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SURVEILLANCE ISSUE

CONTAMINANTS

<u>SURVEILLANCE ISSUE</u>

CONTAMINANTS

<u>OPERATIONAL COMPONENT</u>

Atmospheric

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: ATMOSPHERIC

WATERBODY: Lake Huron

(see Eutrophication Issue for details)

TABLE 1

ISSUE: CONTAMINANTS

ECOSYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
INPUTS	* 1. ATMOSPHERE (see Eutrophication Issue)	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
AREAS OF EFFECT	3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AREA OF CONCERN	Yes	Water, Sediments - Suspended and Bottom, Biota	Area specific lists, should include some of the above variables
	6. WILDLIFE	Yes	Gull eggs	Above list & chlorinated benzenes, chlorinated styrenes
OUTPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
MISC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: ATMOSPHERIC

WATERBODY: Lake Erie

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: ATMOSPHERIC

WATERBODY: Lake Ontario

CHAPTER 10

ATMOSPHERIC CONTAMINANTS

BASIS FOR CONCERN

The atmosphere has long been recognized to be an important component in the transport and deposition of materials to the earth's surface. In a natural ecosystem, it is important that an equilibrium be maintained between natural emission and deposition such that there is no overall increase in the atmospheric concentration of any chemical species on a global basis. However, man-made emissions, concentrated in the highly industrialized regions of the world, have resulted in situations where these emissions exceed natural emission, thus creating high depositions. These emissions and depositions have created environmental issues such as acid rain and the long range transport of toxic pollutants.

One of the key strategies in the management of Great Lakes water resources is to reduce material inputs to the Great Lakes. Atmospheric inputs represent a significant and uncontrollable fraction of the total input. The discovery of trace organics such as PCB's and toxaphene in the biota from remote islands in Lake Superior have identified organic contaminants from the atmosphere as a serious health hazard to the environment.

To provide information on Great Lakes atmospheric deposition, Annex 11 of the 1978 Agreement on Great Lakes Water Quality recommended that surveillance and monitoring activities be carried out on atmospheric deposition.

While the atmosphere is a known source of numerous contaminants, the loading from the atmosphere, both in absolute terms and relative to other input sources, has not been established. In fact, for many contaminants, the measurements are semi-qualitative at best. Research is required in this area, especially with regard to analytical methodology, sample collection procedures, monitoring network design, and atmosphere transport mechanisms.

Indirect effects of atmospheric deposition may also be significant, especially the effects of acid precipitation on the upper watersheds of those tributaries which drain into Lake Ontario. There is currently a great effort underway to study acid precipitation from a continental perspective. Acid percipitation, combined with the limited alkalinity of certain soils, can lower the pH of lakes and ponds to the point where they are unable to support aquatic life. Also, the acid precipitation phenomenon has the potential to add to the heavy metal loading in the tributaries. Other possible effects, such as increased plant stress, are poorly understood although much research is now underway.

Presently, a number of programs in both the United States and Canada address the issue of contamination from the atmosphere. This chapter is based on two of these programs, one conducted by the Canada Centre for Inland Waters (Canada Department of the Environment (DOE)) and the other by the Great Lakes National Programs Office (U.S. Environmental Protection Agency (EPA)). This chapter recommends modifications aimed at achieving a practical, cost-effective plan. The Task Force did not consider other atmospheric sampling programs and networks, which may be able to help meet the requirements of this component of the Plan.

PROJECT DESCRIPTION

Objective and Scope

1. Provide qualitative information (presence/absence) on organic and metal contaminants in atmospheric deposition; thus identifying emerging problems in the Great Lakes Basin.

2. Provide annual loading estimates of metals to Lake Ontario.

Data Usage

1. Provide estimates of annual loadings of metals to Lake Ontario.

2. Provide evidence of a source of contaminant loadings to the lake.

Monitoring Network Design and Rationale

The state of the art in the analysis of trace organics in atmospheric precipitation is semi-qualitative at best. Both Canada DOE and U.S. EPA are conducting (experimenting) with their methods of collection. The U.S. EPA composites its monthly bulk samples at 10 sites on a quarterly basis while Canada DOE collects wet-only samples on a bi-weekly basis at two locations and with on-site solvent extraction. It is recommended that more funding be allocated to this project so that reliable data can be generated for use in possible source identification of contaminants.

For trace metals, the approach taken by the two agencies is to collect wet-only and bulk samples from a network of land-based stations to measure the composition of precipitation and to estimate, where possible, open lake loading from rainfall measurements. Measurement of wet-only deposition is comparatively straight forward, while dry deposition measurements are still very much a research effort. The problem is further complicated by the inherent high degree of natural variation due to events and normal atmospheric conditions across the vast expanse of the Great Lakes. Recognizing that bulk samples may not represent wet plus dry, total deposition estimates will be augmented by dry deposition studies from the scientific communities.

Present locations of samplers are given in Figure 1. On the Canadian side, the Kingston site has been phased out, but it is planned that a new station be located in this region in the near future. Existing information indicates only a single bulk sampler (in Fair Haven, New York) in the present U.S. EPA program. It is recommended that bulk samplers be established at each of the four U.S. stations, as both wet and bulk deposition values are required for loading estimates.

Monitoring Parameters and Frequency of Sample Collection

Ideally, collection and [immediate] analysis of precipitation samples strictly on an event basis would provide the most reliable data. Samples collected in this manner could more easily be compared with meteorological information for possible source identification. However, one runs into the problem of definition of an "event" with this type of sampling. Also, logistics dictate that either samples collected in this manner be composited, or samples be collected on a less frequent basis to allow sufficient precipitation to accumulate.

It is, therefore, recommended that collection from both bulk and wet samplers be conducted on a monthly basis for trace metal analysis to include: cadmium, copper, iron, lead, nickel, and zinc. Mercury and selenium, measured in the open waters of the lake, will not be measured in precipitation. Both of these metals require immediate preservation. In addition, mercury samples must be collected in glass which would entail installation of a separate sampler just for mercury. As levels of mercury found in the open lake are routinely less than the detectable level (0.05 ug Hg/L), mercury in precipitation does not appear to be an issue.

Should additional parameter information be generated at no extra cost, that is a bonus. However, as in the open lake work, it is imperative that detection limits for the required parameters be low enough that the data generated does not merely consist of "less than's".

Table 1 proposes, for each parameter, the number of samples to be collected, the analytical method, sample preservation, and holding time. Analyses will also be considered for other parameters. These will be drawn from several sources, including:

1. The list of chemicals developed by the Human Health Effects Committee and published in the "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Ecosystem," held in March 1982.

2. Other chemicals identified by the Human Health Effects Committee, as published in their annual reports.

3. Chemicals identified as the result of studies conducted under the auspices of the Niagara River Toxics Committee.

The parameters for which analyses will be conducted will be established later.

Sampling Procedures

Presently, the Canada DOE and the U.S. EPA sampling protocols have very little in common - samplers, containers, in-field preservation and measurements, and frequency of collection are all different. If found to be necessary (see Commentary, below), efforts should be directed at standardizing protocols. Suggest co-location of samplers at either Sault Ste. Marie or Niagara-on-the-Lake to evaluate any biases in data. Canada DOE personnel visit the Niagara-on-the-Lake site weekly, so collector maintenance and sample collection could be attended to by them. Samples could then be split and analyzed by both agencies.

Sample Custody Procedures

This will be dependent on method(s) chosen for sample collection (to be determined).

If buckets are continued to be used by the Canadian agency, the following sample custody procedures will be adhered to:

1. Pre-cleaned buckets (one for wet, one for bulk) and 2-litre LPE bottles will be sent to collectors for installation at the beginning of each month.

2. At the end of each month, samples will be directly transferred to the 2 L bottles and mailed to the responsible personnel for splitting, preservation, and submission to the laboratory.

Should polyethylene bags be used, it must be decided whether these are sealed in the field and mailed back, or transferred to the bottles for mailing.

Standardized procedures should be drawn up for the collectors specifying handling of samples, specifically such issues as: thawing of samples before transferring to bottles (lid on, at room temperature, no obvious contaminating sources in immediate vicinity, etc.); what to do in case of spillage on transferring; what to do if continuous precipitation throughout the time designated to exchange buckets/bags; etc.

Likewise, standardized pre-cleaning of buckets/bags/bottles must be determined.

Calibration Procedures and Preventative Maintenance

Annual visits to all sites will be made to inspect samplers and lubricate and repair as required. In addition, any unexpected malfunctioning of the samplers will be attended to immediately. Periods of breakdown/malfunctioning will be recorded for reference.

SCHEDULE OF TASKS AND PRODUCTS

Samples will be collected monthly and submitted for analysis.

Loading estimates and interpretation of data will be prepared annually for submission to the Lake Ontario Task Force.

PROJECT ORGANIZATION AND RESPONSIBILITY

To be provided.

DATA QUALITY REQUIREMENTS AND ASSESSMENTS

The detection limits listed in Table 2 are the same ones specified for the open lake. Analysis completed to date, reporting the old detection limits, consistently gave "less than" data for many of the parameters in precipitation. This unnecessarily complicated loading calculations.

DOCUMENTATION, DATA REDUCTION, DATA MANAGEMENT, AND REPORTING

To be provided.

DATA VALIDATION

To be provided.

PERFORMANCE AND SYSTEMS AUDITS

Agencies will carry out the following to ensure data compatibility:

1. Carry out internal audit checks to ensure sample integrity.

2. Participate in Data Quality Work Group interlaboratory studies.

3. Co-locate precipitation collectors at one designated location (Niagara-on-the-Lake or Sault Ste. Marie recommended) in the near future to exchange precipitation samples so as to evaluate any biases between the two agencies.

CORRECTIVE ACTION

None

PROJECT FISCAL INFORMATION

To be supplied.

DATA INTERPRETATION

See above.

REPORTS

See above.

COMMENTARY

As was stated earlier, atmospheric sampling for organic contaminants is still very much in the realm of research. Continued effort is required in the development of a suitable protocol for sample collection, after which, because of volatilization flux and other associated problems, considerable research must be directed toward interpretation of the data obtained. To reiterate, more resources must be allocated to studying organic contaminants in precipitation.

Presently, the agencies involved in the atmospheric program have different sampling and analytical procedures. Obviously, standardization of protocol would give maximum assurance as to compatability of data produced. However, one must consider the objectives of the program - are such stringent measures necessary? Biases in data obtained by the two agencies would not affect contaminant identification. Furthermore, loading calculations are such gross estimates (monthly composites at four or five stations around the basin extrapolated to give yearly loading estimates for the lake on each side of the border) that minor biases could be discounted. These factors must be taken into consideration when discussing protocol.

TABLE 1

PARTICULARS ABOUT COLLECTION AND ANALYSIS OF PRECIPITATION SAMPLES

PARAMETER	NUMBER OF SAMPLES*	ANALYTICAL METHOD[1]	SAMPLE PRESERVATION[1,2]	HOLDING TIME[1]
Cadmium	216			
Copper	216			
Iron	216			
Lead	216			
Nickel	216			
Zinc	216			

*216 bulk samples, 216 wet samples.
[1]To be determined by C. H. Chan and E. Klappenbach. Whatever method chosen must provide required detection limits (See Table 2.)
[2]Although standard procedures call for metal samples to be preserved at a pH level of at least 1.6, it is assumed that the pH of precipitation in the Lake Ontario basin (~ 4.0) should be sufficiently acidic to stablilize the samples during the month in the field.

TABLE 2

DETECTION LIMITS FOR METALS IN PRECIPITATON SAMPLES

PARAMETER	DETECTION LIMIT (ug/L)	PRECISION AND ACCURACY
Cadmium	0.01	To be determined from method chosen.
Copper	0.1	
Iron	0.1	
Lead	0.1	
Nickel	0.05	
Zinc	0.05	

U.S. EPA		DOE	
WET	BULK	WET	BULK
Olcott	[Olcott]†	Niagara-on-the-Lake	Niagara-on-the-Lake
Rochester	[Rochester]‡	Burlington	Burlington
Fair Haven	Fair Haven	Woodbridge	Woodbridge
Cape Vincent	[Cape Vincent]‡	Trenton	Trenton
		[Kingston]*	[Kingston]*

Figure 1. Atmospheric deposition stations.

