Michigan Department of Environmental Quality
Surface Water Quality Division
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Total Maximum Daily Load for Polychlorinated Biphenyls for the Kawkawlin River Bay County, Michigan

INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of a pollutant to a waterbody based on the relationship between pollutant sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reduction necessary from both point and/or nonpoint sources to maintain and/or restore the quality of their water resources.

This TMDL follows a phased approach due to inherent uncertainties in deriving numeric targets and estimating loadings from nonpoint sources. Under the phased approach, load allocations (LAs) and waste load allocations (WLAs) are calculated using the best available data and information, recognizing the need for additional monitoring data to determine if the load reductions required by the TMDL result in WQS attainment. The phased approach provides for the implementation of the TMDL, while additional data are collected to reduce uncertainty.

The purpose of this TMDL is to establish appropriate levels for polychlorinated biphenyls (PCBs) in the Kawkawlin River that will result in WQS attainment.

PROBLEM STATEMENT

The TMDL reach of the Kawkawlin River, a warmwater designated waterbody, is located in Bay County and extends 5 miles upstream from the Saginaw Bay confluence (Figure 1). It is identified in the Michigan's Section Year 2002 Section 303(d) report (Creal and Wuycheck, 2002) as follows:

Waterbody:	**Kawkawlin River**		WBID#: **210501F**
County:	Bay	HUC: 4080102	Size: 5 M
Location:	Saginaw Bay confluence u/s to the N. Br. Kawkawlin River confluence.		
Problem:	**FCA-PCBs.**		
TMDL Year(s): 2002		RF3RchID:	4080102 0005

The reason for this TMDL is based on skinless fillets of carp and northern pike from the lower Kawkawlin River have elevated PCB concentrations indicating an exceedance of WQS for PCBs and impaired designated use. In August 1988, 10 carp and 9 northern pike were collected from within a reach extending from the Saginaw Bay confluence upstream to the North Branch Kawkawlin River confluence and edible portions analyzed for PCBs (Figure 1). PCB average concentrations for the carp and northern pike were 3.62 and 0.61 milligrams per kilogram (mg/kg), respectively (Table 1).

NUMERIC TARGET

The impaired fishery of the Kawkawlin River is caused by PCBs. Rule 57 (Toxic Substances) of Michigan's WQS was used to establish a numeric WQS criteria for PCB in water of 0.000026 micrograms per liter (ug/l) (Human Cancer Value). This criteria affords an acceptable level of human health protection from cancer risk due to PCBs. This value equates to a fish tissue concentration of 0.023 mg/kg. To measure near or below the water criterion for PCBs requires specialized techniques at this time. Fish sampling does not require as rigorous techniques because the chemical bioaccumulates in fish to much greater levels than in water. Fish also integrate exposure over time to different levels in the environment. Therefore, for the initial phase of this TMDL, the numeric target will be 0.023 mg/kg in the edible portion of fish tissue.

SOURCE ASSESSMENT

In August 1988, 10 carp and 9 northern pike were collected from the lower Kawkawlin River (in the reach between Saginaw Bay and the North Branch Kawkawlin River confluence) and edible portions were analyzed. PCB average concentrations for the carp and northern pike were 3.6 and 0.61 mg/kg, respectively (Table 1).

From June 25 through July 23, 2001, a 28-day exposure caged fish study was conducted using channel catfish to assess PCB uptake. Two cages, each containing 20 catfish 6 to 8 inches in length, were suspended off the bottom of the Kawkawlin River, Wheeler Road, and south Huron Road (Route 13) (Figure 1). These sites were selected because they had sufficient depth and were located upstream of any chemical influence of Saginaw Bay water during periods of onshore seiches. A control aliquot of 20 fish (4 groups of 5 fish each) was taken from the pool of fish used in the caged fish study. Lipid normalized analytical results demonstrated low-level presence of PCBs in all the samples, including the control samples (Table 2). The lipid normalized PCB concentration in the control samples averaged 0.0014 mg/kg. The mean net uptake concentrations of total PCBs in the caged fish at Wheeler Road and south Huron Road were 0.0054 and 0.0125 mg/kg, respectively.

