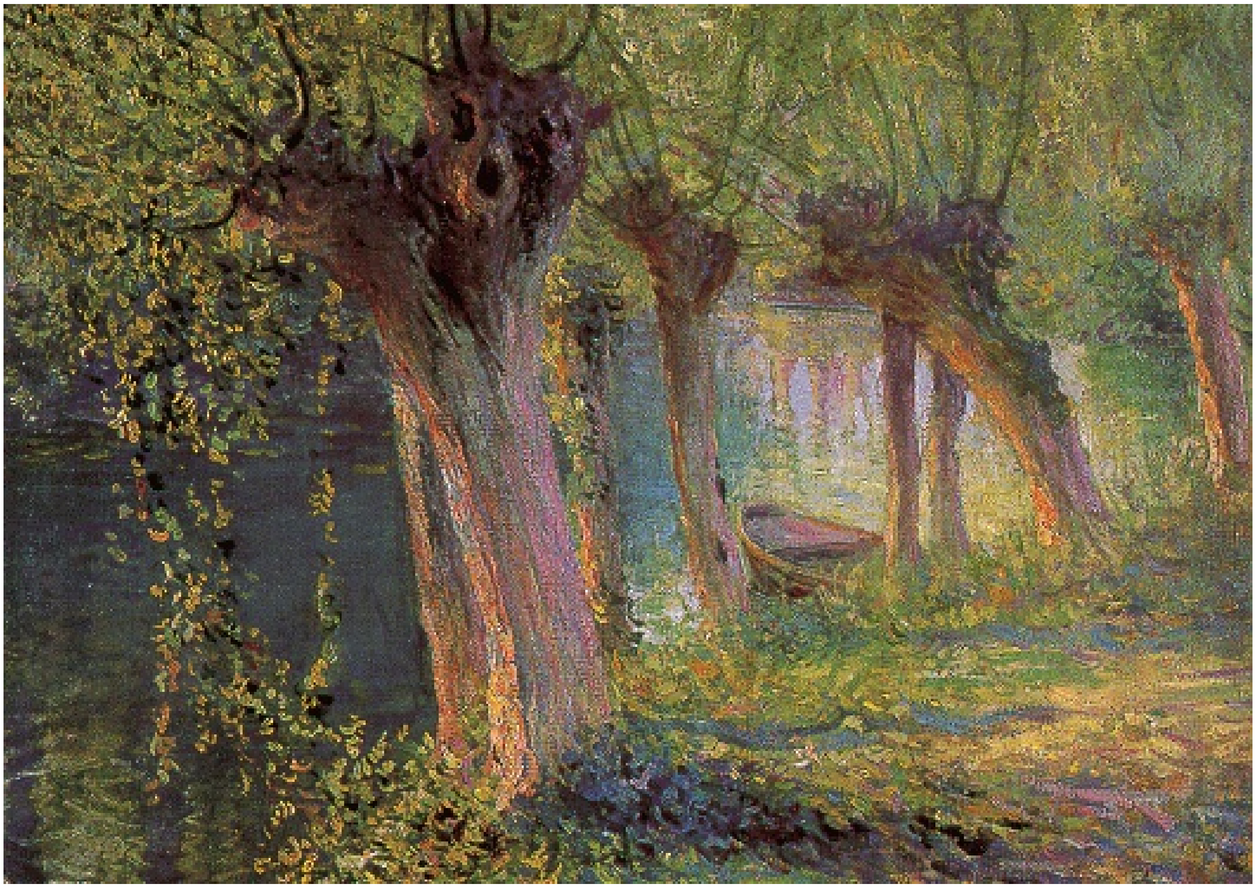

Guy Rose: *(River Epte, Giverny)*, **1904-12**

Powers Lake Management Plan
Washington County, MN

March 2000

Prepared for:
South Washington Watershed District

Prepared by:
Bonestroo, Rosene,
Anderlik and Associates
St. Paul, MN

Powers Lake Management Plan

--Contents--

Powers Lake Management Plan
Washington County, MN

Summary

Powers Lake is a 56 acre lake in the City of Woodbury with an ultimate drainage area of 1,230 acres. The lake has several stormwater fed inlets and one natural inlet that receives runoff from a developing area. A lift station on the northwest end of Powers Lake serves as an outlet for this previously land-locked lake.

Watershed: In 1999, the contributing watershed was 430 acres. Because of expansion of the stormsewer network with increasing development, the area draining to Powers Lake will eventually be 1,230 acres.

Shorelands: A unique shoreland feature of Powers Lake is the city owned easement around the shoreline of Powers Lake. This allows the opportunity to keep shoreland conditions natural, attract wildlife, and serve as a water quality buffer. The shoreland currently is in a natural state.

Dissolved Oxygen in the lake: Powers Lake stratifies, by temperature, with a warm water top layer of 12 to 30 feet thick in the summer, with the thickest warm water found in late summer. Dissolved oxygen is absent in mid-summer and remains that way until fall turnover.

Water clarity: Water clarity in lakes is typically measured with a secchi disc. Water clarity in Powers Lake has fluctuated from 1994 to 1999. In 1994, the summer average was around 11 feet and in 1998 it was about 5 feet, however, in 1999, the summer average improved to 10.5 feet.

Phosphorus: Phosphorus levels have fluctuated over the last six years, and have not noticeably increased or decreased. The phosphorus summer average in 1998 was 30 parts per billion and in 1999 the summer average was 15 ppb. Phosphorus levels for both these years were within the ecoregion range.

Chlorophyll and algae: Chlorophyll readings are an indicator of the amount of algae in a lake. Chlorophyll levels have been checked over the last five years and may have increased, indicating that algae has increased also. Blue-green algae are the dominant late summer algae.

Zooplankton: Zooplankton are small, mostly microscopic, crustaceans found in all lakes. They are important in the lake's food chain. Zooplankton feed on algae and, in turn, small fish feed on zooplankton. Powers Lake has a typical assemblage of zooplankton for lakes in this region.

Aquatic Pants: Aquatic plants are essential for maintaining good clarity for moderately fertile lakes in this region. Since water levels have risen at least 10 feet in the last 20 years, the flooded lake sediments do not have an aquatic plant seedbank. Aquatic plant diversity is low and is dominated by 2 exotic plants: Eurasian watermilfoil and curlyleaf pondweed.

Lake Sediment Fertility and Nuisance Plant Growth: Power's Lake sediments were tested for fertility levels in order to predict where nuisance Eurasian watermilfoil might grow. Results show over 60% of the shoreline could support nuisance growth based on high nitrogen levels.

Fish: The fish community is dominated by bluegill sunfish, but they are small, with an average of 5 inches. Gamefish are present, but in low numbers although, northern pike, largemouth bass, and walleyes are found within regional ranges.