‡ recommended

* This station has recently been deleted. It is expected that a new station will be located in this region in the near future

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Tributaries

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: TRIBUTARIES

WATERBODY: Lake Huron

TABLE 1

ISSUE: CONTAMINANTS

COSYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
NPUTS	1. ATMOSPHERE	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	* 2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
REAS OF EFFECT	3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AREAS OF CONCERN	Yes	Water, Sediments - Suspended and Bottom, Biota	Area specific lists, should include some of the above variables
	6. WILDLIFE	Yes	Gull eggs	Above list & chlorinated benzenes, chlorinated styrenes
UTPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
IISC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

<u>SURVEILLANCE ISSUE:</u> CONTAMINANTS

<u>OPERATIONAL COMPONENT:</u> TRIBUTARIES

<u>WATERBODY:</u> Lake Erie

For information, see <u>Eutrophication Issue</u>

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: TRIBUTARIES

WATERBODY: Lake Ontario

1984.09.21

CHAPTER 8
TRIBUTARY WATER

BASIS FOR CONCERN

Organic and metal contaminants are being introduced into the Great Lakes in several ways, including by way of tributaries. Tributaries to Lake Ontario receive the wastewater from point sources including large metropolitan areas, a variety of industries, as well as non-point source land runoff. Contaminants originate both from present discharges and re-suspension of bottom sediments which contain the residue from historic discharges. Measurement of tributaries near the river mouth is a convenient and probably the only accurate method of measuring the amount of contaminants actually being discharged from a watershed into the lake. If the levels of contaminants entering Lake Ontario and the aquatic biota are to be controlled or reduced, sources must be identified and, as technology permits, the loadings quantified.

This program element must be coordinated with the tributary contaminant program for nutrients (Chapter 22) and, if appropriate, for the particular areas of concern if the tributary discharges into an area of concern. Should contaminants be identified in either the tributary waters entering the lake or in the sediments carried and deposited near the tributary mouth, then trackdown into the upstream watershed is appropriate. Trackdown is further discussed in Chapter 6A, and would be used to pinpoint sources which are presently contributing to identified problems.

While an accounting of upstream sources is not as important in determining lake loadings as other factors, it does take on significance if fish populations are exposed in tributary waters to chemical contaminants. Fish migrating upstream as part of their habitat or to spawn could be affected by upstream sources. If this exposure is determined to be significant, then the upstream sources need to be monitored and appropriate action taken for abatement.

Studies have shown that much of the tributary loading of contaminants occurs during discharge events. These events may be characterized as the annual spring snow melt and periodic significant rainfall. Therefore, the discharge events for each major lake tributary must be captured in the sampling program. There will be great variability from tributary to tributary as each is uniquely sensitive to various types of precipitation. For example, the Niagara River will show much less short-term flow variability than a small tributary which may actually become non-existent in the summer between major rainfall episodes. Details about event monitoring are presented in Chapter 22.

Tributary loading is only one factor in the total loading picture for contaminants entering Lake Ontario. Other loading factors discussed in other chapters include direct point source discharges (Chapter 6A), storm sewer overflows (Chapter 6B), and atmospheric inputs (Chapter 10). This chapter discusses only the waterborne contaminants from tributaries. When the relative significance of various loading sources is realized, then the contributing factors should be weighted to assure that the most significant inputs receive the highest degree of monitoring.

PROJECT DESCRIPTION

This project consists of defining a sampling program, including flow measurement and gauging stations and sampling points, which will measure the contaminant inputs from those tributaries to Lake Ontario which are believed to carry a significant contaminant load. Based upon stream size and previously determined actual and potential sources of pollution, a flow measurement and sampling frequency program will be devised to provide for definition of event-related discharges (see also Chapter 22). The project will also define the analytical and reporting procedures for the analyses done.

The specific questions to be answered are:

1. Which tributaries, and to what extent, contribute to the discharge of organic and metallic contaminants to Lake Ontario?

2. On which tributaries are remedial measures necessary to reduce significant and unacceptable loads into Lake Ontario?

3. What is the current level or baseline discharge of metallic and organic contaminants? Over time, what improvement is evident from control and remedial measures?

4. What new substances of concern are detected from the tributary water discharges entering Lake Ontario?

Objective and Scope

The scope of this project is to establish an enhanced tributary sample and analysis program for organic chemicals and metallic contaminants which are introduced to Lake Ontario from tributary discharges. The specific objectives are to quantify such loadings through flow measurements and contaminant analysis. Tributaries will be selected based upon analysis of previous discharges, review of the annual hydrograph, and the inclusion in their watersheds of significant actual or suspected sources of contamination.

The program will be structured to define the majority of loadings entering the lake, based upon both the size of the tributary and a selected frequency of analysis to increase the sampling during significant discharge periods.

The objective of the enhanced tributary monitoring program is to increase the precision of tributary loading estimates for major significant tributaries by the use of an improved sample strategy. A tiered or stratified approach will be utilized in which the frequency of sampling will be adjusted depending on the stage of stream flow so that more frequent samples are taken as flow increases. This will increase the statistical reliability of the data, as it has been determined that proportionately more contaminants are moved from the tributary during increases in flow, particularly major significant events such as the annual spring runoff and intense short-duration storms. There will be additional benefits, including an improved data base covering a variety of hydrologic and geographic areas and a better ability to quantify input loadings and plan future sampling schedules.

Monitoring Network Design and Rationale

All major Lake Ontario tributaries will be measured for organic and metallic contaminants on a routine and/or an event-related basis. Table 1 lists the tributaries to be monitored and includes their drainage area and average discharge. On the south shore of Lake Ontario in the United States, there are dozens of minor tributaries which enter the lake from basically rural and agricultural areas. These tributaries are not significant in terms of either flow or loading to the lake and are not proposed for monitoring. They would be expected to contain input from non-point sources which may be contaminated from agricultural runoff which would include pesticides. Selected monitoring of nearshore waters is proposed in Chapter 7A to identify whether these sources would have significance when compared to the major tributaries selected. Contaminants would also be detected and quantified through the water intake monitoring program (see Chapter 4). The major tributaries selected encompass the majority of urban areas and basin population.

Long-term stream gauging stations and sampling points will be established on each selected tributary where this has not already been done. Based upon hydrograph flow analysis and previous sampling, a selection will be made of stations and frequency which is expected to provide for the measurement of between 80 and 90% of the contaminant loadings entering Lake Ontario from its tributaries. The Niagara River, the lake's largest tributary, is not specifically considered in this program. As a connecting channel waterway, it is subject to the development of a monitoring program specific to it, and as the lake's most significant tributary, will most probably have a specific monitoring program of greater scope frequency and duration than other less significant tributary water bodies. Therefore, because of its special status, it is not included in the average program design and rationale.

Monitoring Parameters and Frequency of Collection

Table 2 indicates the frequency of sampling for metallic and organic contaminants. The substances for which monitoring will be considered will be drawn from several sources, including:

1. The list of chemicals developed by the Human Health Effects Committee and published in the "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Ecosystem," held in March 1982.

2. Other chemicals identified by the Human Health Effects Committee, as published in their annual reports.

3. Chemicals identified as the result of studies conducted under the auspices of the Niagara River Toxics Committee.

4. Chemicals included in the Ontario Ministry of the Environment's Special Intensive Drinking Water Monitoring Program (Tables 3 and 4).

The chemical selection process will be tempered by consideration of the sources upstream in a particular tributary basin.

For this chapter, the spring snow melt episode is defined as those conditions during which stream flow rises at a significant rate because of melting snow which may or may not be accompanied by rainfall. This period will usually last approximately four weeks in any year but may vary at time of onset depending upon the particular winter conditions from late February through early April. A rainfall episode is arbitrarily defined so that approximately 8 to 10 runoff episodes per year will be included with the spring runoff and routine monthly sampling program. A review of rainfall records indicates that a rainfall of 0.4" in three hours or 0.5" in eight hours will probably provide this level of sampling.

Sampling Procedures

The sampling procedures will be specified by the requirements of the sampling protocols and quality assurance/quality control procedures established for the overall control of the Plan. Generally, samples will be grab samples integrated over depth taken at mid-channel as respresentative of general flow for concentration. For minor tributaries, consideration will be given to automated sampling equipment from which samples can be collected and mailed to appropriate laboratories by contracted personnel rather than utilizing professional employees of the jurisdictions.

Sample Custody Procedures

No special chain of custody arrangements are recommended, as the samples are intended for monitoring and surveillance purposes rather than for enforcement.

Analytical Procedures

Analtyical procedures will be specified at a later date. A number of alternative procedures are available. After requirements for this component of the Plan have been more fully defined, the array of analytical procedures available will be reviewed, to determine which can provide the data required.

Calibration Procedures and Preventive Maintenance

Since grab samples only are proposed, no special calibration or preventive maintenance on sampling equipment is necessary other than normal cleanup after each sample. If automated sampling equipment is employed on minor tributaries, then periodic checking of the equipment will be necessary to assure its proper functional status. Otherwise, appropriate protocols to be followed will be dictated by the quality assurance/quality control requirements established for the entire Plan.

SCHEDULE OF TASKS AND PRODUCTS

Summer 1984

1. Selected sampling on summer rainfall events.

Fall 1984

1. Assemble analysis of available data.

Winter 1984/85

1. Final design of the sampling program.

Spring 1985

1. Beginning of the sampling program with the spring snow melt.

Summer 1985

1. Continuance of sampling program on selected rainfall events.

PROJECT ORGANIZATION AND RESPONSIBILITY

It is the responsibility of New York and Ontario to insure that the necessary samples are collected and that the laboratory analyses are run satisfactorily. Each jurisdiction will be responsible for the mobilization and equipment of the field forces necessary to undertake the sampling or for the contract of local agencies or responsible parties to undertake specific tributary monitoring.

DATA QUALITY REQUIREMENTS AND ASSESSMENT

To be determined upon completion of the overall quality assurance/quality control requirements for the Plan.

DOCUMENTATION, DATA REDUCTION, DATA MANAGEMENT, AND REPORTING

To be determined upon completion of the overall quality assurance/quality control requirements for the Plan.

DATA VALIDATION

To be determined upon completion of the overall quality assurance/quality control requirements for the Plan.

PERFORMANCE AND SYSTEMS AUDITS

To be determined upon completion of the overall quality assurance/quality control requirements for the Plan.

CORRECTIVE ACTION

Follow up will be to a great extent governed by the significance of the findings. Exceedance of established standards and criteria requires further investigation as to source, frequency, duration, risk, etc. The Task Force report should go to appropriate jurisdictional authorities and to the individual water suppliers to determine proper follow up actions.

PROJECT FISCAL INFORMATION

To implement this part of the program will be a very costly undertaking. The base sampling recommended would result in approximately 60 samples for each of 23 tributaries or a total of 1,380 samples. The estimated cost for sample collection and priority pollutant or organic chemical analysis is approximately $1,800 per sample. Therefore, the sampling program, absent any additional requirements for quality assurance/quality control field blanks and replicates, would cost approximately $2.5 million. Therefore, careful consideration should be given as to whether the frequency of analysis and the hydrograph events that would trigger sample collection and analysis should be followed at the same frequency as that recommended for nutrient sampling analysis.

It would be recommended that this program continue for two years in duration and be re-evaluated for either reduced sampling frequency related to specific identified significant events or be returned to routine interval sampling. It is unknown at this point whether the tributary loadings of organic chemicals will vary proportionately the way that tributary loadings of nutrients have been demonstrated.

DATA INTERPRETATION

The primary responsibility for data interpretation rests with the principal investigator. The overall interpretation and presentation will be subject to review by the chapter or program coordinator and the Data Quality Work Group.

Those data which do not assist the project objectives should be identified; they may be subject to discard in further runs. Those data which raise questions not asked should be identified; they may lead to project redefinition.

REPORTS

Preliminary draft reports, consisting of raw data, preliminary evaluation, tentative conclusions and tentative recommendations should be available for peer review and project coordinator review six months after the last annual sample is taken.

Final reports to the quality established in the work plan should be available one year after the last annual sample is taken.

COMMENTARY

Currently, New York does once monthly routine grab samples April to November with analysis for phosphorus and nitrogen. Special periodic sampling is done for metals and organic toxic pollutants in the Genesee, Oswego, Black, and Niagara Rivers. Ontario is currently conducting an enhanced tributary monitoring program which provides for increased frequency of sampling on an event-related basis. This program could provide the foundation for proposed surveillance of toxic organic and metal pollutants.

This program should be closely coordinated with the nutrient sampling procedures in Chapter 22. For economy of manpower particularly, the field sampling programs should be coincidental.

