

Comparison Of The 1978 Great Lakes Water Quality Agreement Water Quality Objectives To State Standards And Ontario Objectives Applicable To The Great Lakes



COMPARISON
OF
THE 1978 GREAT LAKES WATER QUALITY AGREEMENT
WATER QUALITY OBJECTIVES
TO
STATE STANDARDS AND ONTARIO OBJECTIVES

U.S. ENVIRONMENTAL PROTECTION AGENCY
GREAT LAKES NATIONAL PROGRAM OFFICE
CHICAGO, ILLINOIS

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1. The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation

$$f(x) = \int_0^x \frac{1}{1+t^2} dt$$

for $x \in \mathbb{R}$. It is shown that $f(x)$ is an odd function and that it satisfies the inequality

$$f(x) \leq \frac{\pi}{2} \quad \text{for } x \geq 0.$$

2. In the second part, we consider the function $g(x)$ defined by the equation

$$g(x) = \int_0^x \frac{t}{1+t^2} dt$$

for $x \in \mathbb{R}$. It is shown that $g(x)$ is an even function and that it satisfies the inequality

$$g(x) \leq \frac{\pi}{4} \quad \text{for } x \geq 0.$$

3. Finally, we study the function $h(x)$ defined by the equation

$$h(x) = \int_0^x \frac{t^2}{1+t^2} dt$$

for $x \in \mathbb{R}$. It is shown that $h(x)$ is an odd function and that it satisfies the inequality

$$h(x) \leq \frac{\pi}{4} \quad \text{for } x \geq 0.$$

INTRODUCTION

This report has been developed by the Great Lakes National Program Office to facilitate its review of the current status of state and federal water quality requirements for the Great Lakes. A brief discussion summarizes the water quality objective development process as referenced in the Great Lakes Water Quality Agreement of 1978. Efforts have been made to ensure veracity of the information contained in this report. However, if errors are noticed we would appreciate being informed of them so corrections could be made.

We wish to thank Mr. Kent Walker of the International Joint Commissions's Great Lakes Regional Office for his technical assistance and the clerical staff for their work in putting together the comparison table. Mr. Paul J. Horvatin of the Great Lakes National Program Office served as the principal author of this report.

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GREAT LAKES WATER QUALITY OBJECTIVES

Article IV of the 1909 Boundary Waters Treaty between the United States and Canada states, among other things, that "boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property of the other." The 1978 Great Lakes Water Quality Agreement is a specific application of this principle. Articles III and IV of the 1978 Agreement set out the general and specific water quality objectives to be met to ensure that pollution of the boundary waters does not occur.

Water quality objectives are minimum desirable levels of water quality to be obtained in the boundary waters of the Great Lakes System and are not intended to preclude the establishment of more stringent requirements. They take into account the criteria for a whole spectrum of water uses: supplies for municipal, industrial and agricultural purposes, recreation, aesthetic enjoyment and the propagation of aquatic life and wildlife. Once the United States and Canada accept water quality objectives, they are obligated by the Agreement to develop programs and measures (including water quality standards) consistent with achievement of these objectives in boundary waters of the Great Lakes. In general, water quality objectives are goals to be maintained or achieved in all of the boundary waters through effective pollution control programs in both countries. Compliance with the objectives is intended to ensure protection of the most sensitive uses of the international waters.

On the other hand, water quality standards and other legally enforceable regulatory requirements are prescribed levels of water quality established by governmental authorities in each jurisdiction. They are generically different from objectives. While water quality objectives are developed on the sole basis of scientifically defensible data to protect the most sensitive uses, standards and similar legal requirements are generally established by each jurisdiction after considering the designated uses, the site specific ecology, and the factors of social and economic consequences as well as technological ability. For this reason, standards are not necessarily identical to water quality objectives.

HOW WATER QUALITY OBJECTIVES ARE ESTABLISHED

Under Article VII of the 1978 Agreement (Table 1), the International Joint Commission was designated to assist in the implementation of the Agreement. Among the responsibilities given to the Commission was the "tendering of advice and recommendations to the Parties and to the State and Provincial Governments on problems of and matters related to the quality of the boundary waters of the Great Lakes System including specific recommendations concerning the General and Special Objectives..." Further, the Commission was directed to establish a Great Lakes Water Quality Board to assist it and serve as principal advisor to the Commission with regard to the exercise of powers and responsibilities assigned to it under the Agreement.

TABLE 1
ARTICLE VII

2.

POWERS, RESPONSIBILITIES AND FUNCTIONS OF THE INTERNATIONAL JOINT
COMMISSION

1. The International Joint Commission shall assist in the implementation of this Agreement. Accordingly, the Commission is hereby given, by a Reference pursuant to Article IX of the Boundary Waters Treaty, the following responsibilities:

- (a) Collation, analysis and dissemination of data and information supplied by the Parties and State and Provincial Governments relating to the quality of the boundary waters of the Great Lakes System and to pollution that enters the boundary waters from tributary waters and other sources;
- (b) Collection, analysis and dissemination of data and information concerning the General and Specific Objectives and the operation and effectiveness of the programs and other measures established pursuant to this Agreement;
- (c) Tendering of advice and recommendations to the Parties and to the State and Provincial Governments on problems of and matters related to the quality of the boundary waters of the Great Lakes System including specific recommendations concerning the General and Specific Objectives, legislation, standards and other regulatory requirements, programs and other measures, and intergovernmental agreements relating to the quality of these waters;
- (d) Tendering of advice and recommendations to the Parties in connection with matters covered under the Annexes to this Agreement;
- (e) Provision of assistance in the coordination of the joint activities envisaged by this Agreement;
- (f) Provision of assistance in and advice on matters related to research in the Great Lakes Basin Ecosystem, including identification of objectives for research activities, tendering of advice and recommendations concerning research to the Parties and to the State and Provincial Governments, and dissemination of information concerning research to interested persons and agencies;
- (g) Investigations of such subjects related to the Great Lakes Basin Ecosystem as the Parties may from time to time refer to it.

2. In the discharge of its responsibilities under this Reference, the Commission may exercise all of the powers conferred upon it by the Boundary Waters Treaty and by any legislation passed pursuant thereto including the power to conduct public hearings and to compel the testimony of witnesses and the production of documents.

3. The Commission shall make a full report to the Parties and to the State and Provincial Governments no less frequently than biennially concerning progress toward the achievement of the General and Specific Objectives including, as appropriate, matters related to Annexes to this Agreement. This report shall include an assessment of the effectiveness of the programs and other measures undertaken pursuant to this Agreement, and advice and recommendations. In alternate years the Commission may submit a summary report. The Commission may at any time make special reports to the Parties, to the State and Provincial Governments and to the public concerning any problem of water quality in the Great Lakes System.

4. The Commission may in its discretion publish any report, statement or other document prepared by it in the discharge of its functions under this Reference.

5. The Commission shall have authority to verify independently the data and other information submitted by the Parties and by the State and Provincial Governments through such tests or other means as appear appropriate to it, consistent with the Boundary Waters Treaty and with applicable legislation.

6. The Commission shall carry out its responsibilities under this Reference utilizing principally the services of the Water Quality Board and the Science Advisory Board established under Article VIII of this Agreement. The Commission shall also ensure liaison and coordination between the institutions established under this Agreement and other institutions which may address concerns relevant to the Great Lakes Basin Ecosystem, including both those within its purview, such as those Boards related to Great Lakes levels and air pollution matters, and other international bodies, as appropriate.

The Water Quality Board had formed a Water Quality Objectives Subcommittee to assess the adequacy of the objectives in the 1972 Agreement and develop new or revised objectives. This Subcommittee, together with the Research Advisory Board's Standing Committee on Scientific Basis for Water Quality Criteria, proposed specific water quality objectives designed to protect the most sensitive beneficial use of the boundary waters.

These two groups jointly reviewed all available scientific information on each of the proposed objectives and recommended those levels that research indicated would protect the most sensitive beneficial use. The objectives proposed were designed to protect aquatic life or its consumers (fish, birds and mammals), public water supply and recreational use.

The objectives were based on best available scientific information on cause/effect relationships between pollutants and water use. The objectives provided a refinement of the restoration, enhancement and nondegradation principles set forth in the Agreement.

The Water Quality Board reviewed the proposed objectives and in making its recommendations to the International Joint Commission gave primary consideration to the protection and enhancement of Great Lakes water quality.

The Board reviewed all aspects of the proposed objectives including the practical aspects of using them as a basis for regulatory action. The Board was aware of the fact that the dischargers and the public must bear the cost of meeting regulatory requirements but did not use these factors in its decisions to recommend objectives.

STATUS OF OBJECTIVES

The status of water quality objectives is shown in Table 2. The 1978 Water Quality Agreement contains 41 Specific Water Quality Objectives. Four others (chlorine, cyanide, silver, temperature) that were previously recommended to the International Joint Commission by the Water Quality Board are being reconsidered by the Board at the request of the governments and the IJC. A revised objective for dissolved oxygen is being reviewed by the Board.

An ecosystem objective and objectives for indicator organisms and pathogens, pentachlorophenol, polychlorinated dibenzodioxins and polynuclear aromatic hydrocarbons are being considered.

PROCEDURES UTILIZED BY JURISDICTIONS TO CONSIDER WATER QUALITY OBJECTIVES IN THEIR REGULATORY REQUIREMENTS

In Article V of the Agreement, the Parties agreed to use their best efforts to ensure that water quality standards and other regulatory requirements will be consistent with the achievement of water quality objectives. The following sections outline the procedures taken by each jurisdiction towards this end.

TABLE 2

4.

STATUS OF AGREEMENT WATER QUALITY OBJECTIVES

CONTAINED IN 1978 AGREEMENT		UNDER RECONSIDERATION	
<u>Persistent Toxic Substances</u>		<u>Persistent Toxic Substances</u>	
<u>Organic</u>	<u>Inorganic</u>	<u>Inorganic</u>	
Aldrin/Dieldrin	Arsenic	Silver	
Chlordane	Cadmium		
DDT and Metabolites	Chromium		
Endrin	Copper	<u>Non-Persistent Compounds</u>	
Heptachlor/ Heptachlor Epoxide	Iron	<u>Organic</u>	<u>Inorganic</u>
Lindane	Lead	Cyanide	Chlorine
Methoxychlor	Mercury		
Mirex	Nickel		
Toxaphene	Selenium		
Phthalic Acid Esters	Zinc		
PCBs	Fluoride	<u>Physical Characteristics</u>	
Other Organic Contaminants	Total Dissolved Solids	Temperature	
<u>Non-Persistent Toxic Substances</u>			
<u>Organic</u>	<u>Inorganic</u>	UNDER REVIEW	
Diazinon	Ammonia	Dissolved Oxygen	
Guthion	Hydrogen Sulfide		
Parathion			
Other Pesticides			
Unspecified Non-Persistent Toxic Substances and Complex Effluents		UNDER DEVELOPMENT	
Oil and Petrochemicals		Ecosystem Objective	
<u>Other Substances</u>		Indicator Organisms and Pathogens	
Dissolved Oxygen	Nutrients	Pentachlorophenol	
pH	Tainting Substances	Polychlorinated dibenzo- dioxins	
<u>Physical Characteristics</u>		Polynuclear Aromatic Hydrocarbons	
Asbestos	Temperature		
Settleable and Suspended Solids, & Light Transmission			
<u>Microbiological</u>			
<u>Radiological</u>			

CANADA AND ONTARIO

Canada and Ontario have agreed to adopt the water quality objectives as the minimal basis to be used by them in establishing water quality standards or their regulatory requirements respecting the boundary waters. They have also agreed that the objectives shall be the basis for designing and assessing pollution abatement programs and other measures taken to improve or maintain water quality in the Great Lakes. [From paragraph 3, Canada-Ontario Agreement on Great Lakes Water Quality, March 1977.]

The Province of Ontario employs guidelines and criteria for water quality management in approving the adequacy of facilities for waste discharge and disposal. The booklet, "Water Management - Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment", published in November 1978 contains a statement that "the Province has agreed that the revised Specific Water Quality Objectives contained in the Great Lakes Water Quality Agreement shall be used in environmental programs to achieve and maintain Great Lakes water quality". The revision takes into account the requirements of Article VI, Section 1(b) of the 1978 Agreement, specifying the establishment of effluent limitations for industrial facilities. Such requirements are incorporated in Certificates of Approval for new or expanded work, and in formal programs and control orders for existing waste dischargers.

U.S. FEDERAL GOVERNMENT AND GREAT LAKES STATES

In accordance with the Agreement, the U.S. Federal Government has assumed the responsibility to ensure that the water quality objectives are considered in the State Water Quality Standards review process which is required at least once each three-year period as stipulated in Section 303 of PL 95-217, The Clean Water Act.

It is U.S. EPA's policy that water quality objectives under the Agreement and water quality criteria outlined in the U.S. EPA publication Quality Criteria for Water 1976 should be considered. In instances where water quality objectives in the Agreement are more stringent than criteria listed in the EPA publication, the more stringent values should be considered for the Great Lakes waters. The approach is recommended because the U.S. Government recognizes the Great Lakes as a unique and sensitive water body meriting special protection.

The states conduct a technical evaluation of their water quality standards incorporating the following steps:

- 0 Review the proposed water quality objectives in the Agreement to verify their technical adequacy and achievability.
- 0 Compare the proposed objectives with the water quality standards which are currently in effect.

- 0 Evaluate the impact of the proposed objective on present or future wastewater dischargers to determine if the objective would result in a change in the required level of treatment.
- 0 Determine if implementation of existing water quality standards and abatement programs would result in the achievement of water quality consistent with the proposed objectives.
- 0 Evaluate the social and economic consequences of the proposed objective.
- 0 Determine if the goals of the proposed objective are consistent with the maintenance of the designated use of the waters for the public interest.

