Carver County
Reitz Lake
Nutrient
TMDL Report

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September 2010

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	EPA TMDL Summary Sheet	**TMDL Page #**
Water body ID	Reitz Lake 10-0052 HUC 07020012	Viii & 1 Viii
Location	Located just east of the City of Waconia in Carver County, Minnesota, which is within the Minnesota River Basin	6
303(d) Listing Information	The water body listed above was added to the 303(d) list in 2002 because of excess nutrient concentrations impairing aquatic recreation. MPCA prioritized this TMDL to start in 2006 and be completed by 2007.	1
Impairment / TMDL Pollutant(s) of Concern	Excess Nutrients	1
Impaired Beneficial Use(s)	Aquatic recreation (swimming)	1
Applicable Water Quality Standards/ Numeric Targets	The MPCA has established numerical thresholds based on ecoregions for determination of Minnesota lakes as either impaired or unimpaired. The protected beneficial use for all lakes is aquatic recreation (swimming). Reitz Lake, according to the MPCA definition, is considered a deep drainage lake in the North Central Hardwood Forest (NCHF) ecoregion. Therefore, the NCHF ecoregion deep lake standard of 40µg/L will be set as the goal for Reitz Lake.	2
Loading Capacity (expressed as daily load)	The loading capacity is the total maximum daily load for each of these conditions. The critical condition for these lakes is the summer growing season. The loading capacity is set forth in Table 6.1 and was calculated to be: 0.45 kg/day	35

Wasteload Allocation	Source	Permit #	Individual WLA		35
	Permitted Stormwater	City of Waconia MS400232; Laketown TWP MS400142;	See Table 6.1		
Load Allocation	Source			Individual LA	35
	Non-MS4 watershed load, atmospheric load, and internal load		See Table 6.1		
Margin of Safety	The margin of safety is implicit in the TMDL due to the conservative assumptions of the model.				39
Seasonal Variation	Seasonal variation is accounted for by developing targets for the summer critical period where the frequency and severity of nuisance algal growth is greatest. Although the critical period is the summer, lakes are not sensitive to short-term changes but rather respond to long term changes in annual load.				39
Reasonable Assurance	Reasonable assurance is provided by the County Board which acts as the “governing body” of the Carver County Water Resource Management Area (CCWRM) for surface water management in which this lake is located. The purpose of establishing the CCWRMA is to fulfill the County’s water management responsibilities under Minnesota Statute and Rule. The County Land and Water Services Division is responsible for administration of the water plan and coordinating implementation. Other departments and agencies will be called upon to perform water management duties that fall within their area of responsibility. Areas within the City of Waconia and Laketown Township that drain to this lake are regulated under the NPDES program, and Minnesota’s General Permit requires MS4s to amend their Stormwater Pollution Prevention Plans and NPDES permits within 18 months after adoption of a TMDL to set forth a plan to meet the				43

	TMDL wasteload allocation.		
Monitoring	Carver County Land and Water Services monitors this lake annually and will continue to do so through the implementation period. Also, additional monitoring will be conducted during and following implementation.		47
Implementation	This TMDL sets forth an implementation framework and general load reduction strategies that will be expanded and refined through the development of an Implementation Plan.		48
Public Participation	The County has utilized stakeholder meetings, citizen surveys, workshops and permanent citizen advisory committees to gather input from the public and help guide implementation activities.		41

Table of Contents

APPENDICES

TABLES

FIGURES

EXECUTIVE SUMMARY

Reitz Lake is a deep (36 feet maximum depth), 90-acre lake located east of Waconia in Carver County, Minnesota (about 25 miles southwest of Minneapolis). The lake has a 3,621-acre (including Reitz Lake) watershed. The watershed consists of approximately 290 acres of developed land, 781 acres of natural areas, 1,942 acres of agriculture, with the remaining acres being water and wetlands. The entire watershed contains approximately 93 properties with septic systems and 118 animal units. The 2000 Carver County Census data estimates the watershed population to be 470 residents. The area immediately to the west of the lake is currently being developed and is reflected in the numbers above.

Reitz Lake at a Glance

HUC: 07020012
Lake ID: # 10-0052
Recreational uses: Fishing, considered light/moderate by most surveyed, boating, water skiing, wildlife observation and swimming.
Year Listed: 2002
Drainage basin: Minnesota River
Impaired by: Excess nutrients (phosphorus)
Total Phosphorus (summer mean: Sampled 1985 -2004): 94 µg/L
Total Phosphorus (2004 summer mean: 9 samples): 90 µg/L
Phosphorus standard: 40 µg/L
Lake surface area: 90 acres
Mean/Maximum depth: 13 ft/36 ft.
Total drainage area: 3,621 acres (including Reitz Lake)
Sources of phosphorus:
External: Stormwater runoff from developed and agricultural areas, failing or direct-discharge septic systems, degraded wetlands.
Internal: Anoxic sediments, seasonal turnover, mixing by wind and boat propellers, aquatic plant senescence.

Reitz Lake has been identified for impairment of aquatic recreation (swimming) due to excess nutrients (phosphorus). As a result, it has been placed on the list of Minnesota impaired waters. Because of the exceedances, Carver County conducted a Total Maximum Daily Load (TMDL) study. A TMDL is defined as the maximum quantity of a pollutant that a water body can receive, and continue to meet water quality standards for designated beneficial uses.

Water quality data collected from 1985-2004 revealed that Reitz Lake has average total phosphorus concentrations ranging from 43 to 152 micrograms per liter (µg/L). Nutrient reductions for Reitz Lake are set for phosphorus because it is the limiting nutrient for aquatic plant and algal growth. While phosphorus is an essential nutrient, it is considered a pollutant when it stimulates excessive growth of algae.

Based on the federal Clean Water Act, waters that do not meet water quality standards are “impaired.” The Clean Water Act requires states to develop a cleanup plan for each impairment that affects a water body. The cleanup plan and the process used to create it is a Total Maximum Daily Load (TMDL).

A TMDL must identify all sources of the pollutant that is causing a water body to violate standards. The TMDL also determines the amount by which each source must reduce its contribution to ensure that a water body meets applicable water quality standards.

The phosphorus load to Reitz Lake over the 2004 season was determined to be 611 kilograms per year (kg/yr), or 1.67 kg/day. Of this total, external sources have been determined to contribute approximately 544 kg annually. The external sources include 7 kg/yr from the atmosphere (precipitation plus dryfall); the remaining external sources comprise tributary inflows and watershed runoff (mostly non-point sources, but with some loading from regulated MS4s) and septic systems. The remaining load of 67 kg/yr is from nutrient recycling within the lake.

The water quality goal is 40 µg/L for the mean total phosphorus concentration during the summer growing season (June 1 – September 30). This goal is equal to the state phosphorus standard for deep lakes in the North Central Hardwood Forest Ecoregion.

Because the assimilative capacity of a water body varies with the water load, and ultimately precipitation, the TMDL was set for close to an average precipitation year, 2004. The critical condition for Reitz Lake is the summer growing season when the frequency and severity of nuisance algal growth are greatest. Although the critical period is the summer, lakes primarily respond to long-term changes in annual load.

The TMDL for Reitz Lake is 0.45 kg/day, which is equivalent to 164 kg/yr.

Results indicate the phosphorus loading into and within Reitz Lake must be reduced by 9 to 84 percent, depending on yearly precipitation, to achieve the water quality goal of 40 µg/L.

To reach the reduction goals, Carver County will rely largely on its current Water Management Plan. Implementation goals not covered in the Water Management Plan will be identified and amended. A final implementation plan that further refines watershed loads will be developed within a year of the final approval of the TMDL by the U.S. Environmental Protection Agency (EPA). Regular bi-weekly monitoring of Reitz Lake from April-October of each year will continue as identified in the Water Plan. However, after implementation of nutrient reduction strategies, a stepped-up approach of monitoring will be conducted.

When establishing a TMDL, reasonable assurances must be provided demonstrating the ability to reach and maintain water quality endpoints. Several factors control reasonable assurances, including a thorough knowledge of the ability to implement best management practices (BMPs), as well as the overall effectiveness of the BMPs. Carver County is positioned to implement the TMDL and ultimately achieve water quality standards.

The County has utilized stakeholder meetings, citizen surveys, workshops, permanent citizen advisory committees, and personal meetings with the City of Waconia and Laketown Township and their consultants to gather input for the study, and to help guide implementation activities. The use of this public participation structure will aid in the development of this and other TMDLs in the County.

The City of Waconia and Laketown Township are permitted Municipal Separate Storm Sewer Systems (MS4s) under the EPA's stormwater program. MS4s are regulated through state-issued permits, and must create and implement stormwater pollution-prevention programs (SWPPPs). The SWPPP for these MS4s will need to include nutrient loading to Reitz Lake.

Because of the uncertainties involved in the development of the TMDL, and the success of management strategies used to reduce pollution, it is necessary to use an "adaptive management" approach to implementation. This approach involves continual evaluation and monitoring of implementation actions taken to reduce pollution over a period of several years.

1.0 Introduction

1.1 PURPOSE

The goal of this TMDL is to quantify the pollutant reductions needed to meet the water quality standards for nutrients in Reitz Lake. The Reitz Lake nutrient TMDL is being established in accordance with section 303(d) of the Clean Water Act, because the State of Minnesota has determined waters in Reitz Lake exceed the State-established standards for nutrients.

1.2 PROBLEM IDENTIFICATION

Reitz Lake has been monitored (April 15-Oct 1) for total phosphorus, chlorophyll-a and Secchi transparency periodically since 1985 and yearly beginning in 2000. The TMDL monitoring was conducted during 2004. The lake has been monitored by Carver County Environmental Services, Metropolitan Council Environmental Services, and Minnesota Pollution Control Agency (MPCA). Reitz Lake was identified for impairment of aquatic recreation (swimming) due to excess nutrients and placed on the State of Minnesota's 303(d) list of impaired waters in 2002. The lake was listed as a result of mean summer phosphorus values that exceeded the 40 µg/L North Central Hardwood Forest (NCHF) Ecoregion phosphorus standard for Class 2 recreational waters. In order to be listed, the MPCA will only consider the most recent 10-year period of water quality data, and requires that there are at least 12 observations of total phosphorus, chlorophyll-a, and Secchi transparency.

Table 1.1 Identification of the Impaired Waterbody.

Lake	DNR Lake #	Affected Use	Pollutant or Stressor
Reitz Lake	10-0052	Swimming	Excess Nutrients

The MPCA projected schedule for TMDL report completion, as indicated on Minnesota's 303(d) list of impaired waters, implicitly reflects Minnesota's priority ranking of these TMDLs. The Reitz Lake TMDL was scheduled to begin in 2005 and be complete in 2009. Ranking criteria for scheduling TMDL projects include, but are not limited to: impairment impacts on public health and aquatic life; public value of the impaired water resource; likelihood of completing the TMDL in an expedient manner, including a strong base of existing data and restorability of the water body; technical capability and willingness locally to assist with each TMDL; and appropriate sequencing of TMDLs within a watershed or basin.

2.0 Target Identification and Determination of Endpoints

2.1 MINNESOTA WATER QUALITY STANDARDS AND ENDPOINTS

The MPCA has established numerical thresholds based on ecoregions for determination of Minnesota lakes as either impaired or unimpaired. The protected beneficial use for all lakes is aquatic recreation (swimming). Table 2.1 outlines the MPCA water quality goals (MPCA 2005). These goals were used to determine that Reitz Lake should be placed on the 303(d) list of impaired waters in Minnesota.

Table 2.1. MPCA Assessment Targets for Class 2B Waters (North Central Hardwood Forest Ecoregion). (MPCA 2005)

Impairment Designation	Total Phosphorus (µg/L)	Chlorophyll-a (µg/L)	Secchi Depth (m)
Full Use	<40	<15	≥1.6
Review	40 – 45	NA	NA
Impaired	>45	>18	<1.1

However, a water quality standards rules revision was recently completed. The new rules provide for nutrient cycling differences between shallow and deep lakes, resulting in more appropriate standards for Minnesota lakes. The numerical standards are provided in Table 2.2.

Table 2.2. MPCA Lake Water Quality Standards for Protecting Class 2B Waters. (June 1 through September 30). (MPCA 2008)

	Ecoregions			
	North Central Hardwood Forest		Western Corn Belt Plains	
Parameters	Shallow[1]	Deep	Shallow[1]	Deep
Phosphorus Concentration (µg/L)	60	40	90	65
Chlorophyll-a Concentration (µg/L)	20	14	30	22
Secchi disk transparency (meters)	>1.0	>1.4	>0.7	>0.9

[1] Shallow lakes are defined as lakes with a maximum depth of 15 feet or less, or with 80 percent or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (littoral zone).

According to the MPCA definition, Reitz Lake is a “deep” lake in the North Central Hardwood Forest (NCHF) ecoregion. However, three factors differentiate Reitz Lake from many deep lakes in the ecoregion. The first is that Reitz Lake demonstrates many characteristics of shallow lakes. The western portion of Reitz Lake is a large shallow bay that is turbid throughout most of the year, and where carp have been identified by local landowners (Greg Aamodt, pers. comm.). Secondly, Reitz Lake is near the border of two ecoregions (NCHF and Western Corn Belt Plains; WCBP), where the total phosphorus standard would shift from 40 µg/L to 65 µg/L, and the land use/cover of the Reitz Lake watershed is very similar to the land use/cover on the WCBP side of the border. Based on these factors, the interim phosphorus goal will be set at the WCBP deep lake standard of 65 µg/L; however, by utilizing the principles of adaptive management, the final goal will be to meet the NCHF standard of 40 µg/L.

2.2 PRE-EUROPEAN SETTLEMENT CONDITIONS

Another consideration when evaluating nutrient loads to lakes is the natural background load. Ultimately, the background load represents the load the lake would be expected to receive under natural, undisturbed conditions. This load can be determined using ecoregion pre-European settlement nutrient concentrations as determined by diatom fossil reconstruction. Diatom-inferred total phosphorus concentrations are presented in Table 2.3 for both the NCHF and WCBP ecoregions.

Table 2.3. Pre-European settlement total phosphorus concentrations based on water quality reconstructions from fossil diatoms (MPCA 2002).

	Ecoregions			
	North Central Hardwood Forest		Western Corn Belt Plains	
Parameters	Shallow (75th percentile)	Deep (75th percentile)	Shallow (75th percentile)	Deep (75th percentile)
Total Phosphorus Concentration (µg/L)	47	26	89	56

Based on the diatom fossils, pre-European settlement concentrations were approximately 26 µg/L for deep lakes in the NCHF ecoregion. Presumably, these approximate the undisturbed or best conditions for Reitz Lake. The predicted pre-settlement phosphorus concentrations were used to determine the background or natural load for Reitz Lake.

Another benchmark that may be useful in determining goals and load reductions for Reitz Lake are expected stream concentrations under natural or undisturbed conditions. Table 2.4 provides data from minimally-impacted streams in the NCHF ecoregion.

Table 2.4. Interquartile range of summer mean concentrations by ecoregion for minimally impacted Minnesota streams in the North Central Hardwood Forest Ecoregion (McCollor and Heiskary 1993).

	Total Phosphorus (µg/L)		
Ecoregion	25th percentile	50th percentile	75th percentile
NCHF	70	100	170

As we explore load-reduction scenarios, these benchmarks can be used to assess what constitutes reasonable concentrations for streams within the watershed. This data collected from minimally-impacted streams serves as one source for comparison.

2.3 QUALITATIVE LAKE CONDITIONS

Aside from the numerical water quality goals, other factors must be considered when determining end points or desired conditions for Reitz Lake. Based on morphological and ecological characteristics of the lake, management strategies will include tactics that will aid in restoring the littoral portions of the lake to a largely native aquatic plant (macrophyte) dominated state, and shift from the current algal-dominated state in the deeper-water area of the lake. This type of lake is characterized by low rough fish populations, clearer water, higher wildlife values and positive feedback mechanisms that maintain the lake in this condition (Scheffer 1998).

Another goal is to improve public perception of the recreational suitability of Reitz Lake. A public survey was conducted to assess public perception of the recreational suitability of Reitz Lake. The results of the survey will be used during implementation to identify goals appropriate for increasing the public perception of recreational suitability. (See Appendix D for survey results.)

3.0 Watershed and Lake Characterization

3.1 LAKE MORPHOMETRY

Reitz Lake is a 90-acre lake east of the town of Waconia in Carver County, Minnesota within the Minnesota River Basin (Figure 3.1). Table 3.1 summarizes the lake morphometry and Figure 3.7 shows the basic bathymetry of Reitz Lake. The lake is relatively shallow with a 15 acre western bay that has a maximum depth of 5 feet, and a 75-acre eastern section of the lake with a maximum depth of 36 feet. The lake has an Osgood Index of 6, indicating the potential for strong stratification. The Osgood Index ranges from 0-14; zero represents the most extreme mixing.

Table 3.1. Reitz Lake morphometric characteristics.

Parameter	Reitz Lake
Lake Surface Area (ac)	90
Average Depth (ft)	13
Maximum Depth (ft)	36
Lake Volume (ac-ft)	1,167
Residence Time (years)	0.3-0.5
Littoral Area (ac)	51
Direct Watershed (excluding lake) (ac)	3,531
Lake:Watershed area	1:39

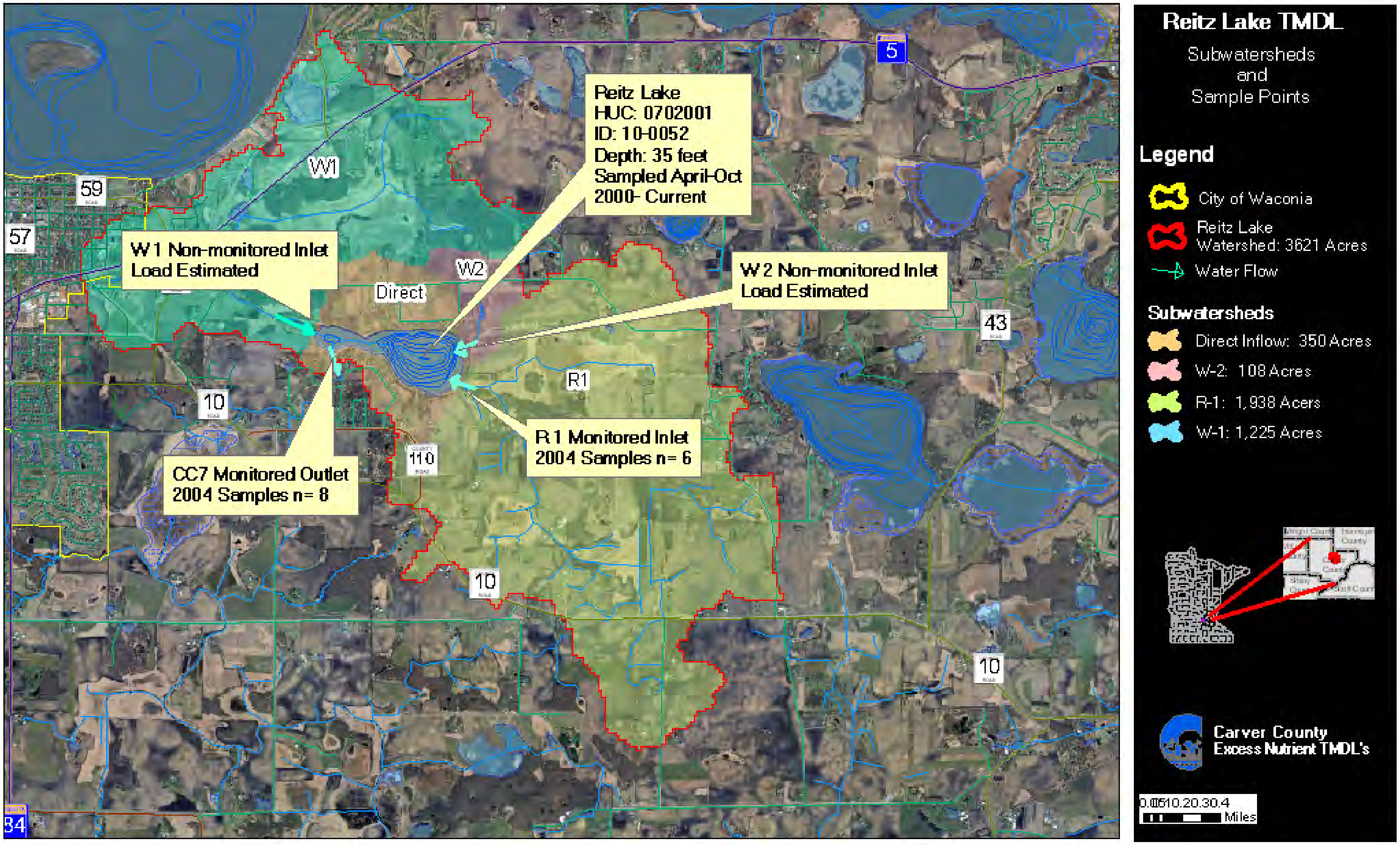


Figure 3.1 Reitz Lake modeled subwatersheds and lake morphometry. Blue arrows indicate subwatershed flow direction into Reitz Lake (see legend for subwatershed name).