The observed fish uptake levels are very low and consistent with results from other caged fish studies among Michigan rivers where sediment analytical results showed no localized PCB-contaminated sediments. The anthropogenic sources of PCB loadings to the Kawkawlin River are primarily attributed to atmospheric loadings since there are no point sources. Strachen and Eisenreich (1988) estimated that 78% of the loadings to Lake Huron and the Saginaw Bay area was attributable to atmospheric deposition.

Additional sources of PCBs to the Kawkawlin River system may be attributed to the upstream migration, from Saginaw Bay, of anadromous fish, including salmon, walleye, gizzard shad, alewife, carp, and northern pike (James Baker, Michigan Department of Natural Resources, Fisheries Division, May 2002 Personal communication). Some of the fish are preyed upon and enter into the food chain, the salmon contribute to the PCB budget of the Kawkawlin River via spawning (egg deposits), and decomposition process of spent (post spawning) adult salmon. Primary sources of PCBs to the entire Saginaw Bay PCB budget are atmospheric, waterborne loadings from tributaries; point sources; contaminated, in-place sediments; and biological recycling.

Overall, available information supports the premise that the sources for PCBs in the Kawkawlin River Watershed are atmospheric loadings to the watershed and/or upstream migration of contaminated anadromous fish from Saginaw Bay.

LINKAGE ANALYSIS

Linkage is defined as the cause and effect relationship between the selected indicators and the sources. The linkage between the PCB concentration in edible portions of fish from the Kawkawlin River and sources is the basis of the development of the TMDL. Such linkage also serves as the basis for estimating the assimilative capacity of the river and any needed load reductions. Therefore, this TMDL assumes that a reduction in PCB inputs to the Kawkawlin River will result in reductions in fish tissue PCB levels.

TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by the waterbody while still meeting WQS. As previously indicated, the numeric target is the Rule 57 Human Cancer Risk Value of 0.000026 ug/l, which in turn equates to a 0.023 mg/kg total PCB criteria in edible portions of fish tissue. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Many TMDLs are designed around the concept of a "critical condition." The "critical condition" is defined as the environmental conditions that, if controls are designed to protect, will assure attainment of objectives for all other conditions. For example, the critical conditions for the control of point sources in Michigan are defined in R 323.1082 and R 323.1090. In many cases, the lowest of the 12 monthly 95% exceedance flows for the stream is used as a design condition. For human health values, such as for PCB, R 323.1090 specifies the harmonic mean flow as a design condition. The harmonic mean for the Kawkawlin River at Route 13 (south Huron Road), 3.5 miles upstream from the Saginaw Bay confluence, is 7.5 cubic feet per second (cfs) (4.85 million gallons per day (mgd)). The drainage area of the river at this point is 220 square miles. The numeric target of 0.000026 ug/l and the harmonic mean flow of 4.85 mgd were used to derive a TMDL for the Kawkawlin River of 0.000001 pounds/day of PCBs.

ALLOCATIONS

TMDLs are comprised of the sum of individual WLAs for point sources and LAs for nonpoint sources. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

$$TMDL = S^{WLAs} + S^{LAs} + MOS$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still meeting WQS. The overall loading capacity is subsequently allocated in the TMDL components of WLA for point sources, LA for nonpoint sources, and the MOS.

WLA:

There are no point source loadings of PCBs to the Kawkawlin River. Therefore, the WLA is equal to zero.

LA:

The entire loading of PCBs to the Kawkawlin River is due to nonpoint sources. Therefore, 100% of the TMDL is allocated to the LA. This equates to 0.000001 pounds/day

The current PCB loading in the Kawkawlin River was estimated by comparing the PCB concentration in the edible portion of the carp and northern pike to the numeric target of 0.023 mg/kg. Such a comparison indicates that PCBs need to be reduced in edible portions of carp and northern pike by 99 and 96%, respectively, to achieve the numeric target of 0.023 mg/kg. This assumes a direct relationship between PCB loadings and fish tissue level and that they are proportional on a one-to-one basis.