Each state distributes, for public review, the proposed revisions to its standards usually upon issuance of a notice for public hearing. Single or multiple hearings are held, depending on the area affected by the standard revisions, chaired by an impartial hearing officer. On the basis of comments received, further revisions may be made. Before adoption as final standards, legal, legislative or administrative review and approval are required. The exact procedure for the final review will vary from state to state dependent on administrative requirements. In most states, water quality standards become state law upon promulgation.

U.S. EPA reviews the proposed standards revisions concurrently with the state prior to public hearings. Once the standards are adopted by the state, they are submitted to U.S. EPA for final approval under Section 303 of The Clean Water Act. In the event that a state adopts standards not acceptable to U.S. EPA, the Agency can promulgate standards either wholly or in part for that state as per Section 303 of The Clean Water Act.

CURRENT STATE OF STATE WATER QUALITY STANDARDS

ILLINOIS

No changes to water quality standards proposed.

INDIANA

Revised water quality standards for Lake Michigan are currently being reviewed by U.S. EPA Region V for approval.

MICHIGAN

Proposed revisions are being prepared by the State for public hearings.

MINNESOTA

Proposed partial revisions have been reviewed by U.S. EPA Region V and comments have been submitted. State has conducted public hearing on proposed revisions.

OHIO

U.S. EPA is preparing to promulgate water quality standards under Section 303 of The Clean Water Act.

WISCONSIN

The State is reviewing their water quality standards for possible revisions.

PENNSYLVANIA

Revised water quality standards are currently being reviewed by U.S. EPA Region III for approval.

NEW YORK

The State is developing a process for public review of costs and benefits of achieving various risk levels of several specific toxic criteria. Development of the water quality standards proposal will be based on this and an economic impact statement which is to be developed.

WATER QUALITY OBJECTIVE COMPARISON TO JURISDICTIONAL REQUIREMENTS

Appendix 1 summarizes the numerical values and statements for parameters referenced in the Quality Criteria for Water 1976 (Red Book), the Great Lakes Water Quality Agreement Water Quality Objectives, the Great Lakes States' Water Quality Standards, and Ontario's Water Quality Objectives. As previously discussed, objectives and standards are not the same and any direct comparison of the numbers is not valid. It should be noted that many state standards were last revised prior to signing of the 1978 Water Quality Agreement.

Tables 3, 4, and 5 summarize the Federal Register Notices (March 16, July 25 and October 1, 1979, respectively) for the proposed water quality criteria for pollutants listed as toxic under The Clean Water Act. The criteria were developed pursuant to Section 304 of the Act and in compliance with a court order. The criteria state maximum recommended concentrations consistent with the protection of aquatic life and human health.

A Section 304(a) water quality criterion is a qualitative or quantitative estimate of the concentration of a water constituent or pollutant in ambient waters which, when not exceeded, will ensure a water quality sufficient to protect a specified water use. Under the Act a criterion is a scientific entity, based solely on data and scientific judgment. It does not reflect considerations of economic or technological feasibility. A criterion based on the protection and propagation of fish, shellfish and wildlife, for example, is simply the best estimate informed scientists are able to make of the maximum concentration of a given pollutant that can be tolerated while still maintaining protection of aquatic life. A criterion intended for the protection of human health, by the same reasoning, is the best estimate of the concentration which may exist and still not pose an undue risk to humans who drink water without further treatment or eat fish or shellfish from the water.

TABLE 3

MARCH 15, 1979 PROPOSED TOXIC POLLUTANT WATER QUALITY CRITERIA

Toxic Pollutant	Freshwater Aquatic Life		Human Health Effects
	24-Hr. Average	Maximum	
	ug/l	ug/l	ug/l
Arsenic.....	57	130	0 (a)
Benzene.....	3,100	7,000	0 (a)
Beryllium.....	e(1.24 ln(hardness))-6.65)	e(1.24 ln(hardness))-1.46)	0 (a)
Cadmium.....	e(0.87 ln(hardness))-4.38	e(1.3 ln(hardness))-3.92)	10
Carbon Tetrachloride.....	620	1,400	0 (a)
Chlordane.....	0.024	0.36	0 (a)
Chlorinated Naphthalenes:			
1-Chloronaphthalene.....	29	67	-
Trichloronaphthalenes.....	-	-	3.9
Tetrachloronaphthalenes.....	-	-	1.5
Pentachloronaphthalenes.....	-	-	0.39
Hexachloronaphthalenes.....	-	-	0.15
Octachloronaphthalene.....	-	-	0.08
Chloroform.....	500	1,200	0 (a)
2-Chlorophenol.....	60	180	0.3
Dichlorobenzenes:			230 (b)
1,2-Dichlorobenzene.....	44	99	-
1,3-Dichlorobenzene.....	310	700	-
1,4-Dichlorobenzene.....	190	440	-
Dichloroethylenes:			
1,1-Dichloroethylene.....	530	1,200	0 (a)
1,2-Dichloroethylene.....	620	1,400	-
2,4-Dichlorophenol.....	0.4	110	0.5
2,4-Dimethylphenol.....	38	86	- (c)
Fluoranthene.....	250	560	200
Heptachlor.....	0.0015	0.45	0 (a)
Hexachlorobutadiene.....	-	-	0 (a)
Hexachlorocyclopentadiene.....	0.39	7	1
Lead.....	e(1.51 ln(hardness))-3.37)	e(1.51 ln(hardness))-1.39	50
Nitrosamines:			
N-nitrosodimethylamine.....	-	-	-
N-nitrosodiethylamine.....	-	-	0 (a)
N-nitrosodipropylamine.....	-	-	0 (a)
N-nitrosodipropylamine.....	-	-	0 (a)
N-nitrosopyrrolidine.....	-	-	0 (a)
Pentachlorophenol.....	6.2	14	140
Selenium.....	9.7	22	10
Silver.....	0.009	1.9	10
2,3,7,8-tetrachlorodibenzo-p-dioxin.....	-	-	0 (a)
Tetrachloroethylene.....	310	700	0 (a)
Thallium.....	-	-	4
Trichloroethylene.....	1,500	3,400	0 (a)
Vinyl chloride.....	-	-	0 (a)

(a) Interim risk levels proposed.

(b) All dichlorobenzene isomers combined.

(c) Data is insufficient to set a criterion but EPA recommends minimizing exposure to this substance as soon as possible.

TABLE 4

JULY 25, 1979 PROPOSED TOXIC POLLUTANT WATER QUALITY CRITERIA

Toxic Pollutant	Freshwater Aquatic Life		Human Health Effects
	24-Hr. Average	Maximum	
	ug/l	ug/l	ug/l
Acenaphthene.....	110	240	.02 mg/l
Acrolein.....	1.2	2.7	6.5
Antimony.....	120	1,000	1.45
Chlorinated Phenols:			
4-chlorophenol.....	45	180	30
2,4,6-trichlorophenol.....	52	150	100 (a)
3-chlorophenol.....	-	-	50
2,5-dichlorophenol.....	-	-	3.0
2,6-dichlorophenol.....	-	-	3.0
2,4,5-trichlorophenol.....	-	-	10 (a)
2,3,4,6-tetrachlorophenol.....	-	-	263 (a)
Copper.....	e(0.65 ln(hardness)-1.94)	e(0.88ln(hardness)-1.03)	1 mg/l
Cyanide.....	1.4	38	0.2 ug/l
3,3-dichlorobenzidine.....	-	-	0 (b)
Dichloropropanes(enes):			
1,1-dichloropropane.....	410	930	203
1,2-dichloropropane.....	920	2,100	203
1,3-dichloropropane.....	4,800	11,000	203
1,3-dichloropropene.....	18	250	0.63
Dinitrotoluene:			
2,3-dinitrotoluene.....	12	27	0 (b)
2,4-dinitrotoluene.....	620	1,400	0 (b)
Diphenylhydrazine.....	17	38	0 (b)
Endosulfan.....	0.042	0.49	0.1 mg/l
Endrin.....	0.0020	0.10	1
Ethylbenzene.....	-	-	1.1 mg/l

TABLE 4 (continued)

Haloethers:				
4-bromophenylphenyl.....	6.2	14		-
Halomethanes:				
Methyl Chloride.....	7,000	16,000		2
Methyl Bromide.....	140	320		2
Methylene Chloride.....	4,000	9,000		2
Bromoform.....	840	1,900		2
Bromo Chloroethane.....	-	-		2
Dichlorodifluoromethane.....	-	-		3,000
Trichlorofluoromethane.....	-	-		3,200
Isophorone.....	2,100	4,700		460
Naphthalene.....	-	-		143
Nickel.....	$e(1.01 \ln(\text{hardness}) - 1.02)$	$e(0.47 \ln(\text{hardness}) + 4.19)$		133
Nitro Benzene.....	480	1,100		30
Nitrophenols:				
2-nitrophenol.....	2,700	6,200		-
4-nitrophenol.....	240	550		-
2,4-dinitrophenol.....	79	180		68.6
2,4-dinitroresol.....	57	130		12.8
2,4,6-trinitrophenol.....	1,500	3,400		10
Phenol.....	600	3,400		3.4 mg/l
				1.0 (a)
Phthalate Esters:				
dimethyl phthalate.....	-	-		160 mg/l
diethyl phthalate.....	-	-		60 mg/l
dibutyl phthalate.....	-	-		5 mg/l
di-2-ethylhexyl phthalate.....	-	-		10 mg/l
PCB.....	0.0015	6.2		0 (b)
Toluene.....	2,300	5,200		12.4 mg/l
Toxaphene.....	.007	0.47		0 (b)
Zinc.....	$e(0.67 \ln(\text{hardness}) + 0.67)$	$e(0.64 \ln(\text{hardness}) + 2.46)$		5 mg/l

(a) Organoleptic effects.

(b) Interim risk levels proposed.

TABLE 5

OCTOBER 1, 1979 PROPOSED TOXIC POLLUTANT WATER QUALITY CRITERIA

Toxic Pollutant	Freshwater Aquatic Life		Human Health Effects
	24-Hr. Average	Maximum	
	ug/l	ug/l	ug/l
Acrylonitrile.....	130	300	0 (c)
Aldrin/dieldrin.....	0.0019	1.2	0
Asbestos.....	(a)	-	0
Benzidine.....	-	-	0
Chloroalkyl Ethers			
bis(2-chloroisopropyl).....	-	-	175.8
bis(2-chloroethyl).....	-	-	0
bis(chloromethyl).....	-	-	0
Chlorinated Benzene			
Chlorobenzene.....	1,500	3,500	20 (b)
1,2,4-trichlorobenzene.....	120	470	13 (b)
1,2,3,5-tetrachlorobenzene.....	170	390	17
1,2,4,5-tetrachlorobenzene.....	97	220	17
Pentachlorobenzene.....	16	36	0.5
Hexachlorobenzene.....	-	-	1.25 ng/l
Chlorinated Ethanes			
1,1-dichloroethane.....	-	-	-
monochloroethane.....	-	-	-
1,2-dichloroethane.....	3,900	8,800	0
1,1,1-trichloroethane.....	5,300	12,000	15.7 ng/l
1,1,2-trichloroethane.....	310	710	0
1,1,1,2-tetrachloroethane.....	420	960	-
1,1,1,2,2-tetrachloroethane.....	170	380	0
Pentachloroethane.....	440	1,000	-
Hexachloroethane.....	62	140	0
Chromium			
Trivalent chromium.....	e(0.83.ln(hardness)+2.94)	e(0.183.ln(hardness)+3.72)	50
Hexavalent chromium.....	10	110	0
DDT.....	0.00023	0.41	0
Hexachlorocyclohexane			
Lindane.....	0.21	2.9	0
BHC.....	-	-	0
Mercury			
Inorganic mercury.....	0.064 (d)	3.2 (d)	0.2
Methylmercury.....	0.016	8.8	0.2
Polynuclear Aromatic Hydrocarbons.....	-	-	0

(a) Data is insufficient to set criterion, but EPA recommends minimizing exposures.

(b) For organoleptic effects.

(c) Interim risk levels proposed.

(d) Insufficient data, but EPA derived criterion using procedures other than water quality guidelines.

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APPENDIX 1

WATER QUALITY STANDARDS, OBJECTIVES AND CRITERIA
APPLICABLE TO THE GREAT LAKES

General Criteria, Objectives and Standards Applicable To The Waters of the Great Lakes System.

Waters of the Great Lakes should be free from substances attributable to wastewater or other discharges that:

- 1) Settle to form objectionable deposits;
- 2) Float as debris, scum, oil, or other matter to form nuisances;
- 3) Produce objectionable color, odor, taste, or turbidity;
- 4) Injure or are toxic or produce adverse physiological responses in humans, animals or plants; and
- 5) Produce undesirable or nuisance aquatic life.