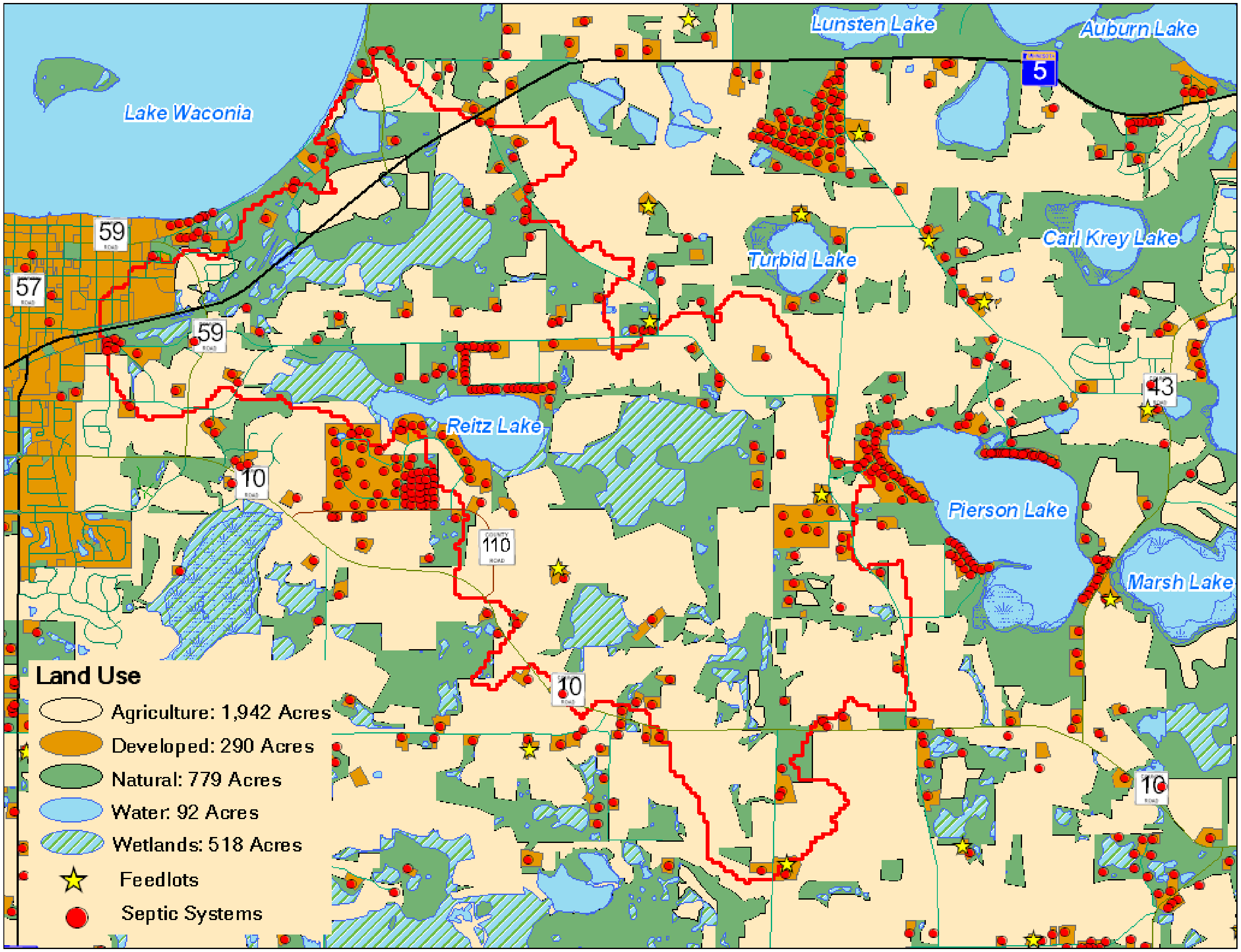


Figure 3.2 2000 land use within the Reitz Lake watershed. Comprehensive Plans indicate that there will be increasing conversions of agricultural land to residential development.

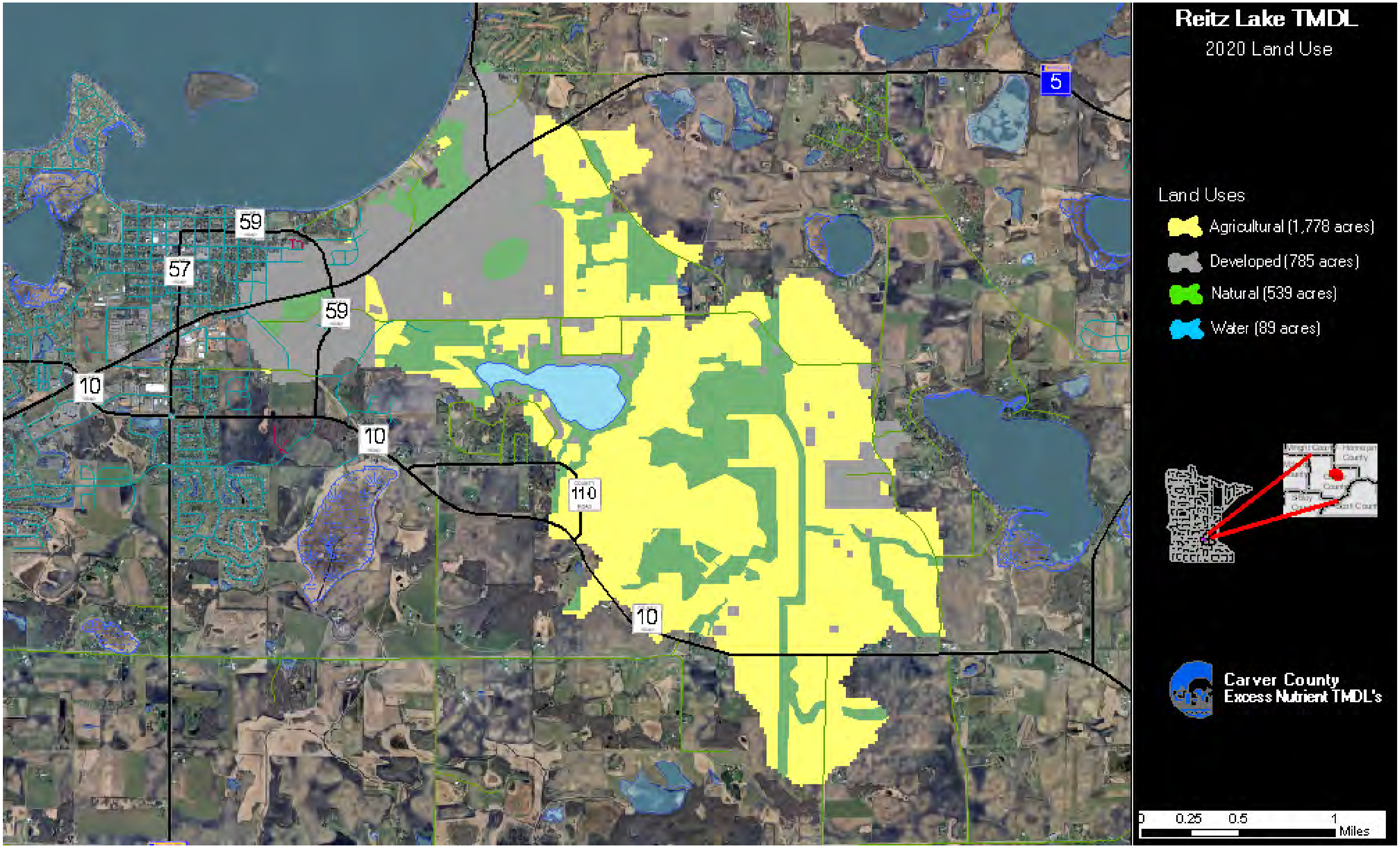


Figure 3.3. 2020 land use within the Reitz Lake watershed.

3.2 WATERSHED DESCRIPTION

3.2.1 Land Use

Land use in the watershed is primarily tilled agriculture with increasing conversions to residential developments (Figures 3.2 and 3.3; Table 3.2). 2.3 percent of the Reitz Lake drainage area contains the rapidly growing City of Waconia. Of roughly 445 buildings currently in the watershed, approximately 93 of these have individual septic systems. The remaining buildings are connected to the Metropolitan Council Environmental Services 201 sewer system. Twenty homesteads are within 300 feet of Reitz Lake, and four feedlots exist in the watershed, with approximately 118 animal units (per 2000 feedlot inventory).

Table 3.2. Current land use in the Reitz Lake watershed.

	2000	
Land use	Acres	Percent
Agriculture	1,942	54%
Forest/Grassland	781	22%
Wetland	518	14%
Water (Including lake)	90	3%
Developed	290	7%
TOTAL	3,621	100%

3.3 RECREATIONAL USES

According to a survey distributed to landowners in the Reitz Lake watershed, the lake is utilized most often by fisherman. Although many of the fishermen are lakeshore owners, during field studies Carver County staff did run into several fishermen who had traveled from outside the watershed. There is a Minnesota DNR public boat landing located on the north side of the lake. Fishing traffic is indicated to be light (1-5 boats/day) on the weekdays and moderate (>10 boats/day) during the weekends.

Non-fishing water recreation on Reitz Lake generally includes activities such as swimming, waterskiing and wildlife observation. Since there is no public swimming beach, it is projected that the majority of lake users conducting these activities live on the lake. According to the lake survey, the average perception of the water quality during the summer months (June - August) is that Reitz Lake does not support recreational uses such as swimming. Swimming is expected to increase greatly when water quality is improved.

3.4 FISHERIES

Historical and present Minnesota DNR fisheries surveys conducted on Reitz Lake provide insight into the lake’s fish community. Reitz Lake is a DNR class 30 lake. Lake classes range from 1 to 44. As lake class numbers increase, lake maximum depth and Secchi depth decrease while littoral percent and alkalinity increases. In other words, lakes with a high classification are generally shallow, productive, and turbid compared to lakes in NE Minnesota (i.e., lake class of 3) which are deep, clear, and unproductive (T.J.

Debates, Minnesota DNR, pers. comm.). Trap nets and gill nets were employed to sample the fish population in the lake in 1998 and 2004. The survey conducted in June 1998, showed that panfish, especially bluegill and black crappie, along with yellow perch, dominated the fish community in both abundance and biomass (Figures 3.3 and 3.4). Northern pike and largemouth bass were sampled within the normal range for lakes of this class, but made up a small percentage of the abundance and biomass in Reitz Lake. Black and yellow bullheads were also captured, with black bullheads being five times more abundant than yellow bullheads. Black bullheads are commonly associated with more turbid waters. Low numbers of carp were captured.

The data from the survey conducted in June 2004 demonstrates a fish community quite different from that of the 1998 survey. The 2004 lake survey was conducted during high water conditions. Abundance of both bluegill and black crappie decreased dramatically in the trap nets, possibly a result of the high water affecting the effectiveness of the trap nets at capturing these species. Yellow perch numbers decreased from the 1998 survey, but were still found in good number.

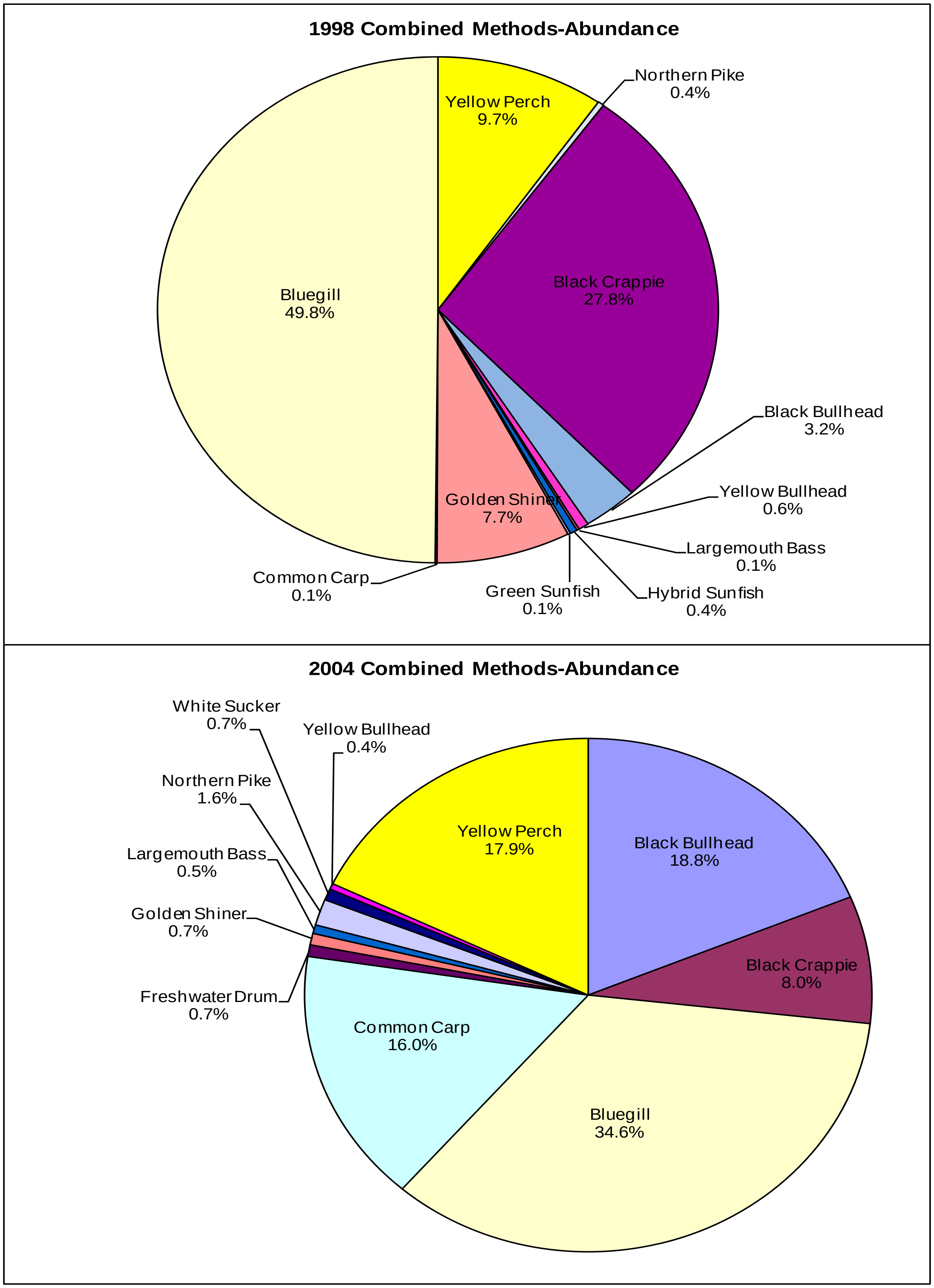
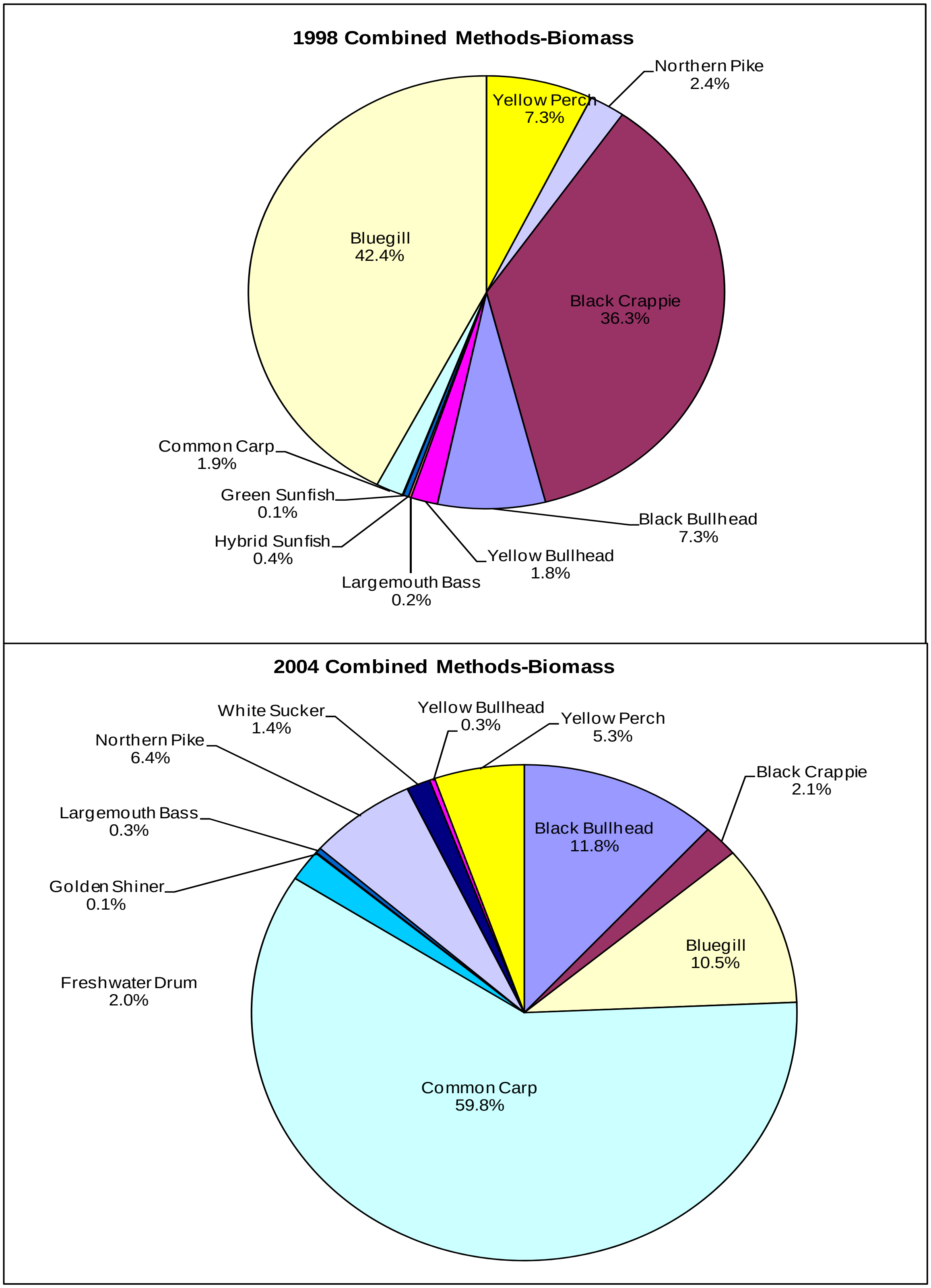


Figure 3.4. 1998 and 2004 fish survey results for total fish biomass in Reitz Lake via trap nets and gill nets.



1998 Combined Methods-Biomass

2004 Combined Methods-Biomass

Figure 3.5. 1998 and 2004 fish survey results for total fish abundance in Reitz Lake via trap nets and gill nets.

While northern pike and largemouth bass again made up a small portion of the population and biomass, rough fish such as black bullhead, yellow bullhead, and carp made up a larger portion of the fish community than in 1998.

In the 2004 survey, carp were nearly thirty times more abundant in the nets, and made up the majority of the biomass of the sampled fish. As in the 1998 survey, black bullheads were more abundant than yellow bullheads. The increase in carp is likely due to a migration from lakes and wetlands downstream of Reitz Lake, made possible by high water during years of above-average precipitation in the watershed. It is very likely that these fish migrated into Reitz Lake because the fish captured in the survey were large sized, and carp do not reproduce well in the lake due to heavy predation on carp eggs by the large panfish population (Daryl Ellison, Minnesota DNR, pers. comm.). Recent reports from residents of the lake about increased carp numbers are also evidence of an increase in the carp population. The carp influx into Reitz Lake during high-precipitation years may contribute to degraded water quality. Fluctuations in water quality during high precipitation years, partially attributed to carp, can be seen in Figure 3.6.

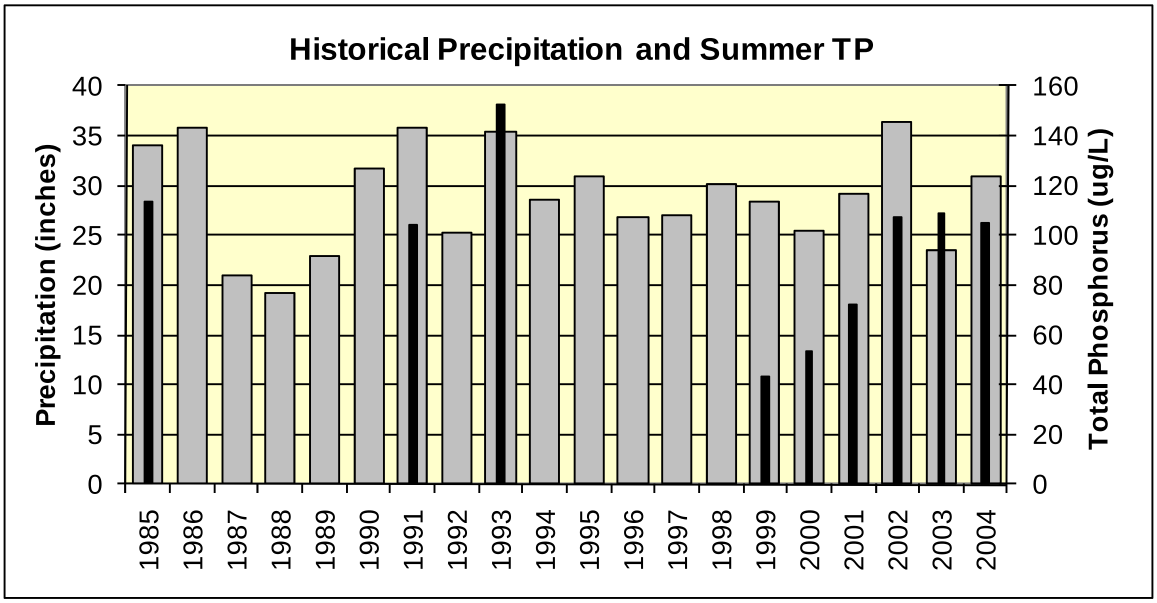


Figure 3.6. Summer growing season (June 1- September 30) in lake total phosphorus and annual precipitation for Reitz Lake. The small black bars are summer average total phosphorus.

3.5 AQUATIC PLANTS

3.5.1 Introduction

Native aquatic plants are beneficial to lake ecosystems, provide spawning opportunities and cover for fish, habitat for macroinvertebrates, refuge for prey, habitat for epiphytic algae, and the plants stabilize sediments. However, in excess, curlyleaf pondweed and Eurasian water milfoil limit recreation activities such as boating and swimming, as well as aesthetic appreciation. Because macrophytes utilize nutrients from the sediments, excess nutrients in lakes can lead to native aquatic plants and exotics (non-native invasive plants) taking over a lake. Some exotics can lead to special problems in lakes. For example, Eurasian water milfoil can reduce plant biodiversity in a lake because it grows in great densities, and squeezes all the other plants out. Ultimately, this can lead to a shift in the fish community because these high densities favor panfish over larger game fish. Species such as pondweed can cause very specific problems by changing the dynamics of internal phosphorus loading. All in all, there is a delicate balance between the aquatic plant communities in any lake ecosystem.

3.5.2 Littoral Zone

The littoral zone is defined as that portion of the lake that is less than 15 feet in depth, and it is where the majority of the aquatic plants are found. The littoral zone of the lake also provides the essential spawning habitat for most warm water fishes (e.g. bass, walleye, and panfish). Reitz Lake is approximately 57 percent littoral, with a large western bay that is less than 5 feet deep. Reitz Lake should support a healthy aquatic plant community, especially in the western bay.

3.5.3 Aquatic Plants

Carver County staff conducted simplified spring and fall macrophyte surveys on May 19 and September 21, 2005. Twenty-five sample points were inspected with macrophyte type, depth and abundance recorded (Figure 3.6). The spring survey documents a total of four submergent species flourishing in up to eight feet of water; narrow leaf pondweed, sago pondweed, yellow water lily, and curlyleaf pondweed. Of the four species, curlyleaf was documented to be dominant. In addition, cattail and bulrush were found at the lake shore. The fall survey illustrated similar findings. Although the life cycle for curlyleaf pondweed had been completed, few live plants remained. Other species present during the fall survey included Eurasian water milfoil, found at one sample point on the northeast shore of the lake, and white water lily *(Nymphaea spp*.).

