

Michigan Department of Environmental Quality  
Surface Water Quality Division  
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Total Maximum Daily Load (TMDL) for Phosphorus in Ore Lake

**Location:** Ore Lake is a 192 acre (78 ha) natural lake of South Ore Creek located in Livingston County (Figure 1). Ore Lake is located 2.5 miles downstream of Brighton Lake.

**Pollutant:** Total Phosphorus.

**Phosphorus Data and Goal:**

Year	Total Phosphorus Concentration (mg/L)	Total Load to lake (pounds/year)	Actual Point Source contribution (pounds/year)	Nonpoint Source contribution (pounds/year)	
1978	<b>0.055</b>	<b>3,900</b>	<b>2,300</b>	<b>1,600</b>	
1997	<b>0.019</b>	1,500	100	1,400	
1998	<b>0.013</b>	1,000	140	860	
1999	<b>0.021</b>	1,400	110	1,290	
Average 1997-99	0.018	1,300	117	1,183	
	Total Phosphorus Concentration (mg/L)	Loading Capacity (pounds/year)	Waste Load Allocation (pounds/year)	Load Allocation (pounds/year)	Margin of Safety (pounds/year)
<b>TMDL Goal</b>	0.025	1,940	600	1,300	40

**Bold numbers indicate actual measured values.**

**Background:** In the late 1970's, Ore Lake was classified as a highly eutrophic to hypereutrophic lake with frequent nuisance algae blooms (Grant, 1978). Phosphorus was identified as the most controllable nutrient for reducing frequent nuisance algae growth in Ore Lake. In 1978, the spring turnover phosphorus concentration was 0.055 mg/L with a total load of 3,900 pounds/year of phosphorus to Ore Lake (Grant, 1978). Of the 3,900 pounds of phosphorus, approximately 59 percent was from the single upstream point source discharge, the Brighton Publicly Owned Treatment Works (POTW), and 41 percent was from nonpoint source contributions. In 1988, the Brighton POTW was upgraded to a rapid sand infiltration bed and underdrain system and its discharge moved downstream of Brighton Lake.

Subsequent to the upgrade of the POTW, overall water quality in Ore Lake has improved. This improved water quality can be attributed to significant reductions in total phosphorus loading to Ore Lake. Very few nuisance algae blooms have been reported within the past few years. In 1997, spring turnover phosphorus concentration was 0.019 mg/L (Alexander, 1998). Using the Walker Model (Reckhow, 1978), total phosphorus loading in 1997 was estimated to be 1,500 pounds/year. Of the total loading for 1997, 7 percent was from point source contributions and 93 percent was from nonpoint source contributions. In 1998, spring turnover phosphorus concentration was 0.013 mg/L (Alexander, 1999). Using the Walker Model, total phosphorus loading in 1998 was estimated to be 1,000 pounds/year, with point source contributions making up 14 percent of the total and nonpoint source contributing 86 percent.

Based on the data through 1998 and the rapid growth in this area, Ore Lake was listed as a threatened waterbody on Michigan's 1998 Section 303(d) list of waterbodies needing TMDLs. The primary issue identified as threatening Ore Lake was nutrient enrichment (phosphorus).

In April 1998, a 12-month phosphorus loading analysis was begun to confirm the appropriateness of the Walker Model as a phosphorus predictive tool for Ore Lake (Alexander, 1999). This phosphorus analysis showed a total phosphorus load to Ore Lake of 1,400 pounds from April 1998 to March 1999. The April 1999 spring turnover phosphorus concentration was 0.021 mg/L, and the predicted in-lake phosphorus concentration using the Walker Model was 0.021 mg/L. Based on comparison of the actual in-lake phosphorus concentration and the predicted, the Walker Model was determined to be a good predictor for phosphorus, both loading and in-lake concentration for Ore Lake.

A goal of 0.030 mg/L in-lake phosphorus concentration was originally recommended in the draft TMDL for phosphorus in Ore Lake, which was public noticed from January 18, 1999 to February 19, 1999. After reviewing the considerable public comments received and considering the existing condition of Ore Lake, a goal in-lake phosphorus concentration of 0.025 mg/L was established for Ore Lake. This concentration is generally accepted in the majority of available literature to be in the middle range of eutrophic conditions. Additionally, this goal will meet the requirements of Water Quality Standards R 323.1060(2) for plant nutrients. This rule states "nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the waters of the state."

**Waste Load Allocation:** The waste load allocation was established at 600 pounds/year, using the current National Pollutant Discharge Elimination System permit limit for the Brighton POTW. Phosphorus loading from the Brighton POTW averaged 117 pounds/year during 1997, 1998, and 1999, significantly less than the 2,300 pounds/year in 1978.

**Load Allocation:** The estimated total nonpoint source contribution during 1997, 1998, and 1999 averaged 1,200 pounds/year with a range of 860 pounds/year to 1,400 pounds/year, slightly lower than the 1,600 pounds/year in 1978. Based on this information, a load allocation of 1,300 pounds/year of phosphorus was established for nonpoint source contributions to Ore Lake. The total nonpoint source phosphorus load includes contributions from atmospheric deposition, ground water contribution, and immediate drainage area runoff (Alexander, 1999).

**Margin of Safety:** There are 40 pounds/year of phosphorus loading allocated to a margin of safety. This represents about two percent of the total capacity. This was determined to be adequate based on finding the model as a good predictor for phosphorus loading and in-lake concentrations.

**Summary:** The TMDL for Ore Lake allocates 1,300 pounds of phosphorus to nonpoint source loads, 600 pounds of phosphorus to point source loads, and 40 pounds to a margin of safety. These loads are established on an annual basis to meet the goal of 1,940 pounds per year and an in-lake total phosphorus concentration of 0.025 mg/L.

#### **References:**

Alexander, M. A. 1998. A nutrient chemistry survey of Brighton, Kent, Ore, Portage, Sandy Bottom, and Strawberry Lakes, Livingston, Oakland, and Washtenaw Counties, April, June, and August 1997. MDEQ, Surface Water Quality Division, Report #MI/DEQ/SWQ-98/010.