WATER QUALITY STANDARDS, OBJECTIVES AND CRITERIA APPLICABLE TO THE GREAT LAKES

PARAMETER	RED BUNK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Alkalinity	20 mg/L as CaCO ₃ (a)	-	-	-	20 mg/L as CaCO ₃	-	-	20 mg/L as CaCO ₃	20 mg/L as CaCO ₃	-	Not decreased by more than 75% background
Ammonia	20 µg/L (a) (un-ionized)	20 µg/L (a) (un-ionized) 500 µg/L (b)	20 µg/L monthly average	50 µg/L daily maximum	-	200 µg/L	25 µg/L un-ionized ammonia at no time shall ammonia-N concentrations exceed 6.5 mg/L	20 µg/L un-ionized	0.1 x 96hr C ₅₀ (H) 500 µg/L	2000 µg/L at pH 8	20 µg/L (a) un-ionized
Asbestos	50 µg/L (b) 100 µg/L (c)	50 µg/L (b) (lowest practical level)	10 µg/L	50 µg/L	-	10 µg/L	50 µg/L	50 µg/L 100 µg/L (c)	50 µg/L	-	10 µg/L (b) 100 µg/L (a)
Boron	1 mg/L (b)	-	1 mg/L	1 mg/L	-	1 mg/L	1 mg/L	1 mg/L	-	-	-
Bromine	10 µg/L soft water (a) 1000 µg/L hard water (a) 100 µg/L (c)	-	-	-	-	-	1100 µg/L hard	11 µg/L soft water (a) 1000 µg/L hard water (a) 100 µg/L (c)	-	-	11 µg/L soft water (a) 1000 µg/L hard water (a)
Bromine (calculation)	750 µg/L (c)	-	-	-	-	-	-	750 µg/L (c)	-	-	-
Cadmium	10 µg/L (b) (a) soft water 0.4 µg/L hard water 1.2 µg/L for cladocerans & salmonid fishes	0.2 µg/L (a)	10 µg/L	-	0.03 x 96 hr TL _m	10 µg/L	1.2 µg/L	10 µg/L (b) (a) soft water 0.4 µg/L hard water 1.2 µg/L for cladocerans & salmonid fishes	0.01 x 96hr LC ₅₀ (H)	300 µg/L	0.2 µg/L (a)
Chlorine	soft water 4.0 µg/L hard water 12 µg/L other less sensitive aquatic life	-	-	-	-	-	-	soft water 4.0 µg/L hard water 12 µg/L other less sensitive aquatic life	-	-	-

NOTE:

- (a) Protection for aquatic life
(b) Protection for health, welfare
(c) Protection for irrigation
(d) Every reasonable effort should be made to minimize human exposure
(e) The persistence, bioaccumulation potential and carcinogenicity caution human exposure to a minimum.
(f) Concentration in edible portion of fish (wet weight basis).
(g) Concentration in whole fish tissues (wet weight basis).
(h) Representative important species.

PANORAMA	BIRD HOOK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Carbon Dioxide	-	-	-	-	<5 mg/l as free CO ₂	-	-	-	-	-	-
Oxygen	-	12 mg/l	15 mg/l monthly average	20 mg/l daily maximum	50 mg/l monthly average	50 mg/l	-	-	-	-	>50 mg/l (b)
Total Residual Chlorine	2 µg/l Salmonid fish 10 µg/l (a)	-	-	-	-	-	2 µg/l	2 µg/l salmonid fish 10 µg/l (a)	-	-	2 µg/l
Turbidity	50 µg/l (b) 100 µg/l (a)	50 µg/l	50 µg/l	50 µg/l	20 µg/l	20 µg/l	50 µg/l	50 µg/l 100 µg/l	50 µg/l	-	100 µg/l (a)
Carbon Dioxide from Fishes	-	-	-	-	-	-	-	-	-	-	200 µg/l (b)
Fecal Coliform Bacteria	Based on a minimum of 5 samples taken over a 30-day period, fecal coliforms shall not exceed a geometric mean of 200 per 100 ml.	Based on a minimum of 5 samples taken over a 30-day period, fecal coliforms shall not exceed a geometric mean of 200 per 100 ml.	The fecal coliform content for whole body contact recreation shall not exceed 200/100 ml as a monthly geometric mean based on not less than 5 samples per month. If more than 10% of all samples taken during a month (MPN or MF count/100 ml) The fecal coliform content in the open water of Lake Michigan shall not exceed a geometric mean of 20 per 100 ml.	State protected for total body contact recreation shall contain no more than 200 fecal coliforms per 100 ml.	Disinfection of wastewater effluent to reduce the coliform organisms levels is required year round. The geometric mean for fecal coliform organisms shall not exceed 100 in a period of 30 consecutive days & 400 probable number per 100 ml in a period of 7 consecutive days.	The membrane filter fecal coliform count shall not exceed 200 per 100 ml as 5 samples with in 30-day period shall not exceed 100 per 100 ml in more than 10% of the samples taken during any month.	The geometric mean fecal coliform content (either MPN or MF), based on not less than 5 samples with in 30-day period shall not exceed 100/100 ml Total coliforms shall not exceed 400 per month, nor exceed 800 per 100 ml in more than 10% of all samples during any month.	The geometric mean of not less than 5 samples taken over not more than a 30-day period should not exceed 100/100 ml Total coliform per 100 ml. Total coliform for 200 per 100 ml of fecal coliform.	A potential health hazard exists if the fecal coliform geometric mean density for a series of water samples exceeds 1000 per 100 ml. Water quality is considered impaired when the total coliform geometric mean density for a series of water samples exceeds 1000 per 100 ml.	-	5 mg/L

PARAMETER	RED BOOK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Color	Waters shall be virtually free from substances producing objectionable color for aesthetic purposes. The source of supply should not exceed 75 color units on the platinum-cobalt scale for domestic water supplies; and increased color (in combination with turbidity) should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life.	-	-	5 color units monthly average 15 daily maximum	10% of the incident light should reach the bottom of any desired zone in which adequate dissolved oxygen levels are maintained.	15 color units	-	75 color units	-	-	5 colour units
Copper	1.0 mg/L (b) 0.1 mg/L (c) Sensitive aquatic resident species	5 µg/L	20 µg/L	-	0.1 mg/L T _{lm}	10 µg/L 0.1 mg/L T _{lm} Sensitive aquatic resident species	5 µg/L	1.0 mg/L 0.1 mg/L T _{lm} Sensitive aquatic resident species	0.1 mg/L T _{lm} (H)	200 µg/L	1000 µg/L (b) 5 µg/L (a)
Cyanide	5 µg/L (a)	-	25 µg/L	10 µg/L	-	10 µg/L	25 µg/L 5 µg/L Amenable to chlorination	5 µg/L HCN + CN ⁻	5 µg/L HCN + CN ⁻	100 µg/L	5 µg/L (b) 10 µg/L (b)
Ferric	-	-	-	-	-	-	-	-	-	400 µg/L as Fe (CN) ₆	-
Foaming Agents	-	-	500 µg/L	-	-	-	-	-	-	-	-
Fluoride	-	1200 µg/L (b)	1400 µg/L	1000 µg/L	-	1500 µg/L	1800 µg/L	-	2000 µg/L	-	1200 µg/L (b)
Gases, Total Dissolved	To protect freshwater and marine aquatic life, the total dissolved gas concentrations in water should not exceed 110% of the saturation value for gases at the existing atmospheric and hydrostatic pressures.	-	-	-	-	-	-	-	-	-	To protect aquatic organisms, the total dissolved gas concentrations in water should not exceed 110% of the saturation value for gases at the existing atmospheric and hydrostatic pressures.
Hardness	Conc. mg/L CaCO ₃ 0-75 Soft 75-150 Moderately hard 150-300 Hard 300 & up Very hard	-	-	-	-	50 mg/L	-	-	-	-	-

PARAMETER	RED BOOK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Iron	300 µg/L (b) 1000 µg/L (a)	300 µg/L (a)	300 µg/L	150 µg/L monthly average 300 µg/L daily maximum	300 µg/L	300 µg/L (b)	1000 µg/L 300 µg/L soluble	300 µg/L (b) 1000 µg/L (a)	300 µg/L or natural levels	300 µg/L Lake Erie and Niagara River	300 µg/L (a)(b)
Lead	50 µg/L for domestic water supply (health), 20 µg/L for 96-hr LC50 value, using the comparable water as the diluent & soluble lead measurements (using 0.45 micron filter) for sensitive freshwater resident species.	10 µg/L (a) Lake Superior Lake Huron 25 µg/L all others	50 µg/L	50 µg/L	-	50 µg/L	30 µg/L	50 µg/L	50 µg/L or 0.01x96 hr LC50 (h)	-	The total lead concentration should not exceed the values given below. Alkali- nity lead mg/L as CaCO ₃ concentration µg/L - <20 20-40 10 40-80 20 - >80 25
Manganese	50 µg/L (b)	-	50 µg/L	-	-	50 µg/L	50 µg/L	50 µg/L	1000 µg/L	-	50 µg/L (b)
Mercury	2.0 µg/L (b) 0.05 µg/L (a)	0.2 µg/L 0.5 µg/L (c)	0.5 µg/L	0.05 µg/L	-	-	0.5 µg/L Whole fish 0.05 µg/L monthly average 0.2 µg/L any time	2.0 µg/L (b) 0.05 µg/L (a)	0.2 µg/L Unfiltered Water Sample	-	0.2 µg/L Filtered 0.5 µg/L (c)
Mixing Zones	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached
NH ₄ S/LAS	-	-	-	-	0.14x48 hr TL _m MBAS/LAS	0.5 mg/L MBAS	0.5 mg/L MBAS	-	-	-	0.5 mg/L MBAS (b)
Nickel	0.01x96 hr LC50 (a)	25 µg/L	1000 µg/L	-	-	-	25 µg/L	0.01x48 hr LC50	0.01x96 hr LC50	-	25 µg/L (a)
Nitrates	-	-	10 mg/L	-	-	45 mg/L as NO ₃	10.0 mg/L	10 mg/L	-	-	10 mg/L (h)
Nitrites	-	-	1 mg/L	-	-	-	-	-	-	-	-
Nitrate & Nitrite	10 mg/L (b) Nitrate Nitrogen	-	-	-	-	-	100 mg/L	-	10 mg/L	-	-
Nitrogen	-	-	-	-	-	-	-	-	-	-	0.15 mg/L No ammonia

PARAMETER	OLD BOOK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Oil and Grease	For domestic water supply. Virtually free from oil and grease, particularly from the tastes and odors that emanate from petroleum products. For aquatic life: (1) levels of individual petrochemicals in the water column should not exceed 0.01 of the lowest continuous flow 96-hr LC50 to several important freshwater or marine species, each having a demonstrated high susceptibility to oils and petrochemicals; (2) levels of oil in the sediment which cause deleterious effects to the biota should not be allowed; (3) Surface waters shall be virtually free from floating nonpetroleum oils of vegetable or animal origin, as well as petroleum derived oils.	Oil and petrochemicals should not be present in concentrations that: (1) can be detected as visible film, sheen or discoloration on the surface; (11) can be detected by odor; (111) can cause tainting of edible aquatic organisms; and (iv) can form deposits on shorelines and bottom sediments that are detectable by sight or odor or are deleterious to residual aquatic organisms.	0.1 mg/L Hexane-Soluble	Oil or similar materials shall not be present in such quantities that they will produce a visible film on the water surface, coat the banks and bottom of the lake or harbor or any way be toxic or harmful to fish and aquatic life.	Absent	Absent	Surface waters shall be free from floating oils and shall at no time produce a visible sheen or color film. Levels of oils or petrochemicals on the banks or of a watercourse which cause deleterious effects to the biota will not be permitted. At no time will chlorofluorocarbon extractable materials in water exceed 5 mg/L.	Surface waters shall be free from floating oils and shall at no time produce a visible sheen or color film. Levels of oils or petrochemicals on the banks or of a watercourse which cause deleterious effects to the biota will not be permitted. At no time will chlorofluorocarbon extractable materials in water exceed 5 mg/L.	Absent	No visible film	Oil or petrochemicals should not be present in concentrations that: can be detected as a visible film, sheen, or discoloration on the surface; can be detected by odor; can cause tainting of edible aquatic organisms; can form deposits on shorelines and bottom sediments that are detectable by sight or odor or are deleterious to residual aquatic organisms.
Dissolved Oxygen	Aesthetics: Water should contain sufficient dissolved oxygen to maintain aerobic conditions in the water column and, except as affected by natural phenomena, at the sediment-water interface. Freshwater aquatic life: A minimum concentration of dissolved oxygen to maintain cool fish populations is 5.0 mg/L. The criterion for salmonid spawning beds is a minimum of 5.0 mg/L in the interstitial water of the gravel.	In the connecting channels and in the upper waters of the lakes, the dissolved oxygen level should not be less than 6.0 mg/L at any time, in hypolimnetic waters, it should be not less than necessary for the support of fish-life, particularly cold water species.	90% of saturation	7.0 mg/L	6.0 mg/L	7.0 mg/L October 1 to May 31 6 mg/L - All other times	6.0 mg/L	5.0 mg/L	6.0 mg/L	6.0 mg/L in Lake Erie and Niagara River 4.0 mg/L in Lake Ontario and excepted areas in Lake Erie	see attached