The most diverse plant life was found on the northeast corner of the lake where the water typically has greater clarity, and there is less shoreline disturbance than the south and east portions of the lake. The shallow western bay, however, contained little to no aquatic plants. This bay has a maximum depth of five feet and is very turbid. At the time of the survey, large carp were seen in the bay.

According to a survey distributed to landowners in the Reitz Lake watershed, 81 percent of users responding indicated that lake use is interfered with by aquatic plants. It was indicated that 84 percent of these people use some form of aquatic plant control. Sixty percent of plant control is accomplished by manual pulling, and there are equal amounts of chemical and automatic plant control. Excessive/inappropriate use of aquatic plant control may interfere with native aquatic plant establishment.

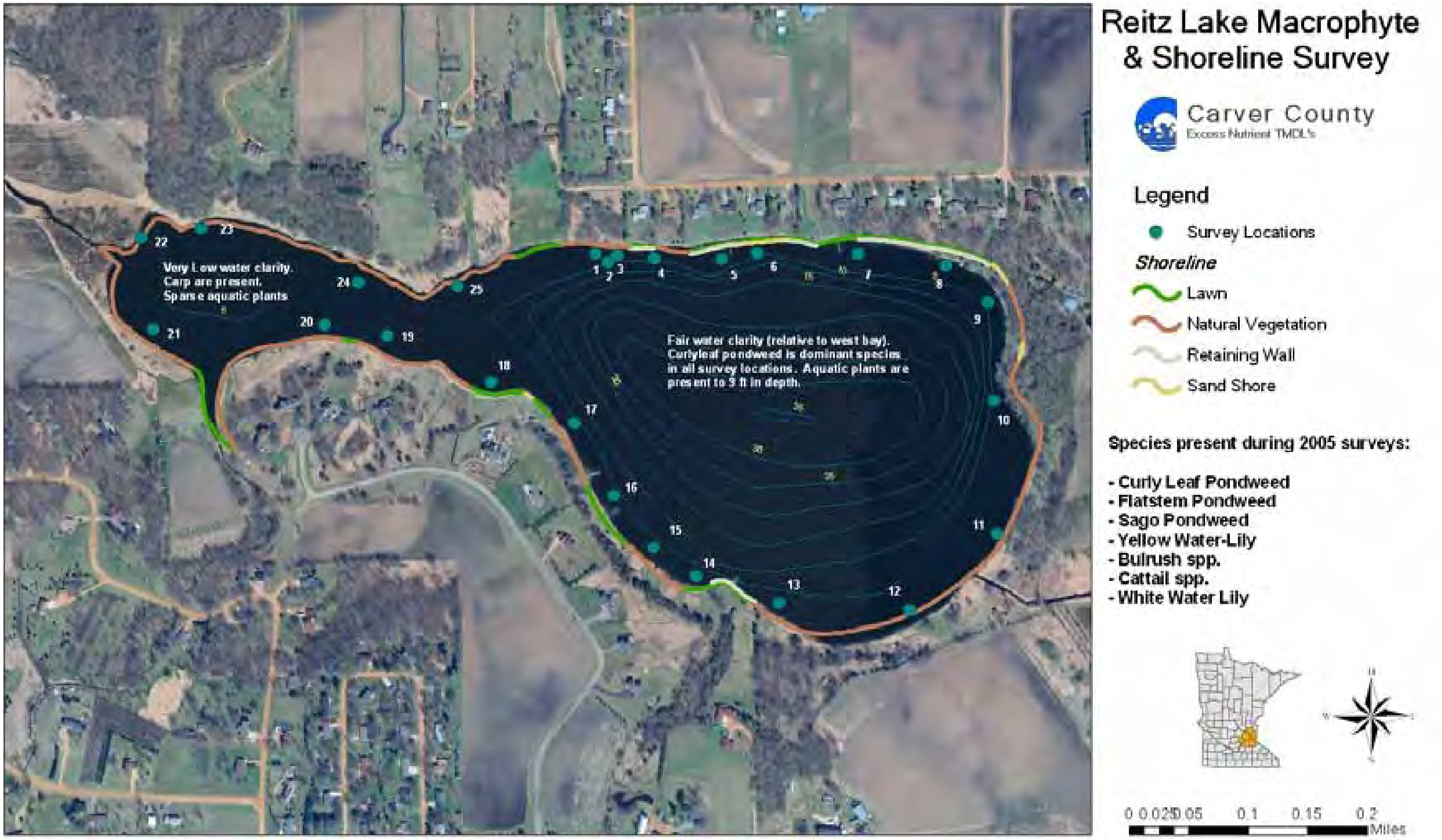


Figure 3.7. 2005 aquatic plant and shoreline survey locations and results.

3.5.4 Curlyleaf Pondweed (*Potamogeton crispus*)

Curlyleaf pondweed is an exotic, like Eurasian water milfoil, that can easily take over a lake's aquatic macrophyte community. Curlyleaf pondweed presents a unique problem in that it is believed to significantly affect the in-lake release of phosphorus, contributing to the eutrophication problem. Curlyleaf pondweed grows under the ice, but dies back relatively early (late June-early July), releasing nutrients to the water column in summer, and possibly leading to algal blooms. Curlyleaf pondweed can also out-compete more desirable native plant species.

3.6 SHORELINE HABITAT AND CONDITIONS

The shoreline areas are defined as the areas adjacent to the lakes edge with hydrophytic vegetation and water up to 1.5 feet deep or a water table within 1.5 feet from the surface. Natural shorelines provide water quality treatment, wildlife habitat, and increased biodiversity of plants and aquatic organisms. Natural shoreline areas also provide important habitat to fisheries including spawning areas and refuge, as well as aesthetic values.

Carver County staff conducted a shoreline survey in June 2005 by utilizing a Trimble GPS unit and an ArcPad program. Staff circumnavigated the shoreline, mapped and recorded shoreline type such as natural vegetation, sand beach, mowed to shoreline, and retaining wall (Figure 3.6). Although the majority of shoreline is considered "natural" (69 percent), much of the shoreline that is mowed or sand beach also contains retaining walls. This vision magnifies the importance of natural shorelines or buffers to stabilize the shoreline.

Vegetated shorelines provide numerous benefits to both lakeshore owners and lake users including improved water quality, increased biodiversity, important habitat for both aquatic and terrestrial animals, and stabilizing erosion resulting in reduced maintenance of the shoreline. Identifying projects where natural shoreline habits can be restored or protected will enhance the overall lake ecosystem.

3.7 WATER QUALITY

3.7.1 Data Sources and Methodology

Carver County Environmental Services Carver County and its Water Plan act to coordinate monitoring of County lakes and streams. Monitoring of lakes follows the Water Plan management goal of creating and maintaining a comprehensive, accurate assessment of surface and ground water quality trends over the long term. In order to establish baseline water quality, Carver County set up a network of sampling sites in the 1990s.

In accordance with the County Water Plan, watersheds were given a priority (high, medium, low) based on funding available, need for monitoring data, current water quality conditions, current land use and staff availability. Carver Creek and Reitz Lake have been given a high priority in the current Water Plan. In addition, Carver County promotes volunteer monitoring efforts in an attempt to broaden the public's awareness and expand our monitoring network. Carver County staff and volunteers follow the monitoring techniques set up by the Metropolitan Council Environmental Services (MCES) for the Citizens Assisted Monitoring Program (CAMP). This program includes bi-weekly samples that are analyzed for total phosphorus, chlorophyll-a, and total Kjeldahl nitrogen, in addition to a Secchi depth measurement and a user perception survey. Monitoring takes place from April to October of each year.

Reitz Lake has also been monitored by the MPCA Citizen Lake Monitoring Program (CLMP). The CLMP is similar to the Metropolitan Council's CAMP program in that it employs the help of citizen volunteers who live on or near the lake to take measurements. The CLMP program has been in existence since 1973. All records and observations are sent to the MPCA, and entered into the U.S. Environmental Protection Agency's STORET data base.

3.7.2 TMDL Tributary Monitoring

Water quality and hydrology for this TMDL was monitored during the TMDL-funded study in 2004 at the primary inlet and outlet to Reitz Lake (R1& CC7; Figure 3.1). Water quality was monitored with a handheld electronic meter in the field, and with chemical analyses of each grab sample performed by the Metropolitan Council Laboratory in St. Paul, MN. Samples were analyzed for total phosphorus, total suspended solids, nitrate + nitrite, total ammonia nitrogen, volatile suspended solids, turbidity, dissolved phosphorus, alkalinity and chemical oxygen demand. A total of eight samples during a range of flow conditions were targeted for the 2004 sampling season. Due to the low flow at the inlet (R1), six of the possible eight samples were collected when the site had a recordable discharge. The site demonstrated minimal flow regardless of precipitation, most likely because of the large wetland complex immediately preceding the inlet. Monitoring at the outlet mirrored inlet sampling. Flow was monitored during the water quality sampling events, utilizing a handheld SonTec FlowTracker. The results of tributary monitoring in 2004 are integrated into our computer modeling exercises. Lab data and field data are summarized in Appendix B.1 for both R1 and CC7.

Total suspended solids and the associated volatile suspended solids can be used in analysis as another measurement of potential phosphorus entering the lake. Phosphorus usually binds with sediments and is carried within streams and ditches to a water body.

Reitz Lake was divided into four separate subwatersheds for more accurate model inputs to the lake (Table 3.3). Through both monitoring and use of the Reckhow-Simpson model, loading inputs for the Bathtub model were calculated (Table 5.5).

Table 3.3. Reitz Lake Subwatershed Acreage

	W1	W2	R1	Direct	Total
Developed	95	16	109	70	290
Forest/Grassland	426	15	376	55	872
Water	0	0	0	0	0
Agriculture	504	76	1242	120	1942
Wetland	200	1	211	13	425
Total	1225	108	1938	258	3529

3.7.3 Temperature and Dissolved Oxygen

Temperature and dissolved oxygen plots are presented in Figures 3.8 and 3.9. Reitz Lake demonstrated stratified conditions over the summer growing season with anoxic sediments. These results are similar with previous years suggesting that the lake is dimictic, or mixes twice a year in the spring and fall (2002 isopleths Appendix A). The thermocline was established around 15 feet in depth and began to deepen in early August, with near total mixing occurring in late August.

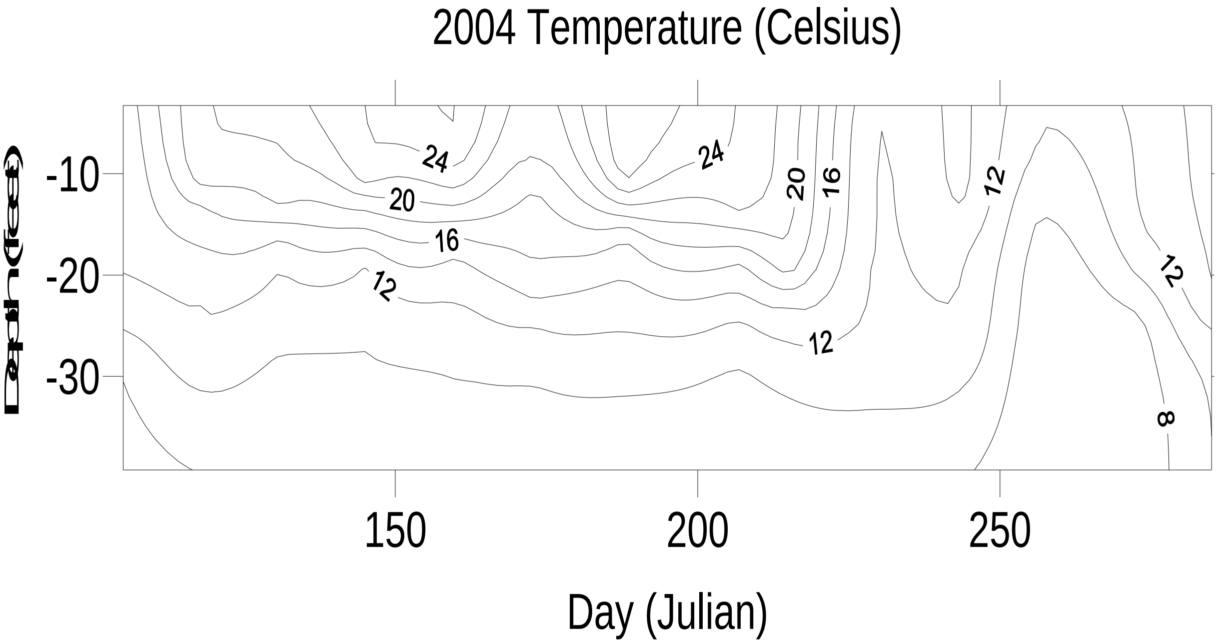


Figure 3.8. Temperature contour plot for Reitz Lake (10-0052) in 2004.

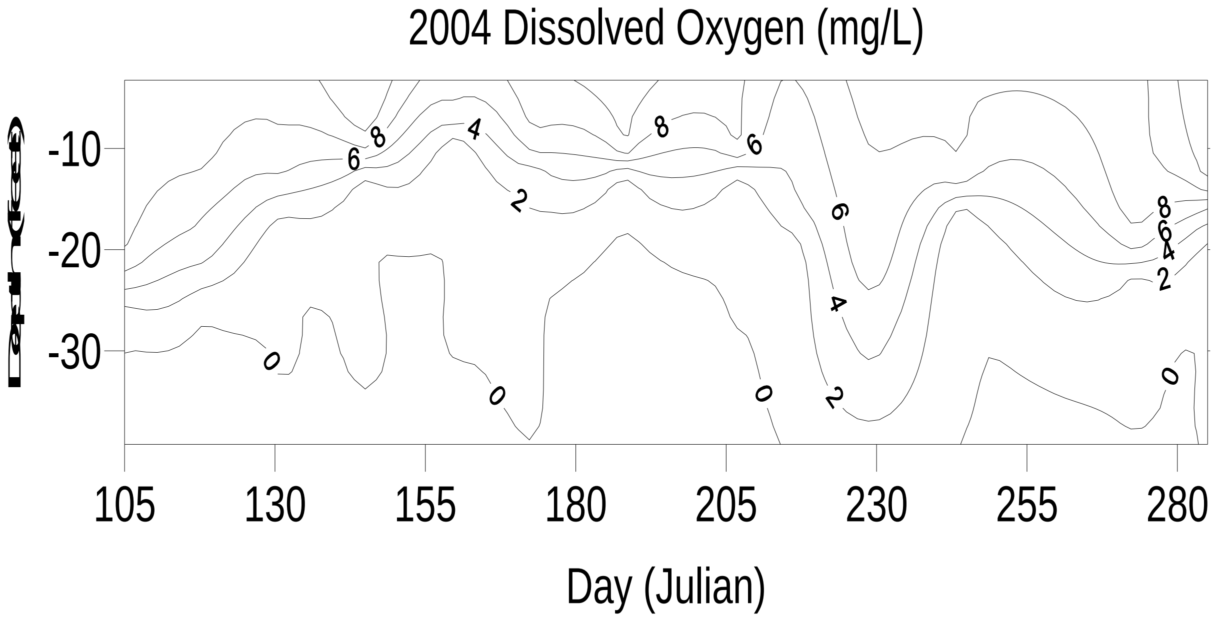


Figure 3.9. Dissolved oxygen contour plot for Reitz Lake (10-0052) in 2004.

3.7.4 Phosphorus, Chlorophyll-a, and Secchi Depth

Phosphorus was measured to determine the availability of nutrients for algal and aquatic plant production. Total phosphorus is a measure of all the phosphorus in the water, while orthophosphorus measures the most readily available form of phosphorus to grow plants and algae. The 2004 total phosphorus concentrations in Reitz Lake ranged from 76 to164 µg/L with a growing season average of 105 µg/L. Figure 3.12 graphs both precipitation and total phosphorous. Ortho and total phosphorous are represented in Figures 3.13 and 3.14, respectively.

Chlorophyll-a is a good estimator of algal biomass. In addition, Secchi depth aids in the prediction of algal production by measuring the clarity of lake water. Chlorophyll-a concentrations remain fairly low throughout early summer, and increase beginning in August. Chlorophyll-a concentrations generally track with changes in total phosphorus concentrations, and Secchi depth generally corresponds with chlorophyll-a concentrations. All readings remained greater than 1 meter prior to the increase in chlorophyll-a in August. The results suggest that algal growth responds to inputs of phosphorus, which is seen late in the summer when the phosphorus rich water in the hypolimnion is mixed with the epilimnion. Figure 3.11 graphically displays the 2004 in-lake lab results for Reitz Lake.

3.7.4.1 Historical

Historic data for Reitz Lake suggests that the water quality has been variable over the years (Table 3.4) with very poor conditions in some years (1993 TP=152 μg/L) and quite average conditions in others (1999 TP=43 μg/L) (Figure 3.10). Based upon the Met Council Water Quality Report Card summary for TP, for 1999 results would receive a C grade and for 1993 the grade would be an F (Osgood 1989). There are several factors that control these changes in water quality conditions. First, precipitation levels influence total phosphorus levels in Reitz Lake.

The best water quality was recorded from 1999-2001 when precipitation levels were below or close to average (Figure 3.10). In contrast, 2002 experienced above-average rainfall and an increase in total phosphorus. These trends are indicators of external loading caused by runoff of nutrients from the watershed. Another factor influencing water quality may have to do with changes in carp populations. Carp are thought to reproduce poorly in Reitz Lake, and are believed to migrate in during flood conditions (pers. comm. Daryl Ellison DNR Fisheries). Since carp do not reproduce well in the lake, they may migrate into surrounding lakes during high water, and then be unable to get back into the lake due to low water levels. Finally, the infestation of curlyleaf pondweed influences pulses in total phosphorus. Although it is unclear as to the timing of curlyleaf pondweed infestation, it currently inhabits Reitz Lake. Although total phosphorus levels have fluctuated over the years, Secchi depth has remained fairly consistent at depths greater than one meter. Total Kjeldahl nitrogen values have remained fairly consistent, however, the majority of samples are above 2000 μg/L, the threshold which marks a negative response in water quality (MPCA 2005).

Table 3.4. Growing season (June 1 –September 30) mean lake water quality for Reitz Lake and number of samples collected (n) (data obtained from the MPCA website).

Year (n)	Total Phosphorus Concentration (μg/L	Chlorophyll-a Concentration (μg/L)	Secchi disk transparency (meters)	Total Kjeldahl Nitrogen (mg/L)
1985 (4)	114	NA	0.9	2.1
1991(9)	104	46	1.1	2.2
1993 (10)	152	NA	1.1	2.2
1999 (10)	43	20	1.2	1.7
2000 (11)	54	35	1.1	1.7
2001 (6)	72	40	0.7	2.1
2002 (9)	107	40	1.4	2.1
2003 (10)	109	65	2.2	2.0
2004 (9)	105	44	1.0	2.1

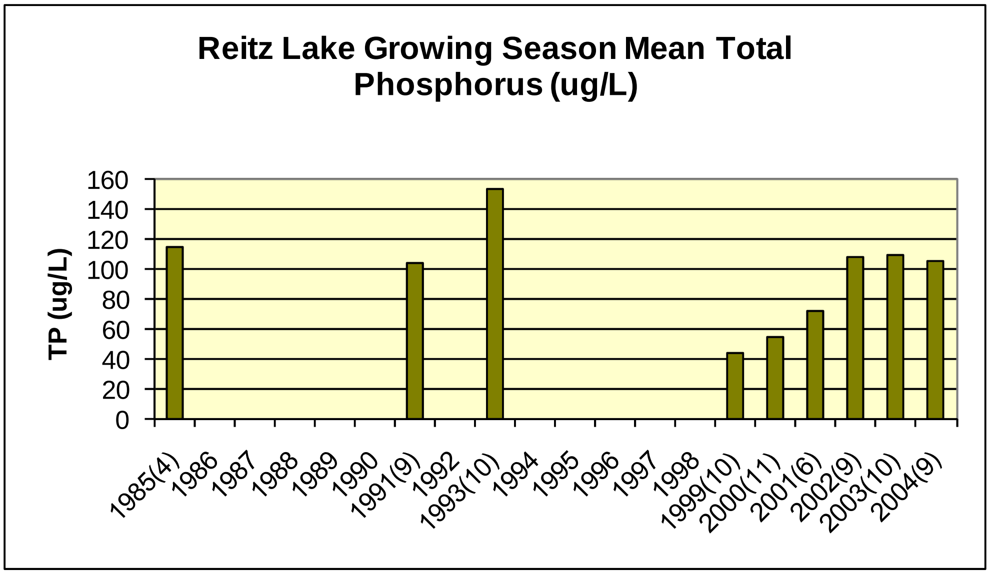


Figure 3.10. Growing season mean total phosphorus concentrations for Reitz Lake.

3.7.4.2 Current Water Quality

Current water quality conditions demonstrate a highly eutrophic, dimictic lake. Summer total phosphorus concentrations increased significantly between the mid- and late-June samples (Figure 3.11). This increase is attributed to curlyleaf pondweed senescence that typically occurs in late June or early July, and is often followed by a phosphorus pulse. The pulse was also compared to daily precipitation to identify a potential runoff event that may have caused the pulse of total phosphorus (Figure 3.12). Two significant rain events each over one inch occurred in early June. Staff was able to collect one grab sample from the first storm which had inlet and outlet TP concentrations of 292 µg/L and 126 µg/L, respectively. Although the lake does not typically respond to rain events with a pulse in total phosphorus, this pulse likely was tied to the rain event due to the limited extent of crop cover present in June. With limited vegetation, infiltration is reduced and surface soil (which is high in nutrients from applied chemical fertilizer or manure) is prone to overland erosion. Nutrients dissolved in the runoff or bound to soil particles in the runoff can be transported from the fields to the lake. Therefore, the midseason increase in total phosphorus is attributed to both curlyleaf pondweed senescence and the large precipitation event.

Figure 3.11 summarizes lab results for the 2004 sampling season. Secchi disk results ranged from 0.5 m on August 17th, 2004 to 5.5 m on May 11th, 2004. Typical TP results ranged from 76 µg/L to 164 µg/L. Chlorophyll-a ranged from 1.9 µg/L on May 11th, 2004 to 98 µg/L on April 15th, 2004.

