IV. SURFACE WATER RESOURCES

A. Overview

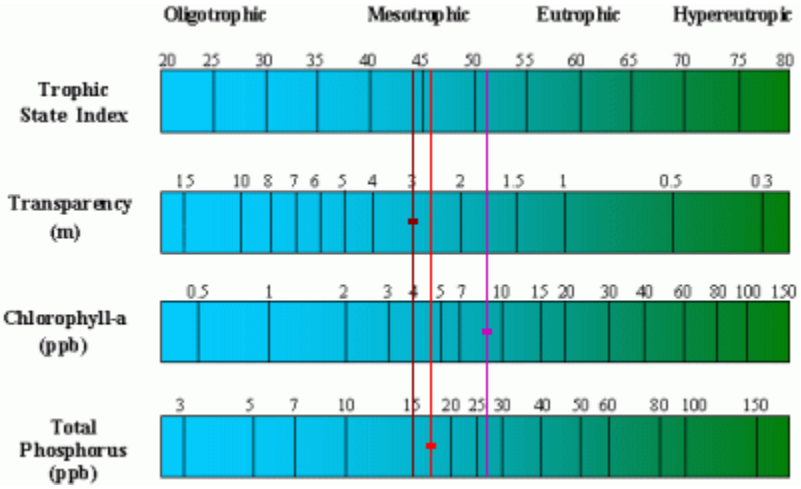
The current condition of the majority of Chanhassen's surface water resources is very good, with lake quality trends showing general improvements in water quality. There are a few exceptions to this trend, and the need to improve these waters and protect the quality of all City surface waters is the primary basis of this Plan. To support the City's goals to protect and improve water quality, each water body has been assigned a management classification based on the use, function and current water quality characteristics. This management classification system is shown in Table 20 for all surface waters except wetlands, and is intended to help City staff in managing the overall surface water management program. The classification system provides the basis for establishment of treatment requirements for future development projects and prioritizing opportunities to retrofit the existing City treatment system.

The basis for most water body designations is the Carlson Trophic State Index (TSI), which is a measure of a lake's trophic state. Trophic state is one way to measuring a lake's productivity, health and succession, and is designated as one of four categories ranging from Oligotrophic, which is typically crystal clear and very nutrient poor, to hypereutrophic, which has excess nutrients, and is frequently covered in thick vegetation and frequent algae blooms. Between these two extremes are mesotrophic and eutrophic, which are the most common classifications for the City's lakes. Trophic state is usually determined by collecting water samples from the lake and analyzing it for phosphorus concentration and chlorophyll a. Water clarity can also be measured physically using a Secchi disk to determine how far light penetrates the surface. Each of these values can be used to estimate a trophic state, although multiple samples are required to establish an overall state and to track changes over time.

Total phosphorus and chlorophyll-a are measured in micrograms per liter (μg/L), and Secchi disk transparency is measured in meters (3.281 feet per meter). The TSI scale ranges from 0 (ultra-oligotrophic) to 100 (hypereutrophic). High and/or increasing trophic status values indicate more eutrophic conditions (higher productivity). The following values are indicative of the conditions present for the range of TSI values possible

TSI < 30	Classical Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.
TSI 30 - 40	Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.
TSI 40 - 50	Water moderately clear, but increasing probability of anoxia in hypolimnion during summer.
TSI 50 - 60	Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.
TSI 60 - 70	Dominance of blue-green algae, algal scums probable, extensive macrophyte problems.
TSI 70 - 80	Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic.
TSI > 80	Algal scums, summer fish kills, few macrophytes, dominance of rough fish.

The following is an example of the water quality monitoring data for Lake Minnewashta compiled by the Minnesota Pollution Control Agency and presented on their website.



Major lakes in Chanhassen are classified in Table 20 as Management Class: Preserve; Improve-1, Improve-2 or Improve-3 water bodies. Storm water ponds are classified as Constructed. Table 20 also establishes a management strategy and storm water treatment level for each class of water resources. Figure 7 shows the locations of these water resources and the management class associated with each water feature. The management class is based on the water quality trends, designated uses and regulatory status (i.e., EPA's impaired waters list). For example, Lakes Lotus and Riley are classified as 'Improve-1' because these two lakes both have been identified as impaired due to excessive nutrients. There is not only a desire to improve the water quality; there is also a regulatory need for improvement in these lakes. Other examples are Lake Minnewashta and Lake Ann, which are classified as 'Improve-2' water bodies. Both of these lakes have relatively high water quality and steady to improving trends. The City wishes to continue the improving trends and will do so by continuing to manage the watershed to maintain and improve the quality of these water bodies.

This section of the Plan is intended to describe the key water bodies within Chanhassen according to their relative priority or management classification. Each water body or special feature is presented in the following sections, along with a summary of the information collected and analyzed for each water body to date, an assessment of any problems, and recommended implementation activities.

The Minnesota Pollution Control Agency (MPCA) has also identified a number of Outstanding Resource Value Waters (ORVW), requiring a higher level of protection (Minnesota Rules, Chapter 7050). Discharge to ORVWs is more stringently regulated than the other waters in the state because these waters have statewide significance or are unique and/or outstanding water resources. For example, if a project discharges to a trout stream designated as an ORVW, more stringent BMPs are required by the NPDES Construction Stormwater Permit and the City is required to manage these waters differently as part of its NPDES MS4 SWPPP. In the case of trout waters, the requirements include establishing BMPs that provide temperature control of the

storm water prior to discharge to the trout water. The Seminary Fen and Assumption Creek are both ORVWs.

Table 20. Water Management Classification for Chanhassen Water Features

Management Class	Management Strategy	Storm Water Treatment (3)	Water Resource	Use Designation (1)
Preserve	Preserve and improve, **impose highest standards**.	NURP Plus Enhanced Treatment	Seminary Fen	Calcareous Fen
			Assumption Creek	Trout Stream
Improve - 1	Goal to improve trends, **impose higher standards.** These waters are "impaired" see Table 21 for details. (2)	NURP Plus Enhanced Treatment	Lotus Lake	Recreational Development
			Lake Riley	Recreational Development
			Bluff Creek	Natural Stream
			Riley Creek	Natural Stream
Improve - 2	Goal to maintain or improve. Look for **opportunities to apply higher standards**.	NURP Enhanced Treatment if Opportunities Present	Lake Ann	Recreational Development
			Christmas Lake	Recreational Development
			Lake Minnewashta	Recreational Development
			Lake Susan	Recreational Development
Improve - 3	Goal to maintain water quality and keep long-term trends stable to improving	NURP	Harrison Lake	Natural Environment
			Lake Lucy	Recreational Development
			Rice Marsh Lake	Natural Environment
			Silver Lake	Natural Environment
			Lake St. Joe	Natural Environment
Constructed	NA	NA	Storm Water Ponds	Treatment System

(1) Use designation taken from the City's Comprehensive Plan.
(2) TMDL list of impaired waters for nutrients (Riley and Lotus Lakes), Turbidity (Bluff and Riley Creeks), Fish IBI (Bluff Creek). See Table 21 for additional information on TMDL listings including Mercury-impaired waters.
(3) Standards provided in Appendix D. NURP level is removal of 90% TSS, 60% TP. Enhanced treatment for one or more of the following: higher level of TSS/TP removal, additional discharge rate controls and/or temperature controls.

Waters that are on the TMDL list of impaired waters for one or more pollutants are shown in Table 21. One of the key considerations that is not fully addressed in this Plan is the waters listed on the Draft 2006 TMDL List of Impaired Waters. The City understands that the TMDL process is really just beginning and that the 2004 Final TMDL List of Impaired Waters (as required under Section 303(d) of the Clean Water Act) is updated every two years.

To date, approximately 8 percent of Minnesota's river miles and 14 percent of Minnesota's lakes have been tested for pollution problems. Approximately 40 percent of those tested are polluted with human and animal waste, phosphorus, suspended solids and mercury. As more of the states' surface waters are tested for pollution problems, the state will continue to add surface waters to the TMDL list. It is reasonable to assume that as more waters are assessed, then more waters will be listed as impaired in subsequent biennial cycles. When studies are completed, the TMDLs will likely be used by the MPCA and local entities to further prioritize management actions and establish additional regulatory controls.

The City will consider the listing of the lakes in Table 21 in future management decisions and actively manage the activities in the contributing watersheds to limit the delivery of these pollutants (primarily nutrients and sediment) to these waters. The City's approach to addressing potential pollutant loadings to these waters will be to evaluate the opportunities for a level of storm water "treatment" higher than the basic standards established in this Plan on a case-by-case basis prior to completion of the TMDL study and associated implementation plan.

