the DNR and the USGS have the lakes in the opposite configuration. The GLMP will refer to the City's configuration.

GLC-4 - The far northern portion of the watershed is the most recent to develop. Runoff from the new commercial development on both sides of Highway 55 is very well managed through a series of detention ponds and wetland treatment systems. All of the runoff from the sub-basin also passes through a large wetland before discharging to GLC-5. As a result of the extensive and effective treatment currently in place, the load was reduced by 50%. Load is further reduced prior to input to downstream GLC-5 by a 10% decrease assumed for the pond located in Maple Creek Park (Plymouth).

GLC-5 - The water flowing through GLC-5 is split by an in-channel low-flow weir that allows most low flow water to flow into GLC-3, but diverts high flow and some leaking low flow to the south and into the bottom portion of GLC-6. Overland flow below the weir also eventually flows into GLC-3. Flow from GLC-5 is partitioned, with one-quarter going to GLC-3 and three-quarters to GLC-6. Of note, the in-channel weir leaks about one-half of the low flow volume into the pipe leading to GLC-6. If this is not intended to be a "leaky" weir, some repair is needed. TP load in the one-quarter flow proceeding toward GLC-3 is reduced by 33% in the wetland system immediately below the weir.

GLC-1, 2, 3, 4 and upper 5 - GLC-3 collects direct overland runoff from the area within its boundaries, as well as the already-settled channel flow from GLC-1 and -2 combined (through Kreatz Lake) and the upper portion of GLC-5. Although six detention ponds, some with wetlands surrounding them (see photo to right), exist in the channel as it flows through this sub-basin, the ponds are stagnant and assumed very shallow. The ponds are assumed to be only about 10% effective in the removal of TP, mostly because the particulates are likely solubilized into dissolved phosphorus. The ineffective ponds in this sub-basin should be the focus of future BMP rehabilitation or retrofit attention.

GLC-5 lower portion - The lower three-quarters of GLC-5 flows southward through a system of pipes and open channels, until it reaches the Steele Lake system. Flow and load into the diversion pipe from GLC-4 via the low-flow weir is combined with inputs from the lower portion of GLC-5, and routed into the Steele system. Because the Steele system is stagnant and assumed shallow, only a 10% reduction in TP load is assumed. The flow from all of lower GLC-5 enters GLC-6 near Co. Rd. 6.

GLC-1, 2, 3, 4, 5 and 6 - All of the upper part of the Gleason Lake watershed comes together in GLC-6. The MCWD detention pond (see photo to right) located between Co. Rd. 6 and Gleason Lake is within this sub-basin. However, the detention pond is approximately one-quarter of an acre in size, draining an area of approximately 1640 acres, resulting in an extremely low ratio of only 0.02%. The result of the very low pond-to-drainage area ratio is that the pond is overwhelmed by flow, and rendered generally ineffective because of the large volume of water scouring anything that might be deposited from baseflow. Preliminary work on the pond by the WD yielded an estimate of 12% effectiveness for TP, but even this low figure is not considered accurate because of its small size. No reduction in TP load is expected for this pond. It should become the focus of a future BMP enhancement because of its key location relative to the watershed draining to the Lake.

GLC-1 through 7- Input from GLC-7 consists of drainage from an area tributary to the north bay of the Lake that joins with the outflow from GLC-6. Several small ponds serve local drainage within the sub-basin. Most of the small ponds are stagnant and shallow, and were, therefore, assigned a TP load reduction of only 5%. The 8th Avenue Pond and the Cimarron Ponds development series of ponds should be the focus of rehabilitation/dredging in the future. They appear to do a satisfactory job of locally settling solids, but could be much more effective if properly configured.

GLC-1 through 8 - GLC-8 drains the east side of the Lake area. Runoff drains through a large, but ditched wetland west of the Wayzata Central Middle School. A reduction of 10% was assigned to this feature. Drainage from all of the impervious surfaces at the school (parking, buildings and roads) receives no pre-settling before discharge to the wetland. The school should be a primary focus for future load reduction from this sub-basin.

GLC-1 through 9 - GLC-9 is the sub-basin that directly surrounds Gleason Lake, in addition to draining an area northwest of the Lake. No change in the runoff load from this sub-basin is assumed because of its development density and general lack of detention storage.

In-Lake Modeling

After the runoff loads were modeled, an in-lake model was prepared to reflect the response of the lake to all of the phosphorus load inputs. The WiLMS (Wisconsin Lake Models Suite, version 3.3.8 - developed by the Wisconsin Department of Natural Resources and updated in 2002) group of models was used to select a model to accurately represent lake behavior. WiLMS uses a suite of 13 commonly used lake loading/response models to provide a user with a model choice that calibrates well to available field data. The Canfield-Bachmann (Canfield and Bachmann, 1981) equations for natural lakes (in WiLMS) were used for the lake model discussed here, as these equations are the most appropriate for Gleason Lake's morphometry, mixing regime, and geographic location.

Hydrology and nutrient loads are entered into WiLMS, and all 13-lakes models are run at the same time. WiLMS can use gaged watershed flow data, but loads must be derived and then entered into the model. Loads are based on land use and export coefficients.

The result of the in-lake model is a "predicted" in-lake phosphorus concentration that can be compared to actual field data. These numbers, in turn, can be compared with the level that would be expected under "natural" conditions according to the MPCA Ecoregion concept, within which lake quality characteristics of certain geographic regions in Minnesota can be ascertained. The difference between the Ecoregion (or natural) value and the observed value generally indicates the level of degradation resulting from anthropomorphic (or human-induced) pollutant inputs.

Table 3.2.4 summarizes the in-lake model results for Gleason Lake. Watershed load estimates in the table come from Table 3.2.3, and the in-lake results from WiLMS.

Table 3.2.4. Gleason Lake Modeling Results.

Modeled TP Load (lbs./year)		In- Lake TP Modeling Results (µg/L)
Current	2020	
650	776	- 98 µg/L predicted - 122 µg/L observed - In 2020 lake predicted to be 124 µg/L* - 55 µg/L North Central Hardwood Forests Ecoregion predicted value

* The 2020 lake TP estimate is based on the predicted increase in load between existing and 2020 conditions, which is added to the "observed" load to lake to better reflect actual conditions.

The results in Table 3.2.4 show that observed phosphorus levels in the lake are far greater than predicted by simply using lake inflow loads. This indicates that another, most likely internal, source of phosphorus is present. The details of these load sources and their control occurs in Chapter 3.3.

Figure 3.2.4 presents the findings of the above TP analysis, as well as similar findings for Secchi disk transparency (a measure of clarity) and Chlorophyll-*a* (a measure of algal abundance).

Figure 3.2.4 presents a very interesting finding relative to lake behavior. Note that both the Secchi disk transparency and the Chlorophyll-*a* predicted values are worse than the observed values - directly opposite of the behavior for TP. In other words, the lake is clearer and contains <u>less</u> algae than expected, especially when the very high TP level is considered. Figure 3.2.5 illustrates where the various measures fit on the Carlson Trophic State Index scale, and shows how the hypereutrophic TP levels are not reflected in similar clarity and algae levels. It is suspected that the macrophytes (plant community) play a key role in this unusual behavior. This will be addressed in Chapter 3.3.

Figure 3.2.4. Gleason Lake Model Results for TP, Secchi Disk Transparency and Chlorophyll-*a*.

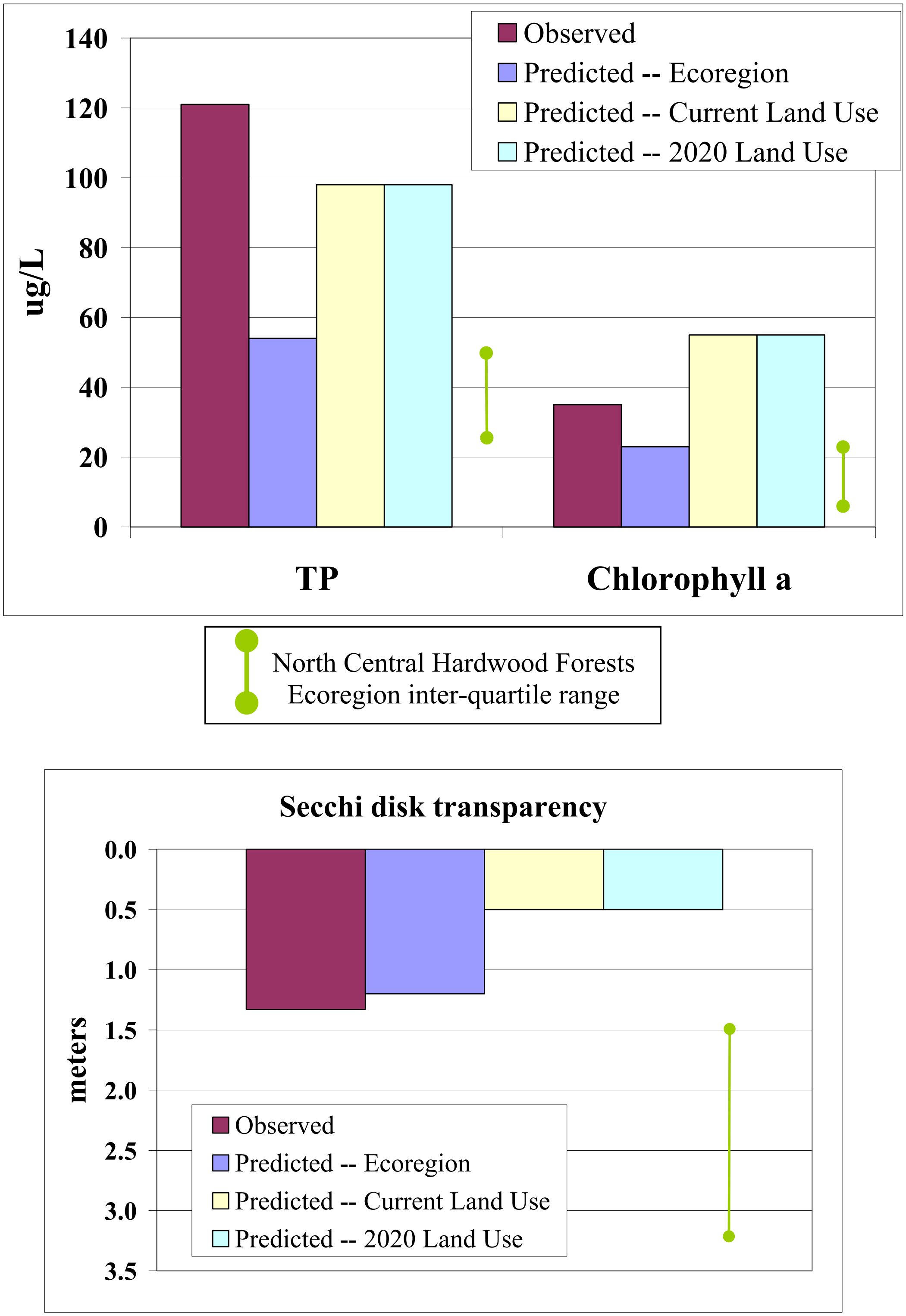
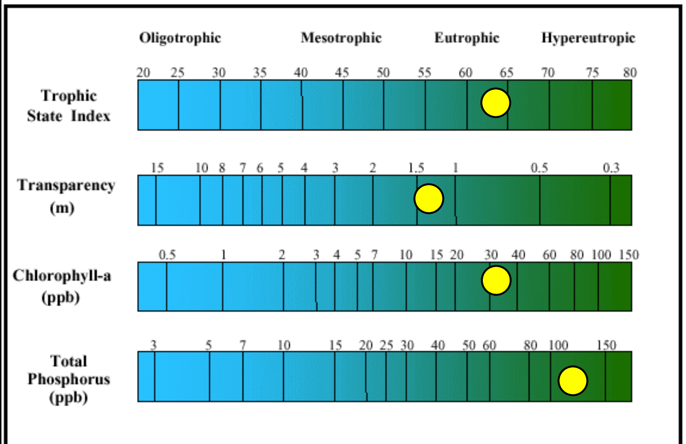


Figure 3.2.5. Carlson Trophic State Index Scales.



After Moore, 1. And K. Thornton, [Ed.]1988. Lake and Reservoir Restoration Guidance Manual. USEPA>EPA 440/5-88-002.

Gleason Lake
TSI = 64
Transparency = 1.33
Chlor. *a* = 35
TP = 121

Ecoregion inter-quartile range: 48 - 65

3.3. IN-LAKE DATA ANALYSIS

Much of the data that are available for Gleason Lake are contained within the *Lake Management Plan - Data Summary* provided under separate cover in August 2002 to GLIA.

Gleason Lake is a relatively shallow lake in an urban setting with a watershed size that has been artificially increased over the years beyond its natural boundaries. It is not uncommon for these types of lakes to exhibit poor water quality because of the added input. Although phosphorus concentrations for Gleason Lake indicate it has poor water quality, water clarity measurements indicate a better than expected transparency based on phosphorus. This section summarizes Gleason Lake water quality and explains how this is possible.

Physical Aspects

Gleason Lake and its watershed area are located primarily in the City of Plymouth (~95%), but with small areas also in Wayzata and Minnetonka. There have been numerous opinions on the actual area of the Lake, varying from 131 acres (Engstrom and Wright, 1998) to 156 acres (MCWD). In some respects this variation can be expected due to the variation in the amount of rainfall in any given year and the fact that these numbers relied upon manual measurements using a planimeter. This Management Plan carefully measured the area of the Lake (Table 3.3.1) using the latest Geographic Information System (GIS) capabilities and determined an area of 160.2 acres, with an additional 13.9 acres of attached wetland (cattail) area, for a total "wet covered" area of 174.1 acres. Clean-Flo notes an area of 177 acres covering the lake and the adjacent wetlands in its oxygen reports.

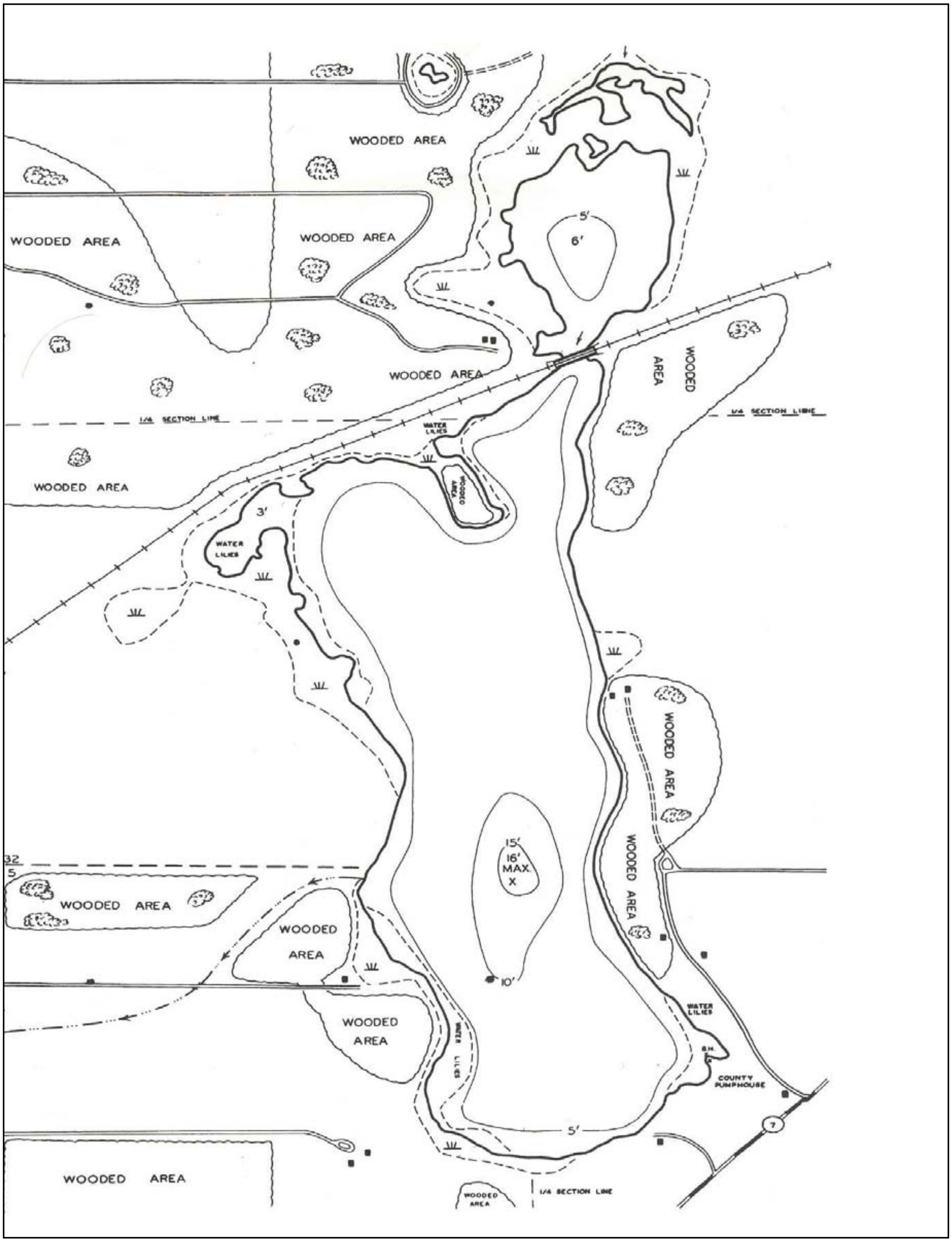
The Lake itself is comprised of a north bay (about 31 acres) and a main lake (about 129.2 acres). MCWD (Figure 3.3.1) reports that the maximum depth of the Lake is 16 feet, with a mean depth of 7.7 feet and a volume of 1,201 acre-feet (about 390 million gallons). Using the same mean depth, the adjusted volume based on the GIS-based area would be 1,233.5 acre-feet (about 402 million gallons). The length of lakeshore is close to 3.9 miles (DNR Fisheries has previously reported a shoreline of 4.01 miles).

Table 3.3.1. Lake-Related Data.

Feature	Measure
North Bay	
- littoral area*	30.98 acres
- total lake area	30.98 acres
- wetland	3.49 acres
- shoreline	1.04 miles (5,492 ft.)
Main Lake	
- littoral area	125 acres
- total lake area	129.22
- wetland	10.43 acres
- shoreline	2.85 miles (15,049 ft.)
Total water area for Gleason Lake	160.2 acres
Total wetland surrounding Lake	13.92 acres
Total "wet" area	174.1 acres
Total shoreline of Lake (water area only)	3.89 miles (20,541 ft.)

*Littoral area is the lake surface area where the water depth is 15 feet (~4.6 meters) or less.

Figure 3.3.1. Gleason Lake Contours (DNR).



Gleason Lake Water Quality Data

A summary of the historic water quality data collected for Gleason Lake is contained in the *Lake Management Plan - Data Summary*, which was presented to the GLIA in August 2002. The following section examines the data for the Lake relative to management implications.