PARAMETER	RED BURN	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
pH	5 - 9 (b) 6.5 - 9.0 (a)	Values of pH should not be outside the range of 6.5 to 9.0. nor should discharge change the pH at the boundary of a limited use zone more than 0.5 units from that of the ambient waters.	7.0 - 9.0	7.5 - 8.5	6.7 - 8.5	6.5 - 8.5	6.5 - 9.0	6.0 - 9.0	6.5 - 9.0	6.7 - 8.5 in Lake Erie and Niagara River. 6.5 - 8.5 in Lake Ontario and excepted areas of Lake Erie	6.5 - 8.5
Phenol	1.0 µg/L (b) to protect aquatic fish fresh tainting	1.0 µg/L (b)	1 µg/L	1 µg/L monthly average 3 µg/L daily maximum	-	1 µg/L	1 µg/L	1 µg/L	5 µg/L	5.0 µg/L in non-excepted portion of Lake Ontario only	1 µg/L tainting
Phosphorus	0.1 µg/L yellow	See attached Water Quality Agreement Annex 3	.007 µg/L	0.03 µg/L monthly average 0.04 µg/L daily maximum	-	1 µg/L Discharge Effluent	1 µg/L Discharge Effluent	0.1 µg/L Yellow	Prevent nuisance growth	Prevent nuisance growth	20 µg/L Prevent nuisance growth
Plant Nutrients	-	-	-	-	Prevent nuisance growth	-	-	-	-	-	-
Phthalate Esters	3 µg/L (a)	-	-	-	-	-	3 µg/L	3 µg/L	-	-	-
Diethyl Phthalate	-	4.0 µg/L (a)	-	-	-	-	-	-	4 µg/L	-	4 µg/L
Di (2-ethylhexyl) Phthalate	-	0.6 µg/L (a)	-	-	-	-	-	-	0.6 µg/L	-	0.6 µg/L
Other Phthalic Acid Esters	-	0.2 µg/L (a)	-	-	-	-	-	-	0.2 µg/L	-	0.2 µg/L
Polychlorinated Biphenyls	0.001 µg/L (a) (F)	0.1 µg/g (G)	-	0.001 µg/L	-	-	Absent (b) 0.001 µg/L other waters 10.0 µg/g (G)	0.001 µg/L	0.001 µg/L 0.1 µg/g (G)	-	0.001 µg/L
Selenium	10 µg/L (b) 0.01x96 hr LC50 (a) Sensitive resistant species	10 µg/L (b)	10 µg/L	10 µg/L	-	10 µg/L	10 µg/L	10 µg/L 0.1x96 hr LC50	10 µg/L	-	100 µg/L (a)
Silver	50 µg/L (b) 0.01x96 hr LC50 (a) Sensitive resistant species	-	5.0 µg/L	50 µg/L	-	50 µg/L	50 µg/L	-	-	-	0.1 µg/L (a)

PARAMETER	RED BOOK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Solids (Dissolved)	250 mg/L (b) Chlorides Sulfates	Total Dissolved Solids In Lake Erie, the International Section of the St. Lawrence River, the level of total dissolved solids should not exceed 200 mg/L. In the St. Clair River, Lake St. Clair, the Detroit River & the Niagara River, the level should be consistent with maintaining the levels of total dissolved solids in Lakes Erie and Ontario at not to exceed 200 mg/L. In the remaining bountiful waters, pending further study, the level of total dissolved solids should not exceed present levels.	180 mg/L	172 mg/L monthly average 200 mg/L daily maximum	Controlled point source 500 mg/L monthly average 750 mg/L any time Lake Erie 200 mg/L	500 mg/L	200 mg/L	500 mg/L monthly average 750 mg/L any time	200 mg/L	200 mg/L in Lake Erie and Niagara River 500 mg/L in Lake Ontario and excepted areas of Lake Erie	500 mg/L (b) Dissolved solids must not be added to increase the ambient concentrations by more than 1/3 of the natural concentrations to protect aquatic life. The added solids should not significantly alter the overall ionic balance of the receiving waters.
Solids (Suspended Settleable) turbidity	Freshwater fish and other aquatic life: Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life.	Settleable and Suspended Solids and Light Transmission For the protection of aquatic life, waters should be free from substances attributable to municipal, industrial or other discharges resulting from human activity that will settle to the bottom or otherwise objectionable sludge deposits or that will alter the value of Secchi disc depth by more than 10%.	-	-	No unnatural turbidity, color, oil films, floating solids, foams, settleable solids or deposits injurious to any designated use.	30 mg/L	-	-	-	None from sewage or other wastes which will cause deposition or be deleterious for any best use determined for the specific waters which are assigned to this class.	-
Sulfide-Hydrogen Sulfide	2 µg/L (a) Undissociated	2.0 µg/L (a) Undissociated	-	-	-	-	-	2 µg/L	-	-	2 µg/L (a)
Sulfates	-	-	24 mg/L	26 mg/L monthly average 50 mg/L daily maximum	-	250 mg/L	-	-	-	-	250 mg/L (b)

PARAMETER	RED BUCK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Tainting Substances	Materials should not be present in concentrations that individually or in combination produce undesirable flavors which are detectable by organoleptic tests performed on the edible portions of aquatic organisms.	(a) Raw public water supply sources should be essentially free from objectionable taste and odor for aesthetic reasons. (b) Levels of phenolic compounds should not exceed 1.0 µg/L in public water supplies to protect against taste and odor in domestic water. (c) Substances entering the water supply of human activity that cause tainting of edible aquatic organisms should not be present in concentrations which will lower the acceptability of these organisms as determined by organoleptic tests.	see attached	see attached	see attached	Materials that impart odor or taste to fish flesh or other products are not allowed to enter receiving waters at levels that produce tainting.	see attached	see attached	see attached	see attached	see attached
Temperature	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached
Toxic Substances	-	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached
Toxicity Value	-	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached	see attached
Zinc	5 mg/L (b) 0.01 µg/L (a) Sensitive resident species	0.03 mg/L (a)	1.0 mg/L	-	10.010 0.01 µg/L hr 11m	5 mg/L	0.03 mg/L	5 mg/L	0.01 µg/L hr 11m (ii)	0.3 mg/L	<10% change of Secchi disc reading 0.03 mg/L (a) 5 mg/L (b)

PHONO IIR	RED BOOK	WATER QUALITY OBJECTIVES	ILLINOIS	INDIANA	MICHIGAN	MINNESOTA	OHIO	WISCONSIN	PENNSYLVANIA	NEW YORK	ONTARIO WATER QUALITY OBJECTIVES
Radiological	None	The level of radioactivity in waters outside of any defined source control area should not result in a 10mSv (total) equivalent dose integrated over 50 years as calculated in accordance with the methodology established by the International Commission on Radiological Protection) greater than 1 millirem to the whole body from a daily ingestion of 2.2 liters of lake water for 1 year. For dose commitments between 1 and 5 millirem at the periphery of the source control area, source investigation and corrective action are recommended if releases are not as low as reasonably achievable. For dose commitments greater than 5 millirem, the responsible regulatory authorities shall determine appropriate corrective action.	Gross beta concentration shall not exceed 100 pico curies per liter ($\mu\text{Ci/L}$) (Concentrations of radium 226 and strontium 90 shall not exceed 1 and 2 pico curies per liter respectively.)	Gross beta concentration shall not exceed 100 pico curies per liter ($\mu\text{Ci/L}$). (Concentrations of radium 226 and strontium 90 shall not exceed 1 and 2 pico curies per liter respectively.)	Criteria of U.S. Atomic Energy Commission (Nuclear Regulatory Commission)	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having use.	-	-	Radioactivity should be kept at the lowest practicable level in any event should be controlled to the extent necessary to prevent harmful effects on health.	Should be kept at the lowest practicable levels and in any event should be controlled to the extent necessary to prevent harmful effects on health.	Gross beta emitters - 1000 $\mu\text{Ci/L}$ Radium-226 3 $\mu\text{Ci/L}$ Strontium-90 10 $\mu\text{Ci/L}$

APPENDIX 2

MIXING ZONES

INTRODUCTION

A mixing zone is an area contiguous to a discharge where receiving water quality may meet neither all quality criteria nor requirements otherwise applicable to the receiving water. It is obvious that any time an effluent is added to a receiving waterway, where the effluent is poorer in quality, there will be a zone of mixing. The mixing zone should be considered as a place where wastes and water mix and not as a place where effluents are treated.

RATIONALE

Because damage to the aquatic resource can occur when quality standards are violated, the permissible size of a mixing zone is dependent upon the acceptable amount of damage. The permissible size depends in part on the size of the particular receiving water; the larger the water body, the larger the mixing zone may be without violating quality standards in more than a given percentage of the total area or volume of the receiving water. Likewise, the greater number of mixing zones within a reach of river or within a water body, the smaller each must be in order to maintain an appropriate mixing zone to water body ratio. Future industrial and population growths must be considered in designating such areas for wastes' admixture.

As a guideline, the quality for life within a mixing zone should be such that the 96-hour LC₅₀ for biota significant to the indigenous aquatic community is not exceeded; the mixing zone should be free from effluent substances that will settle to form objectionable deposits, free from effluent-associated materials that float to form unsightly masses, and free from effluent-associated substances that produce objectionable color, odor, or turbidity.

A prime purpose in designating the location, size, and area constraints of a mixing zone is to protect the aquatic life within the receiving waterway. Shallow water areas, generally, are the nursery areas for aquatic ecosystems. Designating offshore mixing areas or providing a larger available volume or area for mixing offshore as a viable alternative to a smaller shoreline area has a lesser potential for adverse biotic effects than a comparable discharge area in shallow water. Offshore, diffusion will tend to occur in all directions and not be constrained by a land barrier. Mixing zones may be less harmful biologically when located deep within the receiving water and, wherever possible, beneath the light-penetration area where photosynthesis occurs and algae and associated protozoa and other organisms provide the extensive base for the aquatic food web.

An axiom of environmental quality is that different areas vary in ecological importance. Generally the highest importance, and therefore the greatest protection, must be placed on shallow-water shoreline areas of rivers, lakes, and coastal zones and on the Nation's wetlands. These are commonly the areas that protect the young and supply the food not only for the animals that live in open waters but also for those animals that depend upon water in some measure for their existence. Likewise, one local aquatic area may have a higher social or ecological value than another, and the higher that value the greater the protection from degradation that is warranted within a waste mixing area.

Mixing zones should be located in such a manner that they do not form a barrier to the migratory routes of aquatic species. On a given reach of a stream or river, it would be good practice to limit the total mixing zone area to one-third of the receiving water width. In the same fashion, the combined areas of all mixing zones within a lake should not exceed 10 percent of the lake surface area. In some cases, this maximum should be reduced depending on lake volume and other local conditions. Within an estuary, the maximal dimension of the mixing area should not exceed 10 percent of the cross-sectional area of the waterway. It is not the objective of this rationale to outline limits for effluents, but to provide the reader with some of the general biological and physical considerations necessary for the establishment of mixing zones.

In essence, the positioning of mixing zones should be accomplished in a manner that will provide the greatest protection to aquatic life and for the various uses of water. Generally, shoreline and surface areas for waste admixture should be discouraged in preference to deep water, offshore designations. The relative social and ecological values of the aquatic life that may inhabit a particular waterway area should be given due consideration in zone definition (Fetterolf, 1973; NAS, 1974). The designation of particular mixing zones is a task that should follow the biological, physical, and chemical appraisal of the receiving waterway.

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LIMITED USE ZONES WATER QUALITY OBJECTIVES

27.

1. The Parties, in consultation with the State and Provincial Governments, shall take measures to define and describe all existing and future limited use zones, and shall prepare an annual report on these measures. The measures shall include:
 - (a) Identification and quantitative and qualitative description of all point source waste discharges (including tributaries) to boundary waters;
 - (b) Delineation of boundaries for limited use zones assigned to identified discharges;
 - (c) Assessment of the impact of the proposed limited use zones on existing and potential beneficial uses; and
 - (d) Continuing review and revision of the extent of limited use zones to achieve maximum possible reduction in size and effect of such zones in accordance with improvements in waste treatment technology.
2. limited use zones within the boundary waters of the Great Lakes System shall be designated for industrial discharges, and for municipal discharges in excess of 1 million gallons per day before January 1, 1980, in accordance with the following principles:
 - (a) The boundary of a limited use zone shall not transect the international boundary.
 - (b) The size, shape and exact location of a limited use zone shall be specified on a case-by-case basis by the responsible regulatory agency. The size shall be minimized to the greatest possible degree, being no larger than that attainable by all reasonable and practicable effluent treatment measures.
 - (c) Specific Objectives and conditions applicable to the receiving water body shall be met at the boundary of limited use zones.
 - (d) Existing biological, chemical, physical and hydrological conditions shall be defined before considering the location of a new limited use zone or restricting an existing one.
 - (e) Areas of extraordinary natural resource value shall not be designated as limited use zones.
 - (f) Limited use zones shall not form barriers to migratory routes of aquatic species or interfere with biological communities or populations of important species to a degree which damages the ecosystem, or diminishes other beneficial uses disproportionately. Routes of passage for specific organisms which require protection and which would normally inhabit or pass through limited use zones shall be assured either by location of the zones, or by design of conditions within the zones.
 - (g) Conditions shall not be permitted within the limited use zones which:

- (i) are rapidly lethal to important aquatic life;
 - (ii) cause irreversible responses which could result in detrimental post-exposure effects; or
 - (iii) result in bioconcentration of toxic substances which are harmful to the organism or its consumers.
 - (h) Concentrations of toxic substances at any point in the limited use zone where important species are physically capable of residing shall not exceed the 24-hour LC50.
 - (i) Every attempt shall be made to insure that the zones are free from:
 - (i) objectionable deposits;
 - (ii) unsightly or deleterious amounts of flotsam, debris, oil, scum and other floating matter;
 - (iii) substances producing objectionable colour, odour, taste or turbidity; and
 - (iv) substances and conditions or combinations thereof at levels which produce aquatic life in nuisance quantities that interfere with other uses.
 - (j) Limited use zones may overlap unless the combined effects exceed the conditions set forth in other guidelines.
 - (k) As a general condition, limited use zones should not overlap with municipal and other water intakes and recreational areas. However, knowledge of local effluent characteristics and effects could allow such a combination of uses.
3. Candidate areas for designation as limited use zones shall be reported, in all available detail, by the responsible regulatory agencies to the International Joint Commission. Within 60 days, the Commission may comment upon the extent of the area proposed for designation as a limited use zone, or any other aspect or measure to promote the attainment of the General and Specific Objectives of this Agreement. The responsible regulatory agency will take the comments of the Commission into account prior to making a formal designation of the area as a limited use zone. If no comment is received from the Commission within 60 days, it may be assumed that the Commission agrees with the proposed designation.
 4. The Parties shall consult to develop more definitive procedures to delineate the extent of individual limited use zones and to develop scientific guidelines for determining the maximum portions of the boundary waters of each of the Great Lakes and connecting channels which may be occupied by limited use zones.