Lake Report Card: The report card grades go back to 1994. Total phosphorus has received A's and B's except for 1998 and water clarity got A's and B's except for 1997 and 1998. In 1999 Powers Lake rebounded with higher grades then were recorded in 1998.

Goals and What Powers Lake Could Look Like in the Future: The goal for Powers Lake is to maintain ecoregion values which would mean maintaining a lake grade of B or better. However, watershed modeling indicates it will be difficult to maintain a B-grade.

In the near future, good water quality can be maintained, but when the watershed is fully developed in the future, lake water quality will more then likely fall to a C-grade. Proposed lake management projects are designed to prevent lake degradation below a C-grade and possibly hit B's as well.

Lake Management Program: The Powers Lake management program has 5 components:

1. Watershed District plan amendment.
2. Subwatershed development standards.
3. Lake projects.
4. Public information.
5. Surface water monitoring.

A summary of each component follows:

1. **Plan amendment:** The South Washington District Management Plan may need to be amended to adopt the Powers Lake Management Plan.

2. **Subwatershed development standards:** Depending on the proximity to Powers Lake, watershed best management practices will be recommended accordingly. Construction and development in the direct lakeshed will have the highest priority for sediment and nutrient control. For second and third order subwatersheds, standards are less stringent.

3. **Lake projects:** Projects occurring in Powers Lake will help maintain good water quality also. Projects to sustain native aquatic plants will be implemented along with fish habitat improvements. Lake drawdown as an exotic plant management technique is also recommended.

4. **Public information:** Ongoing efforts to inform and educate lake users and the watershed community adds to the overall enjoyment of the water resource as well as helping to protect it. Lake brochures, lawn soil testing, informational kiosks, community events at the lake are planned. Also, policies on watercraft use and shoreland use will be developed.

5. **Monitoring program:** Ongoing monitoring of Powers lake should continue in order to track lake trends as well as to spot early warning signs of potential problems. Lake water quality and watershed runoff water quality monitoring programs will integrate biological and chemical aspects.

1. Introduction and Project Setting

Powers Lake is 56 acres in size with a total planned drainage area of 1,238 acres. The lake has several stormwater fed inlets fed on the east and west sides. A lift station was installed in 1995 and currently serves as the outlet for this previously land-locked lake.

A public access and fishing pier are proposed to be constructed just east of County Road 19. The DNR has done fishery surveys in 1977, 1984, 1992, and 1997, but has not conducted fish stocking due to the lack of a public access. Fisheries management could begin following the construction of the public access. Based on the limited fisheries and water quality data, and on conversations with anglers, it appears that the lake possesses a fair self-propagating gamefish population.

A bathymetric map, furnished by the DNR, is shown in Figure 1. Powers Lake has a maximum depth of 41 feet and a littoral zone (fringe area from 0 to 15 feet in depth where macrophytes grow) covering about 48 percent of its surface.

The water quality goal for Powers Lake is to keep the phosphorus concentrations within ecoregion values. Stormwater management practices such as ponding, erosion control, and the diversion of the phosphorus inputs from Markgrafs Lake are some of the ways the phosphorus inputs to Powers Lake could be reduced under ultimate development conditions. If the phosphorus concentrations are still found to be in excess of ecoregion values, in-lake techniques may be needed to reduce the phosphorus concentration in the lake.

Figure 1. Bathymetric map of Powers Lake.

2. Watershed Characteristics

Overview of Watershed Conditions -Existing and Future

The watershed of Powers Lake is changing rapidly, both in terms of size and land use composition. Currently, three stormwater culverts drain to Powers Lake. In 1998, the watershed of the lake was estimated at approximately 430 acres (Figure 2). Based on a field survey conducted in spring 1999, single family residential comprised the majority of the watershed, followed by open/park uses, and commercial use. For the most part, St John's Drive marks the eastern boundary of the watershed under current conditions except for a few small culverts under the road which provide a connection with several local, largely undeveloped drainages to the east of this road.

Under ultimate development conditions, the watershed to Powers Lake will almost triple in size to approximately 1,237 acres because of topography and the expansion of the storm sewer network to the east of St. John's Drive (Figure 3). The expected land use composition of the watershed under ultimate development conditions is shown in Appendix A.

One of the Powers Lake storm sewer inlets on the east side.

Figure 3. 1998 development conditions of the Powers Lake watershed.

Figure 4. Ultimate development conditions.

3. Wetlands

A wetland inventory of the Powers Lake watershed within the boundaries of the South Washington Watershed District was conducted in 1998. Within the Powers Lake watershed west of St. John's (approximately the existing watershed in 1999), 24 historical wetlands comprise about 28 acres (about 6.5%) of the current watershed area. Less than two acres of this historical wetland base has been filled or drained and the remainder are used for stormwater management purposes.

East of St. John's Drive, only that portion of the Powers Lake ultimate development watershed that falls within the South Washington Watershed District has been inventoried in detail. Historical wetlands in this portion of the watershed comprise just over 28 acres, but two large wetland complexes -wetlands PL-1-2 and PL-1-9 (Fish Lake) - make up almost 80% of the total wetland area. Because virtually all of these wetlands have been degraded by adjacent agricultural practices, they have also been classified for use as stormwater management features, though direct discharge of stormwater to the wetlands will be strongly discouraged.

Figure 4 shows the location of the inventoried wetlands in the watershed along with their proposed management classification.

4. Shoreland Characteristics

Shorelands are critical areas around a lake. Shorelands encompass the lakeshore, the shoreline and the shallow water zone just off shore. Shorelands have several functions. They attract wildlife and are aesthetically pleasing as well being capable of assimilating phosphorus and nitrogen which can reduce algae blooms in the lake.

Shoreland Inventory

A shoreland inventory was conducted to evaluate existing conditions around the shoreland and areas several hundred feet off the lake. Panoramic photographs were used to characterize existing conditions.

The Powers Lake shoreland setting is unique because the City of Woodbury has a shoreline easement around 90% of the shoreland and there is no shoreline alternations allowed. Most of the shoreline is in a natural state.

Figure 5. Example of shoreland conditions on the periphery of Powers Lake.

Figure 6. Representative shoreland conditions around Powers Lake in 1998. A photographic shoreland inventory was conducted using two scales: photography was taken at 100 feet (top) and 200 feet (bottom) from shore. The 100-foot distance gives more detail, but the 200-foot distance uses fewer pictures and is easier to catalog.

5. Lake Characteristics

Powers Lake has been routinely sampled since 1994 for phosphorus, chlorophyll, and water clarity. Other parameters have been monitored less frequently. This section presents lake characteristics from the water quality sampling efforts.

Dissolved Oxygen and Temperature Profiles

Powers Lake exhibits temperature stratification over the summer (Figure 7) and dissolved oxygen is depleted in the bottom water. This is typical for stratified lakes in the region.