Table 21. TMDL Listed Impaired Waters in Chanhassen

Receiving Water	Assessment ID or DNR Lake #	Affected Use	Pollutant or Stressor (1)
Lotus Lake	10-0006	Aquatic Recreation	Excess Nutrients
		Aquatic Consumption	Mercury FCA
Riley Lake	10-0002	Aquatic Recreation	Excess Nutrients
		Aquatic Consumption	Mercury FCA
Bluff Creek	07020012-510	Aquatic Life	Fish IBI
		Aquatic Life	Turbidity
Riley Creek	07020012-511	Aquatic Life	Turbidity
Lake Lucy	10-0007	Aquatic Consumption	Mercury FCA
Lake Ann	10-0012	Aquatic Consumption	Mercury FCA
Lake Susan	10-0013	Aquatic Consumption	Mercury FCA
Christmas Lake	27-0137	Aquatic Consumption	Mercury FCA
Lake Minnewashta	10-0009	Aquatic Consumption	Mercury FCA

(1) FCA = Fish Consumption Advisory

According to the MPCA's Draft Statewide Mercury TMDL Study, most of the mercury in Minnesota's fish comes from atmospheric deposition, with approximately 90 percent originating from outside the state. Because mercury has regional TMDL implications, little effort will be placed on TMDL recommendations related to mercury for these waters as part of this planning effort. The City will continue to review recommendations for mercury that may be offered by

EPA and/or MPCA to see if the regional approach to mercury has any future implications on the City. More detail on the progress of the statewide mercury TMDL process can be found on the MPCA's website.

B. Lakes

1. Background and Previous Findings

Nine of the twelve lakes located entirely or partially within the City of Chanhassen were discussed in the 1994 Surface Water Management Plan. The 1994 Plan described historic and existing water quality, biological quality, lake and watershed quality conditions and trends. The 1994 Plan summarized existing data, and then recommended future studies and management needs and objectives for each of the nine lakes and the community as related to these lakes. Priorities and planning needs were established for each lake and included both short and long term goals and objectives. The nine lakes addressed in the 1994 Plan were; Riley, Rice Marsh, Susan, Ann, Lucy, Minnewashta, Lotus, Christmas, and St. Joe. The City's Comprehensive Plan lists two additional 'natural environment' lakes: Harrison Lake and Silver Lake. Rice Lake is located in the southeast corner of the City, on the border of Chanhassen and Eden Prairie. These three lakes were not evaluated in the 'Lakes' section of the 1994 Plan. Table 22 provides a summary of the basic physical characteristic of each of the 12 lakes in Chanhassen.

The 1994 Plan defined and classified each lake according to the conditions and qualities that were revealed through previous studies, lake monitoring, or through geospatial data interpretations. Previous studies include aquatic vegetation surveys, lake water quality studies, and lake management plans conducted for any of the nine referenced lakes. The 1994 Plan utilized the Minnesota Department of Natural Resources (MNDNR) Ecological Classification System to establish and model a baseline condition for future monitoring, lake management, and restoration goals. The 1994 Plan then identified and prioritized monitoring and lake management needs, goals, and objectives. These recommendations and priorities range widely in content for the individual lakes, and include education, management, engineering, and biological based topics.

This 2006 SWMP Update included a review of the 1994 Plan as well as a review of the studies completed and the lake monitoring data available since 1994. The City participates in the Citizen Assisted Monitoring Program (CAMP), and currently Lake St. Joe, Lotus Lake, Lake Susan, and Riley Lake are monitored as part of this program. The Metropolitan Council monitors water quality and level of Bluff Creek at the intersection of existing TH 212 and TH 101.

Table 22. Lake Physical Characteristics

Lake	Lake Surface Area (ac)	Max. Depth (ft)	Watershed Area (ac)	NWL	OHW	100-yr HWL	Lake Recreational Uses
Ann	116	45	257	955.2	955.5	956.0	Boating (electric motors only), fishing, and swimming,.
Christmas	257	87	410		932.8		Boating, fishing and swimming.
Harrison			(1)		993.6		
Lotus	246	29	1,340	895.4	896.3	896.7	Boating, fishing, and swimming.
Lucy	92	20	972	955.2	956.1	956.8	Boating, fishing, and swimming
Minnewashta	738	70	2,653	942.2	944.5	943.1	Boating, fishing and swimming.
Rice Marsh	79	11	934	874.8	877.0	876.62	
Rice					699.2		
Riley	297	49	1,667	862.8	865.3	864.2	Boating, fishing and swimming.
Silver			N/A	898.53	898.1		
Susan	93	17	1,330	881.4	881.8	885.5	Boating, fishing and swimming.
St. Joe	14	52	204	945.4	945.2	946.3	Boating, fishing and swimming.

(1) Lake Harrison watershed area included in Lake Lucy watershed area.

In general, the recommendations confirm that the continued monitoring of transparency by Secchi disc readings and sampling of water quality (primarily phosphorus) are the most important activities to monitor the long-term trends in water quality of the City's lakes. Each lake will have its own needs for monitoring that are discussed more in the sections that follow. This review focused on general trends and activities and, as such, does not in all cases provide specific recommendations for additional parameters, monitoring locations or frequencies. In some cases these recommendation are provided, while for others the details are best left to results of more detailed lake management planning efforts or diagnostic studies.

2. Methods and Approach

The objectives of this discussion are three-fold. The first objective is to identify, summarize and compare studies and lake monitoring results completed on the nine lakes since the 1994 Plan, and to establish some trends and gaps in information. The second objective involves the review and reclassification, if necessary, of each lake's watershed land use determinations and nutrient budgets. The third objective is to develop or revise short and long-term lake management

strategies and goals to improve or manage these valuable natural resources towards trends associated with high quality lakes in the Ecoregion. It should also be recognized that there have been advances in lake management methods and data analysis; and these approaches will be referenced and incorporated into the findings when appropriate. The first two objectives are addressed below for each lake while the third objective is addressed globally following the discussion of each lake.

a. Lake Ann (MNDNR I.D. No. 10-12P)

Lake Ann is located partially within a City of Chanhassen Municipal Park northwest of the downtown area. Lake Ann has a surface area of 116 acres, a maximum depth of 45 feet and a maximum depth of plant growth at 13 feet. The Ordinary High Water (OHW) level for Lake Ann is 955.5 ft above Mean Sea Level (MSL). Plant growth is categorized as abundant and the dominant bottom substrate is sand, detritus and muck. Public access is provided through a concrete boat ramp located within the municipal park. Boats are restricted to non-motorized use and electric motors.

Numerous studies and plans have been completed on Lake Ann, starting with the monitoring of the lake water levels by the MNDNR in 1959. Water quality studies and monitoring events occurred in 1994 and 2003. The following two studies were also generated on Lake Ann:

- Aquatic Plant Surveys for Ann Lake, Chanhassen, Minnesota; May 2004 – results of early summer survey in June 2003 and fall survey in September 2003.
- Chanhassen Water Quality Monitoring Results for Ann, Lucy, Rice Marsh, and Susan for 2003.

These two studies, coupled with the 1994 Plan results, indicate that Lake Ann has maintained its condition of a relatively healthy lake system. Utilizing the Metropolitan Council (Met Council) grading criteria for metropolitan lakes (see criteria in Appendix F), Lake Ann was graded A for all three categories of water quality: Secchi disc average (water clarity), total phosphorus, and chlorophyll a. A grade of A is the highest quality ranking for these three parameters. Water clarity appears to have improved since the 1994 Plan, when the average transparency value was 4.8 feet compared to the 2003 studies when it was 11.0 feet.

The Aquatic Plant Survey results also identify some trends for Lake Ann. The establishment of Eurasian watermilfoil (*Myriophyllum spicatum*), a nuisance/exotic species, was first identified in Lake Ann by the MNDNR in 1995. Despite the widespread distribution and relatively high densities of Eurasian watermilfoil, Lake Ann's aquatic vegetation community has continued to maintain high species diversity and establishment of desirable species within both the submergent and emergent vegetation communities. Curlyleaf pondweed (*Potamegeton crispus*), another potential nuisance species, has also become established, but has not expanded aggressively throughout Lake Ann. Whether or not this pondweed species will be a problem remains to be seen. Perturbations in water quality typically drive pondweed growth invasions and given the stable conditions, the probability of pondweed expansion may be low for Lake Ann.

The 1994 plan identified Lake Ann as a mesotrophic lake in accordance with the data obtained. The Plan further referenced that Lake Ann is borderline eutrophic and should be given high priority for maintaining the mesotrophic status. Lake Ann was also identified as thermally stratified with a defined thermocline. The stratification may account for the unusually high phosphorus readings sampled in the lower strata (hypolimnion).

The existing management and water quality BMPs that have been implemented within the Lake Ann watershed, the position of the lake within a City Park and undeveloped properties, and other implemented management approaches will maintain the Met Council overall lake quality ranking of A. Future monitoring and implementation activities should focus on:

- Monitoring the health and diversity of the lake's aquatic vegetation community, with a special emphasis on Eurasian watermilfoil and curlyleaf pondweed management.
- Additional water quality monitoring events should occur at least once per every five years. Monitoring the phosphorus levels, especially within the hypolimnion, and secchi disc sampling should occur monthly every year during the summer months.
- Continue to follow the recommendations for Lake Ann in the 1994 Plan.