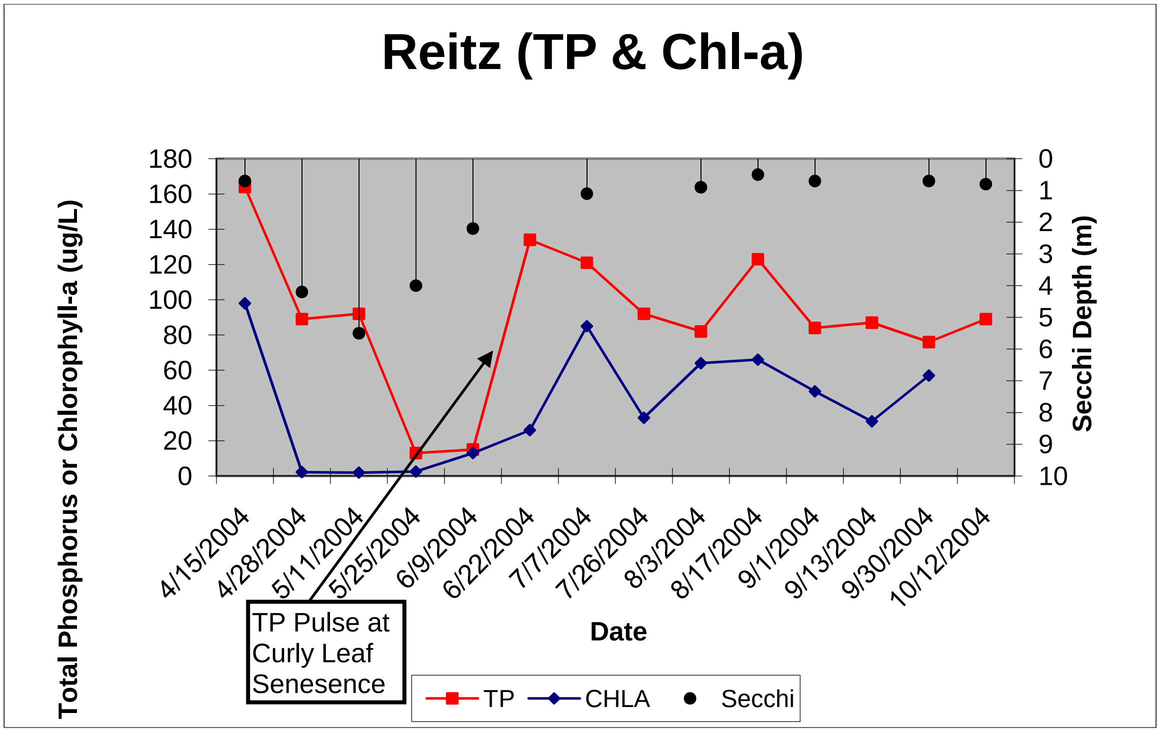


Figure 3.11. Total phosphorus, chlorophyll-a, and Secchi depth - 2004 monitoring season. The midsummer pulse of phosphorus may be attributed to curlyleaf pondweed senescence and precipitation event.

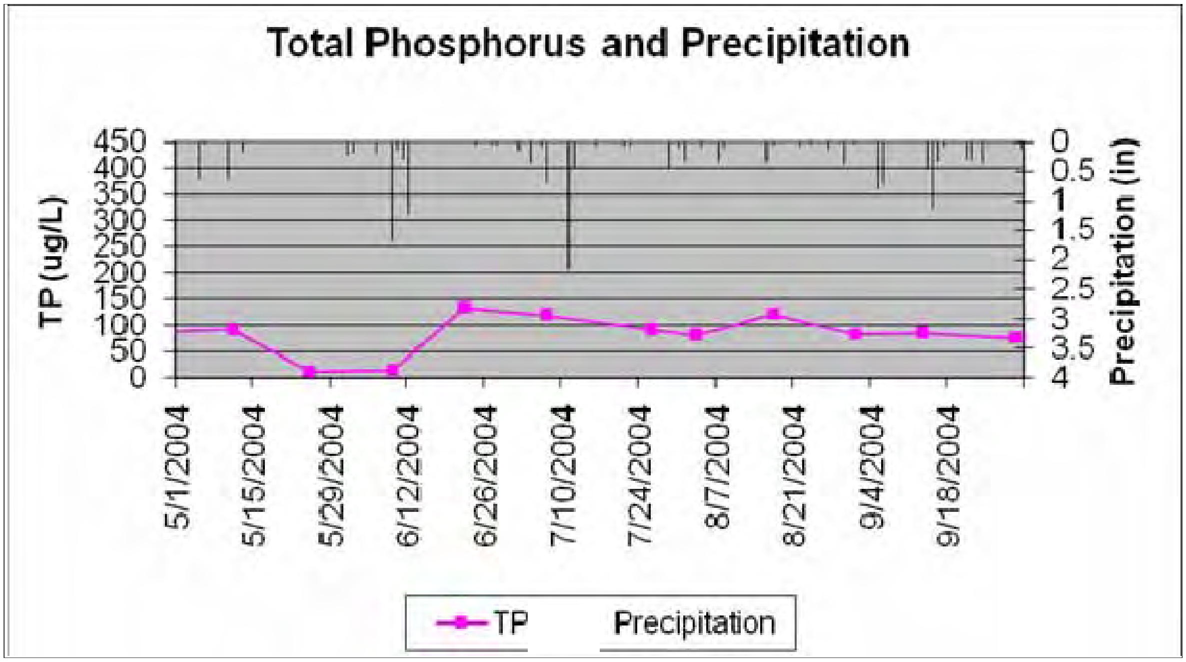


Figure 3.12. Reitz Lake total phosphorus and daily precipitation (Chanhassen) – 2004 summer growing season.

Surface, middle, and bottom phosphorus samples were also collected from the deep portion of Reitz Lake (Figures 3.13 and 3.14). Reitz Lake remains stratified throughout the summer resulting in an anoxic hypolimnion. Under these conditions, lake sediments can release phosphorus. Data collected demonstrate the buildup of phosphorus during the stratified period. This phosphorus may become available for phytoplankton production by diffusing across the thermocline, and ultimately becoming an important phosphorus source for the lake.

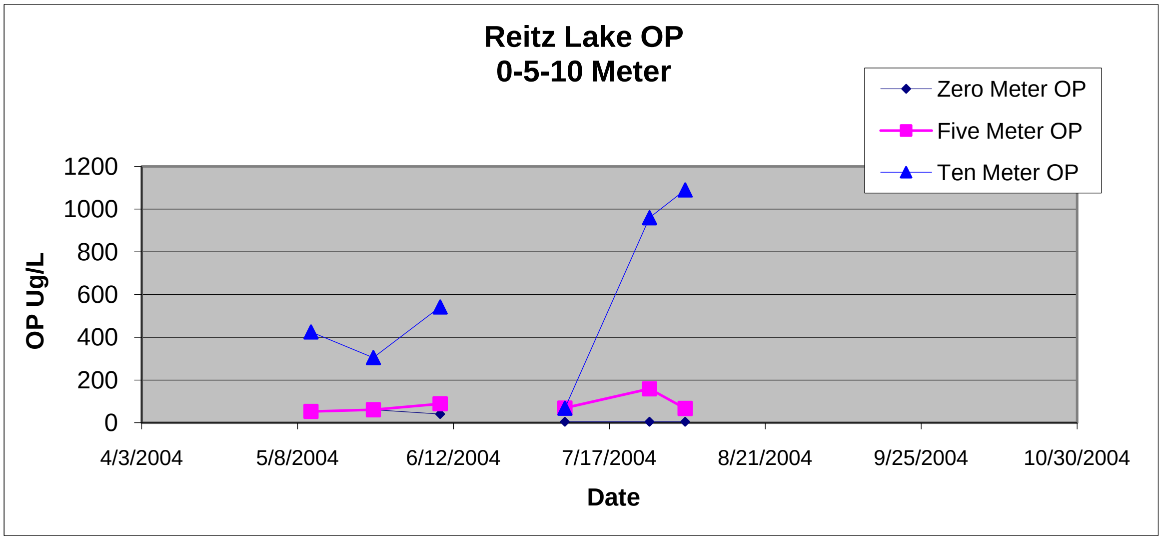


Figure 3.13. Surface, middle and bottom ortho-phosphorus – 2004 summer growing season.

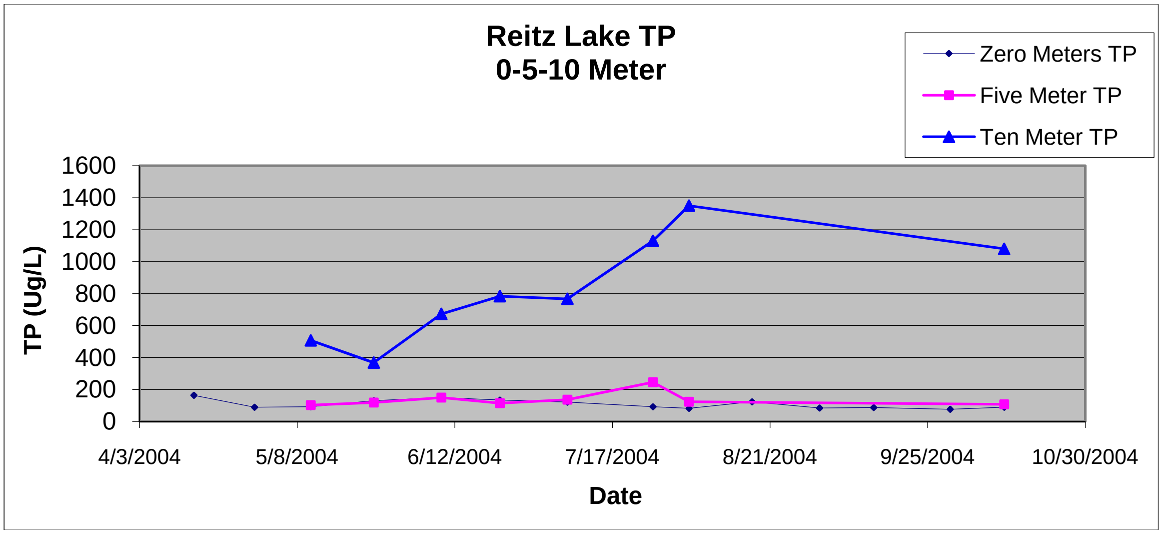


Figure 3.14. Surface, middle and bottom total phosphorus – 2004 summer growing season.

3.7.5 Summary

Water quality in Reitz Lake has historically demonstrated conditions ranging from mesotrophic to hypereutrophic conditions. Data results from 2004 supports the hypothesis that years of neglect has lead to increased internal loading and poor water quality. Bathtub modeling, Reckhow-Simpson modeling, and Canfield-Bachman modeling, inlet and outlet monitoring, as well as in-lake monitoring all support this hypothesis. The factors affecting this range of water quality is not clear, but evidence suggests that both internal and external loads are affecting in-lake water quality. Internal loads may be controlled by the presence of curlyleaf pondweed, carp, or anoxic sediments during stratified periods.

4.0 Nutrient Source Assessment

4.1 INTRODUCTION

Understanding the sources of nutrients to a lake is a key component in developing a TMDL for lake nutrients. In this section, we provide a brief description of the potential sources of phosphorus to the lake.

4.1.1 Septic Systems

There are approximately 93 Subsurface Sewage Treatment Systems (SSTS) in the watershed which can be an important source of phosphorus to surface/ground waters. Based on compliance reports submitted to Carver County, there is an average of 45 to 65 percent failure rate of SSTSs for the entire county (Carver County 2005). Failing or poorly operating septic systems, particularly within 100 feet of the lake, may be a phosphorus source to Reitz Lake.

4.1.2 Urban/Development Runoff

Phosphorus transported by stormwater represents one of the largest contributors of phosphorus to lakes in Minnesota. Transport of urban runoff to local water bodies is quite efficient as a result of local storm sewer systems. As a result of this efficiency, other materials are transported to the water bodies including grass clippings, fertilizers, crop land erosion and runoff, leaves, car wash wastewater, and animal manure. All of these materials contain phosphorus which can impair local water quality. Some of the material may add to increased internal loading through the breakdown of organics and subsequent release from the sediments. Additionally, the input of organic material increases the sediment oxygen demand, further exacerbating the duration and intensity of phosphorus release from lake sediments. Consequently, stormwater is an important water quality source in urban and urbanizing watersheds. Since large portions of the Reitz Lake watershed are expected to develop in the next 25 years, stormwater will be an important source of phosphorus to control. The current structure of the urban/developed areas that drain to Reitz Lake have limited stormwater treatment. Note: As of January 1, 2005, all fertilizers containing phosphorus were banned from use on lawns in Minnesota. The only exceptions to this ruling are when establishing new lawns or when soil test results show the need for phosphorus.

4.1.3 Agricultural Runoff

Agricultural runoff can supply significant phosphorus loads to surface waters by transporting eroded soil particles and excess fertilizers into surface waters. More than 50 percent of the Reitz Lake watershed is agriculture with significant drainage and ditching.

Runoff and erosion from these fields are likely contributing to Reitz Lake phosphorus loads.

4.1.4 Animal Manure

Animal agriculture can affect water quality, especially nutrients. Animal manure, which contains large amounts of both phosphorus and nitrogen, is often applied to agricultural fields as fertilizer. A regional Minnesota study suggests that the applied manure represents a 74 percent greater amount of phosphorus than the University of Minnesota recommended amounts (Mulla et al. 2001). This can average an extra 35 pounds per acre of phosphorus, which will ultimately be available for runoff. It is believed, however, that in more recent years more efficient use of manure is being achieved in Minnesota due to both economic and environmental concerns (Minnesota Corn Growers Association, Devonna Zeug, pers. comm., 2010). In addition, properly applied manure can improve soil's ability to infiltrate water, thus reducing the potential for runoff (MPCA, 2005). Additionally, runoff from some feedlots can transport animal manure to surface waters.

There are four feedlots in the Reitz lake watershed with a total of 118 animal units. Although it is unclear as to what proportion of the phosphorus load animal manure accounts for, it may be a factor contributing to agricultural runoff and so will be further evaluated and, if needed, appropriate BMPs will be recommended within an adaptive management approach.

4.1.5 Atmospheric Deposition

Precipitation contains phosphorus (generally from airborne sources which are outside the watershed) that can ultimately end up in Reitz Lake as a result of direct precipitation on the lake surface, or as a part of stormwater runoff from impervious surfaces in the watershed. Atmospheric inputs are accounted for in the load allocation. During the development of an implementation plan for lake improvement, direct inputs to the lake surface are impossible to control, but runoff from impervious surfaces in the watershed can be dealt with by using BMPs.

4.1.6 Internal Phosphorus Release

Internal phosphorus loading from lake sediments has been demonstrated to be an important aspect of the phosphorus budgets of lakes. However, measuring or estimating internal loads can be difficult, especially in lakes which have a large percent of littoral area. Internal loading can be a result of sediment anoxia where poorly-bound phosphorus is released in a form readily available for phytoplankton production. Internal loading can also result from sediment re-suspension that may result from rough fish activity, wind-driven events, or prop wash from boat activity. Additionally, curlyleaf pondweed can increase internal loading because it senesces and releases phosphorus during the summer growing season (late June to early July). All of these factors affect internal phosphorus cycling in Reitz Lake.

5.0 Linking Water Quality Targets and Sources

5.1 INTRODUCTION

A detailed nutrient budget can be a useful tool for identifying management options and their potential effects on water quality. Additionally, lake response models can be developed to understand how different lake variables respond to changes in nutrient loads. Through this knowledge, managers can make educated decisions about how to allocate restoration dollars and efforts, as well as the resultant effect of such efforts.

5.2 SELECTION OF MODELS AND TOOLS

Modeling was completed in order to translate the target in-lake phosphorus concentration into allocations, loading responses, and final goal reductions of phosphorus loading from the watershed and within the lake. The models used throughout the process included BATHTUB, a Reckhow-Simpson spreadsheet, and a Canfield-Bachman spreadsheet.

The Reckhow-Simpson Model was used for estimating watershed loads for unmonitored subwatersheds. As input to the Reckhow-Simpson Model, land use-based runoff coefficients for the whole Carver Creek watershed were calibrated to outlet flow monitoring (see subsection 5.3.1 below). These runoff coefficients were used to estimate annual runoff volumes from all areas draining to Reitz Lake. The Reckhow-Simpson Model relies on phosphorus export coefficients based on land uses to estimate phosphorus loadings (see subsection 5.3.2). The runoff volumes and phosphorus export coefficients were used to calculate phosphorus concentrations used as input for unmonitored subwatersheds within the BATHTUB model.

For Reitz Lake’s major subwatershed, which was monitored at station R1, the monitoring data were used to calculate a flow-adjusted mean phosphorus concentration, and this was combined with the flow estimate (see again subsection 5.3.1) to estimate the phosphorus load. To derive the TP concentration at R1, a flow-weighted mean concentration (FWMC) was first calculated from the sample data and corresponding gaged flows. Next, the sample TP values and flows were plotted against one another on log-log scales, and the least-squares slope (exponent) was used to correct the FWMC according to the ratio of the annual mean flow to the mean of the sample flows (see Appendix B). This technique is the same as Method 4 in the FLUX model (Walker 1999).

A Canfield-Bachmann spreadsheet was used to model in-lake response and to estimate the total annual phosphorus load necessary to achieve target goals. This spreadsheet considers annual precipitation, lake morphometry and residence time. The model was calibrated utilizing observed water quality data. Using the Canfield-Bachmann equation, historic loads and load reductions were calculated for Reitz Lake.

The Reckhow-Simpson and Canfield-Bachmann Models were selected based upon the sparseness of monitoring data for the watershed. These models give a good prediction of watershed loading and lake response without extensive data requirements, such as needed for other models. The negative for using these models is that it is based upon that limited amount of monitored data.

BATHTUB V6.1 (Walker 1999) was used to model Reitz Lake's water quality under various scenarios. Monitored lake and subwatershed data from 1991 and 2004 was used to calibrate the model. These years had extensive data collection done by Carver County Staff as well as showing the response of the lake to seasonal variation. 1991 precipitation levels indicated that the year was a seasonally "wet" year and 2004 precipitation levels indicated a seasonally "normal" year. The calibrated BATHTUB model allowed us to estimate internal loading and the relative phosphorus contributions from each subwatershed.

5.3 PHOSPHORUS BUDGET COMPONENTS

5.3.1 Watershed Hydrology

Watershed runoff was estimated using runoff coefficients assuming average watershed slopes of less than 2 percent (Ward and Elliott 1995). Runoff coefficients used are presented in Table 5.1.

Table 5.1. Runoff coefficients used to estimate runoff from the Reitz Lake Watershed.

Land Use	Watershed runoff coefficients
Developed	0.27
Natural	0.09
Water	0
Agriculture	0.25
Wetland	0

Runoff coefficients were developed by applying literature values to the entire 52,923 acre Carver Creek watershed, and then adjusting the values to better predict monitored annual runoff volumes. Actual watershed runoff was monitored at Carver Creek site CA 1.7, which is monitored continuously by the Metropolitan Council Environmental Services Watershed Outlet Monitoring Program (WOMP). Predicted and monitored annual runoff volumes are presented in Table 5.2. Monitored runoff was very low in 2000 due to both the low precipitation (25.39 inches) and the timing of precipitation. Most of the precipitation occurred mid-summer at which time vegetation was present and absorbed the majority of rainfall. Most years had a runoff difference of less than 20 percent and were deemed to be reasonable to apply to the Reitz Lake watershed. Runoff coefficients are a key component of both the Reckhow-Simpson and Canfield-Bachmann Models, as noted in previous sections.

Table 5.2. Predicted (runoff coefficient) and monitored annual runoff for the Carver Creek Watershed (52,923 acres).

	1998	1999	2000	2001	2002	2003	2004	2005
Predicted Runoff (ac-ft)	25,109	23,739	21,208	24,316	30,413	19,655	25,061	35,241
Monitored Runoff (Ac-ft)	26,680	23,190	3,772	28,451	38,155	17,489	20,965	28,704
% Difference	-6%	2%	82%	-17%	-25%	11%	20%	19%

5.3.2 Land Use Load

To estimate watershed phosphorus loads, land use loading rates were applied to the watershed land use (Table 5.2 and Table 3.2). Phosphorus export coefficients were selected based on values that best represented conditions in the Reitz Lake watershed, and based on experience from other watersheds in central Minnesota (EPA 1980). Additionally, values were compared to concentrations used in other similar lake studies (MPCA 2005). Reckow-Simpson modeling relied on the total phosphorus loading rates to calculate the total phosphorus concentrations.

Table 5.3. Phosphorus loading rates used to predict watershed runoff concentrations.

	Total Phosphorus Loading Rate (kg/ha)			Total Phosphorus Concentration[1] (µg/L)		
Land Use	Low	Average	High	Low	Average	High
Developed	0.3	0.4	0.6	118	188	283
Forest/Grassland	0.01	0.04	0.08	14	57	113
Agriculture	0.2	0.5	1.3	102	254	661
Wetland	0	0	0	0	0	0

[1] Based on estimated water volumes in 2004.

Using a model that predicts a potential range of phosphorus loading can help to determine potential phosphorus loads in a variety of conditions. Actual phosphorus loading rates likely fall somewhere between the low end and high end of the estimated loading rates. When considering loading rates for the developed areas, it was assumed that no BMPs were in place within the watersheds. Total phosphorus concentrations were used within the BATHTUB models.

5.3.3 Urban/development

Urban and developed land phosphorus loads used in modeling were calculated utilizing the above-described runoff coefficients and loading rates. The selection of the unit-area load (UAL) is extremely important in evaluating the total phosphorus export of the developed land to Reitz Lake. While the average loading rate was used, actual phosphorus export rates likely fall somewhere between the low end and high end of the estimated loading rates. In addition, when considering loading rates for the developed areas, it was assumed that no BMPs were in place within the watersheds. Phosphorus loads are an integral part of the BATHTUB modeling process where monitoring data are sparse.

5.3.4 Septic System Load

Septic system loads were estimated based on the following: 93 SSTSs in the watershed, 2.8 capita per residence, standard phosphorus loading rate, and the phosphorus retention by the system and soils. The standard phosphorus load rate was assumed to be 1.5 kg/capita/year with a 70 percent retention coefficient (MPCA 2004). However, this calculation does not account for failing systems in the watershed. Based on County survey data, approximately 45-65 percent of the systems in the County are failing (Carver County 2005). The failing septic systems would have a lower phosphorus retention rate than 70 percent, but, the soil would still retain a fair amount of phosphorus and provide treatment as the water moves through the soil profile and travels toward surface/ground water. Since it is difficult to estimate the export rate for failing systems, it was assumed that the 70 percent phosphorus retention rate reasonably represents the watershed with failing septic systems. We do recognize that septic system loading may be underrepresented, and failing systems will be addressed through implementation. Septic system loads are directly input into the BATHTUB models to determine subwatershed contributions to the lake.