Figure 7. Examples of dissolved oxygen and temperature profiles for Powers Lake in July and September, 1998.

Water Clarity, Phosphorus, and Chlorophyll a

Data collected on Powers Lake through the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP) provides the best available historical information on water chemistry, water clarity, physical condition and recreational suitability of the lake. These data have been collected on a bi-weekly basis between May and October since 1994. It is the only data set available for Powers Lake that provides information on recreation season values for the key parameters - total phosphorus, chlorophyll a, and water clarity - most helpful in assessing aesthetic and recreational suitability.

Phosphorus concentrations are important because the availability of this plant nutrient often controls the amount of algae growth in an aquatic ecosystem. The amount of algal growth (expressed as chlorophyll "a" concentration) strongly influences the clarity of the water. Water clarity is a key physical parameter affecting user perceptions of the suitability of a lake for recreational purposes. In general, higher phosphorus concentrations cause more algal growth which decreases water clarity. As water clarity decreases, human perceptions of the suitability of the lake for recreational uses also drop. Thus, all three parameters provide important information on the condition of the lake.

Figure 8. Steve Kernik, City of Woodbury, is taking a secchi disc transparency reading on Powers Lake during the summer of 1998.

Water Clarity (measured by a secchi disc)

Water clarity (using summer averages) in Powers Lake has fluctuated between good to fair over the last six years (Figure 9). The lowest summer average was 5.3 feet in 1998 and highest average was 14.7 feet in 1996.

A number of variables effect water clarity including nutrient concentrations, water temperatures, and aquatic plant growth. At this time there does not appear to be any kind of water clarity trend in Powers Lake.

Secchi disc

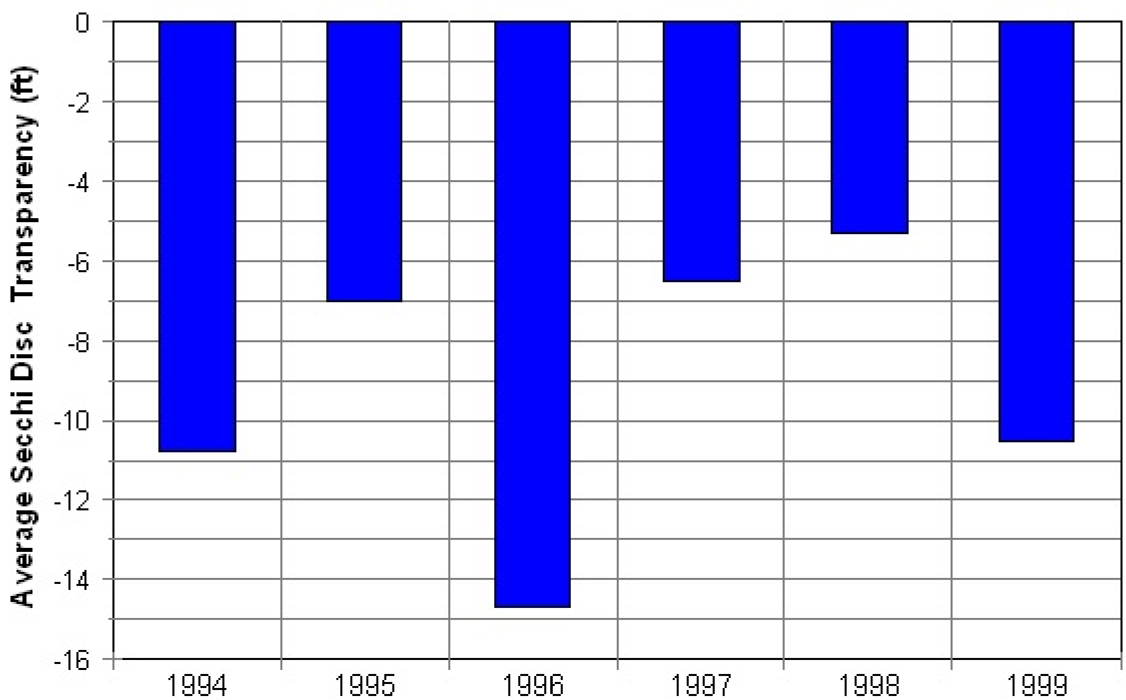

Figure 9. Average secchi disc transparencies for 1994-1999 from the Met Council data summaries. Results are shown in feet.

Phosphorus and Chlorophyll a

Phosphorus levels also have fluctuated in Powers Lake over the last six years (Figure 10) somewhat following water transparency averages.

Powers Lake appears to be a lake in transition and may continue to experience swings in phosphorus levels and clarity until the watershed stabilizes. This could take some time. Factors contributing to the phosphorus swings include rainfall, runoff, and internal loading. Because elevated phosphorus levels have been found in the bottom water (Table 1), it is possible these contribute to the upper water phosphorus concentrations.

Table 1. Top and bottom total phosphorus concentrations in Powers Lake in 1998.