Dissolved Oxygen (DO)

Although Gleason Lake is shallow, it can lose oxygen in the bottom waters. This has been evident since dissolved oxygen profiles have been taken back to DNR's 1980 data (Figure 3.3.2). Because temperature stratification is weak, a moderate wind will probably mix the lake. This means the lake is polymictic (mixes 3 or mores times per year).

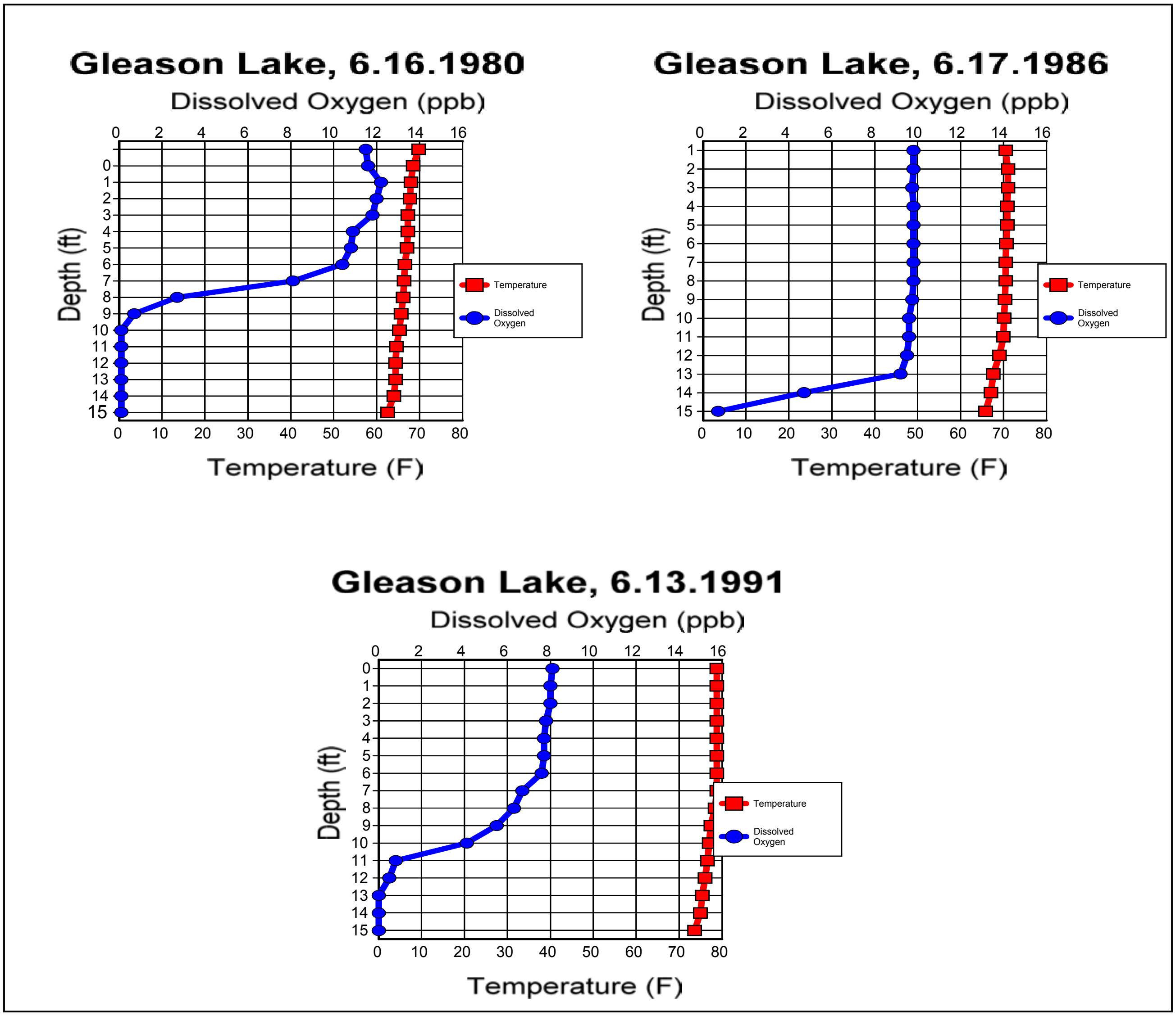


Figure 3.3.2. Dissolved Oxygen and Temperature Profiles (MCWD).

Recent recorded dissolved oxygen levels show the same pattern that was found in 1980, with commonly occurring low oxygen during summer in the bottom water (Figure 3.3.3).

Low oxygen in the bottom of the lake often results in phosphorus release from the lake sediments. Phosphorus sampling indicates this may be occurring (details are found in the phosphorus section).

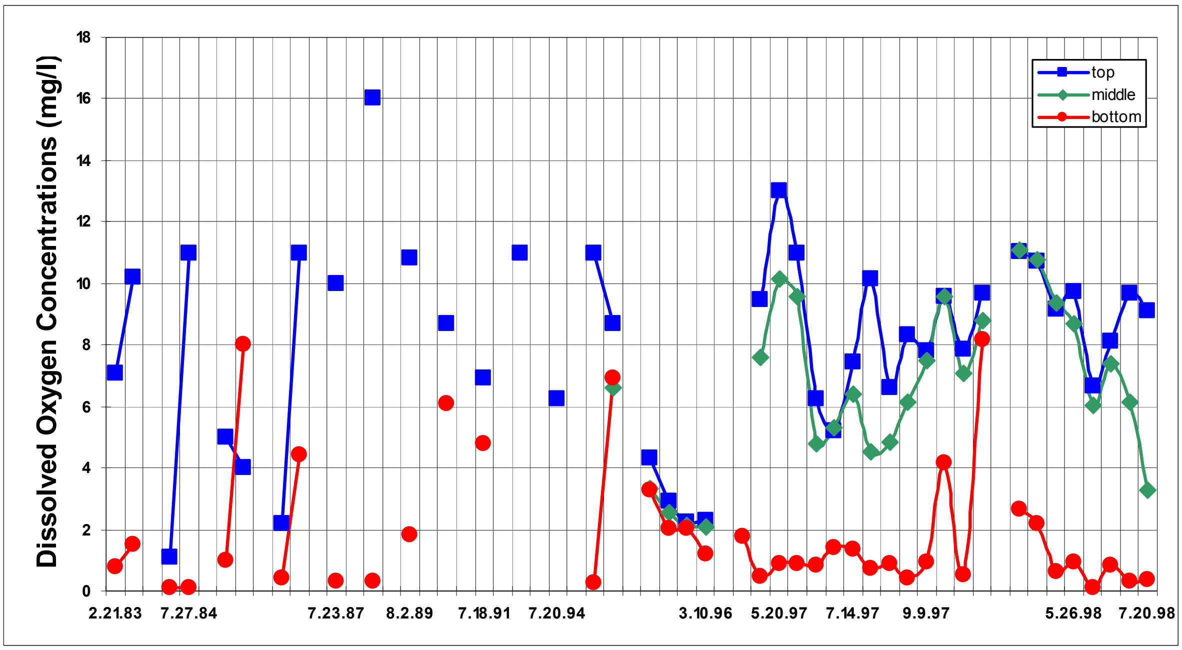


Figure 3.3.3. Dissolved Oxygen Concentrations for Top, Middle, and Bottom Depths in Gleason Lake (MCWD).

Secchi Disc

The seasonal water clarity trend in Gleason Lake follows a pattern. Growing season water clarity data from 1998 through 2001 is shown in Figure 3.3.4. There is good transparency in May and June, with July being a transition month. In August and September, water clarity is around one meter (3 feet). The summer clarity average turns out to be better than predicted. However, by mid- to late-summer the algae flourish because of high phosphorus concentrations. Typically the loss of transparency is due to blue-green algae blooms.

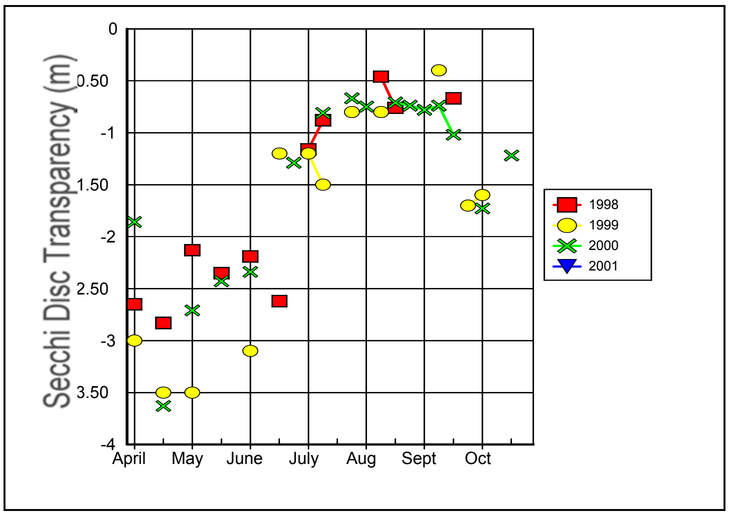


Figure 3.3.4. Secchi Disc Readings for Gleason Lake from 1998-2001 (MCWD).

Total Phosphorus

Phosphorus is measured in lake water because it is generally the controlling nutrient that stimulates algae growth. Phosphorus levels as measured from 1998-2001 in Gleason Lake are high (Figure 3.3.5). Phosphorus concentrations over 40 ppb can produce nuisance algae blooms.

The pattern in Gleason Lake is common for shallow, eutrophic lakes. Phosphorus concentrations start out in a desirable range, but increase as the summer progresses. In July and August, phosphorus concentrations are over 100 ppb. Other non-impacted lakes in the area will have late summer phosphorus concentrations of 50 ppb or less. The source of phosphorus is from watershed inputs and from lake sediments.

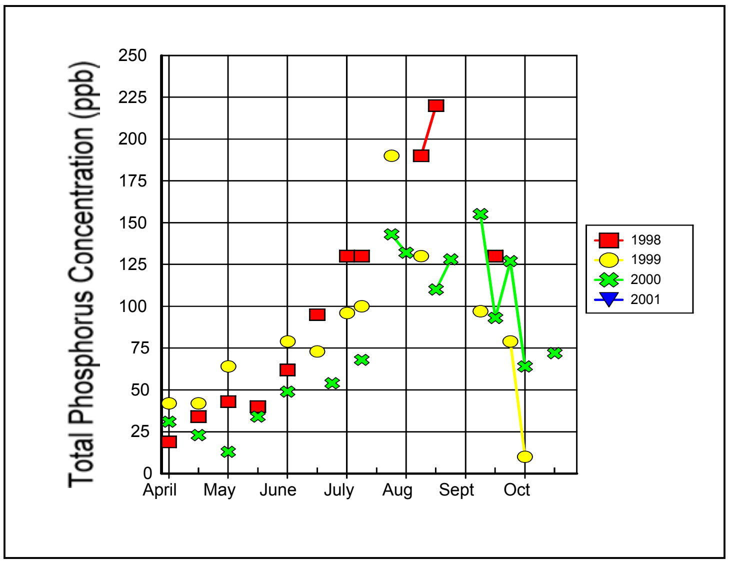


Figure 3.3.5. Total Phosphorus Readings for Gleason Lake from 1998-2001 (MCWD).

Elevated phosphorus concentrations in the bottom water indicate phosphorus release from lake sediments (Figure 3.3.6 and Table 3.3.2). Phosphorus data from 2000 are representative of other years. Bottom phosphorus concentrations are typically high in the summer months. If the lake turns over during this period, as Gleason probably does, then the bottom water phosphorus is brought into the photic zone and is available to algae.

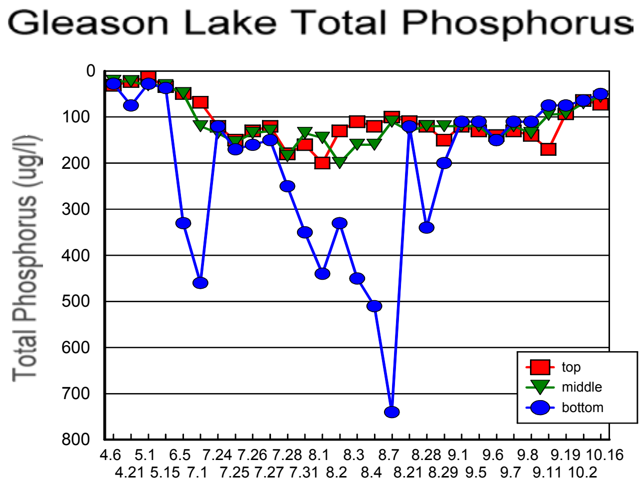


Figure 3.3.6. Total Phosphorus Concentrations for Top, Middle, and Bottom Depths in Gleason Lake for 2000 (MCWD).

Table 3.3.2. Gleason Lake Phosphorus Data for 2000 (MCWD).

2000			
Date	top	middle	bottom
4.6	31	22	28
4.21	23	23	75
5.1	13	31	28
5.15	34	31	37
6.5	49	49	330
7.1	68	120	460
7.24	120	135	120
7.25	150	155	170
7.26	130	135	160
7.27	120	130	150
7.28	180	185	250
7.31	160	135	350
8.1	200	145	440
8.2	130	200	330
8.3	110	160	450
8.4	120	160	510
8.7	100	110	740
8.21	110	130	120
8.28	120	120	340
8.29	150	120	200
9.1	120	120	110
9.5	130	120	110
9.6	140	150	150
9.7	130	120	110
9.8	140	135	110
9.11	170	95	75
9.19	93	93	75
10.2	64	70	64
10.16	72	56	50

Chlorophyll-*a*

Chlorophyll-*a* is a measure of the algal biomass in a lake. Records for 1998-2001 (MCWD) show a reverse pattern that correlates with water clarity (Figure 3.3.7); that is, as the algal biomass increases, clarity decreases.

When chlorophyll-*a* levels go above 40 ppb, the lake user typically perceives a nuisance algae bloom. These nuisance levels of algae typically occur in July, August and September in Gleason Lake.

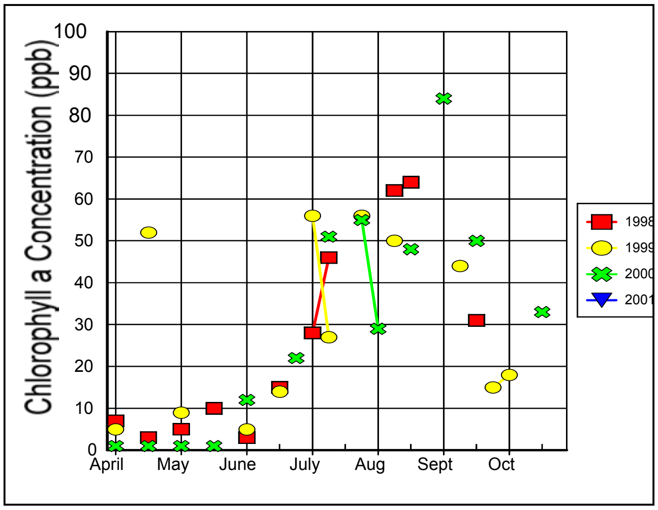


Figure 3.3.7. Chlorophyll Readings for Gleason Lake from 1998-2001 (MCWD).

Aquatic Plants

Aquatic plants are a significant feature in Gleason Lake, with the submerged plant community dominated by curly-leaf pondweed in early summer and coontail in late summer (Table 3.3.3). Eurasian watermilfoil was observed in Gleason Lake in 1998, but Eurasian watermilfoil has not been much of a factor in the last few years. Curly-leaf pondweed is an exotic, non-native plant that grows to nuisance conditions in early summer and then dies back. Experimental herbicide applications are being used to try to control curly-leaf pondweed (see later discussion).

The overall diversity of aquatic plants in mid summer is low in Gleason Lake, but there is abundant plant coverage due to the broad distribution of coontail. Table 3.3.3 gives some indication of the limited plant diversity.

On July 9, 2002 a survey was conducted by EOR staff of the macrophyte distribution in the main (southern) part of Gleason Lake (Table 3.3.3). The north bay was surveyed on June 27, 2002 by John Skogerboe of the U.S. Army Corps of Engineers. Skogerboe researching the effects of chemical control (Aquathol-K) on curly-leaf pondweed (a nuisance weed). To save cost and avoid duplication, the north bay was not re-surveyed on July 9th. Skogerboe's data from his June 2002 sampling are reported in Table 3.3.4, which completes the whole-lake survey.

Table 3.3.3. Aquatic Plant Occurrence, Based on 73 Stations from an Aquatic Plant Survey Conducted on July 9, 2002 by EOR, Inc.

	Number of observations at the stations	% Occurrence
Duckweed	7	10
White water lily	14	19
Yellow water lily	3	4
Coontail	56	77
Curly-leaf pondweed	23	32
Elodea	1	1
Sago pondweed	1	1

Table 3.3.4. Skogerboe (Corps of Engineers) 2002 Macrophyte Survey Data.

Plant composition of north bay of Gleason Lake, 2002					
	Percent Occurrence*				
DATE	CEDE4**	ELCA7	NYOD	POCR3	UNKNOWN
APR 02	79.1%	32.6%	2.3%	81.4%	0.0%
JUN 02	95.3%	32.6%	41.9%	2.3%	4.7%
AUG 02	81.4%	9.3%	41.9%	0.0%	0.0%
* Total number of sample points = 43					
** Plants are listed by USDA plant codes					
CEDE4 = *Ceratophyllum demersum*, Coontail					
ELCA7 = *Elodea canadensis,* American elodea					
NYOD = *Nymphaea oderata,* White water lily					
POCR3 = *Potamogeton crispus,* Curly-leaf pondweed					

The EOR survey was conducted on a series of 21 transects across the lake, from west to east, totaling 73 individual sites. The survey points are shown in Figure 3.3.8, and the macrophytes detected at each survey point are listed in Table 3.3.5. The survey noted only presence and did not quantify mass of material present. Skogerboe's data on the north bay does include mass collection, as well.

The survey data show the dominance of coontail, present at almost every one of the sampling stations. The June 2002 survey by Skogerboe also detected a total dominance of coontail in the north bay, with no detection of curly-leaf pondweed.

During the north bay survey, it was noted by Skogerboe and EOR staff that the water beneath the masses of coontail was tinted brown, but very clear. The only algae visible were filamentous green algae attached to the top of the coontail, where they could get light. The clear water was indicative of the intense shading the coontail provided. This is suspected to be the reason that the high TP does not seem to match the low chlorophyll-*a* and the relatively high Secchi depths seen in the lake. Any manipulation of the macrophyte population should, therefore, be carefully considered for the secondary impacts that could result. For example, large-scale removal of plants could allow light to penetrate the phosphorus-rich lake water and result in a nuisance algal bloom. For this reason, it is recommended that coontail removal be done only on a local scale. Coontail can be removed physically or chemically. Clearing paths through the plants will most likely need to be repeated because coontail <u>is not rooted</u> and will migrate toward the opening. Several cuts or chemical applications will probably be needed to establish a path, followed by several more to keep it open.