The Ontario enhanced Drinking Water Monitoring Program should be evaluated carefully before final design of this element in this Plan is undertaken. The choice of sampling frequency and the definition of events will markedly influence effort and cost.

This program is designed to look for contribution of metallic and toxic organic pollutants from tributaries to Lake Ontario. Because of the number of tributaries selected, and the proposed frequency of sampling, the cost is very high. It may be prudent to carefully select two to [illegible] streams as a beginning program, run as designed for one year, evaluate the results, and then decide whether the data justify extension to the other selected streams. This will allow judgement as to the usefulness of the data and possibly an opportunity to streamline field collection procedures.

TABLE 1

TRIBUTARIES TO LAKE ONTARIO WHICH SHOULD BE MONITORED FOR METALS AND ORGANIC CONTAMINANTS

TRIBUTARY	LOCATION OF GAUGING STATION (DISTANCE ABOVE MOUTH, km)	WATERSHED AREA ABOVE GAUGE (km^2)	AVERAGE DISCHARGE (m^3/S)
New York			
Niagara River	9.8		b
Genesee River		6,335	77.4
Oswego River	1.3	12,950	181.4
Black River	5.6	5,000	111.3
Eighteen Mile Creek	a		
Salmon River		740	unmeasured
Ontario			
Twelve Mike Creek		-	195
Trent River		12,600	162
Welland Canal		-	84.5
Moira River		2,620	33.2
Salmon River		891	12.5
Napanee River		777	11.0
Credit River		829	8.1
Humber River		887	8.4
Don River		316	4.2
Oakville Creek		349	3.5
Rouge River		329	3.6
Duffin Creek		249	3.2
Spencer Creek		233	2.5
Etobicoke Creek		204	2.1
Highland Creek		99	1.3
Oshawa Creek		138	1.3
Welland River		-	-

[a]No gauging station.
[b]To be provided.

TABLE 2

ESTIMATED NUMBER OF SAMPLES TO BE COLLECTED FOR ANALYSIS OF METALS AND ORGANIC CONTAMINANTS

TRIBUTARY	COLLECTIONS FOR EACH STREAM[e]: SNOW MELT EPISODES	RAINFALL EVENTS	ROUTINE SAMPLING
Major Streams[a] Genesee River Oswego River Black River	1 sample per tributary per day for 20 days, for a total of 20 samples per tributary. See frequency below.	1 sample per tributary per day, 20 days per year, for a total of 20 samples per tributary. See frequency below.	2 samples per tributary per month, for a total of 24 samples per tributary per year.
Significant Streams[b] Welland River[c] Don River[c] Trent River[c] Welland Canal Moira River Humber River[c] Oakville Creek Eighteen Mile Creek Salmon River (Ont.)	2 samples per tributary per day, for 10 days, for a total of 20 samples per tributary. From March 1 to May 15: every second day from start of snowmelt until runoff peak occurs, then one sample per week until stream returns to normal + 50%.	1 sample per tributary per day, 45 days per year, for a total of 45 samples per tributary. Sample after start of stream rise and each day until peak is reached, then every third day until flow returns to normal + 50%.	2 samples per tributary per month, for a total of 24 samples per tributary per year.
Other Streams[d]	10 days per stream per year. No special sampling.	45 days per stream per year. No special sampling.	1 sample per stream per month, for a total of 12 samples per stream per year.
Niagara River	-	-	2 samples per month.
Regulated Streams Salmon River (NY) Twelve Mile Creek Trent River	2 samples per stream per week, for a total of 6 samples per stream.	1 sample per stream per event, for a total of 8 samples per stream.	2 samples per stream per month, for a total of 24 samples per stream per year.

[a]Major streams are those with large drainage basins where discharge events are normally damped and where localized rainfall events in a part of the watershed will not cause a large increase in flow at the mouth.

[b]Significant streams are those which have large flows or carry high nutrient loads (greater than 100 kg/d total phosphorus) and are event sensitive.

[c]These tributaries are presently (1983) monitored for high flow events.

[d]As given in Table 1.

[e]Grab samples are taken at mid-channel, mid-depth.

TABLE 3

PARAMETERS FOR WATER SAMPLES

GENERAL CHEMISTRY (LABORATORY)

Hardness	Alkalinity
pH	Colour
Turbidity	Conductivity
Total Solids	Fluoride
Nitrite	Nitrate
Sodium	Chloride

GENERAL CHEMISTRY (FIELD)

Chlorine Residual	Free & Total

BACTERIOLOGICAL

Total Coliform	[illegible] Coliform
Standard Plant Count	

METAL SCAN

Copper	Nickel
Zinc	Cadmium
Cobalt	Chromium
Lead	Iron
Manganese	Aluminum
Magnesium	Calcium
Vanadium	Barium
Beryllium	Strontium
Tin	Uranium

VOLATILE ORGANICS

1,1-Dichloroethylene	Trans-1,2-Dichloroethylene
1,1-Dichloroethane	Chloroform
1,1,1-Trichloroethane	1,2-Dichloroethane
Carbon Tetrachloride	Benzene
1,2-Dichloropropane	Trichloroethylene
Dichlorobromomethane	Toluene
1,1,2-Trichloroethane	Chlorodibromomethane
Tetrachloroethylene	Chlorobenzene
Ethylbenzene	M- and P-Xylene
Bromoform	O-xylene
1,1,2,2-Tetrachloroethane	1,4-Dichlorobenzene
1,3-Dichlorobenzene	1,2 Dichlorobenzene
Dibromoethane	Styrene
Methylene Chloride	

PCB/ORGANOCHLORINE SCAN & PESTICIDES

PCB	Hexachlorobenzene
Heptachlor	Aldrin
Mirex	α-BHC
β-BHC	γ-BHC (Lindane)
α-Chlordane	γ-Chlordane
OP DDT	PP DDD
PP DDT	PP DDE
Heptachloroepoxide	Dieldrin
Endrin	Thiodan I
Thiodan II	Thiodan Sulphate
Methoxychlor	Toxaphene

CHLORO AROMATICS

Hexachlorobutadiene	Hexachloroethane
1,3,5-Trichlorobenzene	1,2,4-Trichlorobenzene
2,4,5-Trichlorotoluene	2,3,6-Trichlorotoluene
α-2,6-Trichlorotoluene	1,2,3,4-Tetrachlorobenzene
1,2,4,5-Tetrachlorobenzene	1,2,3,5-Tetrachlorobenzene
Pentachlorobenzene	Octachlorostyrene

TABLE 4

CHLOROPHENOLS	
2,4,6-Trichlorophenol	2,4,5-Trichlorophenol
2,3,4-Trichlorophenol	2,3,5,6-Tetrachlorophenol
2,3,4,5-Tetrachlorophenol	Pentachlorophenol

SPECIFIC PESTICIDES	
Carbaryl	Diazinon
Methyl Parathion	Parathion
2,4-D	2,4,5-TP

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Point Sources

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: POINT SOURCES

WATERBODY: Lake Huron

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: POINT SOURCES

WATERBODY: Lake Erie

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: POINT SOURCES

WATERBODY: Lake Ontario

1984.09.17

CHAPTER 6A

MUNICIPAL AND INDUSTRIAL POINT SOURCES

BASIS FOR CONCERN

Point source discharges directly to Lake Ontario, and to streams tributary to the lake, may contain metallic and organic contaminants (toxic pollutants) at levels which could adversely affect aquatic life in Lake Ontario. While periodic surveys have identified substances of concern and substances of potential concern, comprehensive surveillance needs to be done to establish the impacts of these discharges of metals and organics upon aquatic life in Lake Ontario.

This program element for municipal and industrial point source discharges is designed to identify the sources for substances of concern in Lake Ontario, by tracking the substances back through areas of concern, tributary mouths, and upstream to inland dischargers, if necessary. Point sources to be included are those known or suspected to be discharging substances of concern that affect aquatic life in the lake, or substances of potential concern that could affect aquatic life. Of particular interest are pollutants which can bioaccumulate in fish tissue. There is additional concern for exposure of migrating fish populations to toxic discharges directly, whether in the lake, or in bays, harbors, or tributaries. Selection of candidate substances for monitoring will, in large part, be influenced by what problems are identified in the lake, particularly for aquatic life.

Most point source discharges to Lake Ontario are from municipal or other local governmental jurisdictions and are characterized as sewage. However, there are industries connected to many of these discharges. Municipal systems are usually not required by the jurisdictions to be sampled frequently for other than conventional sewage parameters. A broader scan of possible chemical contaminants is required, in order to detect discharges of substances of concern or potential concern into Lake Ontario.

Direct industrial dischargers are also an important aspect of the program. Industries should be monitored for substances of concern or potential concern, as well as being screened by biotesting methods for acute and chronic toxicity of their effluents. Industrial discharge limitations may not contain controls or testing requirements for substances known or suspected to be present. Historical data need to be examined, industrial sources characterized, and decisions made regarding which candidates are considered significant and warrant further effluent testing.

For both municipal and industrial discharges, an intensive program on a few carefully selected significant sources will provide more usable data than a sample or two on all the dischargers.

Municipalities with significant industrial contributions to their municipal systems should be covered by a sewer use by-law or ordinance to control inputs of contaminants that would be diluted without effective treatment, or could adversely affect the sewer system or subsequent treatment. Additional controls are often imposed on industries to assist the sewage treatment plant to meet effluent limits imposed by governments. Direct industrial dischargers will (should) have effluent limitations imposed on conventional and toxic pollutants. However, these limits may not cover known substances of concern, or testing requirements may not address all present or suspected contaminants.

There is concern that possible sources of metallic and organic pollutants are not adequately monitored and tested to assure compliance with effluent limits, nor monitored frequently enough to determine loadings, and not monitored with sufficient sensitivity to detect problems or substances of concern or potential concern.

PROJECT DESCRIPTION

The proposed program is designed to monitor direct dischargers to Lake Ontario, and selected discharges to tributaries which have, or may have, a direct effect on Lake Ontario. The questions to be addressed are:

1. Which point sources are significant contributors of metallic and organic contaminants to Lake Ontario?

2. Which point sources should be selected for increased and intensive monitoring, as they may be significant dischargers of metallic and organic contaminants and substances of concern or substances of potential concern?

3. What sampling frequency and what parameters are appropriate to characterize effluent quality and quantity.

<u>Objective and Scope</u>

The objectives are:

1. To determine compliance with the 1978 Agreement objectives for metallic and organic contaminants in Lake Ontario ambient water outside mixing zones.

2. To identify and quantify significant municipal and industrial discharges of metallic and organic contaminants to Lake Ontario from point sources. To determine, if practical, or to estimate with some probability, loadings of contaminants from significant point sources.

3. To establish a consistent point source monitoring strategy for all point source discharges to, or directly affecting, Lake Ontario. Point-to-point variability will require individually designed programs.

4. To establish consistent quality assurance/quality control requirements for all sample collection and analytical measurement procedures, in order to allow comparability of data and compilation of loadings.

The scope is:

1. To sample significant direct discharges to Lake Ontario, or to harbors or tributaries to the lake, where such discharges affect Lake Ontario. These are defined as:

   A. All public sewage treatment plants discharging to Lake Ontario or into a tributary, where the discha[illegible] is near the tributary mouth.

   B. All industrial waste treatment plants with a surface discharge to Lake Ontario or into a tributary to the lake, where the discharge is near the tributary mouth.

   C. Storm water discharges from industrial or other areas with significant expected contamination with substances of concern.

2. To establish a frequency of sampling.

3. To eliminate from further monitoring those discharges where further consideration is decided not to be needed. To assist in this decision making, consideration will be given [illegible] using the fact sheet in Table 1.

A list of all municipal and industrial discharges in the Lake Ontario Basin is given in Appendix A.

Data Usage

Data will be utilized by the jurisdictions:

1. To characterize effluents.

2. To determine the effects of metallic and organic contaminants on Lake Ontario from significant point sources. To determine, as practical, loadings to Lake Ontario.

3. To evaluate compliance with the 1978 Agreement objectives and with effluent limitations.

4. To determine needs for new or stricter effluent controls.

Monitoring Network Design and Rationale

Significant point sources of metallic and organic pollutants will be selected for periodic intensive survey, above and beyond routine discharge monitoring required by regulatory programs. Selection will be based upon evaluation of previous studies, magnitude or significance of the source, and known or suspected discharge of toxic pollutants.