	Powers Lake	
	Top (ppb)	Bottom (pbb)
7.15.98	48	195
9.28.98	26	237

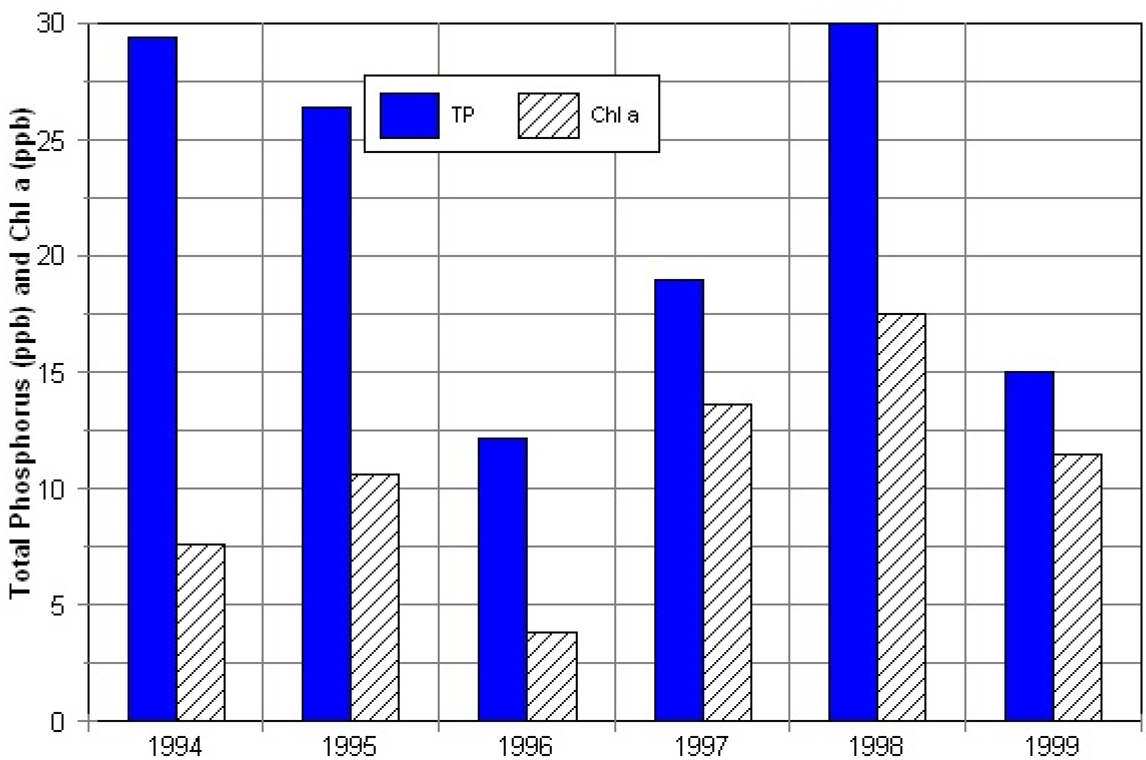

Figure 10. Total phosphorus and chlorophyll a concentrations for 1994-1999 from Met Council data summaries. Concentrations are shown in parts per billion (ppb).

Phosphorus and Chlorophyll a - continued

Chlorophyll a is a rough indicator of the algae biomass. Chlorophyll a has also fluctuated since 1994. Summer algae in Powers Lake is composed of typical species for this region and includes three common blue-green algae: *Microcystis, Anabena,* and *Aphanezomenon* (Figure 11). Under high phosphorus concentrations, these species can form nuisance algae blooms.

Figure 11. Example of the algae found in Powers Lake during the summer of 1999.

Summary of Water Quality Data for 1994-1999

Growing season averages and ranges (Table 2) and monthly averages (Tables 3, 4, and 5) for secchi disc, total phosphorus, and chlorophyll show the variability of the three primary water quality indicators from 1994-1999. Growing season averages for total nitrogen (Table 2) show it has been fairly stable over the six year period of record.

After the low transparency recorded in 1998, clarity improved in 1999.

Table 2. Growing season water quality averages (May - September). Source: Met Council.

	1994	1995	1996	1997	1998	1999
Secchi Disc (feet)						
Average	10.8	7.0	14.7	6.5	5.3	11.5
Range	9.4-12.5	3-13.6	9.8-18.7	3.5-11	3.3-8.2	3.0-19.8
n	11	10	12	10	7	8
Total Phosphorus (ppb)						
Average	29.4	26.4	12.2	19	30	15
Range	20-40	15-40	10-15	10-30	20-40	5-40
n	11	10	12	10	7	8
Chlorophyll a (ppb)						
Average	7.6	10.6	3.8	13.6	17.5	11.5
Range	3-12	5-15	2-8	5-30	7.3-48.0	1-57
n	11	10	12	10	7	8
Total Nitrogen (ppm)						
Average	0.62	0.77	0.52	0.70	0.83	0.76
Range	0.50-0.80	0.43-1.20	0.44-0.66	0.50-0.95	0.51-1.10	0.51-1.2
n	11	10	12	10	7	8

Table 3. Secchi disc transparency (feet) over the growing season from 1994-1999. Source: Met Council.

	1994	1995	1996	1997	1998	1999
April	13.5	14.8	--	--	--	6.6
May	12.5	13.6	15.8	11.0	7.4	19.0
June	10.7	9.5	18.7	9.4	--	12.1
July	10.8	4.2	15.4	4.9	4.6	10.5
August	10.7	3.0	9.8	3.5	3.3	3.0
September	9.4	4.9	13.9	3.9	5.6	7.6
October	--	5.7	5.7	6.7	5.6	9.8
May-Sept Ave	**10.8**	**7.0**	**14.7**	**6.5**	**5.2**	**10.5**

Table 4. Total phosphorus concentrations (ppb) over the growing season form 1994-1999. Source: Met Council.

	1994	1995	1996	1997	1998	1999
April	20	30	--	--	--	20
May	20	20	13	15	30	15
June	40	15	10	13	--	8
July	25	27	10	10	40	8
August	27	40	15	27	30	20
September	35	30	13	30	20	40
October	--	20	30	30	40	40
May-Sept Ave	**29**	**26**	**12**	**19**	**30**	**15**

Table 5. Chlorophyll a concentrations (ppb) over the growing season from 1994-1999. Source: Met Council.

	1994	1995	1996	1997	1998	1999
April	4	4	--	--	--	8
May	3	5	2	5	10	3
June	10	8	2	6	--	6
July	4	12	8	13	29	4
August	9	15	3	30	20	57
September	12	13	4	14	11	11
October	--	18	11	13	12	14
May-Sept Ave	**8**	**11**	**4**	**14**	**18**	**12**

Zooplankton

Zooplankton are important in the lake ecosystem. They graze on algae and can keep algae densities down. However zooplankton are eaten by small fish. Zooplankton may be playing a role and account for some of the variability in the Powers Lake water clarity fluctuations. Two samples collected in 1998 indicate a typical zooplankton community for this region (Table 6 and Figures 12, 13). More samples collected over the growing season would be needed to determine impacts of zooplankton on water clarity.

Table 6. Zooplankton counts for Powers Lake.

	7.15.98	9.28.98
Cladocerans	**22**	**96**
Big	4	82
Little	10	12
Ceriodaphnia	0	0
Bosmina	7	0
Chydorus	1	2
Copepods	**57**	**53**
Calonoids	9	9
Cyclopoids	43	37
Nauplii	5	7
Rotifers	**100**	**17**
Total Zooplankton	**179**	**166**

Figure 12. An example of a copepod found in Powers Lake during the summer of 1999.

Figure 13. [top] An example of a cladoceran found in Powers Lake on July 15, 1999. [bottom] Examples of rotifers found in Powers Lake on July 15, 1999.

Aquatic Plants

In shallow lakes, aquatic plants are essential for helping sustain clear water conditions. In Powers Lake aquatic plants are still establishing themselves. Unfortunately, in 1999, the two dominant plants are two exotic species: curlyleaf pondweed and Eurasian watermilfoil. Milfoil distribution is shown in Figure 14. Native aquatic plant species are scarce at this time. Examples of plant conditions in 1998 are shown in Figures 15 and 16.

Figure 14. Locations within Powers Lake where Eurasian watermilfoil was found in 1998.

Figure 15. [top] Eurasian watermilfoil was first found at the northwest end of Powers Lake. [bottom] Eurasian watermilfoil was growing to the lake surface in this area.

