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**REPORT ON THE PROGRESS OF THE REVISION OF
THE MOE GUIDELINES FOR DREDGED MATERIAL
OPEN WATER DISPOSAL, 1984/85**

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EXECUTIVE SUMMARY

This report is part of the first step towards revision of the Ontario Ministry of the Environment (MOE) guidelines for the disposal of sediment dredged from Great Lakes harbours and waterways. The work was carried out during 1984/85 under project ECD-236.

A literature search was carried out to obtain all available information on recent and background concentrations of parameters listed in the current MOE guidelines. Significant differences in concentrations of contaminants reported in the Great Lakes sediments may reflect the different analytical procedures and sediment sampling techniques used. Consequently, it was recommended to develop and test a standard sediment sampling protocol and recommendations for standard analytical techniques for determination of the concentration of contaminants in dredged material, including statistical criteria such as stratified random sampling with replicates. It was recommended to include more parameters, in particular organic contaminants, in the revised MOE guidelines. A method for selection of these parameters is included. Finally, a "Bioassessment Protocol" was proposed to assess the impact of dredged material on the water column, sediment-water interface and sediment components of the ecosystem.

PERSPECTIVE-GESTION

Le présent rapport s'inscrit dans la révision globale qu'entend mener le MEO des lignes directrices sur l'élimination des sédiments dragués dans les Grands Lacs. Il renferme des recommandations portant sur l'élaboration d'autres méthodes permettant d'évaluer l'incidence des contaminants de sédiments se trouvant dans les ports et les voies maritimes des Grands Lacs.

Rapport sur l'avancement de la révision du document Guidelines for Dredge Material Open Water Disposal, 1984-1985, du ministère de l'Environnement de l'Ontario.

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MANAGEMENT PERSPECTIVE

This report contributes to a complete reevaluation of the Ontario Ministry of the Environment guidelines for the disposal of dredged sediment in the Great Lakes. It contains recommendations for development of further procedures to assess the impact of in-situ sediment contaminants in the Great Lakes harbours and waterways.

RÉSUMÉ ADMINISTRATIF

Le présent rapport constitue la première étape de la révision des lignes directrices du ministère de l'Environnement de l'Ontario sur l'élimination des sédiments dragués dans les ports et les voies maritimes des Grands Lacs. Les travaux ont été réalisés au cours de 1984-1985 dans le cadre du projet ECD-236.

On a effectué une recherche de documents pour recueillir tous les renseignements possibles sur les concentrations récentes et historiques des paramètres énumérés dans les lignes directrices actuelles du MEO. Les grandes différences observées dans la concentration de contaminants présents dans les sédiments des Grands Lacs peuvent indiquer que des méthodes d'analyse et des techniques d'échantillonnage de sédiments différentes ont été utilisées. Par conséquent, on a recommandé de concevoir et de tester un protocole d'échantillonnage de sédiments uniforme et de mettre au point des techniques d'analyse normalisées permettant de déterminer la concentration de contaminants présents dans les matières draguées, y compris des critères statistiques comme l'échantillonnage aléatoire stratifié et répété. On a recommandé d'inclure plus de paramètres, surtout des contaminants organiques, dans les lignes directrices révisées du MEO. Une méthode servant à sélectionner des paramètres en fait partie. Enfin, un protocole d'évaluation biologique a été proposé pour évaluer l'incidence des matières draguées sur la tranche d'eau, l'interface entre les sédiments et l'eau et les composantes sédimentaires de l'écosystème.

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ABSTRACT

A review and summary of available data on concentrations of contaminants in Great Lakes sediment was undertaken by the Federal Department of Environment (DOE) and Ontario Ministry of the Environment (MOE) as part of a review of MOE dredged material guidelines. The major findings of the data review were:

- (a) higher concentrations of contaminants than given in the MOE guidelines were found in some background samples, drainage basin soil, bluff material, or bedrock for most parameters in most locations, and
- (b) sampling and analytical techniques were too varied to allow quantitative comparison of many data.

These findings suggest that revision of the MOE guidelines will require directed bioassessment research (i.e. toxicity, uptake and accumulation), and that continued case-by-case application of the existing guidelines will be required while this is in progress. Future development of guidelines for additional parameters, including trace organics, will be required as will standardized techniques for sediment sampling, chemical analysis and bioassessment.

RÉSUMÉ

Environnement Canada et le ministère de l'Environnement de l'Ontario ont commencé à revoir et à résumer les données dont ils disposent sur les concentrations de contaminants présents dans les Grands Lacs dans le cadre d'une révision des lignes directrices sur les matières draguées du MEO. Voici les principaux points découlant de la révision des données :

- a) Des concentrations de contaminants plus fortes que celles prescrites dans les lignes directrices du MEO ont été trouvées dans certains échantillons de base, soit le sol des bassins de drainage, les déblais des falaises ou les murs imperméables, et ce, pour la plupart des paramètres, dans pratiquement tous les sites;
- b) les techniques d'échantillonnage et d'analyse étaient trop variées pour qu'on puisse faire une comparaison quantitative des données.

D'après ces résultats, la révision des lignes directrices du MEO semble justifier des recherches dirigées aux fins de l'évaluation biologique (par exemple, toxicité, absorption et accumulation). Il faudra continuer d'appliquer ces lignes directrices pour obtenir des paramètres additionnels, y compris des éléments à l'état de trace, et des techniques normalisées aux fins de l'échantillonnage des sédiments, de l'analyse chimique et de l'évaluation biologique.

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INTRODUCTION

In the early 1970's the Ontario Water Resources Commission (OWRC) drafted guidelines for the review of proposed dredging and dredged material disposal in the Great Lakes. The concentrations of parameters selected by the OWRC to evaluate dredging projects were modified from the US EPA criteria to reflect Ontario's experience with sediment data from the harbours on the Canadian side of the Great Lakes. The factors considered in the evaluation of dredged material were formalized with the publication of the Ministry of the Environment (MOE) document "Evaluating Construction Activities Impacting on Water Resources (Construction Handbook)" published June 1976. The concentration of parameters selected by MOE are used presently as guidelines to indicate whether sediments are contaminated.

In the absence of federal guidelines for the evaluation of dredged material disposal activities, Environment Canada utilizes the MOE guidelines as a means of evaluating the acceptability of sediment for open-water disposal. In addition, since provincial guidelines and regulations are used to prevent water quality and degradation in the nearshore areas of the Great Lakes, the federal government endeavours to meet the intent of provincial regulations. Subsequent to the publication of MOE guidelines, new information on lakewide background and surficial sediment quality has been obtained. In view of this

new information and the need for bioassessment tests to complement the bulk chemical guidelines, MOE and Environmental Protection Service (EPS), Ontario Region, undertook a complete reevaluation of the 1970 guidelines. This report is a part of the first step toward guidelines revision and provides a comprehensive overview of the existing MOE guidelines in light of background and surficial concentration of contaminants in sediments including harbours, river mouths, bluffs and embayments. Available information and data gaps for the different areas are summarized. Suggestions for including additional parameters and changes to existing parameters in the MOE guidelines are included.

GUIDELINES REVISION PROCESS

A joint committee was formed by the Department of Environment (DOE)/Ministry of the Environment (MOE) in 1984 to review the MOE guidelines. The objectives of this committee are to review and update the bulk chemical guidelines used to identify the total concentrations of metals, nutrients and organic contaminants present in freshwater sediment and as outlined in the MOE guidelines for open water disposal. These updated guidelines will form the basis for evaluating dredged material disposal in Ontario.

The outline of the proposed review process is summarized in Table 1.

ACTIVITIES AND FINDINGS OF THE 1984/85 REVIEW

Review Activities

A literature search was carried out to obtain all available information on concentrations of parameters listed in the current MOE guidelines. All pertinent available information was reviewed and compiled (Table 2). Concentrations of individual parameters found in the last decade within the sediment of Lakes Ontario, Erie, St. Clair, Huron, Michigan and Superior are summarized.

In organizing the information summarized in Table 2, consideration was given to sediment sampling methods and analytical procedures used for the quantitative determination of each parameter and the year in which the data were published. This information is presented in Appendix I.

Concentrations of individual parameters in Table 2 are given for depositional basins, areas where no deposition of fine grained sediment exists (such as nearshore zones), embayments, harbours, tributary mouths, and (where available) for shoreline bluffs and drainage basin soils. Concentrations in surface sediment relate to the topmost 5 cm layer. Background concentrations represent, in most cases, those in the pre-colonial sediment determined by the Ambrosia pollen horizon or dating by radionuclides. In some cases, the background is the concentration of a contaminant reached at a certain

sediment depth without any significant changes towards the bottom of the sediment core. In addition, the particle size distribution of the surface and background sediment in depositional basins is similar. However, lack of information of differences in particle size distribution between surface and background sediment existed in other lake areas. Additional information on the concentration of the various parameters in rocks and soils are given in Table 3.

Concentrations of metals in the Great Lakes sediments (Table 2) and, where relevant, in rocks and soils (Table 3) are compared with the MOE guidelines.

Findings

Arsenic

Little information is available on the concentration of arsenic in the Great Lakes sediments. However, available data show that the concentration of As in the surface sediment in depositional basins of Lakes Ontario, Erie, Huron and Michigan exceed the MOE guidelines. It should be noted that the maximum value of concentration of As in sedimentary rocks (Table 3) is higher than the MOE guidelines while the minimum values in sedimentary rocks and values in igneous rocks and soils are below the guidelines.

Cadmium

The concentration of Cd in Lakes Ontario and Erie bluffs and soils of Lake Erie drainage basin exceeded the present MOE guidelines ($1 \mu\text{g.g}^{-1}$ Cd). The same applies to the background concentrations of Cd in depositional basins of Lakes Ontario, Erie and Huron (Table 2).

Chromium

With the exception of Lake Erie, the background concentration of Cr in sediments of the Great Lakes exceeded the MOE guidelines ($25 \mu\text{g.g}^{-1}$). However, no data were available for bluffs and soils in the Great Lakes drainage basin. Values available in the literature show a wide range of Cr concentrations in sedimentary rocks ($11 - 90 \mu\text{g.g}^{-1}$) and a greater concentration in soils ($43 \mu\text{g.g}^{-1}$) than the MOE guidelines (Table 3).

Copper

The range of background concentration of Cu exceeded the MOE guidelines ($25 \mu\text{g.g}^{-1}$) in all Great Lakes except Lake Michigan (Table 2). No data were available for bluffs and soils of the Great Lakes drainage basin. The upper concentration of Cu in the range for igneous and sedimentary rocks given in the literature is higher than

the MOE guidelines. However, the concentration in soils is lower than the guidelines (Table 3).

Iron

The concentration of Fe in bluffs, soils, pre-colonial sediment of the Great Lakes (Table 2) and in rocks and soils (Table 3) is greater than the MOE guidelines (1%).

Lead

The concentration of Pb in Lake Erie bluffs was similar to that in the guidelines ($50 \mu\text{g.g}^{-1}$) and the background concentration in all Great Lakes except Lake Superior were lower than the guidelines. The values given in the literature for rocks and soils were also lower.

Nickel

The background concentration of Ni in all Great Lakes sediments exceeded the MOE guidelines ($25 \mu\text{g.g}^{-1}$). No data were available for bluffs and soils of the Great Lakes drainage basin. Upper values of the concentration range of Ni in sedimentary and igneous rocks exceeded the guidelines (Table 3).

Loss on Ignition

Loss on ignition calculated from organic C content in Lake Erie drainage basin soils exceeded the guidelines. In addition, the background concentration of organic matter in the Great Lakes sediments exceeded the guidelines in many cases.

Nitrogen

With the exception of Lake Erie, background concentrations of N exceeded the MOE guidelines (0.2%) in the Great Lakes sediments, soils and bluffs (Table 2).

Mercury

All background concentrations of Hg in the Great Lakes sediments, bluffs and soils were lower than the MOE guidelines ($0.3 \mu\text{g.g}^{-1}$).

Zinc

The background concentration of Zn in Lakes Ontario, Erie and Lake Superior exceeded in many cases the MOE guidelines ($100 \mu\text{g.g}^{-1}$). The upper limit of the concentration range for Zn found

in the literature for igneous and sedimentary rocks is very close to the guidelines (Table 3). However, the concentration of Zn in Lake Ontario and Erie bluffs and soils was lower than the guidelines (Table 2).

PCB's

No background values are available for PCB because this contaminant did not exist prior to the settlement in the Great Lakes drainage basin. Consequently, the background concentration cannot be utilized for the objectives for PCB values in the guidelines. Also, no background values are available for oils and greases.

SUMMARY OF EXISTING GUIDELINE PARAMETERS

We would like to point out that the concentration of contaminants in the bedrock, soils and pre-colonial sediments in excess of the MOE guidelines is not, by itself, sufficient to establish improved guidelines. The evaluation of contaminants availability, uptake and toxicity by chemical speciation and bioassessment will provide the most important basis for improved sediment quality guidelines. However, the literature search indicated significant differences in surficial and background concentration of contaminants in sediment, in particular, metals between the upper and

lower Great Lakes. Consequently, the revision of the guidelines should include the comparison of bioavailability of metals in sediments in harbours along the North Channel and Lake Superior. In addition, a survey of benthic organisms may provide useful information on the effect of metals on benthic communities in these harbours.

Significant differences in metal concentrations reported in the Great Lakes sediments may reflect the different analytical procedures and sediment sampling techniques used. The variability of results, sampling methods and analytical techniques found during the literature search suggests that the benefits of further data compilation may be limited to reinforcing the need for improved survey design and the "Quality Assurance/Quality Control" in future studies. Consequently, the results of the literature search indicate the need for a development of a standard sediment sampling protocol and standard analytical procedures for determination of the concentration of contaminants in dredged material, both with statistical criteria such as stratified random sampling with replicates.

Frequently, the information on concentration of metals, nutrients or organic contaminants in lakes sediments is based on analyses of one or a few samples. Consequently, it is important to know how representative one sediment sample is for an area in the Great Lakes.

An investigation was carried out on the heterogeneity of the sediment in the depositional zone of the Western Basin of Lake

Ontario. Chemical characteristics of surface sediment and sediment cores, as measured by the concentration of ten major and six trace elements, were used to assess and model spatial and temporal variability. Sediment sampling localitions and an example of the results are shown in Table 4.

This example indicates that the 0-3 cm surface sediment is fairly homogeneous over the sampling area in the depositional zone of the Western Basin of Lake Ontario. However, concentration profiles of Pb given as an example in Table 4 show that the background concentrations occur at different sediment depths and that the sedimentation rate varies significantly within the Western Basin of Lake Ontario. In addition to the sediment heterogeneity, the effects of sediment sampling techniques on the concentration of contaminants were investigated. Sediment was sampled at few stations in the Western Basin of Lake Ontario using a Shipek grab sampler and a box corer. Surface 0-3 cm of sediment were collected from each sampler and analyzed for major and trace elements. The results indicated a loss of fine grained surface sediment from the Shipek grab (Table 5).

The results obtained by the investigation of the sediment heterogeneity and sampling methods should be considered in the proposal of a sediment sampling protocol and evaluation of the information on concentrations of contaminants reported in the literature.

Additional Parameters

A review was carried out on parameters which are presently included in the MOE guidelines and those which should be considered as candidate substances in the future.

The first step was to develop a comprehensive list of candidate substances. To do this, a master list of 99 organic and inorganic compounds was compiled using:

- Substances with a mean water score of 15 or greater that appear in the MOE report "Hazardous Contaminants Program, Chemical Identification", October, 1982.
- Those compounds that are analyzed for in the MOE sediment PCB Organic Contaminant Scan.
- Substances from the U.S. Environmental Protection Agency's 129 Priority Pollutants List were chosen by only including those compounds whose sorption potential is known to exist or is uncertain. Those compounds that are known not to sorb to sediments were excluded from the candidate list.

Chemical evaluations of the candidate substances consisted of literature searches on each compound's sorption potential, persistence in sediments, bioaccumulation in aquatic biota (algae, benthic organisms and fish), aquatic toxicity (both acute and chronic) and genotoxicity to humans. Each of these data parameters was assigned a score to rank their relative importance (degree of

environmental concern) based on the literature findings. After all the literature sources were exhausted, the scores were totalled and the substances were prioritized accordingly to their overall scores (see Appendix II).

MOE's analytical capability is included as an important consideration in selecting compounds for guideline establishment. The solubility and vapour pressure of each chemical substance was used to estimate the sorption potential of a substance if this information was non-existent in the literature.

A summary of the evaluation of individual parameters is presented in Table 6. The method used for the categorization of the contaminants and results of the scoring are in Appendix II.

Cadmium and PCB had the highest score from the parameters included in the present MOE guidelines, followed by lead, mercury, zinc and chromium. Copper and nickel had significantly lower score.

Phosphorus should be included in a final list of compounds for guideline establishment because of its indirect effects on the aquatic environment as a nutrient.

However, the priority list included organic contaminants recently found in Lake Ontario sediments. From these hexachlorobenzene, 2,3,7,8-TCDD and Mirex had the highest score and should be considered as additional parameters in the guidelines. The following recommendations were made for updating the list of parameters included in the present guidelines.

A broader more in-depth literature review using computer search strategies is needed to fill the numerous information gaps.

Primary literature sources should be reviewed to improve the confidence in the data needed for the selection of chemical compounds for dredging guideline establishment.

To orient the scoring process towards those compounds that are of concern in Ontario, information in the following areas should be included in the scoring approach:

- Amounts produced in Ontario
- Amounts imported into Ontario
- Uses in Ontario
- Rates and amounts discharged into Ontario waters
- Ambient concentrations in sediments aquatic biota and water.

However, use of "amount of a compound used-produced in Ontario" as a scoring factor when considering additional parameters for new guideline development, should not be overemphasized at the expense of a bioassessment. Although infrequently used, compounds are not likely to be of widespread concern, the relative lack of use does not lessen the potential for impact in those areas where they are found.

Quality Assurance

Analytical procedures used for quantitative determination of contaminants in the Great Lakes sediment may significantly influence

concentrations reported in the literature. An example of concentration of metals determined in one sediment sample by ten different laboratories is shown in Table 7. Such variations have to be considered and included in the revised guidelines for open water disposal of dredged material.

Proposed "Bioassessment Protocol"

A proposed bioassessment protocol is shown in Table 8. By using this protocol, the effects of contaminants from dredged material on the water column, sediment-water interface and sediment components of the lake ecosystem can be assessed individually or in a combination, and the biological responses can be directly observed. The approach is site specific, adaptable and based on established protocols which most biological laboratories can perform. Acute lethality data for protecting water quality and organisms passing through disposal areas and minimizing biological disturbances (such as fish kills) are readily available on a short-term basis. The proposed bioassessment protocol recommends preliminary information on sediment contamination, physico-chemical properties and extractability of contaminants by lake water and different chemicals (Table 8).

In addition to the proposed protocol, a compilation of the available information on the bioavailability, bioaccumulation and toxicity of existing and proposed guideline parameters in sediments

should be conducted. This compilation should be similar to that of the International Joint Commission for the Water Quality Objectives and should include any information on the relationship between metal species in sediment and effects/bioaccumulation on aquatic biota. Gaps in the knowledge in this field should be pointed out.

TABLE I Outline of the Reviewing Process of the MOE Guidelines for Dredged Material Disposal

WORK OUTLINE	1984/85	1985/86
1.	Compile all available data on concentration of contaminants in the Great Lakes sediment:	1. Testing of bioassays reviewed in 1984/85.
	a) in surface sediment	2. Review and testing of chemical speciation and relationship to the bioavailability.
	b) in pre-colonial sediment (i.e. background concentration)	
	c) concentrations at different areas in the Great Lakes (for example depositional areas, inshore zones, embayments, harbours)	3. Review and evaluation of sediment elutriation testing methods.
	d) sediment sampling methodology	
	e) analytical methods	
	f) effect of sediment heterogeneity	
2.	Identification and review of parameters which are presently included in the MOE guidelines and of additional contaminants found in the Great Lakes system.	
3.	Carry out a literature review on sediment bioassessment.	
4.	Assessment of quality assurance for determination of sediment contaminants and implications for guidelines development.	
<u>Contents of the Final Report (1986)</u>		
Review of individual parameters (for example Rg):		
- concentration in different type of sediment		
- chemical speciation in sediment		
- release during elutriation or leaching of sediment		
- toxic levels to aquatic biota (plankton, benthos, fish)		
<u>Methods of implementation of revised guidelines.</u>		
Identification of gaps in the present knowledge of sediment toxicity.		

TABLE 2. Summary of Reported Concentrations of Parameters Included in the NOD Guidelines in the Great Lakes Sediments, Bluffs and Soils

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
Depositional Basins:						
- surface	0.2-17.0	0.45-12.3	2.5-3.4*	14.7-54.0	5-15	-
- background	-	0.16- 1.0	-	-	5-8	-
Nondepositional Zones:						
- surface	0.2-26.0	-	-	-	-	-
- background	-	-	-	-	-	-
Embayments:						
- surface	-	-	-	-	0.2-42	-
- background	-	-	-	-	8-15	-
Harbours:						
- surface	-	6.0-8.0	-	-	-	-
- background	-	0.5-1.2	-	-	-	-
River Mouth:						
- surface	-	-	-	-	-	-
Bluffs:						
Soils:						

* Whole lake 0-2 cm surface.

TABLE 2. Summary of Reported Concentrations of Parameters Included in the ISON Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

**Parameter: Cadmium
Concentration in $\mu\text{g.g}^{-1}$ dry weight**

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
Depositional Basins:						
- surface	0.1-6.2	0.8-13.7	1.0-3.0	<.3-4.3	.05-1.8	1.4-2.5
- background	0.9-3.7	0.1-1.7	-	.2-1.8	0.5 -0.7	0.4-0.7
Nondepositional Zones:						
- surface	<0.20-20.6	0.1-8.3	-	-	-	-
- background	-	0.1-1.3	-	-	-	-
Embayments:						
- surface	<.30-22.0	-	-	<.3-4.6	0.07-1.93	-
- background	-	-	-	.6-1.5	0.5 -1.3	-
Harbours:						
- surface	<0.5-10.0	0.1	<.5-1.0	-	-	-
- background	1.1(mean)	-	-	-	-	-
River Mouth:						
- surface	1.2-18.3	.6-7.8	.9-5.5	.1-2.0	0.1-16.6	.1-1.3
Bluffs:						
-	0.2-3.2	.7-2.8	-	-	-	-
Soils:						
-	1.4-2.3	-	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the NOR Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

Parameter: Chromium Concentration in $\mu\text{g.g}^{-1}$ dry weight

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
Depositional Basins:			(whole lake)			
- surface	8.0-133	12-362	1.0-275	5.5-86.4	140	29.5-60.2
- background	63-86	9-25	-	30.0-47.1	50	26.1-73.1
Nondepositional Zones:						
- surface	3.7-500	-	-	-	-	37.6-45.6
- background	45-100	-	-	-	-	49.8-51.8
Embayments:						
- surface	4-665	-	-	5-81	2-72	13.7-87.3
- background	-	-	-	28.5-43.7	-	-
Harbours:						
- surface	<0.3-390	13-150	12.0-155	-	-	-
- background	4(mean, SD-45)	30-250	-	-	-	-
River Mouth:						
- surface	5-143	4.5-124.5	6.0-77.9	0.1-30.0	0.5-1,295	.9-22.8
Bluffs:						-
Soils:						-

**TABLE 2. Summary of Reported Concentrations of Parameters Included in the NOS Guidelines in the Great Lakes
Sediments, Bluffs and Soils cont'd.**

Parameter: Copper Concentration in $\mu\text{g.g}^{-1}$ dry weight						
Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
(whole lake) (0-20 cm)						
Depositional Basins:						
- surface	26-109	5-207	2.0-48.0	3.3-78	54	113-173
- background	35-56	20-48	-	31-48	15	30-84
Nonpositional Zones:						
- surface	2.1-200	3-138	-	-	-	162-213
- background	60-100	-	-	-	-	57-69
Embayments:						
- surface	3-265	-	-	2-95	0.8-54	
- background	-	-	-	25-51	-	12-300
Harbours:						
- surface	1.0-860	2-100	1.0-54.0	-	-	-
- background	-	10-110	-	-	-	-
River Mouth:						
- surface	6.8-83	1.5-69.8	4.5-80.6	1.9-61.2	0.5-84	.6-262.8
Bluffs:	-	-	-	-	-	-
Soils:	-	-	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the MNR Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
Depositional Basins:						
- surface	2.41-9.62	1.1-7.79	-	.47-5.11	-	4.91-5.76
- background	1.92-5.25	.89-4.82	-	1.15-5.02	-	3.18-5.88
Nondepositional Zones:						
- surface	.29-8.31	1.34-13.72	-	-	-	5.52-6.23
- background	-	-	-	-	-	5.37-5.94
Embayments:						
- surface	-	-	-	.53-6.7	0.4-2.55	5.10(SD:58%)
- background	-	-	-	4.07-5.20	-	-
Harbours:						
- surface	.39-13.7	1.01-6.10	-	-	-	-
- background	2.0(mean; SD=0.8%)	.1-1.5	-	-	-	-
River Mouth:						
- surface	.35-4.06	-	-	-	-	.6-262.8
Bluffs:						
-	1.29-3.52	1.71-3.09	-	-	-	-
Soils:						
-	-	2.71-3.36	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the NWG Guidelines in the Great Lakes
Sediments, Bluffs and Soils cont'd.

