Final

Silver Lake TMDL for Phosphorus

October 10, 2003

Background

This TMDL report is for Silver Lake, located in Manitowoc Rapids Township, Manitowoc County, Wisconsin, in the Manitowoc River Basin. The lake is geographically located across portions of Sections 33 and 34 of T19N, R23W of the USGS Manitowoc Quadrangle. The location map is included as Figure 1.Silver 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 on the 1998 303(d) list as a h*igh* priorit*y* water and external load sources are nonpoint source (NPS) dominated. The *designated use* for Silver Lake is defined as a full recreation, warm water sport fishery water. Pollutant export data and information on the soils, topography, and other background information on the Silver Lake watershed is included in the *Nonpoint Source Pollution Control Plan for the Sevenmile-Silver Creek Priority Watershed,* dated February 1987 (Attachment 1).

Water quality in Silver Lake is generally poor to very poor, falling into the eutrophic to hypereutrophic category (see "Nonpoint source control Plan for the Sevenmile – Silver Creek Priority Watershed Plan" (PWP) report page 21 for a complete description of physical features). Summer surface water column total phosphorus levels average 184 ug/l. Mats of filamentous algae cover a large portion of the lake bottom and 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.

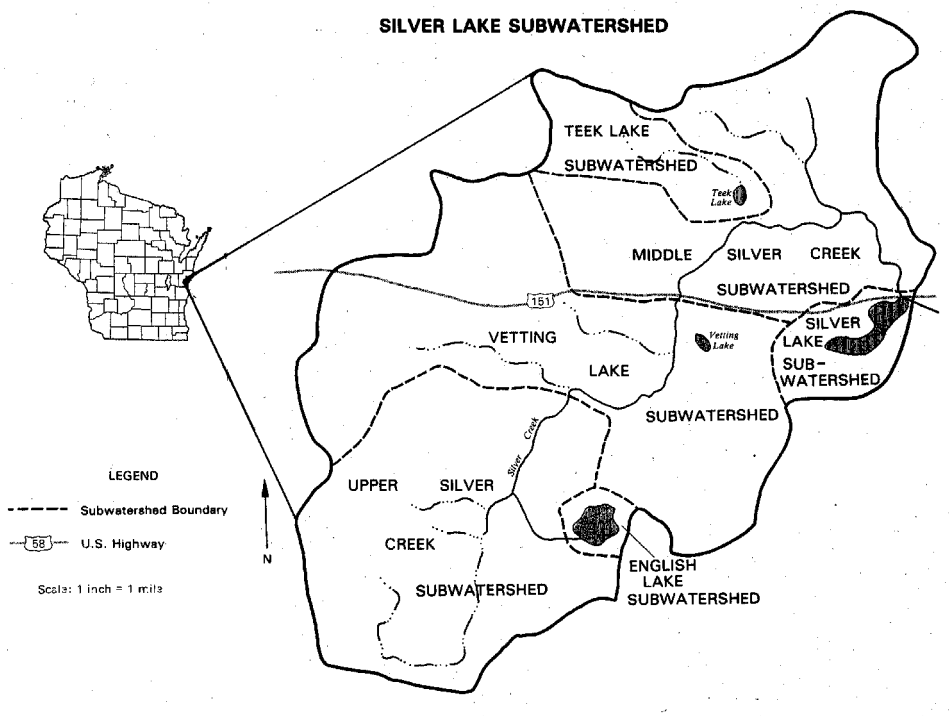

Figure 1. Silver Lake location map

Water quality standards

Silver 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 Silver 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 80 *ug*/L and was determined using data from a number of sources. One data source was a review and comparison of Silver Lake's water quality data with data from 14 nearby lakes, (assessment by analogy as discussed in Attachment 2): *Silver Lake Update Supplement to the Nonpoint Source Pollution Control Plan for the Sevenmile-Silver Creek Priority Watershed*, dated July 1998). Another data source used in the goal selection process was the historical phosphorus values derived from lake sediment cores. Using data from both of these sources in combination with best professional judgment, a goal was selected that was reasonable and attainable. Review of the water quality data for Silver Lake indicates a total nitrogen to total phosphorus (N/P) ratio of 20. Lakes with nonpoint source loading domination and values greater than 10 should be considered P limited (Thomann and Mueller, 1987). The in-lake TP concentration represents the mean growing season (GSM) eplimnetic concentration. This narrative criterion is based on the best professional judgment of the WDNR applied to site-specific conditions, using available monitoring data and modeling tools. The receiving water capacity in this situation represents cleaning-up the water body to minimize the frequency of algal blooms and reduce nuisance conditions in the lake. The chlorophyll-a concentration in Silver Lake responds directly to the in-lake phosphorus concentration. 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) these include: the Soil and Water Assessment Tool (SWAT), WINHUSLE, a Wisconsin developed USLE/hydrologic runoff model, and the phosphorus export coefficients of the Wisconsin Lake Model Suite (WiLMS). For a summary of models and results see Attachment 2: *Silver Lake Update Supplement to the Nonpoint Source Pollution Control Plan for the Sevenmile-Silver Creek Priority Watershed*, dated July 1998. The estimated unit area export value for the Silver Creek watershed is 0.4 Kg/Ha/Yr., which falls in-between the low to most likely export values (0.2 – 1.0 Kg/Ha/ Yr.) for agricultural watersheds in Wisconsin. Even with its low unit area phosphorus export, BMP installation continues in the Silver Creek watershed in both the direct and indirect tributary areas to Silver Lake.