5.3.5 Internal Load

Internal load terms were determined based on a residual process utilizing the BATHTUB model. After accounting for and entering land use and nutrient loads corresponding to the segment and tributaries using a 1.0 mg/m^2/day of internal loading, the model was run. Predicted and observed values were evaluated. At this point, if the in-lake predicted phosphorus values remained below that of the observed, additional internal loading was added until the predicted and observed nutrients were within 10 percent of each other. This process suggests that the internal load is the load remaining after all external sources have been accounted for. The result of this method was an internal loading rate of 0.5 mg/m^2/day for 2004 and 0.5 mg/m^2/day for 1991.

5.3.6 Atmospheric Load

Atmospheric loading rates for both 1991 and 2004 were set at a rate of 20 kg/km^2/yr. The total atmospheric load was determined to be approximately 7 kg/yr. Similar to septic system loads outlined in the previous section, these numbers are essential for BATHTUB models to function properly and to formulate an accurate estimate of the phosphorus loadings for Reitz Lake.

5.4 BENCHMARK PHOSPHORUS BUDGET AND MODEL VALIDATION

The BATHTUB model was set up to simulate Reitz Lake’s nutrient response. BATHTUB is a standard modeling tool and is widely used for eutrophication assessments in Minnesota and elsewhere. Details on the BATHTUB model can be found in Walker (1999) and at the USACE web site:
http://www.wes.army.mil/el/elmodels/index.html#wqmodels

The BATHTUB model for Reitz Lake was calibrated and validated using data for the years 1991 and 2004 (Appendices B and C). Monitored lake and subwatershed data were used to calibrate the model. For unmonitored portions of the lake's watershed, the Reckhow-Simpson model was used to estimate P loads. The selection of model options in BATHTUB was based on past experience in modeling lakes in Minnesota. We chose the Canfield-Bachmann model for natural lakes to predict in-lake total phosphorus concentrations. The model option selected for chlorophyll-*a* was the empirical relationship between chlorophyll-*a* and P, N, light, and temperature. Secchi depth was predicted using the empirical relationship between Secchi depth and chlorophyll-*a* and turbidity. Model coefficients available in the model for calibration or adjustment were left at the default values except for the Secchi/chlorophyll-*a* slope, which was decreased from 0.025 to 0.015 based on the relationship from Minnesota Lakes. Following calibration and validation, the 2004 version of the BATHTUB model was then used to simulate current and possible future conditions (Appendix C).

5.4.1 Fit of the Model

Model results from 1991 and 2004 are presented in Table 5.4 along with observed values and a coefficient of variation (standard error of the mean). The phosphorus budget development will focus on 2004 (a close to average precipitation year) where the monitoring data set was most complete. A variety of diagnostics are provided by the model, and included in Appendix C. Here we will focus on the primary indicators of trophic status: total phosphorus, chlorophyll-a, and Secchi depth. In both years the model represents reasonable agreement with the monitored data.

Table 5.4. Observed and predicted in-lake water quality for Reitz Lake in 1991 and 2004 (June 1-September 30).

		Predicted		Observed		
Year	Variable	Mean	CV[1]	Mean	CV[1]	n
2004	Total Phosphorus (µg/L)	105	0.28	105	0.39	9
	Chlorophyll-a (µg/L)	43	0.30	44	0.49	9
	Secchi Depth (meters)	1.0	0.22	1.0	0.60	7
1991	Total Phosphorus (µg/L)	104	0.27	104	0.65	9
	Chlorophyll-a (µg/L)	46	0.30	46	0.26	9
	Secchi Depth (meters)	1.1	0.25	1.1	0.66	9

[1] Coefficient of variation
n = Number of samples (June 1-September 30)

Chlorophyll-a concentrations and Secchi depths were only slightly off for both years. These differences can be attributed to numerous factors including sampling frequency, where the values may be skewed based on sampling either side of an algal bloom or missing the bloom altogether. For all predicted outcomes, the range of difference was between 0.8 to 7 percent. Secchi depth for the modeled year 2004 had a difference of 23 percent, which might be the result of sampling during a severe algal bloom that was not accurately modeled within BATHTUB. Apart from this, the low percent averages of differences between the modeled and observed variables imply that the model adequately simulates the lake.

5.4.2 Benchmark Phosphorus Budget

One of the key aspects of developing TMDLs is an estimate of the nutrient budget for the lake. Estimated nutrient and water budgets for an average precipitation year (2004) are presented in Table 5.5. These budgets do not account for any ground water exchange. It is assumed that the lake acts as a ground water discharge and recharge area, so the net effect on the water or nutrient budgets is very small.

Most of the phosphorus loading into the lake arises from land use within the Reitz Lake watershed. R1 is the largest external load to Reitz Lake, followed by W1 contributing approximately 39 percent and 20 percent, respectively, of the total annual phosphorus load into Reitz Lake (Table 5.5). Land use in the subwatersheds is predominantly agricultural with some animals maintained in the watershed, which contributes to some spreading of manure on agricultural fields. Failing septic systems in the watershed also contribute to the overall phosphorus load. Internal loading accounts for approximately 11 percent of the load.

Table 5.5. Summary of BATHTUB model outputs for phosphorus export based on current (2004) inflow.

Subwatershed	Area km^2	Water Inflow hm^3/yr	Estimated TP Load kg/yr	% of total Load
W1	4.96	0.60	123	20%
W2	0.44	0.08	19	3%
R1	7.84	1.19	237	39%
Direct	1.04	0.17	39	6%
Septic		0.04	119	19%
Atmospheric Deposition	0.37	0.29	7	1%
Total External	14.65	2.37	544	89%
Total Internal			67	11%
TOTAL P LOADING			611	100%

5.5 CONCLUSIONS

Reitz Lake is a eutrophic lake with both external and internal loads contributing phosphorus to the lake. External loads were greatest from the R1 and W1 subwatersheds where the land use is currently dominated by agriculture. Septic systems represent a portion of the phosphorus load, and must also be addressed in order to ensure the meeting of the TMDL. Internal cycling appears to be controlled by the rough fish population, the presence of curlyleaf pondweed, and turbulent diffusion from anoxic sediments to the epilimnion. However, these inputs seem to be minor compared to external sources.

6.0 TMDL Allocation

6.1 LOAD AND WASTELOAD ALLOCATIONS

Loads in this TMDL are set for phosphorus since this is typically the limiting nutrient for nuisance aquatic plants. Loads are expressed both as annual and daily loads; however, an annual load better represents this TMDL because the growth of phytoplankton and aquatic plants respond to changes in the annual load and not the daily load. The TMDL was developed based on monitoring data for a close-to-average precipitation year, 30.96 inches/yr, (2004). The annual mean precipitation is 30.44 inches/yr, at the Chaska, MN climate station.

6.1.1 Loading Capacity Determination

The loading capacity of Reitz Lake was determined by fitting the phosphorus load to the State Standard of 40 µg/L as a summer surface mean, using the original Canfield-Bachmann model. For this purpose, all other parameters of the Canfield-Bachmann model, as outlined earlier in this report, were kept the same. The loading capacity, which is the same as the TMDL, is 164 kg P/yr (average of 0.45 kg P/day). The TMDL requires an overall load reduction of 73 percent relative to the average benchmark load computed in 2004. Table 6.1 presents the TMDL and its components, which are discussed in the following subsections.

Table 6.1. TMDL as set for critical conditions.

Load Units	TMDL	WLAs			LAs			MOS	RC
		City of Waconia	Laketown Township	Construction/ Industrial	Atmospheric	Internal	non-MS4		
kg/yr	163.84	31.28	6.97	0.16	7.00	18.60	99.83	Implicit	0
kg/day	0.45	0.09	0.02	0.0004	0.02	0.05	0.27	Implicit	0

6.1.2 Load Allocations (LAs)

Load allocations (LAs) include watershed runoff loading from non-Municipal Separate Storm Sewer System (non-MS4) areas (i.e., watershed load not covered by a NPDES permit), as well as atmospheric and internal loadings.

Atmospheric loadings are set to the benchmark phosphorus budgets (Section 5.3.6) as this is not a load that can be reduced. The atmospheric loading rate was assumed to be 20 $kg/km^2/yr$.

Watershed runoff loadings were based upon 2020 Land Use GIS shapefiles within 2030 boundaries for the municipalities in order to account for expected future growth.

Derivation of the LAs for internal loading and non-MS4 area loading as well as WLAs for MS4 area loading were done as follows:

1) Using the total loading capacity (TMDL) as determined per Section 6.1.1. subtracted the following loads:
    a. any WLAs for wastewater facilities and construction/industrial stormwater
    b. atmospheric allocation

    The resulting load is the combined allowable load for the watershed runoff and internal loading.
2) Determined future external loading to the lake from the watershed (if no reductions were to be done) using export coefficients as outlined in Table 5.3 multiplied by 2020 land use areas.
3) Estimated future internal loading to the lake (if no reductions were to be done) as the internal loading from benchmark BATHTUB modeling per Section 5.4.2.
4) Determined the ratio of combined allowable load calculated in step 1 to the sum of the overall future loading from step 2 plus internal loading from step 3.
5) Separated regulated MS4 community area loading out of the direct watershed loading. Regulated MS4 loading was determined using 2020 Land Use GIS shapefiles using only designated "developed" land use areas within defined 2030 municipal boundaries (i.e., those areas projected to contribute to a stormwater conveyance; specifically, single family, multi-family, commercial and public/industrial).
6) Multiplied the following loads by the calculated ratio in step 4:
    a. non-MS4 area loading (from step 5)
    b. MS4 area loading (from step 5)
    c. internal loading (from step 3)

The resulting loads are the non-MS4 area LA, the MS4 area WLA and internal loading LA.

6.1.3 Wasteload Allocations (WLAs)

Wasteload allocations (WLAs) are required for regulated MS4 discharges, municipal and industrial wastewater discharges, and stormwater runoff from both industrial and construction sites.

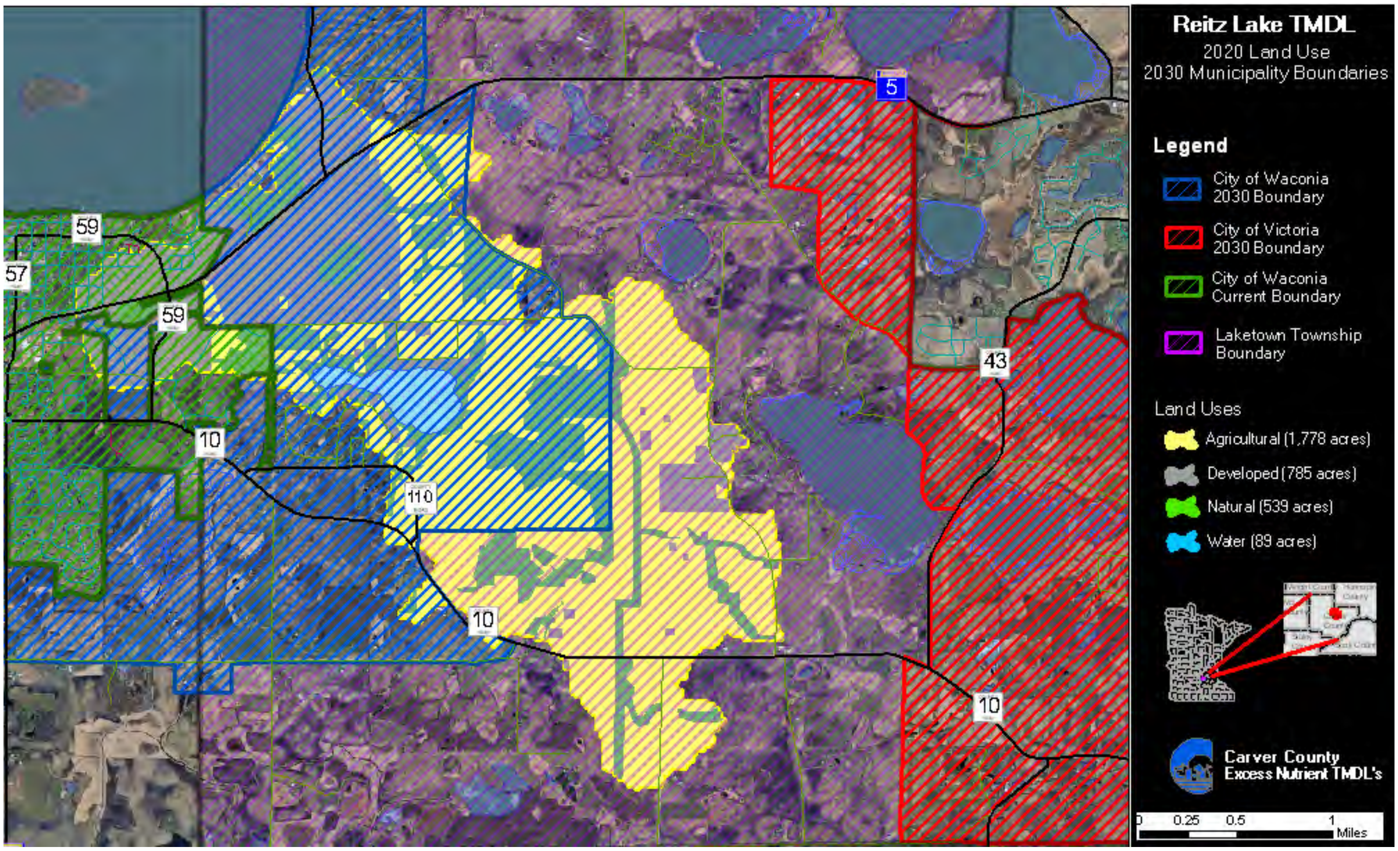


Figure 6.1. 2030 Municipal Boundaries and Reitz Lake 2020 Land Use.

6.1.3.1 Municipal Separate Storm Sewer Systems (MS4s)

The process for determining WLAs for regulated MS4 areas was described above in Section 6.1.2. The City of Waconia (permit number MS400232; 809 acres of developed land) and Laketown Township (permit number MS400142; 96 acres of developed land) are partly within the Reitz Lake direct watershed and each is assigned a WLA.

If and when annexation of land within Laketown Township by either Waconia or Victoria occurs, the corresponding WLAs associated with those areas will be transferred to the annexing city. If and when areas within the watershed designated as LA are developed (urbanized) or become part of the Twin Cities Urban Area and thus fall under an NPDES regulated MS4 framework, the TMDL will be re-opened and load will be transferred from the LA to the WLA as appropriate.

6.1.3.2 Municipal and Industrial Wastewater Discharges

No NPDES permitted wastewater facilities are located within the watershed.

6.1.3.3 Construction Stormwater and Industrial Stormwater

Construction storm water activities are considered in compliance with provisions of the TMDL if they obtain a Construction General Permit under the NPDES program and properly select, install, and maintain all BMPs required under the permit, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit.

Industrial storm water activities are considered in compliance with provisions of the TMDL if they obtain an Industrial General Permit under the NPDES program and properly select, install and maintain all BMPs required under the permit.

The land area representing construction and industrial stormwater would be expected to make up a very small portion of the watershed at any one time. Therefore, WLA for construction and industrial stormwater combined were conservatively set at 0.1 percent of the loading capacity (TMDL).

6.2 HISTORICAL LOADS

Historical loads were estimated for those years with monitoring data using an inverted Canfield-Bachmann model. The model was run for average runoff conditions in each monitored year, although precipitation varies from year to year. The loads varied significantly, with the lowest load occurring in 1999 where only a 9 percent reduction was necessary to meet the standard and to the highest load requiring an 84 percent reduction (Figure 6.2). Total phosphorus loads from 1999 through 2001 were significantly lower than other monitored years. Lower than average, (29.11 inches/yr) rainfall may have reduced runoff from nearby agricultural land to the lake, therefore, greatly reducing the nutrient load to the lake. In addition, low water levels at the outlet and carp harvests may have decreased carp populations, therefore, reducing sediment disturbance. Although the factors that resulted in the 1999-2001 conditions are unclear, the fact that the lake was recently near the State standard shows some promise for lake recovery.

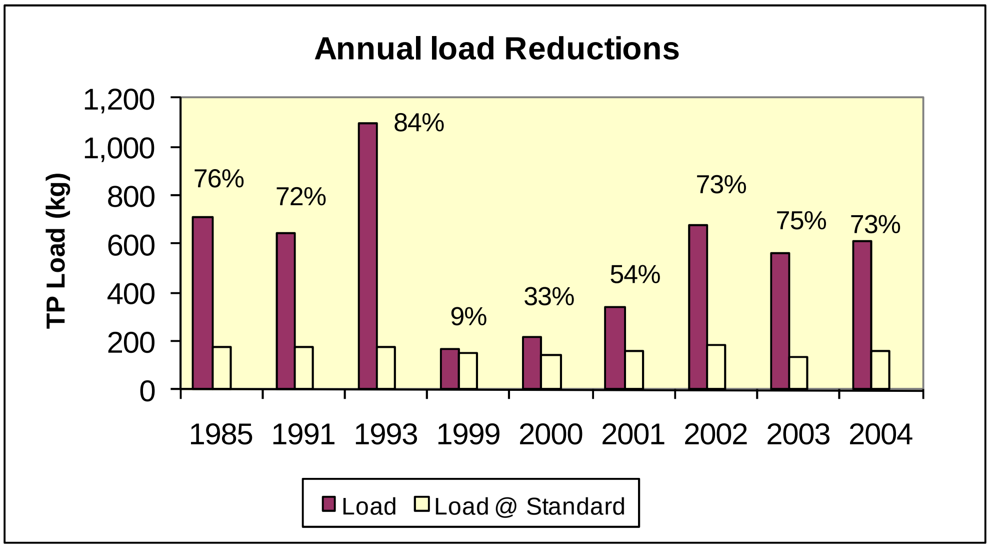


Figure 6.2. Modeled annual loads for monitored conditions (June 1-Sept. 30) and predicted loads at the final goal of 40 µg/L total phosphorus. percentages represent the necessary reduction to meet the standard.

6.3 LOAD RESPONSE

In addition to meeting a phosphorus limit of 40 µg/L, a lake must either meet or exceed one of two other parameters (chlorophyll-a or Secchi). BATHTUB modeling of the TMDL load results in Hydes Lake meeting the Secchi depth requirement of greater than 1 meter (Table 6.5). Chlorophyll-a concentrations are still above the State Standards of 14 µg/L. To view BATHTUB inputs and results for this model, see Appendix C.

Table 6.2. BATHTUB modeling of TMDL Loads for Reitz Lake

Results	Reitz Lake
TP Concentration	40
Chlorophyll-a Concentration	22
Secchi Depth	2.4

6.4 SEASONAL VARIATION

Seasonal variation is accounted for through the utilization of annual loads and developing targets for the summer period where the frequency and severity nuisance algal growth will be the greatest. Although the critical period is the summer, lake water quality responds mainly to long-term changes such as changes in the annual load. Therefore, seasonal variation is accounted for in the annual loads. Additionally, by setting the TMDL to meet targets established for the most critical period (summer), the TMDL will inherently be protective of water quality during all other seasons.

6.5 MARGIN OF SAFETY

A margin of safety has been incorporated into this TMDL by using a conservative modeling approach to account for an inherently imperfect understanding of the lake system and to ultimately ensure that the nutrient reduction strategy is protective of the water quality standard.

The lake response model for total phosphorus used for this TMDL uses the rate of lake sedimentation, or the loss of phosphorus from the water column as a result of settling, to predict total phosphorus concentration. Sedimentation can occur as algae die and settle, as organic material settles, or as algae are grazed by zooplankton. Sedimentation rates in shallow lakes can be higher than rates for deep lakes. In large part Reitz lake functions much like a shallow lake due to its large littoral area (57 percent of the lake area). Shallow lakes differ from deep lakes in that they tend to exist in one of two states: turbid water and clear water. Lake response models assume that even when total phosphorus concentration in the lake is at or better than the state water quality standard the lake will continue to be in that turbid state. However, as nutrient load is reduced and other internal load management activities such as fish community management occur to provide a more balanced lake system, shallow lakes will tend to “flip” to a clear water condition. In that balanced, clear water condition, light penetration allows rooted aquatic vegetation to grow and stabilize the sediments, and zooplankton to thrive and graze on algae at a much higher rate than is experienced in turbid waters. Thus in a clear water state more phosphorus will be removed from the water column through settling than the model would predict.

The TMDL is set to achieve water quality standards while still in a turbid water state. To achieve the beneficial use, the lake must flip to a clear water state which can support the response variables at higher total phosphorus concentrations due to increased zooplankton grazing, reduced sediment resuspension, etc. Therefore, this TMDL is inherently conservative by setting allocations for the turbid water state.

6.6 RESERVE CAPACITY

Reserve Capacity (RC) is that portion of the TMDL that accounts for future growth. This is most relevant for those entities in the WLA category. For the City of Waconia and Laketown Township, regulated MS4s, future growth was accounted for in their WLAs by basing their allocations for stormwater contribution on their developed land area projections for 2020. As land use continues to change within the watershed, the overall phosphorus loading will need to meet the overall allocation provided to the watershed runoff load.

7.0 Public Participation

7.1 INTRODUCTION

The County has an excellent track record with inclusive participation of its citizens, as evidenced through the public participation in completion of the Carver County Water Management Plan, approved in 2001. The County has utilized stakeholder meetings, citizen surveys, workshops and permanent citizen advisory committees to gather input from the public and help guide implementation activities. The use of this public participation structure will aid in the development of this and other TMDLs in the County.

In addition to the participation opportunities described below, this TMDL was also made available for public comment from July 12 to August 11, 2010, via a public notice in the State Register.

7.2 TECHNICAL ADVISORY COMMITTEE

The Water, Environment, & Natural Resource Committee (WENR) is established as a permanent advisory committee. The WENR is operated under the County's standard procedures for advisory committees. WENR works with staff to make recommendations to the County Board on matters relating to watershed planning.

The make-up of the Water, Environment, & Natural Resource Committee (WENR) is as follows:
1 County Board Member
1 Soil and Water Conservation District Member
5 citizens – (1 appointed from each commissioner district)
1 City of Chanhassen (appointed by city)
1 City of Chaska (appointed by city)
1 City of Waconia (appointed by city)
1 appointment from all other cities (County Board will appoint)
2 township appointments (County Board will appoint– must be on existing township board.)
4 other County residents (1 from each physical watershed area – County)

The full WENR committee received updates on the TMDL process from its conception. For Reitz Lake, updates and input were received on May 31, 2005, and July 26, 2005.

As part of the WENR committee, two sub-committees are in place and have held specific discussions on the Excess Nutrients TMDL. These are the Technical sub-committee and the Policy/Finance sub-committee. Sub-committee review meetings for Reitz Lake were held on June 8, 2005, and July 13, 2005.