Parameter: Lead

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
(whole lake) (0-2 cm)						
Depositional Basins:						
- surface	7.0-285	6-299	-	14.4-151.4	10-130	74.9-138.2
- background	18-32	21-49	-	14.4-36	8-10	20.5-68.0
Nondepositional Zones:						
- surface	1.8-287	9-221	-	-	-	68.7-143.9
- background	25	-	-	-	-	18.4-24.6
Embankments:						
- surface	6-520	-	-	<.3-2.30	1.3-56.2	10.5-39.7
- background	-	-	-	83.9-93.0	8-29	-
Harbours:						
- surface	<1.0-1,600	<1-192	<1.0-52.0	-	-	-
- background	28(mean;SD=34)	-	-	-	-	-
River Mouth:						
- surface	7.3-168.6	-	12.1-151.1	3.5-258.7	1.3-149.0	1.2-61.8
Bluffs:	12-35	33-47	-	-	-	-
Soils:	-	33-40	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the FNR Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

		Parameter: Mercury Concentration in $\mu\text{g.g}^{-1}$ dry weight					
Lake:		Ontario	Erie	St. Clair	Huron	Michigan	Superior
		(whole lake) (0-2 cm)					(whole lake)
Depositional Basins:		.140-.3.95	.045-4.8	.30-10.28	<.01-.805	0.030-0.380	.004-.584
- surface		.03-.09	.01-.19	-	.035-.080	8-10	.094-.160
- background							
Nondepositional Zones:							
- surface	<.01-7.76	.080-1.881	-	-	-	-	.172-.856
- background	0.40-0.70	-	-	-	-	-	.080-.084
Embayments:							
- surface	<0.01-1.20	.33-1.44	2.1-2.3	<.01-9.50	-	-	.030-.420
- background	-	-	-	.030-.323	-	-	-
Harbours:							
- surface	<0.01-7.00	.015-2.2	.020-.320	-	-	-	-
- background	-	.05-7.00	-	-	-	-	-
River Mouth:							
- surface	.01-3.90	.06-.86	.07-2.77	<.01-.36	<0.01-1.20	<.010-1.050	
Bluffs:	-	.04-.05	-	-	-	-	-
Soils:	-	.08-.09	-	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the NOR Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
(whole lake)						
(0-2 cm)						
Depositional Basins:						
- surface	29.0-99.0	16-150		5.3-96.7	25	28.9-66.4
- background	42-48	10-76		5.0-43.0		24.4-69.8
				-	29.9-50.9	
Nondepositional Zones:						
- surface	4.0-160	9-69		-		
- background	.30-100	-		-		
					-	
Embayments:						
- surface	-	-		-	15-132.2	1.7-54.2
- background	-	-		-	49.6-61.1	-
						5.7-70
Harbours:						
- surface	<1.0-75.0	2-90	2.0-35.0	-	-	
- background	14 (mean; SD=7)	55-65	-	-	-	
River Mouth:						
- surface	8.7-140	4.5-37.2	8.7-49.2	1.8-184.8	1.6-74.8	1.1-33.4
Bluffs:	-	-	-	-	-	-
Soils:	-	-	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the NAW Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

**TABLE 2. Summary of Reported Concentrations of Parameters Included in the NDR Guidelines in the Great Lakes
Sediments, Bluffs and Soils cont'd.**

Parameter: Oil & Grease
Concentration in % dry weight

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
Depositional Basins:						
- surface	$\leq 118-126$	$\leq 164-1,195$	$\leq 60-172$	-	-	-
- background	-	-	-	-	-	-
Nondepositional Zones:						
- surface	≤ 71	≤ 310	-	-	-	-
- background	-	-	-	-	-	-
Embayments:						
- surface	-	-	-	-	-	-
- background	-	-	-	-	-	-
Harbours:						
- surface	$<60-11,777$	$<60-11,250$	$<60.0-491.0$	$<60.0-491.0$	-	-
- background	-	-	-	-	-	-
River Mouth:						
- surface	-	-	-	-	-	-
Bluffs:						
Soils:	-	-	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the MDE Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.
Parameter: Organic Carbon (Loss on Ignition)
Concentration in % dry weight

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
LOI						
Depositional Basins:	(0.1-6.7%)					
- surface	0.89-7.06	.50-5.24	.01-3.03	.006-5.8	2.17-2.5	.40-3.94
- background	1.59-2.80	1.01-1.61	-	3.13-4.17	0.67-2.63	2.24-2.40
Nondepositional Zones:						
- surface	0.01-6.0	.01-3.65	.20-.95	.001-3.81	-	.40-3.85
- background	2-4	-	-	-	-	2.29-2.73
LOI						
Embankments:	(0.3-8.2%)					
- surface	<0.01-0.31	-	-	0.0-5.7	0.16-4.13	1.08-31.2
- background	-	-	-	2.11-3.42	-	-
LOI						
Harbours:	(0.45-14.0%)					
- surface	0.19-12.86	.35-6.77	.10-4.61	-	-	-
- background	-	-	-	-	-	-
River Mouth:						
- surface	.09-4.25	-	-	-	-	-
Bluffs:	.07-1.0	.46-2.18	-	-	-	-
Soils:	-	2.48-3.80	-	-	-	-

**TABLE 2. Summary of Reported Concentrations of Parameters Included in the NCR Guidelines in the Great Lakes
Sediments, Bluffs and Soils cont'd.**

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
Parameter: PCB Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight						
Depositional Basins:				(whole lake) (0-2 cm)		(whole lake) .0025-.0570
- surface	<.005-.280	.004-.660	.001-.040	0.003-0.090	0.002-0.0735	.004-.390
- background	-	-	-	<0.005	-	-
Nondepositional Zones:						
- surface	.001-3.60	.008-.800	-	0.003-0.043	0.063 (mean)	(trace)
- background	.078	-	-	-	-	-
(Long Point Bay (Inner))						
Embayments:	1,330	0-0.240	-	0.003-1.200	0.0016-0.0067	-
- surface	-	-	-	<0.005	-	-
- background	-	-	-	-	-	-
Harbours:						
- surface	<0.001-4.450	<.010-.880	<.010-.060	-	-	-
- background	-	-	-	-	-	-
River Mouth:						
- surface	-	-	-	-	-	-
Bluffs:	-	.46-2.18	-	-	-	-
Soils:	-	2.48-3.80	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the NOX Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
(whole lake) (188-2,863)						
Depositional Basins:						
- surface	857-8,800	650-2,550	-	190-2,500	-	900-1,000
- background	700-2,800	550-1,300	-	700-900	-	600-1,000
Nonpositional Zones:						
- surface	280-3,800	100-3,450	-	-	-	1,000-2,000
- background	567-1,010	-	-	-	-	700-1,200
Embayments:						
- surface	410-3700	-	-	210-8,600	-	1,100
- background	-	-	-	900-1,600	-	-
Harbours:						
- surface	300-5,900	590-2,415	-	-	-	-
- background	800 (mean; SD=300)	-	-	-	-	-
River Mouth:						
- surface	-	-	-	-	-	-
Bluffs:	300-900	600-900	-	-	-	-
Soils:	-	400-900	-	-	-	-

TABLE 2. Summary of Reported Concentrations of Parameters Included in the NOK Guidelines in the Great Lakes Sediments, Bluffs and Soils cont'd.

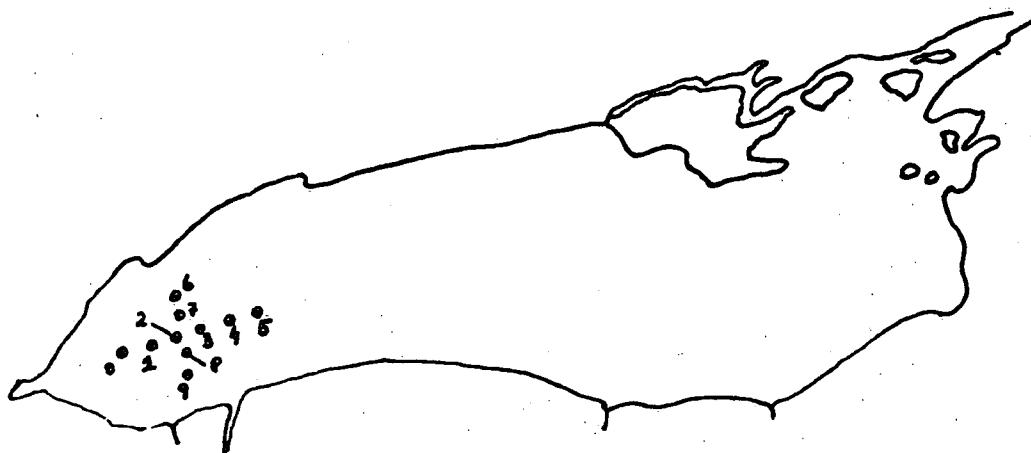
Lake:	Ontario	Erie	St. Clair	Huron	Michigan	Superior
(whole lake) (0-2 cm)						
Depositional Basins:						
- surface	87-3,507	18-536	8.0-107.0	8.2-233	40-350	143-105
- background	83-163	8-128	-	60-88	40-50	53-137
Nondepositional Zones:						
- surface	6-1,120	16-351	-	-	-	165-202
- background	100	-	-	-	-	105-117
Embayments:						
- surface	14-1,225	-	-	-	6-230	2.4-160
- background	-	-	-	-	78-116	50-80
Harbours:						
- surface	5-2,010 (mean)	12-650	9.0-132.0	-	-	-
- background	210 (mean)	40-50	-	-	-	-
River Mouth:						
- surface	24.5-500	15.7-220.8	31.2-330.3	5.7 257.2	3.5-398.0	3.0-85.5
Bluffs:	16-65	39-76	-	-	-	-
Soils:	-	59-89	-	-	-	-

TABLE 3. Concentration of Metals in Rocks and Soils¹

Parameter	Igneous Rocks ($\mu\text{g.g}^{-1}$)	Concentration in	
		Sedimentary Rocks ($\mu\text{g.g}^{-1}$)	Soils ($\mu\text{g.g}^{-1}$)
Arsenic	1.0-2.1	1.1-12	7.5 (median)
Cadmium	0.1-0.2	<0.01-0.3	0.1-0.5
Chromium	4.1-2,980	11-90	43 (median)
Cobalt	1-110	0.1-19	10 (median)
Copper	12-72	5-42	15 (median)
Iron	14,200-94,300	3,800-47,000	21,000 (median)
Lead	1-18	5-25	17 (median)
Mercury	0.004-0.04	0.02-0.40	0.056 (median)
Nickel	4.5-2,000	2-68	17 (median)
Vanadium	40-250	20-130	57 (median)
Zinc	51-94	21-100	36 (median)

¹Source: Rose, A.W., Hawkes, H.E., and Webb, J.S. 1981. Geochemistry in mineral exploration. Academic Press Inc., Ltd. (London), p. 657.

TABLE 4. Sediment Heterogeneity in the Western Basin of Lake Ontario



Sampling stations: box corer, 0 - 3 cm sediment subsample and a hand core at four stations (each core subsampled into 1 cm sections).

(At station no. 7, one box core was subsampled into nine surface sediment samples to investigate the heterogeneity over the core area).

Parameters Determined:

Si, Al, Ca, Mg, K, Na, Ti, Fe, Mn, P, Zn, Cu, Cr, Co, Ni, V, Pb

Method:

X-ray fluorescence spectrometry

<u>Example:</u>	<u>Concentration of Pb</u>	<u>Concentration in One Box Core at Station No. 7</u>	<u>Tested Precision of the Method</u>
Station 1	144 $\mu\text{g.g}^{-1}$	Section 1 131 $\mu\text{g.g}^{-1}$	Run 1 351 $\mu\text{g.g}^{-1}$
Station 2	137 $\mu\text{g.g}^{-1}$	Section 2 127 $\mu\text{g.g}^{-1}$	Run 2 369 $\mu\text{g.g}^{-1}$
Station 3	134 $\mu\text{g.g}^{-1}$	Section 3 125 $\mu\text{g.g}^{-1}$	Run 3 356 $\mu\text{g.g}^{-1}$
Station 4	121 $\mu\text{g.g}^{-1}$	Section 4 129 $\mu\text{g.g}^{-1}$	Run 4 348 $\mu\text{g.g}^{-1}$
Station 5	120 $\mu\text{g.g}^{-1}$	Section 5 131 $\mu\text{g.g}^{-1}$	
Station 6	144 $\mu\text{g.g}^{-1}$	Section 6 132 $\mu\text{g.g}^{-1}$	
Station 7	133 $\mu\text{g.g}^{-1}$	Section 7 131 $\mu\text{g.g}^{-1}$	
Station 8	133 $\mu\text{g.g}^{-1}$	Section 8 133 $\mu\text{g.g}^{-1}$	
Station 9	134 $\mu\text{g.g}^{-1}$	Section 9 130 $\mu\text{g.g}^{-1}$	
Mean:	134	Mean: 130	Mean: 356
SD:	9	SD: 3	SD: 8

**TABLE 4. Sediment Heterogeneity in the Western Basin of Lake Ontario
Concentration Profiles of Pb from Stations 2, 4, 6 and 8
cont'd.**

Depth cm	Station 2	Station 4	Station 6	Station 8
0-1	135	117	150	124
1-2	160	132	161	154
2-3	241	153	230	250
3-4	222	232	221	158
4-5	135	233	49	127
5-6	102	151	21	96
6-7	72	138	17	54
7-8	46	108	23	48
8-9	48	83	21	39
9-10	27	69	18	17
10-11	26	52	24	21
11-12	24	39	19	21
12-13	23	45	21	18
13-14	19	42	21	19
14-15	24	19	19	19

Concentration in $\mu\text{g.g}^{-1}$ dry weight.

TABLE 5. Comparison of Sampling Techniques

Station *	Parameter								
	Fe ₂ O ₃	MnO	P ₂ O ₅	Ni	Cr	μg·g ⁻¹	V	Zn	Cu
9-Shipek (0 - 3 cm)	4.5	0.79	0.28	79	74	205	47	183	26
9-Box Corer (0 - 3 cm)	5.0	1.25	0.37	129	71	226	52	264	41

* Sediment from the Western Basin of Lake Ontario

TABLE 6. Evaluation of Chemicals after Literature Search

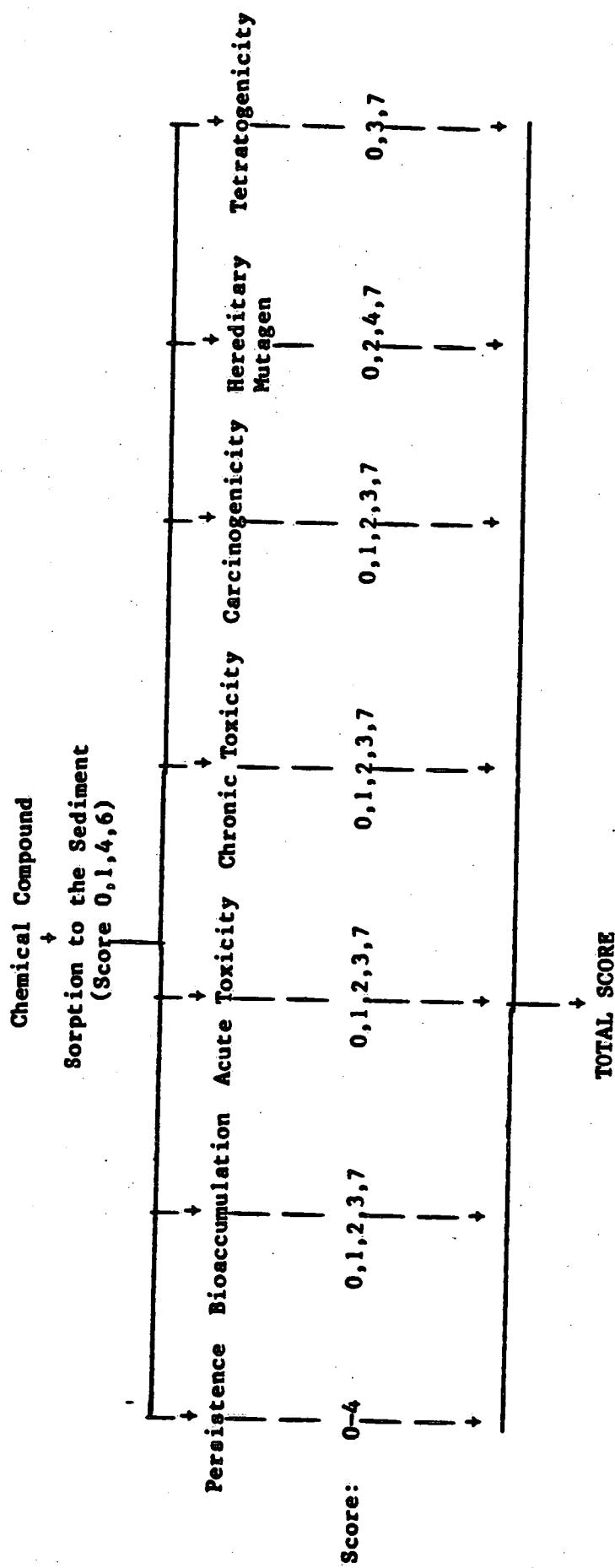
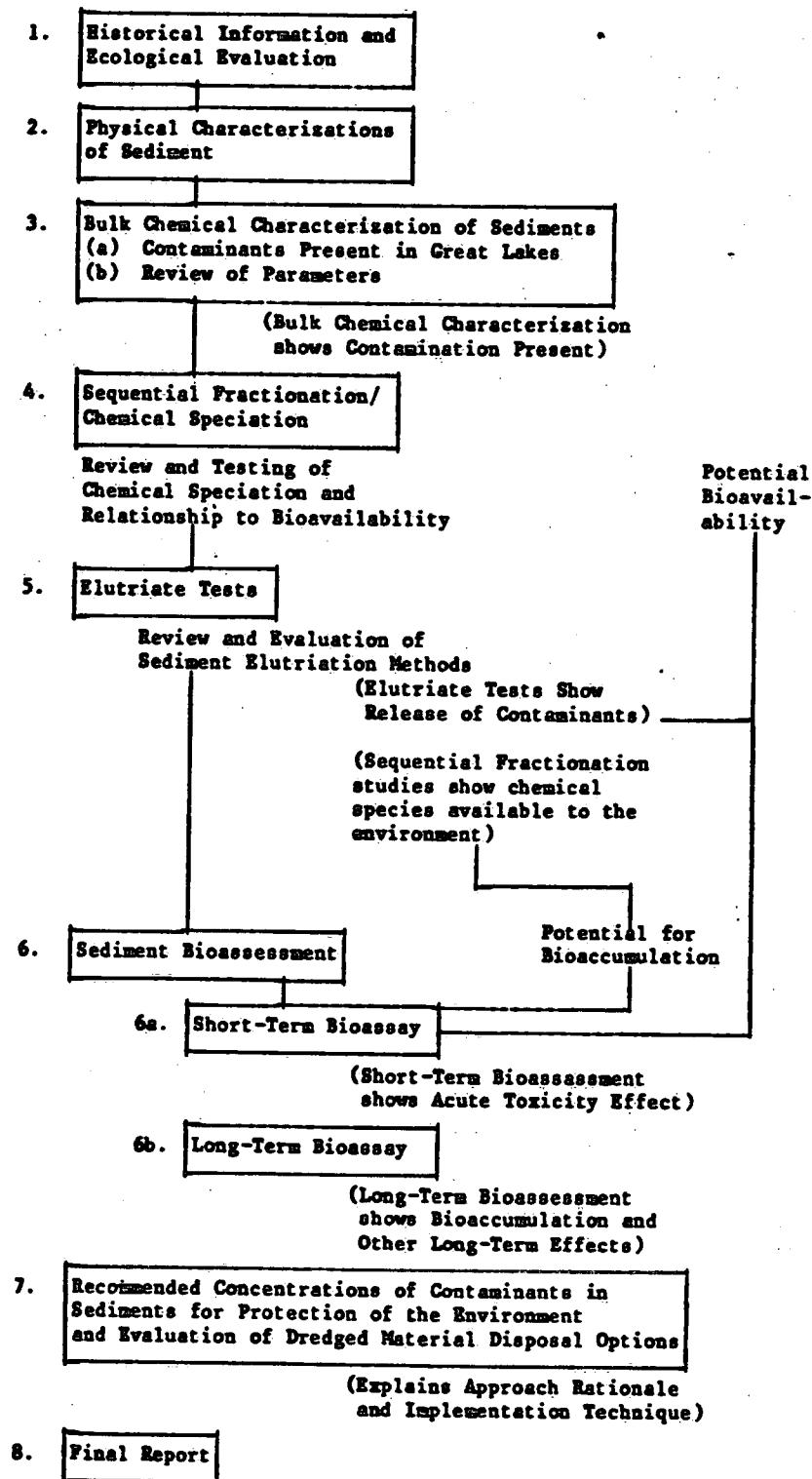


TABLE 7. Variations in Quantitative Determination of Metals in Sediment

Reference Value	Cr	Fe%	Ni	Cu	Zn	As	Se	Cd	Mg	Pb
1	134.0	3.66	44.0	99.0	1412	9.0	1.0	4.0	.34	259
2	96.1	2.25	38.0	97.6	1427	17.1	1.34	4.3	.50	232
3	134.0	3.29	35.0	93.6	1420	13.0	.67	6.6	.45	221
4	130.0	3.60	40.0	101.0	1600	10.0	.40	5.	.51	240
5	72.0	1.87	48.0	110.0	1760	5.7	-	-	.38	182
6	168.0	3.46	52.0	80.0	990	6.0	1.0	2.4	.11	260
7	144.0	3.30	42.0	102.0	1676	-	-	4.2	.40	228
8	120.0	3.77	36.0	100.0	1830	11.0	-	-	-	384
9	132.8	3.60	60.4	102.8	1584	3.88	.56	7.9	.02	241.7
10	137.0	3.72	43.0	104.0	1640	9.6	.82	4.0	.48	240
Median	133.4	3.53	42.0	100.5	1592	9.6	.745	4.1	.40	240

All values are in g/l (dry basis) except for iron (%).