The 1994 Plan identified a list of proposed storm water ponds within the Lake Ann subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 23 is a summary of the proposed storm water ponds in the Lake Ann subwatershed.

Table 23. Lake Ann Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Improve-2	LA-P1.7, LA-P1.13
Second	Improve-2	LA-P1.5
Fourth	Improve-2	LA-P1.2
Eighth	Improve-2	LA-P1.9

The RPBCWD completed a Use Attainability Analysis (UAA) for Lake Lucy and Lake Ann in 1999. The UAA set specific goals and recommendations for water quality and quantity in the Lake Ann Watershed. The following recommended BMPs were included in the UAA:

- Preserve all existing wetlands in the watershed.
- Add five ponds in the Lake Ann watershed in areas that contribute significant particulate phosphorus loads to each lake.
- Provide infiltration basins throughout the Lake Ann watershed in areas that experience a significant change in impervious area between existing and future (Year 2020) land use conditions.
- Manage the lake's macrophytes by continuing to survey communities in order to detect nuisance, non-native growths.

Refer to Figure Ex-8 in the Lake Lucy and Lake Ann UAA for the proposed locations for upgraded and additional storm water ponds. Most of the recommended locations for additional storm water ponds in the Lake Ann watershed are addressed in Appendix I of the Plan. The City will continue to work with the RPBCWD as opportunities arise to construct the additional storm water treatment ponds in the Lake Ann watershed.

b. Christmas Lake (MNDNR I.D. No. 27-137P)

Christmas Lake is located mostly within the City of Shorewood, but a small portion of it extends into the north-central portion of the City of Chanhassen. Christmas Lake has a surface area of 257 acres, a maximum depth of 87 feet. The OHW level for Christmas Lake is 932.77 above MSL. Public access is provided by a concrete boat ramp on the northwest bay. Christmas Lake was partially evaluated in the 1994 Plan under the "Drainage to Neighboring Communities" section.

A Christmas Lake Management Plan was completed in 1996 and partially funded by the City of Chanhassen, the City of Shorewood, and the Christmas Lake Home Owners Association. In summary, the management plan provided the following observations, analyses, and recommendations.

Christmas Lake has a surface area of 257 acres and a watershed of approximately 410 acres. Water quality studies on Christmas Lake extend as far back as 1908, and included chemical analyses in 1993 and 1994. The lake is strongly thermally stratified with a well defined thermocline and a very oxygen-poor hypolimnion. Nutrients, in particular phosphorus, are in low to moderate concentrations and appear to be stable. The aquatic vegetation community is diverse, but Eurasion watermilfoil was first documented in 1992 and curlyleaf pondweed has also invaded. Both nuisance species are being monitored and controlled when necessary. Christmas Lake is a "two-story" fishery with warm water species in the warmer hyperlimnion and shallows depths, and cold water species (MNDNR stocked rainbow trout) in the hypolimnion and deeper, colder depths.

The Christmas Lake Management Plan includes management and improvement recommendations that are either in-lake or within the watershed. Most of these are outside of the City of Chanhassen, with the exception of the recommendations established in the 1994 SWMP. The recommendations for Christmas Lake are to:

- Implement BMPs in the Chanhassen areas tributary to the lake, as opportunities arise, that address storm water runoff management and nutrient runoff controls (i.e., ponding areas).
- Continue to follow the 1994 SWMP recommendations and install ponding areas based on the classification system (priority basis) of this Plan if they have not yet been implemented (see Appendix I).

The 1994 Plan identified a list of proposed storm water ponds within the Christmas Lake subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond

from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 24 is a summary of the proposed storm water ponds in the Christmas Lake subwatershed.

Table 24. Christmas Lake Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
Fifth	Improve-2	CL-P1.2A
Sixth	Improve-2	CL-P2.2
Eighth	Improve-2	CL-P1.1

The MCWD's 3rd Generation Water Management Plan, which is in the process of being completed, sets phosphorus loading reduction goals for the cities in the watershed. In the Christmas Lake subwatershed, the phosphorus loading reduction goal for Chanhassen is 7 lbs/year. By constructing two of the proposed ponds in Appendix I, ponds CL-P1.2A and CL-P2.2, Chanhassen will be meeting this phosphorus reduction goal.

c. Lotus Lake (MNDNR I.D. No. 10-6P)

Lotus Lake is located in the northeast corner of the City of Chanhassen. Lotus Lake has a surface area of 246 acres, and a maximum depth of 29 feet. The OHW level for Lotus Lake is 896.3 ft above MSL. Lotus Lake is classified as eutrophic. Access is provided at South Lotus Lake Park located on the south end of the lake.

Lotus Lake has been monitored for water clarity sporadically since at least 1979. Secchi disc readings taken in 1979, 1980, 1988, 1989, 1990, 1991, 1993 and 2004 show a gradual improvement trend in water clarity. The 1979 average reading was 2.8 feet and the most recent reading (2004) was 5.2 feet. Lotus Lake's water clarity ranges from "acceptable" to "good", and is "impaired" for recreational use (a common ranking for Metropolitan area lakes) according to the Met Council. Past monitoring and the 1993 Plan studies also demonstrated that chlorophyll a values and high phosphorus value increases in Lotus Lake are coupled with decreases in water clarity, another expected trend.

An Aquatic Plant Survey for Lotus Lake was completed in 2004. Eurasian watermilfoil (*Mynophyllum spiratum*) was first documented in 1989 and is the second most abundant species in the lake, with coontail (*Ceratophyllum demersum*) being the most abundant. Curlyleaf pondweed has also become well established. Six species of submergent and six emergent species were documented. Emerged vegetation grew to a depth of seven feet in Lotus Lake. The 1994 Plan also identified some stands of purple loosestrife (*Lythrum salicaria*) within fringe and adjacent wetland basins. Lastly, American lotus (*Nelumbo lutea*) was also identified in the Aquatic Plant Survey. The American Lotus is listed as a 'DNR Protected Wild Flower' on the DNR's website and no removal is allowed.

In addition to the storm water and surface water based recommendations that were provided in the 1994 Plan, additional recommendations here include:

- Focusing on the management of nuisance invasive/exotic species, primarily Eurasian watermilfoil, curlyleaf pondweed and purple loosestrife.
- Control of Eurasian watermilfoil is critical, especially in light of the presence of the American lotus. Eurasian watermilfoil could potentially out-compete and eliminate lotus and other species from the lake. The extensive coverage established by Eurasian watermilfoil in Lotus Lake warrants the need for control. Curlyleaf pondweed should be monitored and controls implemented if it becomes dominant.
- Purple loosestrife control should be continued or initiated and biocontrol agents (beetles) seem to be the best long-term solution.

The 1994 Plan identified a list of proposed storm water ponds within the Lotus Lake subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table _ is a summary of the proposed storm water ponds in the Lotus Lake subwatershed.

Table 25. Lotus Lake Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Improve-1	LL-P7.5
Second	Improve-1	LL-P9.2, LL-P10.17
Third	Improve-1	LL-P2.2, LL-P6.6
Fourth	Improve-1	LL-P6.7
Fifth	Improve-1	LL-P2.1
Sixth	Improve-1	LL-P2.5
Seventh	Improve-1	LL-P8.1, LL-P8.2

The RPBCWD completed a Use Attainability Analysis (UAA) for Lotus Lake in 2005. The UAA set specific goals and recommendations for water quality in Lake Lotus. It was determined in the UAA that watershed loading provides approximately 23 percent of the annual total phosphorus to the lake, while internal loading (caused by direct release of phosphorus from lake sediments) provides approximately 62 percent of the annual total phosphorus to the lake. The UAA also states that improving the lake's water clarity will likely result in increased curlyleaf pondweed and Eurasian water milfoil unless a vegetation management program is completed first. Therefore following implementation plan was selected for the management of aquatic plants and water quality in Lotus Lake:

- Herbicide treatment of curlyleaf pondweed and Eurasian watermilfoil for 4 years followed by 3 consecutive years of alum treatment.
- Beetles (*Galerucella pusilla, Galerucella calmariensis)* will be introduced in purple loosestrife infested areas to control shoreline purple loosestrife and promote native vegetation.

The City will continue to work with the RPBCWD on the implementation plan for the Lotus Lake.

d. Lake Lucy (MNDNR I.D. No. 10-7P)

Lake Lucy is located within the central portion of the City of Chanhassen, northwest of the downtown area and immediately north of Lake Ann. Lake Lucy has a surface area of 92 acres, a maximum depth of 20 feet, and a maximum depth of plant growth of 10 feet. The OHW level for Lake Lucy is 956.1 MSL. Plant growth is abundant and the bottom substrate is muck, detritus, and sand. The vast majority of land on Lake Lucy is privately owned and, therefore, public access is not available except through the channel connecting with Lake Ann, which is neither permanent nor maintained to provide human or vehicular access

Starting in 1990, Lake Lucy has been monitored for water clarity annually. Average secchi disc readings during this period have varied from a low of 2.6 feet in 1998 to a high of 5.3 feet in 2002. The remaining readings have varied within these two extremes. The water clarity, phosphorus and chlorophyll a trends assessed under the Met Council's criteria indicate that Lake Lucy's overall water quality fluctuates between "impaired" to "severely impaired". High phosphorus is attributed as the main source of the poor water quality. Since the late 1980s, the source of the phosphorus has shifted from agricultural to urban storm water run-off sources. The trend was determined through a lake modeling study completed during the preparation of the 1994 Plan.

