Cedar Lake Phosphorus TMDL
Revised June 1, 2003
Revised July 1, 2003
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Background

This TMDL report is for Cedar Lake, located in Alden Township in Polk county and Star Prairie Township in St. Croix county Wisconsin, respectively. The lake is located within the St. Croix River drainage basin and geographically spans Sections 34 and 35, T32N, R 18W – Polk county and Sections 2 and 3, T31-32 N R18W in St. Croix county on the New Richmond North USGS quadrangle. Cedar Lake is listed on the Wisconsin Department of Natural Resources' (WDNR) 1998 303(d) List of Impaired Waters. The Lake is nutrient (phosphorus (P)) impaired as a result of agriculture, internal loading and local land use, is listed as a medium priority water with external load sources are nonpoint source (NPS) dominating. The designated use for Cedar Lake is defined as a full recreation, warm water sport fishery water. For additional detailed information on the watershed relevant to the TMDL see the *Nonpoint Source Pollution Control Plan for the Horse Creek Priority Watershed Project* dated June 2001 (Attachment 1).

Water quality in Cedar Lake is generally poor to very poor, falling into the eutrophic to hypereutrophic category (see *Cedar Lake – Management Plan, Polk and St. Croix Counties*, *page 3*) dated 1989 (Attachment 2). Summer (1986-2001) surface water column total phosphorus levels average 83 ug/l. Summer algal blooms result in foul odors and an unsightly build-up of algae biomass on the shoreline. In addition, trophic conditions in the lake limit rooting depth for emergent vegetation used by the resident fish populations. As a result, these impairments impact the recreational/aesthetic value of the lake and stress sport fish populations.

Water quality standards

Cedar Lake is not currently meeting applicable narrative *water quality criterion* as defined in NR 102.04 (1); Wis. Admin. Code:

> "To preserve and enhance the quality of waters, standards are established to govern water management decisions. Practices attributable to municipal, industrial, commercial, domestic, agricultural, land development or other activities shall be controlled so that all waters including the mixing zone and the effluent channel meet the following conditions at all times and under all flow conditions: (a) Substances that will cause objectionable deposits on the shore or in

> the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state, (b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in waters of the states, (c) Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state."

This criterion describes the acceptable water quality conditions and guides the WDNR in setting a numerical target pollutant concentration. The application of a narrative criterion for Cedar Lake necessitates the development of a site-specific in-water value for the purpose of this TMDL.

The site-specific eplimnetic total phosphorus concentration goal has been identified as 50 ug/L. The in-lake TP concentration represents the mean growing season (GSM) eplimnetic concentration. This narrative criterion is based on a comparison with similar lake types in the area taking into account site-specific conditions, using available monitoring data and modeling tools. The receiving water capacity in this situation represents cleaning-up the waterbody to achieve attainable uses.[1] Based on a 2001 growing season (June/September) mean total phosphorus concentration of 100 ug/l, Cedar Lake is hypereutrophic. Specifically, the intent is to minimize the frequency of algal blooms and reduce nuisance conditions in the lake. The chlorophyll-a concentration in Cedar Lake responds directly to the in-lake phosphorus concentration. Cedar Lake is phosphorus limited based on a TN/TP ratio of 25. Lakes with ratios above 10 are considered to be phosphorus limited. As P concentration rises, the chlorophyll-a concentration rises and algal biomass production increases. This cause and effect relationship is measured using a Secchi disk to measure water clarity (poor water clarity results in limited emergent vegetation rooting depth and indicates the presence of significant biomass in the water column). Reducing P reduces chlorophyll-a, which results in improved water clarity and diminished algae production.