TABLE 8. Proposed Protocol for Bioassessment of Dredged Material



**APPENDICES I AND II TO THE REPORT ON
REVISION OF DREDGING GUIDELINES**

1984/85

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APPENDIX I

**Concentration of parameters included in
the MOE guidelines in the Great Lakes sediments**

Parameter: Cadmium

Lake: Ontario

Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface sediment: 1983: 0-3 cm: 4.5-6.2 Benthos core
- surface sediment: 1980: 0.1 - 4.9 Shipek grab - 0.3 cm subsample
- surface sediment: 1976: 0-1 cm: 3.7-6.2 Benthos core
- surface sediment: 1983: 0-3 cm: 2.9 (mean, SD=1.0) Shipek grab - 0-3 cm subsample
- background: 1984: 9-10 cm: 2.3-3.7 Benthos core
- background: 1976: 15-40 cm: 0.9-2.0 Benthos core

Nearshore zones:

- surface: 1984: <0.20-11.0 Shipek Grab
- surface: 1984: <0.30-2.0 Ehman dredge
- surface: 1976: 1.0-12.6 Ponar Grab
- surface: 1983: 0-3 cm: 0.84-3.37 Shipek Grab - 0-3 cm subsample
- surface: 1980: 0.1-20.6 Shipek Grab - 0-3 cm subsample

Rabeyments:

- Number Bay: 1984
- surface: <0.30-22.0 Shipek grab

River mouths and harbours:

- Niagara River: 1976: surface: 1.3-3.4 NOE
- Genesee River: 1976: surface: 2.0-8.3 NOE - aqua regia
- 15 rivers: 1975: surface: 1.2-2.8 NOE - aqua regia
- Hamilton Harbour: 1978: surface: mean 5.0 (SD=3.8) NOE
- Hamilton Harbour: 1978: background: mean 1.1 (SD=1.9) Same
- Toronto Harbour (inner & island lagoon): 1984:
- surface: 0-5 cm: <3.0-10.0 Core
- Seall Craft Harbours: 1980: surface: <0.5-2.0 Mini-Shipek

Bluffs:

- northern & southern shore: 1976: 0.2-3.2 Not described

Years of references: 1975-1984

Analytical Procedure:

- D.C. Argon Plasma AAS, aqua regia, H₂O₂/HF extraction
- AAS - aqua regia
- AAS - after HCl (20 min. at 90°C)
- AAS - after acid extract
- D.C. Argon Plasma AAS, aqua regia, H₂O₂/HF extraction
- AAS - after HCl (20 min. at 90°C)
- NOE
- NOE - aqua regia
- AAS - after acid digestion
- AAS - after acid digestion
- AAS - aqua regia

SUMMARY:

surface sediment in depositional basins: 0.1-6.2
background sediment in depositional basins: 0.9-3.7
surface sediment in nearshore zones: <0.20-20.6
background sediment in nearshore zones: <0.30-22.0
surface sediment in river mouths: 1.2-18.3
surface sediment in harbours: <0.5-10.0
background sediment in harbours: 1.1 (mean)
bluffs: 0.2-3.2

Parameter:	Chromium	Lake:	Ontario	Concentration in $\mu\text{g g}^{-1}$ dry weight	Sampling Methods:	Analytical Procedure:
Depositional basins:						
- surface: 1983: 0-3 cm: 62 (mean, SD=22)	Shippek grab - 0-3 cm subsample	AAS - acid extraction.				
- surface: 1980: 0-3 cm: 8.0-133.0	Same	Same				
- surface: 1983: 0-3 cm: 103-116	Benthos core	D.C. argon plasma E3 - aqua regia, $\text{H}_2\text{O}_2 + \text{HF}$ extraction				
- background: 1983: 9-10 cm: 63-86	Same	Same				
Recreational zones:						
- surface: 1980: 0-3 cm: 6.0-500.0	Shippek grab - 0-3 cm subsample	AAS - acid extraction				
- surface: 1976: 8-245	Ponar grab	AAS - acid extraction				
- surface: 1983: 0-5 cm: 50-100	Box core & hand core - 0-5 cm subsample	X-ray fluorescence				
- surface: 1983: 0-3 cm: 22.9-90.1	Shippek grab - 0-3 cm subsample					
- surface: 1976: <8 - 68	Ponar grab	AAS - acid extraction				
- surface: 1984: 4.0-70.0	Ekman dredge	AAS - same				
- surface: 1984: 0-3 cm: 4.8-65.0	Core	HDE - aqua regia, AAS				
- surface: 1984: 4.6-230.0	Shippek grab	Same				
- surface: 1984: 0-3 cm: 3.7-78.0	Core	Same				
- background: 1983: 10->25 cm: 45-100	Box core & hand core - subsamples	X-ray fluorescence				
Embayments:						
Rumber Bay: 1984: surface: 4-665	Shippek grab	HDE - aqua regia, AAS				
River mouths and harbours:						
Genesee River mouth: 1976: surface: 5-143	Ponar grab	AAS - acid extraction				
15 river mouths: 1975: surface: 6.5-43.1	Ekman dredge & custom made core	AAS - nitric: perchloric acid (1:1) digestion and evaporation to dryness (350°F)				
Hamilton Harbour: 1978: surface: mean 200 (SD=190)	Phleger core	HDE				
Hamilton Harbour: 1978: background: mean 34 (SD=45)	Same	Same				
Toronto Harbour: (inner & outer): 1984: surface: 4-320	Shippek Grab	HDE - aqua regia, AAS				
Toronto Harbour (inner & island lagoon): 1984:						
- surface: 0-5 cm: <0.3-390.0	Core - 0-5 cm	HDE - aqua regia, AAS				
Toronto Harbour - Keating channel: 1984:						
- surface: 0-10 cm: 8.0-46.5	Core - 0-10 cm subsample	HDE				
Small Craft Harbours: 1980: surface: 7-102	Mini-Shippek	AAS - aqua regia				

Years of references: 1975, 1976, 1978, 1980, 1983, 1984

SUMMARY:

surface sediment in depositional basins: 8.0-133.0
background sediment in depositional basins: 63-86
surface sediment in nearshore zones: 3.7-500
background sediment in nearshore zones: 45-100
surface sediment in embayments: 4-665
surface sediment in river mouths: 5-143
surface sediment in harbours: <0.3-390.0
background sediment in harbours: 34 (mean, SD=45)

Parameter: Copper
Lake: Ontario
Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Analytical Procedure:

Da depositional basins

- | | | | | | |
|---|-------------|-------|-----------|------------------|--------------------------------|
| - | surface: | 1980: | 0-3 cm: | 26-100 | Shipok grab - 0-3 cm subsample |
| - | surface: | 1976: | 0-1 cm: | 79-109 | Benthos core |
| - | surface: | 1983: | 0-3 cm: | 83-92 | Benthos core |
| - | surface: | 1983: | 0-3 cm: | 77 (mean; SD=13) | Shipok grab - 0-3 cm subsample |
| - | background: | 1976: | 15-40 cm: | 35-56 | Benthos core |
| - | background: | 1983: | 9-10 cm: | 43-50 | Same |

Meerhoren zagen:

- | | | | | |
|---------------|-------|------------|-----------|-----------------------------|
| - surface: | 1980: | 0-3 cm: | 3.0-131.0 | AAS - after acid extraction |
| - surface: | 1983: | 0-5 cm: | 100-200 | X-ray fluorescence |
| - surface: | 1983: | 0-3 cm: | 12.1-76.3 | AAS - after acid extraction |
| - surface: | 1976: | <7-24 | | Same |
| - surface: | 1976: | 7-45 | | Same |
| - surface: | 1984: | 0-3 cm: | 2.2-54.0 | Core |
| - surface: | 1984: | 4.8-130.0 | | Shipok Grab |
| - surface: | 1984: | 0-3 cm: | 2.1-91.0 | Core - 0-3 cm subsample |
| - surface: | 1984: | 2.5-66.0 | | Ettman Grab |
| - background: | 1983: | 10->25 cm: | 60-100 | Box corer & hand core |

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- | | Number Bay: 1984: surface: 3-265 | Shipok grab | HOB - aqua regia, AAS |
|--|--------------------------------------|---|-----------------------|
| river mouths and harbours: | | | |
| Genesee River mouth: 1976: surface: <10-83 | Ponar grab | AAS - after acid extraction | |
| 15 river mouths: 1975: surface: 6.8-72.3 | Eknam dredge & custom made hand core | AAS - nitric: perchloric acid (1:1) extraction and evaporation to dryness (350°C) | |
| Toronto Harbour: (inner & outer): 1984: surface: 2-860 | Shipok grab | HOB - aqua regia, AAS | |
| Toronto Harbour (inner & island lagoon): 1984:
- surface: 0-5 cm: 1.8-370.0 | Core - 0-5 cm subsample | Same | |
| Toronto Harbour - Keating Channel: 1984:
- surface: 0-10 cm: 7.0-65.0 | Core - 0-10 cm subsample | Same | |
| Small Craft Harbour: 1980: surface: 1.0-130.0 | Mini-Shipok | AAS - aqua regia | |

uffg:

- AAS - aqua regia
- northern & southern shore: 1976: 8-44
area of references: 1975, 1976, 1983, 1984
Not described

SUMMARY:

surface sediment in depositional basins: 26-109
background sediment in depositional basins: 35-56
surface sediment in nearshore zones: 2.1-200
background sediment in nearshore zones: 60-100
surface sediment in embayments: 3-265
surface sediment in river mouths: 6.8-83
surface sediment in harbours: 1.0-660

Parameter: Iron

Lake: Ontario

Concentration in % dry weight

Analytical Procedure:

Depositional basins:

- surface: 1980: 0-3 cm: 3.31-9.62%
- surface: 1976: 0-1 cm: 3.75-4.44%
- surface: 1983: 0-3 cm: 2.41-6.62%
- background: 1983: 9-10 cm: 1.92%
- background: 1976: 15-40 cm: 3.74-5.25%

Rearshore zones:

- surface: 1976: 0.29-7.8%
- surface: 1976: 0-4-2.0%
- surface: 1980: 0-3 cm: 0.69-8.31%

River mouths and harbours:

- Genesee River mouth: 1976: surface: 0.35-4.06%
- Hamilton Harbour: 1978: surface: 7.0%
(mean, SD=6.4%)
- Hamilton Harbour: 1978: background: 2.0%
(mean, SD=0.8%)
- Toronto Harbour - Reating Channel: 1984:
 - surface: 0-10 cm: 0.54-1.95%
 - Small Craft Harbours: 1980: surface: 0.39-6.19%

Bluffs:

- northern & southern shore: 1976: 1.29-3.52%

Years of references: 1976, 1978, 1980, 1983, 1984

Sampling Methods:

- Shippek grab - 0-3 cm subsample
- Benthos core
- Same
- Same
- X-ray fluorescence spectrometry

- X-ray fluorescence spectrometry
- X-ray fluorescence spectrometry
- D.C. argon plasma AES, aqua regia, $H_2O_2 + HF$ extraction
- Same
- X-ray fluorescence spectrometry

- AAS - after acid digestion
- AAS - same
- X-ray fluorescence spectrometry

- X-ray fluorescence spectrometry

SUMMARY:

surface sediment in depositional basins: 2.41-9.62%

background sediment in depositional basins: 1.92-5.25%

surface sediment in nearshore zones: 0.29-9.31%

surface sediment in river mouths: 0.35-4.05%

surface sediment in harbours: 0.39-13.7%

background sediment in harbours: 2.0% (mean, SD=0.8%)

bluffs: 1.29-3.52%

Parameter:	Lead	Lake:	Ontario	Concentration in $\mu\text{g.g}^{-1}$ dry weight	Sampling Methods:	Analytical Procedure:
Depositional basins:						
- surface:	1980: 0-3 cm: 7.0-261.0				Shipak grab - 0-3 cm subsample	AAS - aqua regia
- surface:	1983: 0-3 cm: 156 (mean, SD=41)				Same	Same
- surface:	1976: 0-1 cm: 176-285				Benthos core	AAS - HCl concentration (20 min. at 90°C)
- surface:	1983: 0-3 cm: 167-206				Same	D.C. argon plasma AES - aqua regia, $\text{H}_2\text{O}_2 + \text{HF}$ extraction
- background:	1976: 15-40 cm: 26-32				Same	AAS - HCl concentration (20 min. at 90°C)
- background:	1983: 9-10 cm: 18-19				Same	D.C. argon plasma AES - aqua regia, $\text{H}_2\text{O}_2 + \text{HF}$ extraction
Nearshore zones:						
- surface:	1980: 0-3 cm: 4.0-287.0				Shipak grab - 0-3 cm subsample	AAS - aqua regia
- surface:	1976: <10-42				Ponar grab	AAS - acid extraction
- surface:	1976: 7-165				Same	Same
- surface:	1983: 0-3 cm: 27.1 to 157.0				Shipak grab - 0-3 cm surface	Same
- surface:	1984: 4-127				Eckman grab	HgE - aqua regia - AAS
- surface:	1984: 0-3 cm: 1.8-70.0				Core - 0-3 cm subsample	Same
- surface:	1984: 3.0-150.0				Shipak grab	Same
- surface:	1984: 0-3 cm: 3.5-180.0				Core - 0-3 cm subsample	Same
- surface:	1983: 0-5 cm: 100-200				Box core & hand core	Same
- background:	1983: 14->25 cm: 25				Same	X-ray fluorescence
Embayments:						
River mouths and harbours:						
15 river mouths:	1975: surface: 7.3-168.6					
Hamilton Harbour:	1978: surface: 260 (mean, SD=20)				Eckman dredge & custom made piston	AAS - nitric: perchloric acid (1:1) extraction and evaporation to dryness (350°F)
Hamilton Harbour:	1978: background: 28 (mean, SD=24)				core	HgE - aqua regia - AAS
Toronto Harbour (inner & island lagoon):	1984: same				Phleger core	Same
- surface:	0-5 cm: 3.0-1,100.00				Core - 0-5 cm subsample	Same
Toronto Harbour (inner & outer):	1984: same				Shipak grab	Same
Toronto Harbour - Keating Channel:	1984: same				Core - 0-10 cm subsample	Same
- surface:	0-10 cm: 24-265				Mini-Shipak	AAS - aqua regia
Small Craft Harbours:	1980: surface: <1.0-750.0					Same
Bluffs:						
- northern & southern shore:	1976: 12-35				Not described	
Years of references:	1976, 1978, 1980, 1983, 1984					

SUMMARY:

surface sediment in depositional basins: 7.0-283.0
background sediment in depositional basins: 18-32
surface sediment in nearshore zones: 1.8-27
background sediment in nearshore zones: 25
surface sediment in embayments: 6-520
surface sediment in river mouths: 7.3-168.6
surface sediment in harbours: <1.0-1,600
background sediment in harbours: 28 (mean, SD=34)
bluffs: 12-35

Parameter:	Mercury		Sampling Methods:	Analytical Procedure:
Lake:	Ontario	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight		
Depositional basins:				
- surface:	1980: 0-3 cm:	0.140-2.100	Shipek grab - 0-3 cm subsample	AAS - flameless (Bondar & Clegg)
- surface:	1976: 0-1 cm:	0.54-3.95	Benthos core	Same
- surface:	1983: 0-3 cm:	1.161 (mean, SD=0.637)	Shipek grab - 0-3 cm subsample	Not described
- background:	1976: 15-40 cm:	0.03-0.09	Benthos core	AAS - flameless (Bondar & Clegg)
Nearshore zones:				
- surface:	1980: 0-3 cm:	0.025-1.295	Shipek grab - 0-3 cm subsample	Same
- surface:	1984: <0.01-0.36		Shipek grab	MOR
- surface:	1984: 0-3 cm:	<0.01-0.33	Core - 0-3 cm	Same
- surface:	1984: 0-3 cm:	<0.01-0.13	Same	Same
- surface:	1976: 0.05-7.76		Ponar grab	AAS - flameless
- surface:	1976: <0.05-0.66		Same	Same
- surface:	1983: 0-3 cm:	0.67-4.30	Shipek grab - 0-3 cm subsample	AAS - flameless
- surface:	1983: 0-5 cm:	0.90-7.1	Box corer & hand core	AAS - flameless
- background:	1983: 25 cm:	0.40-0.70	Same	Same
Whole Lake:				
- surface:	1976: 0-3 cm:	0.032-2.1	Shipek grab - 0-3 cm surface	Not described
Estuaries:				
Rumber Bay:	1984:	<0.01-1.20	Shipek grab	MOR - AAS - aqua regia - flameless
River mouths and harbours:				
Niagara River mouth:	1977:	surface: 2.90-3.90	Ekman grab	Not described
Genesee River mouth:	1976:	surface: 0.03-0.67	Ponar grab	AAS - flameless
15 river mouths:	1975:	surface: 0.01-0.67	Ekman dredge & custom made piston core	Coleman MAS 50 mercury analyzer (Van Loen, 1974)
Hamilton Harbour:	surface: 1977:	0.750-3.890	Ekman grab	Not described
Toronto Harbour (inner & island lagoon):	1984:		Core - 0-5 cm subsample	MOR - aqua regia - AAS - flameless
- surface:	0-5 cm:	<0.01-7.00	Same	Same
Toronto Harbour (inner & outer):	1984:		Shipek grab	Same
- surface:	0-5 cm:	<0.01-1.1		
Toronto Harbour (inner & outer):	1976:			
- surface:	0-5 cm:	<0.01-3.4		
Toronto Harbour - Keating Channel:	1984:			
- surface:	0-10 cm:	0.03-0.25		
Small Craft Harbours:	1980:	surface: 0.010-0.930	Core - 0-10 cm subsample	MOR
			Mini-Shipek	AAS - flameless (Bondar & Clegg)

Bluffe:

- northern & southern shore: 1976: 0.01-0.08

Not given

Years of references: 1975, 1976, 1977, 1980, 1983, 1984

SUMMARY:

surface sediment in depositional basins: 0.140-3.95
background sediment in depositional basins: 0.03-0.09
surface sediment in nearshore zones: <0.01-7.76
background sediment in nearshore zones: 0.40-0.70
surface sediment in embayments: <0.01-1.20
surface sediment in river mouths: 0.01-3.90
surface sediment in harbours: <0.01-7.00

AAS - flameless

Parameter: Nickel

Lake: Ontario

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-3 cm: 29.0-99.0
- surface: 1981: 0-3 cm: 67 (mean, SD=10)
- surface: 1983: 0-3 cm: 57-77
- background: 1983: 9-10 cm: 42-48

Nearshore zones:

- surface: 1980: 0-3 cm: 4.0-121.0
- surface: 1976: 12-15
- surface: 1983: 0-3 cm: 15.8-67.7
- surface: 1976: 11-160
- surface: 1983: 0-5 cm: 100-150
- background: 1983: 11->25 cm: 30-100

River mouths and harbours:

Genesee River: 1976: surface: 9-140

15 rivers mouths: 1975: surface: 0.9-28.1

- Hamilton Harbour: 1978: surface: 39 (mean, SD=26)
Hamilton Harbour: 1978: background: 14 (mean SD=7)
Toronto Harbour (inner & island lagoon): 1984:
- surface: 0-5 cm: 3-71

Toronto Harbour (inner & outer): 1984: surface: 3-54

Toronto Harbour - Keating Channel: 1984:
- surface: 0-10 cm: 3.5-24.5

- Small Craft Harbours: 1980: surface: <1.0-75.0
Corer- 0-5 cm subsample
Shipek grab
Corer- 0-10 cm subsample
Mini-Shipek

Years of references: 1975, 1976, 1978, 1980, 1983, 1984

Analytical Procedure:

- AAS - aqua regia
Same
D.C. argon plasma AAS, aqua regia $\text{H}_2\text{O}_2 + \text{HF}$ extraction
Same

- AAS - aqua regia
AAS - acid extraction
AAS - acid extraction
Same
X-ray fluorescence
Same

- AAS - aqua regia
AAS - acid extraction
AAS - acid extraction
Same
X-ray fluorescence
Same

- AAS - aqua regia
AAS - nitric perchloric acid (1:1) extraction and evaporation to dryness (350 °F)
NOX - aqua regia - AAS
Same

SUMMARY:

surface sediment in depositional basins: 29.0-99.0
background sediment in depositional basins: 42-48
surface sediment in nearshore zones: 4.0-160
background sediment in nearshore zones: 30-100
surface sediment in river mouths: 8.9-140
surface sediment in harbours: <1.0-75.0
background sediment in harbours: 14 (mean, SD=7)

Parameter: Nitrogen

Lake: Ontario

Concentration in % dry weight

Depositional basins:

- surface: 1971: 0-3 cm: 0.36-0.71%
- surface: 1976: 0-1 cm: 0.29-0.80%
- surface: 1977: 0-3 cm: 0.110-0.59%
- background: 1976: 15-40 cm: 0.20-0.33%

Rearshore zones:

- surface: 1976: 0.14-4.03%
- surface: 1976: 0.08-1.19%
- surface: 1977: 0-3 cm: 0.003-0.580%
- surface: 1971: 0-3 cm: 0.03-0.26%
- surface: 1984: N.D. -0.41%
- surface: 1984: 0-3 cm: 0.010-0.198%
- surface: 1984: 0-3 cm: 0.01-0.35%

Estuaries:

- Rumber Bay: 1984: surface: 0.012-0.665%
 Bay of Quinte: 1976: surface: 0-1 cm: 0.9-1.5%

River mouths and harbours:

- Genesee River mouth: 1976: surface: 0.12-2.62%
 Hamilton Harbour: 1978
 - surface: 0.27% (mean, SD=0.17%)
 - background: 0.16% (mean, SD=0.15%)
 Toronto Harbour (inner & island lagoon): 1984:
 - surface: 0-5 cm: 0.01-0.31%
 - surface: 0.01-0.37%
 Toronto Harbour - Keating Channel: 1984:
 - surface: 0-10 cm: 0.019-0.155%

Bluffs:

- northern & southern shore: 1977: 0.005-0.030%
- northern & southern shore: 1976: 0.005-0.030%

Sampling Methods:

Analytical Procedure:

- Shipek grab - 0-3 cm subsample
 Benthos core
 Shipek grab - 0-3 cm subsample
 Benthos core
 Shipek grab - 0-3 cm subsample
 Benthos core
 Coleman, C,H,N analyser
 Same
 Leco Model V0-14SP nitrogen determinator (Dumas method)
 Coleman Model 29A analyser (method of Kenney & Bremer)

- Ponar grab
 Ponar grab
 Shipek grab - 0-3 cm subsample
 Same
 Ekman
 Core - 0-3 cm subsample
 Shipek grab

- HOB - 1981, 1983
 Kjeldahl digestion

- Coleman C,H,N analyser
 HOB - 1981, 1983
 Same
 Coleman Model 29A analyser
 HOB - 1981, 1983
 Same
 Same