Single family housing developments are currently the largest source of the storm water run-off and pollutant loading in the Lake Lucy watershed. Some of the loading results from human activities like fertilizing lawns and spillage of the fertilizers or grass clippings into the streets where it has a more direct route to the lake. Also, there are few storm water ponds in the subwatershed. Previous modeling demonstrated that, under the present and future land use conditions with "NURP-level" storm water management practices (i.e., treatment consistent with the City's NURP standard), Lake Lucy will not degrade further, but it also will not likely improve.

In 2003 a water quality study was completed on Lake Lucy. The average secchi disc reading was 6.9 feet, a significant improvement over the previous years' values. Phosphorus and chlorophyll a values also show an improving water quality trend. The Met Council grades for each of these three parameters is "C", "B-", and "B+" respectively. The Overall Quality value for Lake Lucy was B. These results suggest that Lake Lucy's water quality may be improving.

An Aquatic Plant Survey for Lake Lucy was also completed in 2003. Eurasian watermilfoil, first confirmed in 1989, was not present in the 2003 survey. This may be the result of a species misidentification in 1989. The 2003 survey identified northern milfoil (*Myriophyllum sibricum*), a similar-looking related species that is native and not considered a nuisance species. Eurasian watermilfoil was observed in Lake Lucy during the wetland inventory, so it is still present. Curlyleaf pondweed was present and comprised nearly half of the submergent vegetative community. Coontail was the most abundant of the 11 submergent species identified and two emergent species were identified. The maximum depth of plant establishment was 10 feet.

The storm water quality, wetland restoration/management, and lake management recommendations discussed in the 1994 Plan should be revaluated and updated due to the land

use changes within the lake watershed. Recent studies suggest that water quality may be improving. Specific recommendations for Lake Lucy include:

- Curlyleaf pondweed should be monitored and a control/management plan should be developed.
- A Lake Lucy Lake Management Plan is recommended to identify if the lake water quality is improving and the sources driving this improvement.
- A vegetation management plan should be developed separately or as part of an updated Lake Management Planning project.

The 1994 Plan identified a list of proposed storm water ponds within the Lake Lucy subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 26 is a summary of the proposed storm water ponds in the Lake Lucy subwatershed.

Table 26. Lake Lucy Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
Second	Improve-3	LU-P3.4
Third	Improve-3	LU-P5.2, LU-P5.14, LU-P5.16
Fourth	Improve-3	LU-P5.13
Fifth	Improve-3	LU-P5.12
Sixth	Improve-3	LU-P5.3
Seventh	Improve-3	LU-P6.1
Eighth	Improve-3	LU-P2.6, LU-P5.4, LU-P5.10, LU-P6.2

The RPBCWD completed a Use Attainability Analysis (UAA) for Lake Lucy and Lake Ann in 1999. The UAA set specific goals and recommendations for water quality and quantity in the Lake Lucy Watershed. The following recommended BMPs were included in the UAA:

- Preservation of al existing wetlands in the Lake Lucy watershed.
- Upgrade two ponds in the Lake Lucy watershed to provide more wet detention for stormwater treatment.
- Add seven ponds in the Lake Lucy watershed areas that contribute significant particulate phosphorus loads to the lake.

Refer to Figure Ex-8 in the Lake Lucy and Lake Ann UAA for the proposed locations for upgraded and additional storm water ponds. Most of the recommended locations for additional storm water ponds in the Lake Lucy watershed are addressed in Appendix I of the Plan. The City will continue to work with the RPBCWD as opportunities arise to construct the additional storm water treatment ponds in the Lake Lucy watershed.

e. Lake Minnewashta (MNDNR I.D. No. 10-9P)

Lake Minnewashta is located in the northwestern portion of the City of Chanhassen. Lake Minnewashta has a surface area of 738 acres, a maximum depth of 70 feet, and a maximum depth of plant growth at 8 feet. The OHW level is 944.5 MSL. Plant growth is categorized as abundant and the bottom substrate is comprised of sand, detritus, and muck. Public access is available at two locations within Lake Minnewashta Regional Park.

Water quality sampling data on Lake Minnewashta is fairly extensive. Water transparency sampling has occurred annually since 1978. The Met Council ranks Lake Minnewashta as "very good" with regards to water quality, and that is reflected in the average annual secchi disc readings at or around 7 feet and the low phosphorus readings which are well within the ecoregion value standard. Lake Minnewashta is classified as mesotrophic and this trophic status is stable.

After completion of the 1994 Plan, additional studies were completed on Lake Minnewashta, including a Lake Management Plan in 1995 and an Aquatic Plant Survey in 2001. The primary objective established in the Lake Management Plan was maintaining the lake at the ecoregion values through the maintenance of water transparency averages at 5 to 7 feet, and phosphorus values below 40 parts per billion (ppb). Another objective was to develop an approach to implement Eurasian watermilfoil control/management, ultimately leading to the Aquatic Plant Survey.

The Aquatic Plant Survey confirmed the extent of the Eurasian watermilfoil infestation, first detected in 1989. Eurasian watermilfoil vegetative coverage exceeded 50% during the first half of the summer. Curlyleaf pondweed was also detected, but in relatively lower abundances compared to Eurasian watermilfoil. Nevertheless, curlyleaf pondweed does have the potential to expand and become a concern, and monitoring is recommended. Despite the presence and extent of these nuisance species, Lake Minnewasta's aquatic vegetation community is diverse and rich with desirable species. Approximately 21 submergent, 3 floating, and 4 emergent species were identified.

The Lake Management Plan for Lake Minnewashta identified and appended additional information to the water quality improvement and storm water management needs within the lake's watershed. Wetland quality and restoration potential were also analyzed. The physical, chemical and biological aspects of the lake were analyzed and summarized in the plan, and the results were utilized to model and predict future in-lake trends and management needs. The Lake Management Plan utilized these findings to develop short and long-term implementation strategies including the following:

- Continue to implement storm water management and wetland restoration projects within the Lake Minnewashta watershed.
- Monitor adjacent wetlands for phosphorus input.
- Educate and promote conservation, water quality, and lake management BMPs to watershed residents, for example, through the MNDNR's lakescaping program.

- Implement vegetation management, restoration, and nuisance/invasive species control including both within the lake (Eurasian watermilfoil) and watershed (purple loosestrife).
- Curlyleaf pondweed has the potential to expand and ongoing monitoring is recommended.

The 1994 Plan identified a list of proposed storm water ponds within the Lake Minnewashta subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table _ is a summary of the proposed storm water ponds in the Lake Minnewashta subwatershed.

Table 27. Lake Minnewashta Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Improve-2	LM-P4.2, LM-P5.2, LM-P7.5, LM-P8.11
Second	Improve-2	LM-P1.12, LM-P3.16, LM-P5.20, LM-P8.8
Third	Improve-2	LM-P1.5, LM-P4.3, LM-P8.10
Fourth	Improve-2	LM-P1.6, LM-P3.2, LM-P3.13
Fifth	Improve-2	LM-P1.9, LM-P3.15, LM-P5.6
Sixth	Improve-2	LM-P3.1, LM-P3.8, LM-P3.10, LM-P5.3, LM-P5.5
Seventh	Improve-2	LM-P5.4, LM-P5.14
Eighth	Improve-2	LM-P5.21, LM-P8.1

The MCWD's 3rd Generation Water Management Plan, which is in the process of being completed, sets phosphorus loading reduction goals for the cities in the watershed. In the Lake Minnewashta subwatershed, the phosphorus loading reduction goal for Chanhassen is 27 lbs/year. By constructing the first nine prioritized ponds listed in Appendix I, Chanhassen will be meeting this phosphorus reduction goal by removing approximately 28 lbs/year. The nine ponds include:

- LM-P4.2
- LM-P5.2
- LM-P1.12
- LM-P3.16
- LM-P5.20
- LM-P8.8
- LM-P1.5
- LM-P4.3
- LM-P8.10

f. Rice Lake (MNDNR I.D. No. 27-132P)

Rice Lake is located in the southeast corner of the City of Chanhassen, on the border of Chanhassen and Eden Prairie. The Lower Minnesota River Watershed District (LMRWD) Plan describes Rice Lake as a floodplain lake. Bluff Creek flows into Rice Lake, and it is located within the Raguet Wildlife Management Area. Very little water quality information is available on this lake. According the LMRWD Plan, floodwaters from the Minnesota River contribute a large portion of the overall nutrients and sediments to this lake, and once the flooding subsides the high sediment and nutrient loads are trapped in the lakes. The LMRWD Plan states that improvement to the Minnesota River water quality will help reduce this heavy sediment and nutrient loading to the floodplain lakes like Rice Lake.

g. Rice Marsh Lake (MNDNR I.D. No. 10-1P)

Rice Marsh Lake is located in the east-central portion of the City of Chanhassen, and a portion (126 acres) of the watershed occurs within the City of Eden Prairie. Rice Marsh Lake is a flow-through basin with an inlet that receives outflow from Lake Susan and an outlet that discharges into Lake Riley. Rice Marsh Lake has a surface area of 79 acres and a maximum depth of 11 feet. The OHW level is 877.0 MSL. There are no public accesses on Rice Marsh Lake. Rice Marsh Lake is surrounded by extensive beds of emergent vegetation, some of which have been excavated for water quality improvements. Rice Marsh Lake has had a wastewater treatment plant on its northern shore.