TMDL progress, data results and implementation procedures were presented and analyzed at the WENR meetings mentioned. Committee members commented on carp removal possibilities, sources, internal loading rates, and future monitoring plans. All issues commented on were considered in the development of the Draft TMDL.

7.3 PUBLIC SURVEYS/ MEETINGS

Stakeholders that would be impacted by the Reitz Lake TMDL were given the opportunity to voice their opinions of the TMDL. Stakeholder involvement involved the following components; public survey, public meeting, and personal meetings with the City of Waconia and Waconia consultants.

An open house was held on July 12, 2005, for landowners within the Reitz Lake watershed. Prior to the meeting, landowners were sent surveys inquiring upon lake uses and perceptions. Although close to 250 invitations were sent out, only 32 people attended the meeting and filled out surveys, with 69 percent of those being lakeshore owners. The following is a summary of the user survey and comments received during the meeting:

- Many of the lakeshore owners are concerned about the large numbers of carp, especially in the shallow western bay. Lakeshore owners are concerned that the carp are assisting in eroding the shoreline and causing the low water clarity in the bay. It was identified during the meeting that there has been commercial removal of carp in Reitz Lake in the past.
- There were also remarks of muskrats in the shallow bay destroying the shoreline.
- Attendees were also concerned about the 201 system (a gray water collection system) running along the bottom of the lake. Landowners in the watershed are generally concerned about the sources identified to be polluting Reitz Lake.
- Sources identified by meeting attendees were runoff from lawns, agriculture, 201 system, carp and boat traffic.
- In general, it appears that the public agrees with the identified sources and the reduction goals.
- Of the survey respondents, 50 percent utilized the lake greater than 10 times in 2004.
- Uses of the lake include fishing, swimming, boating, waterskiing, and wildlife observation.
- An important point made in the survey was that 81 percent of users believe that their use of the lake is interfered with by aquatic plants and/or algae.

Carver County staff, along with MPCA staff invited the City of Waconia Planners along with their engineers to a meeting and comment session regarding the WLA to the City as a MS4 in February 2007. City staff was presented with the TMDL development methods and the TMDL allocations.

8.0 Reasonable Assurance

8.1 INTRODUCTION

When establishing a TMDL, reasonable assurances must be provided demonstrating the ability to reach and maintain water quality endpoints. Several factors control reasonable assurances including a thorough knowledge of the ability to implement BMPs, as well as the overall effectiveness of the BMPs. Carver County is positioned to implement the TMDL, and ultimately achieve water quality standards.

8.2 CARVER COUNTY

The Carver County Board of Commissioners (County Board), acting as the water management authority for the former Bevens Creek (includes Silver Creek), Carver Creek, Chaska Creek, Hazeltine-Bavaria Creek, and South Fork Crow River watershed management organization areas, has established the “Carver County Water Resource Management Area” (CCWRMA). The purpose of establishing the CCWRMA is to fulfill the County’s water management responsibilities under Minnesota Statute and Rule. The County chose this structure because it will provide a framework for water resource management as follows:

- Provides a sufficient economic base to operate a viable program;
- Avoids duplication of effort by government agencies;
- Avoids creation of a new bureaucracy by integrating water management into existing County departments and related agencies;
- Establishes a framework for cooperation and coordination of water management efforts among all of the affected governments, agencies, and other interested parties; and
- Establishes consistent water resource management goals and standards for at least 80 percent of the county.

The County Board is the “governing body” of the CCWRMA for surface water management, and the entire county, for ground water management. In function and responsibility the County Board is essentially equivalent to a joint powers board or a watershed district board of managers. The Reitz Lake watershed is part of the CCWRMA.

The County is uniquely qualified through its zoning and land use powers to implement corrective actions to achieve TMDL goals. The County has stable funding for water management each year, but will likely need assistance for full TMDL implementation in a reasonable time frame, and will continue its baseline-monitoring program. Carver County has established a stable source of funding through a watershed levy in the

CCWRMA taxing district (adopted 2001). This levy allows for consistent funding for staff, monitoring, engineering costs and also for on the ground projects.
The County has also been very successful in obtaining grant funding from local, state and federal sources due to its organizational structure.

Carver County recognizes the importance of the natural resources within its boundaries, and seeks to manage those resources to attain the following goals:

1. Protect, preserve, and manage natural surface and ground water storage and retention systems;
2. Effectively and efficiently manage public capital expenditures needed to correct flooding and water quality problems;
3. Identify and plan for means to effectively protect and improve surface and ground water quality;
4. Establish more uniform local policies and official controls for surface and ground water management;
5. Prevent erosion of soil into surface water systems;
6. Promote ground water recharge;
7. Protect and enhance fish and wildlife habitat and water recreational facilities; and
8. Secure the other benefits associated with the proper management of surface and ground water.

Water management involves the following County agencies including: Carver County Land and Water Services Division, Carver County Extension and the Carver SWCD. The County Land and Water Services Division is responsible for administration of the water plan and coordinating implementation. Other departments and agencies will be called upon to perform water management duties that fall within their area of responsibility. These responsibilities may change as the need arises. The key entities meet regularly as part of the Joint Agency Meeting (JAM) process to coordinate priorities, activities, and funding.

8.3 REGULATORY APPROACH

8.3.1 Watershed Rules

Water Management Rules establish standards and specifications for the common elements relating to watershed resource management including: Water Quantity, Water Quality, Natural Resource Protection, Erosion and Sediment Control, Wetland Protection, Shoreland Management, and Floodplain Management. Of particular benefit to Nutrient TMDL reduction strategies are the stormwater management and infiltration standards which are required of new development in the CCWRMA. The complete water management rules are contained in the Carver County Code, Section 153.

8.3.2 NPDES MS4 Stormwater Permits

MS4's that have been designated by the MPCA for permit coverage under Minn. R. ch 7090 are required to obtain a NPDES/SDS stormwater permit. As part of the permit, the city will be required to develop and implement a stormwater pollution prevention program (SWPP) to reduce the discharge of pollutants from their storm sewer system. The SWPP's are required to cover six "minimum control measures" to ensure adequate stormwater management and pollution prevention. Measures include 1) Public education and outreach, 2) Public participation/involvement, 3) Illicit discharge, detection and elimination, 4) Construction site runoff control, 5) Post-construction site runoff control, and 6) Pollution prevention/good housekeeping. For more information visit the MPCAs Web site: *http://www.pca.state.mn.us/water/stormwater/stormwater-ms4.html*

8.3.3 NPDES Permits

The MPCA issues NPDES permits for any discharge into waters of the state. These permits have both general and specific limits on pollutants that are based on water quality standards. Permits regulate discharges with the goals of 1) protecting public health and aquatic life, and 2) assuring that every facility treats wastewater. More information about permits, water quality data and other MPCA programs can be found on the agency's Web site: *http://www.pca.state.mn.us/water*

8.3.4 Feedlot Permitting

The County Feedlot Management Program includes the feedlot permitting process including manure management. The permit process aids to ensure that the feedlot meets State pollution control standards and locally adopted standards. The County has had a locally operated permitting process under delegation from the MPCA since 1980. The County adopted a Feedlot Ordinance in 1996. The Feedlot Ordinance incorporates State standards plus additional standards and procedures deemed necessary to appropriately manage feedlots in Carver County. More information on the County Feedlot Management Program and manure management can be found in the Carver County Water Management Plan 2001 or on the County's Web site: *http://www.co.carver.mn.us/water/wmp.asp*

8.3.5 County SSTS Ordinance

The SSTS ordinance regulates the design, location, installation, construction, alteration, extension, repair, and maintenance of SSTSs. The County currently enforces the ordinance in the unincorporated area; cities are responsible in their jurisdiction. The law gives responsibility to the County unless a city specifically develops and implements its own program and SSTS ordinance.

8.4 NONREGULATORY APPROACH

8.4.1 Education

The implementation of this Plan relies on three overall categories of activities: 1) Regulation, 2) Incentives, and 3) Education. For most issues, all three means must be part of an implementation program. The County has taken the approach that regulation is only a supplement to a strong education and incentive based program to create an environment of low risk.

Understanding the risk through education can go a long way in preventing problems. In addition, education can be a simpler, less costly and more community friendly way of achieving goals and policies in many cases. Education efforts can provide the framework for more of a “grass roots”, community plan implementation, while regulation and incentives traditionally follow a more “top-down” approach. It is recognized, however, that education by itself will not always meet intended goals, has certain limitations, and is characteristically more of a long-term approach.

To this end, Carver County created the Environmental Education Coordinator position in 2000. This position has principal responsibility for development and implementation of the water education work plan.

Several issues associated with the water plan were identified as having a higher priority for education efforts. These were identified through discussions with the advisory committees, ease of immediate implementation and knowledge of current problem areas and existing programs. The higher priority objectives are not organized in any particular order. The approach to implement the fecal TMDL will mimic the education strategy of the water plan. Each source reduction strategy will need an educational component, and will be prioritized based on the number of landowners, type of source, and coordination with existing programs.

8.4.2 Incentives

Many of the existing programs on which the water management plan relies are incentive based programs offered through the County and the Carver and Sibley SWCDs. Some examples include state and federal cost share funds directed at conservation tillage, crop nutrient management, rock inlets, conservation buffers, and low interest loan programs for SSTS upgrades. Reducing nutrient sources will need to rely on a similar strategy of incorporating incentives into implementing practices on the ground. After the approval of the TMDL by the EPA and the County enters the implementation phase, it is anticipated that we will apply for monies to assist landowners in the application of BMPs identified in the Implementation Plan.

8.5 MONITORING

Regular bi-weekly, in-lake monitoring of Reitz Lake from April-October of each year will continue as identified by its high priority in the Water Plan. However, after implementation of BMPs, a stepped-up approach of monitoring will be conducted. Adaptive management relies on the County conducting additional monitoring as BMPs are implemented in order to determine if the implementation measures are effective, and how effective they are. Additional areas that may need to be monitored include: runoff from development, remaining inlets not monitored during the initial TMDL study, wetlands at the inlets to Reitz Lake, sampling of the shallow bay, and additional hypolimnetic samples. This monitoring will assist in evaluating the success of projects and identify changes needed in management strategies. Revision of management and monitoring strategies will occur as needed.

9.0 Implementation

9.1 INTRODUCTION

This section provides an overview of the implementation strategy to be used to address Reitz Lake. A more detailed implementation plan is being developed and will be completed within one year of the approval of the TMDL. The activities and BMPs identified are the result of several stakeholder and permanent citizen advisory committee meetings led by Carver County Water Management staff.

The phosphorus allocations represented in this TMDL represent aggressive goals. Consequently, implementation will be conducted using adaptive management principles. Adaptive management is appropriate because it is difficult to predict the phosphorus reduction that will occur from implementing strategies with the scarcity of information available to demonstrate expected reductions. Limited reduction research is available for BMPs at this time, but this is expected to change in the next several years as state agencies and local experience provide more accurate reduction data. The County has and will continue to look at viable tools that will help to predict and measure the actual reductions that installation of a particular may have.

Timelines are provided below within tasks and are defined as: Short Term 0-5 years from the inception of the plan, Medium Term 5-12 years from the inception of the plan and Long Term greater than 12 years or on-going from the inception of the plan. These timelines are estimates as they are dependent on staff resources, funding and willingness of landowners to carry out actions.

The overall estimated cost to implement actions to achieve the needed external and internal loading reductions for the TMDL is approximately $1.3 million.

9.2 EXTERNAL LOADING REDUCTION STRATEGIES

External loading reduction strategies include a variety of agricultural and urban BMPs. In non-MS4 areas, BMP establishment will be on a voluntary basis. State and federal grant monies will be solicited by CCWMO to cost share BMP establishment and incentives if needed. The total estimated cost for external loading reductions is $746,000. (Note: Failing SSTSs will be addressed under the Carver, Bevens, and Silver Creek Bacteria TMDL Implementation Plans, and therefore are not mentioned below).

9.2.1 Agricultural Cropland Runoff Control and Storage BMPs

Task 1. Identify and prioritize key erosion/restoration areas within the Reitz Lake watersheds. Identification will be based on monitoring results and/or visual inspections of field conditions.

1) Responsible Parties: CCWMO, Carver SWCD, NRCS
2) Timeline: Short Term
3) Estimated Cost: $2,500

Task 2. Identify and educate landowners through meetings, brochures, Carver County quarterly newspaper (The Citizen), Carver County Website, and various workshops.

1) Responsible Parties: CCWMO, Carver SWCD
2) Timeline: Long Term
3) Estimated Cost: $5,000

Task 3. Design and implement cropland BMPs to reduce phosphorus inputs to Reitz Lake. BMPs will be targeted on land identified as significant contributors of phosphorus and sediment. Agricultural BMPs will be designed and implemented to reduce sediment and nutrients into Reitz Lake. Examples include nutrient management, crop residue management, and other practices utilized by the Carver SWCD and NRCS and identified in the NRCS field handbook available electronically at www.nrcs.usda.gov/technical/efotg/

1) Responsible Parties: CCWMO, Carver SWCD, NRCS
2) Timeline: Long Term
3) Estimated Cost: $150,000

Task 4. Design and implement practices that will reduce sediment and nutrients into Reitz Lake by installing buffer strips, wetland restorations, alternate rock inlets or other water retention devices or practices identified by qualified staff.

1) Responsible Parties: CCWMO, Carver SWCD, NRCS
2) Timeline: Long Term
3) Estimated Cost: $150,000

9.2.2 Animal Manure/Feedlot Management

Animal manure management and to a lesser extent feedlot run-off will be examined and appropriate measures will be taken to ensure that these activities do not result in a phosphorus load entering Reitz Lake.

Task 1. Identify potential areas and contact landowners to inform them of funding and projects that they can initiate to benefit Reitz Lake and their properties.

1) Responsible Parties: CCWMO, Carver SWCD
2) Timeline: Long Term
3) Estimated Cost: $1,500

Task 2. Identify and educate landowners through meetings, brochures, Carver County quarterly newspaper (The Citizen), Carver County Website, and various workshops.

1) Responsible Parties: CCLWS/CCWMO, Carver SWCD
2) Timeline: Long Term
3) Estimated Cost: $5,000

Task 3. Work directly with the landowners that have feedlots or land application of manure on their properties. For active feedlots the MINNFARM computer software will be used to identify potential pollution problems. Current NRCS technical practices and standards will be used for feedlot pollution abatement and manure application.

1) Responsible Parties: CCLWS/CCWMO, Carver SWCD
2) Timeline: Long Term
3) Estimated Cost: $40,000

9.2.3 Urban/Development Runoff

Urban/developed phosphorus runoff management will include but is not limited to the following components: installation of rain gardens, street sweeping, removal of leaf litter from streets, installation of shoreline buffers, stabilization of eroding lakeshore infiltration/detention ponds, erosion and sediment control and utilizing low impact development (LID) techniques.

CCWMO requires filtration/bio-retention treatment for new development and promotes and encourages reduction in runoff and increased infiltration in re-development and retrofits. CCWMO addresses the uses of components such as infiltration ponds, silt fencing and minimization of new impervious surfaces in the County Water Management Plan and Rules. CCWMO will continue to take the lead on ensuring preventative measures are installed during construction as well as retrofits and will evaluate increased standards in the update of its Plan and Rules.

Task 1. Utilize Carver County’s GIS to identify potential project areas and “hotspots” within the Reitz Lake sub-watersheds (i.e., areas without current stormwater management). Then research and identify what practices outlined above or from the Minnesota Stormwater BMP Manual should be considered.

1) Responsible Parties: CCWMO, Carver SWCD, City of Waconia
2) Timeline: Long Term
3) Estimated Cost: $10,000

Task 2. Identify and educate landowners through meetings, brochures, Carver County Website, and various workshops.

1) Responsible Parties: CCWMO, Carver SWCD, City of Waconia
2) Timeline: Long Term
3) Estimated Cost: $5,000

Task 3. Design and implement urban BMPs to reduce phosphorus inputs to Reitz Lake based on interest of targeted landowners and available monies. BMPs will include rain gardens, shoreline restorations and other stormwater BMPs.

1) Responsible Parties: CCLWS/CCWMO, Carver SWCD, City of Waconia
2) Timeline: Long Term
3) Estimated Cost: $250,000

Task 4. Identify current and future street sweeping schedules that the City of Waconia has in place and if necessary conduct a load analysis to determine optimum level of sweeping necessary. If necessary, work with the city to implement a continual spring and fall schedule for sweeping within the sub-watersheds. The City has identified this BMP in both the Local Water Management Plan and the SWPPP.

1) Responsible Parties: CCLWS/CCWMO, Carver SWCD, City of Waconia
2) Timeline: Medium Term
3) Estimated Cost: $2,000

Task 5. Identify current and future stormwater pond clean out schedules within the subwatershed to ensure proper operation and maintenance schedules are in place. A maintenance plan is included in the City's Local Water Management Plan. If necessary, work with the City to develop and implement a schedule that will more adequately treat the runoff leaving these areas. Additional activities may include identifying and retrofitting any current stormwater ponds that could be updated with current standards.

1) Responsible Parties: CCWMO, Carver SWCD, City of Waconia
2) Timeline: Medium Term
3) Estimated Cost: $50,000

Task 6. All currently undeveloped land within the Reitz Lake Watershed will be required to meet current and any amended stormwater standards including volume reduction and runoff treatment. Review and updates of both the CCWMO plan and ordinances will include the pollutant reduction methods needed for the Reitz

TMDL. The City plan and SWPPP will need to be updated to meet any revised CCWMO plans and ordinances. Additional LID practices will be encouraged during the site design and review process. Incentives will be considered in order to promote these practices.

1) Responsible Parties: CCWMO, Carver SWCD, City of Waconia
2) Timeline: Long Term
3) Estimated Cost: $25,000

Task 7. Ongoing monitoring of Reitz Lake and tributaries

1) Responsible Parties: CCWMO
2) Timeline: Long Term
3) Estimated Cost: $50,000

9.3 INTERNAL LOADING REDUCTION STRATEGIES

Internal phosphorus loading reduction options include: fish barriers, rough fish control, removal of invasive aquatic plants and establishment of native vegetation, motorized boat wake restrictions, and alum dosing.

CCWMO will partner with the Minnesota Department of Natural Resources (MDNR) to determine possible fish barrier sites and feasibility. Possible barrier sites include the lakes two inlets and the outlet. The purpose would be to prevent carp from utilizing surrounding wetland areas as breeding grounds. In addition to the barriers, CCWMO will coordinate with the MDNR and University of Minnesota to determine if rough fish removal is necessary.

Native aquatic plants would promote improved water quality by minimizing recirculation of bottom sediments, competing with algae for nutrients, and providing habitat for zooplankton (which eat algae). Currently Reitz Lake is overpopulated by invasive species including Eurasian watermilfoil and curlyleaf pondweed. There are many instances where lakeshore residents clear aquatic vegetation by various means. CCWMO and Carver SWCD will pursue a partnership with the MDNR to reduce the invasive species currently present and establish a healthy native aquatic plant population in areas of the lake less than 15 feet in depth.

Motorized boat traffic wake restrictions could aid in the reduction of in-lake nutrient recirculation, especially in the western shallow bay of Reitz Lake. The mixing is a result of wind mixing, rough fish rooting and boat motors in areas less than 10 feet in depth. Homeowners have identified that lake use by motor boats can be moderate on the weekends and restricting speed near the shoreline may yield a reduction in sediment/nutrient re-suspension in shallow areas of the lake and also would reduce the erosion impacts the waves have on shoreline.

Aluminum sulfate (alum) is a chemical addition that forms a non-toxic precipitate with phosphorus. The alum binds with water column phosphorus, precipitates to become part of the lake sediments making that phosphorus unavailable for algal growth. Alum also forms a barrier between lake sediments and the water to restrict phosphorus release from the sediments. CCWMO will inquire if alum or any other internal manipulation is a viable option and if so will establish the treatment area and dosing rates.

Another important issue that has been discussed in detail throughout this project is the fact that there is currently a two-inch sewer line that lies on the lake bottom and carries effluent from one pumping station to another pumping station approximately 3,000 feet on the opposite side of the lake. This line was installed as part of an Army Corp of Engineers project in 1985. Laketown Township is currently responsible for the system (referred to as the 201 system) and its maintenance. Lakeshore owners and township staff fear that the line breaking or being compromised would pose a great risk to the water quality of the lake. It would behoove all parties to look at all available options to remove this from the lake.

The interim goal of the internal reduction strategy is to reduce the internal phosphorus load in Reitz Lake to 3 kg/year by the midpoint of the project. The final goal of the internal reduction strategies is to reduce the internal phosphorus load in Reitz Lake to 2 kg/year. The total estimated cost for internal loading reductions is $582,500.

9.3.1 In-Lake/Internal Strategies

Task 1. Identify fish barrier sites and the possibility of rough fish removal success. If fish removal is deemed beneficial begin a program to adequately address the goal of the TMDL.

1) Responsible Parties:	CCWMO, MDNR
2) Timeline:	Short Term
3) Estimated Cost:	$30,000

Task 2. Chemical or mechanical removal of invasive aquatic plant species and replace with diverse native aquatic plant species.

1) Responsible Parties:	CCWMO, Carver SWCD, MDNR
2) Timeline:	Long Term
3) Estimated Cost:	$75,000

Task 3. Determine if designation of near shore wake-restricted zones is necessary and determine appropriate actions and steps for implementation, including signage and education.

1) Responsible Parties:	CCWMO
2) Timeline:	Short Term
3) Estimated Cost:	$2,500

Task 4. Determine if alum treatment(s) to Reitz Lake to reduce internal phosphorus loading is feasible and viable. If so, then implement an alum treatment. Also, consider and schedule long-term treatment options as suggested by state agencies and/or consultants.

1) Responsible Parties: CCWMO, MDNR
2) Timeline: Long Term
3) Estimated Cost: $175,000

Task 5. Determine the feasibility of drawing down the lake or other viable mechanical options (aeration, barley straw, dredging, etc.) to reduce phosphorus loading. Implement if feasible and funding is available.

1) Responsible Parties: CCWMO, MDNR
2) Timeline: Long Term
3) Estimated Cost: $50,000

Task 6. Remove and reroute the 201 system's effluent sewer line from the lake.