Figure 16. [top] At the south end of Powers Lake aquatic plant growth was sparse. Here is some sago pondweed along with milfoil fragments.
[bottom] Eurasian watermilfoil is slowly expanding its territory. Here it is on the north east side growing into native plant beds.

Lake Sediment Fertility and Nuisance Plant Growth

Lake sediments play an important role in supporting various species of aquatic plants. Fertile lake sediments can produce nuisance growth of plants and research shows that one of the plants that responds to high sediment fertility is Eurasian watermilfoil. Because Eurasian watermilfoil is present in Powers Lake, a shallow lake sediment survey was conducted to evaluate the potential for nuisance growth of milfoil. A soil auger was used to collect sediments (Figure 17) and they were analyzed at a soil testing laboratory.

Results found that about 60% of the nearshore area around Powers Lake could support nuisance levels of milfoil based on sediment nitrogen levels (Table 7 and Figure 18).

Figure 17. Modified soil auger (5-inch diameter) used to collect Powers Lake sediments.

Table 7. Lake soil sample results for Powers Lake from November 4, 1998. Lake sediments were collected in shallow water with a modified soil auger. Sediments were placed in plastic bags and sent to Eco-Agri Laboratories and tested as soil samples. Data represent the results from routine soil analysis, using standard agricultural soil testing methods for North Central soils.

	Depth (ft)	Substrate**	EWM*** Density/ Other Plant Species	NH_4	Org Matter	Bray P	Olsen P	Exch K	Mang	Iron	Sulfur	Zn	Cu	B	Ca	Mg	Na	pH	CEC
P1	3.5	SS	5/1	12.4	1.6	12	13	92	8.6	96	18	0.52	2.64	0.21	880	207	100	6.6	6.8
P1b	3.5	SS	5/0	8.2	2.3	11	17	111	7.3	97	97	1.00	3.52	0.16	960	277	104	6.6	7.8
P2	7.0	SS	0/1	5.1	1.3	16	11	67	6.8	91	48	0.50	2.64	0.18	680	197	62	6.8	5.5
P3	5.0	S	0/1	4.7	1.6	10	9	85	6.9	90	87	0.56	2.42	0.19	840	227	66	6.8	6.6
P4	5.5	S	0/1	4.1	1.2	16	8	77	7.6	63	8	0.42	1.16	0.19	400	95	40	6.4	3.2
P5	8.0	SS	0/2	5.0	2.3	8	18	106	7.0	97	118	0.92	3.52	0.29	1080	305	62	6.6	8.5
P6*	5.0	SS	0/2	3.8	2.0	22	11	58	7.2	69	21	1.06	1.58	0.24	560	122	40	6.6	4.1
P7	5.0	R	0/0	3.0	0.5	16	6	34	3.8	19	79	0.24	1.14	0.19	240	62	30	6.5	1.9
P8	5.0	R	0/0	4.6	0.7	30	19	136	7.5	70	36	0.36	2.52	0.18	1240	325	72	7.2	9.6
P9	6.0	M	0/2	6.6	3.4	13	8	57	8.0	91	15	3.50	1.80	0.31	680	137	32	6.6	4.8
P10	4.0	R	0/0	8.3	0.9	4	6	84	7.6	106	13	0.32	3.56	0.20	640	172	58	5.6	5.1
P11	5.0	S	0/1	6.1	0.7	25	13	35	3.7	79	11	0.20	0.90	0.14	80	35	48	5.6	1.0
P11b	5.0	S	0/1	3.6	0.6	23	10	31	3.4	77	11	0.18	0.72	0.12	80	35	62	5.6	1.0
P12	8.0	SS	0/1	3.1	1.2	14	8	31	4.8	79	9	0.74	0.68	0.17	200	45	28	5.9	1.6
P13	5.0	S	0/0	3.9	2.1	14	6	42	6.0	59	20	2.02	0.82	0.23	520	100	22	6.1	3.6
P14	5.0	R	0/0	3.3	0.9	18	8	68	4.6	24	14	0.20	1.46	0.15	520	145	84	6.9	4.3
P15	5.0	R	0/0	2.8	1.0	20	10	43	6.1	57	19	0.62	1.54	0.15	280	77	80	6.3	2.5

* in front of storm sewer outlet
** substrate key:
SS = silty sand
S = sand
R = rocky (gravel to cobble size)
M = mucky
***EWM = Eurasian watermilfoil

Figure 18. Sediment sample locations and nitrogen concentrations on Powers Lake sediments at 15 locations. Locations over 4 ppm-N can support nuisance growth of Eurasian watermilfoil.

Figure 19. [top] Eurasian watermilfoil in 3-5 feet in Powers Lake. A sediment sample was taken near the root crown. This site was rated having a density of 5 because milfoil came to the surface. A rating system of 1-5 was used with 5 being the densest.
[bottom] Eurasian watermilfoil was only found with a density of a 5 in the north end of Powers Lake. Here is a milfoil sample on a lake sampler.

Fish

The most recent MnDNR fish survey and management recommendations are from 1997. The narrative from the 1992 and 1997 fish surveys is shown below.

1992: The catch in the 1992 survey of walleyes numbered four fish; all taken in gillnets. One walleye was taken in the 1984 survey and none in 1982. Growth history of walleyes from the 1992 survey was average. The presence of walleyes in Powers Lake is more than likely due to angler transplants of fish from nearby walleye rearing ponds.

Northern pike were sampled at the same catch rate as in 1982. In 1984 no pike were taken. Pike from the 1982 catch were bigger than fish from 1992. Growth histories of northern from this survey were above average to Year 3 then fell off slightly by Year 4.

Largemouth bass, not seen in 1982 and 1984 passive gear were sampled in this survey at levels higher than state and local medians from both number and size in both gear types used. Shoreland seining produced numbers of young of the year bass and a few yearlings.

Yellow perch, not seen in the last two surveys, were sampled in 1992 in numbers greater than state and local medians; pounds/net was less than the statewide median and greater than the local median. Young of the year perch were abundant in shoreline seine hauls. White suckers, another species not netted in the two previous surveys, were sampled in high numbers; the fish were large.

Several other species were sampled in this survey. Black crappies numbers and average size were down from 1984. White crappies, seen in low numbers in the 1984 survey, were not taken during this survey. Bluegill sunfish, sampled in high numbers although small size in the 1982 and 1984 survey, were observed in average numbers and large size in this year's survey. Large numbers of young of the year bluegill were sampled in shoreline seining in late summer. One medium-sized pumpkinseed sunfish was sampled.

1997: Angling on Powers Lake is done primarily from shore. The City of Woodbury owns the entire shoreline and is building a walking path around the lake, which should provide additional shore angling opportunity. Boat access for small craft is also possible at the northwest corner of the lake. This access point is to be blocked as the walking path is constructed, but a carry-in access will still be available, with parking. Only electric motors are allowed.