MOS:

The MOS in a TMDL is used, in part, to account for variability of source inputs to the system and is either implicit or explicit. The MOS is implicit for this PCB TMDL because the fish tissue target concentration represents an integration of the cycling of PCBs over all critical conditions and uses the edible portion of fish as the numeric target.

SEASONALITY

Seasonality in this TMDL is addressed by expressing the TMDL in terms of a fish tissue numeric target that integrates PCB cycling through all seasons.

MONITORING PLAN

Monitoring of the Kawkawlin River fish community will be conducted on a 5-year rotation cycle, commencing in 2005, to assess fish tissue concentrations of PCBs. Using Great Lakes and Environmental Assessment Section Procedure 31 (Fish Contaminant Monitoring Program – Fish Collection Procedure, Revised 1/31/95), monitoring will consist of periodic fish collections and analysis to assess the effectiveness of actions to reduce edible portion fish tissue concentrations of PCBs. This monitoring will include, as a minimum, the collection of 10 carp of a comparable size range to those collected in 1988 (20 to 28 inch length). Efforts will also be made to collect other available fish species using equivalent assessment techniques.

In addition, a caged fish study of the Saginaw River in the vicinity of Bay City will be conducted in the summer of 2002 to assess the effectiveness of the Saginaw River PCB-contaminated sediment cleanup project completed in 2001. This specific project, and associated activities, resulted in the removal or isolation of an estimated 20,000 pounds of PCBs that, otherwise, would have accumulated in the aquatic environment of Saginaw River and Saginaw Bay.

REASONABLE ASSURANCE

The focus of the actions to restore the Kawkawlin River is directed towards restricting and eliminating available PCB sources and loadings to the various waterbodies that contribute to the Kawkawlin River PCB budget. Overall, control measures include: removal or isolation of identified potential sources of PCB contaminated sediments, elimination of point source discharges of PCBs to the Saginaw River and Saginaw Bay through individual National Pollutant Discharge Elimination System (NPDES) permit process and reduction of atmospheric deposition sources.

Various factors and actions have been implemented that will reduce PCBs available to the environment and, ultimately, fish, wildlife, and humans. PCBs became a “restricted chemical” as a result of the federal Toxic Substance Control Act of 1976, thereby, restricting its use and discharge. Additional efforts to further reduce PCBs in the Saginaw Bay area include sediment remediation, implementation of Area of Concern remedial action plans, controlling source pathways, pollution prevention, support of existing reduction efforts, and continued monitoring of both air and water. Specifically, attainment of WQS for PCBs is assisted by the use of NPDES discharge permits for point sources that require attainment of PCB water quality-based effluent limits and the development and implementation of a PCB minimization plan. The Michigan

Department of Environmental Quality's (MDEQ's) Pollution Prevention Plan assistance program is focused on providing technical and financial assistance to businesses so as to prevent pollution. In addition, the Saginaw River was the focus of an extensive PCB-contaminated sediment remediation project. During the years 2000 and 2001, about 342,433 cubic yards of PCB-contaminated sediments were removed from the Saginaw River in the vicinity of Bay City at a cost of $9.7 million (Bredin, 2002). The goal of this project was to remove a continuing source of PCBs to fish and wildlife. An estimated 8,000 pounds of PCB were removed from the aquatic environment during this activity. An additional 12,000 pounds of PCBs were also prevented from entering the Saginaw River via the Crotty Street storm sewer by redirecting the discharge through a new channel and isolating and filling the PCB-contaminated channel. Collectively, the above actions serve to reduce PCBs availability to the PCB budget of the Saginaw River, Saginaw Bay, and its tributaries, including the Kawkawlin River system.

In addition, the Great Lakes Binational Toxics Strategy report (USEPA/Canada, 2001) states that Environment Canada and the USEPA are committed to assessing atmospheric inputs of toxic substances, including PCBs, to the Great Lakes basins. The focus of this effort is to evaluate and report jointly on the contribution of atmospheric loadings ("long-range transport") from worldwide sources. If ongoing long-range sources are confirmed, work will commence within international frameworks to reduce releases of such substances.