The preliminary results of Skogerboe's curly-leaf pondweed control program indicate the herbicide applications are promising for annual control, but that long-term control or eradication is not conclusive as of 2003. The June 2002 survey showed a total absence of the weed in the north bay, which is the only part of the lake being controlled with the test chemical (Aquathol-K). The July 2002 lower lake survey detected the weed at about one-third of the survey points. The chemical control success means that a high probability exists that annual control can be effective in this part of the lake. However, homeowners around the lake reported the return of curly-leaf pondweed in the early summer of 2003. The Skogerboe study will extend through 2003, when the scientific findings and predictions for long-term effectiveness will be available. At that point, a decision will be needed on continuation of the chemical program.

There are some alternatives to chemical treatment available. A Hockney weed cutter is one curly-leaf control option for Gleason Lake, but it would have to be run by the Lake Association. The Christmas Lake Association has some experience with a Hockney cutter, and could be contacted to get their views on how successful that technique has been for them. Mechanical harvesting is difficult because there is a need to get equipment into the lake, as well as off-load plants.

A whole lake herbicide treatment is possible using Sonar. The Sonar manufacturers recommend a two-year, back-to-back treatment. However, curly-leaf control using Sonar has not been very successful.

A drawdown can be effective for curly-leaf control, but probably not feasible for Gleason Lake due to the difficulty of drawing down the Lake while still receiving inflow from the Creek. Also, major fish loss would occur.

Research is ongoing to determine the limiting nutrient for curly-leaf. If this is discovered, then a long-term curly-leaf management program linked to watershed and in-lake nutrient management will be feasible.

In summary, aquatic plants help keep lake water clear. A robust native plant community currently in place produces water clarity that is better than predicted based on phosphorus concentrations. Although coontail can grow to nuisance conditions, the best way to control the excessive growth is through lake nutrient reduction that would best occur at a watershed level. Harvesting or the use of herbicides will give temporary relief, but coontail will return quickly if the nutrient levels remain high.

One of the benefits of the macrophyte abundance on Gleason Lake is the good fishery that results. Fish analysis occurs in a later part of this section.

Figure 3.3.8. Macrophyte Survey Transect Points (July 8, 2002 - EOR, Inc.)

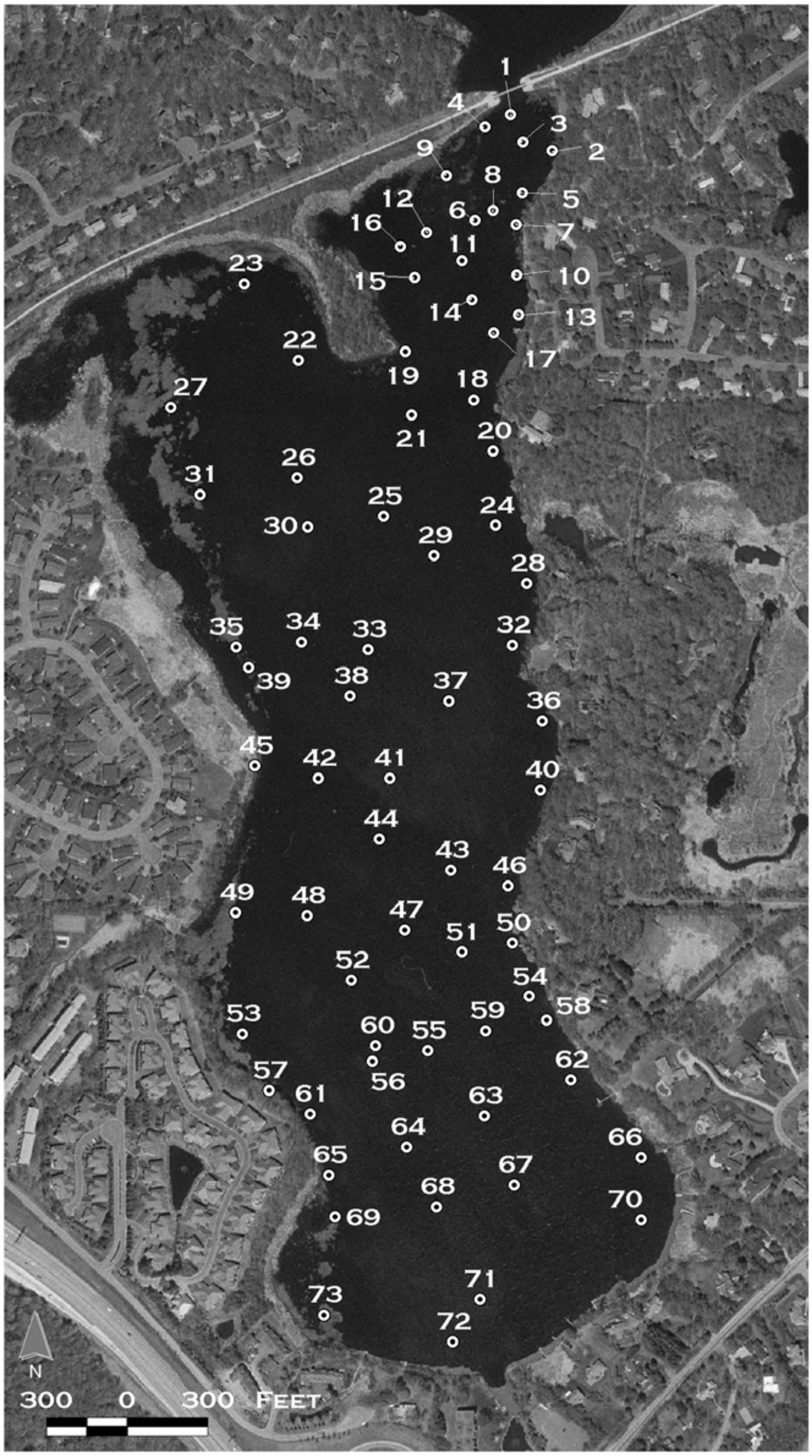


Table 3.3.5. RESULTS OF THE JULY 9, 2002 EOR, INC. MACROPHYTE SURVEY FOR THE GLMP							
Survey conducted by Melissa Arikian and Marcey Westrick (EOR, Inc.)							
Transect point	Coontail	White Water Lily	Duckweed	Curly-Leaf Pondweed	Yellow Water Lily	Elodea	Sago Pondweed
1	X						
2	X						
3	X						
4	X			X			
5	X	X					
6				X			
7	X		X				
8	X						
9	X	X					
10	X	X					
11	X						
12	X			X			
13	X	X					
14	X						
15	X						
16	X	X	X				
17	X						
18	X						
19	X						
20	X						
21	X			X			
22	X			X			
23	X						
24	X						
25	X						
27	X			X			

Transect point	Coontail	White Water Lily	Duckweed	Curly-Leaf Pondweed	Yellow Water Lily	Elodea	Sago Pondweed
28	X		X				
29	X						
30				X			
31	X		X	X			X
32	X						
33	X			X			
34				X			
35	X						
36	X						
37				X			
38	X			X			
39	X	X					
40	X						
41				X			
42				X			
43							
44	X						
45							
46	X						
47							
48				X		X	
49	X	X					
50	X						
51							
52				X			
53	X	X		X			
54	X						
56	X						
57	X						

Transect point	Coontail	White Water Lily	Duckweed	Curly-Leaf Pondweed	Yellow Water Lily	Elodea	Sago Pondweed
58	X						
59							
60	X						
61	X				X		
62	X						
63	X						
64				X			
65	X	X	X	X	X		
66	X	X	X				
67	X						
68	X			X			
69	X	X			X		
70	X	X	X				
71				X			
72	X	X					
73	X	X		X			

Occurrence of Purple Loosestrife

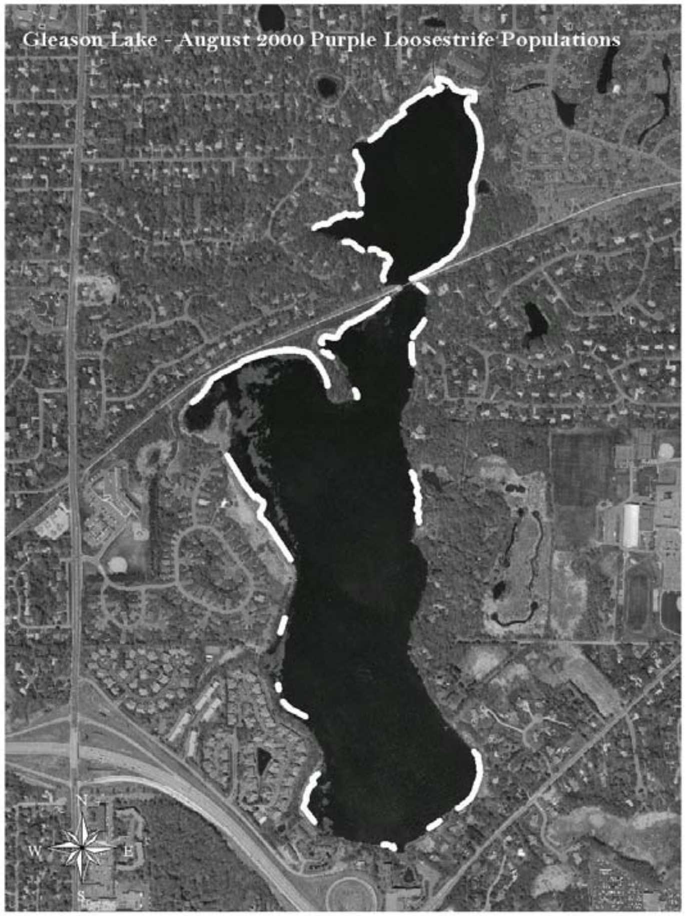
Purple loosestrife (*Lythrum salicaria*) is a perennial plant native to Europe and Asia that has become widely established as a nuisance plant in the U.S. and Canada. It grows and reproduces prolifically in wetlands and other moist habitats. Mature plants grow to 4-7 foot tall and can produce 30 or more purple flower spikes, which in turn can produce over 2.5 million seeds per year. Once purple loosestrife becomes established, it frequently becomes the dominant vegetation by out-competing native plants. As native plant communities are reduced, so too are wildlife species that depend on them. Declines in ducks, geese and other wetland birds, as well as muskrats, mink and some amphibians have all been noted. There is also concern that purple loosestrife may reduce spawning habitat for some fish.

In the past, controlling *L. salicaria* has been a challenge for water resource managers. Conventional control methods like hand-pulling, cutting, flooding, herbicides, and plant competition were moderately effective in controlling purple loosestrife, at best. However, in the 1980s a huge effort to identify natural predators of loosestrife was under-taken and five beetle species were identified as being almost exclusively dependent upon *L. salicaria.* One species, a leaf-eating beetle, *Galerucella calmariensis*, is being widely used in the State of Minnesota. Since these beetles are not a threat to native vegetation, using them as a bio-control is considered the most viable option for more complete control for heavy loosestrife infestations. Once established at initial release sites, populations of *G. calmariensis* will increase, effectively reducing the density of purple loosestrife by reducing shoot growth, preventing or delaying flowering, and reducing seed production. When the number of loosestrife plants on a site dwindles, the beetles will move to other loosestrife stands to feed. While these insects will not entirely eradicate loosestrife, they may significantly reduce the populations enough so co-habitation with native species becomes a realistic possibility. Since the beetles will never completely eradicate loosestrife populations, there will be a continual food source for remaining populations.

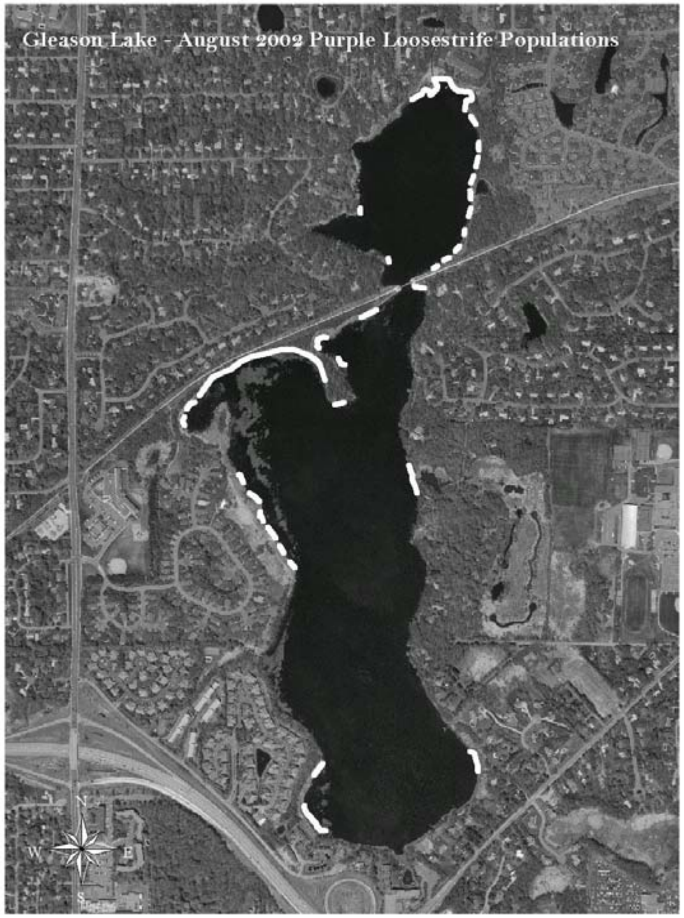
In the Gleason Lake watershed, purple loosestrife was identified as a serious problem in the 1990s, with large populations identified around the fringe of the lake and adjacent wetland. In an effort to control purple loosestrife around Gleason Lake, GLIA began a biological control program in 2000 using *G. calmariensis*. For each of four consecutive years, 40,000 beetles were released around Gleason Lake. A survey of purple loosestrife populations was conducted in August 2000 and another survey was conducted in August 2002. Figure 3.3.9.a shows the location of purple loosestrife populations in 2000, and Figure 3.3.9.b shows the location of purple loosestrife populations in 2002. A quantitative measure of the amount of loosestrife was not taken, but the survey shows that 10,775 feet of shoreline had loosestrife in August of 2000, and that the coverage reduced to 5,200 feet in August of 2002 - a reduction in lakeshore occurrence of about

52%. Based on these two periods, it appears that the loosestrife populations surrounding Gleason Lake have been significantly reduced. However, to assure that this is not a transient observation, it is recommended that GLIA continues to survey purple loosestrife on a long-term basis. This will also help to determine if the beetle populations around the lake are self sustaining.

Figure 3.3.9. The 2000 (a) and 2002 (b)Occurrence of Purple Loosestrife Around Gleason Lake (data collected by Dick Steiner, GLIA).



(a) August 2000



(b) August 2002

Fish

The most common fish in Gleason Lake from 1980 through the 1996 MnDNR fish surveys are bluegills and black bullheads (Figure 3.3.10 and Table 3.3.6). Northern pike and largemouth bass are present, but found in low numbers. As of 1996, bluegills were not stunted and there was a decent panfish population of bluegills and black crappies.

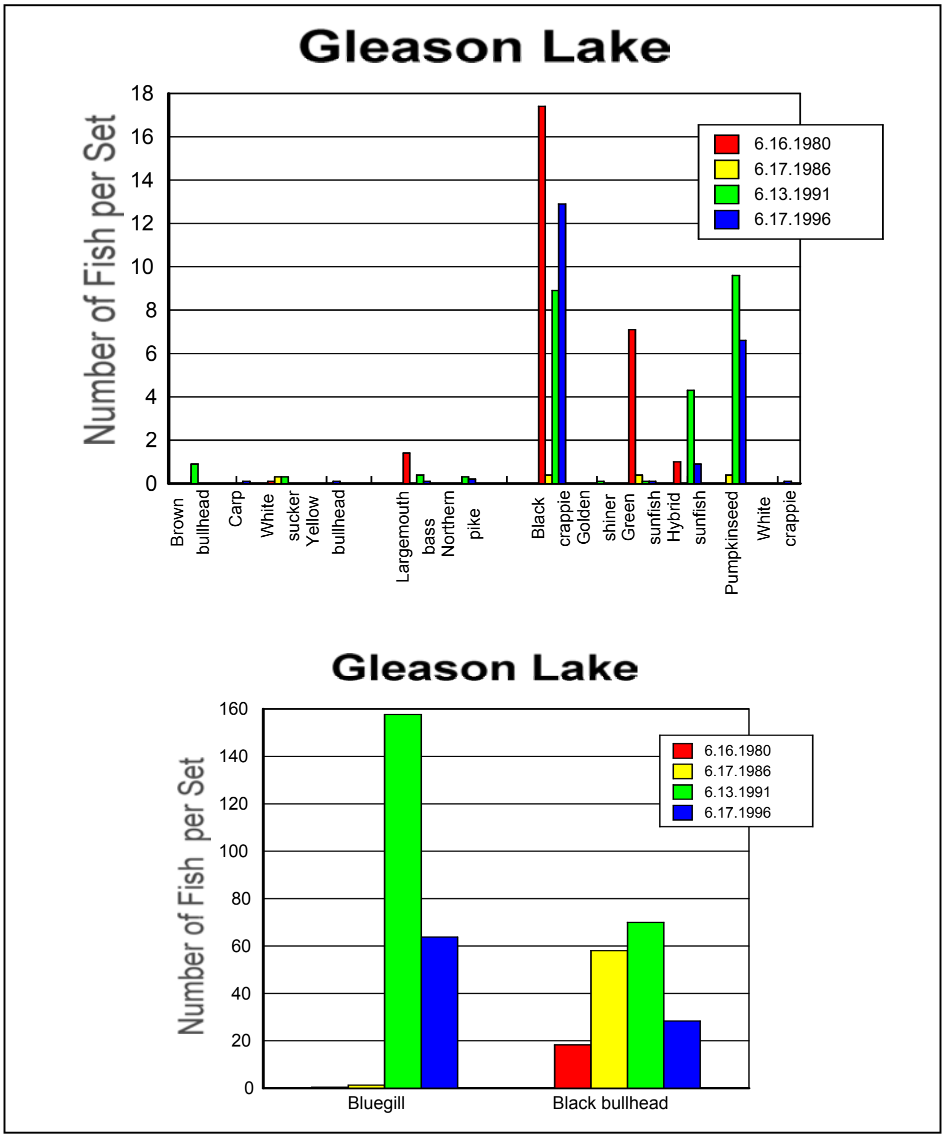


Figure 3.3.10. Summary of MnDNR Trap-net Results from Gleason Lake.

The fish population is typical for a shallow, eutrophic lake like Gleason. Black bullheads have been present in moderate numbers in the fish surveys and bluegills have made a strong comeback from 1980. Winter aeration probably has helped to maintain the sunfish population. The crappie population continues to fluctuate, which probably reflects success of various spawning years.

Table 3.3.6. Summary of MnDNR Trap-net Results from Gleason Lake Fish Surveys.