Bluegills are the most abundant game species in Powers Lake, but are small, with an average length of 5 inches. Northern pike are present in low to moderate numbers, with an average length of 25 inches. Neascus (black spot) was found in about one third of the northern pike. Black crappie, pumpkinseed, and hybrid sunfish are all present in low to moderate numbers, but small size. Black crappies averaged 7 inches with none over 8 inches. Walleye were sampled in low numbers in 1997 and past surveys. Walleye size was from 17 to 28 inches. Largemouth bass are also present. They were sampled in low numbers, but their population is probably higher than sampling suggests because the gear used does not adequately sample them. Anglers have reported successful largemouth bass fishing. Black bullhead were found in low numbers, but size was large - average length of 14 inches.

Table 8. Fish sampled in 1992 and 1997 surveys.

Species	Gear Used	**Number Caught per net**		Normal Range	**Average Fish Weight (lbs)**		Normal Range (lbs)
		1992	1997		1992	1997	
Yellow perch	gillnet	12.5	0.5	1.5-12.8	0.16	0.10	0.1-0.2
	trapnet	0	6.7	0.3-1.5	--	0.06	0.1-0.2
Pumpkinseed sunfish	gillnet	0	0.5	not available	--	0.08	not available
	trapnet	0.2	5.9	0.8-5.3	0.10	0.07	0.1-0.2
White sucker	gillnet	6.5	1.5	0.5-2.0	2.22	1.95	1.0-2.2
	trapnet	0	1.0	0.3-1.6	--	2.83	1.0-2.2
Walleye	gillnet	2.0	1.5	0.5-3.5	1.45	3.92	1.1-3.0
Northern pike	gillnet	2.0	4.5	2.5-7.9	0.35	3.37	1.8-3.3
	trapnet	0.2	0.2	NA	2.10	4.11	NA
Largemouth bass	gillnet	2.0	0.5	0.3-1.1	0.35	0.15	0.4-1.5
	trapnet	0.4	0	0.3-0.8	0.23	--	0.2-1.1
Bluegill	gillnet	1.0	11.0	NA	0.15	0.07	NA
	trapnet	21.4	71.2	6.5-59.6	0.31	0.04	0.1-0.2
Black crappie	gillnet	0.5	9.0	1.9-18.0	0.85	0.20	0.1-0.3
	trapnet	2.0	1.0	1.8-18.1	0.24	0.17	0.2-0.3
Black bullhead	trapnet	0	1.2	1.3-26.0	--	1.35	0.2-0.3
Hybrid sunfish	trapnet	0	0.9	not available	--	0.09	not available

6. Lake Report Card

Powers Lake is a lake in transition and it's lake report card reflects the changes it experiences from year to year (Table 9). Factors that influence water quality are wide ranging. All lakes are influenced by rainfall and seasonal variations in temperature. But in addition, Powers Lake has had significant increase in water level and runoff from a developing watershed that is increasing in size. Not only that, dominant aquatic plant species are two exotic plants: Eurasian watermilfoil and curlyleaf pondweed which are growing to nuisance conditions.

Although Powers Lake has a overall "A" in 1999, it had a "C" in 1998. Powers Lake trophic state, which is a fertility and algae index, places it in the moderate fertility (mesotrophic) range (Figure 19).

Table 9. Powers Lake report card, based on data from the Metropolitan Council's CAMP program.

	1994	1995	1996	1997	1998	1999
Total phosphorus	B	B	A	A	C	A
Chlorophyll a	A	B	A	B	C	B
Secchi disc	A	B	A	C	C	A
Overall	A	B	A	B	C	A

Figure 19. The range trophic state index for Powers Lake in 1998 (high values).

7. Goals for Powers Lake: What Could It Look Like in the Future?

The results of conventional lake and watershed modeling show that under ultimate development conditions with (NURP) ponding to treat runoff from upstream developed areas, water quality will continue to degrade from that measured in 1999. Further, about two-thirds of the total phosphorus loading to the lake under ultimate development conditions is expected to entire the lake through a single subwatershed at a very low concentration. These concentrations are unlikely to be reduced further by conventional treatment measures. This suggests that preservation of good water quality in the lake will depend on a combination of conventional watershed management measure (such as wet detention basins), in-lake treatment measures designed to reduce the impact of the higher loadings on lake water quality, and other less traditional urban load reduction measures.

Details of the Watershed and Lake Modeling Results

Computer models were used to help assess the effect of watershed expansion and development on water quality in Powers Lake. Two types of models were selected to carry out this task. The model PONDNET was used to generate information on phosphorus and water loads from the watershed of Powers Lake under both existing (1998) conditions and ultimate watershed development conditions. This model is endorsed by the Mn Pollution Control Agency for use in watersheds dominated by urban land uses where phosphorus - the pollutant of primary concern for Powers Lake - is generated by runoff.

Outputs from the PONDNET model for phosphorus and water loading were then used as inputs to a second modeling tool named the Wisconsin Lake Model Spreadsheet (WILMS). WILMS is composed of ten empirical lake response models that were developed using monitoring data from various lakes throughout North America, Canada, and Europe. The lake models predict either spring overturn or growing season (May-September) in-lake total phosphorus concentrations. The lake models included in WILMS represent a cross-section of many lake types and characteristics, are commonly used today for lake management purposes, and have been published in technical journals.

A PONDNET model was developed to reflect existing 1998 watershed conditions for Powers Lake. Using precipitation data from a Woodbury site, the annual watershed loads for phosphorus and water were generated for 1998. Watershed total phosphorus loads for 1998 were estimated at approximately 110 lbs./yr. The Reckow Oxic Lake Model predicted a May-September in-lake total phosphorus concentration of 33 ug/l compared to a measured value of 34 ug/l. This value falls within the moderate range of phosphorus concentrations for lakes in this eco-region and is slightly above the value of 30 ug/l recommended by MnPCA for full support of swimming.

A similar analysis was conducted assuming ultimate size and land use conditions for the watershed of Powers Lake and no special management provisions (such as ponding). Modeling results show that phosphorus loading to Powers Lake will increase about three times to 430 lbs./yr. and that summer in-lake total phosphorus concentrations would rise to 85 ug/l. This value is reflective of extreme nutrient enrichment (hypereutrophy) and implies that the lake would experience impaired or non-supportable conditions for swimming at least 75% of the summer.

Finally, another analysis was conducted assuming ultimate development conditions for the Powers Lake watershed. This analysis, however, assumed that large regional ponds designed to meet NURP criteria for water quality treatment would be constructed for each sub-watershed in the expanded watershed. Results indicate that the phosphorus loading to Powers Lake during an average precipitation year would be reduced to 280 lbs./yr. and that summertime in-lake total phosphorus concentrations would be 53 ug./l. At this value, the relatively high frequency of algal blooms and reduced water clarity will result in a high percentage of the summer (40-50%) being perceived as impaired for swimming.