The 1994 Plan recognized that Rice Marsh Lake was not a well studied lake. Despite this status, water quality and clarity data was available annually from 1972 through 1991. Rice Marsh Lake is classified as hypereutrophic due to excessive nutrients (high phosphorus), excess algae, and poor water clarity, with average Secchi disc readings of 1.5 feet. Based on the data available, the trophic conditions are likely attributed to several factors, including the lake's small size, shallow depths, watershed-to-lake ratio (large watershed compared to the size of the lake), specific land uses and, to some extent, the wastewater treatment plant discharge. The Met Council score for water quality on Rice Marsh Lake ranges from "poor" to "very poor".

Following the recommendations of the 1994 Plan, a Water Quality Monitoring study and Aquatic Plant Survey were both completed for Rice Marsh Lake in 2003. The results demonstrate a trend of improving water quality. Water clarity (Secchi disc) readings averaged 7.0 feet and were consistent throughout the summer. Phosphorus has dropped below the 40 ppb threshold and chlorophyll a was noticeably lower. The new Met Council grading system gave an overall water quality grade of B, which is an improvement over the "poor" to "very poor" grade. Grade B would equate to "good" in the old system.

The Aquatic Plant Survey identified five species of emergent plants and two submerged species. No Eurasian watermilfoil was identified, but curlyleaf pondweed was extensive with peak coverage of 64% in the early summer. Coontail was the most abundant submerged species with nearly 97% coverage at the end of summer. White water lily (*Nymphaea tuberosa*) was the most abundant emergent species, covering 50% of the lake surface. Floating filamentous algae mats

became well established throughout the lake towards the end of summer. With a maximum depth of plant growth at 10 feet, most of Rice Marsh Lake is littoral and vegetated.

Future management needs and watershed improvements for Rice Marsh Lake are to:

- Focus on continued implementation of the recommendations in the 1994 Plan.
- Development and implementation of a lake management plan or strategy for controlling curlyleaf pondweed. A Lake Management Plan is a recommended tool that may be a means to identify the sources of the improved water quality on Rice Marsh Lake, and is a tool for setting long and short term management goals and priorities. For example, given the shallow depths and flow-through hydrology of Rice Marsh, management priorities could focus on managing Rice Marsh Lake for wildlife, or for multiple uses that include wildlife management with storm water or flood storage improvements.

The 1994 Plan identified a list of proposed storm water ponds within the Rice Marsh Lake subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 28 is a summary of the proposed storm water ponds in the Rice Marsh Lake subwatershed.

Table 28. Rice Marsh Lake Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Improve-3	RM-P5.7
Third	Improve-3	RM-P4.9
Fifth	Improve-3	RM-P3.1

The RPBCWD completed a Use Attainability Analysis (UAA) for Rice Marsh Lake and Lake Susan in 1999. The UAA set specific goals and recommendations for water quality and quantity in the Rice Marsh Lake watershed. The following recommended BMPs were included in the UAA:

- Upgrade five ponds in the Rice Marsh Lake watershed.
- Add four ponds in the Rice Marsh Lake watershed.
- Treat Rice Marsh Lake with in-lake alum treatment.

Refer to Figure Ex-7 in the Lake Susan and Rice Marsh Lake UAA for the proposed locations for upgraded and additional storm water ponds. Most of the recommended locations for additional storm water ponds in the Rice Marsh Lake watershed are addressed in Appendix I of the Plan. According to the 2005 wetland and storm water pond inventory, improvements have been made at several locations within the Rice Marsh Lake watershed. The City will continue to work with the RPBCWD as opportunities arise to construct the additional storm water treatment ponds in the Rice Marsh Lake watershed.

h. Lake Riley (MNDNR I.D. No. 10-2P)

Lake Riley is located in the east-central portion of the City of Chanhassen and a portion (603 acres) of the watershed is within the City of Eden Prairie. Lake Riley is the last watershed in a chain-of-lakes in Chanhassen and receives run-off from upstream watersheds. Surface water management within the City and in upstream watersheds can have effects on Lake Riley. Lake Riley has a surface area of 297 acres, a maximum depth of 49 feet, and an OHW level of 865.3 MSL. Public access is available within an Eden Prairie City park located on the northeast side of the lake.

The information on Lake Riley in the 1994 Plan is relatively extensive. Water clarity monitoring has been conducted annually since 1979. Secchi disc readings have fluctuated widely with a high of 6.6 feet in 1982 to a low of 2.0 in 1997. Phosphorus levels and chlorophyll a have also spiked and fluctuated, and the 1994 Plan shows a strong correlation between water clarity and nutrient loading. Water clarity decreases during years of high phosphorus and chlorophyll a readings, indicating that phosphorus is the primary vector driving water quality on Lake Riley. The Met Council water quality ranking for Lake Riley is "poor" to "very poor". Lake Riley is also classified as eutrophic. At the time of the 1994 Plan, Lake Riley's watershed was predominantly agricultural. Watershed conditions and the position of Lake Riley within the chain-of –lakes could be potential factors for the poor water quality.

A Lake Riley Aquatic Plant Survey was completed in 2001. The presence of Eurasian watermilfoil was first confirmed in 1990 and was the second most abundant submergent species (56% cover) documented after coontail (60% cover). Curlyleaf pondweed was also present but only comprised approximately 2% of the vegetative cover. Five submergent species and no emergent or floating leaf species were documented on Lake Riley.

Lake Riley is one of the twelve lakes where the contributing watershed has experienced a measurable change in land use since completion of the 1994 Plan. The major development changes are a result of new residential developments. The hydrologic model update also identified an increase in the runoff curve number between the 1994 and 2006 Plans.

The 1994 Plan recommended updating the diagnostic/feasibility study completed for Lake Riley in 1980. A comparable, equivalent and more contemporary format would be a water quality monitoring study. This study should reevaluate the water quality of Lake Riley in accordance with the changes in land use, as the Lake Riley watershed appears to have become more urbanized and less agricultural since the 1994 Plan. The study should determine if phosphorus is still a major concern and source of the eutrophic conditions. Upon completion of the water quality monitoring study, a lake management plan can be assembled with long and short term management goals for improving the water and biological quality of Lake Riley. Similarly, the Lake Riley Aquatic Plant Survey includes supporting information for completion of the Management Plan and for assembly of an Aquatic Vegetation Management Plan for Lake Riley.

There are proposed improvement projects within the Rice Marsh Lake and Riley Lake subwatersheds to improve the water quality of both lakes. The Cities of Chanhassen and Eden Prairie have petitioned these projects, and they will be designed and managed by the Riley Purgatory Bluff Creek Watershed District.

Specific recommendations for Lake Riley include:

- Completion of a water quality monitoring study in lieu of an update to the diagnostic feasibility study. Details of the monitoring study would be established considering the data needs of the planned TMDL study. Alternatively, the City could delay completion of the study until after the non-degradation assessment has been completed as part of the NPDES permit.
- Support the implementation of water quality treatment practices throughout the watershed.

The 1994 Plan identified a list of proposed storm water ponds within the Lake Riley subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 29 is a summary of the proposed storm water ponds in the Lake Riley subwatershed.

Table 29. Lake Riley Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
Second	Improve-1	LR-P2.5, LR-P4.6
Third	Improve-1	LR-P2.3, LR-P2.6, LR-P3.8
Fourth	Improve-1	LR-P4.5
Fifth	Improve-1	LR-P3.6
Sixth	Improve-1	LR-P3.3
Seventh	Improve-1	LR-P2.2, LR-P3.7

The RPBCWD completed a Use Attainability Analysis (UAA) for Lake Riley in 2002. The UAA set specific goals and recommendations for water quality and quantity in the Lake Riley watershed. The following recommended BMPs were included in the UAA:

- Treat Rice Marsh Lake with alum and lime slurry.
- Treat Lake Riley with alum.
- Treat highway runoff by constructing three ponds in the Lake Riley watershed.