	Number per Set			
	6.16.1980	**6.17.1986**	**6.13.1991**	**6.17.1996**
Black bullhead	18.3	58	69.9	28.3
Brown bullhead	0	0	0.9	0
Carp	0	0	0	0.1
White sucker	0.1	0.3	0.3	0
Yellow bullhead	0	0	0	0.1
Largemouth bass	1.4	0	0.4	0.1
Northern pike	0	0	0.3	0.2
Black crappie	17.4	0.4	8.9	12.9
Bluegill	0.4	1.3	157.6	63.8
Golden shiner	0	0	0.1	0
Green sunfish	7.1	0.4	0.1	0.1
Hybrid sunfish	1	0	4.3	0.9
Pumpkinseed	0	0.4	9.6	6.6
White crappie	0	0	0	0.1
Number of Nets	7	7	7	--

3.4. LAKESHORE AND GLEASON CREEK ANALYSIS

Stream and Lakeshore Erosion Survey

Survey Information

The channel and lakeshore erosion survey was conducted on July 12, 2002 by the staff of EOR (Gary Oberts). EOR was assisted on the lakeshore portion of the survey by Dick Steiner of GLIA.

The entire channel of the mainstem of Gleason Creek (County Ditch 15) was surveyed from Vicksburg Lane and 32nd Ave. North, to the point at which backwater from Gleason Lake made access impossible. This occurred just downstream of Pond #7, the detention pond just upstream of the lake. Several additional reaches of tributary stream and storm sewer inflows in portions of the watershed not draining directly to the creek were also surveyed.

In addition to the creek and shoreline survey, EOR assessed the function of many detention ponds or wetlands located throughout the watershed as part of the H&H Study.

Survey Results

The locations of the points identified in the creek and lakeshore erosion survey are shown in Figure 3.4.1, with the details of the survey findings contained in Table 3.4.1.

Figure 3.4.1. Creek and Lakeshore Erosion Survey Results.

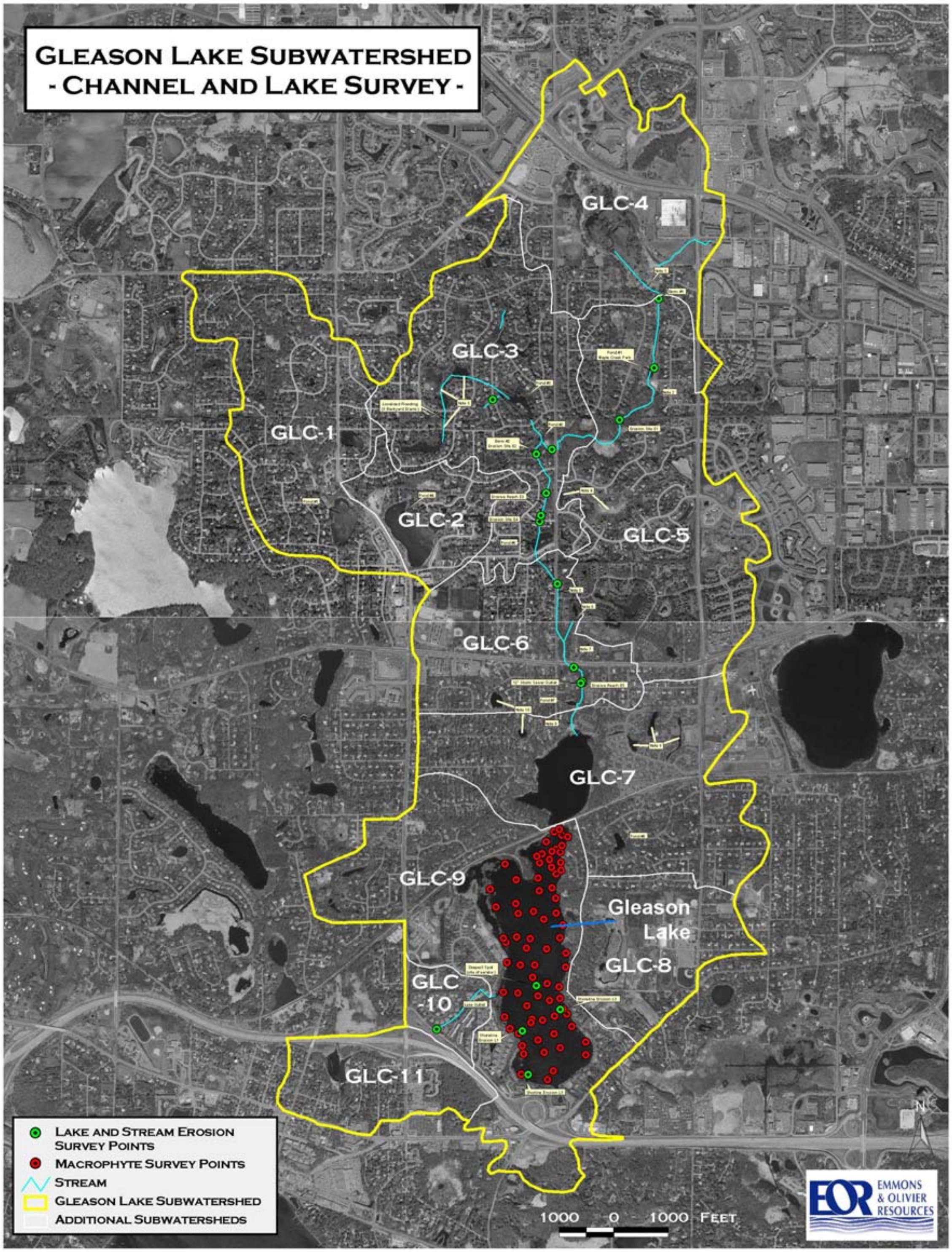


Table 3.4.1. Results of the July 12, 2002 Creek and Shoreline Erosion Survey by EOR.

Location (Figure 3.4.1) Reference	Severity of Problem	Comments
Gleason Creek		
Erosion Site E1	Low	The channel makes a turn to the south and has eroded the right descending bank about 0.5 foot in depth for a distance of about 100 feet. Repair need not immediate, but situation should be monitored.
Erosion Site E2	High	Berm #2 on the channel is eroding at the point where the berm joins the right descending bank. Failure to correct this problem could lead to loss of the berm and much more severe erosion of the stream bank.
Erosion Reach E3	High	Water flows through this reach of the channel at an accelerated velocity because of the channel grade. From 0.5-6 feet of erosion occurs along a reach length of about 425 feet. Most of the erosion is on the right descending bank, but some also occurs on the left. Recommend channel repair and grade stabilization/drop structures to dissipate energy. Most erosive reach on creek.
Erosion Site E4	Moderate	Flow leaving from the culvert outlet on the downstream side of 22nd Ave. has eroded the banks on both sides to a depth of about 5 feet. Immediate channel repair and reinforcement recommended.
Erosion Site E5	Moderate	This reach was identified by RT3 members as a serious problem. A reach of about 450 feet has general erosion of about 1 foot on each side of the channel. This erosion has had boulders placed along it to stop addition al erosion. Although possibly effective for small events over the short-term, these are not a solution to the erosion. One location on the left descending bank at a southwestward turns has eroded about 3 feet of the bank for a length of about 25 feet. This entire reach should be considered a good candidate for introduction of "natural channel stabilization" with native vegetation and channel re-meandering. Note in Figure 3.4.3 that a 12-inch storm sewer also discharges in this reach.

(continued)

Location (see Figure 3.4.1) Reference - Plymouth Water Resources Management Plan Name	Severity of Problem	Comments
Pond #1 - GL-P2A	Low	The pond located in Maple Creek Park occurs shortly downstream from Note #1 (below) and is therefore generally receiving clean water. The pond could be converted to a treatment wetland by expansion eastward and installation of a flow-through system that uses wetland vegetation.
Pond #2 - Unnamed, upstream of point 204	Moderate	This pond occurs at the confluence of drainage from east and north. It is currently stagnant and covered with duckweed, but is at a good location to become a candidate for retrofit into a wetland treatment configuration.
Pond #3 - GL-P5	Severe	This pond is severely eutrophic and in need of rehabilitation. Outflow is controlled by a berm, but there is also a stop-log assembly at the down-stream road culvert. Resident complained about deterioration during site inspection.
Pond #4 - GL-P12	No problem noted	Kreatz (Kraetz) Lake. This is a good example of a local pond that is both attractive and effective at runoff control. Some evidence of algae, but generally clean. Note that this lake appears as Snyder in DNR and USGS maps.
Pond #5 - GL-P11	Low	Snyder Lake. Stagnant local drainage pond that is likely ineffective. Some rehabilitation needed. Note that this lake appears as Kreatz in DNR and USGS maps.
Pond #6 - GL-P13	Moderate	This pond is located on the downstream end of the erosion problems noted in E2-4, and is therefore critical to water quality. Pond should be evaluated for rehabilitation in concert with channel improvements.

(continued)

Location (see Figure 3.4.1) Reference - Plymouth Water Resources Management Plan Name	Severity of Problem	Comments
Pond #7 - Unnamed, just downstream from point 229	Moderate	This pond was installed as a final detention pond to serve all of the Gleason Creek watershed draining to the lake. It is woefully undersized (about 0.3 acres serving a 1,642 acre drainage area, or 0.02%), but has remained in fairly good shape anyway. A good flow was moving through on the day of inspection, but flow leaves the pond immediately (within 25 feet) after entering. This pond should be dredged to re-establish its capacity, while consideration is given to how its size can be increased and how it can be incorporated into the natural configuration recommended for this final reach before the lake. If the current configuration is maintained for any period of time, a flow diverter should be installed between the inflow and outflow to prevent flow from short-circuiting.
Pond #8 - GL-P26	Low	Another example of stagnant and duckweed covered neighborhood pond. Could be improved by dredging to original configuration.
Berm #1	No problem noted	This berm and inlet structure with inside weir is located in the channel, apparently for flow control.
Berm #2	See Erosion Site E2	
Note 1 - GL-P2	No problem noted	This point marks the location where all of the upper part of the watershed enters Gleason Creek. The drainage to this point is generally treated in some manner, with clear water flowing from the wetland to the north.
Note 2	No problem noted	The channel has been relocated in this reach. It is well buffered and not an erosive threat.
Note 3 - GL-P3, 4, and 5	Moderate	All three of the ponds associated with this Note in Figure 3.4.3 are stagnant and algae-laden. They serve as local treatment ponds for runoff, but are not likely very effective. Candidates for rehabilitation. Note also that localized flooding occurs in the back yards of several houses; three inlets were installed there to help drainage.

(continued)

Location (see Figure 3.4.1) Reference - Plymouth Water Resources Management Plan Name	Severity of Problem	Comments
Note 4 - GL-P15 and unnamed	Low	Two ponds with poor water quality, but moderately effective at treating local runoff. Good local amenities in a park and neighborhood.
Note 5	No problem noted	Creek enters pipe and flows under road right-of-way. Consider this reach for future day-lighting creek along a strip of open space on east side of road (Dunkirk).
Note 6 - GL-P16, 17, 18, and 19	Low	The development surrounding Steele Pond all drains to the creek at this location. The ponds within this development are stagnant, but treat local runoff fairly effectively. Evaluate pond system for rehabilitation.
Note 7 - GL-P20	Severe	New area of construction with no vegetative cover and totally ineffective sediment pond, located near lake. Work with the City to get this site stabilized.
Note 8	No problem noted	The reach from Pond #7 to the lake was under the effects of backwater from the lake during the inspection. This condition likely results in the deposition of suspended solids prior to entry into the lake. The condition of this reach would lend itself to incorporation into the natural approach recommended for the upper end of the reach above Pond #7.
Note 9 - GL-P24A-C	Low	The ponds in Cimarron Ponds development are stagnant and algae laden, but they appear to be working to treat local runoff. They should each be evaluated relative to sediment accumulation and dredged if needed.
Note 10 - GL-P22 and 27	Low	These ponds are typical of many in the watershed - stagnant, but effective locally. They should be evaluated for sediment accumulation and the need to be dredged.

(continued)

Location (see Figure 3.4.1) Reference - Plymouth Water Resources Management Plan Name	Severity of Problem	Comments
Gleason Lake		
Lakeshore Site L1	Severe	About 800 feet of shoreline was stripped of vegetative under-story at Waycliffe. Exposure of 25-40 foot slopes led to erosion along the entire length of shoreline. A need for stabilization continues, with some vegetation growing back, but erosion continuing. Approximately 15 large trees on the slopes were lost to erosion. This is the worst shoreline erosion on the lake.
Lakeshore Site L2	Moderate	About 50 feet of shoreline along the Gleason Lake Townhomes site is eroding on a 20 feet high slope. Stabilization with vegetation is recommended.
Lakeshore Site L3	Low	A steep 30-40 feet slope has some erosion over a short width, with the loss of a few trees at the toe.

Additional Notes Resulting from the Survey

On the afternoon of the survey (July 12, 2002), the landscaping crew cutting Waycliffe's grass was observed directing grass clippings to the street. Although EOR staff did not stay on-site until the crew left, it is likely that the clippings remained on the street and were subsequently washed into the lake with runoff. We recommend that GLIA contact each of the condominium associations around the lake and talk to them about some common housekeeping practices. Attachment A accompanying this report lists some common practices that could help with maintaining good water quality.

The Gleason Lake watershed has many eutrophic little ponds that will be difficult to rehabilitate because of their small size, limited flow-through, and accumulated nutrients. In spite of their stagnant look, these ponds detain localized runoff and thus are a net benefit to the watershed. Table 3.4.1 noted several of these ponds and generally recommended evaluation for the need to dredge to re-establish the original depth. In some cases, it is suspected that these ponds were not designed, but were rather left in their natural state. Since development occurred all around these ponds, whether they were constructed or not, material has moved from the watershed and accumulated in them over the years. Dredging a few critical ponds to increase the permanent pool depth should help to both improve their ability to treat runoff and their appearance. It should be clear, however, that dramatic improvements in these ponds will not likely occur.

Some recommendations in Table 3.4.1 suggest wetland treatment system development. These proposals would involve the establishment of a flow-through system of natural wetland vegetation, with a variable flow outlet that would lead to detention of excess water in a temporary pool. Vegetation would be chosen that is capable of surviving inundation for short periods of time.

Recommendations for channel stabilization would generally involve a bio-engineering approach of channel bank reinforcement with a combination of geo-technical fabric, natural-looking rock and native vegetation. Grade stabilization on a downward-cutting channel would be accomplished in all cases possible with natural rock rather than structural steel. The goal will be to replicate the natural channel by using native material and designs compatible with this environmentally sensitive corridor.

CHAPTER 4. MANAGEMENT FRAMEWORK

4.1. LAKE USE ASSESSMENT

Use of the lake was a subject of discussion early in the HHPLS Regional Team 3 meeting process. GLIA members at those meetings defined a vision of improved lake quality leading to the achievement of water clean enough for full body contact. The Team also wanted a more aesthetic lake that would provide improved boating and fishing opportunities. Improvement to allow for swimming or full body contact will require a fair amount of effort because of the current high level of phosphorus and degraded lake quality relative to swimming. Most full body contact in the lake now occurs by water skiers. The only public access to the lake is for fishing at the Luce Line Trail bridge between the north bay and the main part of the lake.

The following two sections contain details on how the lake use goals translate into pollution load reduction numbers and action programs.

4.2. WATER QUALITY GOALS

Much discussion about the proper goal to set for Gleason Lake occurred at the HHPLS Region Team 3 meetings. The debate centered around the need to be aggressive and try to reach a goal of beginning to make the lake swimmable (50 µg/L or parts per million - ppm), or to be more realistic and set a level that is more reflective of moderate clean-up (90 µg/L) beyond existing conditions (120 µg/L). The moderate level was set as the lake goal by the Minnehaha Creek Watershed District in its 1997 *Watershed Management Plan*.

After some debate, the Team decided on an interim approach that would eventually lead to a swimmable lake quality. First, an interim ten-year (2002-2012) goal of 80 µg/L is recommended. Once this goal is achieved, a new goal reflective of improved conditions is recommended as the next step toward improvement. It is hoped that the next step would be the establishment of the original 50 µg/L goal proposed by some of the Team. Chapter 3.1 contains the basis for this decision.

Chapter 3.2 of this Plan contained some information on where Gleason Lake fits in the scale of trophic status (eutrophic). Figure 4.2.1 is based on information from the Minnesota Pollution Control Agency (MPCA) displaying the relationship between TP level in the lake and the attainment of swimming. Even at 50 µg/L, the lake will still be partially impaired for swimming, according to the MPCA criteria. The Lake would need to get below 40 µg/L to attain marginal support for swimming, and below 30 µg/L for full support.

Figure 4.2.1. Relationship of Gleason Lake TP to Swimming Support (based on MPCA material).

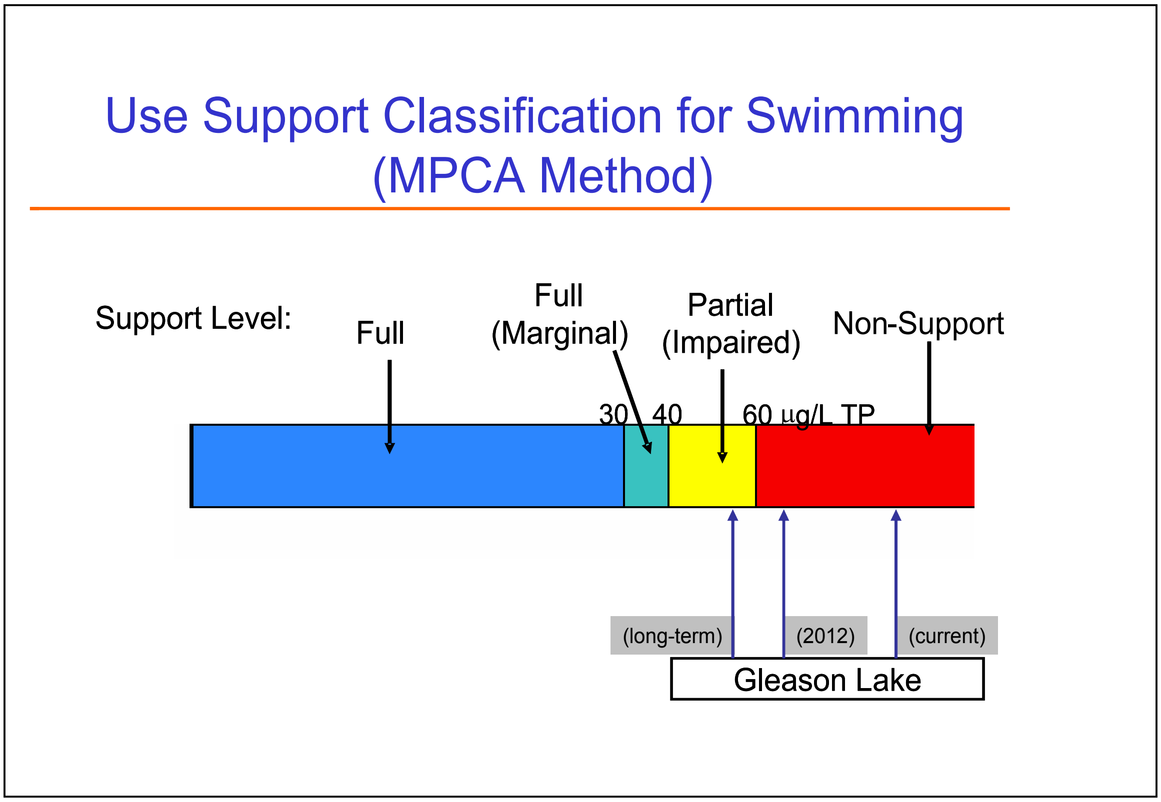


Figure 4.2.2 illustrates how moving from a current condition of about 120 µg/L mean summertime surface TP in Gleason toward the interim and long-term goals will theoretically lead to a reduction in "very severe nuisance" algal blooms, from the current 50%+ to about 20% for the interim goal, and down to less than 5% for the long-term goal. The previous statement was qualified, however, with the term theoretical because of the complexity introduced to Gleason Lake by the macrophytes (described in Chapter 3.4). That is, since current Chlorophyll-*a* levels are well below what is expected for current phosphorus, reducing TP levels might not be as important as implied in Figure 4.2.2. However, the achievement of both interim and long-term goals is still recommended because the long-term health of the lake still relies on reducing the flow of nutrients into it.