In support, the United States and Canada have:

- Maintained the Great Lakes Integrated Atmospheric and Deposition and Monitoring Network (IADN) program;
- Improved the integration of monitoring networks and data management; and
- Continued the research on the atmospheric science of toxic pollutant transport.

These reasonable assurance actions will proceed to implement this TMDL under the phased approach. This allows for the collection of additional data to determine if the load reductions anticipated are occurring, and if the load reductions result in WQS attainment. If the numeric targets are not met, the TMDL will be reevaluated and modified as appropriate.

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References:

Baker, J. May 2002 Personal Communication. Migrating Fish Populations of the Kawkawlin River.

Bredin, J. 2002. Lake Huron Initiative Action Plan Update April 2002. MDEQ/Office of the Great Lakes. 27 pp.

Creal, W. and J. Wuycheck. 2002. Michigan's Clean Water Act Section 303(d) List – Michigan Submittal for Year 2002. MDEQ Report #MI/DEQ/SWQ-02/013.

Strachan, W. and Eisenreich, S. 1988. Mass Balancing of Toxic Chemicals in the Great Lakes: The Role of Atmospheric Deposition. Appendix 1 of the Workshop on Great Lakes Atmospheric Deposition. International Joint Commission. Pp. 114.

USEPA/Canada. 2001. The Great Lakes Binational Toxics Strategy. Annual Progress Report. USEPA Great Lakes National Program Office, Chicago.