Refer to Figure 14 in the Lake Riley UAA for the proposed locations for upgraded and additional storm water ponds. Most of the recommended locations for additional storm water ponds in the Lake Riley watershed are addressed in the TH 212 storm water management system. The City will continue to work with the RPBCWD as opportunities arise to construct the additional storm water treatment ponds in the Lake Riley watershed.

i. Lake Susan (MNDNR I.D. No. 10-13P)

Lake Susan is located in the central portion of Chanhassen and receives significant hydrology from Lake Ann via open channel and several large wetlands. Lake Susan discharges through an

outlet into Rice Marsh Lake, all within the Chanhassen chain-of-lakes. Lake Susan has a surface area of 93 acres, a maximum depth of 17 feet and an OHW of 881.8 MSL. The Lake Susan watershed is well developed with many different land use types. Lake Susan has a 13:1 watershed area to lake area ratio, making storm water treatment a critical need. Lake Susan is classified as hypereuthrophic. Public access is provided through a City park located on the northwest side of the lake and a significant amount of land on Lake Susan is publicly owned.

The 1994 Plan identified Lake Susan with a Met Council ranking of "very poor" for water quality. Water clarity was poor in most years with annual averages of 2.0 feet, and total phosphorus levels typically exceed 40 ppb. Chlorophyll a values also correlated with increased phosphorus and decreased Secchi disc values. The temperature profiles suggest that Lake Susan rarely or poorly stratifies and is subject to low oxygen conditions (anoxia). The lack of stratification enhances mixing and contributes to algae blooms through nutrient mixing of the bottom sediments. The findings of the 1994 Plan resulted in additional studies, planning and ultimately a restoration project for Lake Susan.

The Lake Susan Management Plan, completed in 1998, involved additional water quality and water clarity diagnoses, identified water quality and biological trends, and identified lake management objectives and restoration projects. Phosphorus from surface water run-off and in-lake conditions (e.g. rough-fish) was identified as the potential sources for Lake Susan's hypereutrophic conditions. Storm water management, wetland restoration and management, whole lake chemical treatment, and rough-fish control were recommended actions in the Lake Management Plan.

In 1998, four Lake Susan restoration projects were implemented and evaluated in annual monitoring events through 2001, including the following:

- Carp and bullhead harvesting conducted in the winter – approximately 18,700 pounds of carp and 6,000 pounds of bullheads were removed.
- Spring bullhead trapping – involved removal of 17,000 pounds of bullhead in 1998 and another 14,000 pounds in 1999.
- Carp barrier installation – a carp barrier was placed at the Lake Susan outlet. This carp barrier is marginally effective.
- Whole-lake alum treatment – 40,000 gallons of alum were applied in the Spring of 1998.

Lake Susan responded rapidly following the completion of the four restoration efforts, and the improved water quality results were sustained during the three year monitoring schedule. Phosphorus concentrations dropped to around 40 ppb, and secchi disc readings improved to as high as seven feet, the best readings since recordkeeping was initiated in 1971. Other projects have complimented and benefited the restoration efforts, including the installation of a winter aeration system, creation of a new wetland in the watershed, and storm water pond improvements. Additionally, riparian buffer plantings and bioengineered shoreline stabilization were also completed on Lake Susan in 2002-2003 and 2004-2005, respectively.

Lastly, an Aquatic Plant Survey was completed for Lake Susan in 2003. The survey occurred one year prior to the confirmation of Eurasian watermilfoil in 2004. The survey identified six submergent, three floating-leaved, and one emergent species. Curlyleaf pondweed was present and comprised 28% of the emergent vegetative cover making it the most abundant species in Lake Susan. American lotus (*Nelumbo lutea*) is common in the lake, particularly in the southwest portion.

Future restoration and management efforts on Lake Susan and within the watershed should continue to focus on:

- Implementation of storm water management BMPs within the watershed.
- Active efforts to control rough fish.
- With the recent and confirmed establishment of Eurasian watermilfoil, future efforts should also focus on monitoring and managing nuisance species, including curlyleaf pondweed.
- Participate in the installation of a carp barrier between Lake Susan and Rice Marsh Lake that will be installed by the MnDNR and paid for by the RPBCWD in conjunction with the TH 101 corridor project.

The 1994 Plan identified a list of proposed storm water ponds within the Lake Susan subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 30 is a summary of the proposed storm water ponds in the Lake Susan subwatershed.

Table 30. Lake Susan Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
Third	Improve-2	LS-P3.1, LS-P2.12, LS-P3.7A
Fourth	Improve-2	LS-P3.7B
Fifth	Improve-2	LS-P3.8
Eighth	Improve-2	LS-P1.3

The RPBCWD completed a Use Attainability Analysis (UAA) for Rice Marsh Lake and Lake Susan in 1999. The UAA set specific goals and recommendations for water quality and quantity in the Rice Marsh Lake watershed. The following recommended BMPs were included in the UAA:

- Upgrade or improve nine storm water ponds in the Lake Susan watershed.
- Add eight storm water ponds in the Lake Susan watershed.
- Treat Lake Susan with an in-lake alum treatment.

Refer to Figure Ex-7 in the Lake Susan and Rice Marsh Lake UAA for the proposed locations for upgraded and additional storm water ponds. Most of the recommended locations for additional storm water ponds in the Lake Susan watershed are addressed in Appendix I of the Plan. In-lake alum treatment has been used in the past to provide improvement to Lake Susan's

water quality. The City will continue to work with the RPBCWD as opportunities arise to construct the additional storm water treatment ponds and provide additional treatment in the Lake Susan watershed.

j. Lake St. Joe (MNDNR I.D. No. 10-11P)

Lake St. Joe is a small lake located in the northwest corner of the City of Chanhassen on the west side of Lake Minnewashta. Despite the small surface area (14 acres of open water), Lake St. Joe is relatively deep with a maximum depth of 52 feet. The OHW level is at elevation 945.2 above MSL. A small portion of Lake St. Joe's watershed occurs within the City of Victoria. Lake St. Joe discharges to Lake Minnewashta through a 42-inch pipe. Public access is available on the northeast side of the lake.

A Lake St. Joe Management Plan was completed in 1998 in response to the following conditions identified in the 1994 Plan. Lake St. Joe is meso-eutrophic with good water clarity averaging 7.0 annually, but had very high phosphorus concentrations, especially within the bottom sediments. This was attributed to historical and existing surface water run-off contributions. The Lake St. Joe Management Plan established the following goals for implementation:

- Maintain the summer average phosphorus concentration range of 30 to 42 ppb.
- Maintain a range of secchi disc readings from 5 to 7 feet throughout the summer.
- Maintain native aquatic vegetative coverage at 40 percent or greater.

A Lake St. Joe Aquatic Plant Survey was completed in 2001. Two submergent and three emergent species were identified and no nuisance species were present or have been documented since 2001. The recommended goals can be achieved through:

- Implementation of storm water management BMPs within the watershed and considering the priority of the lake in the classification system.
- Consider the possibly of using in-lake phosphorus treatments.
- Continued monitoring is recommended, especially for phosphorus concentrations.

3. Lakes Summary

Table 31 summarizes the management recommendation discussed above for each lake within the City. The storm water pond recommendations within each of these lake's watersheds, based in part on the 1994 Plan recommendations, are included in Appendix I for reference. Overall, the nine lakes addressed in the 1994 Plan have undergone varying degrees of improvement through increased monitoring, in-lake management, and storm water management. With the exception of Lake Riley, Lake Lucy and Lake Susan, the contributing watersheds for the other eight lakes have experienced little to no change in land use in the contributing watersheds since the 1994 Plan. Furthermore, it is probably safe to assume the improved stormwater management methods and applications that have been constructed and/or retrofitted within each lake watershed are partially responsible for water quality improvements or observed steady trends. This assumption extends to areas within and beyond the City limits into the major watershed.

Approximately 8 percent of Minnesota's river miles and 14 percent of Minnesota's lakes have been tested for pollution problems. Approximately 40 percent of those tested are polluted with human and animal waste, algae from phosphorus, fertilizers and mercury. As more of the states' surface waters are tested for pollution problems, the state will continue to add surface waters to the TMDL list. It is possible that additional surface waters within the City of Chanhassen will be added to this list in the future.

The management goals and objectives established for each lake have in some cases been implemented or even achieved. The extensive lake monitoring that has and will continue to occur should allow continued tracking of each lake and provide a base of comparison to ensure that these goals and objectives continue to be met.

Table 31. Lake Management Recommendation Summary.