201 Mixing Zones

ILLINOIS

- (a) In the application of any of the rules and regulations in this Chapter, whenever a water quality standard is more restrictive than its corresponding effluent standard then an opportunity shall be allowed for the mixture of an effluent with its receiving waters. Water quality standards must be met at every point outside of the mixing zone. The size of the mixing zone cannot be uniformly prescribed. The governing principle is that the proportion of any body of water or segment thereof within mixing zones must be quite small if the water quality standards are to have any meaning. This principle shall be applied on a case-by-case basis to ensure that neither any individual source nor the aggregate of sources shall cause excessive zones to exceed the standards. The water quality standards must be met in the bulk of the body of water, and no body of water may be used totally as a mixing zone for a single outfall or combination of outfalls. Moreover, except as otherwise provided in this Chapter, no single mixing zone shall exceed the area of a circle with a radius of 600 feet. Single sources of effluents which have more than one outfall shall be limited to a total mixing area no larger than that allowable if a single outfall were used.

In determining the size of the mixing zone for any discharge, the following must be considered:

1. The character of the body of water,
 2. the present and anticipated future use of the body of water;
 3. the present and anticipated water quality of the body of water,
 4. the effect of the discharge on the present and anticipated future water quality,
 5. the dilution ratio, and
 6. the nature of the contaminant.
- (b) In addition to the above, the mixing zone shall be so designed as to assure a reasonable zone of passage for aquatic life in which the water quality standards are met. The mixing zone shall not intersect any area of any such waters in such a manner that the maintenance of aquatic life in the body of water as a whole would be adversely affected, nor shall any mixing zone contain more than 25% of the cross-sectional area or volume of flow of a stream except for those streams where the dilution ratio is less than 3:1.

MIXING ZONES

29.

INDIANA

Sec. 5. (Mixing Zone) The mixing zone shall be considered a place where waste and receiving waters mix and not as a place where effluents are treated. All mixing zones will be determined on a case-by-case basis by the Indiana Stream Pollution Control Board after consideration of the following:

- (a) The dilution ratio,
- (b) The physical, chemical, and biological characteristics of the receiving body of water,
- (c) The physical, chemical, and biological characteristics of the waste effluent,
- (d) The present and anticipated uses of the receiving body of water,
- (e) The existence of and impact upon any spawning or nursery areas of any indigenous aquatic species, and
- (f) The synergistic effects of overlapping mixing zones or the aggregate effects of adjacent mixing zones.

MICHIGAN

R 323.1082. Mixing zones.

Rule 1082. (1) A mixing zone to achieve a mixture of a point source discharge with the receiving waters shall be considered a region in which organism response to water quality characteristics is time-dependent. Exposure in mixing zones shall not cause an irreversible response which results in deleterious effects to populations of important aquatic life and wildlife. As a minimum restriction the toxic substance 96 hour TL_m for important species of fish or fishfood organisms shall not be exceeded in the mixing zone at any point inhabitable by these organisms, unless it can be demonstrated to the commission that a higher concentration is acceptable. The mixing zone at any transect of a stream shall contain not more than 25% of the cross-sectional area or volume of flow of the stream or both unless it can be demonstrated to the commission that designation of a greater area or volume of streamflow will allow passage of fish and fishfood organisms so that effects on their immediate and future populations are negligible or not measureable. Watercourses or portions thereof which, without one or more point source discharges, would have no flow except during periods of surface runoff may be considered as a mixing zone for a point source discharge. For Lake Michigan, mixing zones shall not exceed a defined area equivalent to that of a circle of radius of 1,000 feet unless the discharger can demonstrate to the commission that the defined area for a thermal discharge is more stringent than necessary to assure the protection and propagation of a balanced indigenous population of aquatic life and wildlife in the receiving water.

- (2) All mixing zones established by the commission pursuant to subrule (1) shall be determined on a case-by-case basis.

MIXING ZONES

MINNESOTA

Means for expediting mixing and dispersion of sewage, industrial waste, or other waste effluents in the receiving interstate waters are to be provided so far as practicable when deemed necessary by the Agency to maintain the quality of the receiving interstate waters in accordance with applicable standards. Mixing zones be established by the Agency on an individual basis, with primary consideration being given to the following guidelines: (a) mixing zones in rivers shall permit an acceptable passageway for the movement of fish; (b) the total mixing zone or zones at any transect of the stream should contain no more than 25% of the cross-sectional area and/or volume of flow of the stream, and should not extend over more than 50% of the width; (c) mixing zone characteristics shall not be lethal to aquatic organisms; (d) for contaminants other than heat, the 96 hour median tolerance limit for indigenous fish and fish food organisms should not be exceeded at any point in the mixing zone; (e) mixing zones should be as small as possible, and not intersect spawning or nursery areas, migratory routes, water intakes, nor mouths of rivers; and (f) overlapping of mixing zones should be minimized and measures taken to prevent adverse synergistic effects.

WISCONSIN

(4) Mixing zones. Water quality standards must be met at every point outside of a mixing zone. The size of the mixing zone cannot be uniformly prescribed, but shall be based on such factors as effluent quality and quantity, available dilution, temperature, current, type of outfall, channel configuration and restrictions to fish movement. As a guide to the delineation of a mixing zone, the following shall be taken into consideration:

(a) Limiting mixing zones to as small an area as practicable, and conforming to the time exposure responses of aquatic life.

(b) Providing passageways in rivers for fish and other mobile aquatic organisms.

(c) Where possible, mixing zones being no larger than 25% of the cross-sectional area or volume of flow of the stream and not extending more than 50% of the width.

(d) For contaminants other than heat, the 96-hour TLM to indigenous fish and fish food organisms not being exceeded at any point in the mixing zone.

(e) Mixing zones not exceeding 10% of a lake's total surface area.

(f) Mixing zones not interfering with spawning or nursery areas, migratory routes, nor mouths of tributary streams.

(g) Mixing zones not overlapping, but where they do, taking measures to prevent adverse synergistic effects.

(B) MIXING ZONE

(1) Non-Thermal

For Lake Erie, outside of the excepted areas established in Division (C) of this rule, the following criteria will apply:

- (a) Except as subsequent provisions of this section provide different limits, no mixing zone shall:
 - (1) interdict the mouth of a stream, thereby blocking any portion of it; or
 - (2) interdict the migratory routes or interfere with natural movements, survival, reproduction, growth, or increase the vulnerability to predation of any representative aquatic species; or
 - (3) include spawning or nursery areas of any representative aquatic species; or
 - (4) include a public water supply intake; or
 - (5) include any bathing area where bath houses and/or lifeguards are provided;
 - (6) contact the shoreline, whenever such contact can be avoided.
- (b) At least 90 percent of the volume of the mixing zone shall not exceed at any time the 24 to 96 hour LC₅₀ for any representative aquatic species, as determined by static bioassays for persistent toxicants and dynamic bioassays for non-persistent toxicants in accordance with methods described in "Standard Methods for the Examination of Water and Wastewater," 15th Edition, 1975 published by the American Public Health Association, American Water Works Association and the Water Pollution Control Federation.

(2) Thermal

- (a) A thermal mixing zone to permit dilution and cooling of a waste heat discharge shall be considered a region in which organism response to temperature is time-dependent. Exposure to temperatures in a thermal mixing zone shall not cause an irreversible response which results in deleterious effects to the wildlife and aquatic life representative of the receiving waters. The daily

average temperature in a thermal mixing zone at the point nearest to the discharge that is accessible to the resident aquatic organisms shall not exceed the temperatures in Table 7d at the corresponding ambient temperature. at ambient temperatures of 59°F (15°C) and above the daily average temperature in a thermal mixing zone will be determined on a case-by-case basis.

- (b) Thermal mixing zone size limitations shall be established by the Director pursuant to Section (B)(2)(a) of this rule on a case-by-case basis for all point source discharges subject to permit.
- (c) Except as Divisions (B)(2)(a) and (B)(2)(b) of this rule establish different limitations, no thermal mixing zone shall:
 - (1) interdict the migratory routes or interfere with natural movements, survival, reproduction, growth, or increase the vulnerability to predation of any representative aquatic species;
 - (2) interfere with or prevent the recovery of an aquatic community or species population that could reasonably be expected as previously limiting water quality conditions improve;
 - (3) include a public water supply intake, or;
 - (4) include any bathing area where bath houses and/or life guards are provided.
- (d) Closed-cycle cooling blowdown discharge will be exempt from Divisions (B)(2)(a) and (b) of this rule.

Table 7d: Daily average temperatures of thermal mixing zones at corresponding ambient temperatures. Shown as degrees Fahrenheit and (celsius).

<u>Ambient</u>	<u>Daily Average Temperature</u>	<u>Ambient</u>	<u>Daily Average Temperature</u>
32(0)	41(5.0)	46(7.8)	65(18.3)
33(0.6)	41(5.0)	47(8.3)	66(18.9)
34(1.1)	43(6.1)	48(8.9)	68(20.0)
35(1.7)	45(7.2)	49(9.4)	70(21.1)
36(2.2)	46(7.8)	50(10.0)	71(21.7)
37(2.8)	48(8.9)	51(10.6)	73(22.8)
38(3.3)	50(10.0)	52(11.1)	75(23.9)
39(3.9)	52(11.1)	53(11.7)	77(25.0)
40(4.4)	53(11.7)	54(12.2)	78(25.6)
41(5.0)	55(12.8)	55(12.8)	80(26.7)
42(5.6)	57(13.9)	56(13.3)	82(27.8)
43(6.1)	59(15.0)	57(13.9)	84(28.9)
44(6.7)	61(16.1)	58(14.4)	86(30.0)
45(7.2)	62(16.7)	59(15) and above-daily average limit will be determined on a case-by-case basis.	

MIXING ZONES
New York

The following criteria shall apply to all waters of the State receiving thermal discharges, except as provided in Section 704.6.

- (a) The Department shall specify definable, numerical limits for all mixing zones (a set linear distance from the point of discharge, surface area involvement, or volume of receiving water entrained in the thermal plume).
- (b) Conditions in the mixing zone shall not be lethal in contravention of water quality standards to aquatic biota which may enter the zone.
- (c) The location of mixing zones for thermal discharges shall not interfere with spawning areas, nursery areas and fish migration routes.

Terms and conditions related to the mixing zones may be outlined in Certificates of Approval, based on the minimum requirements outlined below. Inherent in these conditions, a mixing zone may not be used as an alternative to adequate treatment. The mixing zone dimensions will be kept as small as possible while ensuring that the Provincial Water Quality Objectives are met at the boundary of the mixing zone.

1. Mixing zones should not contain:
 - materials which form objectionable deposits, i.e. scums, oil or floating debris;
 - substances producing objectionable colour, odour, taste or turbidity;
 - substances which produce objectionable growths of nuisance plants and animals;
 - substances which render the mixing zone aesthetically unacceptable.
2. The presence of a mixing zone should in no way pose a threat to the species survival of any organism in the receiving water outside the mixing zone.
3. No conditions within the mixing zone should be permitted which:
 - a) are rapidly lethal to important aquatic life (resulting in conditions which result in sudden fish kills and mortality of organisms passing through the mixing zones); or
 - b) cause irreversible responses which could result in detrimental post-exposure effects; or
 - c) result in bioconcentration of toxic materials which are harmful to the organism or its consumer; or
 - d) attract organisms to the mixing zones, resulting in a prolonged and lethal exposure period.
4. A mixing zone shall not be allowed to create a barrier to the migration of fish and aquatic life.
5. Rapid changes in the water quality which could kill organisms by shock effects must not be present. Such conditions could have the effect of creating a higher toxicity value.
6. Municipal and other water supply intakes and recreational areas, as a general rule, should not lie within a mixing zone. However, knowledge of the effluent characteristics and the type of discharge associated with the mixing zone could allow such a mixture of uses.
7. Mixing zones may overlap unless the combined effects exceed the conditions specified in these mixing zone guidelines.
8. Limitations on mixing zones should be established by the Ministry on a case-by-case basis, where "case" refers to both local considerations and the waterbody as a whole or segments of the waterbody.
9. Existing biological, chemical, physical and hydrological conditions should be known when considering the location of a new mixing zone or limitations on an existing one.
10. The design and location of the outfall should be considered on a case-by-case basis to reduce the impact of the mixing zone on the receiving waters.
11. Total loadings into all the mixing zones within a river, lake or segment thereof, must not exceed the acceptable loadings from all point-source discharges required to maintain satisfactory water quality.

APPENDIX 3

ONTARIO DISSOLVED OXYGEN OBJECTIVE

ONTARIO OBJECTIVE

Dissolved Oxygen At no time should dissolved oxygen concentrations be less than the values specified below:

Temperature °C	Dissolved Oxygen Concentration			
	Cold Water		Warm Water	
	Biota		Biota	
	% Saturation	mg/L	% Saturation	mg/L
0	54	8	47	7
5	54	7	47	6
10	54	6	47	5
15	54	6	47	5
20	57	5	47	4
25	63	5	48	4

In situations where additional physical and/or chemical stresses are present these minimum levels may prove inadequate and more stringent Objectives may be necessary.