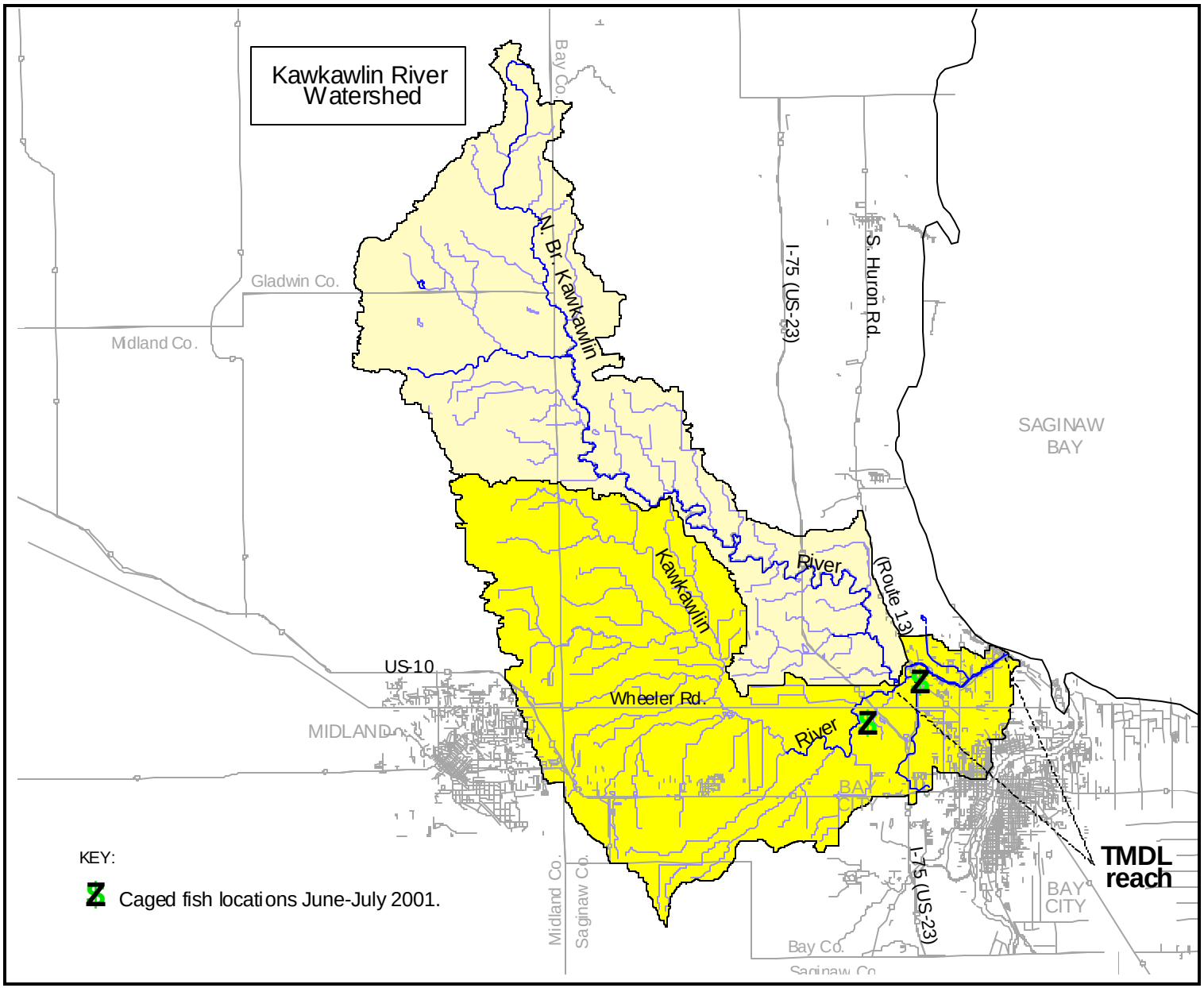

Figure 1. Kawkawlin River Watershed located in Bay, Gladwin, Midland, and Saginaw Counties, Michigan.

Table 1. Kawkawlin River fish tissue analytical results for PCBs collected August 4, 1988, Bay County, Michigan. Analyses are on skinless fillets.

Waterbody	Sample ID#	Fish Species	Length (in)	Weight (lbs)	Total PCBs (mg/kg)
Kawkawlin River	88027	Northern Pike	20.9	1.7	0.161
		" "	20.3	1.7	0.501
		" "	21.7	1.7	0.08
		" "	21.7	2.3	0.213
		" "	21.5	2.0	0.444
		" "	21.9	2.3	0.541
		" "	20.7	1.3	0.314
		" "	19.7	1.4	0.368
		" "	31.1	6.7	2.874 mean = 0.61
		Carp	22.4	5.6	4.706
		" "	21.9	5.2	2.555
		" "	22.6	6.3	4.266
		" "	19.5	3.6	1.174
		" "	20.5	4.8	1.598
		" "	25.4	7.5	0.703
		" "	25.2	9.2	5.852
		" "	26.4	11.3	6.438
		" "	27.8	12.5	7.12
		" "	27.2	10.5	1.793 mean = 3.62

Table 2. Kawkawlin River caged fish study results for a 28 day exposure (June 25 through July 23, 2001) using channel catfish, Bay County, Michigan.

Location	Sample ID#	Percent Fat	PCB (ppb)	Lipid normalized PCB (ppb)	Mean Net PCB Uptake (ppb)
Control Samples	2001126-01	4.2	0.0060	0.0014	
	2001126-02	3.66	0.0030	0.0008	
	2001126-03	5.05	0.0080	0.0016	
	2001126-04	3.69	0.0070	0.0019	
	Mean	4.15	0.0060	0.0014	-
Wheeler Rd.	2001127-01	2.15	0.0100	0.0047	
	2001127-02	0.95	0.0060	0.0063	
	2001127-03	1.1	0.0110	0.0100	
	2001127-04	0.8	0.0050	0.0063	
	Mean	1.25	0.0080	0.0068	0.0054
S. Huron Rd. (Route 13)	2001128-01	1.05	0.0220	0.0210	
	2001128-02	1.5	0.0170	0.0113	
	2001128-03	1.85	0.0210	0.0114	
	2001128-04	1.5	0.0180	0.0120	
	Mean	1.47	0.0195	0.0139	0.00125