In addition to effluent chemical characterization, toxicity screening to evaluate acute toxic effects should be done. Discharge of an acutely toxic effluent is prohibited in both the U.S. and Canada. Chronic toxic effects on Lake Ontario aquatic life will be evaluated as part of the fisheries and aquatic organism program (see Chapters 11, 12, and 16).

This element should be limited to major discharges directly and significantly influencing the lake.

Monitoring Parameters and The Frequency of Sample Collection

The parameters selected must be specific to each direct industrial discharger or to contributory industry in a municipal discharge. Generally, heavy metals and organic chemicals will be investigated. A few carefully selected discharges should be followed over time in an intensive sampling program.

Single samples of many sources will not be sufficient to meet the study objectives. However, a single effluent priority pollutant scan should be performed periodically on all significant discharges, to assist in establishing what to look for in more detail and to assist in refining sampling and analytical techniques.

A list of parameters will be developed for each major discharge. In addition to developing a scheme to monitor for substances of known concern, consideration will also be given to substances of potential concern. Such substances will be drawn from several sources, including:

1. The list of chemicals developed by the Human Health Effects Committee and published in the "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Ecosystem," held in March 1982.

2. Other chemicals identified by the Human Health Effects Committee, as published in their annual reports.

Sampling Procedures

Sampling procedures will incorporate the quality assurance/quality control requirements established for the overall Plan. Flow-proportioned composite samples are generally required.

Sample Custody Procedures

No special chain of custody is recommended, as these are surveillance and not enforcement samples. Custody procedures will incorporate the quality assurance/quality control requirements established for the overall Plan.

Calibration Procedures and Preventive Maintenance

Calibration procedures and preventive maintenance will incorporate the quality assurance/quality control requirements established for the overall Plan.

SCHEDULE OF TASKS AND PRODUCTS

Fall/Winter/Spring 1984/1985

1. Review available studies and literature to establish current state of knowledge. Evaluate current control programs of jurisdictions. Determine what needs to be known that isn't known now.

2. Prepare monitoring plan.

Summer 1985

1. Conduct effluent sampling scans on selected sources.

Fall 1985

1. Evaluate results of summer survey.

Winter 1985/1986

1. Refine and revise program as necessary.

Spring 1986

1. Conduct point source monitoring program on selected discharges.

PROJECT ORGANIZATION AND RESPONSIBILITY

The jurisdictions should carry out this sampling, in order to assure field quality and laboratory compliance with established protocols. Dischargers should not do this work, due to quality control concerns.

DATA QUALITY REQUIREMENTS AND ASSESSMENTS

Data quality requirements and assessments will incorporate the quality assurance/quality control requirements established for the overall Plan.

DOCUMENTATION, DATA REDUCTION, DATA MANAGEMENT, AND REPORTING

These will incorporate the quality assurance/quality control requirements established for the overall Plan.

DATA VALIDATION

Data validation will incorporate the quality assurance/quality control requirements established for the overall Plan.

PERFORMANCE AND SYSTEMS AUDITS

Performance and systems audits will incorporate the quality assurance/quality control requirements established for the overall Plan.

CORRECTIVE ACTION

Excursions from established effluent limitations should be reported to the jurisdictions for follow-up. Contaminants not in the permits, discovered at significant levels, should also be presented to the jurisdictions for possible limitation in revised or future effluent discharge limitations.

PROJECT FISCAL INFORMATION

Project fiscal information will be determined later.

DATA INTERPRETATION

Interpretation should be done by the principal investigators under the supervision of the project coordinator.

REPORTS

A preliminary report of raw data and tentative conclusions should be available six months after the last annual plan sample is collected. A final report to the standard established by the Task Force should be available one year after collection of the last annual sample.

COMMENTARY

Considerable comment has been raised as to the reliability with which a study of this type can be conducted, with the accuracy of the measurements to be made, with the usefulness of the data that would be gathered, and particularly, with reliability of any effluent loadings that might be calculated. The difficulties experienced by the Niagara River Toxics Committee with data of this type should be particularly instructive.

Other comments upon which suggestions should be made for refinement of this portion of the Plan are:

1. The 1978 Agreement contains the fundamental reasons for providing point source data. These relate to such issues as water quality management, areas of concern, and transboundary movement. The meanings of the words "exceedence" and "compliance" are critical. What is regarded as "compliance" in one jurisdiction may be regarded as a violation in the other and vice versa. Standardization of the specific meanings of exceedence and compliance is highly desirable. Included in this would be standardization of:

    (a) Analytical techniques
    (b) Parameters reported
    (c) Method of flow measurement
    (d) Loadings on a consistent "net" or "gross" basis
    (e) The basis for the agency requirement.

2. Currently used methods of flow measurement provide accuracy to approximately ±10%. Small errors are also associated with analytical techniques and somewhat larger errors are associated with sampling techniques. Loading data supplied could be associated with cumulative errors approaching ±20% or greater. All these should be taken into consideration when evaluating "compliance".

3. Total basin loadings are often calculated by adding up individual calculated loadings. Many parameters (e.g. BOD, ammonia, ether solubles, TKN) do not accumulate because of natural stabilization or degradation by such properties as volatility, oxidation, or reduction or bacterial action. Loading totals by this method are probably almost meaningless. In addition, if a large number of sources being reported are remote from the lake, reported loadings may never reach it.

4. The way in which data are reported needs careful thought. The program may not provide for accurate calculation of the effect of a contaminant on the ecosystem. Reporting only concentrations leaves the reviewer with no idea of significance. The statistical design should be developed so that clear choices can be made on sampling frequency and detection limits so that effluents can be reliably estimated.

5. The mechanisms by which a particular chemical is removed from the water column must be considered, as well as the chemical transformations which may occur in the environment, before a valid cost-effective sampling program may be defined. The selection of surrogate parameters to represent classes of chemicals must be considered as a means to minimize analysis costs.

TABLE 1

LONG-TERM MONITORING FACT SHEET

POINT SOURCE DISCHARGES

General Facility Description

Point Source Type: ____ Industrial ____ Combined/Storm Sewer

____ Municipal ____ Other

Facility Name:

Facility Location:

Industrial Category (where Applicable):

Type of Discharge:

____ Process Waste Water

____ Treated Process Waste Water

____ Non-Contact Cooling Water

____ Cooling Water

____ Storm Runoff

____ Boiler Blowdown

____ Sanitary Waste Water

____ Treated Sanitary Waste Water

____ Leachate

____ Other

Discharge Flow Rates: Indicate individual flow rates for each discharge.

Type of Intake: ____ City Water

____ Surface Water (Indicate river, lake, etc.)

____ Groundwater

Intake Flow Rates: Indicate individual flow rate for each intake

Self Monitoring Program Description

a) Sampling and Analysis

Sampling Points (Description)	Parameters Monitored	Frequency	Sample Type

b) Reporting Requirements

II Agency Monitoring Program Description

a) Sampling and Analysis

Sampling Points (Description)	Parameters Monitored	Frequency	Sample Type

b) Reporting Requirements

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Combined Sewer Overflows

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: COMBINED SEWER OVERFLOWS

WATERBODY: Lake Huron

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: COMBINED SEWER OVERFLOWS

WATERBODY: Lake Erie

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: COMBINED SEWER OVERFLOWS

WATERBODY: Lake Ontario

CHAPTER 6B

STORM WATER DISCHARGES AND COMBINED SEWER OVERFLOWS[a]

BASIS FOR CONCERN

In metropolitan areas, storm water and sanitary sewage often are both carried by combined sewage systems. During wet weather, storm water from significant rainfalls may cause overflow including sanitary sewage from the combined sewage system. These overflows may or may not contain significant quantities of metallic and organic contaminants, depending upon the timing and duration of the overflow, the characteristics of the sewage, and the character of the drainage area. In addition to combined sewer systems, discharges from separate storm water systems serving industrial, commercial, residential, and suburban areas are also often highly polluted. The discharges contain fertilizers and pesticides from lawn care, atmospheric deposition materials, and oils and heavy metals washed from roadways, parking lots, and gasoline service stations. Many of the studies have shown that these overflows and discharges may cause environmental problems by exceeding water quality objectives, by creating nuisance conditions, or by transporting persistent organic compounds into surface waters.

PROJECT DESCRIPTION

The proposed Surveillance Plan for combined sewer overflows and storm water discharges to Lake Ontario is designed to answer the following questions:

1. Where do significant overflows of combined sewage and discharges of storm water occur? What are their frequency, volume, and duration? What type of precipitation or runoff events cause the overflows and discharges?

---

a. See Chapter 21 for consideration of conventional sewage pollutants and nutrients in storm water discharges and combined sewer overflows.

2. What organic and metallic contaminants are discharged from storm and combined sewers to Lake Ontario? What is necessary to quantify discharged contaminants?

3. What is the significance of the various contaminants, and at what levels do they become important to the ecosystem and to water usage?

4. Is corrective action necessary to prevent the discharge of metallic and organic contaminants to Lake Ontario through storm and combined sewers?

Objective and Scope

The objectives are:

1. To determine compliance with the 1978 Great Lakes Water Quality Agreement for ambient water outside mixing zones. This element would be implemented if and when monitoring of areas of concern or the nearshore area showed non-attainment of the Agreement objectives associated with precipitation and runoff events and traceable to storm water overflows.

2. To establish the frequency, duration, quantity, and constituents of significant combined storm sewer overflows and storm water discharges to Lake Ontario. The application of various available models to estimate with some probability, loadings of contaminants and their effect on the lake during various weather simulations will be evaluated.

The scope is:

1. To assemble and review available literature, data, and mathematical models to evaluate the present state of knowledge about combined sewer overflows and storm water discharges, and how they affect the receiving waters. The plan for this element could stop at this point if sufficient information is available.

2. To devise a sampling program for significant combined sewer overflows and storm water discharges, in order to address questions not satisfactorily answered by current literature and previous studies, or that are needed to evaluate the various models which might be used.

3. To sample selected combined sewer overflows and storm water discharges during wet weather and significant precipitation events. Wet weather encompasses spring snow melt and accompanying rainfall. Significant precipitation events include those of >1.2 cm (0.5 inches) per hour, or >3.7 cm (1.5 inches) in 24 hours.

Data Usage

Project data will be utilized by the jurisdictions:

1. As input into mathematical models, to predict runoff events and their effects.

2. To determine which storm and combined sewers, and to what extent, cause significant input of metallic and organic contaminants to Lake Ontario.

3. To evaluate whether and to what extent combined sewer overflows and storm water discharges cause exceedence of the Agreement objectives in ambient water.

4. To determine whether combined sewer overflows or storm water discharges contribute to environmental degradation in identified areas of concern or in other nearshore areas of Lake Ontario.

5. To consider which combined sewer overflows or storm water discharges require corrective abatement action.

Monitoring Network Design and Rationale

Storm and combined sewers in metropolitan areas which contain significant industrial contributions will be selected for periodic monitoring during the spring wet weather period, if appropriate, and during precipitation events which cause discharge and overflow conditions. The most significant discharges are expected to occur at Rochester, Hamilton, Burlington, Mississauga, and Toronto. Considerable information already exists, and local authorities will be consulted in the design of the program, in order to obtain information concerning the frequency, duration, and cause of storm water discharges and combined sewer overflows and for assistance in selection of the most significant discharge and overflow points for sampling. Existing data will be assembled and evaluated, and models run, if desirable, to assist in determining the scope, intensity, and duration of the project in each area.

Monitoring Parameters and Frequency of Sample Collection

The program to be designed for each municipal or industrial area should reflect the contributing types of industries that are expected to be involved in a discharge or overflow event. This requires city-by-city designs on local situations. The frequency of collection will also be dependent on local circumstances, as causes will vary from system to system.

Parameters will be determined on a site-specific basis, depending on the industries or the type of land use tributary to the overflow point. Review of previous study work will be used to establish a list of expected significant substances for each area. Generally, parameters will include heavy metals and a priority pollutant scan. The selection of parameters for monitoring will be tempered by consideration of the nature of the sources in the drainage area served by the sewers. Consideration will also be given to the list of chemicals developed by the Human Health Effects Committee and published in the "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Ecosystem", held in 1982; and to other chemicals identified by that Committee, as published in their annual reports.

Details on analytical protocols and field procedures will incorporate the quality assurance/quality control requirements as established for the overall Plan.

Sampling Procedures

Sampling procedures will incorporate the quality assurance/quality control requirements established for the overall Plan. Generally, a series of samples will be taken over the course of an overflow or discharge event, in order to allow for a flow composite as well as for discrete time-related samples.