- Core - 0-10 cm

- Not given
 Not given

- Leco Model V0-14SP nitrogen determinator (Dumas method)
 Coleman model 29A

Years of Reference: 1971, 1976, 1977, 1978, 1984

SUMMARY:

surface sediment in depositional basins: 0-11-0.80%

background sediment in depositional basins: 0.20-0.33%

surface sediment in nearshore zones: 0.01-4.3%

surface sediment in embayments: 0.012-1.5%

surface sediment in river mouths: 0.12-2.6%

surface sediment in harbours: 0.01-0.37%

background sediment in harbours: 0.16% (mean, SD=0.15%)

Parameter: Oils & Grease

Lake: Ontario

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Analytical Procedure:

Depositional basins:			
- surface:	1983: <u><116-126</u>		Shippek grab
Nearshore zones:			
- surface:	1983: <u><71</u>		Same
Harbours:			
Small Craft Harbours:	1979: surface: <u><60-11,777</u>		Mini-Shippek grab
Years of references:	1980, 1983		

SUMMARY:

surface sediment in depositional basins: <118-126

surface sediment in nearshore zones: <71

surface sediment in harbours: <60-11,777

Parameter:	Organic Carbon (or Loss on Ignition)		
Lake:	Ontario	Concentration in % dry weight	
		Sampling Methods:	Analytical Procedure:
Depositional basins:			
- surface sediment: 1980: 0-3 cm: 0.93-7.06%		Shipek grab - 0-3 cm subsample	Leco carbon analyser (sulfur. acid)
- surface sediment: 1971: 0-3 cm: 2.13-5.01%		Same	Same
- surface sediment: 1969: 0-3 cm: 3.23-3.41%		Same	Same
- surface: 1977: 0-3 cm: 0.89-4.99%		Same	Same
- surface: 1980: 0-5 cm: 2.26-4.24%		Benthos core	Same
- surface: 1972: 0-3 cm: 2.96 & 3.08% (mean, SD=0.50 & 0.60%)		Shipek grab - 0-3 cm subsample	Same
- surface: 1976: 0-1 cm: 3.237-6.28%		Benthos core	Same
- background: 1980: 25-35 cm: 1.59-2.42%		Same	Same
- background: 1976: 15-40 cm: 1.83-2.80%		Same	Same
Rearshore zones:			
- surface: 1972: 0-3 cm: 0.96 (mean, SD=1.05%)		Shipek grab - 0-3 cm subsample	Same
- surface: 1980: 0-3 cm: 0.01-5.27%		Same	Same
- surface: 1977: 0-3 cm: 0.03-4.96%		Same	Same
- surface: 1971: 0-3 cm: 0.97-2.79%		Same	Same
- surface: 1971: 0-3 cm: 0.001-0.85%		Same	Same
- surface: 1983: 0-3 cm: 0.38-3.02%		Same	Same
- surface: 1976: 0.03-1.34%		Ponar grab	Coleman C,H,N analyser
- surface: 1976: 0.25-2.80%		Same	Same
- surface: 1984: 0.12-2.40%		Eckman dredge	HDE
- surface: 1984: 0.033-0.508%		Same	Same
- surface: 1984: 0-3 cm: 0.045-1.60%		Core - 0-3 cm subsample	Same
- surface: 1984: 0-0-3.0%		Shipek grab	HDE
- surface: 1984: 0-3 cm: 0.05-1.30%		Core - 0-3 cm subsample	Same
- surface: 1984: 0-3 cm: LOI: 0.21-4.4%		Core - 0-3 cm subsample	HDE - 600°C for a hr
- surface: 1984: 0-3 cm: TOT: 0.1-6.7%		Same	Same for 1 hr
- surface: 1983: 0-5 cm: 3.0-6%		Box core & hand core	Leco carbon analyser (sulfurous acid)
- background: 1983: 10-25 cm: 2-4%		Same	Same
Estuaries:			
Number Bay: 1984: surface: <0.01-0.31%		Shipek grab	Same
Number Bay: 1984: surface: <u>LOI: <1.0-8.2%</u>		Same	Same
Number Bay: 1984: surface: <u>LOI: 0.3-6.8%</u>			

River mouths and harbours:

Genesee River mouth: 1976; surface: 0.09-4.25%

Toronto Harbour (inner & island lagoon): 1984;
- surface: 0-5 cm: LOI: <1-13%

Toronto Harbour (inner & outer): 1984;
- surface: 0-5 cm: LOI: <1.0-13.0%

Toronto Harbour (inner & outer): 1984;
- surface: 0-3 cm: LOI: 0.58-14.0%

Toronto Harbour - Keating Channel: 1974;
- surface: 0-10 cm: LOI: 0.45-6.3%

Small Craft Harbour: 1980; surface: 0.19-12.86%

Bluffs:

- northern & southern shore: 1977: 0.07-1.0%
- northern & southern shore: 1976: 0.07-1.0%

Years of references: 1969, 1971, 1972, 1974, 1976, 1977, 1980, 1983, 1984

SUMMARY:

surface sediment in depositional basins: 0.89-7.06%

background sediment in depositional basins: 1.59-2.80%

surface sediment in nearshore zones: 0.01-6.0%

background sediment in nearshore zones: 2-4%

LOI surface sediment in embayments: 0.1-6.7%

LOI surface sediment in embayments: <0.01-0.31%

surface sediment in river mouths: 0.3-8.2%

surface sediment in harbours: 0.09-4.25%

LOI surface sediment in harbours: 0.19-12.86%

bluffs: 0.07-1.0%

Coleman C,H,N analyser

HDX - 600°C for 1 hr

Core - 0-5 cm subsample

Diver-hand-cores - 0-5 cm

Shipkit Grab - 0-3 cm subsample

Core - 0-10 cm subsample

Mini-Shipkit

Leco carbon analyser (sulfurous acid)

Same

Same

Parameter:	PCB	Lake:	Ontario Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight	Sampling Method(s):	Analytical Procedure:
Depositional basins:					
- surface:	1980:	0-3 cm:	0.001-0.280	Shipuk grab - 0-3 cm subsample	GC - Ontario Pesticide Laboratory Guelph
- surface:	1983:	0-3 cm:	0.089 (mean, SD=0.068)	Same	Same
Nearshore zones:					
- surface:	1984:	0-3 cm:	<0.020-0.155	Core - 0-3 cm subsample	HGT
- surface:	1984:	<0.020-0.130		Shipuk grab	Same
- surface:	1984:	0-3 cm:	<0.020-0.100	Core - 0-3 cm subsample	Same
- surface:	1984:	<0.020-0.210		Bikram dredge	Same
- surface:	1980:	0-3 cm:	0.001-0.210	Shipuk grab - 0-3 cm subsample	GC - Ontario Pesticide Laboratory Guelph
- surface:	1983:	0-1 cm:	1.300	Benthos core	GC - capillary, acetone/hexane (florisil column cleanup & Hg)
- surface:	1983:	7-8 cm:	3.100	Benthos core	Same
- surface:	1983:	9-10 cm:	3.600	Benthos core	Same
- background:	1983:	25-26 cm:	0.078 (1985)	Same	Same
Estuaries:					
Number Bay:	1986:	surface:	N.D.-1.330	Shipuk grab	GC - electron capture (MOE)
Bay of Quinte:	1980:	depositional basins:		Shipuk grab - 0-3 cm subsample	GC - Ontario Pesticide Laboratory Guelph
- surface:	0-3 cm:	<0.002-0.200		Same	Same
Bay of Quinte:	1980:	nondepositional zone:			
- surface:	0-3 cm:	<0.002-0.260			
River mouths and harbours:					
Toronto Harbour (inner & island lagoon):	1984:			Shipuk grab	GC - electron capture (MOE)
- surface:	0-5 cm:	N.D.-3.300			
Toronto Harbour (inner & outer):	1984:				
- surface:	N.D.-4.450				
Toronto Harbour - Keating Channel:	1984:				
- surface:	0.011-0.515				
Seasol Craft Harbours:	1980:	surface:	<0.001-0.150	Shipuk grab Mini-Shipuk	GC - Bonder & Clegg, Ottawa
Years of references:	1980, 1983, 1984				

Years of Reference: 1971, 1976, 1977, 1978, 1984

SUMMARY:

surface sediment in depositional basins: <0.001-0.260

surface sediment in nearshore zones: 0.002-3.60

background sediment in nearshore zones: 0.078

surface sediment in embayments: N.D.-1.330

surface sediment in harbours: <0.001-4.450

Parameter:	Phosphorus		
Lake:	Ontario	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight	
		Sampling Methods:	Analytical Procedure:
Depositional baseline:			
- surface:	1980: 0-3 cm: 1,000-5,500	Shippek grab - 0-3 cm subsample	X-ray fluorescence spectrometry
- surface:	1974: 0-5 cm: 857-1,461	Benthos core	Perchloric acid, spectrometry
- surface:	1976: 0-1 cm: 1,200-2,200	Same	X-ray fluorescence spectrometry
- surface:	1983: 0-3 cm: 4,300-8,800	Same	D.C. argon plasma AEG, aqua regia, $\text{H}_2\text{O}_2 + \text{HF}$ extraction
- background:	1974: 15-20 cm: 1,182	Same	Perchloric acid, spectrometry
- background:	1976: 15-40 cm: 700-1,600	Same	X-ray fluorescence spectrometry
- background:	1983: 9-10 cm: 2,800	Same	D.C. argon plasma AEG, aqua regia, $\text{H}_2\text{O}_2 + \text{HF}$ extraction
Rearshore zones:			
- surface:	1980: 0-3 cm: 300-3,200	Shippek grab - 0-3 cm subsample	X-ray fluorescence
- surface:	1974: 0-3 cm: 248-911	Benthos core	Perchloric acid digestion, spectrometry
- surface:	1983: 0-3 cm: 900-2,700	Shippek grab - 0-3 cm subsample	X-ray fluorescence
- surface:	1986: N.D. -1,250	Ekman dredge	N.D.
- surface:	1984: 0-3 cm: 280-1,760	Core - 0-3 cm subsample	N.D.
- surface:	1984: 500-3,800	Shippek grab	N.D.
- surface:	1984: 0-3 cm: 300-1,700	Core - 0-3 cm subsample	N.D.
- background:	1974: 15-20 cm: 567-1,010	Benthos gravity	Perchloric acid extraction, spectrometry
Rabeynerts:			
Humber Bay:	1984: surface: 410-3,700	Shippek grab	N.D.
River mouths and harbours:			
Hamilton Harbour:	1978: surface: 2,400 (mean, SD=1,500)	Phleger core	N.D.
Toronto Harbour - Keating Channel:	1984: surface: 0-5 cm: 300-4,700	Same	Same
Toronto Harbour (inner & island lagoon):	1984: surface: 200-4,600	Core - 0-5 cm subsample	N.D.
Small Craft Harbours:	1980: surface: 10-5,910	Shippek grab	N.D.
Bluffs:	northern & southern shore: 1976: 300-900	Core - 0-10 cm subsample Mini-Shippek	X-ray fluorescence spectrometry
		Not given	X-ray fluorescence spectrometry

Years of references: 1974, 1976, 1978, 1980, 1983, 1984

SUMMARY:

surface sediment in depositional basins: 857-8,800
background sediment in depositional basins: 700-2,800
surface sediment in nearshore zones: 280-3,900
background sediment in nearshore zones: 567-1,010
surface sediment in embayments: 410-3,700
surface sediment in harbours: 300-5,900
background sediment in harbours: 800 (means, SD=300)
bluffs: 300-900

Parameter:	Zinc		
Lake:	Ontario	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight	
		Sampling Methods:	Analytical Procedure:
Depositional basins:			
- surface: 1976: 0-1 cm: 319-600	Benthos core	AAS - extraction by HCl conc. for 20 min. at 90°C	
- surface: 1980: 0-3 cm: 83-2,507.0	Shipek Grab - 0-3 cm subsample	AAS - aqua regia extraction	
- surface: 1983: 0-3 cm: 355-385	Benthos core	D.C. 'argon plasma AES - aqua regia, H_2O_2 MIP extraction	
- background: 1983: 9-10 cm: 83-163	Same	Same	
- background: 1976: 15-40 cm: 86-121	Same	AAS - extraction by HCl conc. for 20 min. at 90°C	
Rearshore zones:			
- surface: 1980: 0-3 cm: 6.0-500.0	Shipek Grab - 0-3 cm subsample	AAS - aqua regia	
- surface: 1983: 0-5 cm: 100-500	Box core & hand core	X-ray fluorescence spectrometry	
- surface: 1976: 17-184	Ponar Grab	AAS - acid extraction	
- surface: 1983: 0-3 cm: 73-356	Shipek Grab - 0-3 cm subsample	Same	
- surface: 1976: 10-1,120	Ponar Grab	Same	
- surface: 1984: 11-244	Ekman dredge	HDE - aqua regia - AAS	
- surface: 1984: 0-3 cm: 12.0-140.0	Core - 0-3 cm	Same	
- surface: 1984: 13.0-580.0	Shipek Grab	Same	
- surface: 1984: 0-3 cm: 9.3-270.0	Core	Same	
- background: 1983: 13-45 cm: 100	Box core & hand core	X-ray fluorescence spectrometry	
Estuaries:			
Number Bay: 1984: surface: 14-1,225	Shipek grab	HDE - aqua regia - AAS	
River mouths and harbours:			
Genesee River: 1976: surface: 25-500	Ponar Grab	AAS - acid extraction	
15 river southe: 1975: surface: 24.5-178.0	Stem dredge & custom made piston core	AAS - nitric: perchloric acid (1:1) extraction and evaporation to dryness (350°F)	
Hamilton Harbour: 1978:	Phleger core	HDE - aqua regia - AAS	
- surface: 2.010 (mean, SD=1,780)	Same	Same	
Hamilton Harbour: 1978:	Core	Same	
- background: 210 (mean, SD=260)	Shipek grab	Same	
Toronto Harbour (inner & island lagoon): 1984:	Core	Same	
- surface: 0-5 cm: 17.0-830	Core	Same	
Toronto Harbour (inner & outer): 1984:	Core	Same	
- surface: 5-960	Core	Same	
Toronto Harbour (inner & outer): 1984:	Core	Same	
- surface: 0-5 min: 18-390	Core	Same	
Toronto Harbour - Keating Channel: 1984:	Core	Same	
- surface: 0-10 cm: 41-290	Core	Same	
Small Craft Harbour: 1980: surface: 6.0-485.0	Mini-Shippek	AAS - aqua regia (Bonder & Clegg, Ottawa)	

Bluffs:

- northern & southern shore: 1976: 16-65

AAS - acid extraction
Not described

Years of references: 1975, 1976, 1980, 1983, 1984

SUMMARY:

surface sediment in depositional basins: 83-3, 507
background sediment in depositional basins: 83-163
surface sediment in nearshore zones: 6-1, 120
background sediment in nearshore zones: 100
surface sediment in embayments: 14-1, 225
surface sediment in river mouths: 24, 5-500
surface sediment in harbours: 5-2, 010 (~~mean!~~)
background sediment in harbours: 210 (~~mean!~~)
bluffe: 16-65

Lake Erie

Parameter: Cadmium
 Lake: Erie
 Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-3 cm: 1.0-10.8
Shipak grab
- surface: 1974: 0-1 cm: 1.0-7.0 Gravity core
- surface: 1976: 0-1 cm: 3.3-4.5 Benthos core
- surface: 1976: 0-1 cm: 2.5-4.3 Same
- surface: 1979: 0-2 cm: 6.6 Same
- surface: 1979: 0-2 cm: 3.4 Same
- surface: 1979: 0-2 cm: 3.5 Same
- surface: 1979: 0.8-8.4 Ponar grab
- background: 1976: 2.2-13.7 Same
- background: 1976: 15-50 cm: 0.5-1.7 Benthos core
- background: 1976: 30-120 cm: 0.9 Same
- background: 1974: 6-35 cm: 0.1-1.4 Gravity core

Reearshore zones:

- surface: 1980: 0-3 cm: 0.1-8.3
Shipak grab

River mouths and harbours:

- Buffalo Harbour: 1974: surface: 0-1 cm: 1.3 Gravity core
- Buffalo Harbour: 1974: background: 18 cm: 0.1 Same
- Small Craft Harbour: 1980: surface: <0.5-1.0 Mini-Shipak

River mouths: 1972: surface: 20 samples: 0.6-7.8 Ekman dredge & custom made

Piston core

Bluffs:

- northern shore: 1976: 12 samples: 0.7-2.8 Not given

Soils:

- Essex county: 1976: 1.4-2.3

Agriculture Canada samples

Years of references: 1974, 1975, 1976, 1979, 1980

Analytical Procedure:

- AAS - aqua regia at 90°C for 90 min.
- N. Activation
- AAS - HCl at 90°C for 20 min.
- Same
- AAS - aqua regia at 90°C for 90 min.
- Same
- Same
- Same
- HOE - aqua regia - AAS
- Same
- AAS - HCl at 90°C for 20 min.
- Same
- N. activation

- AAS - aqua regia at 90°C for 90 min.
- N. Activation
- Same
- AAS - aqua regia (Bondar & Clegg)
- AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°F)
- Same

- AAS - HCl at 90°C for 20 min.

Same

SUMMARY:

surface sediment in depositional basins: 0.8-13.7
background sediment in depositional basins: 0.1-1.7
surface sediment in nearshore zones: 0.1-8.3
surface sediment in harbours: 0.1-1.3
background sediment in harbours: 0.1
surface sediment in river mouths: 0.6-7.8
bluffe: 0.7-2.8
soils: 1.4-2.3

Parameter: Chromium

Lake: Erie

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface sediment: 1979: 50-362 Ponar grab
- surface sediment: 1979: 50-150 Same
- surface sediment: 1974: 0-1 cm: 12-145 Gravity core
- surface sediment: 1980: 0-3 cm: 14.0-238.0 Shipak grab
- background: 1974: 6-80 cm: 9-25 Gravity core

Nearshore zone:

- surface: 1980: 0-3 cm: 6.0-211.0 Shipak grab

River mouths and harbours:

- Buffalo Harbour: surface: 1974: 0-1 cm: 100 Gravity core
- Buffalo Harbour: background: 1974: 12 cm: 250 Same
- Buffalo Harbour: background: 1974: below 25 cm: 30 Same
- Cleveland Harbour: surface: 1974: 0-1 cm: 150 Same
- Cleveland Harbour: background: 1974: 95 cm: 30 Same
- Sail Craft Harbours: surface: 1980: 13.0-138.0 Mini-Shipak grab
- River mouths: surface: 1975: 20 samples: 4.5-124.5 Ekman dredge & custom made piston core.

Years of references: 1974, 1975, 1980

SUMMARY:

- surface sediment in depositional basins: 12-362
- background sediment in depositional basins: 9-25
- surface sediment in nearshore zones: 6-211
- surface sediment in harbours: 13.0-150.0
- background sediment in harbours: 30-250
- surface sediment in river mouths: 4.5-124.5

Analytical Procedure:

- HDX - aqua regia, AAS
- Same
- N. Activation, AAS
- AAS - aqua regia for 90 min. at 85-90°C
- N. activation, AAS
- AAS - aqua regia for 90 min. at 85-90°C

Parameter: Copper
 Lake: Erie
 Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface sediment: 1979: 10-97
- surface sediment: 1979: 30-183
- surface sediment: 1979: 0-2 cm: 104-146
- surface sediment: 1976: 0-1 cm: 49-66
- surface sediment: 1974: 0-1 cm: 12-52
- surface sediment: 1980: 0-3 cm: 5-207
- background: 1976: 15-120 cm: 20-34
- background: 1979: precolonial: 48

Reshore zones:

- surface: 1980: 0-3 cm: 3.0-138.0

River mouths and harbours:

- Buffalo Harbour: 1974: surface: 0-1 cm: 55
- Buffalo Harbour: 1974: background: 10 cm: 110
- Buffalo Harbour: 1974: background: 25 cm: 10
- Cleveland Harbour: 1974: surface: 0-1 cm: 100
- Cleveland Harbour: 1974: background: 120 cm: 10
- Small Craft Harbours: 1980: surface: 2-58
- River mouths: 1975: surface: 1.5-69.8

Bluffs:

- northern shore: 1976: 12 sampling stations: 15-89

Soils:

- Essex county: 1976: 4 samples: 17-46

Years of references: 1974, 1975, 1976, 1979, 1980

Analytical Procedure:

- Ponar grab
- Same
- Benthos core
- Same
- Gravity core
- Shipak grab
- Benthos core
- Same
- AAS - aqua regia
- Same
- AAS - HCl conc. for 20 min. at 90°C
- N. activation
- AAS - aqua regia
- AAS - HCl conc. for 20 min. at 90°C
- AAS - aqua regia

- AAS - aqua regia

- N. Activation
- Same
- AAS - aqua regia
- Same
- AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°C)
- AAS - aqua regia
- Same
- AAS - HCl conc. for 20 min. at 90°C

Agriculture Canada samples

SUMMARY:

surface sediment in depositional basins: 5-207
background sediment in depositional basins: 20-48
surface sediment in nearshore zones: 3-138
surface sediment in harbours: 2-100
background sediment in harbours: 10-110
surface sediment in river mouths: 1.5-69.8
bluffs: 15-89
soils: 17-46

Parameter: Iron
 Lake: Erie
 Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-3 cm: 2.61-7.79
- surface: 1976: 0-1 cm: 1.1-2.8
- surface: 1976: 0-1 cm: 3.65-4.62
- surface: 1976: 0-1 cm: 5.31-5.52
- background: 1976: 30-120 cm: 4.67-4.82
- background: 1976: 15-50: 2.76-3.89
- background: 1974: 6-260 cm: 0.89-1.7

Nearshore zones:

- surface: 1980: 0-3 cm: 1.34-13.72

Shipek grab

River mouths and harbours:

- Buffalo Harbour: 1974: surface: 0-1 cm: 2.0
- Buffalo Harbour: 1974: background: 25 cm: 1.1
- Cleveland Harbour: 1974: surface: 0-1 cm: 3.0
- Cleveland Harbour: 1974: background: 120 cm: 1.5
- Small Craft Harbours: 1980: surface: 1.01-6.10

Bluffs:

- northern shore: 1976: 12 samples: 1.71-3.09

Not given

Soils:
 Essex county: 1976: 4 samples: 2.71-3.36

Agriculture Canada samples

Years of references: 1974, 1976, 1980

SUMMARY:

surface sediment in depositional basins: 1.1-7.79
 background sediment in depositional basins: 0.89-4.82
 surface sediment in nearshore zones: 1.34-13.72
 surface sediment in harbours: 1.01-6.10
 background sediment in harbours: 1.1-1.5
 bluffs: 1.71-3.09
 soils: 2.71-3.36

Analytical Procedure:

X-ray fluorescence spectrometry
 N. activation
 Gravity core
 Benthos core
 Same
 Same
 Same
 Same
 N. activation

