

Michigan Department of Environmental Quality
Surface Water Quality Division
January 20, 1999

Total Maximum Daily Load (TMDL) for Phosphorus in Lake Macatawa

Location: Lake Macatawa is a 1,780 acre drowned river mouth lake located along the southeastern shoreline of Lake Michigan near the city of Holland, Michigan. The lake and its watershed encompass 179 square miles (114,560 acres) in Ottawa and Allegan Counties.

Pollutant: Total Phosphorus.

Goal:

Date	Annual Phosphorus Load to Lake Macatawa	In-Lake Phosphorus Concentration
Current (1997)	138,500 lbs/year	0.125 mg/l
January 1, 2009*	Reevaluation of lake response, load reductions, and future strategy. 55,000 lbs/year	 0.050 mg/l

Introduction: Lake Macatawa was included in a 1971 publication entitled "Problem Lakes in the United States" (Kettelle and Uttermark, 1971). Twenty-five years later the lake is still considered to be one of the most nutrient enriched lakes in Michigan. Lake Macatawa displays the classic symptoms of a very hypereutrophic lake. These symptoms include extremely high nutrient (phosphorus) and chlorophyll *a* levels, excessive turbidity with a visibility of less than 1 foot, periodic nuisance algal blooms, low dissolved oxygen levels, and a high rate of sediment deposition.

The Michigan Department of Environmental Quality (MDEQ) received a 104(b)(3) grant from the U.S. Environmental Protection Agency (EPA) in October 1996 to develop a phosphorus TMDL for Lake Macatawa. Sampling to quantify phosphorus loading to Lake Macatawa was conducted October 1996 through November 1997. Total phosphorus loading from nonpoint sources was flow normalized to a typical year, yielding an annual estimate of 126,100 pounds. Phosphorus loading from the 44 point sources in the watershed totaled 12,400 pounds. Sampling in Lake Macatawa was conducted in 1995, 1996, and 1997 to gain a better understanding of the monthly and annual variability of the limnological process controlling the eutrophic state of the lake. Walterhouse (1998) provides a detailed presentation and analysis of the MDEQ's sampling results, loading estimates, and the modeling efforts used to develop the TMDL.

Phosphorus is the limiting nutrient in Lake Macatawa and nearly always the nutrient which controls the eutrophication level of lakes in Michigan. Suspended solids are also problematic, producing the turbidity which is the most obvious problem to residents of the community. Phosphorus and suspended solids are strongly correlated and nearly all efforts to reduce the levels of either parameter will impact both parameters. A goal of 0.050 mg/l was established. This level will serve to bring the in-lake phosphorus concentration and loads down by 60

percent from current levels and should result in improvement in water clarity, fewer algae blooms, and some improvement in the aquatic life community. This level has been identified as the boundary area between hypereutrophic and extremely hypereutrophic lakes, and has also been established as a goal for at least one other lake in Michigan (Ford Lake).

The MDEQ dedicated the remainder of the EPA funds to a local organization called the Macatawa Area Coordinating Council, which is charged with the task of developing a strategy for achieving the phosphorus TMDL. This strategy is under development and will be submitted in the summer of 1999.

Wasteload Allocation: Phosphorus loading from the 44 point source discharges totaled 12,400 pounds during the monitoring period, which accounted for only nine percent of the total load to Lake Macatawa. The vast majority of this loading was from four discharges. The National Pollutant Discharge Elimination System (NPDES) permits for these 44 facilities have a presently permitted annual load of 33,839 pounds. It is anticipated that phosphorus loading, due to growth, will increase to about 20,000 pounds per year in the next 10-20 years. The Wasteload Allocation goal, therefore, was estimated at 20,000 pounds per year. The MDEQ believes this is a viable approach because it allows all parties involved to focus upon the major phosphorus loading in the watershed -- the nonpoint sources -- during the first ten years of implementation.

Load Allocation: The nonpoint source load to Lake Macatawa, which was measured during the study period, was representative of an extremely wet (high annual flow) year according to historic records at the U.S. Geological Survey (USGS) Gage Station. Reduction of the influence of a record flow event during June 1997 produced an estimated phosphorus load more representative of a "normal" year. The measured phosphorus load at the six primary monitoring points plus the estimated load from the unsampled portion of the watershed was 126,100 pounds (Walterhouse, 1998).

The local effort, headed by the Macatawa Area Coordinating Council (MACC), has focused, in part, on Geographic Information Systems and land use, soil type, and elevation data to perform watershed modeling. The watershed modeling was used, initially, to estimate loads from various nonpoint sources. Additional model calibration is necessary during the implementation stage to verify that the model results correlate with the actual phosphorus loads measured at monitoring points throughout the watershed. Estimations of potential reductions from applications of best management practices indicate that a substantial (about 75 percent) reduction in loading is feasible in this watershed, with a lower bound of nonpoint source phosphorus loading of about 30,000 pounds per year. For this TMDL, the loading allocation was set at 35,000 pounds per year.

Further details on the nonpoint source reductions will be determined during development of the local reduction strategy. The local strategy will derive a load allocation by either land uses within the watershed or by sub-basins within the watershed. The local effort will focus on identification of specific Best Management Practices (BMPs) for specific areas of the watershed. Efforts will also be made to verify via a thorough watershed survey that the model predicted priority areas within the watershed are appropriate for the proposed BMPs. Development of the local strategy and accompanying load allocation is scheduled for completion in the summer of 1999.

Summary: The proposed TMDL allocates 35,000 pounds to nonpoint source loads and 20,000 pounds to point source loads on an annual basis to meet the goal of 55,000 pounds per year.

This allocation is based on the projected actual loadings for permitted point source discharges expected in the next 10-20 years, and a substantial reduction (72 percent) of nonpoint source loadings. The focus of phosphorus loading reductions will be on the nonpoint sources, which

accounted for 91 percent of the total load in 1997. This TMDL will be reassessed in 2008*, when it is projected that substantial reductions in nonpoint source loadings will have been made, and the point sources actual loadings will be under approximately 20,000 pounds per year. The reassessment should include an evaluation of Lake Macatawa to determine if Water Quality Standards are being attained and a reevaluation of the current phosphorus goal for the lake. Additional evaluations should include refining the modeled response of the lake to phosphorus reductions, measuring the success and degree of nonpoint source reductions, assessing the actual and projected point source loads, determining the contribution of phosphorus from in-lake sediments, and defining with greater accuracy the impacts of other variables which hinder attainment of Water Quality Standards throughout the watershed._

*In addition to the scheduled reevaluation of this TMDL, a reevaluation prior to this scheduled date will occur if: 1) the annual nonpoint source loadings to Lake Macatawa have been reduced by 90,000 pounds per year; 2) the combined actual point source loading to Lake Macatawa has increased to 18,000 pounds per year; or 3) the phosphorus levels in Lake Macatawa are found to meet state water quality standards. Such reevaluation will be consistent with that described above.

References:

Kettelle, M. and P. Uttermark. 1971. Problem Lakes in the United States, University of Wisconsin for U.S. EPA, Project#06010

Walterhouse, M. 1998. Phosphorus Loading Assessment for Lake Macatawa, 1995 through 1997. MDEQ, SWQD, Report No. MI/DEQ/SWQ-98/015.

Prepared by: Mike Walterhouse, Aquatic Biologist
Great Lakes and Environmental Assessment Section
Surface Water Quality Division
Michigan Department of Environmental Quality
January 20, 1999