Sampling Custody Procedures

No special chain of custody is recommended, as these are surveillance and not enforcement samples. Custody procedures will incorporate the quality assurance/quality control requirements as established for the overall Plan.

Calibration Procedures and Preventive Maintenance

Calibration procedures and preventive maintenance will incorporate the quality assurance/quality control requirements as established for the overall Plan.

SCHEDULE OF TASKS AND PRODUCTS

Fall 1984

1. Review literature, previous studies, and available mathematical models, to establish state of current knowledge and refine proposed plan.

2. Evaluate current control programs and practices of jurisdictions.

3. Evaluate the significance of storm water overflows and determine the extent of effort justified for the program.

Winter 1984/85

1. Run and test the available mathematical models for the major communities or industrial areas.

2. Devise mobilization plans for responding to discharge and overflow events.

Spring/Summer 1985

1. Mobilize and respond to combined sewer overflow and storm water discharge events at selected locations under defined conditions, in order to test workability of plans and the applicability of the models.

Fall 1985 and Winter 1985/86

1. Design program in detail.

2. Consult with municipalities and select final sampling points.

3. Determine frequency and define events which trigger overflow or discharge sampling.

4. Select parameters to be monitored at each overflow or discharge.

Spring and Summer 1986

1. Implement Plan and respond to selected events.

Fall/Winter 1986/87

1. Evaluate results and restructure program if necessary. Continue for second year, and prepare final evaluation and report.

PROJECT ORGANIZATION AND RESPONSIBILITY

The program should be carried out by the jurisdictions in consultation with, and assisted by, local municipalities.

DATA QUALITY REQUIREMENTS AND ASSESSMENTS

Data quality requirements and assessments will incorporate the quality assurance/quality control requirements as established for the overall Plan.

DOCUMENTATION, DATA REDUCTION, DATA MANAGEMENT, AND REPORTING

These will incorporate the quality assurance/quality control requirements established for the overall Plan.

DATA VALIDATION

Data validation will incorporate the quality assurance/quality control requirements established for the overall Plan.

PERFORMANCE AND SYSTEMS AUDITS

Performance and systems audits will incorporate the quality assurance/quality control requirements established for the overall Plan.

CORRECTIVE ACTION

Upon evaluation of results, recommendations should be prepared for local municipalities or, in the case of major violations of water quality standards, enforcement action initiated. These would indicate the scope and significance of the problem and identify those overflows which require abatement actions or the need for improved management priorities by the community.

PROJECT FISCAL INFORMATION

The cost of this element of the Plan cannot be determined until the number of sites for monitoring is selected, the frequency of sampling and flow estimation is determined, and the duration of the program is established.

DATA INTERPRETATION

The primary responsibility for data interpretation will rest with the principal investigators, with overview from the chapter coordinator. Reports should address the questions raised above in the Project Description.

REPORTS

Preliminary reports of raw data and tentative conclusions should be provided for peer review six months after the last sample in the annual plan has been collected. Final reports to the standard established by the Task Force should be completed 12 months after the final sample in the annual plan has been collected.

COMMENTARY

Studies of varying intensity, duration, and complexity have been made by various jurisdictions on storm water discharges and combined sewer overflows. Most of these have focused on conventional pollutants. These studies should be evaluated to assist in the development and design of a recommended program. Additionally, industrial contributions to the system and their characterization must be considered.

Some modelling has also been done which has been shown to have a reasonable conformity with actual measurements.

Evaluation of past studies and models should focus on their objectives, for compatibility with the needs of this Surveillance Plan, and their results, in order to determine which questions may already have been adequately addressed and what future work would be most necessary and valuable.

Priorities need to be established, as this Plan is competing for resources with other interests. For the current proposal, given past focus on conventional pollutants, industrialized areas and industries which discharge metals and organic substances have the most significance. The following sequence is in the order of decreasing unit loadings and increasing volumetric loadings: (1) combined sewer overflows with significant tributary industry, (2) combined sewers in urban areas, (3) storm sewers in industrial/urban areas, and (4) suburban storm sewers. This is the most likely priority ranking from which to select a few carefully chosen areas for further field study. Computer models should be used to confirm or further refine the program emphasis.

As (if) the project proceeds to field work, there must be standardization of sampling frequency during events to be monitored. Flow measurement (estimation) is essential if loading estimates are to be attempted. Concentrations will vary significantly over time; this will require frequent samples, particularly early in a precipitation/runoff event.

Decisions will have to be made on the extension or applicability of data from one geographic area to another, if this is possible. Since this element would be very labor intensive, and could not be done for a large number of sources in any given year, review of past data should include evaluations or comparabilities of different areas and whether or not generalizations could be made.

The keys to further detailed study design lie in three areas: evaluation of past studies and their applicability to current needs, a limited number of studies at a few carefully selected sites specifically geared to gather data on metallic and organic pollutants, and the output of computer models. Further discussions on study design should be deferred until these steps are complete.

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Open Lake

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: OPEN LAKE

WATERBODY: Lake Huron

TABLE 1

ISSUE: CONTAMINANTS

COSYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
NPUTS	1. ATMOSPHERE	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
REAS OF EFFECT	* 3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AREAS OF CONCERN	Yes	Water, Sediments - Suspended and Bottom, Biota	Area specific [illegible]ts, should include some of the above [illegible]ables
	6. WILDLIFE	Yes	Gull eggs	Above list & chlorinated benzenes, chlorinated styrenes
UTPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
ISC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

3.2 AREAS OF EFFECT - OPEN LAKE

3.2.1 INTRODUCTION

The open lake or large ship component of any surveillance plan is often the most controversial. This is because it is the most highly visible component of surveillance, both from a physical presence and from a cost perspective. Indeed, this component often is regarded as the surveillance program and expectations are typically greater than it is possible to deliver. For this reason it must be made very clear that the objectives of this component are achievable and what the expected output will be.

OBJECTIVES

Objectives applicable to all surveillance activities have been abstracted from Annex 11 of the 1978 GLWQA and presented earlier. Within this framework and within the confines of the specific issues particular to Lake Huron outlined in Chapter 1 the specific objectives of open lake surveillance are to:

1. Determine the ambient levels of nutrients, major ions, contaminants and selected components of the aquatic biota in the waters of Lake Huron to establish and maintain a data set that will permit the determination of baseline conditions and the evaluation of long-term trends in the open lake.

2. Monitor these same variables so that violations of water quality objectives can be determined.

3. Assist in the detection of any new or emerging problems which may affect the quality of the Lake Huron ecosystem.

3.2.2 RATIONALE & DESIGN - GENERAL

In establishing the reality of long-term trends in water quality, measurement of physical, chemical, and biological variables is mandatory. This, because chemistry and physics are often causative factors, particularly in degradation of ecosystems by man-induced changes. Yet it is the biological expression of these by increased algal growth, occurrence of nuisance blue-green algae, loss of sport fish, contamination of commercial fisheries that effects the value of Lake Huron to our society.

To determine the significance of changes in the conditions of Lake Huron two major components of variability have to be considered which, because of the size of this lake, are a particular problem. First, spatial variation, from extremes between Saginaw Bay and Georgian Bay which require clear resolution, particularly to determine areas which may be either deteriorating or improving.

Second temporal variation, which occurs on a wide range of scales from hourly, daily, seasonally, annually and perhaps longer cycles, each having different patterns. For the purposes of surveillance the primary interest is in longer time scales of rates of change which requires quantitative annual estimates of lake conditions with known levels of precision. To do this a strategy is needed employing a consistent annual marker of conditions that is comparable from year to year, but also an estimate of the annual noise around that marker. It cannot be over emphasized that the value of a surveillance record of this type comes from its longevity and that trends may often not be seen until 10, 20 or 50 years of data have been obtained sufficient to damp out the year-to-year variations that naturally occur, and furthermore, that annual data points be maintained to understand the year-to-year variations.

Results from the previous surveys on Lake Huron (Stevens, 1983; Kwiatkowski, 1982; Moll and Rockwell 1982) have shown that the chemical conditions in the lake have changed in the last 10 years but that previous measurement programs have often not been of sufficient frequency to statistically validate these changes over that time period. To correct this inadequacy, a continuous annual open lake surveillance program of two cruises, one conducted in the spring which will represent unstratified conditions and open water maximum values for the chemical variables. The summer survey will be conducted during the period of stratification when the vertical differences in phytoplankton distribution are greatest.

These two surveys are considered the minimum to provide a valid annual marker of lake conditions, representing two references in the annual cycle of the lake when the biology of the planktonic community is clearly different because of physical differences in lake structure. In addition to the two annual reference points, i.e. spring unstratified and summer stratified, an estimate of temporal variation on a shorter scale can be obtained from the intake sampling program which provides weekly data. This will ensure the validity of the between year temporal comparability of the two annual cruises.

Another result from the 1980 intensive surveillance was that different changes were observed in different portions of Lake Huron, Georgian Bay and the North Channel. Thus all areas must be sampled to describe all the changes that occur. It was also discovered that variable station patterns made inter-year comparisons difficult and less valid. THEREFORE, THE STATION PATTERN ADOPTED MUST BE MAINTAINED FOR ALL FUTURE SURVEILLANCE CRUISES. The recommended station pattern consists of 95 stations (Figure 2, Table 10) and is regarded as sufficient to adequately characterize the variability of the lake and to satisfy the practical considerations of the surveillance cruises. This station pattern applies only to the nutrient and major ion portions of