A number of models were used to estimate the P loading budget. For the uplands (croplands and woodlands) the WINHUSLE model was used. WINHUSLE is a Wisconsin developed USLE based/hydrologic runoff model. The Cedar Lake water and nutrient budget were developed using methods discussed in the WiLMS documentation and through the application of empirical lake response models in a modeling package called NEWTROPHIC. The documentation on both of these modeling tools has been previously provided to EPA. The load contribution from carp was developed using fish survey data of the carp population multiplied by the total phosphorus contribution per individual. The results of the lake water quality modeling analysis are summarized on page 9 of the *Cedar Lake – Management Plan, Polk and St. Croix Counties, dated May 1989.*

[1] Attainable use in the context of this TMDL is the use that can be attained through the implementation of point source controls and the reasonable implementation of best management practices to control nonpoint sources. See EPA Water Quality Standards Academy Basic Course materials for further discussion on the definition of attainable uses.

NEWTROPHIC was also used to assess changes in the P budget to in-lake responses for Cedar Lake. The NEWTROPHIC analysis is based on factors that included nutrient loading, watershed runoff volume, lake volume and in-lake P retention. The model runs illustrated that P concentration changed under different management scenarios, i.e. installation of best management practices (BMPs) and the reduction of internal loading from carp and the sediments. Based on this mass balance concept, the model predicted an in-lake P concentration based on all P loading sources to the water column. Table 1 lists modeled phosphorus loading to Cedar Lake as well as the load allocation (LA). (The data used to generate Table 1 can be referenced in the attached *Cedar Lake – Management Plan, Polk and St. Croix Counties, dated May 1989.*

Total loading capacity, wasteload allocation and load allocation

The total loading capacity for Cedar Lake is driven by the in-lake P concentration. Nutrient concentrations above this capacity cause the designated use impairments as discussed earlier in this report. The total loading capacity for Cedar Lake was determined using a GSM in-lake P concentration of 50 ug/L of total phosphorus based on trophic conditions. This number is an indication of water quality and in-lake P concentration over this capacity exceeds the *water quality criterion* and triggers excess algal blooms that lead to use impairments.

As described below, the wasteload allocation (WLA) is zero. And, the margin of safety is implicit. Therefore, the Load Allocation plus the background load equals the load capacity.

Table 1
Cedar Lake Annual Phosphorus Budget and LA Reduction Objectives
(Lbs. phosphorus)
(From Table 1 of Cedar Lake Management Plan)

Nonpoint Source	Load Allocation/ Background	Existing (Inventoried) NPS Load (Lb.)	Percent Existing Load	Load Reduction (%)
Watershed	2,000	2,860	23.3	30
Carp Population	2,230	4,460	36.3	50
Sediment Release *	2,610	4,430	36.1	40
Septic Systems	70	70	0.7	0
Background **	450	450	3.6	0
Subtotal	**7,360**	**12,270**	**100**	**40**

*The water column TP goal and sediment allocations have been modified from the original lake management plan to more accurately account for experience gained in operating the existing aeration system. The rough fish management TP reduction has been updated to more accurately reflect current conditions.

** Background is equal to groundwater and atmospheric deposition of phosphorus. Septic system contributions where estimated separately.

The watershed load is based on monitored flows and grab samples collected in tributary streams.

The carp population contribution was estimated based on WDNR fishery survey of population and literature values for phosphorus excretion.

The sediment release contribution was determined based on weekly water chemistry samples taken during July and August and applied to an anoxic area of 545 acres for the critical period.

The contribution from septic systems was based on the number of riparian homes adjusted for the number of user days.

The groundwater contribution was calculated using a number of observation wells and a phosphorus concentration of 0.03 mg/l.

The atmospheric contribution is based on literature values.

Load Allocation (LA) for Nonpoint Sources. As illustrated in Table 1, the total phosphorus load allocation for Cedar Lake is estimated to be 7,360 lbs/P/year.