X-ray fluorescence spectrometry

N. Activation
 Same
 Same
 Same
 X-ray fluorescence spectrometry

X-ray fluorescence spectrometry

Same

Parameter:	Lead		
Lake:	Erie		
	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight		
		Sampling Method:	Analytical Procedure:
Depositional basins:			
- surface: 1980: 0-3 cm: 18-299	Shipak grab	AAS - aqua regia	
- surface: 1979: 6-110	Ponar grab	HgR - AAS, aqua regia	
- surface: 1979: 30-173	Same	Same	
- surface: 1976: 0-1 cm: 83-146	Benthos core	AAS - HCl at 20°C for 90 min.	
- surface: 1979: 0-2 cm: 99-136	Same	AAS - aqua regia	
- background: 1979: precolonial sediment: 26	Same	Same	
- background: 1976: 15-120 cm: 21-49	Same	AAS - HCl conc. for 20 min at 90°C	
Raindepositional zones:			
- surface: 1980: 0-3 cm: 9-221	Shipak grab	AAS - aqua regia	
River mouths and harbours:			
Small Craft Harbours: 1980: surface: <1-192	Mini-Shipak grab	Same	
River mouths: 1974: surface: 3.3-90.6	Ekman grab and custom made piston core	AAS - nitric: perchloric acid (1:1) after evaporation to dryness (350°C)	
Bluffs:			
Northern shore: 1976: 12 samples: 33-47	Not given	AAS - HCl conc. for 20 min. at 90°C	
Soils:			
Essex county: 1976: 4 samples: 33-40	Agriculture Canada samples	Same	
Years of references: 1975, 1976, 1979, 1980			
SUMMARY:			
surface sediment in depositional basins: 6-299			
background sediment in depositional basins: 21-49			
surface sediment in nearshore zones: 9-221			
bluffs: 33-47			
soils: 33-40			

Parameter: Mercury

Lake: Erie

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Depositional basins:

	surface: 1979: 0-3.60	surface: 1979: 0.10-1.30	surface: 1976: 0-1 cm: 0.33-0.99	surface: 1974: 0-1 cm: 0.07-2.9	Benthos core	Gravity core	Benthos core	Shipek grab	Ponar grab	HOE
-	surface: 1976: 0-1 cm: 0.68-1.43	surface: 1976: 0-3 cm: 0.045-2.929	surface: 1973: 0-5 cm: 1.0-4.8	surface: 1972: 0-5 cm: 0.76-0.82	Hand core by diver	Core	Ekman dredge	Shipek grab	Same	Same
-	surface: 1972: 0.35-1.39	surface: 1980: 0-3 cm: 0.045-2.929	background: 1972: 5-14 cm: 0.65-0.73	background: 1973: below 20 cm: 0.04-0.09	Core	Gravity core	Ekman dredge	Shipek grab	AAS	Perkin-Elmer MAS 50 Hg-analyser
-	background: 1976: 15-50 cm: 0.05-0.19	background: 1974: 4-260 cm: 0.010-0.058	background: 1976: 30-120 cm: 0.04-0.09	background: 1976: 30-120 cm: 0.04-0.09	Hand core by diver	Benthos core	Ekman dredge	Shipek grab	Same	Perkin-Elmer MAS 50 Hg-analyser
-						Benthos core	Ekman dredge	Shipek grab	Same	Coleman mercury analyser

Nondepositional zones:

-	surface: 1980: 0-3 cm: 0.080-1.881
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Rabayments:

Sandusky Bay: 1973: surface: 0.33-1.44

River mouths and harbours: Ekman dredge

Buffalo Harbour: 1974: surface: 0-1 cm: 2.2

Gravity core

Buffalo Harbour: 1974: background: 10 cm: 7.00

Same

Buffalo Harbour: 1974: background: 25 cm: 0.05

Same

Cleveland Harbour: 1974: surface: 0-1 cm: 0.95

Same

Small Craft Harbour: 1980: background: 120 cm: 0.200

Same

River mouths: 1975: surface: 0.015-1.770

Min-Shipek Grab

Ekman dredge & custom made piston core

Bluffs:

northern shore: 1976: 12 samples: 0.04-0.05

Not described

Soils:

Essex county: 1976: 4 samples: 0.08-0.09

Agriculture Canada samples

Years of references: 1972, 1973, 1974, 1975, 1976, 1980

Same

SUMMARY:

surface sediment in depositional basins: 0.045-4.8
background sediment in depositional basins: 0.01-0.19
surface sediment in nondepositional zones: 0.080-1.881
surface sediment in embayments: 0.33-1.44
surface sediment in harbours: 0.015-2.2
background sediment in harbours: 0.05-7.00
surface sediment in river mouths: 0.06-0.86
bluffs: 0.04-0.05
soils: 0.08-0.09

Parameter: Nickel

Lake: Erie

Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-3 cm: 16.0-121.0
- surface: 1974: 0-1 cm: 32-150
- background: 1974: 6-200 cm: 10-76

Roderepositional zones:

- surface: 1980: 0-3 cm: 9.0-69.0

River mouths and harbours:

Buffalo Harbour: 1974: surface: 0-1 cm: 60

Buffalo Harbour: 1974: background: 40 cm: 65

Cleveland Harbour: 1974: surface: 0-1 cm: 90

Cleveland Harbour: 1974: background: 0-1 cm: 90

Small Craft Harbours: 1980: surface: 2.0-38.0

River mouths: 1975: surface: 20 samples: 4.5-37.2

Analytical Procedure:

- AAS - aqua regia
- N. Activation & AAS
- Same

- AAS - aqua regia

- AAS - aqua regia
- N. Activation & AAS
- Same
- Same
- AAS - aqua regia
- AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°C)

Years of references: 1974, 1975, 1980

SUMMARY:

surface sediment in depositional basins: 16-150
background sediment in depositional basins: 10-76
surface sediment in nondepositional zones: 9-69
surface sediment in harbours: 2-90
background sediment in harbours: 55-65
surface sediment in river mouths: 4.5-37.2

Parameter: Nitrogen

Lake: Erie

Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1971: 0-3 cm: 0.21-0.43
Shippek grab
Benthos core
- surface: 1976: 0-1 cm: 0.25-0.68
Same
- surface: 1977: 0-3 cm: 0.094-0.477
Shippek grab
Benthos core
- background: 1976: 15-120 cm: 0.10-0.20
Same

Nondepositional zones:

- surface: 1971: 0-3 cm: 0.05-0.21
Shippek grab
- surface: 1977: 0-3 cm: 0.007-0.233
Same

Bluffe:

northern shore: 1977: 12 samples: 0.020-0.080

Not given

Soils:

Erie County: 1976: 4 samples: 0.29-0.34

Agriculture Canada samples

Years of references: 1971, 1976, 1977

SUMMARY:

surface sediment in depositional basins: 0.094-0.68
background sediment in depositional basins: 0.10-0.20
surface sediment in nondepositional areas: 0.007-0.233
bluffe: 0.020-0.080
soils: 0.29-0.34

Analytical Procedure:

Coleman Model 29A analyser
Same
Leco Model VD-14SP nitrogen determinator
Coleman Model 29A analyser

Same
Leco Model VD - 14SP nitrogen determinator

Parameter: Oils & Grease
Lake: Erie
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight
Sampling Method:
Depositional basins:
 - surface sediment: 1983: <164-1,195
Rearshore zones:
 - surface sediment: 1983: <310
Harbours:
 - Small Craft Harbours: 1979: surface sediment:
<60-11,250
Years of references: 1980, 1983

Analytical Procedure:
 CCl_4 -extraction, IR-spectroscopy
Shippek Grab
 Same
Same
Same
Mini-Shippek

SUMMARY:
 surface sediment in depositional basins: <164-1,195
 surface sediment in nearshore zone: <310
 surface sediment in harbours: <60-11,250

Parameter: Organic Carbon
Lake: Erie
Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-3 cm: 0.50-4.44
- surface: 1971: 0-3 cm: 1.88-3.54
- surface: 1969: 0-3 cm: 1.61-2.78
- surface: 1977: 0-3 cm: 1.01-4.04
- surface: 1976: 0-1 cm: 2.30-5.24
- background: 1976: 15-120 cm: 1.06-1.61

Nondepositional zones:

- surface: 1971: 0-3 cm: 0.01-2.10
- surface: 1980: 0-3 cm: 0.02-3.65

Harbours:

Small Craft Harbours: 1980: 0.35-6.77

Bluffs:

Northern shore: 1976: 12 samples: 0.46-2.16

Soils:

Essen County: 1976: 4 samples: 2.48-3.80

Years of references: 1971, 1976, 1977, 1980

SUMMARY:

surface sediment in depositional basins: 0.50-5.24
background sediment in depositional basins: 1.01-1.61
surface sediment in nondepositional zones: 0.01-3.65
surface sediment in harbours: 0.35-6.77
bluffs: 0.45-2.18
soils: 2.48-3.80

Analytical Procedure:

Depositional basins:	Leco Carbon analyser
- surface:	Same
- background:	Same
Nondepositional zones:	Shipet grab
- surface:	Same
- surface:	Same
Harbours:	Shipet grab
Small Craft Harbours:	Same
Bluffs:	Mini-Shipet grab
Northern shore:	Same
Soils:	Not given
Essen County:	Agriculture Canada samples

Parameter:	PCB		
Lake:	Erie		
	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight		
	Sampling Methods:		
Depositional basins:			
- surface:	1980: 0-3 cm:	0.004-0.660	Shipak grab
Nondepositional zones:			GC
- surface:	1980: 0-3 cm:	0.008-0.800	Shipak grab
Rabeyments:			Same
Long Point Bay (inner):	1983: surface:	0-0.240	Ethman dredge
Harbours:			HOK
Small Craft Harbours:	1980: surface:	<0.010-0.880	Mini-Shipak grab
			Same

Parameter: Zinc

Lake: Erie
Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-3 cm: 33-536 Shipak grab
- surface: 1976: 0-1 cm: 192-619 Benthos core
- surface: 1979: 0-2 cm: 314-368 Same
- surface: 1974: 0-1 cm: 18-205 Gravity core
- surface: 1979: 45-440 Ponar Grab
- surface: 1979: 54-530 Same
- background: 1974: 10-80 cm: 8-25 Gravity core
- background: 1979: precolonial sediment: 90 Benthos core
- background: 1976: 5-120 cm: 69-128 Same

Nondepositional zones:

- surface: 1980: 0-3 cm: 16-351 Shipak grab

River mouths and harbours:

- Buffalo Harbour: 1974: surface: 0-1 cm: 2605 Gravity core
- Buffalo Harbour: 1974: background: 25 cm: 50 Same
- Cleveland Harbour: 1974: surface: 0-1 cm: 650 Same
- Cleveland Harbour: 1974: background: 120 cm: 40 Same
- Small Craft Harbour: 1980: surface: 12-250 Mini-Shipak Grab
- River mouths: 1975: surface: 15.7-220.8 Ekman grab and custom made Piston core

Bluffs:

- northern shore: 1976: 12 samples: 39-76 Not given

Soils:

- Esex county: 1976: 4 samples: 59-89

Years of references: 1974, 1975, 1976, 1979, 1980

Analytical Procedure:

- AAS - aqua regia
- AAS - HCl conc. for 20 min. at 90°C
- AAS - aqua regia
- N. activation
- HCl - aqua regia - AAS
- Same
- N. activation
- AAS - aqua regia
- AAS - HCl conc. 20 min. at 90°C

Agriculture Canada samples

Same

AAS - aqua regia

SUMMARY:

surface sediment in depositional basins: 18-536
background sediment in depositional basins: 8-128

surface sediment in nondepositional zones: 16-351

surface sediment in harbours: 12-650

background sediment in harbours: 40-30

surface sediment in river mouths: 15.7-220.8

bluffs: 39-76

soils: 59-89

Lake St. Clair

Parameter:	Cadmium	Sampling Methods:	Analytical Procedure:
Lake:	St. Clair		
	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$: dry weight		
Whole Lake - 55 sampling stations:			
- 1970: 0-2 cm: mean: 1.7, SD: 0.5	Shipetk - 0-2 cm subsample	AAS - after aqua regia extraction	
- 1974: 0-2 cm: mean: 1.4, SD: 0.5	Same	Same	
River mouths and harbours:			
Harbours: (6 samples) 1980: <0.5-1.0	Mini-Shipetk	AAS - after aqua regia extraction	
River mouths (7 samples) 1975: 0.9-5.5	Eksan and custom-made piston core	AAS - after nitric: perchloric acid (1:1)	
Years of references:	Lake: 1975; harbour: 1980; river mouths: 1975	extraction and evaporation to dryness (350°C)	
SUMMARY:			
surface sediment - whole lake: 0-2 cm:	1.0-3.0		
surface sediment - harbour: <0.5-1.0			
surface sediment - river mouths: 0.9-5.5			

Parameter: Chromium

Lake: St. Clair

Concentration in $\mu\text{g g}^{-1}$ dry weight

Sampling Methods:

Whole Lake:

- 1970: 0-2 cm: mean: 42.1, SD: 45.1
- 1974: 0-2 cm: mean: 58.3, SD: 57.1

River mouths and harbours:

Harbours: (6 samples) 12.0-155.0
River mouths (7 samples) 6.0-77.9

Analytical Procedure:

Shipek - 0-2 cm subsample
Same

AAS - aqua regia extraction
AAS - aqua regia extraction
AAS - nitric: perchloric acid (1:1)
extraction and evaporation to dryness (350°C)

Years of references: Lake & river mouths: 1975; Harbours: 1980

SUMMARY:

surface sediment - whole lake: 1.0-275.0
surface sediment - harbours: 12.0-155.0
surface sediment - river mouths: 6.0-77.9

Parameter: Copper
Lake: St. Clair
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Whole Lake - 55 samples:
- 1970: 0-2 cm: mean: 16.3, SD: 11.7
- 1974: 0-2 cm: mean: 14.6, SD: 9.7

River mouths and harbours:

Harbours: (6 samples) 1.0-54.0
River mouths: (7 samples) 4.5-80.6

Mini-Shippek
Ekman dredge & custom-made
Pileton core

Years of references: Lake & river mouths: 1975; harbours: 1980

SUMMARY:

surface sediment - whole lake: 0-2 cm: 2.0-48.0
surface sediment - harbours: 1.0-54.0
surface sediment - river mouths: 4.5-80.6

Analytical Procedure:

AAS - aqua regia extraction
Same

AAS - aqua regia extraction
AAS - nitric: perchloric acid (1:1)
extraction and evaporation to dryness (350°C)

Parameter: Lead

Lake: St. Clair

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Whole Lake:

- 1970:	surface:	0-2 cm:	mean:	26.0, SD:	13.8
- 1974:	surface:	0-2 cm:	mean:	26.7, SD:	13.2

River mouths and harbours:

Harbours: surface: 1980: <1.0-52.0

River mouths: surface: 1975: 12.1-151.1

Analytical Procedure:

AAS - aqua regia extraction
Same

Same
AAS - nitric: perchloric acid (1:1)
extraction and evaporation to dryness (350°C)

Years of references: Lake & river mouths: 1975; harbours: 1980

SUMMARY:

surface sediment - whole lake: 0-2 cm: 7.0-67.0

surface sediment - harbours: <1.0-52.0

surface sediment - river mouths: 12.1-151.1

Parameter: Mercury
Lake: St. Clair
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Whole Lake -
- 1975: 0-3 cm: 0.070-2.565
- 1976: 0-2 cm: 0.030-10.28
Mitchel Bay: 1977: 2.1 and 2.3
March: 1977: 0.108

River mouths and harbours:
Harbours: (6 samples) 1980: 0.020-0.320
River mouths: (7 samples) 1975: 0.07-2.77

Years of references: 1975-1977, harbours: 1980

SUMMARY:

surface sediment - whole lake: 0-3 cm: 0.30-10.28
surface sediment - Mitchell Bay: 2.1-2.3
surface sediment - harbours: 0.020-0.320
surface sediment - river mouths: 0.07-2.77

Analytical Procedure:

Shipok - 0-3 cm subsample
AAS - flameless (Bonder & Clegg, Ottawa)
Not described
Same

AAS - Flameless (Bonder & Clegg, Ottawa)
Coleman MAS50 mercury analyser (Van Loon, 1974)

Parameter: Nickel

Lake: St. Clair

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Whole lake - 55 samples:

- 1970: 0-2 cm: mean: 21.3, SD: 10.4
- 1974: 0-2 cm: mean: 20.6, SD: 9.6

River mouths & harbours:

- Harbours: (6 samples) 1980: 2.0-35.0
- River mouths: (7 samples) 1975: 8.7-49.2

Analytical Procedure:

AAS - aqua regia extraction
Same

River mouths & harbours:

- Mini-Shipek
Ekman dredge & custom made
piston core

AAS - aqua regia extraction
AAS - nitric: perchloric acid (1:1)
extraction and evaporation to dryness (350°C)

Years of references: Whole lake & river mouths: 1975; harbours: 1980

SUMMARY:

surface sediment - whole lake: 0-2 cm: 5.0-43.0
surface sediment - harbour: 2.0-35.0
surface sediment - river mouths: 8.7-49.2

Parameter: Nitrogen
Lake: St. Clair
Concentration in % dry weight

Sampling Methods:

Analytical Procedure:

Depositional zones:
- surface: 1977: 0-3 cm: 0.060-0.193%

Shipok - 0-3 cm subsample

Leco model WD - 14SP Nitrogen determinator
(Dumas method).

Nondepositional zones:
- surface: 1977: 0-3 cm: 0.015-0.075%

Same

Year of references: 1977

SUMMARY:
surface sediment - depositional zone: 0-3cm: 0.060-0.193%
surface sediment - nondepositional zone: 0-3 cm: 0.015-0.075%

Parameter: Oils & Grease

Lake: St. Clair

Concentration in $\mu\text{g.g}^{-1}$ dry weight

Depositional basin (whole lake):
- surface sediment: 1983: $\leq 60-172$

Harbours:
- surface sediment: 1980: $<60.0-491.0$

Years of references: 1980, 1983

Sampling Method:

Analytical Procedure:
 CCl_4 extraction - IR spectrometry

SUMMARY:
surface sediment - depositional zone: $<60-172.0$
surface sediment - harbours: 0-3 cm: $\geq 60.0-491.0$

Parameter: Organic carbon
Lake: St. Clair
Concentration in % dry weight

Sampling Methods:

Depositional basin:
- surface: 1977: 0-3 cm: 1.01-3.03%

Nondepositional areas:
- surface: 1977: 0-3 cm: 0.20-0.95%

Harbours:
- (Canadian shore - 6 harbours) 0.10-4.61%

Years of references: lake: 1977, harbours: 1980

Analytical Procedure:

Shipek - 0.3 cm subsample
Leco carbon analyser after sulfuric acid treatment

Same
Same
Same
Mini-Shipek

SUMMARY:
surface sediment - depositional basin: 1.01-3.03%
surface sediment - nondepositional zone: 0.20-0.95%
surface sediment - harbours: 0-10-4.61%

Parameter:	PCB	Lake:	St. Clair	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight	Sampling Methods:	Analytical Procedure:
Whole lake - 49 samples:						
- surface: 1970: 0-2 cm:	mean: 0.0191, SD: 0.0089				Shippek - 0-2 cm subsample	
- surface: 1974: 0-2 cm:	mean: 0.0100, SD: 0.0063				Same	
Harbours:						
- surface: (6 harbours): 1980: <0.010-0.060					Mini-Shippek	
Years of references:	1973 and 1980					
SUMMARY:						
surface sediment - whole lake: 0-2 cm:	0.0001-0.040					
surface sediment - harbours: <0.010-0.060						

Parameter: Zinc

Lake:

St. Clair
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Whole Lake:

- 1970: surface: 0-2 cm: mean: 45.2, SD: 25.4
- 1974: surface: 0-2 cm: mean: 46.2, SD: 20.2

River mouths and harbours:

Harbours: surface: 1980: 9.0-132.0
River mouths: surface: 1975: 31.2-330.3

Mini-Shipak
Krasan dredge & custom made
platen core

Years of references: Lake & river mouths: 1975; harbours: 1980

SUMMARY:

surface sediment - whole lake: 0-2 cm: 8.0-107.0
surface sediment - harbours: 9.0-132.0
surface sediment - river mouths: 31.2-330.3

Analytical Procedure:

AAS - aqua regia extraction
Same

Same
AAS - nitric: perchloric acid (1:1)
extraction and evaporation to dryness (350°C)

Lake Huron

Parameter:	Cadmium		
Lake:	Luron	Concentration in ug.g ⁻¹ dry weight	Sampling Methods:
Analytical Procedure:			
Depositional basins:			
- surface: 1978: 0-2 cm: 1.4-2.6	Benthos core	AAS - aqua regia at 85-90°C for 90 min.	
- surface: 1976: 0-2 cm: 2.2-2.6	Same	AAS - HCl conc. at 90° for 20 min.	
- surface: 1980: 0-2 cm: 1.5-4.3	Same	NA and AAS	
- surface: 1980: <0.3-0.65	Airlift core	AAS - aqua regia - HCl	
- background: 1978: 12-30 cm: 0.2-0.9	Benthos core	AAS - aqua regia at 85-90°C for 90 min.	
- background: 1976: 8.0-30.0 cm: 1.0-1.8	Same	AAS - HCl conc. at 90°C for 20 min.	
- background: 1980: enrichment factor (surface/background): 1.0	Same	NA & AAS	
Estuaries:			
Georgian Bay: nearshore zone: 1978:			
- surface: 0-1 cm: 2.6-4.6	Same	AIRLIFT core	AAS - aqua regia at 85-90°C for 90 min.
Georgian Bay: surface: 1980: <0.3-0.5	AIRLIFT core	HCl - aqua regia - AAS	
Georgian Bay: background: 1978: 10-24 cm: 0.6-1.0	Benthos core	AAS - aqua regia at 85-90°C for 90 min.	
North Channel: surface: 1980: <0.3-0.55	AIRLIFT core	HCl - aqua regia - AAS	
Sturgeon Bay: surface: 1980: <0.4-0.72	Same	Same	
South Bay: surface: 1976: 0-1 cm: 1.6	Benthos core	AAS - HCl conc. at 90° for 20 min.	
South Bay: surface: 1978: 0-1 cm: 1.6	Same	AAS - Aqua regia at 85-90° for 90 min.	
South Bay: background: 1978: 20-30 cm: 1.0	Same	Same	
South Bay: background: 1976: 8-10 cm: 1.5	Same	AAS - HCl conc. at 90° for 20 min.	
River mouth:			
Lake Huron (11 samples) 1975: surface: 0.2-1.7	Ekman dredge & custom made	AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°F)	
North Channel & Georgian Bay (15 samples)	Piston core	Same	
- 1975: surface: 0.1-2.0	Same	Same	
Years of references:	1975, 1976, 1978, 1980		
SUMMARY:			
surface sediment in depositional basins: <0.3-4.3			
background sediment in depositional basins: 0.2-1.8			
surface sediment in embayments: <0.3-4.6			
background sediment in embayments: 0.3-6.5			
surface sediment in river mouths: 0.1-2.0			

Parameter:	Chromium		
Lake:	Huron	Concentration in $\mu\text{g g}^{-1}$, dry weight	
		Sampling Method(s):	Analytical Procedure:
Depositional basins:			
- surface: 1978: 0-2 cm: 28.7-44.6	Benthos core	AAS - aqua regia at 85-90°C for 90 min.	
- surface: 1980: 0-1 cm: 31.9-86.4	Same	NA & AAS	
- surface: 1980: 5.5-20	Airlift core	MOE - aqua regia - AAS	
- background: 1978: 10-20 cm: 30.0-47.1	Benthos core	AAS - aqua regia at 85-90°C for 90 min.	
Embayments:			
Georgian Bay: nearshore zone: 1978:			
- surface: 0-1 cm: 35.0-43.3	Same	Same	
Georgian Bay: main basin: 1980: surface: 5.5-81	Airlift core	MOE - aqua regia - AAS	
Georgian Bay: nearshore zone: 1978:			
- background: 10-24 cm: 28.5-43.7	Benthos core	AAS - aqua regia at 85-90°C for 90 min.	
North Channel: 1980: surface: 5-77	Airlift core	MOE - aqua regia - AAS	
Sturgeon Bay: 1980: surface: 11-49	Same	Same	
River mouths:			
Lake Huron (11 samples) 1975: surface: 0.1-8.7		AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°F)	
North Channel & Georgian Bay (15 samples)			
- 1975: surface: 1.3-30.0	Piston core	Same	
Years of references: 1975, 1978, 1980			