1) Responsible Parties: CCWMO, MDNR, City of Waconia, Met Council
2) Timeline: Long Term
3) Estimated Cost: $250,000

10.0 Literature Cited

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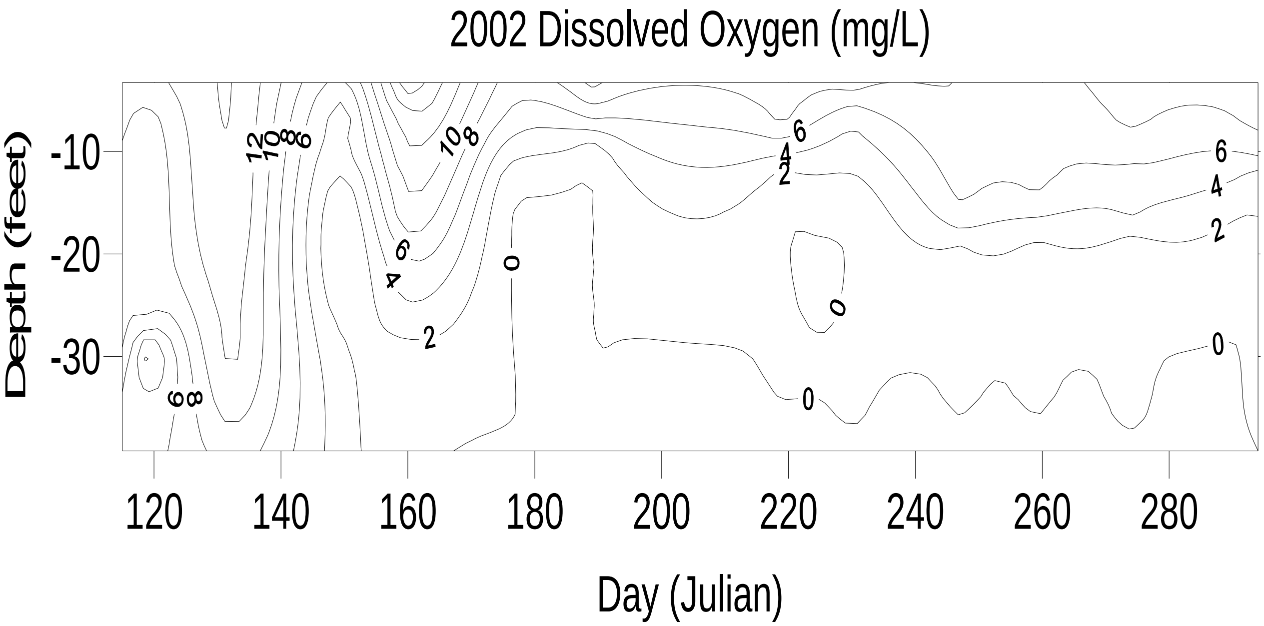
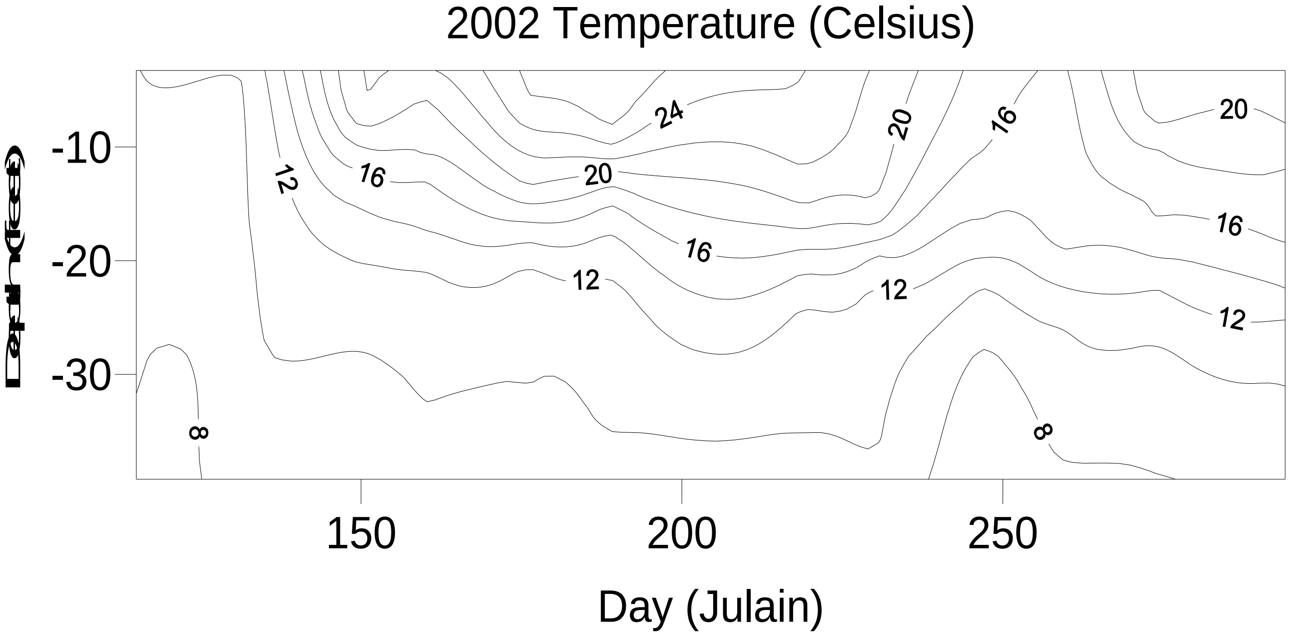
APPENDICES

Appendix A. Reitz Lake Temperature and Dissolved Oxygen Profiles 2002





Appendix B: Reitz Lake Inlet and Outlet Data

Appendix B.1.Tributary Field and Lake Data Results

Reitz Lake Inlet

Proj. Station ID - R1	Met Council Lab ID																	
Start Date	**Start Time**	**Stage**	**Discharge**	**Temp**	**Trans-parency**	**VSS**	**TSS**	**DO**	**COD**	**NO2**	**NO3**	**NH3**	**TKN**	**PO4**	**TP**	**Dissolved P**	**Turbidity**	**Alk as CaCO**
m/dd/yyyy	hh:mm	Feet	CFS	C	cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
13-Apr-04	12:51	4.30	0.22		60	~1	~2		56	<0.03	1.42	~0.03	1.7	<0.005	~0.031	~0.034	1.0	227
29-Apr-04	9:27	4.64	0.50		60	<1	<1		65	0.21	4.44	<0.02	2.4	0.011	~0.021	~0.024	1.6	
13-May-04	8:47	4.32	0.61		60	~7	24		79	0.06	1.21	~0.04	2.4	0.083	0.149	0.180	1.4	241
27-May-04	8:45	5.28	11.82	18.6	60	~4	24	2.4	71	0.09	7.46	0.07	2.7	0.142	0.234	0.121	24.0	179
7-Jun-04	10:05	5.26	3.20	24.4	60	~2	4	1.3	75	0.14	11.60	0.10	3.0	0.178	0.292	0.196	3.0	232
9-Jul-04	8:17	4.38	0.24			~2	~4		51	0.09	1.90	~0.05	1.7	0.175	0.310	0.218	3.5	304
22-Jul-04	9:43	4.36	0.26	15.4	60	~1	~2	6.5	58	0.10	1.24	0.11	1.9	0.138	0.218	0.180	2.5	303

Reitz Lake Outlet

Proj. Station ID - CC7	Met Council Lab ID																	
Start Date	**Start Time**	**Stage**	**Discharge**	**Temp**	**Trans-parency**	**VSS**	**TSS**	**DO**	**COD**	**NO2**	**NO3**	**NH3**	**TKN**	**PO4**	**TP**	**Dissolved P**	**Turbidity**	**Alk as CaCO**
m/dd/yyyy	hh:mm	Feet	CFS	C	cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	mg/L
4/12/2004	9:35	4.18	1.51		55	~6	8		54	0.04	0.80	0.10	2.2	<0.005	0.097	~0.032	2.8	178
4/29/2004	8:54	4.62	3.25		60	4	6		50	0.09	0.77	0.26	2.5	0.053	0.141	0.055	2.4	155
5/13/2004	9:42	4.96	1.26		60	~2	4		50	0.13	0.87	0.27	2.0	0.112	0.181	0.158	2.3	179
5/27/2004	10:06	5.24	10.53		47	~8	41		55	0.06	2.63	0.16	2.1	0.101	0.192	0.097	14.0	168
6/7/2004	10:24	5.20	33.57			~5	23		57	0.08	1.03	~0.05	2.0	0.053	0.126	0.092	7.4	176
7/9/2004	8:40	3.78	0.49	18.7	48	8	11	3.3	57	0.15	3.40	0.84	3.7	0.085	0.240	0.126	8.0	198
7/22/2004	9:58	4.26	2.77	24.4	35	7	22	7.2	58	0.25	0.91	0.23	2.5	0.053	0.150	0.071	8.3	144
9/16/2004	9:50	3.50	0.03	13.6		~5	24	12.3	42	0.09	1.55	~0.03	1.5	0.095	0.182	0.114	6.7	216

Appendix B.2. 2004 In-Lake Water Quality Field and Lab Results, collected by Carver County Staff.

Date	TP (mg/L)	Secchi (m)	CLA (µg/L)
04/15/04	0.164	0.7	87
04/28/04	0.089	4.2	1.6
05/11/04	0.092	5.5	2
05/25/04	0.130	4.0	2.5
06/09/04	0.150	2.2	13
06/22/04	0.134		26
07/07/04	0.121	1.1	82
07/26/04	0.092		32
08/03/04	0.082	0.9	63
08/17/04	0.123	0.5	61
09/01/04	0.084	0.7	43
09/13/04	0.087	0.8	26
09/30/04	0.076	0.7	49
10/12/04	0.089	0.8	75

Appendix B.3. 1991 In-Lake Water Quality Field and Lab Results, obtained from EIMS database from the Metropolitan Council Environmental Services.

Date	TP (mg/L)	Secchi (m)	CLA (µg/L)
4/18/91	0.265	1.0	103
5/7/91	0.165	0.9	97
5/20/91	0.095	2.8	25
6/3/91	0.125	2.9	4
6/12/91	0.100	1.3	50
6/28/91	0.070	0.7	59
7/12/91	0.100	0.7	50
7/25/91	0.070	0.7	65
8/9/91	0.080	1.0	39
8/22/91	0.060	0.7	64
9/6/91	0.050	0.7	58
9/23/91	0.280	1.4	26

B.4. 2004 Flow Weighted Mean Concentration for R1

R1 Reitz Lake Inlet
TP 2004
Flow Weighted Mean and Adjusted Concentration

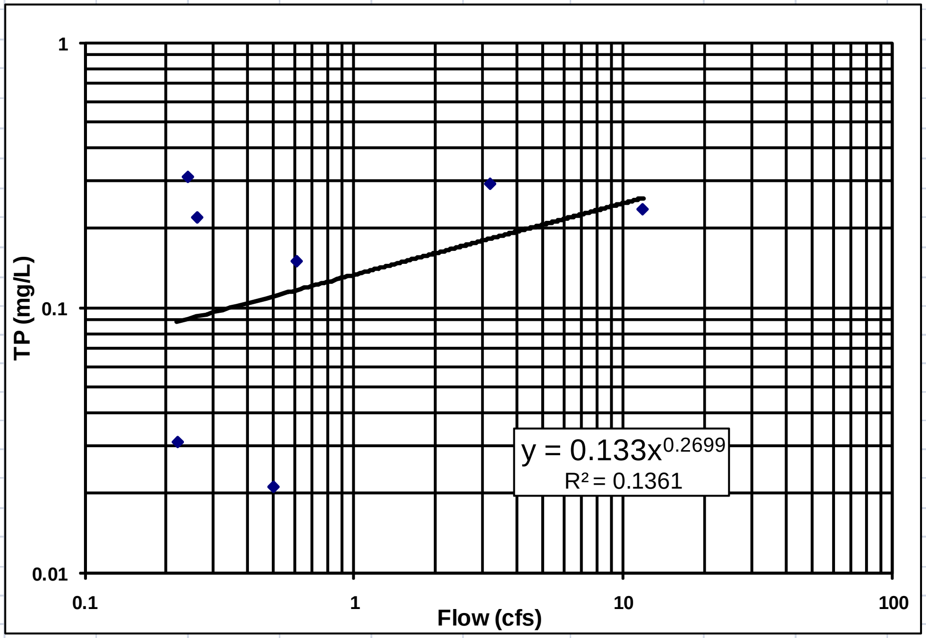
Sampling Point	**Begin Date**	**Begin Time**	**End Date**	**Total Phos** mg/L	**Sample Discharge** cfs	
Data Trimmed from "All Data" Sheet					**Calculations**	
					Sample q	**q*TP**
R1	13-Apr-04	12:51	13-Apr-04	0.031	0.2	0.0
R1	29-Apr-04	9:27	29-Apr-04	0.021	0.5	0.0
R1	13-May-04	8:47	13-May-04	0.149	0.6	0.1
R1	27-May-04	8:45	27-May-04	0.234	11.8	2.8
R1	7-Jun-04	10:05	7-Jun-04	0.292	3.2	0.9
R1	9-Jul-04	8:17	9-Jul-04	0.310	0.2	0.1
R1	22-Jul-04	9:43	22-Jul-04	0.218	0.3	0.1
			Sample Average q		***2.41***	
					Sum Q	**Sum Q*TP**
					16.85	3.9
					FWMC	**0.234**

2004 runoff from Carver Creek-wide calibration:

R1 runoff volume	1.19	hm^3/yr
R1 runoff volume	***965***	***ac-ft/yr***
R1 Yearly Average Q	***1.33***	***cfs***

multiply	**by**	**to obtain**
ac-ft/yr	1.380E-03	cfs
(mg/L) x (ac-ft)	2.719	lb
lb	0.4536	kg
hm^3	810.7	ac-ft

Flux Method



Sample Average q	**Yearly Average Q**	**slope b**
2.41	1.33	0.2699

Flow Adjusted Concentration = **FWMC*(Q/q)^b**

Flow Adjusted Concentration = **0.1993** **mg/L**

Annual Load = **522.8** **lb/yr** **237.1** **kg/yr**

R1 watershed area = **1,937** **ac**

P export = **0.270** **lb/ac-yr**

Appendix C: Bathtub Model Input and Output

Bathtub Model 1991

Model Coefficients	**Mean**	**CV**
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m^2/mg)	0.015	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

1991

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Description:

Global Variables	**Mean**	**CV**
Averaging Period (yrs)	1	0.0
Precipitation (m)	0.92	0.0
Evaporation (m)	0.8	0.0
Storage Increase (m)	0	0.0

Atmos. Loads (kg/km^2-yr)	**Mean**	**CV**
Conserv. Substance	0	0.00
Total P	20	0.50
Total N	1000	0.50
Ortho P	15	0.50
Inorganic N	500	0.50

Model Options	**Code**	**Description**
Conservative Substance	1	COMPUTED
Phosphorus Balance	8	CANF & BACH, LAKES
Nitrogen Balance	0	NOT COMPUTED
Chlorophyll-a	1	P, N, LIGHT, T
Secchi Depth	1	VS. CHLA & TURBIDITY
Dispersion	0	NONE
Phosphorus Calibration	1	DECAY RATES
Nitrogen Calibration	1	DECAY RATES
Error Analysis	1	MODEL & DATA
Availability Factors	0	IGNORE
Mass-Balance Tables	1	USE ESTIMATED CONCS
Output Destination	2	EXCEL WORKSHEET

Segment Morphometry

		Outflow		Area	Depth	Length	Mixed Depth (m)		Hypol Depth		Non-Algal Turb (m^{-1})		Internal Loads (mg/m2-day) Conserv.		Total P		Total N	
Seg	**Name**	**Segment**	**Group**	**km^2**	**m**	**km**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	Reitz Lake	0	1	0.37	3.97	1	3.9	0	0	0	0.2	0	0	0	0.5	0	0	0

Segment Observed Water Quality

	Conserv		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	0	0	103.9	0	2226	0	46.1	0	1.122	0	0	0	0	0	0	0	0	0

Segment Calibration Factors

	Dispersion Rate		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

Tributary Data

				Dr Area	Flow (hm^3/yr)		Conserv.		Total P (ppb)		Total N (ppb)		Ortho P (ppb)		Inorganic N (ppb)	
Trib	**Trib Name**	**Segment**	**Type**	**km^2**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	W1	1	1	4.96	0.7	0	0	0	177.7	0	0	0	0	0	0	0
2	W2	1	2	0.44	0	0	0	0	0	0	0	0	0	0	0	0
3	R1	1	1	7.84	1.38	0	0	0	199.9	0	0	0	0	0	0	0
4	Direct	1	2	1.04	0	0	0	0	0	0	0	0	0	0	0	0
5	W1 Septic	1	3	0	0.01	0	0	0	4130.3	0	0	0	0	0	0	0
6	W2 Septic	1	3	0	0.01	0	0	0	250.3	0	0	0	0	0	0	0
7	R1 Septic	1	3	0	0.01	0	0	0	5006.4	0	0	0	0	0	0	0
8	D1 Septic	1	1	0	0.01	0	0	0	2503.2	0	0	0	0	0	0	0

Tributary Non-Point Source Drainage Areas (km^2)

		Land Use Category--->							
Trib	**Trib Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	W1	0.38	1.72	2.04	0.81	0	0	0	0
2	W2	0.06	0.06	0.31	0	0	0	0	0
3	R1	0.44	1.52	5.03	0.85	0	0	0	0
4	Direct	0.28	0.22	0.49	0.05	0	0	0	0
5	W1 Septic	0	0	0	0	0	0	0	0
6	W2 Septic	0	0	0	0	0	0	0	0
7	R1 Septic	0	0	0	0	0	0	0	0
8	D1 Septic	0	0	0	0	0	0	0	0

Non-Point Source Export Coefficients

		Runoff (m/yr)		Conserv. Subs.		Total P (ppb)		Total N (ppb)		Ortho P (ppb)		Inorganic N (ppb)	
Categ	**Land Use Name**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	Urban	0.25	0	0	0	235	0	0	0	0	0	0	0
2	Forest	0.08	0	0	0	50	0	0	0	0	0	0	0
3	Agriculture	0.23	0	0	0	250	0	0	0	0	0	0	0
4	Wetland	0	0	0	0	38	0	0	0	0	0	0	0
5		0	0	0	0	0	0	0	0	0	0	0	0
6		0	0	0	0	0	0	0	0	0	0	0	0
7		0	0	0	0	0	0	0	0	0	0	0	0
8		0	0	0	0	0	0	0	0	0	0	0	0

1991

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Overall Water & Nutrient Balances

Overall Water Balance **Averaging Period = 1.00 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	W1	4.96	0.70	0.00E+00	0.00	0.14
2	2	1	W2	0.44	0.09	0.00E+00	0.00	0.21
3	1	1	R1	7.84	1.38	0.00E+00	0.00	0.18
4	2	1	Direct	1.04	0.20	0.00E+00	0.00	0.19
5	3	1	W1 Septic		0.01	0.00E+00	0.00	
6	3	1	W2 Septic		0.01	0.00E+00	0.00	
7	3	1	R1 Septic		0.01	0.00E+00	0.00	
8	1	1	D1 Septic		0.01	0.00E+00	0.00	
PRECIPITATION				0.37	0.34	0.00E+00	0.00	0.92
TRIBUTARY INFLOW				12.80	2.09	0.00E+00	0.00	0.16
NONPOINT INFLOW				1.48	0.29	0.00E+00	0.00	0.20
POINT-SOURCE INFLOW					0.03	0.00E+00	0.00	
***TOTAL INFLOW				14.65	2.75	0.00E+00	0.00	0.19
ADVECTIVE OUTFLOW				14.65	2.46	0.00E+00	0.00	0.17
***TOTAL OUTFLOW				14.65	2.46	0.00E+00	0.00	0.17
***EVAPORATION					0.30	0.00E+00	0.00	

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**
Component: **CONSERVATIVE SUBST.**

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance (kg/yr)^2	%Total	CV	Conc mg/m^3	Export kg/km^2/yr

Overflow Rate (m/yr)	6.6	Nutrient Resid. Time (yrs)	0.0000
Hydraulic Resid. Time (yrs)	0.5981	Turnover Ratio	0.0
Reservoir Conc (mg/m3)	0	Retention Coef.	0.000

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**
Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance (kg/yr)^2	%Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	W1	124.4	18.8%	0.00E+00		0.00	177.7	25.1
2	2	1	W2	21.6	3.3%	0.00E+00		0.00	237.0	49.1
3	1	1	R1	275.9	41.7%	0.00E+00		0.00	199.9	35.2
4	2	1	Direct	45.5	6.9%	0.00E+00		0.00	227.2	43.8
5	3	1	W1 Septic	41.3	6.2%	0.00E+00		0.00	4130.3	
6	3	1	W2 Septic	2.5	0.4%	0.00E+00		0.00	250.3	
7	3	1	R1 Septic	50.1	7.6%	0.00E+00		0.00	5006.4	
8	1	1	D1 Septic	25.0	3.8%	0.00E+00		0.00	2503.2	
PRECIPITATION				7.4	1.1%	1.37E+01	100.0%	0.50	21.7	20.0
INTERNAL LOAD				67.6	10.2%	0.00E+00		0.00		
TRIBUTARY INFLOW				425.3	64.3%	0.00E+00		0.00	203.5	33.2
NONPOINT INFLOW				67.1	10.1%	0.00E+00		0.00	230.3	45.3
POINT-SOURCE INFLOW				93.9	14.2%	0.00E+00		0.00	3129.0	
***TOTAL INFLOW				661.2	100.0%	1.37E+01	100.0%	0.01	240.3	45.1
ADVECTIVE OUTFLOW				255.2	38.6%	4.80E+03		0.27	103.9	17.4
***TOTAL OUTFLOW				255.2	38.6%	4.80E+03		0.27	103.9	17.4
***RETENTION				406.0	61.4%	4.80E+03		0.17		

Overflow Rate (m/yr)	6.6	Nutrient Resid. Time (yrs)	0.2309
Hydraulic Resid. Time (yrs)	0.5981	Turnover Ratio	4.3
Reservoir Conc (mg/m3)	104	Retention Coef.	0.614

1991

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Predicted & Observed Values Ranked Against CE Model Development Dataset