In some hypolimnetic waters, dissolved oxygen is naturally lower than the above-specified concentrations. Such a condition should not be altered by adding oxygen demanding materials causing a depletion of dissolved oxygen.

APPENDIX 4

GREAT LAKES WATER QUALITY AGREEMENT
ANNEX 3
CONTROL OF PHOSPHORUS

GREAT LAKES WATER QUALITY AGREEMENT

ANNEX 3

CONTROL OF PHOSPHORUS

1. The purpose of the following programs is to minimize eutrophication problems and to prevent degradation with regard to phosphorus in the boundary waters of the Great Lakes System. The goals of phosphorus control are:

- (a) Restoration of year-round aerobic conditions in the bottom waters of the Central Basin of Lake Erie;
- (b) Substantial reduction in the present levels of algal biomass to a level below that of a nuisance condition in Lake Erie;
- (c) Reduction in present levels of algal biomass to below that of a nuisance condition in Lake Ontario including the International Section of the St. Lawrence River;
- (d) Maintenance of the oligotrophic state and relative algal biomass of Lakes Superior and Huron;
- (e) Substantial elimination of algal nuisance growths in Lake Michigan to restore it to an oligotrophic state; and
- (f) The elimination of algal nuisance in bays and in other areas wherever they occur.

2. The following programs shall be developed and implemented to reduce input of phosphorus to the Great Lakes:

- (a) Construction and operation of municipal waste treatment facilities in all plants discharging more than one million gallons per day to achieve, where necessary to meet the loading allocations to be developed pursuant to paragraph 3 below, or to meet local conditions, whichever are more stringent, effluent concentrations of 1.0 milligram per litre total phosphorus maximum for plants in the basins of Lakes Superior, Michigan, and Huron, and of 0.5 milligram per litre total phosphorus maximum for plants in the basins of Lakes Ontario and Erie.
- (b) Regulation of phosphorus introduction from industrial discharges to the maximum practicable extent.
- (c) Reduction to the maximum extent practicable of phosphorus introduced from diffuse sources into Lakes Superior, Michigan, and Huron; and reduction by 10 per cent of phosphorus introduced from diffuse sources into Lakes Ontario and Erie, where necessary to meet the loading allocations to be developed pursuant to paragraph 3 below, or to meet local conditions, whichever are more stringent.
- (d) Reduction of phosphorus in household detergents to 0.5 per cent by weight where necessary to meet the loading allocations to be developed pursuant to paragraph 3 below, or to meet local conditions, whichever are more stringent.
- (e) Maintenance of a viable research program to seek maximum efficiency and effectiveness in the control of phosphorus introductions into the Great Lakes.

3. The following table establishes phosphorus loads for the base year (1976) and future phosphorus loads. The Parties, in cooperation with the State and Provincial Governments, shall within eighteen months after the date of entry into force of this Agreement confirm the future phosphorus loads, and based on these establish load allocations and compliance schedules, taking into account the recommendations of the International Joint Commission arising from the Pollution from Land Use Activities Reference. Until such loading allocations and compliance schedules are established, the Parties agree to maintain the programs and other measures specified in Annex 2 of the Great Lakes Water Quality Agreement of 1972.

Basin	1976 Phosphorus Load in Metric Tonnes Per Year		Future Phosphorus Load in Metric Tonnes Per Year	
Lake Superior	3600		3400*	
Lake Michigan	6700		5600*	
Main Lake Huron	3000		2800*	
Georgian Bay	630		600*	
North Channel	550		520*	
Saginaw Bay	870		440**	
Lake Erie	20000		11000**	
Lake Ontario	11000		7000**	

* These loadings would result if all municipal plants over one million gallons per day achieved an effluent of 1 milligram per litre of phosphorus.

** These loadings are required to meet the goals stated in paragraph 1 above.

APPENDIX 5

TEMPERATURE

TEMPERATURE

Water Quality Objective

There should be no change in temperature that would adversely affect any local or general use of the waters.

Minnesota

No Material Increase

Pennsylvania

No rise when ambient temperature is 58°F. or above; not more than 5°F. rise above ambient temperature until stream temperature reaches 58°F.; not to be changed by more than 2°F. during any one-hour period.

TEMPERATURE

CRITERIA

Freshwater Aquatic Life

For any time of year, there are two upper limiting temperatures for a location (based on the important sensitive species found there at that time):

1. One limit consists of a maximum temperature for short exposures that is time dependent and is given by the species-specific equation:

$$\text{Temperature (°C)} = 1/b[\log_{10}(\text{time in minutes}) - a] - 2$$

Where:

- a = intercept on the "y" or logarithmic axis of the line fitted to experimental data which are available for some species from Appendix II-C, NAS, 1974.
- b = slope of the line fitted to experimental data which are available for some species from Appendix II-C, NAS, 1974.

2. The second value is a limit on the weekly average temperature that:

- a. in the cooler months (mid-October to mid-April in the north and December to February in the south) will protect against mortality of important species if the elevated plume temperature is suddenly dropped to the ambient temperature, with the limit being the acclimation temperature minus 2°C when the lower lethal threshold temperature equals the ambient water temperature (in some regions this limitation may also be applicable in summer); or
- b. in the warmer months (April through October in the north and March through November in the south) is determined by adding to the physiological optimum temperature (usually for growth) a factor calculated as one-third of the difference between the ultimate upper incipient lethal temperature and the optimum temperature for the most sensitive important species (and appropriate life state) that normally is found at that location and time; or
- c. during reproductive seasons (generally April through June and September through October in the north and March through May and October through November in the south) meets site-specific requirements for successful migration, spawning, egg incubation, fry rearing, and other reproductive functions of important species. These local requirements should supersede all other requirements when they are applicable; or
- d. is a site-specific limit that is found necessary to preserve normal species diversity or prevent appearance of nuisance organisms.

(e) Temperature (STORET numbers - (°F) 00011 and (°C) 00010):

- (1) (A) All sources of heated effluents in existence as of January 1, 1971 shall meet the following restrictions outside of a mixing zone which shall be no greater than a circle with a radius of 1000 feet or an equal fixed area of simple form.
- (i) There shall be no abnormal temperature changes that may affect aquatic life.
- (ii) The normal daily and seasonal temperature fluctuations that existed before the addition of heat shall be maintained.
- (iii) The maximum temperature rise at any time above natural temperatures shall not exceed 3°F. In addition, the water temperature shall not exceed the maximum limits (°F) indicated in the following table:

JAN.	45	JUL.	80
FEB.	45	AUG.	80
MAR.	45	SEPT.	80
APR.	55	OCT.	65
MAY.	60	NOV.	60
JUN.	70	DEC.	50

- (B) The owner or operator of a source of heated effluent which discharges 0.5 billion British Thermal Units per hour (BTU/HR.) or more shall demonstrate in a hearing before this Board not less than five nor more than six years after the adoption of this regulation, that discharges from that source have not caused and cannot be reasonably expected in future to cause significant ecological damage to the Lake. If such proof is not made to the satisfaction of the Board, backfitting of alternative cooling devices shall be accomplished within a reasonable time as determined by the Board.
- (C) The owner or operator of a source of heated effluent shall maintain such records and conduct such studies of the effluents from such source and of their effects as may be required by the Environmental Protection Agency or in any permit granted under the Environmental Protection Act.
- (D) Backfitting of alternative cooling facilities will be required if, upon complaint filed in accordance with Board rules, it is found at any time that any heated effluent causes significant ecological damage to the Lake.

ILLINOIS

- (2) Any effluent source under construction as of January 1, 1971, but not in operation, shall meet all the requirements of Section 1 of this regulation and in addition shall meet the following restrictions:
- (A) Neither the bottom, the shore, the hypolimnion, nor the thermocline shall be affected by any heated effluent.
 - (B) No heated effluent shall affect spawning grounds or fish migration routes.
 - (C) Discharge structures shall be so designed as to maximize short-term mixing and thus to reduce the area significantly raised in temperature.
 - (D) No discharge shall exceed ambient temperatures by more than 20°F.
 - (E) Heated effluents from more than one source shall not interact.
 - (F) All reasonable steps shall be taken to reduce the number of organisms drawn into or against the intakes.
 - (G) Cleaning of condensers shall be accomplished by mechanical devices. If chemicals must be used to supplement mechanical devices, the concentration at the point of discharge shall not exceed the 96-hour TLM for fresh water organisms.
- (3) (A) No source of heated effluent which was not in operation or under construction as of January 1, 1971 shall discharge more than a daily average of 0.1 billion BTU/Hr.
- (B) Sources of heated effluents which discharge less than a daily average of 0.1 billion BTU/Hr. not in operation or under construction as of January 1, 1971 shall meet all requirements of Sections 1 and 2 of this regulation.

INDIANA
TEMPERATURE

- (ee) All new waste heat discharges or enlargements of existing facilities exceeding a daily average of 0.5 billion BTU/hour, which had not begun operation as of February 11, 1972, and which plan to use Lake Michigan waters for cooling, shall be limited to the amount essential for blowdown in the operation of a closed cycle cooling facility. Plants not in operation as of February 11, 1972, will be allowed to go into operation provided they are committed to a closed cycle cooling system construction schedule approved by the State and Federal Regulatory Agencies.
- (ff) Water intakes shall be designed and located to minimize entrainment and damage to desirable organisms. Requirements may vary depending upon local conditions but, in general, intakes are to have minimum water velocity and shall not be located in spawning or nursery areas of important fishes. Water velocity at screens and other exclusion devices shall also be at a minimum.
- (gg) Discharges other than those now in existence shall be such that the thermal plumes do not overlap or intersect.
- (hh) Facilities discharging more than a daily average of 0.5 billion BTU/hour of waste heat shall continuously record intake and discharge temperature and flow and make those records available to regulatory agencies upon request.

- (5) (Temperature) The following temperature standards and criteria shall apply:
- (aa) All temperatures are expressed both in degrees Fahrenheit and degrees Celsius. In all receiving waters the points of measurement shall normally be in the first meter below the surface at such depth as to avoid thin layer surface warming due to extreme ambient air temperatures, but where required to determine the true distribution of heated wastes and natural variations in water temperatures, measurements shall be at a greater depth and at several depths as a thermal profile.
 - (bb) There shall be no abnormal temperature changes so as to be injurious to fish, wildlife, or other aquatic life or the growth or propagation thereof. In addition, plume interaction with the bottom shall be minimized and shall not injuriously affect fish, shellfish, and wildlife spawning or nursery areas.
 - (cc) The normal daily and seasonal temperature fluctuations that existed before the addition of heat shall be maintained.
 - (dd) At any time and at a maximum distance of a 1,000 feet arc inscribed from a fixed point adjacent to the discharge and/or as agreed upon by the Stream Pollution Control Board and Federal Regulatory Agencies, the receiving water temperature shall not be more than 3° Fahrenheit above the existing natural water temperature nor shall the maximum temperature exceed those listed in Table I below, whichever is lower:

TABLE I

	°F	°C
January	45	7.0
February	45	7.0
March	45	7.0
April	55	13.0
May	60	15.5
June	70	21.0
July	80	26.5
August	80	26.5
September	80	26.5
October	65	18.5
November	60	15.5
December	50	10.0

3745-1-11 LAKE ERIE STANDARDS

OHIO

(34) Temperature

- (a) There shall be no water temperature changes as a result of human activity that cause mortality, long-term avoidance, exclusion from habitat, or adversely affect the reproductive success of representative aquatic species, unless caused by natural conditions.
- (b) At no time shall water temperature exceed a monthly or bi-weekly average, or at any time exceed the daily maximum temperature as indicated in Table 7a and 7b. The average and daily maximum temperature standards shall apply and be measured outside of a thermal mixing zone at any point on a thermal mixing zone boundary at depths greater than three feet, as defined in Rule 3745-1-11(B)(2)(a) and (b) of the Ohio Administrative Code.
- (c) The temperature of the hypolimnetic waters of Lake Erie shall not exceed at any time a daily maximum as indicated in Table 7c.

Table 7a: Lake Erie Western Basin - includes the area of Lake Erie west of a line drawn from Pelee Point, Canada to Scott Point on Catawba Island. Shown as degrees Fahrenheit and (Celsius).

	<u>Jan.</u> <u>1-31</u>	<u>Feb.</u> <u>1-29</u>	<u>Mar.</u> <u>1-15</u>	<u>Mar.</u> <u>16-31</u>	<u>Apr.</u> <u>1-15</u>	<u>Apr.</u> <u>16-30</u>	<u>May</u> <u>1-15</u>	<u>May</u> <u>16-31</u>	<u>June</u> <u>1-15</u>
Average:	-	-	-	-	-	53 (11.7)	59 (15.0)	65 (18.3)	75 (23.9)
Daily Maximum:	35 (1.7)	38 (3.3)	39 (3.9)	45 (7.2)	51 (10.6)	56 (13.3)	64 (17.8)	72 (22.2)	78 (25.6)
	<u>June</u> <u>16-30</u>	<u>July</u> <u>1-31</u>	<u>Aug.</u> <u>1-31</u>	<u>Sept.</u> <u>1-15</u>	<u>Sept.</u> <u>16-30</u>	<u>Oct.</u> <u>1-15</u>	<u>Oct.</u> <u>16-31</u>	<u>Nov.</u> <u>1-30</u>	<u>Dec.</u> <u>1-31</u>
Average:	80 (26.7)	83 (28.3)	83 (28.3)	78 (25.6)	76 (24.4)	66 (18.9)	60 (15.6)	53 (11.7)	-
Daily Maximum:	83 (28.3)	85 (29.4)	85 (29.4)	83 (28.3)	81 (27.2)	71 (21.7)	65 (18.3)	58 (14.4)	46 (7.8)

3745-1-11 LAKE ERIE STANDARDS

OHIO

Table 7b: Lake Erie Central Basin - includes the area of Lake Erie east of a line drawn from Pelee Point, Canada to Scott Point on Catawba Island to the Pennsylvania-Ohio state line. Shown as degrees Fahrenheit and (Celsius).