SUMMARY:
surface sediment in depositional basins: 5.5-86.4
background sediment in depositional basins: 30.0-47.1
surface sediment in embayments: 5-81
background sediment in embayments: 28.5-43.7
surface sediment in river mouths: 0.1-30.0

Parameter:	Copper		
Lake:	Buron	Concentration in $\mu\text{g g}^{-1}$ dry weight	
Sampling Methods:			
Depositional basins:			
- surface:	1980: 0-1 cm: 3.3-71.1	Benthos core	AAS & AAS
- surface:	1978: 0-2 cm: 56-78	Same	AAS - aqua regia at 85-90°C for 90 min.
- surface:	1976: 0-2 cm: 63-68	Same	AAS - HCl extraction at 90°C for 20 min.
- surface:	1980: 2.5-15.0	Airlift corer	AAS - aqua regia - MDE
- background:	1976: 8-30 cm: 40-41	Benthos corer	AAS - HCl extraction at 90°C for 20 min.
- background:	1978: 10-30 cm: 31-48	Same	AAS - aqua regia at 85-90°C for 90 min.
- background:	1980: enrichment factor (surface/background): 0.4	Same	WA & AAS
Estuaries:			
Georgian Bay: nearshore zone: 1978:			
- surface: 0-1 cm: 73-92	Same	Airlift core	AAS - aqua regia at 85-90°C for 90 min.
Georgian Bay: surface: 1980: 2-37	Same		AAS - aqua regia, MDE
Georgian Bay: nearshore zone: 1978:			
- background: 10-24 cm: 43-51			
North Channel: surface: 1980: 2-95	Benthos core		AAS - HCl conc. for 20 min. at 90°C
Sturgeon Bay: surface: 1980: 5-21	Airlift core		AAS - aqua regia - MDE
South Bay: surface: 1976: 0-1 cm: 43	Same		Same
South Bay: surface: 1978: 0-1 cm: 43	Benthos gravity		AAS - HCl conc. at 90° for 20 min.
South Bay: background: 1978: 30-40 cm: 25	Same		AAS - aqua regia at 85-90° for 90 min.
South Bay: background: 1976: 8-10 cm: 33	Same		Same
River mouths:			
Lake Huron (11 samples) 1973: surface: 1.9-61.2		Ekman dredge & custom made	AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°F)
North Channel & Georgian Bay:		Piston core	Same
- surface: 1975: 1.3-48.1			
Years of references: 1975, 1976, 1978, 1980			

SUMMARY:

- surface sediment in depositional basins: 3.3-78
- background sediment in depositional basins: 31-48
- surface sediment in embayments: 2-95
- background sediment in embayments: 25-51
- surface sediment in river mouths: 1.9-61.2

Parameter: Iron
Lake: Huron
Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1976: 0-2 cm: 4.63-4.69%
- surface: 1978: 0-2 cm: 3.76-5.11%
- surface: 1980: 0-2 cm: 1.15-4.30%
- surface: 1980: 0.47-1.30%
- background: 1980: 1.15-4.30%
- background: 1978: 10-30 cm: 3.22-5.02%
- background: 1976: 8-30 cm: 4.24-4.65%

Embayments:

- Georgian Bay: nearshore zone: 1978:
 - surface: 0-1 cm: 5.10-5.52%
 - surface: 1980: 0.24-3.90%
- Georgian Bay: surface: 1980: 0.24-3.90%
 - Same
 - Airlift core
- Georgian Bay: nearshore zone: 1978:
 - background: 10-24 cm: 5.04-5.20%
- North Channel: surface: 1980: 0.53-6.72
 - Benthos core
 - Airlift core
- Surgeon Bay: surface: 1980: 0.86-3.00%
 - Same
 - Benthos core
- South Bay: surface: 1978: 0-1 cm: 4.60%
 - Same
 - Benthos core
- South Bay: surface: 1976: 0-1 cm: 4.60%
 - Same
 - X-ray fluorescence spectrometry
- South Bay: background: 1976: 8-10 cm: 4.07%
 - Same
 - Same
- South Bay: background: 1978: 20-30 cm: 4.36%
 - Same
 - Same

Years of references: 1976, 1978, 1980

SUMMARY:

surface sediment in depositional basins: 0.47-5.11%
background sediment in depositional basins: 1.15-5.02%
surface sediment in embayments: 0.53-6.7%
background sediment in embayments: 4.07-5.20%

Analytical Procedure:

Parameter: Lead
 Lake: Huron
 Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:
 - surface: 1978: 0-2 cm: 81.3-151.4
 - surface: 1976: 0-2 cm: 130-151
 - surface: 1980: 0-1 cm: 9.7-140
 - surface: 1980: <3.0-9.0
 - background: 1976: 8-30 cm: 24-36
 - background: 1978: 10-30 cm: 14.4-29.0
 - background: 1980: enrichment factor (surface/background): 2.2

Embayments:
 Georgian Bay: surface: 1978: 0-1 cm: 201-230
 Georgian Bay: surface: 1980: <3-15
 North Channel: surface: 1980: <3-17
 Sturgeon Bay: surface: 1980: <3-28
 South Bay: surface: 1978: 0-1 cm: 106.6
 South Bay: surface: 1976: 0-1 cm: 107
 South Bay: background: 1976: 8-10 cm: 58
 South Bay: background: 1978: 20-30 cm: 33.9
 South Bay: background: 1978: 10-24 cm: 87-93

River mouths:

Lake Huron (11 samples) 1975: surface: 7.0-258.7

Ekman dredge & custom made

North Channel & Georgian Bay (15 samples):
 - surface: 1975: 3.5-42.5

Years of references: 1975, 1976, 1978, 1980

SUMMARY:

surface sediment in depositional basins: <3.0-151.4
 background sediment in depositional basins: 14.4-36
 surface sediment in embayments: <3-230
 background sediment in embayments: 33.9-93
 surface sediment in river mouths: 3.5-258.7

Analytical Procedure:

Benthos core
 Same
 Same
 AAS - aqua regia at 85-90°C for 90 min.
 AAS - HCl concentration at 90°C for 20 min.
 NA - AAS
 HDE - AAS - aqua regia
 AAS - HCl concentration at 90°C for 20 min.
 AAS - aqua regia at 85-90°C for 90 min.
 NA & AAS

AAS - aqua regia at 85-90°C for 90 min.
 HDE - aqua regia - AAS
 Same
 Same
 AAS - HCl concentration at 90°C for 20 min.
 AAS - HCl concentration at 90°C for 20 min.
 AAS - HCl concentration at 90°C for 20 min.
 AAS - aqua regia - 90°C for 90 min.
 Same

AAS - nitric: perchloric acid (1:1) and
 evaporation to dryness (350°F)

Parameter:	Mercury		Sampling Methods:	Analytical Procedure:
Lake:	Buron	Concentration in $\mu\text{g.g}^{-1}$ dry weight		
Depositional basins:				
- surface:	1976:	0-1 cm: 0.090-0.200	Benthos core	AAS - flameless
- surface:	1976:	0-1 cm: 0.13-0.200	Same	Same
- surface:	1980	0-2 cm: 0.03-0.22	Same	NA & AAS
- surface:	1980:	<0.01-0.02	Airlift core	MOE - AAS
- background:	1976:	8-30 cm: 0.07-0.08	Benthos core	AAS - flameless
- background:	1978:	10-30 cm: 0.035-0.075	Same	Same
- background:	1980:	enrichment factor (surface/background): 4.6	Shipak grab - 0-3 cm subsample	NA & AAS (Barringer - 1966)
- whole lake: surface:	1976:	0-3 cm: 0.034-0.805	Shipak grab - 0-3 cm subsample	
Ripayments:				
Georgian Bay: nearshore zone:	1978:			
- surface:	0-1 cm: 0.125-0.175	Benthos core	Same	
Georgian Bay: whole area:	1976:	0-3 cm: 0.012-9.500	Shipak grab - 0-3 cm subsample	(Barringer - 1966)
Georgian Bay: surface:	1980:	<0.01-0.02	Airlift core	MOE
Georgian Bay: nearshore:	1978:			
background:	10-26 cm:	0.030-0.050	Benthos core	AAS - flameless (Barringer - 1966)
North Channel: whole area:	1976:	0-3 cm: 0.008-1.112	Shipak Grab - 0-3 cm subsample	MOE
North Channel: surface:	1980:	<0.01-0.09	Airlift core	Same
Sturgeon Bay: surface:	1980:	<0.01-0.06	Benthos core	AAS - flameless
South Bay: surface:	1976:	0-1 cm: 0.30	Same	Same
South Bay: surface:	1978:	0-1 cm: 0.297	Same	Same
South Bay: background:	1976:	8-10 cm: 0.300	Same	Same
South Bay: background:	1978:	20-30 cm: 0.323	Same	Same
River mouths:				
Lake Huron (11 samples)	1975:	surface: <0.01-0.36	Etkman dredge & custom made	
North Channel & Georgian Bay:	(15 samples)	Piston core		
- surface:	1975:	<0.01-0.18	Same	Same
Years of references:	1975, 1976, 1978, 1980			
			Coleman MAS 50 mercury analyzer (Van Loon, 1974)	

SUMMARY:

surface sediment in depositional basins: <0.01-0.805

background sediment in depositional basins: 0.035-0.080

surface sediment in embayments: <0.01-9.500

background sediment in embayments: 0.030-0.323

surface sediment in river mouths: <0.01-0.36

Parameter: Nickel

Lake: Huron

Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1978: 0-2 cm: 54.1-95.1
- surface: 1980: 0-1 cm: 5.3-96.7
- background: 1978: 10-28 cm: 29.9-50.9
- background: 1980: enrichment factor (surface/background): 0.5

Embayments:

Georgian Bay: nearshore zone:

- surface: 1978: 0-1 cm: 115.6-132.2
- Georgian Bay: nearshore: 1978:
- background: 10-24 cm: 49.6-61.1
- North Channel: surface: 1980: 15-49

River mouths:

Lake Huron (11 samples) surface: 1975: 1.8-20.4

North Channel & Georgian Bay: (15 samples)
- 1975: 4.9-184.8

Years of references: 1975, 1978, 1980

SUMMARY:

surface sediment in depositional basins: 5.3-96.7
background sediment in depositional basins: 29.9-30.9
surface sediment in embayments: 15-132.2
background sediment in embayments: 49.6-61.1
surface sediment in river mouths: 1.8-184.8

Analytical Procedure:

- AAS' - aqua regia at 85-90°C for 90 min.
- NA & AAS
- AAS - aqua regia at 85-90°C for 90 min.
- NA & AAS

- AAS - aqua regia at 85-90°C for 90 min.
- Same
- NAK

- AAS - nitric acid (1:1) and evaporation to dryness (350°F)
- Same

Parameter: Nitrogen
Lake: Huron
Concentration in % dry weight

Depositional basins:

- surface: 1977: 0-3 cm: 0.039-0.520%
- surface: 1978: 0-2 cm: 0.440-0.547%
- surface: 1976 0-2 cm: 0.44-0.55%
- surface: 1971: 0-3 cm: 0.35-0.49%
- surface: 1980: 0.014-0.13%
- background: 1976: 8-30 cm: 0.37-0.48%
- background: 1978: 10-30 cm: 0.380-0.493%

Nondepositionnal & nearshore zones:

- surface: 1971: 0-3 cm: 0.05-0.23%
- surface: 1977: 0-3 cm: 0.002-0.384%

Sampling Methods:

- Shipek grab - 0-3 cm subsample
- Benthos core
- Same
- Shipek grab - 0-3 cm subsample
- Airlift core
- Benthos core
- Same

Embayments:

- Georgian Bay & North Channel: 1977: depositional:
 - surface: 0-3 cm: 0.127-0.613%
 - surface: 0-3 cm: 0.007-0.600%
- Georgian Bay: surface: 1980: 0.013-0.12%
- Georgian Bay: nearshore: surface: 0-1 cm: 0.353-0.427%
- Georgian Bay: nearshore: 1978:
 - background: 10-24 cm: 0.287-0.373%
 - Sturgeon Bay: surface: 1980: 0.066-0.612%
- North Channel: surface: 1980: 0.023-0.32%
- South Bay: surface: 1978: 0-1 cm: 0.475%
- South Bay: surface: 1976: 0-1 cm: 0.48%
- South Bay: background: 1976: 8-10 cm: 0.35%
- South Bay: background: 1978: 20-30 cm: 0.371%

Analytical Procedure:

- Leco Model VO-148P nitrogen determinator
(Dumas method)
- Coleman Model 29A
- Same
- Same
- HOR
- Coleman Model 29A
- Same

Years of references: 1971, 1976, 1977, 1978, 1980

SUMMARY:

- surface sediment in depositional basins: 0.014-0.55%
- background sediment in depositional basins: 0.37-0.493%
- surface sediment in nearshore zones: 0.002-0.386%
- surface sediment in embayments: 0.007-0.61%
- background sediment in embayments: 0.287-0.373%

Parameter: Organic Carbon - and Loss on Ignition

Lake: Huron
Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1973: 0-3 cm: 2.18-3.13 (%mean)
- surface: 1977: 0-3 cm: 0.34-4.49%
- surface: 1980: 0-2 cm: 0.55-5.8%
- surface: 1978: 0-2 cm: 3.56-4.65%
- surface: 1971: 0-3 cm: 1.96-4.00%
- surface: 1976: 0-2 cm: 3.56-4.65%
- surface: 1980: LOI: 0.27-2.3%
- surface: 1980: 0.006-0.079%
- surface: 1980: 0.031-0.66%
- background: 1976: 8-30 cm: 3.13-4.16%
- background: 1978: 10-30 cm: 3.15-4.17%
- background: 1980: enrichment factor (surface/background): 0.2

Nondepositional & nearshore zones:

- surface: 1971: 0-3 cm: 0.001-2.33%
- surface: 1971: 0-3 cm: 0.001-1.03%
- surface: 1977: 0-3 cm: 0.03-3.81%
- surface: 1973: 0-3 cm: 0.82% (%mean; S.D.=0.80)

Katabays:

- Georgian Bay & North Channel: depositional:
 - surface: 0-3 cm: 1.00-4.77%
 - surface: 0-3 cm: 0.04-5.7%
- Georgian Bay & North Channel: 1977: nondepositional:
 - surface: 0-3 cm: 0.04-5.7%
- Georgian Bay: 1978: nearshore:
 - surface: 0-1 cm: 2.68-3.60%
 - Georgian Bay: 1980: surface: 0-0.16%
 - Georgian Bay: 1980: surface: LOI: 0.1-2.7%
 - Georgian Bay: 1978: nearshore:
 - background: 10-24 cm: 2.11-2.78%
- Sturgeon Bay: 1980: surface: LOI: 2.6-14.0%
- Sturgeon Bay: 1980: surface: 0.052-0.50%
- North Channel: 1980: surface: 0.0-0.35%
- North Channel: 1980: surface: LOI: 0.57-8.0%

Analytical Procedure:

- | | |
|---------------------------------|----------------------|
| Shippek grab - 0-3 cm subsample | Leco Carbon analyser |
| Same | Same |
| Benthos core | Same |
| Same | Leco Carbon analyser |
| Shippek grab - 0-3 cm subsample | Same |
| Benthos core | Same |
| Air lift core | MOE |
| Same | Same |
| Same | Same |
| Same | Leco Carbon analyser |
| Same | Same |
| Not described | |

South Bay:	1978:	surface:	0-1 cm:	3.76%	Benthos core
South Bay:	1976:	surface:	0-1 cm:	3.76%	Same
South Bay:	1976:	background:	8-10 cm:	3.06%	Same
South Bay:	1978:	background:	20-30 cm:	3.42%	Same

Years of references: 1971, 1973, 1976, 1977, 1978, 1980

SUMMARY:

surface sediment in depositional basins: 0.006-5.8%
background sediment in depositional basins: 3.13-4.17%
surface sediment in nondepositional and nearshore zones: 0.001-3.81%
surface sediment in embayments: 0.0-5.7%
background sediment in embayments: 2.11-3.42%

Parameter: PCB

Lake: Huron

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Entire Lake:

- surface: 1976: 0.01-0.02

Embayments:

Surgeon Bay: 1981: surface: N.D.

North Channel: 1981: surface: N.D.-0.490

Years of references: 1976, 1981

SUMMARY:

surface sediment in whole lake: 0.01-0.02

surface sediment in embayments: N.D.-0.490

Analytical Procedure:

Modified Webb and McCall, 1973

HDX methods
Same

Parameter: Phosphorus
Lake: Huron
Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1976: 0-2 cm: 1,000 Benthos core
- surface: 1978: 0-2 cm: 900-1,000 Same
- surface: 1980: 0-1 cm: 400-2,500 Same
- surface: 1980: 190-380 NA
- background: 1976: 8-30 cm: 800-900 Airlift core
- background: 1978: 10-30 cm: 700-900 Benthos core
- same: Same

Embayments:

- Georgian Bay: 1978: surface: 0-1 cm: 900-1,200 Benthos core
- Georgian Bay: 1980: surface: 210-790 Airlift core
- Georgian Bay: 1978: background: 10-24 cm: 900-1,000 Benthos core
- Surgeon Bay: 1980: surface: 940-1,600 Airlift core
- North Channel: 1980: surface: 280-8,600 Same

Years of references: 1976, 1978, 1980

SUMMARY:

surface sediment in depositional basins: 190-2,500
background sediment in depositional basins: 700-900
surface sediment in embayments: 210-8,600
background sediment in embayments: 900-1,600

Analytical Procedure:

Parameter:	Zinc		
Lake:	Huron	Concentration in % dry weight	Sampling Methods:
			Analytical Procedure:
Depositional basins:			
- surface:	1976: 0-2 cm: 210-228	Benthos core	AAS - HCl at 90°C for 20 min.
- surface:	1978: 0-2 cm: 147-231	Same	AAS - aqua regia at 85-90°C for 90 min.
- surface:	1980: 8.2-204	Same	NA & AAS
- surface:	1980: 11-37	Airlift core	NOE - AAS - aqua regia
- background:	1976: 8-30 cm: 88	Benthos core	NOE - HCl at 90°C for 20 min.
- background:	1978: 10-30 cm: 60-88	Same	AAS - aqua regia at 85-90°C for 90 min.
Embayments:			
Georgian Bay:	1980: surface: 6-74	Airlift core	NOE - AAS - aqua regia
Georgian Bay:	1978: nearshore:	Benthos core	AAS - aqua regia at 85-90°C for 90 min.
- surface:	0-1 cm: 201-230	Same	Same
Georgian Bay:	1978: nearshore:	Airlift core	NOE - AAS - aqua regia
- background:	10-24 cm: 87-93	Same	Same
Sturgeon Bay:	1980: surface: 27-130	Benthos core	NOE - HCl at 90°C for 20 min.
North Channel:	1980: surface: 12-100600	Same	AAS - aqua regia at 85-90°C for 20 min.
South Bay:	1976: surface: 0-1 cm: 154	Airlift core	AAS - HCl at 90°C for 20 min.
South Bay:	1978: surface: 0-1 cm: 154	Same	AAS - aqua regia at 85-90°C for 20 min.
South Bay:	1976: background: 8-10 cm: 116	Same	AAS - HCl at 90°C for 20 min.
South Bay:	1978: background: 20-30 cm: 78	Same	AAS - aqua regia at 85-90°C for 90 min.
River mouths:			
Lake Huron (11 samples)	surface: 1975: 5-8-257.2	Ekman dredge & custom made piston core	AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°F)
North Channel & Georgian Bay (15 samples):		Ekman Grab	Same
Years of references: 1975, 1976, 1978, 1980			
SUMMARY:			
surface sediment in depositional basins: 8.2-233			
background sediment in depositional basins: 60-88			
surface sediment in embayments: 78-116			
surface sediment in river mouths: 5.7-257.2			

Lake Michigan

Parameter:	Cadmium		
Lake:	Michigan	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight	
			Sampling Method(s):
Depositional basins:		Benthos core	AAS
- surface: 1981: 0-5 cm: 0.5-1.8		Same	Same
- background: 1981: 10 cm: 0.5-0.7			
Embaysments:		Shipok Grab	AAS - aqua regia
Sleeping Bear Point Bay: 1977: surface: 0.07-1.93		Jenkin core	AAS
Green Bay: 1981: surface: 0-5 cm: 1.1-1.8		Same	Same
Green Bay: 1981: background: 15 cm: 0.5-1.3			
River mouths:		Ekman dredge & custom made	AAS - nitric: perchloric acid (1:1) and evaporation to dryness (350°F)
- surface (27 samples): 1975: 0.1-16.6		piston core	
Years of references: 1975, 1977, 1981			

SUMMARY:
 surface in depositional basins: 0.5-1.8
 background in depositional basins: 0.5-0.7
 surface in embayments: 0.07-1.93
 background in embayments: 0.5-1.3
 surface in river mouths: 0.1-16.6

Parameter: Chromium
Lake: Michigan
Concentration in $\mu\text{g/g}^{+1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1981: 140
- background: 1981: 50

Box core
Same

Embayments:

- Little Traverse Bay: 1979: surface: 4.9-72
- Sleeping Bear Point Bay: 1977: surface: 2.0-47.0

Ponar grab
Shipak grab

River mouths:

- surface (27 samples): 1975: 0.5-1,295

Ekman dredge & custom made
piston core

Years of references: 1975, 1977, 1979, 1981

SUMMARY:

surface sediment in depositional basins: 140
background sediment in depositional basins: 50
surface sediment in embayments: 2.0-72
surface sediment in river mouths: 0.5-1,295

AAS - HP: HNO_3 : HClO_4 extraction
AAS - aqua regia

AAS - nitric: perchloric acid (1:1) and
evaporation to dryness (350°F)

Parameter: Copper
Lake: Michigan
Concentration in $\mu\text{g.g}^{-1}$ dry weight

Analytical Procedure:

Depositional basins:

- surface: 1981: 54
- background: 1981: 15

Embayments:

- Grand Traverse Bay: 1970: surface: 7-32
- Little Traverse Bay: 1979: surface: 1.4-54
- Sleeping Bear Point Bay: 1977: surface: 0.8-34.5

River mouths:

- surface (27 samples): 1975: 0.5-64.0

Years of references: 1977, 1979, 1981

SUMMARY:

- surface sediment in depositional basins: 54
- background sediment in depositional basins: 15
- surface sediment in embayments: 0.8-54
- surface sediment in river mouths: 0.5-84

Sampling Methods:

Box core
Same

AAS
AAS - HP: HNO_3 : HClO_4 extraction
AAS - aqua regia

Ponar grab
Same
Shipek grab

AAS - nitric: perchloric acid (1:1) and
evaporation to dryness (350°F)

Parameter: Iron

Lake: Michigan
Concentration in % dry weight

Embayments:

Grand Traverse Bay: 1970: surface: 0.6-1.9

Little Traverse Bay: 1979: surface: 0.4-2.55

Years of references: 1979

SUMMARY: surface sediment in embayments: 0.4-2.55

Analytical Procedure:

AAS
AAS - HF: HNO₃: HClO₄ extraction

Parameter: Mercury

Lake: Michigan

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Analytical Procedure:

Sampling Methods:

Depositional basins:

- surface: 1976: 0-5 cm: 0.030-0.360

Benthos core
Not described

River mouths:

- surface (27 samples): 1975: <0.01-1.20

**Ekaen dredge & custom made
piston core**
Coleman MAS 50 mercury analyser (Van Loon, 1974)

Years of references: 1975, 1976

SUMMARY:

surface sediment in depositional basins: 0.030-0.360

surface sediment in river mouths: <0.01-1.20

Parameter: Nickel

Lake: Michigan

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Analytical Procedure:

Depositional basins:	
- surface: 1981: 25	AAS
- background: 1981: 20	Same
Bayous:	
Sleeping Bear Point Bay: 1977: surface: 1.7-54.2	Shipek grab
River mouths:	
- surface (27 samples): 1975: 1.6-74.8	Ekman dredge & custom made piston core
Years of references: 1977, 1977, 1981	

SUMMARY:

surface sediment in depositional basins: 25
background sediment in depositional basins: 20
surface sediment in embayments: 1.7-54.2
surface sediment in river mouths: 1.6-74.8

Parameter: Organic Carbon

Lake:

Michigan
Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-1 cm: 2.5%
- surface: 1976: 0-5 cm: 2.17-2.23
- background: 1980: 55 cm: 1.8
- background: 1976: 5-40 cm: 0.67-2.63

Estuaries:

Grand Traverse Bay: 1975: surface: 0.7-4.0

Sleeping Bear Point Bay: 1977: surface: 0.16-4.13

Years of references: 1975, 1976, 1977, 1980

SUMMARY:

surface sediment in depositional basins: 2.17-2.5

background sediment in depositional basins: 0.67-2.63

surface sediment in estuaries: 0.16-4.13

Analytical Procedure:

- CHN - analyser (Hewlett-Packard 185-B)
- Not specified
- CHN - analyser (Hewlett-Packard 185-B)
- Not specified

Combustion at 1,300°C MIBCO gasometric Carbon detector Dohrmann Carbon analyser

Parameter: Lead
Lake: Michigan
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1981: 130
- surface: 1981: 0-5 cm: 10-18
- background: 1981: 10 cm: 8-10
- background: 1981: 10

Embayments:

- Green Bay: 1981: surface: 29-48
- Green Bay: 1981: background: 15 cm: 8-29
- Traverse Bay: 1973: surface: 1.3-56.2

River mouths:

- surface: 27 samples: 1975: 1.3-149.0

Years of references: 1973, 1975, 1981

SUMMARY:

- surface sediment in depositional basins: 10-130
- background sediment in depositional basins: 8-10
- surface sediment in embayments: 1.3-56.2
- background sediment in embayments: 8-29
- surface sediment in river mouths: 1.3-169.0

AAS - nitric: perchloric acid (1:1) evaporation
to dryness (350°C)

Parameter: PCB

Lake: Michigan

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Analytical Procedure:

Sampling Methods:

Depositional basins:			
- surface:	1980:	0-3 cm:	0.002-0.0735
Nondepositional zones:			Shipuk grab
- surface:	1980:	0-3 cm:	0.0063 (mean)
Estuaries:			GC
Little Traverse Bay:	1980:	surface:	0.0016-0.0067
Years of references:	1980		Ponar grab
			Same

SUMMARY:

surface sediment in depositional basins: 0.002-0.0735

surface sediment in nondepositional zones: 0.0063

surface sediment in estuaries: 0.0016-0.0067

Parameter: Zinc

Lake: Michigan
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1981: 0-5 cm: 40-170
- surface: 1981: 350
- background: 1981: 10 cm: 40-45
- background: 1981: 50

Analytical Procedure:

- Benthos core AAS
- Box core Same
- Benthos core Same
- Box core Same

Embayments:

- Grand Traverse Bay: 19 : surface: 42-160 Ponar grab
- Little Traverse Bay: 1979: surface: 7.0-136 Same
- Sleeping Bear Point Bay: 1977: surface: 2.4-140.0 Shipek Grab
- Green Bay: 1981: surface: 0-5 cm: 100-160 Jenkin core
- Green Bay: 1981: background: 15 cm: 50-80 Same

River mouths:

- surface: 27 samples: 1975: 3.5-398.0

Ekman Dredge and custom made piston core

Years of references: 1975, 1977, 1979, 1981.

SUMMARY:

- surface sediment in depositional basins: 40-350
- background sediment in depositional basins: 40-50
- surface sediment in embayments: 2.4-160
- background sediment in embayments: 50-80
- surface sediment in river mouths: 3.5-398.0

AAS - nitric: perchloric acid (1:1) evaporation
to dryness (350°C)

Lake Superior

Parameter: Cadmium
Lake: Superior
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Analytical Procedure:

Depositional basins:

- surface: 1978: 0-1 cm: 1.6-2.5
- background: 1978: 10-20 cm: 0.4-0.7

River mouths:

- surface: 0.1-1.3

Sampling Methods:

Sampling Methods:

Benthos core
Same

AAS - aqua regia at 85-90°C for 90 min.
Same

Ethman Dredge and custom made
Piston core

AAS - nitric: perchloric acid (1:1) evaporation
to dryness (350°C)

Years of reference: 1978 (lake); 1975 (river mouths)

SUMMARY:

surface sediment in depositional basins: 1.4-2.5
background sediment in depositional basins: 0.4-0.7
surface sediment in river mouths: 0.1-1.3

Parameter: Chromium

Lake: Superior

Concentration in $\mu\text{g.g}^{-1}$, dry weight

Sampling Methods:

Depositional basins:

- surface: 1978: 0-1 cm: 29.5-60.2
- background: 1978: 26.1-73.1

Benthos core

Same

AAS - aqua regia at 85-90°C for 90 min.

Nearshore zone:

- surface: 1978: 0-1 cm: 44.8-45.6
- surface: 1978: 8-9 cm: 37.6
- background: 1978: 49.8-51.8

Same

Same

Same

AAS - aqua regia at 85-90°C for 90 min.

Embayments:

Western Nippigon Bay: 1975: surface: 13.7-87.3

Ponar grab

River mouths:

- surface: 1975: 0.9-22.8

Stream dredge and custom made piston core

AAS - nitric: perchloric acid (1:1) evaporation to dryness (350°C)

Years of references: 1975 (embayment and river mouths); 1978 (lake)

SUMMARY:

- surface sediment in depositional basins: 29.5-60.2
- background sediment in depositional basins: 26.1-73.1
- surface sediment in nearshore zones: 37.6-45.6
- background sediment in nearshore zones: 49.8-51.8
- surface sediment in embayments: 13.7-87.3
- surface sediment in river mouths: 0.9-22.8

Parameter:	Copper	Lake:	Superior	Sampling Methods:	Analytical Procedure:
Concentration in $\mu\text{g.g}^{-1}$ dry weight	-	-	-	-	-
Depositional basins:					
- surface: 1978: 0-1 cm: 113-173	Benthos core	AAS - aqua regia at 85-90°C for 90 min.			
- background: 1978: 30-84	Same	Same			
Nearshore zone:					
- surface: 1978: 0-1 cm: 162-213	Same	AAS - HCl concentrated extraction			
- surface: 1978: 8-9 cm: 166	Same	AAS - Sieved through 0.177 mm sieve, hot perchloric			
- background: 1978: 14-20 cm: 57-69	Same	acid digestion for 2 hrs			
Embayments:					
Western Nipigon Bay: 1975: surface: 23.0-47.7	Ponar grab	AAS - nitric: perchloric acid (1:1) evaporation			
Kerrennar Point (Upper Michigan): 1972	Shipek grab	to dryness (350°C)			
- Surface: 12-300					
River mouths:					
- surface: 1975: 0.6-262.8	Stman Dredge and custom made piston core				
Years of references:	1972, 1975 (embayments); 1975 (river mouths); 1978 (lake)				
SUMMARY:					
surface sediment in depositional basins: 113-173					
background sediment in depositional basins: 30-84					
surface sediment in nearshore zones: 162-213					
background sediment in nearshore zones: 57-69					
surface sediment in embayments: 12-300					
surface sediment in river mouths: 0.6-262.8					

Parameter:	Iron	Lake:	Superior	Sampling Method:		Analytical Procedure:	
Depositional basins:							
- surface: 1978: 0-1 cm: 4.91-5.76%				Benthic core			
- background: 1978: 10-20 cm: 3.18-5.88%				Same			
Nearshore zones:							
- surface: 1978: 0-1 cm: 5.52-6.23%				Same			
- surface: 1978: 8-9 cm: 5.90%				Same			
- background: 1978: 14-20 cm: 5.37-5.94%				Same			
Embayments:							
Western Nippigon Bay: 1975: surface:				Ponar Grab			
mean: (45 s) 5.10%: S.D. (45 s): 0.58%				Same			
Years of references: 1975 (embayment); 1978 (lake)							
SUMMARY:							
surface sediment in depositional basins: 4.91-5.76%							
background sediment in depositional basins: 3.18-5.88%							
surface sediment in nearshore zones: 5.52-6.23%							
background sediment in nearshore zones: 5.37-5.94%							
surface sediment in embayments: mean: 5.10% (S.D. 0.58%)							

Parameter:	Mercury				
Lake:	Superior Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight				
	Sampling Methods:				
Whole lake (405 samples):					
- surface: 1976: 0-3 cm:	0.004-0.584	Shipak grab - 0-3 cm subsample	Combustion technique (Barringer, 1966)		
Depositional basins:					
- surface: 1978: 0-1 cm:	0.094-0.160	Benthos core	AAS - flameless		
- background: 1978: 10-20 cm:	0.064-0.068	Same	Same		
Nearshore zones:					
- surface: 1978: 0-1 cm:	0.212-0.356	Same	Same		
- surface: 1978: 8-9 cm:	0.172	Same	Same		
- background: 1978: 14-20 cm:	0.080-0.084	Same	Same		
Rabeyments:					
Western Nippigon Bay: 1975: surface:	0.030-0.420	Ponar grab	Same		
River mouths:					
- surface: 1975: <0.010-1.050	Ekman dredge and custom made	Coleman MAS 50 mercury analyser (Van Loon, 1974)			
Years of references:	1975 (embayments & river mouths); 1976 (whole lake); 1978 (deposition and nearshore areas)				
SUMMARY:					
surface sediment in depositional basins:	0.094-0.160				
surface sediment over whole lake:	0.004-0.584				
background sediment in depositional basins:	0.044-0.068				
surface sediment in nearshore zones:	0.172-0.356				
background sediment in nearshore zones:	0.080-0.084				
surface sediment in embayments:	0.030-0.420				
surface sediment in river mouths:	<0.010-1.050				

Parameter:	Nickel		
Lake:	Superior	Concentration in $\mu\text{g g}^{-1}$ dry weight	Sampling Method:
Depositional basins:			Analytical Procedure:
- surface: 1978: 0-1 cm: 28.9-66.4	Benthic core	AAS - aqua regia at 85-90°C for 90 min.	
- background: 1978: 10-20 cm: 26.4-69.8	Same	Same	
Nearshore zone:			
- surface: 1978: 0-1 cm: 55.6-55.7	Same		
- surface: 1978: 8-9 cm: 59.2	Same	Same	
- background: 1978: 14-20 cm: 57.7-63.5	Same	Same	
Estuaries:			
Western Nippigon Bay: 1975: surface: 5.7-68.6	Ponar grab	AAS - HCl concentrated extraction	
Kerrsenar Point (Upper Michigan): 1972:			
- surface: 15-70	Shipet grab	AAS - sieved through 0.177 mm sieve, hot perchloric acid for 2 hrs.	
River mouths:			
- surface: 1975: 1.1-33.4	Ekaen dredge and custom made piston core		
Years of references:	1972, 1975 (embayments & river mouths); 1978 (lake)		
SUMMARY:			
surface sediment in depositional basins:	28.9-66.4		
background sediment in depositional basins:	24.4-69.8		
surface sediment in nearshore zones:	55.6-59.2		
background sediment in nearshore zones:	57.7-63.5		
surface sediment in embayments:	5.7-70		
surface sediment in river mouths:	1.1-33.4		

Parameter:	Nitrogen		
Lake:	Superior	Concentration in % dry weight	
			Sampling Method:
			Analytical Procedure:
Depositional basins:			
- surface: 1977:	0-3 cm:	0.019-0.533%	Coleman model 29A
- surface: 1978:	0-1 cm:	0.400-0.407%	Leco Model WO-148P nitrogen determinator (Dumas method)
- background: 1978:	10-20 cm:	0.247-0.287%	Same
Nearshore zone:			
- surface: 1977:	0-3 cm:	0.019-0.400%	Shipak grab - 0-3 cm subsample
- surface: 1978:	0-1 cm:	0.380-0.443%	Benthos core
- surface: 1978:	8-9 cm:	0.340%	Coleman model 29A
- background: 1978:	14-20 cm:	0.300-0.307%	Leco Model WO-148P nitrogen determinator (Dumas method)
Years of references:	1977, 1978	Same	Same
SUMMARY:			
surface sediment in depositional basins:	0.019-0.533%		
background sediment in depositional basins:	0.247-0.287%		
surface sediment in nearshore zones:	0.019-0.443%		
background sediment in nondepositional zones:	0.300-0.307%		

Parameter:	Organic Carbon		
Lake:	Superior	Concentration in % dry weight	
			Sampling Methods:
Depositional basins:			
- surface: 1977: 0-3 cm: 0.40-3.85%		Shipek grab - 0-3 cm subsample	Leco Carbon analyser (+ sulfuric acid)
- surface: 1978: 0-1 cm: 3.55-3.94%		Benthos core	Same
- background: 1978: 10-20 cm: 2.24-2.40%		Same	Same
Nondepositional zones:			
- surface: 1977: 0-3 cm: 0.40-3.85%		Same	Same
- surface: 1978: 0-1 cm: 3.33-3.84%		Same	Same
- surface: 1978: 8-9 cm: 3.01%		Same	Same
- background: 1978: 14-20 cm: 2.29-2.73%		Same	Same
Estuaries:			
Western Nippigon Bay: 1975: surface: 1.08-31.2%		Ponar grab	Same
Years of references:	1977, 1978 (lake); 1975 (embayment)		
SUMMARY:			
surface sediment in depositional basins:	0.40-3.94%		
background sediment in depositional basins:	2.24-2.40%		
surface sediment in nondepositional zones:	0.40-3.85%		
background sediment in nondepositional zones:	2.29-2.73%		
surface sediment in embayments:	1.08-31.2%		

Parameter:	Lead	Sampling Method:	
Lake:	Superior	Concentration in $\mu\text{g}\cdot\text{s}^{-1}$ dry weight	
Depositional basins:		Analytical Procedure:	
- surface: 1978: 0-1 cm: 74.9-138.2	Benthos core	AAS - aqua regia at 85-90°C for 90 min.	
- background: 1978: 10-20 cm: 20.5-68.0	Same	Same	
Nearshore zones:			
- surface: 1978: 0-1 cm: 68.7-143.9	Same	Same	
- background: 1978: 14-20 cm: 18.4-24.6	Same	Same	
Embayments:			
Western Nippigon Bay: 1975: surface: 10.5-39.7	Ponar grab	AAS - HCl concentrated extraction	
River mouths:			
- surface: 1975: 1.2-61.8	Elman dredge and custom made piston core	AAS - nitric: Perchloric acid (1:1) extraction and evaporation to dryness (350°F)	
Years of references:	1975 (river mouths & embayments); 1978 (lake)		
SUMMARY:			
surface sediment in depositional basins:	74.9-138.2		
background sediment in depositional basins:	20.5-68.0		
surface sediment in nearshore zones:	68.7-143.9		
background sediment in nearshore zones:	18.4-24.6		
surface sediment in embayments:	10.5-39.7		
surface sediment in river mouths:	1.2-61.8		

Parameter:	PCB			
Lake:	Superior	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight	Sampling Method:	Analytical Procedure:
Depositional basins:				
- surface: 1979:	0-3 cm:	0.004-0.390	Box core (0-3 cm subsample)	GC
- surface: 1976:	0.01-0.02		Shipet grab	Modified Webb & McCall (1973)
Nondepositional zones:				
- surface: 1980:	0-3 cm:	0.0039 (mean: 3. D=0.0021)	Shipet grab (0-3 cm subsample)	GC - Ontario Pesticide Laboratory Guelph
- surface: 1974:	trace (?)		Shipet grab	Not described
- Marathon area:	surface:	1974: 0.250	Same	Same
- Marathon area:	surface:	1976: 1.3	Same	Modified Webb & McCall (1973)
Whole lake:				
- surface: 1980:	0-3 cm:	0.0025-0.0570	Shipet grab (0-3 cm subsample)	GC - Ontario Pesticide Laboratory Guelph
Years of references:	1974			
SUMMARY:				
surface sediment in depositional basins:	0.004-0.390			
surface sediment in nondepositional zones:	trace (0.001)-1.3			
surface - whole lake:	0.0025-0.0570			

Parameter:	Phosphorus		
Lake:	Superior		
	Concentration in $\mu\text{g.g}^{-1}$ dry weight		
Depositional basins:		Sampling Methods:	Analytical Procedure:
- surface:	1978: 0-1 cm: 900-1,100	Benthos core	X-ray fluorescence
- surface:	1978: 10-20 cm: 600-1,000	Same	Same
Nearshore zones:			
- surface:	1978: 0-1 cm: 1,100-1,500	Same	
- surface:	1978: 8-9 cm: 2,000	Same	
- background:	1978: 14-20: 700-1,200	Same	
Embayments:			
Western Nippigon Bay:	surface: 1975: - 1,100 (mean for 45 samples, S.D.=300)	Ponar grab	
Years of references:	1975 (embayment); 1978 (lake)		
SUMMARY:			
surface sediment in depositional basins:	900-1,100		
background sediment in depositional basins:	600-1,000		
surface sediment in nearshore zones:	1,100-2,000		
background sediment in nearshore zones:	700-1,200		
surface sediment in embayments:	1,100		

Parameter:	Zinc	Lake:	Superior	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight		Sampling Method:	Analytical Procedure:
Depositional basins:							AAS - aqua regia at 85-90°C for 90 min.
- surface:	1978: 0-1 cm: 143-195	Benthos core	Same				
- background:	1978: 10-20 cm: 53-137	Same					
Nearshore zones:							
- surface:	1978: 0-1 cm: 165-202	Same	Same				
- background:	1978: 19-20: 105-117	Same	Same				
Estuaries:							
Kennebunk Point (Upper Michigan):							
- surface:	1972: 36-150	Ship's grab					
River mouth:							
- surface:	1975: 36-150	Ehman dredge and custom made piston core					
Years of references:	1975 (embayment & river mouth); 1976 (lake)						
SUMMARY:	surface sediment in depositional basins: 143-195 background sediment in depositional basins: 53-137 surface sediment in nearshore zones: 165-202 background sediment in nearshore zones: 105-117 surface sediment in embayments: 36-150 surface sediment in river mouth: 3.0-85.5						

APPENDIX II
Scoring System and
List of Candidate Compounds

SORPTION TO SEDIMENTS

Score	Category
6	Highly sorbed to sediments
4	Moderately sorbed to sediments
1	Poorly sorbed to sediments
0	Not sorbed to sediments
* Insufficient information or Sorption = Log P of the compound	

Rationale:

Sorption or chemical partitioning between sediments and/or suspended particulates occurs in all aquatic environments. The rate of this process is affected by the nature of the chemical (non-polar vs. polar), particle size and organic content of sediments. Finer particle size and higher organic content of aquatic sediments and particulates increases their ability to sorb chemical pollutants.

The n-octanol/water partition coefficient (K_{ow}) has been shown to correlate with the sorption potential of chemical pollutants (Briggs, 1973; Kenag and Goring). Where K_{ow} data exists the log of

this number ($\log P$) is used to indicate the tendency of a compound to sorb onto sediment and particulate matter in the aquatic environment.

In the cases where no K_{ow} values or sorption information could be found in the literature for specific chemicals, the solubility and vapour pressure of these was used to indicate the sorption potential. Generally, chemicals with low vapour pressures and low solubilities tend to accumulate in the sediments.

PERSISTENCE

Score	Category	T 1/2 in Weeks
1	Very persistent	>52
3	Persistent	40-52
2	Slowly degradable	27-39
1	Moderately degradable	14-26
0	Readily degradable	0-13

Rationale:

A major factor for assessing the potential hazard of an environmental contaminant is consideration of its environmental persistence. Many synthetic compounds are highly resistant to natural degradation processes (i.e. biodegradation, photochemical degradation, chemical degradation) and may persist and accumulate in the environment. Continuous exposures to some substances, even at low concentrations, may result in chronic toxic effects on organisms and cumulative effects on populations. In addition, the longer a substance persists, the greater the opportunity for it to bioaccumulate to toxic levels in organisms. Of equal importance, persistent substances have the potential for wider dispersal in the environment.

Time ranges for each category of persistence were selected based on data for pesticides. The very persistent category ($t_{1/2} > 52$ weeks) includes many of the chlorinated hydrocarbon insecticides (e.g. DDT, aldrin, lindane) while the readily degradable category ($t_{1/2} = 0-13$ weeks) includes many of the organophosphorus insecticides (e.g. dichlorvos, disulfoton, malathion) (Brown, 1978). It must be emphasized that the environmental persistence criterion was developed on information currently available. The criterion will be modified as new information and testing methodologies become available.

BIOACCUMULATION

Score	Bioaccumulation	Log P
7	≥ 4000	≥ 6.00
3	1000-3999	5.00-5.99
2	700-999	4.50-4.99
1	300-699	4.00-4.49
0	<300	<4.00

*Insufficient information

Rationale:

In this scoring process, bioaccumulation refers to the potential of a compound to accumulate from the water column to an organism (bioconcentration) or from organism to organism (biomagnification). Where possible, actual measurements of bioconcentration and/or biomagnification are used to indicate a chemical's potential to accumulate in aquatic organisms. If there are no bioaccumulation measurements the logarithm of the n-octanol/water partition coefficient (log P) is used to indicate the chemical's bioaccumulative potential.

Partition coefficients for n-octanol/water are often used as a reliable measure of the tendency for an organic compound to transfer

from water to organisms (lipid phase) and bioaccumulate. The n-octanol/water partition coefficient is defined as the ratio of the concentration of a compound in octanol to its concentration in water. It is generally expressed as the log (base 10) of the partition (log P). The partition coefficient has proven useful as a means of predicting soil adsorption (Briggs, 1973), biological update (Kenaga, 1972; Hamelink et al., 1977), lipophilic storage (Davies et al., 1973; Metcalf et al., 1973; Metcalfe et al., 1975; Neely et al., 1974). These studies have shown a direct relationship between log P values and log bioconcentration factors for organic compounds.

Highly bioaccumulative compounds have log P values greater than 5.0. Examples of these include DDT; DDE; higher chlorinated PCBs and Hexachlorobenzene with log P values of 6.19, 5.69, 2.8 to 7.17 and 6.43 respectively (Chiou et al., 1977). Compounds which bioaccumulate to a lesser degree, such as chlorobenzene, tetrachloroethylene, dicapthon and diphenyl ether have log P values of 2.84, 2.60, 3.58 and 4.20 respectively (Chiou et al., 1977; Ware et al., 1977).