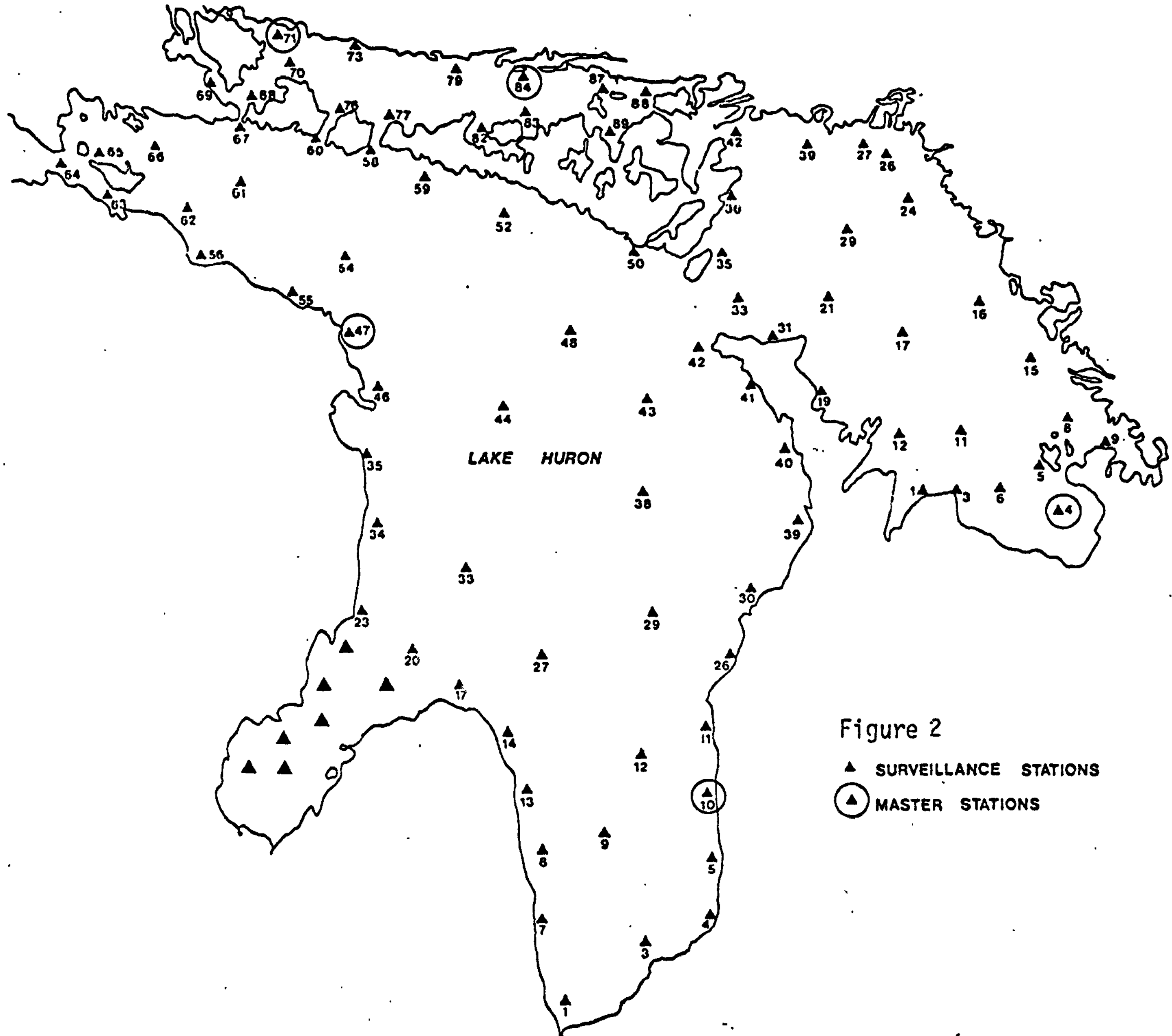


Figure 2

TABLE 10

SAMPLING LOCATIONS IN LAKE HURON, GEORGIAN BAY AND THE NORTH CHANNEL

STATION NUMBER	LATITUDE N.	LONGITUDE W.
Lake Huron		
1	43° 05" 24"	82° 23' 33"
3	43° 15' 24"	82° 02' 17"
4	43° 19' 32"	81° 47' 17"
5	43° 32' 54"	81° 44' 38"
7	43° 20' 32"	82° 30' 22"
8	43° 34' 01"	82° 29' 05"
9	43° 37' 59"	82° 13' 06"
10	43° 45' 18"	81° 46' 56"
11	43° 57' 29"	81° 47' 10"
12	43° 53' 28"	82° 03' 26"
13	43° 45' 14"	82° 34' 08"
14	43° 56' 34"	82° 40' 02"
17	44° 06' 02"	82° 52' 02"
20	44° 13' 01"	83° 05' 00"
23	44° 20' 01"	83° 17' 57"
27	44° 11' 50"	82° 30' 14"
29	44° 21' 29"	81° 49' 57"
30	44° 28' 09"	81° 26' 54"
33	44° 30' 00"	82° 49' 57"
34	44° 38' 26"	83° 14' 00"
36	45° 02' 08"	83° 22' 42"
38	44° 44' 26"	82° 03' 39"
39	44° 39' 26"	81° 22' 35"
40	44° 53' 52"	81° 26' 13"
41	45° 04' 59"	81° 32' 19"
42	45° 13' 19"	81° 49' 15"
43	45° 00' 51"	82° 00' 29"
44	45° 00' 55"	82° 41' 08"
47	45° 15' 21"	83° 20' 51"
48	45° 16' 39"	82° 27' 02"
50	45° 32' 06"	82° 02' 48"
52	45° 39' 06"	82° 39' 06"
54	45° 31' 01"	83° 24' 54"
55	45° 23' 32"	83° 39' 10"
56	45° 31' 13"	84° 05' 00"
58	45° 52' 04"	83° 16' 00"
59	45° 46' 00"	83° 01' 43"
60	45° 54' 00"	83° 31' 07"
61	45° 45' 03"	83° 54' 58"
62	45° 40' 34"	84° 11' 12"
63	45° 42' 14"	84° 30' 37"
64	45° 48' 30"	84° 45' 36"
65	45° 50' 48"	84° 34' 00"
66	45° 51' 50"	84° 17' 42"
67	45° 51' 06"	83° 54' 00"
68	46° 02' 28"	83° 51' 11"
69	46° 04' 43"	84° 01' 42"
70	46° 08' 10"	83° 40' 15"
71	46° 13' 58"	83° 44' 44"
73	46° 11' 18"	83° 21' 12"
76	45° 59' 00"	83° 26' 17"
77	45° 58' 07"	83° 11' 57"
79	46° 07' 24"	82° 53' 09"
82	45° 56' 20"	82° 45' 30"
83	46° 00' 01"	82° 32' 48"

Table 10 - cont'd.

STATION NUMBER	LATITUDE N.	LONGITUDE W.
Lake Huron - cont'd.		
84	46° 05' 31"	82° 33' 26"
87	46° 03' 36"	82° 10' 42"
88	46° 03' 23"	81° 59' 45"
89	45° 55' 00"	82° 09' 45"
95)	44° 12' 46"	83° 22' 13"
96)	44° 07' 36"	83° 10' 20"
97)	44° 06' 58"	83° 31' 46"
98) Saginaw Bay	43° 58' 34"	83° 34' 30"
99)	43° 54' 30"	83° 44' 28"
100)	43° 49' 27"	83° 49' 03"
101)	43° 49' 18"	83° 37' 28"
Georgian Bay		
1	44° 42' 56"	80° 51' 26"
3	44° 43' 34"	80° 36' 49"
4	44° 38' 43"	80° 09' 53"
5	44° 47' 48"	80° 14' 33"
6	44° 44' 16"	80° 26' 08"
8	44° 57' 15"	80° 08' 03"
9	44° 52' 19"	79° 57' 58"
11	44° 55' 10"	80° 36' 16"
12	44° 55' 12"	80° 52' 30"
15	45° 10' 00"	80° 17' 53"
16	45° 21' 12"	80° 29' 03"
17	45° 14' 40"	80° 52' 24"
19	45° 03' 59"	81° 15' 12"
21	45° 21' 50"	81° 11' 16"
24	45° 40' 45"	80° 50' 21"
26	45° 49' 56"	80° 53' 53"
27	45° 51' 53"	80° 59' 53"
29	45° 34' 59"	81° 05' 06"
31	45° 14' 20"	81° 26' 30"
33	45° 22' 13"	81° 35' 06"
35	45° 31' 39"	81° 40' 12"
36	45° 42' 36"	81° 37' 15"
39	45° 52' 27"	81° 15' 30"
42	45° 54' 50"	81° 35' 42"

the plan, the contaminants portion will be conducted at the 24 stations shown in Figure 3. Parameters to be measured for eutrophication, conservative materials transport and contaminants are listed in Tables 11 and 12.

The rationale for parameter selection is outlined below:

Nutrients and Conservative Material Transport

Annex 1 lists objectives for total dissolved solids (TDS), pH, dissolved oxygen, total ammonia and fluoride. Total dissolved solids is calculated according to the formula:

$$TDS = S.C._{25} \times 0.65\ (\pm\ 0.01)$$

where $S.C._{25}$ is the specific conductance corrected to 25°C. Again, worst-case conditions being in the spring, specific conductance will be measured at the full range of stations, at all depths on the spring cruise. Fluoride and total ammonia will be sampled only at selected stations to assess compliance.

As the dissolved oxygen only reaches a minimum during summer months due to restricted epilimnion-hypolimnion exchange, compliance monitoring will be conducted during the summer cruise. pH will be measured at all stations.

Certain parameters will be monitored to aid in interpretation of results. Included in this will be alkalinity, to provide a gross estimate of primary productivity, and soluble reactive silica, as it is the principal frustule (cell wall) constituent of diatoms and is found at limiting concentrations in the summer. Dissolved oxygen levels will be measured at selected stations throughout the cruises, and at all depths where stratification has commenced. Alkalinity and soluble reactive silica will be measured in conjunction with the biological parameters at multiple depths. Also, to assess biologically-induced epilimnetic decalcification, thought responsible for reduced phosphorus levels through co-precipitation, filtered calcium and total phosphorus will be measured.

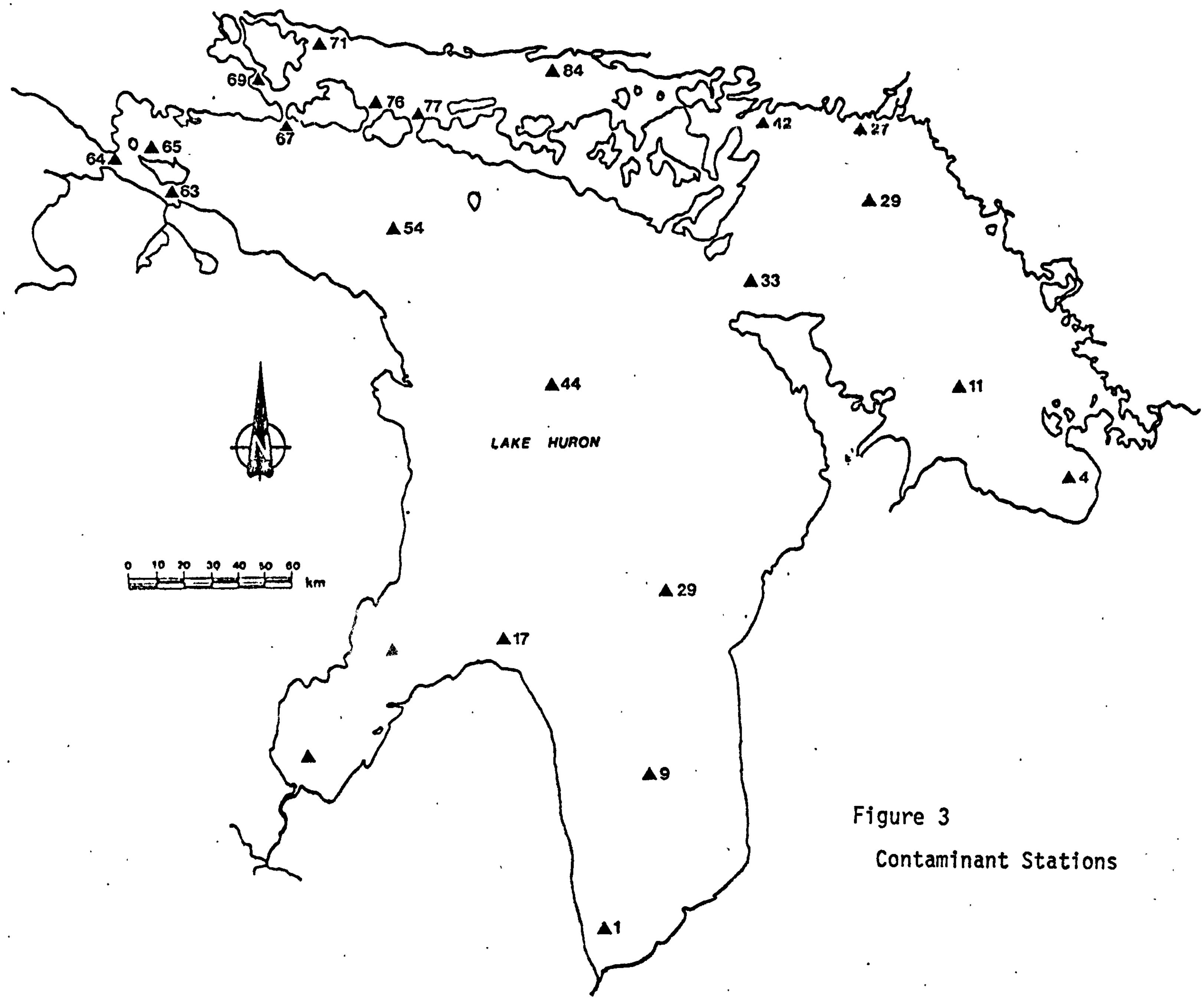


Figure 3

Contaminant Stations

TABLE 12

PARAMETERS TO BE MEASURED ON SPRING AND SUMMER CRUISES
AT TWO OR THREE DEPTHS FOR CONTAMINANT TRANSPORT ISSUES

PARAMETER	COMMENTS
Trace metals: Filtered (.45μ) & Total	- for compliance with objectives outlined in Annex 1 (total concentration); selected stations
Arsenic	- filtered concentrations for spatial monitoring; selected stations
Cadmium	
Chromium	- contaminants issue
Copper	
Iron	
Lead	
Mercury	
Nickel	
Selenium	
Zinc	
Organic compounds	- for compliance with objectives outlined in Annex 1; selected stations
Aldrin	- contaminants issue
Dieldrin	
Chlordane	
DDT and metabolites	
Endrin	
Heptachlor	
Heptachlor epoxide	
Lindane	
Methoxychlor	
Mirex	
Toxaphene	
PCBs	

All major ions, particularly chloride, are conservative elements in the lake system and they are used to calibrate both models and mass balance equations and to distinguish water masses. Therefore, on the spring cruise, major ion samples will be collected at all stations.

Secchi disk will also be done at all stations and cruises during daylight hours to provide input for the assessment of the Secchi disk-chlorophyll relationship.

Total particulate nitrogen and particulate organic carbon are two parameters which aid in the interpretation of biomass. These parameters will be sampled at the full range of stations using a 0-20 M integrator.