Figure 4.2.2. TP/Nuisance Algae Relationship (base graph from MPCA).

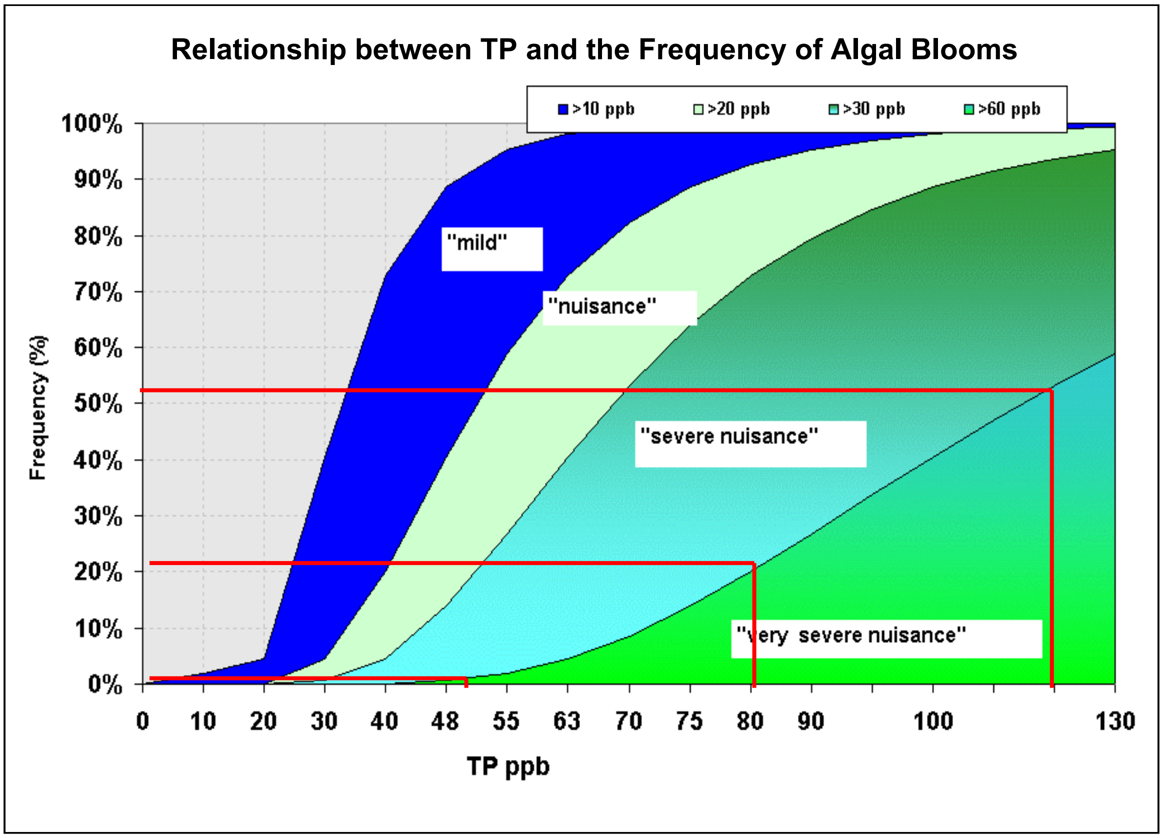
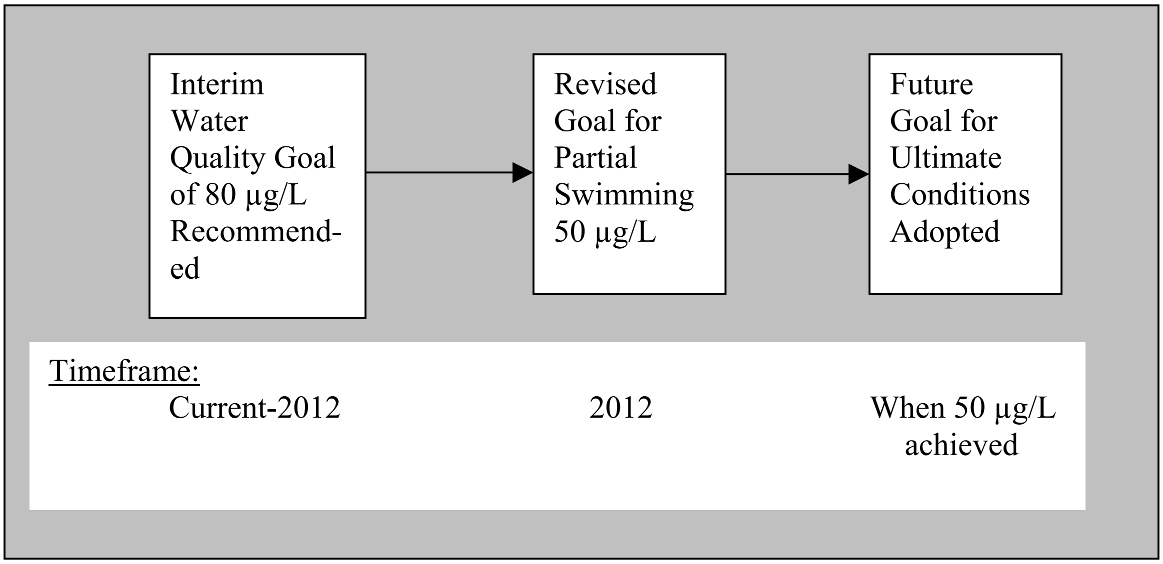


Figure 4.2.2 shows that "very severe" and "severe" nuisance algal blooms will be markedly reduced as TP is reduced in the lake. This will improve not only swimming in the lake, but also recreational use of the lake from an aesthetic and a fishing standpoint, which are both high priority lake uses desired locally.

The selection of a water quality goal(s) sets the stage for implementation of watershed and lake management. An adopted goal sets a quantifiable target that can be measured, monitored, and assessed for achievement. Adoption of the HHPLS Region Team 3 recommended interim goal approach is recommended to GLIA as a reasonable compromise that moves the lake progressively forward, while keeping realistic and affordable achievements within reach.

Figure 4.2.3 presents a schematic of the progression toward an ultimate goal. Defining an ultimate goal at this time is premature, since the first interim goal is not expected to be reached for ten years.

Figure 4.2.3. Goal Schematic for Gleason Lake.



To achieve the first interim goal of 80 µg/L, some external load reduction is needed. The amount of reduction can be quantified through use of the in-lake modeling approach described previously. Table 4.2.1 lists the load reductions that must be achieved to reach the interim and long-term goals. Chapter 4.3 suggests how those reductions can be accomplished.

Table 4.2.1. Gleason Lake Long-term Load Reduction Needed to Achieve In-Lake Goals.

Modeled TP Load (lbs./year)		In- Lake TP Modeling Results (µg/L)	Long-term total phosphorus load goals (lbs/yr)
Current	2020		
650	776	- 98 µg/L predicted - 122 µg/L observed -MCWD goal of 90 µg/L not met with either predicted or observed value -In 2020, without controls, lake predicted to be 124 µg/L	- Reduce to 494 lbs. (24%) to meet interim goal of 80 µg/L - Reduce to 258 lbs. (60%) to meet long-term goal of 50 µg/L

4.3. REMEDIAL WATERSHED ACTIVITIES

Goal

The goal in undertaking watershed load reduction efforts is to achieve greater than 24% reduction (156 lb.) in the current external TP load from the Gleason Creek watershed. This is a necessary step to reach an in-lake, average summer concentration of 80 µg/L (ppb) TP. It is assumed that the load increase predicted for 2020 does not occur, but that the current load is the base level from which to start. This implies that effective watershed management "freezes" the current load, setting the stage for future reductions consistent with Table 4.2.1 values.

BMP Approaches

To achieve the above stated goal, a series of BMPs are needed to reduce TP loads, starting at the head of the basin and working down to the mouth. Specific BMPs will be suggested for consideration, with each assigned an anticipated water quality improvement associated with the improvement. Implementation of the BMPs will be discussed in Chapter 5.

The target TP load reduction from current levels to meet the defined interim TP goal of 80 µg/L (ppb) for Gleason Lake is 156 pounds. This section of the report develops the strategy for implementing BMPs that can meet the load reduction needs. Further reductions to meet the long-term goal of 50 µg/L can be determined after the interim goal is achieved.

General Practices for Good Management

There are some basic management practices that should be a routine part of any activity in the watershed that could result in an increase in runoff and/or the contaminating material that it carries. These are the management practices that can be used to hold the baseline loads at current levels.

Development Runoff Management - Although most of the Gleason Lake watershed is fully developed, there will be in-fill development and re-development that will occur. When any alteration of the landscape or any change in the perviousness of the land surface changes, controls to limit the adverse impact of the alteration should be expected.

The first step is to adequately control the erosion on the site, and the movement of sediment within and off of the site. Sediment not only causes problems inherent to the solids being transported and deposited, but also serves as a transport vehicle for other contaminants, such as nutrients, metals, and toxic organics.

Re-development of a site that has limited or no runoff controls presents an excellent opportunity to introduce good surface water management as an element of the upgrade. Tremendous strides in nonpoint source load reduction can be made by adopting such practices as infiltration, filtering, detention and "good housekeeping" into areas where it does not currently exist. Adopting this approach will help eliminate the load increases expected for 2020, and could even reduce loads below current levels.

Surface Water Management Planning - Adherence to the surface water management plans of the cities and the MCWD will help move toward enhanced water quality in the watershed. The cities' local surface water management plans and the District's second generation watershed plan provide a framework for good water management. Coordinating the elements of these plans and jointly working to properly implement them sends a positive message that water resources are important and will be properly managed.

Technical Guidance - Consistent throughout the HHPLS local input process was the comment that good guidance is needed if cities, developers and the public are expected to do the right thing for water management. Several topical BMP guidance manuals were recommended throughout the HHPLS process, including those addressing construction erosion control, shoreline stabilization, public works, and restoration of natural drainageways/channels. These topical manuals would supplement the MCWD recently adopted *Minnesota Urban Small Sites BMP Manual.*

BMP Maintenance - Many BMPs eventually fail because they are not properly maintained. The intent of most BMPs is to capture contaminating material and remove it from the water column. If it is effectively doing its job, a BMP will eventually become full or saturated with the contamination it is intended to remove. Once this happens, the effectiveness of the BMP becomes negligible. This is symptomatic of the ineffective, stagnant detention ponds noted in the preceding Background section. The City of Plymouth has a program to clean these ponds, but the large number of ponds for which they are responsible (about 800) means that maintenance will be on a select basis only. The MCWD, cities and GLIA could combine to initiate an "Adopt-a-Pond" effort for citizens, students, and companies to keep their neighboring pond clean. This will not get the pond dredged, but it will assure that the surrounding area is kept clean and that, possibly, the pond will be skimmed or floating algae, weeds and litter.

Pond Rehabilitation - Recommendations are made to restore several ponds to their original depth. Beyond that, however, is a need to properly landscape them for safety, aesthetics and effectiveness. Surrounding each pond with a buffer of tall native vegetation keeps both children and geese out of the pond. Children will be discouraged because of the tall plants and geese will go where they feel less threatened. Growing mowed grass right down to the pond will attract geese because of the easy access to the water and the readily available supply of food. A safety bench to a maximum of two-feet deep should also surround each pond. This is a second protection against children wandering into the pond and falling into deep water. This safety bench should be planted as well with emergent vegetation that deters children and provides some water quality benefit. The pond should be finished to a depth of six-to-ten feet. This depth range provides sufficient permanent storage of sediment without the natural tendency to stratify and turn anaerobic, and is a good depth for rooted native aquatic plants to attach. Depths between two-feet and six-feet should be avoided, as this is where vegetation becomes hard to establish.

Specific BMP Recommendations

The focus of pollution reduction to reach the goal for Gleason Lake is total phosphorus (TP). The reason for this is the fact that phosphorus is the controlling nutrient that determines the level of algal growth in Gleason Lake. This is not to say that other contaminants, such as sediment, oil, nitrogen, toxic organics or heavy metals, are not a problem, but that the focus should be on TP reduction. It is important to note, however, that BMPs yielding good TP load reduction will also reduce many other contaminant loads.

To achieve the TP load reduction of about 156 pounds, the following set of BMPs is recommended. The BMPs are presented in worksheet format to explain the details of how the BMP is conceptualized. Figure 3.4.3 showed the locations of the various recommended actions.

Action Scenario:

1) The focal point for the largest TP reduction with new management practice installation is the creek area as it flows through GLC-1 through 6. Reference to the channel erosion survey in Chapter 3.4 of the GLMP (Table 3.4.2) identifies several key areas in need of channel and detention pond restoration. The reach from Pond #3 in GLC-3 to Pond #7 in GLC-6 is critical to load reduction.

The following actions are recommended to improve this reach:

- Dredge Pond #3 to regain its design configuration;
- Enlarge Pond #2 to increase its effectiveness at controlling runoff at the juncture of two channel segments;
- Dredge Pond #6 to regain its design configuration;
- Repair the erosion around Berm #2;
- Repair and stabilize the erosive channel in Erosive Reach E3; and
- Enlarge Pond #7 and incorporate it into a detention/wetland treatment system that more effectively treats input at the bottom of GLC-1 through 6.

The improvement of Ponds 2, 3 and 6, combined with the restoration of the eroding channel banks, is conservatively expected to increase in effectiveness by 33% because of the number of ponds and wetlands located throughout the watershed to pre-settle solids. Better performance could occur, but the small size of the ponds warrants some caution because of the long-term possibility that they will fill with sediment, as is currently the case.

Calculations: Current TP load (GLC-1 through upper 5) = 182.8 lbs.
Improved load under BMP scenario = 182.8 * 0.67 = 122.5 lbs.
Net load reduction = 60.3 lbs.

The performance of Pond #7 is critical to the removal of pollutants immediately before they enter the Lake. As previously noted, this pond is tremendously under-sized and is ineffective in achieving any noticeable load reduction. Altering this pond by increasing its size and tying it into a wetland system that would further treat the creek is recommended. The difficulty in this situation will be building the pond large enough to make it effective. The standard NURP-based (EPA's 1980s-era Nationwide Urban Runoff Program) design of 1% would require a surface area of about 17 acres; currently the pond is about one-quarter of an acre. Taking full advantage of all of the potential space between the current pond inlet and the Lake would yield only 1.5 acres of space - less than 0.1% of the area draining to it.

Backwater from the Lake presents another challenge in the design of an effective detention/wetland system. The problem is that useable storage above the permanent volume reserved for sediment deposition cannot be relied upon because of high water levels from the Lake backing up the channel into the facility. However, the net effect of backwater is the slowing down of flow, which in turn leads to particle deposition. Incorporating backwater into the design of an enlarged detention/wetland treatment system adjacent to the Lake will decrease overall effectiveness, but will not remove it entirely. A system that includes some detention storage and a serpentine path through wetland vegetation during normal runoff events could enhance the current effectiveness of Pond #7. Provision in the design will have to be made for backwater from the Lake to move into the system and occupy the flood storage area during high water events. A Lake stage graph tied into the Lake outflow weir would be developed as part of the design effort. The pond itself could be excavated to provide for a substantial amount of sediment storage, and flow within the main pond routed to prevent short-circuiting from the inlet to the outlet. Special caution and predictive modeling would be needed to prevent any adjacent structure flooding.

Successful alteration of the Pond #7 site will be difficult, but the location just prior to creek discharge into the Lake makes it an ideal focal point for action. Unfortunately, the limited space available will limit its maximum expected effectiveness, and a load reduction of only 20% is expected. Perhaps more solids will drop-out in the system, but larger flows will likely re-suspend them and move them into the Lake.

Calculations: Current TP load with previous 60.3 lb. reduction incorporated (GLC-1 through 6) = 439.9 lbs.
Improved load under BMP scenario = 439.9 * 0.8 = 351.9 lbs.
Net load reduction = 88 lbs.

The total TP removal from rehabilitation of detention ponds and channel bank erosion along the main channel of Gleason Creek is **148.3 pounds**.

2) Runoff from about 15 acres of the Wayzata Central Middle School paved parking lot, building roofs and roadways all makes its way to an adjacent wetland without any treatment. Water is whisked away via a system of drain pipes, storm sewers and drainage swales. GLIA has identified this site as one of the most important single sites for improvement in surface water management. Recommended improvements for decreasing the impact of this runoff involve routing runoff through some vegetated pre-treatment swales, settling in two forebays at the wetland, and routing through a wetland treatment system. Several institutional entities, including the Wayzata School District, the DNR and the City of Plymouth could be involved in this improvement.

Long-term permanent uptake of phosphorus in a wetland requires a loading of less than 1.0 gram of phosphorus per square meter of wetland ($1g/m^2$/year). Approximately one-half acre of wetland would be needed to maintain this rate from the 15 acres of impervious surface draining the school, assuming a TP wash-off event mean concentration of 200 μg/L, two-feet of runoff per year, and pre-settling in a forebay or vegetated swale. Additional runoff would enter the system from the athletic fields on the south and northwest sides of the school property. The south side fields flow overland to the wetland, whereas the northwest fields flow into shallow swales traversing the east side of the fields.

The adjusted load from GLC-8 is 31.6 pounds. This load was adjusted downward by 10% in the original determination because of the wetland at the mouth of the sub-basin. A total load reduction of 33% (or a net decrease of an additional 23%) is assumed if all of the Middle School improvements go in.

Calculations: Current TP load = 31.6 lbs.
Improved load under BMP scenario = 31.6 * 0.77 = 24.3 lbs.
Net load reduction = 7.3 lbs.

The total TP removal from the BMPs proposed to this point is **155.6 pounds** just short of the 156 needed.