Segment: **1** **Reitz Lake**

	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	103.9	0.27	80.5%	103.9		80.5%
TOTAL N MG/M3	2226.0		89.4%	2226.0		89.4%
C.NUTRIENT MG/M3	89.1	0.20	87.4%	89.1		87.3%
CHL-A MG/M3	45.9	0.30	98.0%	46.1		98.1%
SECCHI M	1.1	0.25	52.2%	1.1		52.0%
ORGANIC N MG/M3	1217.8	0.28	96.8%			
TP-ORTHO-P MG/M3	82.3	0.33	85.6%			
ANTILOG PC-1	1382.0	0.44	90.7%	1014.7		86.1%
ANTILOG PC-2	19.0	0.10	98.1%	19.6		98.3%
(N - 150) / P	20.0	0.28	59.4%	20.0		59.4%
INORGANIC N / P	46.6	1.40	67.4%			
TURBIDITY 1/M	0.2		10.3%	0.2		10.3%
ZMIX * TURBIDITY	0.8		3.6%	0.8		3.6%
ZMIX / SECCHI	3.5	0.25	29.1%	3.5		29.3%
CHL-A * SECCHI	51.7	0.12	98.9%	51.7		98.9%
CHL-A / TOTAL P	0.4	0.29	89.9%	0.4		90.1%
FREQ(CHL-a>10) %	98.4	0.02	98.0%	98.4		98.1%
FREQ(CHL-a>20) %	84.8	0.13	98.0%	85.0		98.1%
FREQ(CHL-a>30) %	64.6	0.27	98.0%	64.9		98.1%
FREQ(CHL-a>40) %	46.4	0.41	98.0%	46.8		98.1%
FREQ(CHL-a>50) %	32.7	0.53	98.0%	33.0		98.1%
FREQ(CHL-a>60) %	22.9	0.64	98.0%	23.1		98.1%
CARLSON TSI-P	71.1	0.06	80.5%	71.1		80.5%
CARLSON TSI-CHLA	68.1	0.04	98.0%	68.2		98.1%
CARLSON TSI-SEC	58.3	0.06	47.8%	58.3		48.0%

Bathtub Model 2004

Model Coefficients	**Mean**	**CV**
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m^2/mg)	0.015	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

2004

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Description:

Global Variables	**Mean**	**CV**
Averaging Period (yrs)	1	0.0
Precipitation (m)	0.79	0.0
Evaporation (m)	0.8	0.0
Storage Increase (m)	0	0.0

Atmos. Loads (kg/km^2-yr)	**Mean**	**CV**
Conserv. Substance	0	0.00
Total P	20	0.50
Total N	1000	0.50
Ortho P	15	0.50
Inorganic N	500	0.50

Model Options	**Code**	**Description**
Conservative Substance	1	COMPUTED
Phosphorus Balance	8	CANF & BACH, LAKES
Nitrogen Balance	0	NOT COMPUTED
Chlorophyll-a	1	P, N, LIGHT, T
Secchi Depth	1	VS. CHLA & TURBIDITY
Dispersion	0	NONE
Phosphorus Calibration	1	DECAY RATES
Nitrogen Calibration	1	DECAY RATES
Error Analysis	1	MODEL & DATA
Availability Factors	0	IGNORE
Mass-Balance Tables	1	USE ESTIMATED CONCS
Output Destination	2	EXCEL WORKSHEET

Segment Morphometry

		Outflow		Area	Depth	Length	Mixed Depth (m)		Hypol Depth		Non-Algal Turb (m^{-1})		Internal Loads (mg/m2-day) Conserv.		Total P		Total N	
Seg	**Name**	**Segment**	**Group**	**km^2**	**m**	**km**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	Reitz Lake	0	1	0.3668	3.94	1.25	3.8	0	0	0	0.35	0	0	0	0.5	0	0	0

Segment Observed Water Quality

	Conserv		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	0	0	105.4	0	2100	0	44	0	0.99	0	0	0	0	0	0	0	0	0

Segment Calibration Factors

	Dispersion Rate		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

Tributary Data

				Dr Area	Flow (hm^3/yr)		Conserv.		Total P (ppb)		Total N (ppb)		Ortho P (ppb)		Inorganic N (ppb)	
Trib	**Trib Name**	**Segment**	**Type**	**km^2**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	W1	1	1	4.96	0.6	0	0	0	205.4	0	0	0	0	0	0	0
2	W2	1	2	0.44	0	0	0	0	0	0	0	0	0	0	0	0
3	R1	1	1	7.84	1.19	0	0	0	199.3	0	1900	0	138	0	0	0
4	Direct	1	2	1.04	0	0	0	0	0	0	0	0	0	0	0	0
5	W1 Septic	1	3	0	0.01	0	0	0	4130.3	0	0	0	0	0	0	0
6	W2 Septic	1	3	0	0.01	0	0	0	250.3	0	0	0	0	0	0	0
7	R1 Septic	1	3	0	0.01	0	0	0	5006.4	0	0	0	0	0	0	0
8	D1 Septic	1	3	0	0.01	0	0	0	2503.2	0	0	0	0	0	0	0

Tributary Non-Point Source Drainage Areas (km^2)

		Land Use Category--->							
Trib	**Trib Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	W1	0	0	0	0	0	0	0	0
2	W2	0.06	0.06	0.31	0	0	0	0	0
3	R1	0	0	0	0	0	0	0	0
4	Direct	0.28	0.22	0.49	0.05	0	0	0	0
5	W1 Septic	0	0	0	0	0	0	0	0
6	W2 Septic	0	0	0	0	0	0	0	0
7	R1 Septic	0	0	0	0	0	0	0	0
8	D1 Septic	0	0	0	0	0	0	0	0

Non-Point Source Export Coefficients

		Runoff (m/yr)		Conserv. Subs.		Total P (ppb)		Total N (ppb)		Ortho P (ppb)		Inorganic N (ppb)	
Categ	**Land Use Name**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
1	Urban	0.21	0	0	0	235	0	0	0	0	0	0	0
2	Forest	0.07	0	0	0	50	0	0	0	0	0	0	0
3	Agriculture	0.2	0	0	0	250	0	0	0	0	0	0	0
4	Wetland	0	0	0	0	38	0	0	0	0	0	0	0
5		0	0	0	0	0	0	0	0	0	0	0	0
6		0	0	0	0	0	0	0	0	0	0	0	0
7		0	0	0	0	0	0	0	0	0	0	0	0
8		0	0	0	0	0	0	0	0	0	0	0	0

2004

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Overall Water & Nutrient Balances

Overall Water Balance **Averaging Period = 1.00 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	W1	4.96	0.60	0.00E+00	0.00	0.12
2	2	1	W2	0.44	0.08	0.00E+00	0.00	0.18
3	1	1	R1	7.84	1.19	0.00E+00	0.00	0.15
4	2	1	Direct	1.04	0.17	0.00E+00	0.00	0.17
5	3	1	W1 Septic		0.01	0.00E+00	0.00	
6	3	1	W2 Septic		0.01	0.00E+00	0.00	
7	3	1	R1 Septic		0.01	0.00E+00	0.00	
8	3	1	D1 Septic		0.01	0.00E+00	0.00	
PRECIPITATION				0.37	0.29	0.00E+00	0.00	0.79
TRIBUTARY INFLOW				12.80	1.79	0.00E+00	0.00	0.14
NONPOINT INFLOW				1.48	0.25	0.00E+00	0.00	0.17
POINT-SOURCE INFLOW					0.04	0.00E+00	0.00	
***TOTAL INFLOW				14.65	2.37	0.00E+00	0.00	0.16
ADVECTIVE OUTFLOW				14.65	2.08	0.00E+00	0.00	0.14
***TOTAL OUTFLOW				14.65	2.08	0.00E+00	0.00	0.14
***EVAPORATION					0.29	0.00E+00	0.00	

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**

Component: **CONSERVATIVE SUBST.**

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance (kg/yr)^2	%Total	CV	Conc mg/m^3	Export kg/km^2/yr

Overflow Rate (m/yr)	5.7	Nutrient Resid. Time (yrs)	0.0000
Hydraulic Resid. Time (yrs)	0.6957	Turnover Ratio	0.0
Reservoir Conc (mg/m3)	0	Retention Coef.	0.000

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**

Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance (kg/yr)^2	%Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	W1	123.2	20.2%	0.00E+00		0.00	205.4	24.8
2	2	1	W2	18.7	3.1%	0.00E+00		0.00	236.9	42.4
3	1	1	R1	237.2	38.8%	0.00E+00		0.00	199.3	30.3
4	2	1	Direct	39.1	6.4%	0.00E+00		0.00	227.0	37.6
5	3	1	W1 Septic	41.3	6.8%	0.00E+00		0.00	4130.3	
6	3	1	W2 Septic	2.5	0.4%	0.00E+00		0.00	250.3	
7	3	1	R1 Septic	50.1	8.2%	0.00E+00		0.00	5006.4	
8	3	1	D1 Septic	25.0	4.1%	0.00E+00		0.00	2503.2	
PRECIPITATION				7.3	1.2%	1.35E+01	100.0%	0.50	25.3	20.0
INTERNAL LOAD				67.0	11.0%	0.00E+00		0.00		
TRIBUTARY INFLOW				360.4	58.9%	0.00E+00		0.00	201.3	28.2
NONPOINT INFLOW				57.8	9.4%	0.00E+00		0.00	230.1	39.0
POINT-SOURCE INFLOW				118.9	19.4%	0.00E+00		0.00	2972.5	
***TOTAL INFLOW				611.4	100.0%	1.34E+01	100.0%	0.01	257.9	41.7
ADVECTIVE OUTFLOW				218.5	35.7%	3.84E+03		0.28	105.2	14.9
***TOTAL OUTFLOW				218.5	35.7%	3.84E+03		0.28	105.2	14.9
***RETENTION				392.9	64.3%	3.85E+03		0.16		

Overflow Rate (m/yr)	5.7	Nutrient Resid. Time (yrs)	0.2486
Hydraulic Resid. Time (yrs)	0.6957	Turnover Ratio	4.0
Reservoir Conc (mg/m3)	105	Retention Coef.	0.643

2004

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Predicted & Observed Values Ranked Against CE Model Development Dataset

Segment: **1** **Reitz Lake**

	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	105.2	0.28	80.9%	105.4		81.0%
TOTAL N MG/M3	2100.0		87.6%	2100.0		87.6%
C.NUTRIENT MG/M3	88.3	0.20	87.1%	88.4		87.2%
CHL-A MG/M3	43.1	0.30	97.6%	44.0		97.8%
SECCHI M	1.0	0.22	46.1%	1.0		45.4%
ORGANIC N MG/M3	1166.6	0.28	96.1%			
TP-ORTHO-P MG/M3	81.0	0.32	85.2%			
ANTILOG PC-1	1382.1	0.43	90.7%	1090.9		87.3%
ANTILOG PC-2	16.8	0.12	96.6%	17.2		96.9%
(N - 150) / P	18.5	0.29	55.1%	18.5		54.9%
INORGANIC N / P	38.5	1.27	60.3%			
TURBIDITY 1/M	0.3		26.5%	0.3		26.5%
ZMIX * TURBIDITY	1.3		13.3%	1.3		13.3%
ZMIX / SECCHI	3.8	0.22	34.6%	3.8		35.4%
CHL-A * SECCHI	43.3	0.14	97.9%	43.6		98.0%
CHL-A / TOTAL P	0.4	0.29	87.7%	0.4		88.3%
FREQ(CHL-a>10) %	98.0	0.02	97.6%	98.1		97.8%
FREQ(CHL-a>20) %	82.4	0.15	97.6%	83.2		97.8%
FREQ(CHL-a>30) %	60.9	0.30	97.6%	62.1		97.8%
FREQ(CHL-a>40) %	42.5	0.45	97.6%	43.8		97.8%
FREQ(CHL-a>50) %	29.2	0.57	97.6%	30.3		97.8%
FREQ(CHL-a>60) %	20.0	0.69	97.6%	20.9		97.8%
CARLSON TSI-P	71.3	0.06	80.9%	71.3		81.0%
CARLSON TSI-CHLA	67.5	0.04	97.6%	67.7		97.8%
CARLSON TSI-SEC	60.0	0.05	53.9%	60.1		54.6%

Bathtub Model TMDL Benchmark

Model Coefficients	Mean	CV
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m^2/mg)	0.015	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

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Description:

Global Variables	Mean	CV
Averaging Period (yrs)	1	0.0
Precipitation (m)	0.79	0.0
Evaporation (m)	0.8	0.0
Storage Increase (m)	0	0.0

Atmos. Loads (kg/km^2-yr)	Mean	CV
Conserv. Substance	0	0.00
Total P	20	0.50
Total N	1000	0.50
Ortho P	15	0.50
Inorganic N	500	0.50

Model Options	Code	Description
Conservative Substance	0	NOT COMPUTED
Phosphorus Balance	8	CANF & BACH, LAKES
Nitrogen Balance	0	NOT COMPUTED
Chlorophyll-a	2	P, LIGHT, T
Secchi Depth	1	VS. CHLA & TURBIDITY
Dispersion	1	FISCHER-NUMERIC
Phosphorus Calibration	1	DECAY RATES
Nitrogen Calibration	1	DECAY RATES
Error Analysis	1	MODEL & DATA
Availability Factors	0	IGNORE
Mass-Balance Tables	1	USE ESTIMATED CONCS
Output Destination	2	EXCEL WORKSHEET

Segment Morphometry

		Outflow		Area	Depth	Length	Mixed Depth (m)		Hypol Depth		Non-Algal Turb (m^{-1})		Internal Loads (mg/m2-day) Conserv.		Total P		Total N	
Seg	Name	Segment	Group	km^2	m	km	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	Reitz Lake	0	1	0.37	3.97	1	3.9	0	0	0	0.08	0	0	0	0	0	0	0

Segment Observed Water Quality

	Conserv		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Segment Calibration Factors

	Dispersion Rate		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

Tributary Data

				Dr Area	Flow (hm^3/yr)		Conserv.		Total P (ppb)		Total N (ppb)		Ortho P (ppb)		Inorganic N (ppb)	
Trib	Trib Name	Segment	Type	km^2	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	Direct	1	1	1	2.044	0	0	0	76.52	0	0	0	0	0	0	0

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Overall Water & Nutrient Balances

Overall Water Balance

Averaging Period = 1.00 years

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	Direct	1.0	2.0	0.00E+00	0.00	2.04
PRECIPITATION				0.4	0.3	0.00E+00	0.00	0.79
TRIBUTARY INFLOW				1.0	2.0	0.00E+00	0.00	2.04
***TOTAL INFLOW				1.4	2.3	0.00E+00	0.00	1.71
ADVECTIVE OUTFLOW				1.4	2.0	0.00E+00	0.00	1.49
***TOTAL OUTFLOW				1.4	2.0	0.00E+00	0.00	1.49
***EVAPORATION					0.3	0.00E+00	0.00	

Overall Mass Balance Based Upon Predicted Outflow & Reservoir Concentrations

Component: TOTAL P

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance (kg/yr)^2	%Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	Direct	156.4	95.5%	0.00E+00		0.00	76.5	156.4
PRECIPITATION				7.4	4.5%	1.37E+01	100.0%	0.50	25.3	20.0
TRIBUTARY INFLOW				156.4	95.5%	0.00E+00		0.00	76.5	156.4
***TOTAL INFLOW				163.8	100.0%	1.37E+01	100.0%	0.02	70.1	119.6
ADVECTIVE OUTFLOW				81.5	49.7%	3.32E+02		0.22	39.9	59.5
***TOTAL OUTFLOW				81.5	49.7%	3.32E+02		0.22	39.9	59.5
***RETENTION				82.3	50.3%	3.35E+02		0.22		

Overflow Rate (m/yr)	5.5	Nutrient Resid. Time (yrs)	0.3581
Hydraulic Resid. Time (yrs)	0.7199	Turnover Ratio	2.8
Reservoir Conc (mg/m3)	40	Retention Coef.	0.503

File: **S:\Water\Water Monitoring\TMDL\TMDL\Lake TMDLs**

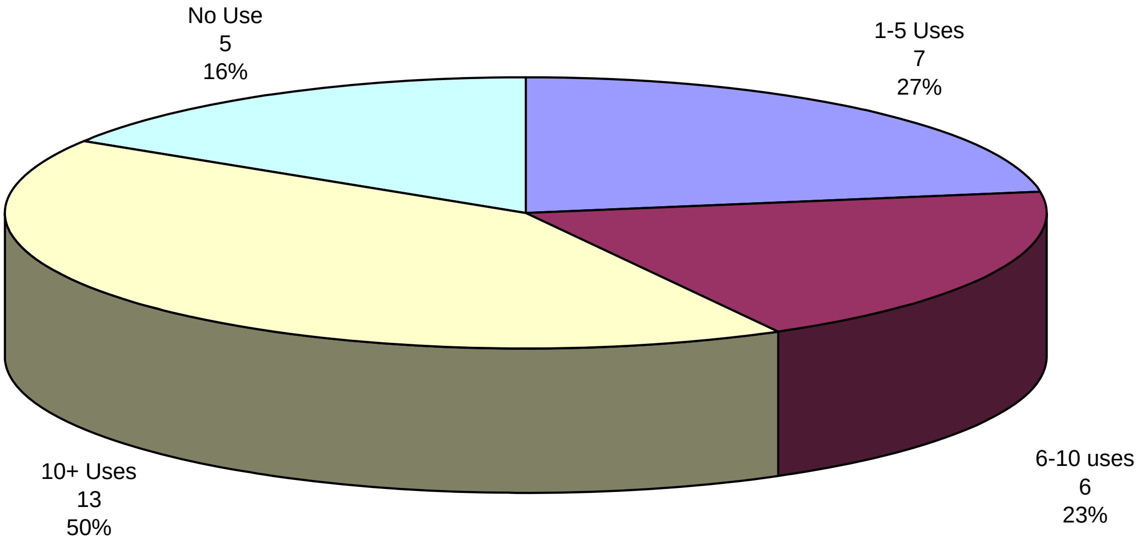
Predicted Values Ranked Against CE Model Development Dataset

Segment: **1** **Reitz Lake**

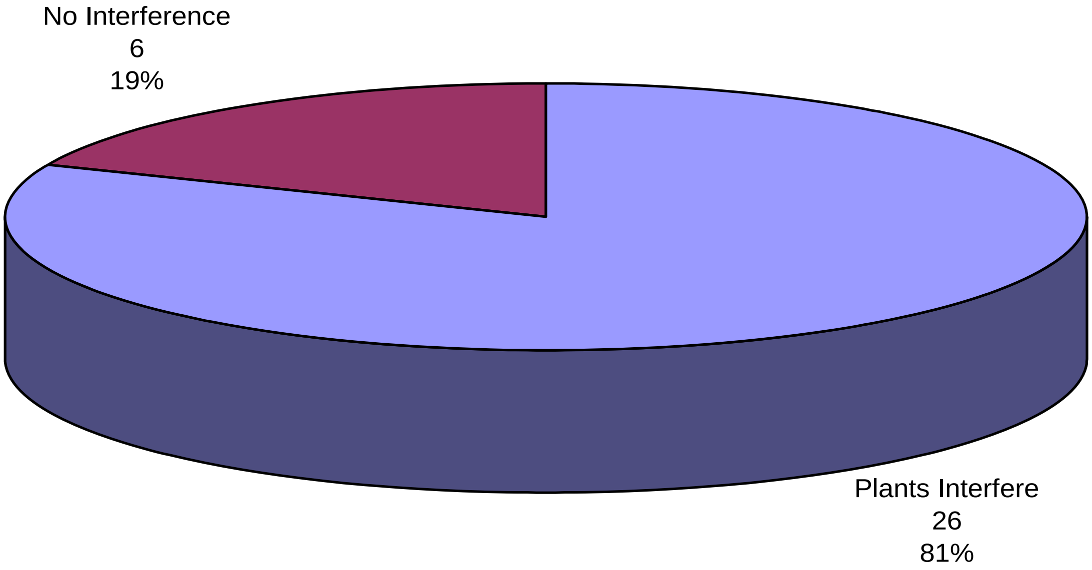
Variable	**Predicted Values---> Mean**	**CV**	**Rank**
TOTAL P MG/M3	39.9	0.22	42.0%
CHL-A MG/M3	22.1	0.34	86.7%
SECCHI M	2.4	0.29	85.7%
ORGANIC N MG/M3	666.4	0.29	74.8%
TP-ORTHO-P MG/M3	37.1	0.39	58.8%
ANTILOG PC-1	245.3	0.59	50.0%
ANTILOG PC-2	21.8	0.08	99.0%
TURBIDITY 1/M	0.1		1.1%
ZMIX * TURBIDITY	0.3		0.1%
ZMIX / SECCHI	1.6	0.29	3.1%
CHL-A * SECCHI	53.7	0.12	99.1%
CHL-A / TOTAL P	0.6	0.26	94.8%
FREQ(CHL-a>10) %	83.3	0.16	86.7%
FREQ(CHL-a>20) %	44.0	0.49	86.7%
FREQ(CHL-a>30) %	21.1	0.76	86.7%
FREQ(CHL-a>40) %	10.2	0.97	86.7%
FREQ(CHL-a>50) %	5.2	1.14	86.7%
FREQ(CHL-a>60) %	2.7	1.29	86.7%
CARLSON TSI-P	57.3	0.06	42.0%
CARLSON TSI-CHLA	61.0	0.06	86.7%
CARLSON TSI-SEC	47.2	0.09	14.3%

Appendix D: Lake User Survey Results

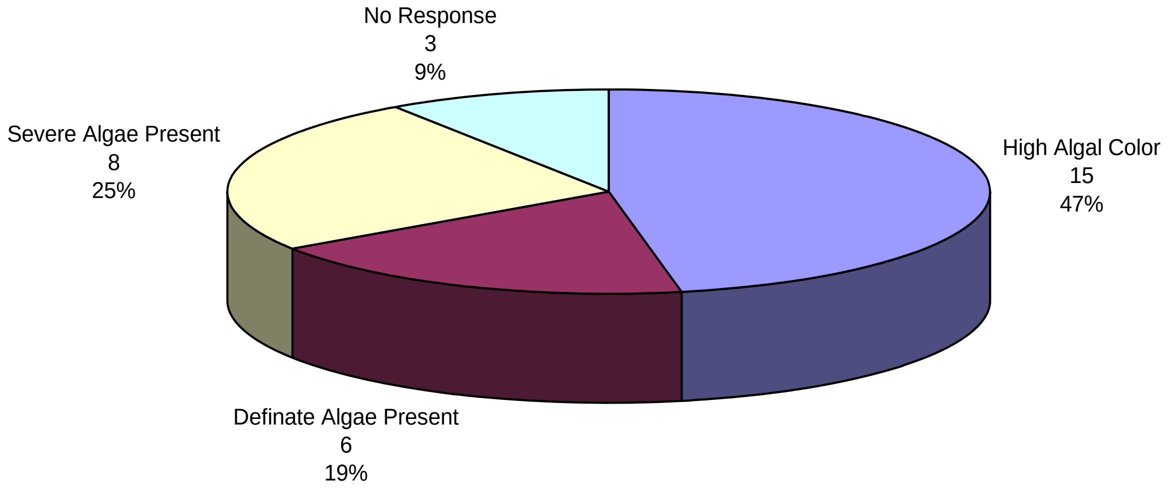
Frequency of Lake Uses in 2004 by Survey Respondents



Interference by plants?



Perception of Average Water Clarity During the Summer Months



Perception of Average Suitability for Recreation During Summer Months