Waste Load Allocation (WLA). The WLA for Cedar Lake is 0 as point sources are absent from the watershed. A summary of the land cover types in the Cedar Lake watershed is contained on page 2 of the *Nonpoint Source Pollution Control Plan for the Horse Creek Priority Watershed Project* dated June 2001. The addition of future point sources is not anticipated

Seasonal Variation

Phosphorus is the pollutant of greatest concern for Cedar Lake as it is the primary cause of poor water quality conditions. Cedar Lake is characterized as a drainage lake with flowing inlet and outlet. The in-lake modeling was based on a critical condition (growing season algal blooms) lake response while the pollutant loading represents annual loads taking hydraulic detention time into account. The portion of the growing season considered critical is June through September. The relationship between annual loading and growing season lake trophic response has been well established and is documented in references such as Reckhow and Charpa, 1983. The bulk of the external P load is introduced during peak spring runoff as most runoff occurs in February, March and April when the land surface is frozen and soil moisture content is highest. In contrast to the majority of the internal loading which occurs during the summer growing season. The goal of this TMDL is to install best management practices and reduce internal loading processes sufficient to reduce water column P loads in Cedar Lake. Preventative

measures in the watershed (over the course of the entire year) will be used to control P load.

Margin of Safety (MOS)

A margin of safety has been provided through the use of conservative implicit assumptions in modeling. Conservative assumptions were used for the pollutant reduction performance of best management practices for barnyard runoff management, manure spreading management and cropland erosion control. For example, for barnyard runoff management the low end of the range of effectiveness was used. In addition, the sediment release rate value was on the high end of the range of literature values. For carp removal, the number of fish assumed to be removed per unit area was on the low end of the range based on WDNR experience with carp removal projects.

Public Participation

Consistent with the Wisconsin DNR Continuing Planning Process and as required by Sections NR 120.08 (Watershed Plans), and NR 121.07(1), (Water Quality Management Plans), Wis. Adm. Code, there was public participation on the Horse Creek Priority Watershed Project Plan. As required by s. NR 120.08 (2), Wis. Admin. Code, a public hearing on this priority watershed plan was held on September 21, 1999. During the public meeting and for a two-week period afterwards, only one comment was made and that did not directly deal with the watershed plan. Since the load allocation in this TMDL is consistent with the Horse Creek Priority Watershed Plan, the Department believes the public participation process used for the priority watershed project meets the intent of public participation requirements for a TMDL.

Reasonable Assurance

As required, the state must provide "reasonable assurance" that the TMDL will be implemented. Reasonable assurance may be provided through a variety of voluntary or regulatory means. In general, Wisconsin's Section 319 Management Plan (approved by EPA in 2000) describes the variety of financial, technical and educational programs in the state. In addition, it describes the "back-up" enforcement authorities for nonpoint source management in Wisconsin. The primary state program described in the 319 Management Plan is the Wisconsin Nonpoint Source Water Pollution Abatement Program (Section 281.65 of the Wisconsin Statutes and Chapter NR 120 of the Wisconsin Administrative Code).

Specific to this TMDL, Cedar Lake is part of a larger priority watershed project, Horse Creek Priority Watershed Project. As part of a financing plan for priority watershed and priority lake projects, long-term cost sharing and local staff funding is committed to the

Horse Creek Priority Watershed Project. No new or additional enforcement authorities are proposed under this TMDL.

Monitoring Plan

Cedar Lake has been monitored during the growing season on a yearly basis since 1986. Monitoring included temperature and dissolved oxygen profiles, Secchi depth clarity, chlorophyll *a* and total phosphorus. Ongoing monitoring is planned to continue at a rate of 4 times per year for a period of 5 years or until such time as it can be established that the lake water quality goals have been met.

References:

Reckhow, K.H and S.C. Chapra. 1983. Engineering approaches for lake management Volume 1: data analysis and empirical modeling. 340p.

Attachments:

1. Nonpoint Source Pollution Control Plan for the Horse Creek Priority Watershed Project (June 2001).

2. Cedar Lake – Management Plan, Polk and St. Croix Counties, dated 1989.