Lake	Recommendations	Schedule	Comments
Ann	Develop a Comprehensive Lake Management Plan. The plan should focus on two primary components: (1) monitoring; and (2) management.	2010-2012	This item addresses completion of the plan itself.
	(1) Monitoring activities should include assessing the health and diversity of the lake's aquatic vegetation community, with a special emphasis on Eurasian watermilfoil and curlyleaf pondweed and continuing the current water quality monitoring program.	Annually	Secchi disc sampling should occur monthly every year during the summer months.
	(2) Management activities should include regular assessments of monitoring data to identify consistency or shifts in trends.	Ongoing	
Christmas	Support the implementation activities in the 1996 Lake Management Plan	Ongoing	In cooperation with Shorewood and Hennepin County.
Lotus	Develop a Comprehensive Lake Management Plan. The plan should focus on two primary components: (1) monitoring; and (2) management.	2008-2010	Coordinate with TMDL Study.
	(1) Monitoring activities should include assessing the health and diversity of the lake's aquatic vegetation community, with a special emphasis on Eurasian watermilfoil and curlyleaf pondweed, and continuing the current water quality monitoring program.	Annually	Continue or initiate control of purple loosestrife with bioagents (beetles)
	(2) Management activities should include regular assessments of monitoring data to identify consistency or shifts in trends.	Ongoing	
	Participate in the development of the Total Maximum Daily Load (TMDL) Study to reduce nutrient loading. The 1994 Plan also recommended that wetlands along the fringe of Lotus Lake should be sampled and monitored to determine their phosphorus input to the lake.	Track TMDL start date	Study start date depends on availability of funding through MPCA.
	Complete a Feasibility Study to evaluate the extended high water levels on Lotus Lake with the goal of identifying what, if any, combination of storage in the upstream areas and/or outlet structure modifications would limit the extent or duration of high water levels. See also Water Quantity project Recommendations.	2007	Use updated model as a starting point. May need to import data to an XP-SWMM model to evaluate effects of additional storage areas in more detail.
	A detailed analysis of alternatives to eliminate street flooding at Carver Beach Road should be undertaken.	2007	Carry over from 1994 (confirm if complete or still pending).

Table 31. Lake Management Recommendations (Continued)

Lake	Recommendations	Schedule	Comments
Lucy	Develop a Comprehensive Lake Management Plan. The plan should focus on two primary components: (1) monitoring; and (2) management.	2012-2014	This item addresses completion of the plan itself.
	(1) Monitoring activities should include assessing the health and diversity of the lake's aquatic vegetation community, and continuing the current water quality monitoring program.	Annually	Water quality trend appears to be improving.
	(2) Management activities should include regular assessments of monitoring data to identify consistency or shifts in trends.	Ongoing	Identify what management activities can be applied to other watersheds.
Minne-washta	Continue to implement the activities specified in the Lake Management Plan. Notable activities include: monitoring adjacent wetlands for phosphorus input; and implementation of vegetation management, restoration, and nuisance species control.	Ongoing	Nuisance species control includes both within the lake (Eurasian watermilfoil) and watershed (purple loosestrife).
Rice Marsh	Develop a Comprehensive Lake Management Plan. The plan should focus on two primary components: (1) monitoring; and (2) management. Also consider setting priorities for wildlife management, storm water or flood storage management as part of the plan development.	2014-2016	This item addresses completion of the plan itself.
	(1) Monitoring activities should include assessing the health and diversity of the lake's aquatic vegetation community, and continuing the current water quality monitoring program.	Annually	Assess the need for wildlife habitat improvements by landscaping the near shore areas.
	(2) Management activities should include regular assessments of monitoring data to identify consistency or shifts in trends.	Ongoing	Implement strategy(ies) for controlling curlyleaf pondweed.
Riley	Focus efforts on new and retrofit ponds and phosphors reduction BMPs in the watershed. Use pond summary in Appendix I as the basis for evaluating pond options.	Annually	The 1994 Plan indicated the need to develop a better understanding of source of algae blooms.
	Develop a Comprehensive Lake Management Plan. The plan should focus on two primary components: (1) monitoring; and (2) management.	2006-2008	Coordinate with TMDL study.
	(1) Monitoring activities should include assessing the health and diversity of the lake's aquatic vegetation community, and continuing the current water quality monitoring program.	Annually	
	(2) Management activities should include regular assessments of monitoring data to identify consistency or shifts in trends.	Ongoing	Look for opportunities to implement additional regional or local storm water treatment systems.

Table 31. Lake Management Recommendations (Continued)

Lake	Recommendations	Schedule	Comments
Susan	Continue to implement the activities specified in the Lake Management Plan.	Ongoing	
	(1) Monitoring activities should include assessing the health and diversity of the lake's aquatic vegetation community, and continuing the current water quality monitoring program.	Annually	Focus on monitoring and managing nuisance species, including Eurasian watermilfoil and curlyleaf pondweed
	(2) Management activities should include regular assessments of monitoring data to identify consistency or shifts in trends.	Ongoing	Focus future restoration and management efforts on storm water management and on rough fish control (bullhead, carp)
St. Joe	Continue to implement the activities specified in the Lake Management Plan. Notable activities include: monitoring phosphorus levels and native vegetation and continuing Secchi disc water clarity readings.	Ongoing	Monitor and maintain native aquatic vegetative coverage at 40 percent or greater.

C. Creeks and Linear Waterways

In addition to the rich abundance of wetlands, Chanhassen has several significant waterways. As part of the wetland inventory, all linear waterways were mapped to complete the comprehensive overview of the City's resources. Linear waterways include the major streams and creeks, but also include some of the ditches, grassed swales, and other areas designated for conveyance of surface waters. Many waterways flow through wetland areas. In these portions, the channel has not been mapped, but is contained within the wetland boundary. The channels have been mapped for those portions not located within a wetland, i.e. those areas that flow through an upland area. Mapping was done with both GPS and through aerial photograph interpretation.

The RPBCWD Water Management Plan (RPBCWD Plan) provides Physical and Ecological Use Classifications of Purgatory, Riley and Bluff Creeks. The classification system for physical classification is the David L. Rosgen system. According to the RPBCWD Plan, this system describes a stream on a reach-by-reach basis, and therefore one stream can have several different stream types. The stream type is defined by the shape, pattern, and profile of the reach. Please see Figures PC1 and PC2 in Appendix E for an illustration of these parameters. Please refer to the RPBCWD Plan for more information on the classification methodology.

According to the RPBCWD Plan, the classification system used for ecological classification of Purgatory, Riley and Bluff Creeks is based on procedures that have been developed by the Wisconsin Department of Natural Resources (WDNR). The purpose of these procedures is to provide a scientific method for designating uses according to a stream's natural ability to support a certain biological community. Please see Tables EUC1 and EUC2 in Appendix E for the criteria used in the ecological classification of Purgatory, Riley and Bluff Creeks. Please refer to the RPBCWD Plan for more information on the classification methodology.

A summary description of some of the major waterways within the City is provided in the following sections.

1. Assumption Creek

Assumption Creek is a tributary of the Minnesota River. It begins just northwest of the Assumption Seminary property and empties into the Minnesota River after flowing through the Raguet Wildlife Management Area, west of Highway 101 and south of Highway 212 in Chanhassen. The creek is Carver County's only remaining native trout stream. It is one of only 15 streams in the metro area that still supports trout populations. Additionally, it is one of the few streams in the metro area that supports native brook trout instead of non-native brown trout. Assumption Creek is also closely associated with Seminary Fen, another critical resource, and extensive wetland along the Minnesota River. Property and storm water management practices have compromised the integrity of stream banks and riparian areas. The entire Assumption Creek drainage area is unique and deserves additional protection.

2. Bluff Creek

Bluff Creek is the most significant waterway within the City. Bluff Creek has several tributaries which originate in large wetlands in the north central portion of the City. Wetlands 10-116-23-09-019 and 10-116-23-16-005 are the origin for the biggest tributaries of the creek. Approximately 20% of Bluff Creek flows through wetland, which is a low proportion compared to other creeks in the City. The northern third of the creek flows mostly through larger wetlands and recently developed residential areas. The middle third of the creek is less developed and has much more agricultural land use. The final third of the creek, before it discharges into the large wetland along the Minnesota River, is undeveloped and is a sensitive bluff area. This final third of the creek has few wetlands, but is a critical natural resource for sensitive bluff species. There are several extensive public walking trails through the Bluff Creek corridor, and these trails are integral to the future health of the corridor.

Two significant escarpments exist in the lower section of Bluff Creek. These cliffs are quite spectacular in their size and form, but could create serious land management issues in the future. There is also a strong likelihood that the meandering process of Bluff Creek will reroute the creek away from the base of these cliffs, slowing the erosion of their face walls.

The RPBCWD Plan physically classifies five reaches of Bluff Creek. Most of the creek consists of C and E stream type, with some portions of type B and type F. The RPBCWD Plan states that:

- Improving the physical characteristics of Bluff Creek where necessary will improve the ability of the stream to convey surface waters without eroding and also improve the ecological characteristics and aesthetics of the stream.
- Problems are described as follows:
    - B2 – Bank stability problems were observed, this is due partly to wet clay soils and change in gradient
    - B3 – Loss of meandering due to straightening and grazing was observed
    - B4 – This reach is likely a degraded C stream type, resulting from the upstream railroad culvert and downstream channel straightening.

The ecological classification for Bluff Creek is mostly Ecological Use Class D and E, according to the RPBCWD Plan. Habitat improvement in the downstream portion of Bluff Creek will result in an ecological use classification change from Class D to Class C. The RPBCWD Plan states that the ecological use of Bluff Creek is limited by its low flow and habitat conditions, but the stream provides habitat for many species of aquatic life. The RPBCWD Plan's main recommendation for preserving Bluff Creek as a valuable resource is to preserve a corridor of undeveloped land along Bluff Creek and preserving the biotic integrity of the stream.