3) There are several small, relatively ineffective ponds that occur within GLC-7 in close proximity to the Lake. These ponds collectively remove only an estimated 5% of the TP load from the sub-basin.

The management approach recommended for GLC-7 is to focus on the Cimarron Ponds subdivision chain of ponds and on Pond #8. These ponds should be dredged to their original design depth and surrounded with buffers. Currently, the Cimarron ponds have mowed grass down to the water. Geese are effectively kept away with reflective geese tape. However, establishing a buffer after pond dredging would be more environmentally beneficial by using some of the nutrients in the grass and filtering overland runoff before it hits the pond.

Improving the performance of these four target ponds will assumedly increase their overall effectiveness to 20%, or an increase by 15%.

Calculations: Current TP load = 114.5 lbs.
Improved load under BMP scenario = 114.5 * 0.85 = 97.3 lbs.
Net load reduction = 17.2 lbs.

Total TP Load Reduction

The sum of the three recommended reduction scenarios above is 172.8 pounds, which exceeds the load reduction goal of 156 pounds by over 16 pounds. It must be stressed that performance at this level relies upon the BMP being well designed, properly installed and well maintained. If this reduction can be achieved, however, the Lake stands a good chance of meeting its goal. Reducing the interim load beyond the target means that the Association will be on its way toward achieving its long-term goal. If the goal cannot be cost-effectively reduced from watershed management activities, then in-lake internal load reduction practices could be explored. At this time, no suggestion is made to pursue those means.

4.4. LAKESHORE AND LAKE IMPROVEMENT PROJECT PLANNING

Lakeshore

A lakeshore erosion survey on Gleason Lake was conducted on July 12, 2002. The results of the survey were summarized in Chapter 3.4 (Figure 3.4.3 and Table 3.4.2).

Among other impacts, perhaps the most serious one is the direct delivery of eroded soil into the lake. When soil washes off of a lakeshore, it is immediately detrimental to the quality of the lake. The turbidity it causes and the associated pollutants (especially nutrients) it carries with it become instant problems.

There are currently three areas of active erosion on the Gleason lakeshore. The first, and most serious, is at the shores of Waycliffe condominiums, identified as Site L1 in Figure 3.4.3. Approximately 800 feet of shoreline had the forest understory removed, leaving about 25-to-40 feet of vertical slope exposed to erosion (total area approximately 20,000-to-32,000 square feet). At least 15 large trees were lost to erosion after the clearing occurred. Although some vegetation has grown back, there remains a need to stabilize this area with an effective re-vegetation plan. At a minimum, the area should be stabilized with erosion control fabric and replanted with shade tolerant native vegetation, such as those on the Minnesota Department of Transportation's (Mn/DOT) Seeding Manual (2000) Mixture 5A (oak woodland) list.

The second area of active lakeshore erosion (Site L2) occurs along about 50 feet at the Gleason Lake Townhomes. Erosion occurs over a slope length of about 20 feet, for a total area of approximately 1,000 square feet. Restoration of this slope would be similar to that recommended for the Waycliffe site.

The final site identified (L3) appears to be more naturally occurring as a result of the steep slope at this point in the lake. Although a full tree canopy and understory exist at the site, a few trees are noticeably down as a result of slope erosion. Because this is a relatively minor problem, the recommendation is simply to remove the fallen trees, inspect for damage under the existing canopy, and repair any erosion that looks as though it might become a problem. Maintaining existing vegetative conditions at this location is also essential so that erosion does not worsen.

Lake

Watershed data, lake models, and observed lake conditions pose a minor dilemma. High phosphorus concentrations in the lake are adequately modeled with the existing conditions model. However, based on the lake phosphorus concentration of about 100 ppb, the model predicts a water clarity growing season average of about 0.5 meters (1.7 feet) rather than the observed growing season average of about 1.4 meters (4.6 feet). The observed clarity is nearly three times better than predicted based on the lake phosphorus concentration (see Table 4.4.1).

Clarity is also better than predicted for the MNLEAP model. The MNLEAP model is run using watershed inputs based on ecoregion values. The results predict what phosphorus and clarity values should be for relatively un-impacted lakes (ecoregion lakes). The observed summer average clarity is better than the MNLEAP prediction.

Table 4.4.1. Gleason Lake Observed Conditions and Model Predictions. (The total phosphorus model used land use export coefficients and closely predicts the observed in-lake phosphorus concentration.)

	Observed	**Existing Conditions Model**	**MNLEAP Model (North Central Hardwood Forest)**	**2020 Conditions Model**
Total phosphorus	108	104	54	106
Secchi disc	1.36	0.48	1.2	0.48
Chlorophyll-*a*	39	57	23	57

The dilemma is that even if a massive watershed program was successful in reducing watershed phosphorus inputs and lake phosphorus concentrations were reduced, average water clarity readings are not expected to improve. However, ignoring watershed loads could lead to worsening lake conditions in the future. Therefore, a cost-effective lake management strategy should address the obvious watershed problem spots identified in this *Plan*, and continue to work with in-lake fish and aquatic plant management projects to maintain good water clarity.

It appears biological effects may be keeping water clarity conditions better than expected. It does not appear that summer aeration or a sediment alum treatment would result in improved lake water clarity. The lake model results indicate that even with a reduction of the in-lake phosphorus concentration, the predicted water clarity would not be better than the observed summer average clarity because of the influence of the macrophytes. Even with good watershed management practices in place, enough phosphorus will be delivered to the lake to produce some summer algae blooms. The goal in moving toward less watershed loading will begin the necessary long-term steps toward lake improvement and less frequent blooms.

Trophic state index (TSI) results (Figure 4.4.1) show that Secchi disc TSI results are consistently lower than phosphorus TSI results. Low TSI values reflect good water quality. When lake conditions are in equilibrium, the phosphorus TSI equals the Secchi TSI. The Secchi TSI is better than what would be expected based on the phosphorus TSI.

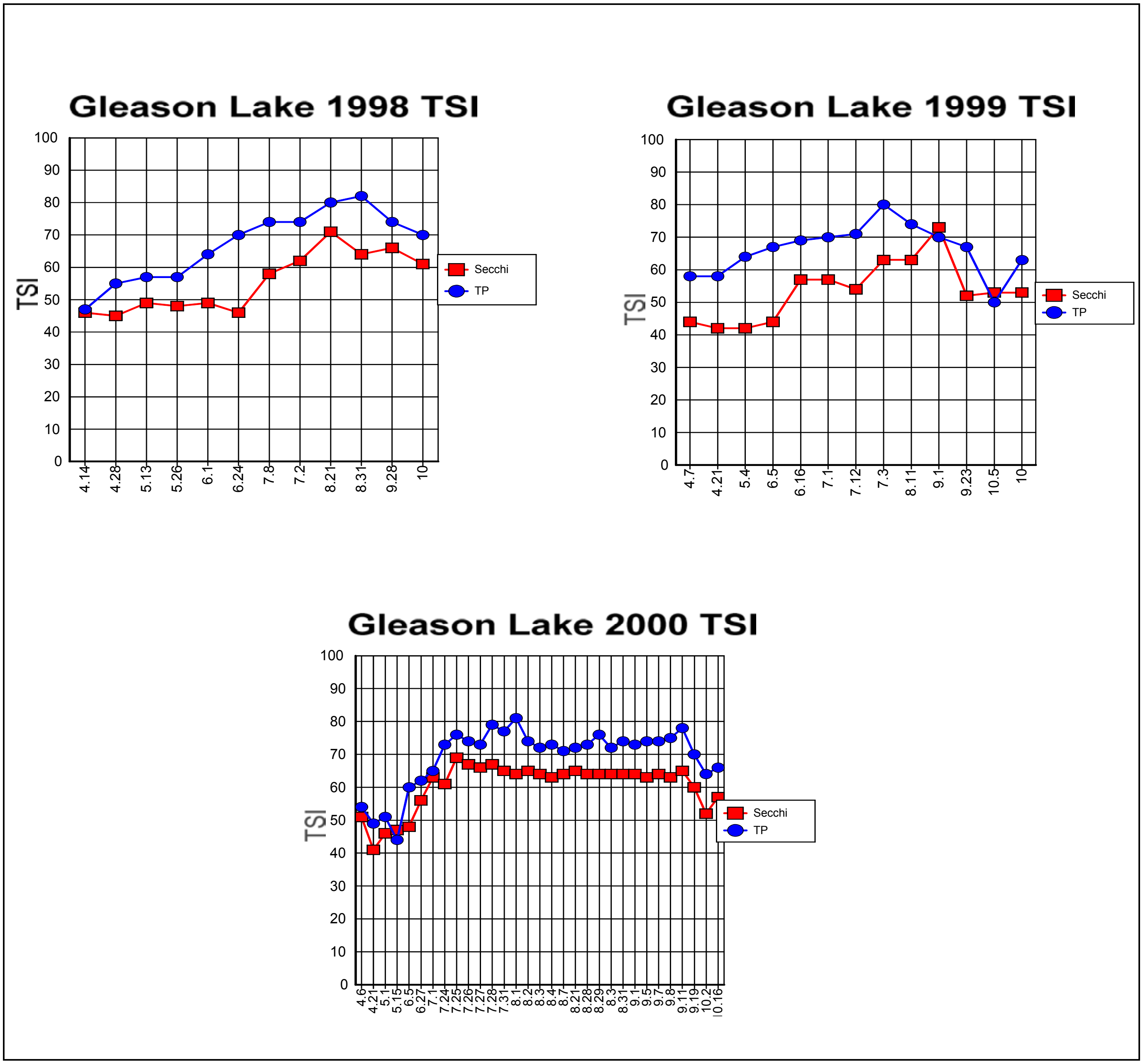


Figure 4.4.1. Trophic State Index (TSI) Results (calculated using MCWD data).

Table 4.2.1 noted a difference in the predicted and the observed level of TP within Gleason Lake. This difference is most likely the result of "internal" loading that comes from the re-introduction of phosphorus from the sediment on the lake's bottom. Phosphorus can be released as a result of chemical conditions (anoxia) or physical conditions (wind and wave action, carp or boat turbulence). The eutrophic character of the lake over the past has contributed a substantial amount of settled nutrients to the bottom of the lake. Macrophytes, algae, and organic debris (ex., leaves and grass) all contribute to the nutrient load that remains on the lake bottom, susceptible to re-suspension under the right conditions.

The Canfield-Bachmann Model (1981) that was previously referenced can also be used to estimate the relative magnitude of this internal loading factor. Completion of this model generated a number of approximately 200 pounds per year as the internal load of phosphorus within Gleason Lake. This figure is roughly one-third of the external loading contained in Table 4.2.1. The Canfield-Bachmann Model determines results of in-lake quality based on external and "average" internal loads. Internal loading in Gleason Lake may be slightly higher than the model estimates. At a moderate phosphorus release rate of 3 $mgP/m^2/day$ for 120 days over 100 lake acres, an estimated internal load of 300 pounds of phosphorus is predicted. Alum additions or aeration could reduce internal loading to about 100 pounds, but would not have much of an impact on phosphorus levels or water clarity.

One of the original intents of the lake aerator when it was installed was to keep the lake aerobic over the entire year. The purpose of doing this is to minimize the chemical release of phosphorus from the lake bottom. A discussion of the effectiveness of the aeration system in meeting its original goal occurred in Chapter 3.3. Operation of the system currently occurs only in the winter, under ice to prevent fish kills from insufficient oxygen. Use of the system to keep the entire lake aerobic and reduce internal loading was previously found not likely to yield improvement in water clarity or algal growth because of the influence of the macrophytes. Similarly, the addition of alum is not recommended for the same reason.

4.5. WATER QUALITY MONITORING

This section of the Plan summarizes suggestions for improved collection of water quality data within the watershed draining to Gleason Lake and the Lake itself.

Watershed

The amount of data collected within the area draining to Gleason Lake has been very limited. Some runoff and creek data were collected by the City of Plymouth as part of a summer 2000 monitoring program for the Lake. Sixteen samples were collected from May 12 to September 12, 2000. The samples were collected on Gleason Creek (County Ditch 15) between County Road 6 and the stormwater detention pond just north of the Gleason Lake inflow. Flow was not reported with the water quality data, nor was sampling technique, so a thorough analysis of flow-weighted pollutant behavior could not be done for this Plan.

Another small set of data (Site SGL01) exist from the "Phase II" MCWD project in 1997. Eleven samples were taken between July 24 and November 5, 1997. As with the 2000 data, flow and sample collection technique are not reported, so a flow-weighted analysis cannot be done. Site SGL01 is assumedly at or close to the location of the 2000 sampling.

The 2000 and 1997 data are combined in Table 4.5.1. Although, as mentioned, a thorough flow-weighted assessment of lake inflow cannot be done on these data, the table is presented as a compilation of "snapshot" data that characterizes quality over two periods of spring-through-fall flow. Characterizing snapshot data can be misleading if not viewed in the proper cautious perspective. With this in mind, the creek inflow can be generalized as low in suspended solids, but high in total solids and phosphorus. Nitrogen is relatively low, reflective of the number of wetlands through which the water flows. A more thorough, flow-weighted data collection program would help better document the behavior of the watershed and the impact it has on the lake.

The above referenced paucity of data points to a very pressing need for the Gleason Lake watershed, that being the need for lake inflow water quality data. The MCWD's "Gleason Lake Creek - Lake Outlet" station (CGL01) is located downstream of the Gleason Lake outlet, and is therefore more reflective of lake surface water quality than tributary inflow to the lake. The first recommendation for better water quality monitoring in this watershed is to re-locate the MCWD "creek" monitoring station upstream of the lake to obtain information of what external load reaches the lake from the creek. A continual flow and flow-weighted water quality station would be optimum. If funds are not available to do this, continual flow and periodic, flow-based water quality sampling would be the next desirable approach. Flow from the lake at the current CGL01 station should be maintained and combined with surficial lake monitoring data to get an idea of lake and watershed loading to Wayzata Bay.

The second suggestion for water quality monitoring is to conduct performance monitoring of the BMPs that might be installed as recommended in the Gleason Lake Management Plan. Of particular importance would be:

- The improvement in water quality downstream of newly dredged ponds;
- The reduction in solids movement resulting from channel repair and stabilization; and
- The overall water quality treatment effectiveness of the improved detention/wetland treatment system between County Road 6 and the lake.

The performance of the various BMP combinations suggested in the implementation plan are estimates based on previous performance studies conducted mostly in Minnesota and the upper Midwest. However, the best way to ascertain actual performance is to collect data that shows whether the application is meeting the intended treatment goal. Studies of this type can be done on individual events, but it is suggested that a suite of rainfall and snowmelt events be monitored to assure that a range of "typical" runoff conditions are examined.

Lake (LGL01)

On-going lake monitoring will help characterize future water quality changes. As a special project, a lake sediment core could be obtained to review the past history of Gleason Lake. The objective of obtaining a sediment core would be to gain insight into predevelopment lake conditions. One of the questions the core could answer is: Has Gleason Lake always been weedy? It may be that the Lake has always been weedy and it is, therefore, its natural condition.

Table 4.5.1. Water Quality Data for Gleason Creek Upstream of the Lake.

Site	Date	TP (mg/L)	SRP (mg/L)	TSS (mg/L)	TN (mg/L)	NH3 (mg/L)	NO3 (mg/L)	TS (mg/L)	pH	Conduct. (µmhos/cm)
Gleason Lake Creek (SGL01)	7/24/97	0.25	0.10	12	1.6	--	--	--	--	--
	8/4/97	0.18	0.07	9	0.7	--	--	--	--	--
	8/6/97	0.18	0.07	5	0.7	--	--	--	--	--
	8/8/97	0.13	0.05	4	0.8	--	--	--	--	--
	8/11/97	0.13	0.06	<4	0.9	--	--	--	--	--
	8/13/97	0.12	0.06	4	0.6	--	--	--	--	--
	8/15/97	0.18	0.05	5	0.9	--	--	--	--	--
	8/18/97	0.68	0.03	45	1.0	--	--	--	--	--
	10/15/97	0.12	0.04	<4**	0.5	--	--	--	--	--
	10/30/97	0.07	0.02	<4	0.3	--	--	--	--	--
	11/5/97	0.10	0.02	<4	0.4	--	--	--	--	--
Gleason Creek (inlet to lake)	5/12/2000	0.19	0.11	--	1.4	0.07	--	--	7.38	--
	5/19/2000	0.27	--	10	1.5	--	0.3	532	--	--
	5/29/2000	0.17	0.02	12	1.0	0.21	0.4	--	7.71	561
	5/31/2000	0.14	0.05	7	1.1	0.18	0.4	736	8.05	519
	6/2/2000	0.10	--	6	1.0	--	--	320	8.01	482
	6/5/2000	0.50	0.02	80	1.1	--	0.3	744	8.04	668
	6/16/2000	0.12	--	5	1.1	--	--	528	9.00	465
	6/20/2000	0.17	0.05	26	0.9	0.08	0.3	244	8.78	148
	6/26/2000	0.11	--	6	1.2	--	--	423	--	--

Site	Date	TP (mg/L)	SRP (mg/L)	TSS (mg/L)	TN (mg/L)	NH3 (mg/L)	NO3 (mg/L)	TS (mg/L)	pH	Conduct. (µmhos/cm)
	7/6/2000	0.10	0.04	2	1.0	0.10	0.3	573	8.03	559
	7/10/2000	0.20	0.08	17	1.6	--	0.3	260	7.80	317
	7/19/2000	0.20	0.06	6	1.6	--	0.6	--	7.92	449
	7/26/2000	0.28	0.17	48	1.3	--	0.4	240	--	287
	8/8/2000	0.33	0.05	38	0.7	--	0.6	313	--	214
	9/5/2000	0.20	0.02	--	0.7	0.45	0.8	--	--	--
	9/10/2000	0.15	--	--	1.7	0.08	0.6	--	--	--
Mean value*		0.20	0.06	17	1.0	0.17	0.4	447	8.07	424

* The "mean value" is presented only to show an approximate number for each constituent; it has limited statistical value since it is not related to flow and each constituent was not collected for all dates.

** "Less than" values not used in determining TSS mean.

4.6. CONSISTENCY WITH PLYMOUTH'S WATER RESOURCES MANAGEMENT PLAN

The GLMP work plan contains an element that compares the consistency of GLMP recommendations to both the Plymouth *Water Resources Management Plan* and the MCWD *Watershed Management Plan*. The compatibility with the MCWD's Hydrologic, Hydraulic and Pollutant Load Study (HHPLS) was previously discussed. MCWD is currently revising its *Watershed Plan* with a third generation plan.

The City of Plymouth adopted its current "*Water Resources Management Plan*" (*WRMP*) in February 2000. This plan outlines the City's intent relative to all waterbodies within the City. Of specific concern to the GLMP is the City's approach toward Gleason Lake and the sub-watersheds draining to it.