	<u>Jan.</u> <u>1-31</u>	<u>Feb.</u> <u>1-29</u>	<u>Mar.</u> <u>1-15</u>	<u>Mar.</u> <u>16-31</u>	<u>Apr.</u> <u>1-15</u>	<u>Apr.</u> <u>16-30</u>	<u>May</u> <u>1-15</u>	<u>May</u> <u>16-31</u>	<u>June</u> <u>1-15</u>
Average:	-	-	-	-	43 (6.1)	53 (11.7)	59 (15.0)	63 (17.2)	75 (23.9)
Daily Maximum:	35 (1.7)	38 (3.3)	39 (3.9)	45 (7.2)	48 (8.9)	56 (13.3)	63 (17.2)	72 (22.2)	78 (25.6)
	<u>June</u> <u>16-30</u>	<u>July</u> <u>1-31</u>	<u>Aug.</u> <u>1-31</u>	<u>Sept.</u> <u>1-15</u>	<u>Sept.</u> <u>16-30</u>	<u>Oct.</u> <u>1-15</u>	<u>Oct.</u> <u>16-31</u>	<u>Nov.</u> <u>1-30</u>	<u>Dec.</u> <u>1-31</u>
Average:	80 (26.7)	83 (28.3)	83 (28.3)	76 (24.4)	71 (21.7)	66 (18.9)	58 (14.4)	48 (8.9)	-
Daily Maximum:	83 (28.3)	85 (29.4)	85 (29.4)	81 (27.2)	76 (24.4)	71 (21.7)	63 (17.2)	53 (11.7)	46 (7.8)

Table 7c: Seasonal daily maximum temperature limitations for the hypolimnetic regions of Lake Erie. Shown as degrees fahrenheit and (celcius).

<u>Month</u>	<u>Daily Maximum</u>
January	44 (6.7)
February	44 (6.7)
March	44 (6.7)
April	47 (8.3)
May	51 (10.6)
June	54 (12.2)
July	59 (15.0)
August	59 (15.0)
September	55 (12.8)
October	46 (7.8)
November	41 (5.0)
December	38 (3.3)

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NR 102.05 Lake Michigan and Lake Superior thermal standards. For Lake Michigan and Lake Superior the following thermal standards are established so as to minimize effects on the aquatic biota in the receiving waters.

(1) (a) Thermal discharges shall not raise the receiving water temperature more than 3°F above the existing natural temperature at the boundary of mixing zones established in paragraphs (b) and (c).

(b) 1. The mixing zone for a shoreline thermal discharge shall be the area included within the perimeter of a rectangular figure extending 1,250 feet in both directions along the shoreline from the outfall and 1,250 feet into the lake.

2. The mixing zone for an offshore thermal discharge shall be the area within a 1,000-foot radius circle with its center at the point of discharge.

(c) The department may, upon request from the owner of a source of thermal discharge, adjust the boundaries of the mixing zone established in paragraph (b) for that source. In no case may any mixing zone so established include an area greater than 72 acres nor may it include more than 2,800 feet of shoreline.

(2) In addition to the limitation set forth in subsection (1), but excepting the Milwaukee Harbor, Port Washington Harbor and the mouth of the Fox River, thermal discharges to Lake Michigan shall not raise the temperature of the receiving waters at the boundary of the established mixing zone above the following limits:

January.....	45°F	May.....	60°
February.....	45°	June.....	70°
March.....	45°	July.....	80°
April.....	55°	August.....	80°
September.....	80°	November.....	60°
October.....	65°	December.....	50°

History: Cr. Register, September, 1973, No. 213, eff. 10-1-73, r. and corr. Register, July, 1975, No. 235, eff. 8-1-75.

R 323.1069. Temperature; general considerations.

Rule 1069. (1) In all waters of the state, the points of temperature measurement normally shall be in the surface 1 meter; however, where turbulence, sinking plumes, discharge inertia or other phenomena upset the natural thermal distribution patterns of receiving waters, temperature measurements shall be required to identify the spatial characteristics of the thermal profile.

(2) Monthly maximum temperatures, based on the ninetieth percentile occurrence of natural water temperatures plus the increase allowed at the edge of the mixing zone and in part or long-term physiological needs of fish, may be exceeded for short periods when natural water temperatures exceed the ninetieth percentile occurrence. Temperature increases during these periods may be permitted by the commission, but in all cases shall not be greater than the natural water temperature plus the increase allowed at the edge of the mixing zone.

(3) Natural daily and seasonal temperature fluctuations of the receiving waters shall be preserved.

R 323.1070. Temperature; Great Lakes and connecting waterways.

Rule 1070. (1) The Great Lakes and connecting waterways shall not receive a heat load which would warm the receiving water at the edge of the mixing zone more than 3 degrees Fahrenheit above the existing natural water temperature.

(2) The Great Lakes and connecting waterways shall not receive a heat load which would warm the receiving water at the edge of the mixing zone to temperatures in degrees Fahrenheit higher than the following monthly maximum temperatures:

(a) Lake Michigan north of a line due west from the city of Pentwater:

J	F	M	A	M	J	J	A	S	O	N	D
40	40	40	50	55	70	75	75	75	65	60	45

(b) Lake Michigan south of a line due west from the city of Pentwater:

J	F	M	A	M	J	J	A	S	O	N	D
45	45	45	55	60	70	80	80	80	65	60	50

(c) Lake Superior and the St. Marys River:

J	F	M	A	M	J	J	A	S	O	N	D
38	36	39	46	53	61	71	74	71	61	49	42

(d) Lake Huron north of a line due east from Tawas Point:

J	F	M	A	M	J	J	A	S	O	N	D
40	40	40	50	60	70	75	80	75	65	55	45

(e) Lake Huron south of a line due east from Tawas Point, except Saginaw Bay:

J	F	M	A	M	J	J	A	S	O	N	D
40	40	40	55	60	75	80	80	80	65	55	45

MICHIGAN

(f) Lake Huron, Saginaw bay:

J	F	M	A	M	J	J	A	S	O	N	D
45	45	45	60	70	75	80	85	78	65	55	45

(g) St. Clair river:

J	F	M	A	M	J	J	A	S	O	N	D
40	40	40	50	60	70	75	80	75	65	55	50

(h) Lake St. Clair:

J	F	M	A	M	J	J	A	S	O	N	D
40	40	45	55	70	75	80	83	80	70	55	45

(i) Detroit river:

J	F	M	A	M	J	J	A	S	O	N	D
40	40	45	60	70	75	80	83	80	70	55	45

(j) Lake Erie:

J	F	M	A	M	J	J	A	S	O	N	D
45	45	45	60	70	75	80	85	80	70	60	50

No discharge which will be injurious to fishlife or make the waters unsafe or unsuitable for any best usage determined for the specific waters which are assigned to each class. See Part 704.

Section 704.1 WATER QUALITY STANDARD FOR THERMAL DISCHARGES.

- (a) All thermal discharges to the waters of the State shall assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water.
- (b) The criteria contained in this Part shall apply to all thermal discharges and shall be complied with, except as provided in this Part.

Section 704.2 CRITERIA GOVERNING THERMAL DISCHARGES.

- (a) General criteria. The following criteria shall apply to all waters of the State receiving thermal discharges, except as provided in Section 704.6:
 - 1. The natural seasonal cycle shall be retained.
 - 2. Annual spring and fall temperature changes shall be gradual.
 - 3. Large day-to-day temperature fluctuations due to heat of artificial origin shall be avoided.
 - 4. Development or growth of nuisance organisms shall not occur in contravention of water quality standards.
 - 5. Discharges which would lower receiving water temperature shall not cause a violation of water quality standards and Section 704.3.
 - 6. For the protection of the aquatic biota from severe temperature changes, routine shut down of an entire thermal discharge at any site shall not be scheduled during the period from December through March.

- (b) Special criteria. The following criteria shall apply to all waters of the State receiving thermal discharges, except as provided in Section 704.6:

1. Non-Trout Waters.

- (i) The water temperature at the surface of a stream shall not be raised to more than 90°F at any point.
- (ii) At least 50 percent of the cross sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be raised to more than 5 Fahrenheit degrees over the temperature that existed before the addition of heat of artificial origin or to a maximum of 86°F whichever is less.
- (iii) At least 50 percent of the cross sectional area and/or volume of flow of the stream including a minimum of one-third of the surface as measured from shore to shore shall not be lowered more than 5 Fahrenheit degrees from the temperature that existed immediately prior to such lowering.

2. Trout Waters.

- (i) No discharge at a temperature over 70°F shall be permitted at any time to streams classified for trout.
- (ii) From June through September no discharge shall be permitted that will raise the temperature of the stream more than 2 Fahrenheit degrees over that which existed before the addition of heat of artificial origin.
- (iii) From October through May, no discharge shall be permitted that will raise the temperature of the stream more than 5 Fahrenheit degrees over that which existed before the addition of heat of artificial origin or to a maximum of 50°F whichever is less.

NEW YORK

- (iv) From June through September no discharge shall be permitted that will lower the temperature of the stream more than 2 Fahrenheit degrees from that which existed immediately prior to such lowering.

3. Lakes.

- (i) The water temperature at the surface of a lake shall not be raised more than 3 Fahrenheit degrees over the temperature that existed before the addition of heat of artificial origin.
- (ii) In lakes subject to stratification as defined in Part 652, thermal discharges that will raise the temperature of the receiving waters shall be confined to the epilimnion.
- (iii) In lakes subject to stratification as defined in Part 652, thermal discharges which will lower the temperature of the receiving waters shall be discharged to the hypolimnion, and shall meet the water quality standards contained in Parts 701 and 702 in all respects.

4. Coastal Waters.

- (i) The water temperature at the surface of coastal waters shall not be raised more than 4 Fahrenheit degrees from October through June nor more than 1.5 Fahrenheit degrees from July through September over that which existed before the addition of heat of artificial origin.
- (ii) The water temperature at the surface of coastal waters shall not be lowered more than 4 Fahrenheit degrees from October through June nor more than 1.5 Fahrenheit degrees from July through September from that which existed immediately prior to such lowering.

ONTARIO OBJECTIVE

Temperature

1) General

The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

2) Waste Heat Discharge

(a) Ambient Temperature Changes

The temperature at the edge of a mixing zone shall not exceed the natural ambient water temperature at a representative control location by more than 10C° (18F°). However, in special circumstances, local conditions may require a significantly lower temperature difference than 10C° (18F°). Potential dischargers are to apply to the Ministry of the Environment for guidance as to the allowable temperature rise for each thermal discharge. This Ministry will also specify the nature of the mixing zone and the procedure for the establishment of a representative control location for temperature recording on a case-by-case basis.

(b) Discharge Temperature Permitted

The maximum temperature of the receiving body of water, at any point in the thermal plume outside a mixing zone, shall not exceed 30°C (86°F) or the temperature at a representative control location plus 10°C (18°F) or the allowed temperature difference, whichever is the lesser temperature. These maximum temperatures are to be measured on a mean daily basis from continuous records.

(c) Taking and Discharging of Cooling Water

Users of cooling water shall meet both the Objectives for temperature outlined above and the "Procedures for the Taking and Discharge of Cooling Water" as outlined in the Implementation Procedures for Policy 3 (page 15).

APPENDIX 6

TOXIC SUBSTANCES

TOXIC SUBSTANCES

WATER QUALITY
OBJECTIVES

Unspecified non-persistent toxic substances and complex effluents of municipal, industrial or other origin should not be present in concentrations which exceed 0.05 of the median lethal concentration in a 96-hour test for any sensitive local species to protect aquatic life.

ILLINOIS

Any substance toxic to aquatic life shall not exceed one-tenth of the 48-hour median tolerance limit 96-hour TLM) for native fish or essential fish food organisms.

INDIANA

(Toxic Substances) Concentrations of toxic substances shall not exceed one-tenth of the 96-hour median lethal concentration (LC_{50}) for important indigenous aquatic species and those artificially propagated by the Indiana Department of Natural Resources. More stringent application factors shall be used when justified on the basis of available evidence and approved by the Board after public notice and opportunity for a hearing.

(Persistent or Bioconcentrating Substances) Concentrations of organic contaminants which can be demonstrated to be persistent, to have a tendency to bioconcentrate in the aquatic biota, and are likely to be toxic on the basis of available scientific evidence, shall be limited as determined by the Board after public notice and opportunity for a hearing. (Note: For substances in 6(b)(2) and 6(b)(3), the United States Environmental Protection Agency Administrator's Quality Criteria for Water will be among the documents used in establishing water quality standards for toxic and/or persistent substances).

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None in amounts that will interfere with use for primary contact recreation or that will be injurious to the growth and propagation of fish, or which in any manner shall adversely affect the flavor, color or odor thereof or impair the waters for any other best usage as determined for the specific waters which are assigned to this class.

TOXIC SUBSTANCES

MICHIGAN

R 323.1057. Toxic substances

Rule 1057. (1) Toxicity of undefined toxic substances not specifically included in subrules (2) and (3) shall be determined by development of 96 hour TL_m 's or other appropriate effect end points obtained by continuous-flow or in situ bioassays using suitable test organisms. Concentrations of undefined toxic substances in the waters of the state shall not exceed safe concentrations as determined by applying an application factor, based on knowledge of the behavior of the toxic substances and the organisms to be protected in the environment, to the TL_m or other appropriate effect end point.