The 1994 Plan identified a list of proposed storm water ponds within the Bluff Creek subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that

were inventoried as part of the most recent wetland inventory. Table 32 is a summary of the proposed storm water ponds in the Bluff Creek subwatershed.

Table 32. Bluff Creek Subwatershed Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Improve-1	BC-P4.11
Third	Improve-1	BC-P2.13, BC-P4.12, BC-P5.11, BC-P6.19, BC-P7.9
Fourth	Improve-1	BC-P4.6, BC-P5.2, BC-P5.6, BC-P6.5
Fifth	Improve-1	BC-P1.8, BC-P4.1, BC-P5.1, BC-P5.13, BC-P6.16
Sixth	Improve-1	BC-P6.1, BC-P6.2, BC-P7.4
Seventh	Improve-1	BC-P1.2, BC-P1.12
Eighth	Improve-1	BC-P5.3, BC-P6.10, BC-P6.11, BC-P6.12, BC-P6.15

3. Lake Minnewashta Outlet

Although mostly flowing through wetlands, there is an unnamed channel that acts as the outlet for Lake Minnewashta and flows into Lake Virginia outside the City limits. Most of the channel is in wetlands or flows through created ditches in front of several single family residential lots. This unnamed stream is within the Minnehaha Creek watershed and discharges into the Mississippi River drainage rather than the Minnesota River.

The 1994 Plan identified a list of proposed storm water ponds within the Minnewashta Oulet Creek subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 33 is a summary of the proposed storm water ponds in the Minnewashta Outlet Creek subwatershed.

Table 33. Minnewashta Outlet Creek Subwatershed Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Improve-2	MC-P2.6
Second	Improve-2	MC-P3.3
Third	Improve-2	MC-P2.9
Fifth	Improve-2	MC-P3.4
Seventh	Improve-2	MC-P4.2

4. Purgatory Creek

Purgatory Creek originates as the outflow of Lotus Lake and is only within the City of Chanhassen through less than 1,000 feet of floodplain forest and a controlled outlet. According to the RPBCWD Plan, the physical classification for Purgatory Creek in the reach that's located within Chanhassen is a Type C Channel. The RPBCWD Plan states that there was some loss of meandering observed at the reach located in Chanhassen. The RPBCWD Plan also states that the existing ecological use for Purgatory Creek within Chanhassen is Ecological Use Classification E. This is also the attainable ecological use class.

The 1994 Plan identified a list of proposed storm water ponds within the Purgatory Creek subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Table 34 is a summary of the proposed storm water ponds in the Purgatory Creek subwatershed.

Table 34. Purgatory Creek Subwatershed Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Improve-1	PC-P1.4
Third	Improve-1	PC-P1.6
Fourth	Improve-1	PC-P1.5

5. Riley Creek

Riley Creek is the second longest waterway in the City. Riley Creek flows through many wetlands and lakes and has less than 10% of the channel not associated with a surface water body or wetland. Riley Creek starts in Lake Lucy and flows south through a small channel to Lake Ann, through a wooded channel to a service road and Trunk Highway 5 crossing. South of TH 5, Riley Creek flows through several wetlands and floodplain forest areas to Lake Susan and then Rice Marsh Lake before leaving the City.

According to the RPBCWD Plan, four reference reaches of Riley Creek were physically classified. Most of the creek consists of type C and E stream, with some portions of type B stream. The RPBCWD Plan states that:

- Improving the physical characteristics of Riley Creek where necessary will improve: (1) the ability of the stream to continue to naturally meander without eroding bank areas, and (2) the ecological characteristics and aesthetics of the stream.
- Observations of problems at particular reference reaches are described as follows:
    - R1 – Stream bank erosion and slumping was observed; this is due to the natural meandering of the stream impinging upon the steep valley walls.
    - R2 – Channel downcutting was observed due to an upstream culvert concentrating overbank flows through the narrow valley.
    - R4 – Bank erosion and bed degradation due to upstream channel straightening.

The ecological classification for Riley Creek is mostly Ecological Use Class D, with a small portion of Ecological Use Class E, according to the RPBCWD Plan. The attainable habitat improvements for ecological use in this stream are related to attainable changes in the physical stream conditions. The RPBCWD Plan identifies the following habitat improvements that can be attained by solving the creek's bank erosion and slumping problems in the downstream reaches:

- Reduced watershed erosion
- Reduced bank erosion
- Improved bank erosion
- Reduced lower bank deposition
- Less bottom deposition
- Improved bottom substrate and available cover
- Improved depth in riffles/runs and pools.

By attaining these habitat improvements the ecological use classification will change from Class E to Class C. Please refer to the RPBCWD Plan for more information regarding the physical and ecological use classification for Riley Creek.

6. Unnamed Creek – Southeast Bluff Area:

The last significant creek in Chanhassen is a short unnamed channel in the southeast portion of the City. Like Bluff Creek, this channel flows through a largely undeveloped area of the bluffs. This area hasn't been identified as having the same critical resources as Bluff Creek has, but similar habitats and erosion control concerns warrant a similar level of protection.

The City currently has setback requirements and restrictions on land use along the creeks. It is recommended that these existing requirements continue to be enforced and that additional requirements be evaluated for the sections of the creeks flowing through the bluff areas. Continued implementation of the current policies is likely sufficient, but additional action may be needed to preserve the most critical natural resources.

7. Minnesota River

The Minnesota River forms the southern boundary of Chanhassen. The wetlands along the river bottom are protected by the Raguet Wildlife Management Area and the Minnesota Valley Wildlife Refuge.

The 1994 Plan identified a list of proposed storm water ponds within the Minnesota River subwatershed. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that

were inventoried as part of the most recent wetland inventory. Table 35 is a summary of the proposed storm water ponds in the Minnesota River subwatershed.

Table 35. Minnesota River Subwatershed Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
First	Preserve	LOM-P1.12
Second	Preserve	LOM-P1.4
Fourth	Preserve	LOM-P1.3, LOM-P1.8
Fifth	Preserve	LOM-P1.1, LOM-P1.11
Seventh	Preserve	LOM-P1.6
Eighth	Preserve	LOM-P1.5

D. Storm Water Ponds

In addition to the wetland basins mapped as part of the 2006 wetland inventory field work, all of the storm water ponds in the city were mapped. Of these, 57 were included with the MnRAM analysis as they were part of the 1992 inventory, or were inadvertently included. Most storm water ponds are open water and would be classified as Type 4 or Type 5 wetlands. Some of the ponds, especially those in the older parts of the city, have significant areas of emergent vegetation and are comparable to a Type 3 wetland. In total, storm water ponds make up 72 acres within the city. Because storm water ponds were created with a specific purpose of treating runoff, they are classified as "Constructed" in this Plan, regardless of what the results of the MnRAM analysis shows. Several of the storm water ponds have wetland characteristics consistent with wetland classified as Manage 1 or Manage 2 if they followed the MnRAM results. Historically, natural wetlands were used for storm water treatment, either through restricting outflows, or excavating wetlands to create additional open water areas and storage volume. While this practice has since been discouraged, many of the storm water ponds, particularly in the northeast portion of the city, were likely wetlands that have been converted. These ponds would still be classified as wetlands under current wetland regulations, and could be subject to replacement if impacted for more than routine maintenance. Even if an area was formerly wetland, however, its current function is storm water treatment, and therefore will be classified as "Constructed". Many of these basins were identified as "Utilized" in the 1994 Plan. For more information on the wetland classification system, see Section V of this Plan.

E. Drainage to Subwatersheds Outside of Chanhassen

A portion of the City of Chanhassen drains to surface waters located outside the City boundaries. A small are of the City in the far east side of the City drains to Mitchell Lake, which is located within the City of Eden Prairie. Another small portion of Chanhassen in the south central part of the City drains to Lake Hazeltine, which is located within the City of Chaska.

The 1994 Plan identified a list of proposed storm water ponds within the Mitchell Lake and Lake Hazeltine subwatersheds. The table in Appendix I lists all recommended storm water ponds from Table III-D1 in the 1994 Plan. The table in Appendix I identifies whether or not a recommended pond from the 1994 Plan has been constructed. The table also includes all new storm water ponds that were inventoried as part of the most recent wetland inventory. Tables 36 and 37 are a

summary of the proposed storm water ponds in the Mitchell Lake and Lake Hazeltine subwatersheds.

Table 36. Mitchell Lake Subwatershed Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
Third	Improve-3	ML-P1.2
Eighth	Improve-3	ML-P1.1, ML-P2.1, ML-P2.2

Table 37. Lake Hazeltine Subwatershed Proposed Ponds Prioritization

1994 Plan Priority Ranking	2006 Water Management Class	Pond Label
Seventh	Improve-3	LH-P1.1
Eighth	Improve-3	LH-P1.4, LH-P1.6, LH-P1.8, LH-P1.9

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