Table 4.6.1 lists the pertinent information from the Plymouth *WRMP* for each of the waterbodies contained earlier in this Plan as possible management sites (see Table 3.4.2.). The City's *WRMP* also prioritizes sub-watershed activity according to the portion of the drainage area contained within the Kreatz/Snyder, 19th Avenue, Dunkirk Lane and Gleason (direct) sub-watersheds. The following paragraphs summarize the City's priority for each of the four sub-watersheds.

Kreatz/Snyder - The City has placed a very low priority on any actions within this sub-watershed. Its analysis shows that little remains to be done with treatment because most of the treatment goals have been reached. This finding is generally consistent with the problem assessment earlier in this Plan (see Chapter 3.4.).

19th Avenue - The City's plan identifies two areas of localized flooding, one of which is in the vicinity of an area noted in the problem assessment (Note 3 in Table 3.4.2), which have severe treatment deficiencies assigned to them.

Dunkirk Lane - The 2000 City plan notes this sub-watershed as a medium priority. The plan notes the total absence of treatment in the far northern end of this sub-watershed. However, since preparation of the City's plan, this part of the sub-watershed developed and did have a substantial amount of treatment capacity added. The GLMP problem assessment noted fairly high loads of TP, TN and TSS from this area, but the added treatment and the routing of this water through the large wetland system near the sub-watershed mouth should result in decreased load movement toward Gleason Lake.

Treatment deficiencies have also been noted by the City for the area draining along County Road 6, west of Gleason creek. This area eventually drains to the MCWD detention pond (Pond #7) that has been recommended for improvement (see Chapter 5.2). If the pond is not improved, this area will remain a concern because of the lack of treatment in place.

Gleason Lake direct - The City's Plan designates this sub-watershed as a medium priority. The Plan also notes the former City position of using Gleason Lake as a storage site for water to keep it from flowing to Lake Minnetonka. The net effect of this, as stated in the Plan, was to "…retain pollutants…" in Gleason Lake rather than pass them on to Lake Minnetonka. Recent MCWD projects have also raised water levels and increased storage volume. The City's Plan places a very low weighting on the fact that Gleason Lake is of such poor existing water quality, with little hope for improvement. One of the areas noted for improvement in the City's Plan is the Wayzata Central Middle School area that drains through the large wetland directly east of Gleason Lake. Implementing the suggestion for improved treatment of this water (see Chapter 5.2) would address this problem. Improvement in the small pond located behind the Gleason Lake Elementary School would address the City Plan problem noted for drainage from the northwest that flows through the pond.

The summary Gleason Lake Action Plan (Table 140 in the City's *WRMP*) has a similar intent to this GLMP, but the objectives are far less rigorous relative to cleaning the lake. The Action Plan states that the clarity does not support swimming and that limited opportunities exist for water quality improvement. The Regional Team process under the MCWD auspices identified a more optimistic goal (interim 80 µg/L TP with a long-term goal of 50 µg/L), which GLIA seems to better match. The Gleason Lake Implementation Plan (Table 141) within the City's *WRMP* does recommend several of the same approaches as this GLMP, including increasing select watershed treatment and routine pond maintenance.

Table 4.6.1. Information from Plymouth WRMP (Feb. 2000) on Potential Management Locations

GLMP Pond #	Plymouth WRMP #	DNR Inventory #	WRMP Wetland Classification	Live Storage (acre-ft)	100-Year Water Elevation
1	GL-P2A (Maple Creek Park)	--	High	5.0	994.0
2	Unnamed - no data				
3	GL-P5	610W	Medium	11.0	979.6
4	GL-P12 (Kreatz Lake)	106P	Medium	36.0	974.0
5	GL-P11 (Snyder Lake)	468W	High	32.0	960.0
6	GL-P13	--	Medium	11.0	962.3
7	Unnamed - no data				
8	GL-P26	--	Medium	3.5	956.3

CHAPTER 5. IMPLEMENTATION FRAMEWORK

5.1. WATERSHED AND LAKE/LAKESHORE BMP PROJECT COSTS

Table 5.1.1 lists the estimated cost for implementing BMPs associated with watershed, lakeshore and in-lake BMPs. The costs are reflective of Fall 2002 prices applied to the various recommended actions throughout the GLMP.

Table 5.1.1.

a) Watershed

Description (sub-basins addressed)	Element and Estimated Cost	Approximate Cost
Improvement in Ponds 2, 3 and 6; dredging to original depth; construction of buffer and safety/vegetation bench (GLC-3)	- Dredging for three ponds; $20,000 per pond - Buffer construction; $20,000 per acre - Establishment of emergent vegetation on safety bench; $20,000 per acre	- $60,000 - $6,500 - $6,500
Rehabilitation of Pond #7 and incorporation of a flow-through wetland treatment system (GLC-6 and 7)	- Expand Pond #7 to 1 acre, 6-10 feet deep; $40,000 per acre-foot - Install outlet control structure with skimmer, using existing material as able - Add 0.5 acre flow-through wetland treatment system	- $240,000 - 400,000 - $40,000 - $20,000
Repair and stabilization of eroding stream banks at E3, and repair of eroding structures at E2 and E4 (GLC-3)	- 300 feet of eroding channel bank on each side; $500 per foot - Bank repair at E2 - Bank repair at E4	- $300,000 - $2,000 - $2,000
Improvement in Cimarron Ponds subdivision chain of ponds and Pond #8 (GLC-7)	- Dredging for four ponds; $20,000 per pond - Buffer construction; $20,000 per acre - Establishment of emergent vegetation on safety bench; $20,000 per acre	- $80,000 - $7,500 - $7,500
Retrofit surface runoff management system at Wayzata Central Middle School	- Grade two infiltration swales totaling about one-half acre, and vegetate one-half acre of swale and one-half acre of restored wetland - Install forebay at pipe outlet to wetland - Install two rain gardens to intercept building runoff	- $20,000 - $5,000 - $10,000
Range of Total Costs		$843,000 - $1,004,000

b) Lakeshore

Description (location addressed from Figure 2.4.1 and Table 2.4.1)	Element and Estimated Cost	Approximate Cost
Site L1 - Waycliffe condominiums	Stabilization of 20,000-32,000 square feet of eroding lakeshore with erosion control fabric/mats and native vegetation; approximate cost $0.50 - $1.50 per square foot (HCD estimate for Hennepin County)	- $10,000 - 48,000
Site L2 - Gleason Lake Townhomes	Stabilization of 1,000 square feet of eroding lakeshore with erosion control fabric/mats and native vegetation; approximate cost $0.50 - $1.50 per square foot	- $500 - 1,500
Site L3 - East shore of Gleason Lake	Remove fallen trees and inspect site for potential new erosion	- $2,000
Range of Total Costs		$12,500 - $51,500

c) Lake

Description	Element and Estimated Cost	Approximate Cost
Maintain a piscivore dominated fishery; stock largemouth bass, if needed.	Supplemental stocking would contribute to bio-manipulation effects; $100-$500 per stocking event.	- $100 - 500
Maintain native aquatic plant coverage and use manual removal methods for nuisance coontail growth in near-shore residential areas to help keep water clear.	Purchase small-scale aquatic plant removal devices.	- $600
Eurasian watermilfoil does not warrant active management at this time, but should be monitored on an annual basis.	Conduct aquatic plant surveys on an annual basis.	- $3,000/year
Maintain current winter aeration to maintain the fish community, which will aid biomanipulation effects.	Standard operation and maintenance costs at $7/day.	- $1,000/year
Consider analyzing a Gleason Lake sediment core to give insight into predevelopment lake conditions to determine if the lake always been weedy	Paleolimnological sediment core; $3,000-10,000	- $4,000
Continue to monitor the extent of curly-leaf pondweed and the methods available to control it; examine long-term conclusions of Skogerboe study and make determination of most effective control method to pursue	Herbicide applications for 20 acres per year about $6,000; a Hockney weed-cutter is a one-time cost of $15,000 and about $1,500/year to operate.	- $6,000 - 15,000+

5.2. IMPLEMENTATION PLAN

The implementation of all of the recommended actions within this Plan requires some additional planning to assure that priorities are met and that financial resources can be budgeted by implementing entities. This section lays out a strategy for how implementation should proceed.

The demonstration pilot project at the Luce Line parking lot has been completed by GLIA. It represents a good first step toward implementation of the GLMP recommendations.

The remaining actions involve a mix from low cost homeowner efforts to expensive corrective actions. Many of the implementation steps identified in Table 5.1.1 require funds from a city or an implementing agency because GLIA does not generate nearly enough revenue to undertake projects of this magnitude. Therefore, it is recommended that GLIA focus its efforts on educational matters while working with local officials to implement capital improvement projects identified in this Plan.

A previous section of this Plan (Remedial Watershed Activities) presented a list of "General Practices for Good Management". This list included the following BMP approaches:

- Development Runoff Management;
- Surface Water Management Planning;
- Technical Guidance;
- BMP Maintenance; and
- Pond Rehabilitation.

These approaches define a framework for GLIA to progress toward its goals for the watershed. This is followed by three action scenarios that lay out projects that will result in phosphorus load reductions needed to achieve the interim lake goal. Finally, a section on lakeshore and lake improvements itemizes actions needed for the lake and its immediate shoreline.

Table 5.2.1 itemizes options for translating these watershed and lake options into action that GLIA and its partners can take. When combined with Table 5.1.1, it forms the basis for several years of planning and capital improvements that the Association can pursue.

Table 5.2.1. Implementation Strategy for Gleason Lake Improvement Association.

Action	Implementing Entity	Timeframe	Description
Education:			
a) Pilot demonstration project	GLIA, DNR, City of Plymouth, Luce Line Trail Association	Completed in 2003	Luce Line parking lot runoff treatment; demonstration of native vegetation/infiltration
b) Lakeshore awareness	GLIA, Hennepin County	On-going program after GLMP available	Educational program for lake homeowners, condominium associations and lake users (Luce Line Trail access area)
c) Watershed awareness	MCWD, Cities of Plymouth, Minnetonka and Wayzata, GLIA	On-going program after GLMP available	Educational program for entire area draining to lake
d) "Adopt-a-pond"	Cities of Plymouth, Minnetonka and Wayzata, MCWD, GLIA	2003-2005	Focused pond maintenance and beautification by residents or cities around ponds
Planning:			
a) Review community surface water management (SWM) programs, including erosion and sedimentation control	MCWD, Cities of Plymouth, Minnetonka and Wayzata	On-going, with focus on next planned update	SWM plans are the key implementation vehicles for cities and the MCWD; many of the recommendations for improved SWM will occur in conjunction with implementing these plans
b) Prepare guidance for selecting, designing, installing and maintaining BMPs	MCWD, Hennepin County, Cities	2003-2008	MCWD can work with cities to prepare guidance based on sub-sets and/or additions to its current BMP manual
c) Formalize aeration scheme	GLIA, DNR	2003	Based on findings in GLMP

Capital improvements:			
a) Rehabilitate select ponds	Cities of Plymouth, Minnetonka and Wayzata, MCWD	2003-2008	Five-year program to undertake improvement in ponds identified in Table 5.1.1; top priority for ponds #2, 3 and 6; secondary priority for pond #8 and Cimarron Ponds
b) Reconfigure MCWD detention system near lake	MCWD	2005-2012	Capital improvement project to re-configure Pond #7 to a flow-through wetland treatment system with detention
c) Stabilize eroding stream channel on priority basis	MCWD, City of Plymouth	2005-2010	Implement corrective channel program based on reaches identified in Table 5.1.1; focus on erosion at berms and culverts (E2 and E4) as top priority, followed by linear erosion (E3)
d) Stabilize eroding lakeshore on priority basis	Cities of Plymouth, Minnetonka and Wayzata, Hennepin County, GLIA	2003-2008	Top priority - Waycliffe (L1); second priority - Gleason Lake Townhomes (L2); remove trees at east shore erosion site (L3) and visually monitor results
e) Install stormwater management retrofit at Wayzata Central Middle School	MCWD, Wayzata School District, GLIA, DNR	2004	Retrofit SWM system for large parking lot and impervious buildings; includes rain gardens, infiltration swales, forebay and wetland treatment

Lake Management:			
a) Implement watershed load reductions to decrease external load of phosphorus	Cities of Plymouth, Wayzata and Minnetonka, MCWD	2004-2010	As noted in previous section
b) Maintain annual weed control and monitor behavior while load reduction program implemented	GLIA, DNR	2004-2010	Continue annual chemical control and select harvesting; monitor results of load reduction on weed behavior
c) Continue winter aeration program	GLIA	Annually	Revise as needed if future conditions change
d) Consider collection of a lake sediment core	GLIA, MCWD	2004	Collect core to analyze lake sediment history
Monitoring:			
a) Collect inflow data to Gleason Lake	MCWD	2004	Adjust stream monitoring program to account for inflow to lake from Gleason Creek; consider moving outlet sampling station to inflow site, while maintaining outflow volume monitoring
b) Assess effectiveness of BMPs	MCWD, Cities of Plymouth, Minnetonka and Wayzata	2004-2008	Determine effectiveness of GLMP by collecting water quality data on select BMP applications for five years
c) GLMP implementation monitoring	GLIA, MCWD, Cities of Plymouth, Minnetonka and Wayzata	On-going after GLMP adopted	See next section

CHAPTER 6. MANAGEMENT PLAN MONITORING

The success of the Gleason Lake Management Plan can only be known if measurable elements reflective of that success are documented. Although some parts of the plan, like the effectiveness of reaching the public with the pilot demonstration project, are difficult to measure, most elements can be measured. Table 6.1 lists the various recommendations made in the Plan and the associated monitoring parameter that can be used to track effective implementation.

Table 6.1. Monitoring of Plan Implementation.

Recommendation	Method of Monitoring Effectiveness
Educate public through pilot demonstration program, community meeting, educational brochure, and lakeshore vegetation demonstration	- Communicate with condominium associations on adoption of housekeeping practices - Document number of educational events and attendees - Monitor distribution of educational brochures
Dredge ponds	- Identify specific design and whether dredging is consistent with recommended locations - Monitor water quality associated with pond change to see effectiveness
Change MCWD creek station	- Determine whether MCWD changes location - Observe findings from inflow station
Repair channel and lakeshore erosion	- Document the number of locations or the feet of erosion improved - Institute periodic survey to identify erosive locations and priority for repair
Institute neighborhood "Adopt-a-Pond" program	- Track number of ponds where adopted and the activities related to the program - Document quantifiable measures, such as pounds of litter or duckweed removed, or number of neighborhood pond-related events
Monitor effectiveness of BMPs	- Target BMPs of interest and document monitoring results - Track maintenance of critical BMPs - Work with MCWD and cities on BMP technical guidance
Alter Pond #7 to enlarged detention/wetland treatment system	- Track progress in changing configuration
Control invasive vegetation (target purple loosestrife)	- Track changes in occurrence and effectiveness of beetle program
Improve operation of aerator	- Continue to collect oxygen data and assess effectiveness

(continued)

Recommendation	Method of Monitoring Effectiveness
Improve lake quality to achieve interim and long-term goals	- Continue lake data collection to track changes in the lake in response to the GLMP improvements - Document stages of success until interim goal achieved, then assess next step
Control nuisance macrophytes	- Institute annual macrophyte survey until sufficient data are obtained to assure certainty of control practices - Monitor the results of Skogerboe (COE) program to chemically control curly-leaf pondweed, and apply findings to rest of lake if successful
Control runoff from Wayzata Central Middle School	- Identify possible funding sources and encourage implementation of the recommended program
Implement effective local water planning	- Monitor success of local and watershed water planning efforts

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Engstrom, D.R. and D.I. Wright, 2002. "Sedimentological Effects of Aeration-Induced Lake Circulation". Lake & Reservoir Management, 18(3):201-214.

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Minnesota Department of Transportation, 2000. Seeding Manual, 2000 Draft. Mn/DOT Office of Environmental Services, Turf Establishment and Erosion Control Unit.

APPENDIX A
PILOT PROJECTS

Figure A1. Wayzata Central Middle School Pilot Demonstration Site Schematic.