The other nutrient parameters of total P, total filtered P, soluble reactive P and filtered nitrate + nitrite will be sampled at all stations on both cruises to ensure the primary nutrients trends in all areas of the lake are maintained.

Contaminants

Trace Metals

The objectives outlined in the Agreement are in terms of total, unfiltered concentrations except for mercury. Total concentrations, however, do not adequately reflect anthropogenic loadings as they are affected by increased particulate loadings attributable to sediment resuspension and runoff. Metal concentrations can vary by orders of magnitude over short periods of time due to the influence of resuspended lake bottom sediments, river-transported particulates, shoreline runoff and bluff erosion. Such variation would invalidate data comparison even within the same cruise. Furthermore, inshore versus offshore comparisons would be biased by particulate concentrations and biological processes (such as assimilation and regeneration). Therefore, both total and filtered metal samples will be collected at selected stations (Figure 3).

High flow conditions associated with spring runoff result in worst-case conditions while during summer both the settling out of resuspended sediments and biological activity could temporarily deplete metal concentrations. Furthermore, when the lake is isothermal (and relatively isochemical), sampling can be restricted to the surface (1 metre) and one other depth. Therefore, all spatial and compliance monitoring will be conducted at two depths during Spring conditions.

Trace Organics

Due to a paucity of data on trace organics in the waters of Lake Huron, the first priority is to establish lakewide baseline conditions. Various sampling techniques are being tested and once these have been evaluated, lakewide monitoring can be carried out at selected sites for determining trends of organics in water. Spring surface sampling is again assumed optimal due both to the isothermal conditions and reduced biological activity. However, knowledge of temporal and spatial trends is required to confirm the optimum sampling strategy. Therefore, multiple-depth sampling at a limited number of stations may be conducted initially.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: OPEN LAKE

WATERBODY: Lake Erie

(Section 1.2 not available)
although listed in
Table of Contents

<u>SURVEILLANCE ISSUE:</u>	CONTAMINANTS
<u>OPERATIONAL COMPONENT:</u>	OPEN LAKE
<u>WATERBODY:</u>	Lake Ontario

1984.09.24

CHAPTER 7

CONTAMINANTS - OPEN LAKE WATER

BASIS FOR CONCERN

The term "contaminant" is meant to encompass both organic and inorganic substances which can, either directly or through the bioaccumulative process of the food chain, potentially cause adverse effects on reproduction, growth, or general health, including a shift in community structure.

The discovery, in 1970, of mercury contamination of fish and bottom sediments in Lake St. Clair and the western arm of Lake Erie prompted nationwide re-evaluation of programs for monitoring harmful or potentially harmful elements and compounds in the environment.

An example that effectively demonstrates the widespread impact that small amounts of these compounds can have on the environment is that of mirex contamination in Lake Ontario. Mirex was used basically as an insecticide against the fire ant in the southern United States. It was manufactured and later packaged at a chemical plant in Niagara Falls, New York. Over a period of approximately 15 years, it has been estimated that a total of 2,000 pounds of mirex was lost from the plant and ultimately made its way into Lake Ontario. As a result, the sediments of Lake Ontario became highly contaminated with mirex. Several species of fish from various locations in the lake were designated as unfit for human consumption because of mirex levels exceeding the human health protection guideline of 0.1 ug/g. It is difficult to believe that a lake as large as Lake Ontario could be susceptible to the effects of a contaminant which was introduced at a rate no greater than that from a leaky tap in one's bathtub.

Many of these contaminants have subsequently been banned or otherwise regulated under toxic substances legislation in both countries (e.g. Environmental Contaminants Act - Canada; Toxic Substances Control Act - United

States). In addition, the 1978 Great Lakes Water Quality Agreement established objectives for both persistent and non-persistent toxic substances (Annex 1).

It is, however, not merely our charge to monitor for compliance with these objectives. Ambient water quality monitoring for contaminants is considered a necessary part of the Plan in order to help establish the movements of contaminants in the ecosystem and their potential for bioaccumulation. Further, as the ability to detect trace levels of contaminants in the water column improves, an open lake contaminant program may serve to reduce the time lag in detecting an emerging problem.

The Agreement also specifies that monitoring be established to assess both spatial and temporal trends of these substances (Annex 12). And, as research in the field of antagonistic/synergistic effects continues, it is important that we be "one step ahead of the game" in having established baseline conditions and trends.

PROJECT DESCRIPTION

Objective and Scope

1. To assess compliance with the objectives outlined in the 1978 Great Lakes Water Quality Agreement (Annex 1).

2. To establish baseline conditions of both organic and trace metal substances in the open waters of Lake Ontario.

3. To identify trends, both spatial and temporal, of contaminant levels in the open lake, thereby identifying potential problems (Annex 12).

4. To provide data for assistance in the development and verification of mathematical models (Annex 11).

Data Usage

Compliance with the objectives outlined in the 1978 Great Lakes Water Quality Agreement for metals and organic substances in water will be assessed.

For the first few years baseline data for organic contaminants in water will be collected. The optimum sampling strategy with respect to time and frequency of sampling will be assessed and recommendations made for a surveillance plan that will provide trend informati

Historical trace metal data on the open lake consists mainly of "less than detection" values. Although the existing detection limits allow for determination of compliance, improved detection limits are necessary to fulfill the requirements of Annex 12, namely spatial and temporal trend analysis. The required detection limits are presented in Table 1. When sufficient "analyzable" data have been collected, trends will be reported and a review of this program will be conducted.

Monitoring Network Design and Rationale

Toxic contaminants, referred to as both persistent and non-persistent toxic substances in the Agreement, include trace metals and trace organic compounds. Objectives for these compounds in water are given in Annex 1. Hence, for the protection of aquatic life, compliance monitoring must be conducted for the substances listed in Table 2. Furthermore, Annex 12 specifies that monitoring of persistent toxic chemicals be established to assess both spatial and temporal trends and to assist in the development of mathematical models.

While Annex 1 of the Agreement provides specific objectives for a variety of organic and inorganic persistent toxic substances (Table 4), the Niagara River Toxics Committee (1) and the Human Health Effects Committee (2), through recent initiatives, have compiled lists of compounds for which ambient water quality monitoring should be conducted; a summary of the lists is presented in

Table 5. Other sources of chemicals for which monitoring may be desirable are the 1983 Appendix E report (3) and the annual reports of the Human Health Effects Committee.

The objectives outlined for trace metals are in terms of total, unfiltered concentrations (except mercury which is total, filtered concentration). Total concentrations, however, do not adequately reflect anthropogenic loadings as they are affected by increased particulate loadings attributable to sediment resuspension and runoff. Rossmann (4) found that total metal concentrations can vary by orders of magnitude over short periods of time due to the influence of resuspended bottom sediments, river-transported particulates, shoreline runoff, and bluff erosion. Such variation would invalidate data comparison even within the same cruise. Furthermore, inshore versus offshore comparisons would be biased by particulate concentrations and biological processes (such as assimilation and regeneration). Therefore, filtered samples will be collected for spatial trend monitoring and trend in time, and totals for objective compliance.

High flow conditions associated with spring runoff result in worst-case conditions while, during summer, both the settling out of resuspended sediments and biological activity could temporarily deplete metal concentrations. Thus, all lakewide compliance monitoring will be conducted during spring conditions. Also, when the lake is isothermal (and assumed isochemical), sampling can be restricted to the surface (1 metre) depth (5) whereas, in summer, stratification necessitates multiple-depth sampling. Therefore, all spatial and compliance monitoring of the open lake will be conducted at the 1 m depth during spring conditions.

Due to a paucity of data on trace organics in the waters of Lake Ontario, the first priority is to establish lakewide baseline conditions. An initial effort, directed primarily at organochlorine pesticides, chlorobenzenes, and PCB's, was carried out in October 1983 at 15 selected stations on large-volume whole water samples, manually extracted with dichloromethane. A continuous-flow automatic sampler/extractor is currently being developed, scheduled for testing in 1984-85. Once operational, continued lakewide monitoring can be carried out using this new method at selected sites for determining trends of organics in water.

Note that whenever a new method for collection and analysis of samples has been developed, duplication of effort (i.e. both old and new method) will be done until comparability of the two procedures has been developed.

Spring surface sampling is again assumed optimal due both to the isothermal conditions. However, a knowledge of temporal and spatial trends is required to confirm the optimum sampling strategy. Therefore, multiple-depth, monthly sampling at a limited number of stations will be conducted initially. Since the list of compounds in Tables 4 and 5 is so extensive and, consequently, costly to measure, only a few of the easily detectable compounds, for which standard analytical methods exist, can be examined in this fashion. Due to the high cost of trace organic analysis, perhaps the research community should study this problem and recommend to the Task Force the optimum sampling depth(s) and time(s).

The stations to be monitored for trace metals and trace organics are depicted in Figures 1-4. The station locations and grid cells (see Chapter 25) are given in Table 3. Additional stations may be added, in order to meet the program and information requirements of other chapters of this Plan, and in order to develop the desired ecosystem perspective. See especially the programs described in Chapter 15 (Contaminants in Fish), Chapter 24 (Biological Community Welfare), and Chapter 25 (Physical Habitat).

Monitoring Parameters and Frequency of Sample Collection

The parameters to be measured in the open lake are listed in Table 4. Trace metals will be measured on both spring cruises only at the 1 m depth; trace organics will be similarly monitored for compliance, plus multiple depth sampling (one sample from each of epilimnion, metalimnion, and hypolimnion, where applicable) on a monthly basis (April to November) at selected stations to determine both the optimum sampling strategy and any temporal trends.

Table 5 lists additional parameters for which surveillance and monitoring should be considered; other sources of candidate parameters were identified above. Any decision regarding the inclusion of these parameters, as well as the frequency of sample collection, will be made at a later date.

Table 6 proposes, for each parameter, the number of samples to be collected, the sample matrix, the analytical method, sample preservation, and holding time.

Sampling and Analytical Procedures

Specific sample collection and analysis procedures and protocols will be specified at a later date. The procedures and protocols will be based on present jurisdictional practices; however, the suitability of these procedures to provide the information required, can only be determined after the program and information requirements for this component of the Plan have been more fully developed.

Sample Custody Procedures

Not applicable.

Calibration Procedures and Preventative Maintenance

To be developed.

SCHEDULE OF TASKS AND PRODUCTS

See Table 7.

PROJECT ORGANIZATION AND RESPONSIBILITY

Responsibilities will be assigned for sampling operations, sampling quality control, laboratory analysis, laboratory quality control, data processing activities, data processing quality control, data quality review, performance auditing, systems auditing, overall quality assurance, and overall project coordination. Project personnel will be identified at a later date.

DATA QUALITY REQUIREMENTS AND ASSESSMENTS

See Table 8.

Although the detection limits for metals are sufficient to address compliance, they do not allow for spatial and/or temporal trend analysis. The detection limits needed to fulfill the requirements of Annex 12 (ug/L) are given in Table 1.

DOCUMENTATION, DATA MANAGEMENT, AND REPORTING

Documentation

Any changes in station location, sampling, and/or analytical methodology will be documented in the cruise report. Computer printouts from trace metal analyses will be stored in the data management vault. Original gas chromatograph scans will be kept for future verification and, if necessary, reinterpretation.

Data Management and Reporting

Once all the analyses for a particular cruise have been completed, and the quality control results approved, the chemist in charge will interpret the gas chromatograph scans and the results will be sent to the project leader. Likewise, once accepted by the chemist in charge, the trace metal results will be sent to the project leader. The project leader is responsible for investigating any suspect data and having it flagged or deleted as deemed appropriate. The data will then be entered into the main computer for public access.

DATA VALIDATION

The project leader will be given the results of all quality assurance analyses (blanks, duplicates, % recoveries of spikes) associated with each data set.

PERFORMANCE AND SYSTEMS AUDITS

All analytical methods are to be documented and evaluated by the Data Quality Work Group for compatability with other methods in use. Quality control will consist of both inter- and intralaboratory programs. The interlaboratory program will consist of participation in interlaboratory round robins, blind audit samples, and the use of standard reference materials. Intralaboratory quality control will incorporate checks for consistency of data across samples (i.e. filtered/total, etc.) and between parameters, spikes, standards, and replicates.

1. Reagent blanks and reagent blanks spiked at various levels of concentration are to be run before samples to check analytical instrument. Also a complete calibration curve is to be run before and after samples.