Table 10 shows a comparison of the three modeling runs discussed above.

Table 10. Comparison of the three models conducted for Powers Lake.

Development Condition	Watershed Area (acres)	Phosphorus Load from Watershed (lbs/yr)	Lake flushing time (yrs)	In-Lake P Concentration (ug/l)
Existing (in 1998)	430	110	3.8	34
Ultimate, no ponding	1,230	430	1.2	85
Ultimate, with ponding	1,230	280	1.2	53

Contributions from Subwatersheds

Watershed modeling results make a compelling case for the use of well-designed water quality ponds to minimize the degradation of Powers Lake as the watershed of the lake expands and develops. Further significant reductions in loadings to the lake from the watershed using conventional methods will be difficult, however.

Table 11 shows the predicted phosphorus loads and average phosphorus concentrations contributed through each of the sub-watersheds discharging directly to the lake under ultimate development conditions with treatment. These modeling results predict that over 60% of the total phosphorus loading to the lake will enter through sub-watershed CD-50.2b at an average concentration of less than 140 ppb. Subwatershed CD-50.2b receives virtually all the treated flow from the expanded watershed to the east of St. John's Drive. Once phosphorus concentrations fall below 150-200 ug/l, it is very difficult to reduce the concentration further regardless of how much additional treatment is provided, based on data collected in the Eastern part of the United States.

Table 11. Subwatershed load contributions to Powers Lake at ultimate development

Sub-Watershed Designation	Modeled TP Load Contribution to Lake (lbs./yr.)	Average TP Concentration (ug/l)	% Load to Powers Lake
CD-48.1	9.8	140	3.3
CD-48.4	15.2	190	5.1
CD-48.5	1.4	235	0.5
CD-50.2a	5.5	440	1.8
CD-50.2b	209.0	135	70.2
CD-50.2c	1.5	190	0.5
CD-50.2d	7.3	215	2.4
CD-63.4	38.8	230	13.0
Direct	9.4	300	3.2
	297.9		100.0%

Management Implications

Further significant reduction in the concentration (and therefore loading) of phosphorus delivered to the lake through subwatershed CD-50.2b is not possible with conventional BMP's. At the same time, reductions in loadings to the lake from other sub-watersheds will have only a very minor impact on water quality, since their contributions will make up only a very small percentage of the overall loading to the lake. Therefore, other management measures will need to be considered if the goal of this lake management effort is to prevent any further degradation in water quality from existing (1998) conditions. These management measures generally fall into one of three categories:

1. In-lake measures designed to increase the assimilative capacity of the lake to receive phosphorus without showing signs of increased enrichment. Representative measures include native aquatic plant introductions, alum treatments, and aeration.

2. Diversion of large portions of the watershed to another drainage likely to be less impacted by the associated phosphorus loads.

3. Application of non-traditional urban best management practices in the watershed. These include the treatment of inflows to the lake with chemical precipitants and the use of infiltration on a large-scale to reduce or eliminate runoff to the lake from small to moderate sized storms.

These options will be addressed in the Lake Management Projects section.

8. Lake Management Projects

A recommended list of projects has been developed (Table 12) after an initial project list was prepared. Because it appears Powers Lake is close to maintaining water quality "A"s and "B"s, conventional watershed BMPs combined with selective use of infiltration and implementing shallow lake management practices should be adequate to maintain good water quality. Watershed diversion or stormwater dosing stations do not appear to be necessary at this time.

Table 12. Summary of Powers Lake management program.

Project	Task Total Cost	Total Costs
Powers Lake subwatershed implementation		
1. Plan Amendment		$5,000
2. Subwatershed development standards for lakesheds and indirect drainage areas		$35,000
3. Lake projects		$62,000
3a. Native aquatic plant introduction	$10,000	
3b. Fish habitat enhancement	$2,000	
3c. Drawdown strategy for exotic weed control	$30,000	
3d. Aquatic plant and shoreland inventory for Wilmes, Colby, and Bailey	$20,000	
4. Public information		$32,500
4a. Lake brochure	$5,000	
4b. Lawn soil testing	$2,500	
4c. Informational kiosk	$10,000	
4d. Community event at lake	$10,000	
4e. Watercraft ordinance	$5,000	
5. Surface water monitoring*		$43,000
Total		$177,500

* Assumes equipment automation to reduce annual sampling costs. If no automation, reduce cost to $37,000.

1. Plan Amendment

The South Washington Watershed District management plan would need to be amended to adopt the Powers Lake management plan.

2. Subwatershed Development Standards

As development increases in the Powers Lake watershed, volume of runoff and pounds of phosphorus transported to Powers Lake are expected to increase. However, the amount of phosphorus exported and the actual amount delivered to a lake are different. For example, if a pound of phosphorus is carried off the land into stormwater in the far northeastern part of the watershed only a fraction of that makes it to Powers Lake. On the other hand most of the phosphorus that is carried off the land 200 yards from the lake ends up in the lake. It is recommended that different development standards be formulated depending on the distance from the lake or on the path stormwater takes to the lake. For example, direct drainage areas or lakesheds have the highest lake protection standards. Watershed runoff that flows through two or three stormwater ponds before entering Powers Lake has less stringent standards. A summary of potential standards and BMPs is shown in Table 13.

Table 13. Possible approach for determining development standards based on potential for phosphorus to get to Powers Lake. Drainage areas closest to the lake have the highest priority.

	1. Direct Drainage Areas (no ponding)	**2. Storm Flows Go Through One Stormwater Pond**	**3. Storm Flows Go Through at Least Two Stormwater Ponds**
Construction site erosion control	high priority inspections, etc.	high priority	lower priority
Small-scale infiltration goal	15%	10%	5%
Custom street sweeping	high priority	medium priority	lower priority
Catch basin silt removal	high priority	medium priority	lower priority
Fertilizer education and use	intense: 2-3 mailings per year for 3 years	moderate: 1-2 mailings per year	low: 1 mailing per year
Soil tests	high priority	medium priority	lower priority
Adopt a pond by neighborhood	--	high priority	high priority

Figure 21. Erosion control at construction sites are essential especially in the lakeshed. [Top] Main inflow to Powers Lake heavily influences water quality. [Bottom] Photo was a 1998 construction project in the Powers lake lakeshed.

Subwatershed Development Standards - continued: The scope of this management plan is to conceptually outline the project approach. In the implementation stage, policies and standards would be established based on engineering considerations and public input.

Figure 22. Small-scale infiltration, like shown above in this parking lot is a recommended BMP.