WiLMS was also used to assess changes in the P budget to in-lake responses for Silver Lake. The WILMS 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), diversion of Silver Creek and removal of the point source discharge. 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 Silver Lake as well as the load allocation (LA). (The data used to generate Table 1can be referenced in the attached *Silver Lake Update Supplement to the Nonpoint Source Pollution Control Plan for the Sevenmile-Silver Creek Priority Watershed*, dated July 1998).

Total loading capacity, wasteload allocation and load allocation

The total loading capacity for Silver Lake is driven by the in-lake P concentration and is determined to be an average annual load of 386 pounds of total phosphorus. This value was derived based on completion of the diversion, elimination of rough fish, the implementation of best management practices in the direct tributary watershed and minimal internal loading. Nutrient concentrations above this capacity cause the designated use impairments as discussed earlier in this report. The total loading capacity for Silver Lake was determined using a GSM in-lake P concentration of 80 *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. The Canfield-Bachmann (1981) natural lake model was used to determine the load allocation. The equation for the model is: $P = 0.8L/z(0.0942(L/z)^{0.422} + p)$, where L (areal loading) = 635 mg/m^2 yr., z(mean depth) = 4.22 m and p(flushing rate) =0.52/yr. for the allocated condition. The model predicts a spring overturn TP of 92 mg/m^3 which is then multiplied by a lake specific conversion factor of 0.87 to get a growing season mean TP = 80 mg/m^3.

Table 1
Silver Lake Average Annual Phosphorus Budget and WLA and LA Reduction Objectives

TP Source[3]	Total Load Capacity (Lb)	WLA (Lb)	Load Allocation (Lb)		Present TP load (Lb)	% of Present TP Load	WL Reduction to Achieve WLA %	Load Reduction to Achieve LA %
Silver Creek	83	----	83		1,390[1]	49	-----	94
Internal	54	----	54		1,080[2]	38	-----	95
Direct Trib. area	187	----	187		311	11	-----	40
WWTP	62	62	----		62	2	0	-----
Subtotal	**386**	**62**	**324**		**2,843**	**100**	**0**	**88**

1. It is assumed that the hydraulic characteristics of the system bypass 65% of the 3,970 LB Silver Creek watershed load on an average annual basis prior to complete diversion.

2. It is assumed that internal loading is reduced via rough fish elimination and an alum treatment.

3. The atmospheric deposition TP loading was included in the modeling and carried through unchanged into the direct tributary load allocation.

Load Allocation (LA) for Nonpoint Sources. As illustrated in Table 1, the total phosphorus load allocation for Silver Lake is 324 lbs/P/year.

Waste Load Allocation (WLA). The total phosphorus WLA for Silver Lake equals the existing load of 62 pounds. The addition of future point sources is not anticipated. The entire load from the existing discharge was allocated in the TMDL with consideration given to each of the following:

- The facility is removing phosphorus with a permit limit of 1.0 mg/l and a monitored mean concentration (1-7-99 through 2-27-02) of 0.52 mg/l, standard deviation 0.19mg/l, 94% removal.

- The treatment plant discharge (flow) has been and is currently projected to be stable.

WDNR will evaluate the situation over time. The permit for the Holy Family Convent requires the discharger to conduct a feasibility study of the environmental impacts and cost-effectiveness of connecting the convent and college to the Manitowoc wastewater treatment plant. The study must be submitted the WDNR by March 31, 2007. During the interim, WDNR will continue to monitor and model the lake's response to implementation of this TMDL. Based on the results of the monitoring, modeling and the feasibility study, in 2007 WDNR will review, and potentially revise, this TMDL.

Seasonal Variation

Phosphorus is the pollutant of greatest concern for Silver Lake as it is the primary cause of poor water quality conditions. Silver Lake is characterized as a drained lake with intermittent inlet and outlet flow. The in-lake modeling was based on worst-case seasonal conditions (summer) while the pollutant loading represents annual loads. 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. The goal of this TMDL is to eliminate, to the extent practicable, those land use practices that introduce significant P loads to Silver Lake during spring runoff events. Since the P loading to Silver Lake is primarily a seasonal occurrence. In the case of Silver Lake, preventative measures in the watershed (over the course of the entire year) will be used to control P load. The characteristics of the chemical form of phosphorus can change seasonally (soluble versus particulate fraction). Typically one would expect greater particulate loads when soil erosion is more prone to occur (spring prior to canopy development) and an elevated soluble fraction during fall vegetation senescence. In this case, the total (sum of particulate and dissolved) was used in the modeling. By using the total phosphorus, any impact of seasonal variation in form is not a significant factor in determining the lake response under a longer (seasonal) averaging period.