Log P values greater than 6.0 must be interpreted carefully before being utilized as a bioaccumulation indicator. An increase in the log P value correlates with increased propensity for bioaccumulation for many classes of chemicals. However, for certain groups of chemicals, large log P values (i.e. greater than 6.0) do not correlate to an increased tendency to bioaccumulate (Tulp and Hultzinger, 1978) because the measurement of this partition coefficient does not account for the rate of depuration of chemical compound from biological organisms.

ACUTE TOXICITY

Score	Aquatic 96 hr LC-50 (mg/L)
7 Extremely toxic	<1
3 Highly toxic	>1-10
2 Moderately toxic	>10-100
1 Slightly toxic	>100-1000
* Insufficient information	

Rationale:

Classification is based upon generally accepted terminology found in the available literature on acute toxicity. The critical levels describing "highly toxic" for oral, dermal and aquatic routes of exposure are adapted from Battelle Memorial Institute, National Academy of Sciences, State of California List of Toxic Substances, Federal Water Pollution Agency, Pesticides-Title 40, Department of Transportation Title 49, Consumer Product Safety Commission, and the Federal Hazardous Substances Labeling Act Title 15 classifications (EPA, 1978), as well as systems presented by Hodge and Sterner (1949)... Levels of "moderate", "slightly" and "relatively nontoxic", as well as all levels for inhalation exposure, are adapted from the National Academy of Sciences (EPA, 1975), Hodge and Sterner (1949) and Gleason et al. (1977).

CHRONIC TOXICITY

Score	Chronic Toxicity EC-50 Aquatic (mg/L)
7	<0.1
3	>0.1-1
2	>1-10
1	>10-100
0	>100
* Insufficient data	

Rationale:

In addition to basic acute toxicity tests [i.e. 48-hour invertebrates), 96-hr (fish)], toxicity studies measuring effects of chemical exposure on the reproductive process and other sublethal effects (i.e. chronic tests) are essential to a comprehensive hazard assessment program. There are basically two types of chronic toxicity tests, partial and full. A partial chronic toxicity test is one which includes a critical portion of a test organism's life cycle while a full chronic test will minimally include one complete life cycle. Full life cycle and partial life cycle tests with fish and invertebrates have become quite common and typically provide lethality and growth results as well as effects on reproduction (e.g. spawning,

gametogenesis and hatching success) and other sublethal responses during the course of testing (Brungs and Mount, 1978). A description of seven standard chronic toxicity tests follows:

(a) Fish Full Life Cycle Test (U.S. EPA, 1972a).

This test allows exposure from newly hatched fry through reproduction and exposure of the next generation. It provides exposure during sensitive developmental stages and assesses the growth and the reproductive processes. A common standard test organism is the fathead minnow (Pimephales promelas) and the test takes approximately nine months to complete.

(b) Fish Critical Life Stage Exposure Test (Macek and Sleight, 1977; McKim, 1977).

This test allows exposure during a very sensitive stage of the life cycle. The test starts with exposure of the organisms during most, preferably all, of the embryonic period and exposure of fry for a period of 30 days after hatching for warm water fish with embryogenic periods ranging from 1 to 14 days, and for 60 days after hatching for fish with longer embryogenic periods (e.g. salmonids). Eggs from the standard test organisms, commonly fathead minnows (P. promelas), rainbow trout (Salmo gairdneri), or bluegill (Lepomis macrochirus), are utilized in this test. Each test requires approximately five to ten weeks for completion.

(c) Partial Life Cycle (U.S. EPA, 1972b)

This test generally parallels the Fish Critical Life Stage Exposure Test described earlier, but makes appropriate modifications in exposure conditions because of the species and also starts with juvenile fish. The most common test organism for these studies is the brook trout (Salvelinus fontinalis).

(d) Daphnia Chronic (Biesinger and Christensen, 1972; Biesinger, 1974; Adema, 1978; Canton and Adema, 1978).

This test is a full cycle reproductive test which utilizes the freshwater invertebrates, Daphnia magna and D. pulex. The test requires only three weeks to complete.

(e) Midge Chronic (Cairns et al., 1978).

This full life cycle reproductive test utilizes a variety of species of these widely distributed genera (e.g. Chironomus). Benthic organisms are easy to culture and use in an extensive program for evaluating compounds of limited solubility or those that tend to accumulate in sediments.

(f) Algal Toxicity Tests (U.S. EPA, 1974, U.S. EPA, 1971).

A variety of tests have been developed which utilize algae as test organisms. Although algal tests are sufficiently short that they can be considered acute tests, most are in part multi-generation reproductive tests. No single published procedure for algal toxicity testing has gained wide acceptance, but recent

candidates are usually patterned after the EPA Algal Assay Procedure (Bottle Test) developed to test for algal growth potential and limiting nutrient effects.

(g) Lemna Inhibition (U.S. EPA, 1978).

The duckweed, Lemna minor, has been used as a test organism for assessing the effects of chemical substances on aquatic macrophytes.

Aquatic chronic toxicity data from these tests will be scored based on the median effective concentration. For the purpose of the Michigan Air Priority Chemicals List, the median effective concentration (EC-50) is defined as the concentration of a test material that causes 50 percent reduction of survival, growth, or reproduction of a test population, when statistically compared to a control population within a chronic test period.

CARCINOGENICITY

Score	Category
7	The chemical has been demonstrated to be a human positive, potential human, or animal positive carcinogen (defined below) by the oral or dermal route of exposure.
3	The chemical has been demonstrated to be a potential animal carcinogen (defined below) by the oral or dermal route of exposure.
2	The chemical has been demonstrated to be an animal positive or potential animal carcinogen by any route other than oral or dermal; or has been demonstrated by accepted mutagenicity screening tests or accepted cell transformation studies to be a strong suspect carcinogen (defined below).
1	The chemical has been demonstrated by accepted mutagenicity tests or accepted cell transformation studies to be a suspect carcinogen (defined below).
*	Insufficient information.

Rationale:

Most cancers are believed to be caused by exposure to extrinsic factors, among which chemical agents are thought to be a major contributor. These agents must be identified, evaluated and controlled if the incidence of cancer is to be reduced. An urgent and essential part of the Michigan Critical Materials Program is the need to protect the public and environment from chemical carcinogenic hazards and their effects. In an effort to meet this need, this carcinogenicity criterion was developed.

In addition to the standard long-term carcinogenicity test, a great deal of research is being conducted to develop rapid test methods. At present, there are two quick test systems that are of most interest, the cell transformation test and the mutagenicity test. The cell transformation test is based on the actual transformation of in vitro cultures of normal mammalian cells into tumor cells by brief exposure of these cell cultures to small amounts of carcinogenic agents. When the transformed cells are implanted into an animal of the species and strain from which the original normal cells were harvested, they develop into malignant tumors. The basis for the mutagenicity test is the hypothesis that carcinogenesis, like mutagenesis, is due to damage of the hereditary material of the cell, DNA. The Ames test, which uses certain mutants of the bacterium Salmonella typhimurium is a well-known example of one of the mutagenicity tests designed to show carcinogenic potential (Bartsch, 1976; Fishbein, 1977; McCann et al., 1975).

It is essential that the procedures used to determine a chemical's carcinogenicity potential be established on the best scientific basis as practically possible. For the purpose of the Michigan Critical Materials Register, chemicals are classified as human positive, potential human, and animal positive carcinogens according to data and interpretation as reported by the IARC, NCI, or NIOSH (IARC; Sontag et al., 1976; Tomatis, 1976; USHEW). Chemicals are placed in the other carcinogenicity categories according to the best information available in the scientific literature. Chemicals can be reclassified to appropriate categories as additional data become available.

For the purpose of the Michigan Critical Materials Register, the categories of carcinogenic effects are defined as follows:

- I. Human positive carcinogens are chemicals which have been demonstrated by epidemiological and/or clinical studies to cause cancer in man.
- II. Potential human carcinogens are chemicals which are animal positive carcinogens and have been suggested to cause cancer in man but adequate epidemiological and/or clinical data are not available at the present time to unequivocally substantiate their carcinogenic effect in man.

III. Animal positive carcinogens are chemicals which have been demonstrated to cause cancer in at least one animal species in replicate studies or demonstrated to cause cancer in more than one animal species.

IV. Potential animal carcinogens are chemicals which have been tested in a nonreplicated study and shown to cause cancer in one animal species.

V. Strongly suspect carcinogens are chemicals which fit one of the following descriptions:

1. The chemical has been shown, using mutagenicity or cell transformation tests (with or without enzyme activation) designed to demonstrate carcinogenic potential, to be mutagenic in three groups of organisms (or cell cultures from three groups) not to include more than:
 - a. one lower test organism (i.e. bacteria, yeast, fungi)
 - b. one plant test organism (including algae)
 - c. two species of mammalian test organisms
 - d. one insect test organism
 - e. one macroscopic aquatic or semi-aquatic organism.

HEREDITARY MUTAGEN

Score	Category
7	Confirmed hereditary mutagen.
4	Potential hereditary mutagen in multicellular organisms.
2	Potential hereditary mutagen in micro-organisms.
0	Not demonstrated to be a hereditary mutagen.
*	Insufficient information.

Rationale:

On a theoretical basis, mutagens can produce significant effects on the long-term survival of any species. In spite of this significant potential impact, effects due to mutagenic substances in nature might not be discernible for a long time (deSerres and Sheridan, 1973).

Most tests for mutagenicity have been designed to maximize their predictive value for carcinogenicity. The present criterion has been selected to emphasize mutagenic effects. Such mutagens represent a high level of environmental and human health concern and should therefore be included in the Critical Materials Register (Canadian Ministry of Health and Welfare, 1975).

For the purpose of the Michigan Critical Materials Register, the classification of Hereditary Mutagens to specific categories is defined below:

To be a confirmed hereditary mutagen, a chemical must produce a statistically significant dose related mutagenic effect in test microorganisms without the use of metabolic activators (i.e. rodent liver fractions, etc.) and in a complex multicellular animal (i.e. insect, rodent, etc.) with mutations inheritable in subsequent generations of the test organisms.

To be a potential hereditary mutagen in a multicellular organism, a chemical must produce a statistically significant dose related mutation in a complex multicellular organism (i.e. plants, insects, rodents, etc.) with mutations inheritable in subsequent generations of the test organism.

To be a potential hereditary mutagen in microorganisms, a chemical must produce a statistically significant dose related mutation in exposed test microorganisms with mutations inheritable in subsequent generations.

A chemical is not considered to be a hereditary mutagen if it has been adequately tested in several appropriate animal species with negative findings.

TERATOGENICITY

Score	Category
7	Confirmed teratogen.
3	Potential teratogen.
0	Not a teratogen.
*	Insufficient information.

Rationale:

Since terrestrial and aquatic populations are exposed to a wide variety of chemicals in the environment on a continuing or chronic basis, recognition and control of teratogens is necessary to prevent repetition of incidences such as Minimata disease and the "thalidomide disaster". A teratogen is any chemical which causes alterations in the formation of cells, tissues and organs resulting from physiologic and biochemical changes, i.e. generative changes. Teratogenic change occurs during embryogenesis and may affect the function as well as the structure of developing cells, tissues and organs (Becker, 1975; Canadian Ministry of Health and Welfare, 1975).

A chemical is classified as a confirmed teratogen if it has been shown by epidemiological evidence to be teratogenic in humans, demonstrated to be teratogenic in two animal species by the oral or dermal route of exposure (U.S. EPA, 1978).

A confirmed teratogen would be placed on the CMR list automatically. The ranking system for suspect teratogens is more lenient to allow for lack of information and consideration of other concerns about the chemical. Should conflicting studies be found, review of the research procedures will be made to evaluate the adequacy of the study and validity of the results.

MOE ANALYTICAL CAPABILITY

Codes

- A. Routine capability and capacity available.**
- B. Limited low volume capacity available - could be upgraded with development.**
- C. GC-MS semi quantitative-methodology only. Routine capacity not available but could be developed (low volume).**
- D. No methodology available at MOE at present.
Development possible.**
- E. Specialized GC-MS. Very low capacity. Non routine test - Cannot be modified for high volume testing.**

MASTER LIST OF CANDIDATE COMPOUNDS

1,2,4-Trechlorobenzene	Dieldrin
1,2-Dichlorobenzene	Diethyl Phthalate
1,2-Dichloropropane	Dimethyl Phthalate
1,2-Diphenylhydrazine	Diphenyl nitrosamine
1,3-Dichlorobenzene	Endosulfan I
1,3-Dichloropropane	Endosulfan II
1,4-Dichlorobenzene	Endosulfan Sulfate
2,4,6-Trichlorophenol	Endrin
2,4-Dimethyl phenol	Endrin Aldehyde
2,4-Dinitrotoluene	Ethylbenzene
2,4-Nitrophenol	Fluoranthene
2,6-Dinitrooluene	Fluorene
2-Chloronaphthalene	Heptachlor
2-Nitrophenol	Heptachlor Epoxide
3,3-Dichlorobenzidine	Hexachlorobenzene
4,6-Dinitro-o-cresol	Hexachlorobutadiene
4-Bromophenyl phenyl ether	Hexachlorocyclopentadiene
4-Nitrophenol	Hexachloroethane
Acenaphthylene	Idens(1,2,3-cd)pyrene
Aldrin	Iron
Ammonia	Lead
Anthracene	Mercury
Antimony	Mirex
Arsenic	Naphthalene
Benzene	Nickel
Benzidine	Nitrobenzene
Benzo(a)anthracene	Oxychlordane
Benzo(a)pyrene	PCB
Benzo(b)fluoranthene	Pentachlorophenol
Benzo(g,h,i)perylene	Phenanthrene
Benzo(k)fluoranthene	Phosphorus
Beryllium	Pyrene
Bis(2-ethylhexyl)Phthalate	Selenium
Bromodichloromethane	Silver
Butyl benzyl Phthalate	TCDD
Cadmium	Thallium
Chlorobenzene	Toluene
Chromium	Toxaphene
Chrysene	Tribromomethane
Cobalt	Trichlorofluoromethane
Copper	Zinc
Cyanide	a-BHC
DDT	a-Chlordan
DMDT Methoxychlor	g-BHC
Di-n-butyl Phthalate	g-Chlordan
Di-n-octyl Phthalate	o,p-DDT
Dibenzo(a)anthracene	p,p-DDD
Dibromochlormethane	p,p-DDE
Dichlorodefluoromethane	p,p-DDT

GUNNAR HEGG RUDOLF LÖFFL

CONT'D.

CONTINUOUS DENSITY ESTIMATION 19

Parameter: Zinc
Lake: Huron
Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1976: 0-2 cm: 210-228
- surface: 1978: 0-2 cm: 147-233
- surface: 1980: 8-2-204
- surface: 1980: 11-37
- background: 1976: 8-30 cm: 88
- background: 1978: 10-30 cm: 60-88

Embayments:

- Georgian Bay: 1980: surface: 6-74
- Georgian Bay: 1978: nearshore:
 - surface: 0-1 cm: 201-230
 - background: 10-24 cm: 87-93
- Sturgeon Bay: 1980: surface: 27-130
- North Channel: 1980: surface: 12-100600
- South Bay: 1976: surface: 0-1 cm: 154
- South Bay: 1978: surface: 0-1 cm: 154
- South Bay: 1976: background: 8-10 cm: 116
- South Bay: 1978: background: 20-30 cm: 78

River mouths:

- Lake Huron (11 samples) surface: 1975: 5-8-257.2
- North Channel & Georgian Bay (15 samples):
 - surface: 1975: 5.7-212.5

Years of references: 1975, 1976, 1978, 1980

SUMMARY:

- surface sediment in depositional basins: 8.2-233
- background sediment in depositional basins: 60-88
- surface sediment in embayments: 78-116
- surface sediment in river mouths: 5.7-257.2

Analytical Procedure:

- AAS - HCl at 90°C for 20 min.
- AAS - aqua regia at 85-90°C for 90 min.
- NA & AAS
- HDE - AAS - aqua regia
- AAS - HCl at 90°C for 20 min.
- AAS - aqua regia at 85-90°C for 90 min.
- HOR - AAS - aqua regia
- NA - aqua regia at 85-90°C for 90 min.
- Same
- HOR - AAS - aqua regia
- Same
- Same
- AAS - HCl at 90°C for 20 min.
- AAS - aqua regia at 85-90°C for 20 min.
- AAS - HCl at 90°C for 20 min.
- AAS - aqua regia at 85-90°C for 90 min.

Lake Michigan

Parameter: Cadmium
Lake: Michigan
Concentration in $\mu\text{g.g}^{-1}$ dry weight

Analytical Procedure:

Depositional basins:

- surface: 1981: 0-5 cm: 0.5-1.8
- background: 1981: 10 cm: 0.5-0.7

Benthos core
Same

Embayments:

- Sleeping Bear Point Bay: 1977: surface: 0.07-1.93
- Green Bay: 1981: surface: 0-5 cm: 1.1-1.8
- Green Bay: 1981: background: 15 cm: 0.5-1.3

Shipley Grab
Jenkin core
Same

River mouths:

- surface (27 samples): 1975: 0.1-16.6

Rhean dredge & custom made
piston core

Years of references: 1975, 1977, 1981

SUMMARY:

surface in depositional basins: 0.5-1.8

background in depositional basins: 0.5-0.7

surface in embayments: 0.07-1.93

background in embayments: 0.5-1.3

surface in river mouths: 0.1-16.6

AAS - aqua regia
AAS
Same

Parameter:	Chromium	Sampling Methods:	Analytical Procedure:
Lake:	Michigan Concentration in $\mu\text{g.g}^{-1}$ dry weight		
Depositional basins:			
- surface: 1981: 140	Box core	AAS	AAS - HF: HNO_3 : HClO_4 extraction
- background: 1981: 50	Same	Same	AAS - aqua regia
Embaysments:			
Little Traverse Bay: 1979: surface: 4.9-72	Ponar grab	AAS - nitric: perchloric acid (1:1) and	
Sleeping Bear Point Bay: 1977: surface: 2.0-47.0	Shipek grab	evaporation to dryness (350°F)	
River mouths:			
- surface (27 samples): 1975: 0.5-1,295	Stream dredge & custom made piston core		
Years of references:	1975, 1977, 1979, 1981		
SUMMARY:			
surface sediment in depositional basins: 140			
background sediment in depositional basins: 50			
surface sediment in embayments: 2.0-72			
surface sediment in river mouths: 0.5-1,295			

Parameter: Copper
Lake: Michigan
Concentration in $\mu\text{g.g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1981: 54
- background: 1981: 15

Analytical Procedure:

- AAS
- Same

Embayments:

- Grand Traverse Bay: 1970: surface: 7-32
- Little Traverse Bay: 1979: surface: 1.4-54
- Sleeping Bear Point Bay: 1977: surface: 0.8-34.5

Box core:

- Same
- Shovel grab

AAS

- AAS - HP: HNO_3 : HClO_4 extraction
- AAS - aqua regia

River mouths:

- surface (27 samples): 1975: 0.5-84.0

Shovel dredge & custom made

ploton core

- AAS - nitric: perchloric acid (1:1) and

evaporation to dryness (350°F)

Years of references: 1977, 1979, 1981

SUMMARY:

- surface sediment in depositional basins: 54
- background sediment in depositional basins: 15
- surface sediment in embayments: 0.8-54
- surface sediment in river mouths: 0.5-84

Parameter: Iron
Lake: Michigan
Concentration in % dry weight
Analytical Procedure:
Sampling Methods:
Emplacements:
Grand Traverse Bay: 1970: surface: 0.6-1.9
Little Traverse Bay: 1979: surface: 0.4-2.55
Ponar grab
Same
AAS
AAS - HF: HNO₃: HClO₄ extraction
Years of references: 1979
SUMMARY:
surface sediment in embayments: 0.4-2.55

Parameter: Mercury
State: Michigan
Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Analytical Procedure:

Depositional basins:
- surface: 1976: 0-5 cm: 0.030-0.380 Benthic core Not described

River mouths:
- surface (27 samples): 1975: <0.01-1.20 Ehsan dredge & custom made
piston core

Years of references: 1975, 1976

SUMMARY:
surface sediment in depositional basins: 0.030-0.380
surface sediment in river mouths: <0.01-1.20

Coleman HAS 50 mercury analyser (Van Loon, 1974)

Parameter: Nickel

Lake: Michigan

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Sampling Methods:

Depositional basins:

- surface: 1981: 25
- background: 1981: 20

Embayments:

- Sleeping Bear Point Bay: 1977: surface: 1.7-54.2
River mouths:
- surface (27 samples): 1975: 1.6-74.8

River mouths:

- surface (27 samples): 1975: 1.6-74.8

Years of references: 1977, 1977, 1981

SUMMARY:

surface sediment in depositional basins: 25
background sediment in depositional basins: 20
surface sediment in embayments: 1.7-54.2
surface sediment in river mouths: 1.6-74.8

Analytical Procedure:

AAS
Same

AAS - aqua regia

AAS - nitric: perchloric acid (1:1) and
evaporation to dryness (350°F)

Parameter: Organic Carbon
Lake: Michigan
Concentration in % dry weight

Sampling Methods:

Depositional basins:

- surface: 1980: 0-1 cm: 2.5%
- surface: 1976: 0-5 cm: 2.17-2.23
- background: 1980: 55 cm: 1.8
- background: 1976: 5-40 cm: 0.67-2.63

Embayments:

Grand Traverse Bay: 1975: surface: 0.7-4.0

Ponar grab

Ponar grab

Shipset grab

Years of references: 1975, 1976, 1977, 1980

SUMMARY:

surface sediment in depositional basins: 2.17-2.5
background sediment in depositional basins: 0.67-2.63
surface sediment in embayments: 0.16-4.13

Analytical Procedure:

- CHN - analyser (Varian-Packard 185-B)
Not specified
- CHN - analyser (Varian-Packard 185-B)
Not specified

Combustion at 1,300°C MTRCO geometric Carbon
detector
Dohrmann Carbon analyser

Parameter: Lead

Lake: Michigan

Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight

Analytical Procedure:

Depositional basins:

- surface: 1981: 130
- surface: 1981: 0-5 cm: 10-58
- background: 1981: 10 cm: 8-10
- background: 1981: 10

Embayments:

- Green Bay: 1981: surface: 29-48
- Green Bay: 1981: background: 15 cm: 8-29
- Traverse Bay: 1973: surface: 1.3-56.2

River mouths:

- surface: 27 samples: 1975: 1.3-149.0

Years of references: 1973, 1975, 1981

SUMMARY:

surface sediment in depositional basins: 10-130
background sediment in depositional basins: 8-10
surface sediment in embayments: 1.3-56.2
background sediment in embayments: 8-29
surface sediment in river mouths: 1.3-149.0

Sampling Methods:

Depositional basins:

- AAS
- Box core
- Benthos core
- Same
- Same
- Same

- Jenkins core
- AAS
- Same
- Not specified

- Shawan Dredge and custom made
- piston core

AAS - nitric: perchloric acid (1:1) evaporation
to dryness (350°C)

Parameter:	PCB		
Lake:	Michigan	Concentration in $\mu\text{g}\cdot\text{g}^{-1}$ dry weight	
			Sampling Methods:
Depositional basins:			
- surface:	1980:	0-3 cm:	0.002-0.0735
Nondepositional zones:		Shipak grab	CC
- surface:	1980:	0-3 cm:	0.0063 (mean)
Embayments:		Same	Same
Little Traverse Bay:	1980:	surface:	0.0016-0.0067
Years of references:	1980	Ponar grab	

SUMMARY:

surface sediment in depositional basins: 0.002-0.0735
surface sediment in nondepositional zones: 0.0063
surface sediment in embayments: 0.0016-0.0067