3. Lake Projects

3a. Native Aquatic Plant Introduction

- Review all data on Powers Lake and surrounding lakes to construct a typical native aquatic plant list.
- Survey downstream lakes for plants.
- Introduce several appropriate pondweed species that include submerged, floating, and emergent.

3b. Fish Habitat Enhancement

- Survey existing fish spawning habitat for sunfish, bass, walleye, and northern pike conditions.
- Enhance existing structure, which is mostly fallen trees and some aquatic plants, with additional natural features. Aquatic plants are the preferred habitat enhancement feature at this time.
- Set-up shoreline fishing stations.
- Evaluate lake conditions for smallmouth bass introduction.

3c. Drawdown for Exotic Weed Control

- Drawdown will expose shallow lake sediments over winter.
- Freezing action kills curlyleaf pondweed and limits Eurasian watermilfoil nuisance control.
- All the shoreline is controlled by the City.
- This would be a unique project and not a routine practice.
- A large 6 inch pump could be used to drawdown Powers Lake rather than having to modify a lift station.
- Lake should refill in Spring.
- A disadvantage of drawdown is phosphorus is released from exposed soils and algae blooms may occur in the summer following drawdown.
- Sometimes there is a fish kill with drawdown. A standby winter aeration system would be needed.

3d. Aquatic Plant/Shoreland Inventory for Wilmes, Colby, and Bailey Lakes

- Because of potential plant exportation from Power's Lake due to a possible drawdown of Powers Lake, that will send water and possibly plant fragments downstream, aquatic plant surveys should be conducted on three downstream lakes: Wilmes, Colby, and Bailey.

Figure 23. Here is Power's Lake at low water. A drawdown would lower the lake level another 5 or 6 feet. A drawdown starts in the fall and lake sediments freeze. The lake generally refills in spring.

4. Public Information Program

4a. Lake Brochure

Three-fold lake brochures should be prepared highlighting fish species present in Powers Lake as well as fishing regulations. In addition, an aquatic plant guide should be prepared also. City of Woodbury and the Watershed District could distribute the brochures and they would be available at the kiosk at the lake.

4b. Lawn Soil Testing

Set-up a watershed soil sampling program and budget for 100 tests. Use the results to promote specific fertilizer programs. Concentrate in drainage areas closest to the lake.

4c. Informational Kiosk

As Woodbury and the Powers Lake watershed develops, Powers Lake will become an even more important natural resource asset. An informational kiosk will allow lake visitors or lake users a chance to get the latest information on Powers Lake. It's water quality status, the fishing, and wildlife would be described. It would help visitors better understand Powers Lake and why it is so valuable.

4d. Community Event at Lake

Powers Lake is an important community asset. A community event such as a fishing contest, picnic, or shoreline clean-up would bring citizens to the lake and create a fun atmosphere. At the same time it would be an opportunity to relay lake protection information.

4e. Watercraft Ordinance

- Summarize other existing water surface use ordinances in the metro area.
- Evaluate impacts of motorboats on Powers Lake.
- Set policy for mooring or storing boats along shoreline.
- City of Woodbury staff takes lead on developing policy.

5. Monitoring Recommendations

Powers Lake currently has fair water quality. Lake monitoring is recommended on a regular basis to detect changes. Secchi disc, total phosphorus, and chlorophyll a measurements are good indicators of water quality. These readings should be taken once or twice a month from May through September to determine summer averages for each parameter. Detection of a significant trend toward water quality degradation will be an indication that in-lake management techniques are needed.

Stormwater monitoring has not been conducted up to this time. Automated samplers at up to three locations would help better characterize watershed nutrient export to Powers Lake.

Aquatic plant surveys should be conducted in spring and late summer for as long as lake projects are being implemented. This will allow tracking of exotic as well as native plants.

Appendix B

Shoreland Inventory

Appendix A

Background Data

Table A1. Land use and phosphorus input for ultimate development, Powers Lake.

Land Use	Acres	Hectares	Export Coeff. (Kg/ha/yr)	Phosphorus Input (kg/yr)
Residential single family	997.40	403.65	0.72	290.6
Residential multiple units	41.10	16.63	1.79	29.8
Commercial/retail, office	6.20	2.51	3.14	7.9
Parks/Open	163.80	66.59	0.10	6.6
Ponds	29.80	21.57	0.22	8.6

Table A2. Powers Lake: Lake model results based on the Canfield/Bachmann model.

Development Conditions	Estimated Phosphorus Input (kg/yr)	Lake Phosphorus Concentration (ppb)
Existing conditions	95	40
Ultimate development with stormwater management	125	55
Ultimate development without stormwater management	345	110

Table B1. Dissolved Oxygen/Temperature Profile for July and September.

7.15.98 Secchi disc transparency: 3.3 ft		
Depth (ft)	Temp (C)	DO
0	28.5	9.8
3	28.5	9.8
6	28.5	9.1
9	26.0	6.6
12	23.5	0.2
15	19.5	0.2
18	16.5	0.2
21	14.0	0.2
24	11.0	0.2
27	10.0	0.2
30	10.0	0.2
33	9.5	0.2
36	9.0	0.2

9.28.98 Secchi disc transparency: 8.7 ft		
Depth (ft)	Temp (C)	DO
0	20.0	7.6
3	20.0	7.5
6	20.0	7.4
9	19.8	7.3
12	19.8	7.0
15	19.5	6.8
18	19.0	4.0
21	14.0	2.2
24	12.0	1.8
37	10.2	1.4
30	10.0	1.3
33	9.8	1.0
36	9.5	0.8
39	9.5	0.8

Figure A-1. Key to photographs of Powers Lake shoreland inventory.

Watershed of Powers Lake

The drainage area to Powers Lake is dominated by pasture/unused land, which comprise 586 acres of the 1,238 acre watershed. Single family and multiple units will eventually comprise 1,038 acres and may contribute up to 320 kg/yr (93%) of the phosphorus entering Powers Lake. Land-use and phosphorus inputs for each land-use under ultimate development conditions can be seen in Table 1.

The lake model predicts that under existing conditions the phosphorus input to the lake should be relatively low, 95 kg/yr, and the in-lake phosphorus concentration is predicted to be 40 parts per billion (ppb)(Table 2). This falls in the mesotrophic (moderate nutrients) range and is consistent with ecoregion values (35-45 ppb).

The model predicts that without water quality management, the phosphorus inputs tot he lake would increase to 350 kg/yr, resulting in a in-lake phosphorus concentration of 110 ppb. These high phosphorus concentrations indicate hyper eutrophic conditions, resulting in poor water quality and frequent algae blooms.

With water quality management, the model predicts that phosphorus inputs to the lake would be 125 kg/yr and the in-lake phosphorus concentration would be 55 ppb, indicating a state between mesotrophic and eutrophic conditions.