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. The use of conservative assumptions are summarized in the Silver Lake Update Supplement and include a modeled value of 50% for the direct tributary area (land use changes would indicate a 60 to 70% is reasonable). The Silver Creek load reduction was modeled at 60% reduction when in fact this is closer to 95%.

Public Participation

A public notice providing an opportunity for public review and comment was issued on November 11, 2003. The following is a summary of the comments received and WDNR responses to those comments.

[Comments relative to the public notice will be summarized here.]

Elements of this TMDL were previously presented at public hearing. As required by s. NR 120.08 (2), Wis. Admin. Code, a public hearing on the Sevenmile-Silver Creeks priority watershed plan was held on August 25, 1986. Public comments were incorporated into the final plan. A public hearing was held prior to the issuance of the Silver Creek diversion permit in January of 2001 and the local Manitowoc Herald Times Reporter included an article by staff writer Rob Young on August 3, 2001 announcing the start of the Silver Creek diversion construction portion of the project. On April 30, 2003, a contested hearing was held on the permit for the Holy Family Convent permit was held. A summary of the findings of that hearing is attached.

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, Silver Lake is part of a larger priority watershed project, Sevenmile – Silver 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 Sevenmile – Silver Creek Priority Watershed Project.

No new or additional enforcement authorities are proposed under this TMDL.

Reasonable assurance of implementation is also demonstrated through measures already implemented or planned for the near future for Silver Lake. These measures include the following:

- The restoration of a former farm to wetlands and natural prairie.
- The completion in the fall of 2001 of a complete diversion of Silver Creek from Silver Lake.
- The eradication and restocking of the fishery budgeted for the summer of 2003.
- The completion of a whole lake alum treatment in the fall of 2003.
- The recent allocation of funds by the Manitowoc County Board to continue implementation.

The map included as Attachment 3 illustrates the watershed nonpoint source control measures completed to date the entire Silver Creek watershed and the watershed directly tributary to Silver Lake. The reasonableness of the BMP load reduction estimates were evaluated using a combination of best professional judgment, literature review and application of the Soil and Water Assessment (SWAT) model. An evaluation of the long-term effectiveness of the bypass was conducted using the SWAT model and a 30-year simulation time period. A flow frequency analysis was then completed using the model results. This work was done as part of the load estimates as summarized in the attached Silver Lake Update Supplement.

Monitoring Plan

Silver Lake has been monitored during the growing season on a yearly basis for more than five years. Monitoring included temperature and dissolved oxygen profiles, Secchi depth clarity, chlorophyll *a* and total phosphorus.

Post-implementation monitoring is planned to continue on a yearly basis after implementation. Comprehensive data evaluations will be conducted after 3 and 6 years taking into account annual variation. The need for additional management actions will then be evaluated based on the results of the data evaluation.

Attachments:

1. Nonpoint Source Pollution Control Plan for the Sevenmile – Silver Creek Priority Watershed Project (February 1987).

2. Silver Lake Update Supplement to the Nonpoint Source Pollution Control Plan for the Sevenmile-Silver Creek Priority Watershed, dated July 1998).

3. Sevenmile-Silver Creek Priority Watershed implementation status map.

4. Manitowoc Herald Times Reporter article.

5. Summary of the Holy Family Convent contested permit hearing.

References:

Thomann, R.V. and J.A. Mueller, 1987. Chapter 7 – Eutrophication *In:* Principals of surface water quality modeling and control. Harper and Row, publishers, New York. 644p.

Attachment 4

DNR finds money for Silver Lake cleanup

By ROB YOUNG
Herald Times Reporter

MANITOWOC - A construction project designed to clean up the algae-choked waters of Silver Lake will begin this year after all, thanks to a last-minute infusion of extra cash from the state Department of Natural Resource, county officials said Thursday.

County Soil & Water Conservation Department Director Tom Ward had announced July 17 that the project probably would not proceed this year because a contractorís bid came in about $80,000 more than expected.

The DNR came up with an extra $40,000 from an emergency fund to get thing moving again, although some elements of the project, such as paving a parking lot and constructing a boat ramp, might be delayed until next year if added cash cannot be raised, Ward said.

The DNR money seems to be acting as a catalyst in raising the added money, he said.

Everybody seems to be trying now to help out and get the goal accomplished, he said.

Sportsmen's groups and individuals are helping make up the $40,000 shortfall. Ward said he will ask the town of Manitowoc Rapids, the city of Manitowoc and the County Board help out, too.

A dike will prevent Silver Creek, which is laden with agricultural phosphorous, from flowing into the lake. Chemicals will be used next year to remove algae and undesirable bottom fish from the lake, which will be stocked with panfish, bass, northern and possibly walleye, Ward said.

The contractor, Phenco Inc. of Menasha, may begin work on the $454,566 project by the end of August, Ward said.

Dan Fischer, county interim administrative coordinator, said it's important to start the project this year.

It would be a mistake to stop now since grants that are helping pay for the project may not be available next year, Fischer said.