(2) For all waters of the state, unless on the basis of recent information a more restrictive limitation is required to protect a designated use, concentrations of defined toxic substances, including heavy metals, shall be limited by application of the toxic substances recommendations contained in the chapter on Freshwater Organisms, "Report of the National Technical Advisory Committee to the Secretary of the Interior, Water Quality Criteria, 1968", or by application of any toxic effluent standard, limitation or prohibition promulgated by the administrator of the United States environmental protection agency pursuant to section 307 (a) of the United States Public Law 92-500, whichever is more restrictive.

(3) In addition to the standards prescribed in subrules (1) and (2), waters of the state used for public water supply shall, at the point of water intake, not exceed the permissible inorganic and organic chemicals criteria for raw public water supply in "Report of the National Technical Advisory Committee to the Secretary of the Interior, Water Quality Criteria, 1968", except that chlorides shall be limited to the same extent as prescribed by rule 1051(2).

MINNESOTA

Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances, of undefined toxicity to fish or other biota shall be resolved in accordance with the latest methods recommended by the U. S. Environmental Protection Agency. The recommendations of the National Technical Advisory Committee appointed by the U. S. Environmental Protection Agency shall be used as official guidelines in all aspects where the recommendations may be applicable. Toxic substances shall not exceed 1/10 of the 96 hour median tolerance limit (TL_m) as a water quality standard except that other more stringent application factors shall be used when justified on the basis of available evidence.

TOXIC SUBSTANCES

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(d) Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. The determination of the toxicity of a substance shall be based upon the available scientific data base. References to be used in determining the toxicity of a substance shall include, but not be limited to:

1. "Quality Criteria for Water". EPA-440/9-76-003. United States Environmental Protection Agency, Washington, D. C., 1976, and

2. "Water Quality Criteria 1972". EPA-R3-73-033. National Academy of Sciences. National Academy of Engineering. United States Government Printing Office, Washington, D.C., 1974.

3. Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances, or undefined toxicity to fish and other biota shall be resolved in accordance with the methods specified in "Water Quality Criteria 1972", "Standard Methods for the Examination of Water and Wastewater", 14th Edition, 1975 (American Public Health Association, New York) or other methods approved by the department of natural resources.

(e) Streams classified as trout waters by the department of natural resources (Wisconsin Trout Streams, Publication 213-72) shall not be altered from natural background by effluents that influence the stream environment to such an extent that trout populations are adversely affected.

1. There shall be no significant artificial increases in temperature where natural trout reproduction is to be protected.

2. Dissolved oxygen in classified trout streams shall not be artificially lowered to less than 6.0 mg/l at any time, nor shall the dissolved oxygen be lowered to less 7.0 mg/l during the spawning season.

3. The dissolved oxygen in great lakes tributaries used by stocked salmonids for spawning runs shall not be lowered below natural background during the period of habitation.

TOXIC SUBSTANCES

OHIO

Toxic Substances

- (a) All pollutants or combinations of pollutants shall not exceed, at any time, one-tenth of the 96 hour median tolerance limit (TLm) of LC₅₀ for any representative aquatic species. However, more stringent application factors shall be imposed where justified by "Quality Criteria for Water," U.S. Environmental Protection Agency, 1976; "Water Quality Criteria 1972," National Academy of Sciences and National Academy of Engineering, 1973; or other scientifically based publications.
- (b) Pollutants or combinations of pollutants which are known to be persistent toxicants in the aquatic environment shall not exceed, at any time, an application factor of one one-hundreth applied to the 96 hour TLm or LC₅₀.
- (c) Any criteria established for a water course or segment by this regulation shall supersede less stringent criteria established in Rule 3745-1-07 of the Ohio Administrative Code after appropriate public hearings as required by Section 6111.041 of the Ohio Revised Code.
- (d) The median tolerance limit (TLm) or LC₅₀ shall be determined by static or dynamic bioassays performed in accordance with methods outlined in "Standard Methods for the Examination of Water and Wastewater," Fourteenth Edition, American Public Health Association, American Water Works Association and the Water Pollution Control Federation, 1975; or performed in accordance with procedures outlined in Methods of Acute Toxicity Tests with Fish, Macroinvertebrates and Amphibians, USEPA 660/3-75-009. Tests will be conducted using actual effluent, receiving water representative species of aquatic life whenever possible.

§ 93.8. Development of specific water quality criteria for the protection of aquatic life.

(a) When a specific water quality criterion has not been established for a pollutant in section 93.7(c), Table 3, or pursuant to section 93.7(f) of this title (relating to specific water quality criteria) and a discharge of a pollutant into waters of this Commonwealth designated to be protected for aquatic life in section 93.9 of this title (relating to designated water uses and water quality criteria) is proposed, a specific water quality criterion for such pollutant may be determined by the Department through establishment of a safe concentration value.

(b) Establishment of a safe concentration value shall be based upon data obtained from relevant aquatic field studies, standard continuous flow bioassay test data which exists in substantial available literature, or data obtained from specific tests utilizing one or more representative important species of aquatic life designated on a case-by-case basis by the Department and conducted in a water environment which is equal to or closely approximates that of the natural quality of the receiving waters.

(c) In those cases where it has been determined that there is insufficient available data to establish a safe concentration value for a pollutant, the safe concentration value shall be determined by applying the appropriate application factor to the 96-hour (or greater) LC50 value. Except where the Department determines, based upon substantial available data, that an experimentally derived application factor exists for a pollutant, the following application factors shall be used in the determination of safe concentration values:

(1) Concentrations of pollutants that are noncumulative shall not exceed 0.05 (1/20) of the 96-hour LC50.

(2) Concentrations of pollutants that are cumulative shall not exceed 0.01 (1/100) of the 96-hour LC50.

(3) Concentrations of pollutants with known synergistic or antagonistic effects with pollutants in the effluent or receiving water will be established on a case-by-case basis using the best available scientific data.

(d) Persons seeking issuance of a permit pursuant to the Clean Streams Law and 33 U.S.C. § 1342 authorizing the discharge of a pollutant for which a safe concentration value is to be established using specific bioassay tests pursuant to subsection (c) of this section shall perform such testing with the approval of the Department and shall submit the following in writing to the Department:

(1) A plan proposing the bioassay testing to be performed.

(2) Such periodic progress reports of the testing as may be required by the Department.

(3) A report of the completed results of such testing including, but not limited to, the following:

(i) all data obtained during the course of testing; and

(ii) all calculations made in the recording, collection, interpretation, and evaluation of such data.

(e) Bioassay testing shall be conducted in accordance with the continuous flow methodologies outlined in EPA Ecological Research Series Publication, EPA-660/3-75-009, Methods of Acute Toxicity Tests with Fish, Macroinvertebrates, and Amphibians (April, 1975); Standard Methods for the Examination of Water and Wastewater (14th Edition); Standard Method of Test for ASTM D1345-59 (Reapproved 1970) and published in the 1975 Annual Book of ASTM Standards - Part 1 - Water; or EPA Environmental Monitoring Series Publication, EPA-600/1-78-012, Methods for Measurement of Acute Toxicity of Effluents to Aquatic Organisms (March, 1978). Use of any other methodologies shall be subject to prior written approval by the Department. Test waters shall be reconstituted according to recommendations and methodologies specified in the previously cited references, or methodologies approved in writing by the Department.

ONTARIO

POLICY 4 – HAZARDOUS SUBSTANCES

The term "hazardous substances" applies to chemicals considered threats to man and the environment. A hazardous substance can be defined as a substance which (individually or in combination with other substances) can cause death, disease including cancer, behavioural abnormalities, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformities in organisms or their offspring. In addition to the above, the consequences of contamination of the environment by hazardous substances include a loss of valuable species, restrictions on important socio-economic activities and a variety of irreversible ecological changes that threaten man's future use and enjoyment of the environment.

About two million chemical compounds are known and each year thousands more are developed by the chemical industry, many of which are introduced commercially. Very little is known about the possible health and environmental effects of most of these compounds. Many are not hazardous but the sheer number of chemical compounds, the diversity of their use, and the adverse effects already encountered by some have made chemical contaminants in our environment an important concern.

To control the problem of hazardous substances in the environment requires the following tasks:

- identification of potentially hazardous substances;
- assessment of the impact of the substances;
- control and regulation of the manufacture, processing, importing, use and disposal of the substances;
- monitoring of the substances in the environment and analysis and interpretation of the monitoring data; and
- establishment of environmental criteria, such as the Provincial Water Quality Objectives, for the protection of water uses, etc.

To date, due to resource and data limitations, some of the above important tasks have been carried out to only a limited extent for a few chemicals such as PCB, DDT, and mercury. Adequate knowledge concerning the degree of safety or hazard of many chemicals is not available and may take years or even decades to develop. Further, control technology for many substances may not be practicable under many circumstances. In light of these limitations, the Ministry has adopted a policy which emphasizes that preventive measures be taken in dealing with the releases of both known and potentially hazardous substances.

To implement this preventive policy, the Ministry must rely largely upon existing knowledge about many substances. Presently, scientific data are available for establishing criteria for the substances included in the Provincial Water Quality Objectives (Table 1). Some of these substances are hazardous if released in sufficient amount. For the control of these substances, the Objectives and the Implementation Procedures outlined for Policy 3 shall be used in setting effluent loadings and concentrations.

Based upon current scientific knowledge, other compounds are classified into one of the following two categories for control purposes.

ONTARIO

1) Substances with Zero Tolerance Limits

It has been established that the substances listed in Table 2, if released in any concentration can bio-accumulate or concentrate in the aquatic environment to levels which are harmful or lethal to organisms. To provide long-term protection to aquatic organisms and man, any release of these substances *should be completely eliminated*. However, it is recognized that trace concentrations of these substances may be found in municipal effluents and other sources and may not be completely removed by current practicable technology; further, some contaminants, such as mercury, may occur in surface waters due to natural conditions. Accordingly, the intent of this policy is to prohibit any new discharges of these substances and to reduce all existing releases to the lowest practicable levels.

Although Provincial Water Quality Objectives are specified in Table 1 for some of the substances included in Table 2, the Objectives are intended as guidance for dealing with past releases or accidental losses, but not for new releases.

2) Substances with Undefined Tolerance Limits

All substances not included in Table 2 or the Provincial Water Quality Objectives (Table 1) may pose an adverse effect on health or the environment. Presently, there are not enough scientific data for establishing water quality Objectives for these substances. Accordingly, the release of all such substances shall be evaluated on a case-by-case basis, and special measures should be taken to protect the environment.

At the present time, substances listed in Table 3 are of primary concern in this regard.

Note: The controlled application of approved biocides for the control of nuisance organisms shall be permitted provided it is authorized by the Ministry under Section 6 of the Pesticides Act.

Unspecified Non-Persistent Toxic Substances and Complex Effluents	For non-persistent compounds or mixtures with no Objectives because of a lack of specific data, their concentration should not exceed 0.05 of the 96 hour LC50 value for any approved test species.
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Table 2
Substances with Zero Tolerance Limits

Mercury
 Dichlorodiphenyltrichloroethane
 (DDT) and metabolites
 Polychlorinated Biphenyl (PCB)
 Polybrominated Biphenyl (PBB)
 Decchlorane - C₁₀Cl₁₂ (Mirex)

Table 3
Substances with Undefined Tolerance Limits

METALS	COMMENTS
Aluminum	<ul style="list-style-type: none"> - in most natural waters the ionized or potentially ionizable aluminum would be in the form of anionic or neutral precipitates. concentrations of 0.1 mg/L or greater of these would be deleterious to growth and survival of fish
Antimony	<ul style="list-style-type: none"> - sources are: mine wastes, weathering of rock - very toxic - 96 hr LC50 for fish is 9 to 80 mg/L (dependent on hardness) - 96 hr LC50 for Daphnia is 20 mg/L
Barium	<ul style="list-style-type: none"> - would expect it to be in the CO₃ or SO₄ form in natural waters; BaCl₂ lethalities to aquatic invertebrates and fish are reported as 96 hr LC50 of 10-15 and 50-1500 mg/L; Barium can be concentrated from water to aquatic organisms by a factor of ~150

ONTARIO

- | | |
|-----------------------------|---|
| Disulfoton (Disyston) | - pesticide, very toxic to fish - 96 hour LC50 < 10 mg/L
- use may be limited and composition unstable |
| Kelthane (Dicofol) | - pesticide, extremely toxic to aquatic invertebrates 96 hour LC50 < 1 mg/L
- frequency of use not identified |
| Methyl Parathion (Metaphos) | - organophosphate pesticide
- very toxic to fish - 96 hour LC50 < 10 mg/L
- degrades in water
- extent of use not identified |
| Naled (Dibrom) | - organophosphate pesticide
- extremely toxic to fish - 96 hour LC50 < 1 mg/L
- degrades in water
- common use in flea control for dogs
- entrance to water limited to accidental spill |
| Rotenone | - popular piscicide extremely toxic to fish - 96 hour LC50 < 1 mg/L |
| PMA | - turf fungicide on golf courses |
| TFM | - lampricide, extremely toxic to fish, 96 hour LC50 < 1 mg/L |

Herbicides Actively Used in Ontario:

Alachlor (Lasso)
Amitrole
Atrazine
Cutrine
Cyanazine
Glyphosate
Paraquat
Trifluralin (Treflan)
2,4,5-T

Insecticides Actively Used in Ontario:

Altosid
Carbofuran (Furadan)
Dimilin
Temephos (Abate)

Fungicides Actively Used in Ontario:

Captan
Dacnil
Pentachlorophenol

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