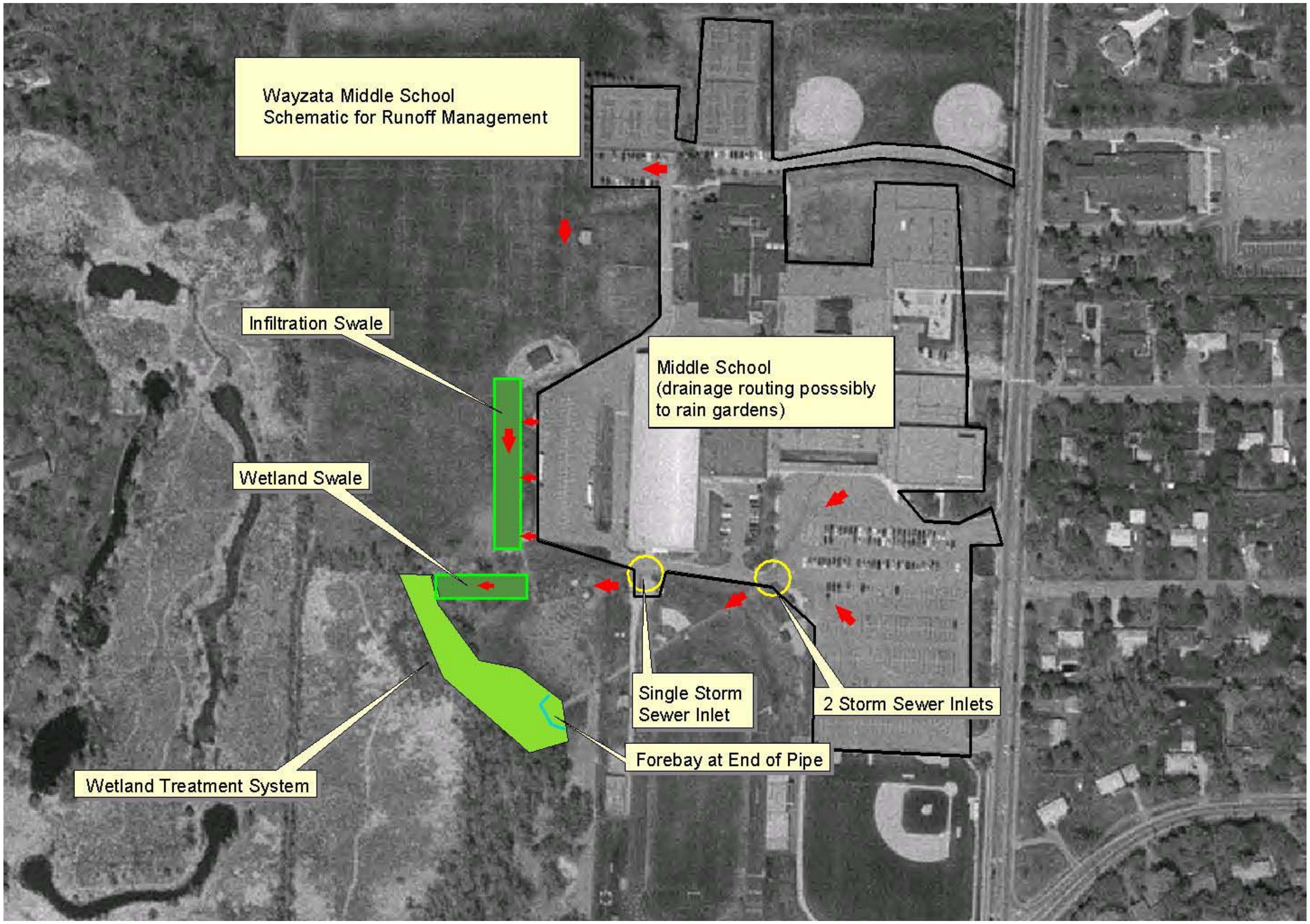
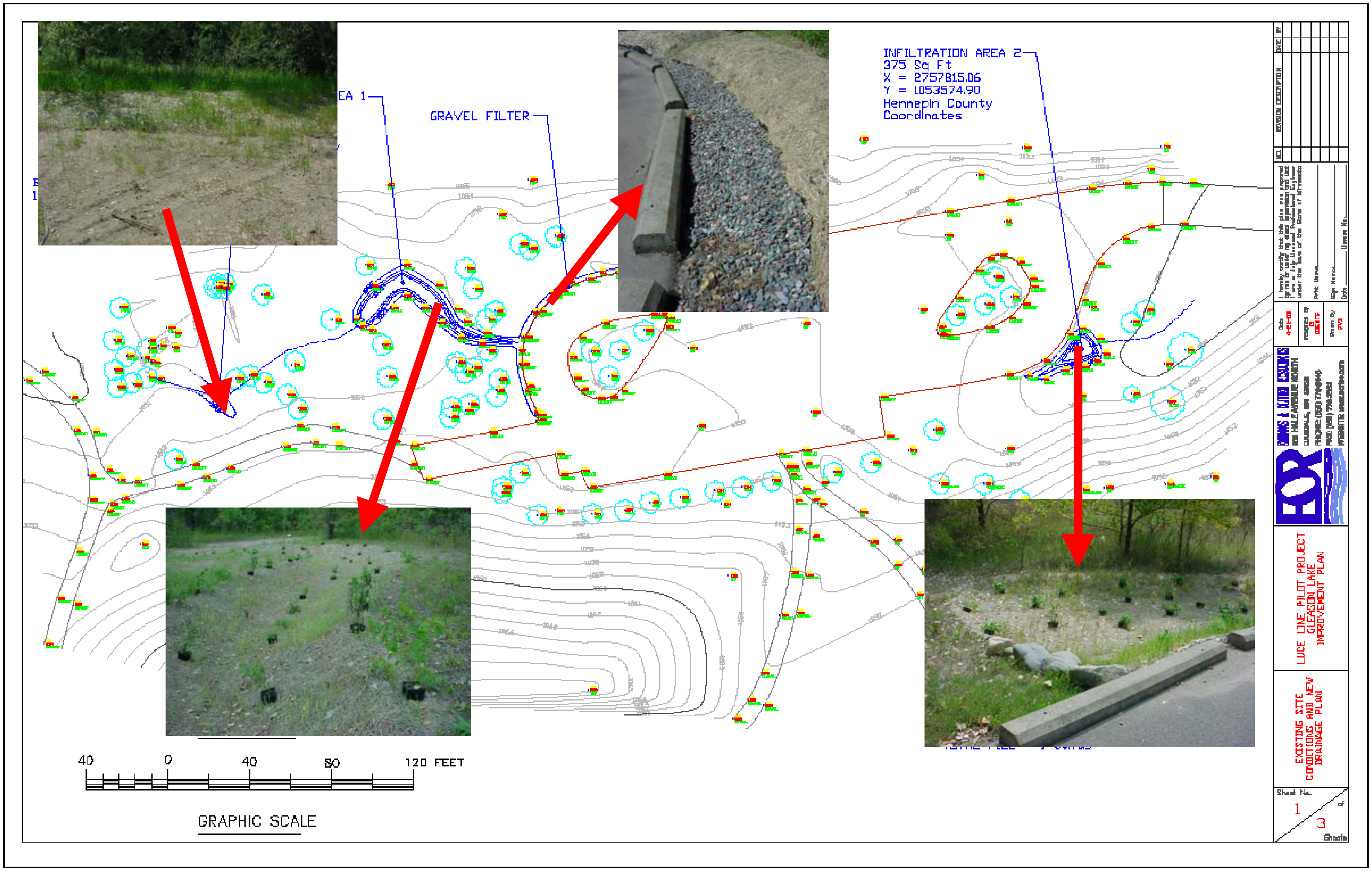


Figure A2. Luce Line Trail DNR Parking Lot Demonstration Final Site Design.



APPENDIX B
INPUT TO GLIA EDUCATIONAL BROCHURE

TEN STEPS TO CLEAN WATER - THINGS YOU CAN DO!

1. Maintain the natural drainage system by preserving and maintaining wetlands, drainage swales and floodways.

2. Keep streets and gutters clean. Don't sweep grass clippings, leaves or twigs into the street.

3. Apply fertilizer judiciously. Do not apply in late fall or early spring, and never over frozen ground, to the edge of water or over paved surfaces. Allow a buffer between the area fertilized and the water or pavement.

4. Don't dispose of oil, grease, antifreeze, yard litter, refuse, etc. down a storm sewer or directly into water.

5. Clean up after your pet, especially when close to a lake or when droppings hit a paved surface.

6. Sweep driveways and collect debris rather than washing with a hose into the street.

7. Aim rooftop downspouts onto the yard, away from paved surfaces.

8. Repair eroding soil immediately before it can wash into moving water.

9. Encourage city officials to keep streets clean, maintain litter containers, provide sanitary facilities in public areas, and control erosion at all construction sites.

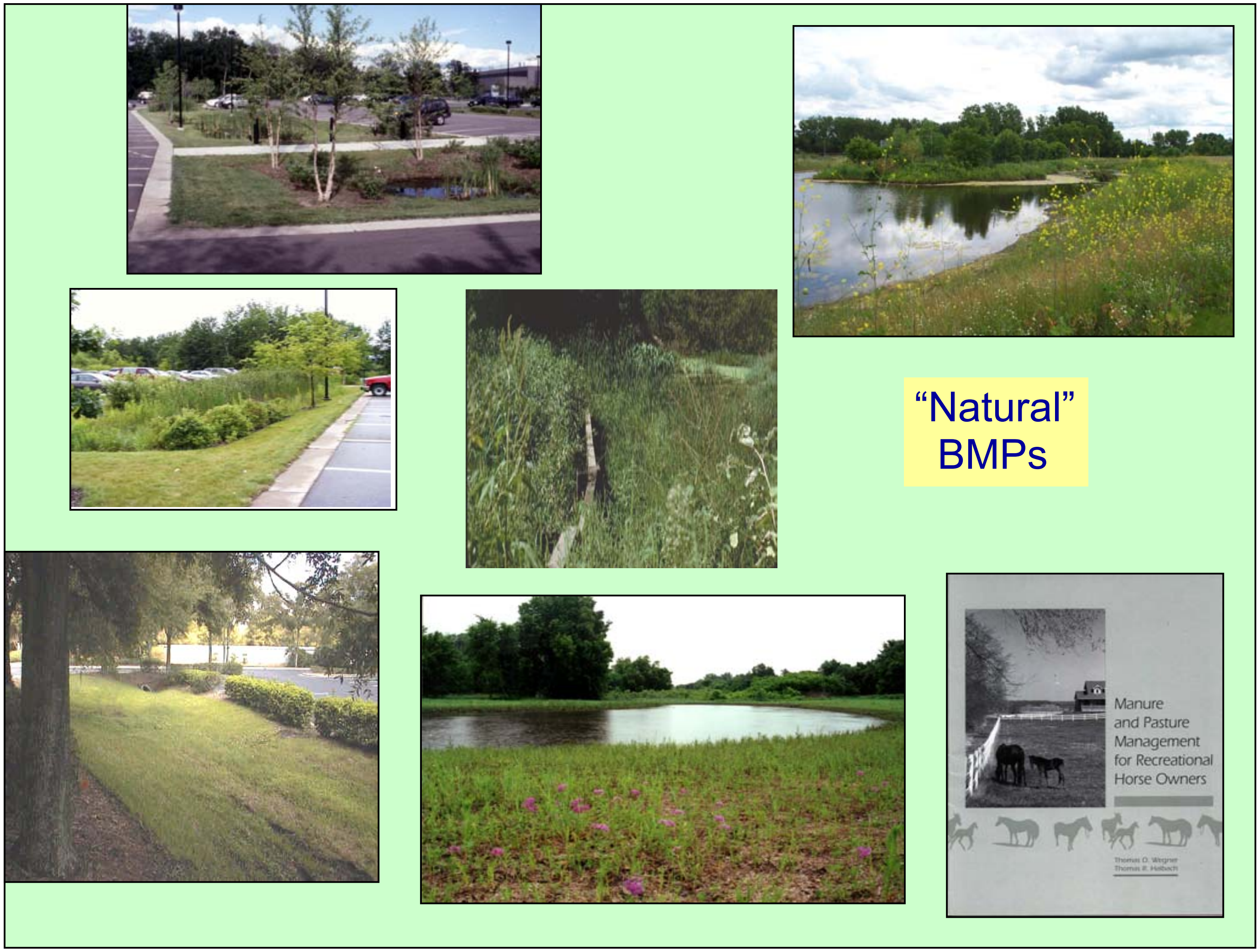
10. Use toxic material only if no alternatives are available and dispose of any leftovers through your community's household hazardous waste program.

BMP “Suites” **B.2.a.**

a.) “Development” BMPs

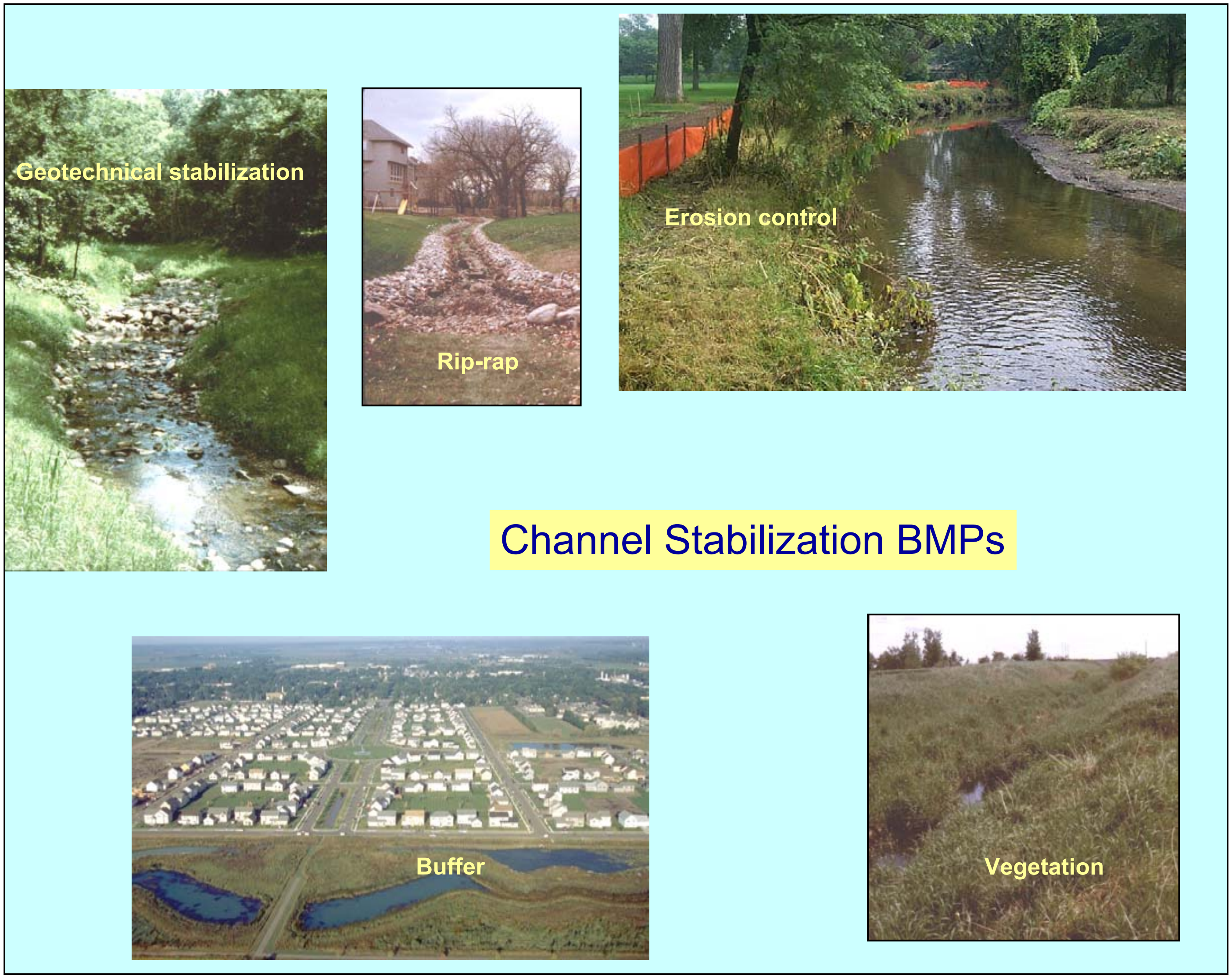
b.) “Natural” BMPs

B.2.b.



c.) Surface Water Management BMPs **B.2.c.**

d.) Channel Stabilization BMPs **B.2.d.**



e.) Shoreland BMPs

B.2.e.

Web-site Links to Further Information: **B.3.**

- Center for Watershed Protection - www.cwp.org and www.stormwatercenter.net

- Project NEMO (Nonpoint Education for Municipal Officials) - www.nemo.uconn.edu

- U.S. Environmental Protection Agency (nonpoint program) - www.epa.gov/owow/nps

- Low Impact Development (LID) Center - www.lid-stormwater.net

- National Stormwater BMP Database - www.bmpdatabase.org

- Minnesota Office of Environmental Assistance - www.moea.state.mn.us

- Minnesota Pollution Control Agency - www.pca.state.mn.us

- Metropolitan Council Environmental Services - www.metrocouncil.org/environment

- Minnesota Department of Natural Resources - www.dnr.state.mn.us

- Minnesota Board of Water and Soil Resources - www.bwsr.state.mn.us

- Minnehaha Creek Watershed District - www.minnehahacreek.org

In-Lake Management **B.4.**

Gleason Lake is a shallow lake that has relatively poor water quality. The state of shallow lakes depends on nutrient inputs, as well as number of other factors that affect the balance between domination by higher plants or by algae.

Shallow lakes can move between two different states: clear water dominated by plants as a result of 1) low nutrient levels or 2) from effective grazing of algae by Cladoceran (Daphnia) zooplankton; or turbid water dominated by phytoplankton. Turbidity of water limits light and prevents plant growth, thus eliminating refuges for algae-grazing zooplankton and perpetuates phytoplankton dominance.

In shallow water dominated by plant communities, algal development is hindered by plants taking up most of the nutrients, allelopathy (a chemical process that a plant uses to keep other plants and/or algae from growing too close to it), and the physical refuges the plants provide for zooplankton, especially Daphnia. Plants also dampen eddy currents, allowing for algae to drop out of suspension to the darker parts of the water or sediment which effectively kills them.

In shallow water dominated by algal communities, the system is usually polymitic with relatively vigorous wind mixing, ensuring their suspension in the well lit surface water body, such as Gleason Lake. Algae are able to respond quickly to environmental change and can suppress other photosynthetic species regrowth through shading. Algal communities offer no refuge for zooplankton (i.e. Daphnia) from zooplanktivorous fish (such as bluegill), leading to decreased populations of algal grazers. This type of environment encourages the establishment of zooplanktivorous fish due to a shortage of predators (piscivores such as bass or walleye) who require plant beds to hide. Submerged plants also provide habitats for the invertebrate prey of piscivores.

In Gleason Lake, the abundant Coontail population out competes algae for both phosphorus and light, thus limiting their growth. Coontail also provides refugia for invertebrates and fish. If the Coontail population was reduced, the dynamics of Gleason Lake would change. Algae would be able to better compete with other native plants and their populations would likely explode. Without Coontail to provide habitat, there would be declines in piscivores fish. This in turn would increase zooplanktivorous fish and decrease zooplankton. Algae blooms would be seen often.

Moss (1998) describes the “switch mechanism” which is required to move from one state to another (I.e., the flip from plants to algae that tends to occur at high nutrient loadings). A reverse switch involves manipulating the fish community (biomanipulation) which seeks to bypass the loss of zooplankton and their refuges by removing zooplanktivorous fish. One way of doing this is by maintaining a piscivorous fishery. (Gary, this is why Steve says by maintaining the aeration system in Gleason Lake is important for fish populations. The fish population is likely to survive the winter low oxygen levels in the lake.

APPENDIX C.
DISSOLVED OXYGEN DATA - GLEASON LAKE

Dissolved Oxygen (DO) Data, in mg/L. (MCWD)

	top	middle	Bottom
2.21.83	7.1		0.8
7.13.83	10.2		1.5
2.13.84	1.1		0.1
7.27.84	11		0.1
2.26.85	5		1
7.23.85	4		8
2.27.86	2.2		0.4
7.14.86	11		4.4
7.23.87	0.3		10
7.22.88	0.3		16
8.2.89	10.8		1.8
7.23.90	8.7		6.1
7.18.91	6.9		4.8
7.27.93	10.97		
7.20.94	6.22		
7.20.95	10.96		0.25
12.20.95	8.7	6.61	6.9
1.24.96	4.3	3.35	3.26
2.1.96	2.9	2.55	2.05
2.5.96	2.24	2.12	2.01
3.10.96	2.31	2.1	1.2
4.23.97			1.78
5.8.97	9.47	7.58	0.48
5.20.97	13	10.16	0.87
6.2.97	11	9.55	0.88
6.16.97	6.25	4.8	0.83
6.30.97	5.21	5.3	1.43
7.14.97	7.46	6.39	1.34
7.28.97	10.12	4.52	0.73
8.11.97	6.6	4.85	0.91
8.26.97	8.34	6.16	0.42
9.9.97	7.78	7.48	0.92
9.22.97	9.56	9.55	4.14
10.15.97	7.86	7.07	0.52
10.27.97	9.68	8.77	8.18
4.14.98	11.01	11.09	2.65
4.28.98	10.74	10.78	2.17
5.13.98	9.15	9.35	0.62
5.26.98	9.73	8.68	0.94
6.10.98	6.65	6.06	0.11
6.24.98	8.11	7.41	0.85
7.8.98	9.69	6.15	0.32
7.20.98	9.08	3.28	0.38
8.5.98		0.82	1.45
8.21.98	12.97	5.15	0.26
8.31.98	9.56	5.44	0.73
9.16.98	8.11	6.77	5.97
9.28.98	8.98	7.46	6.89
10.13.98	9.49	9.27	0.69