2. Standard addition samples are to be run initially and as required, depending on the system, to determine matrix interference effects and recovery.

3. Calibration standards (drift control) are to be run every 20th sample.

4. One sample is to be analyzed 10 or more times to determine precision.

In addition, duplicate analyses will be performed on every 20th trace metal sample. Field blanks will be submitted to check for bottle contamination.

CORRECTIVE ACTION

None.

PROJECT FISCAL INFORMATION

Survey Costs

All sampling will be conducted during the scheduled eutrophication cruises (Chapter 17) or piggy-backed onto research cruises. Therefore, survey costs are negligible.

Laboratory Services

Trace metals		$ 2.5K
Trace organics		$ 9.7K
Toxaphene		$22.4K
	Total	$34.5K

DATA INTERPRETATION

See Data Usage, above.

REPORTS

A report summarizing trends, objective compliance, and providing information regarding the spatial distribution of contaminants in water throughout the lake will be made available to the Lake Ontario Task Force for inclusion in the report to the Water Quality Board of the International Joint Commission.

COMMENTARY

The historical data base for trace metals reflects the wide variety of analytical procedures used over the years (filtered, non-filtered, extracted, totals) and contains results for a broad spectrum of elements. Unfortunately, most of the data have been reported as "less than detection limit". It is the aim of the current plan to establish a reliable collection of baseline data (for a restricted number of parameters) which, after a few years, can provide trend information for the detection of emerging problems.

Up until the present, trace organic analysis of lake water has been more in the realm of research sampling techniques, sample storage, etc. It is hoped that within the next few years baseline data can be established upon which a more extensive-program can be built.

REFERENCES

1. Report of the Niagara River Toxics Committee, to be published late 1984.

2. "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Basin Ecosystem," held March 17-18, 1982 at East Lansing, Michigan. Committee on the Assessment of Human Health Effects of Great Lakes Water Quality, International Joint Commission, Windsor, Ontario, November 1982.

3. An Inventory of Chemical Substances Identified in the Great Lakes Ecosystem," 6-volume report to the Great Lakes Water Quality Board, International Joint Commission, Windsor, Ontario, December 31, 1983.

4. Rossmann, R. Grant proposal to U.S. Environmental Protection Agency, #ORDA 80-1487-P1, 1980.

5. Neilson, M. A. IWD Publication Scientific Series No. 133, 1983.

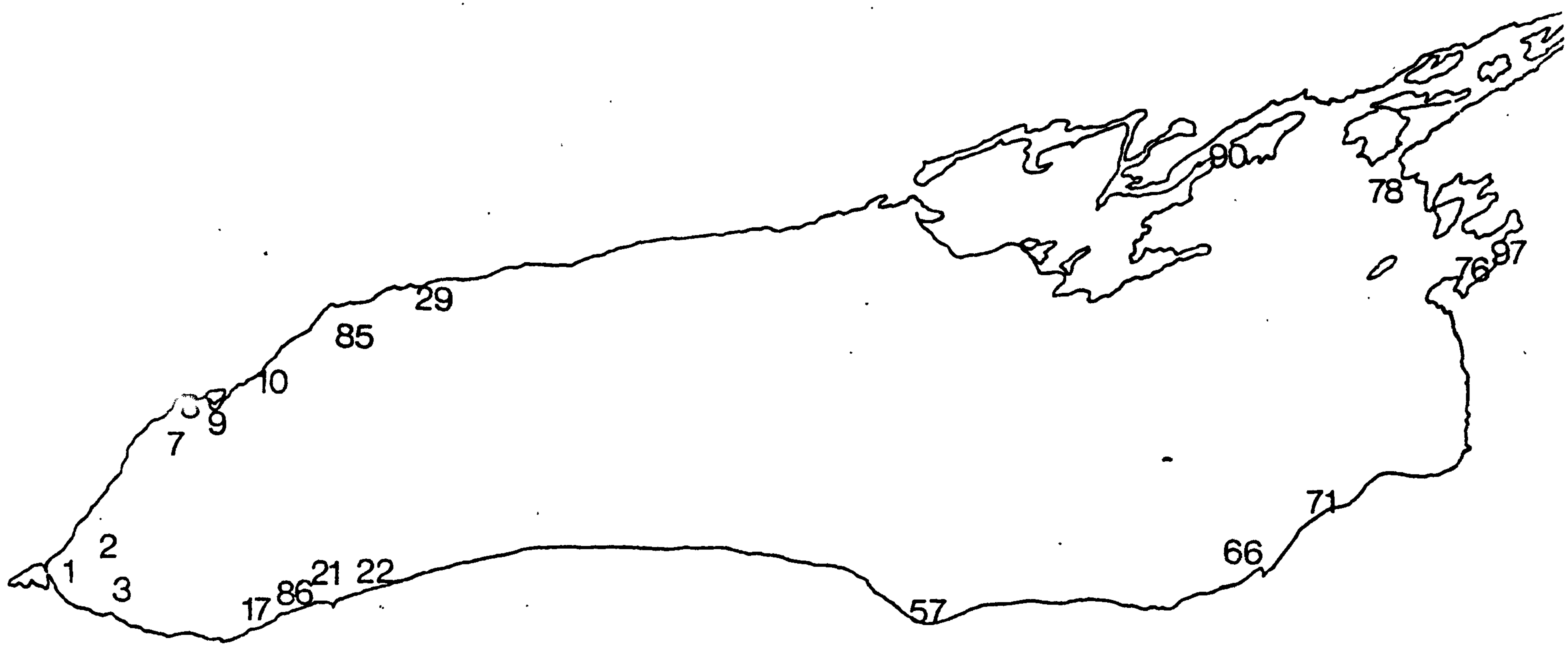


Figure 1. Compliance monitoring stations for total metals (spring, 1 m depth only). 20 stations.

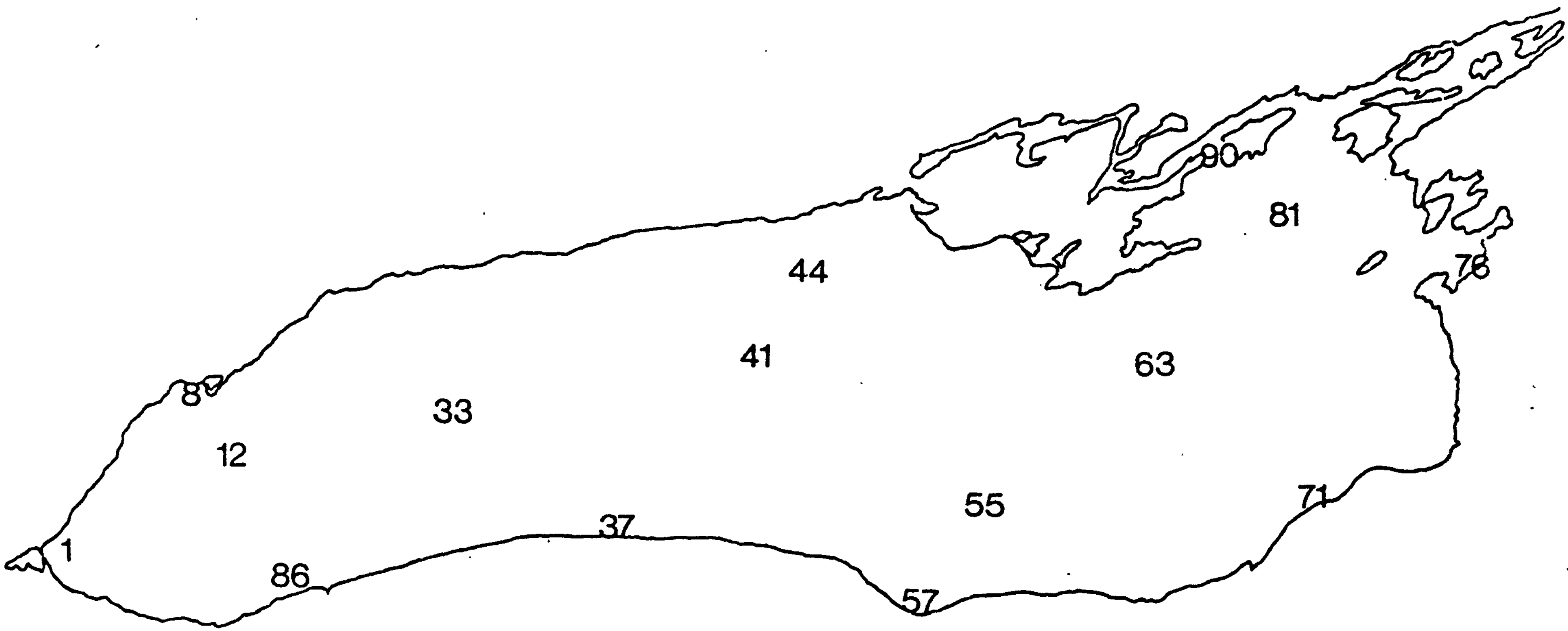


Figure 2. Stations to be sampled for filtered trace metal spatial monitoring (spring, 1m depth).15 stations.

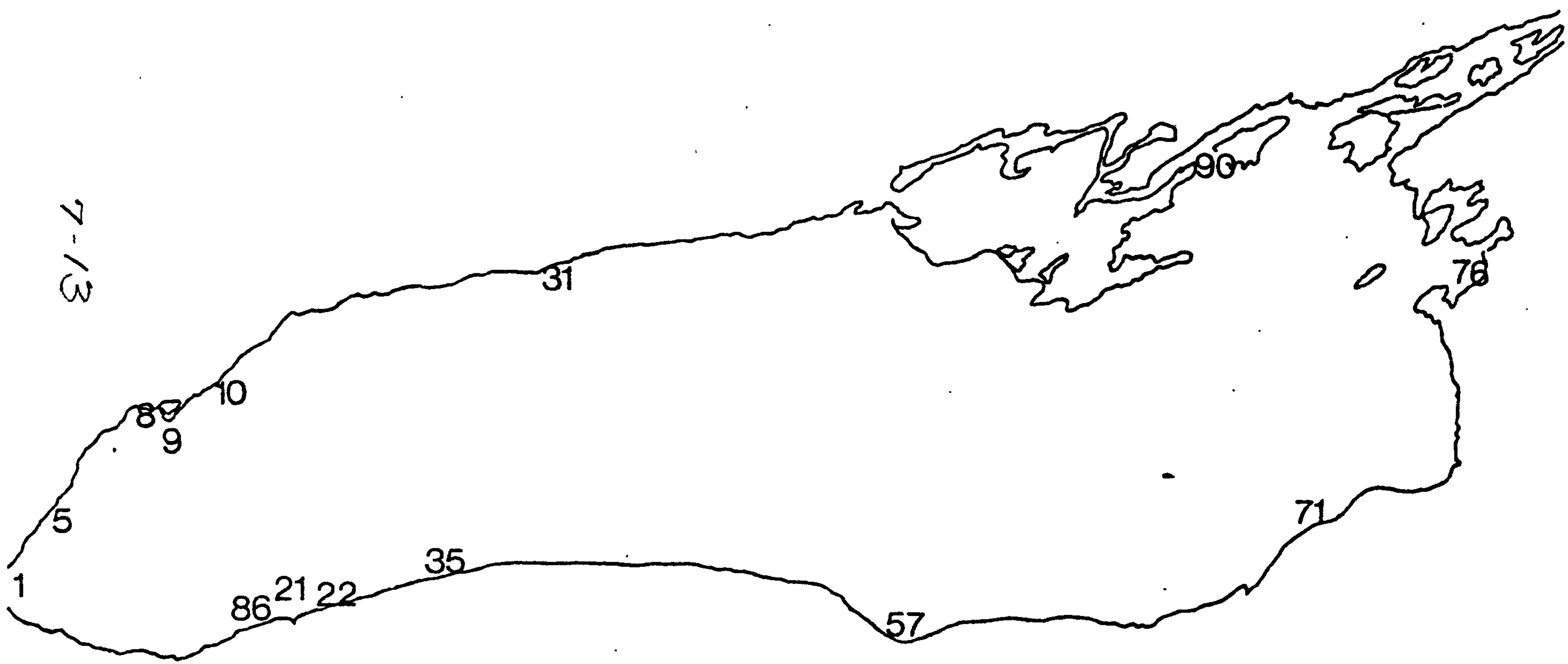


Figure 3. Stations to be sampled for trace organic contaminants compliance monitoring (spring, 1 m depth only). 14 stations.

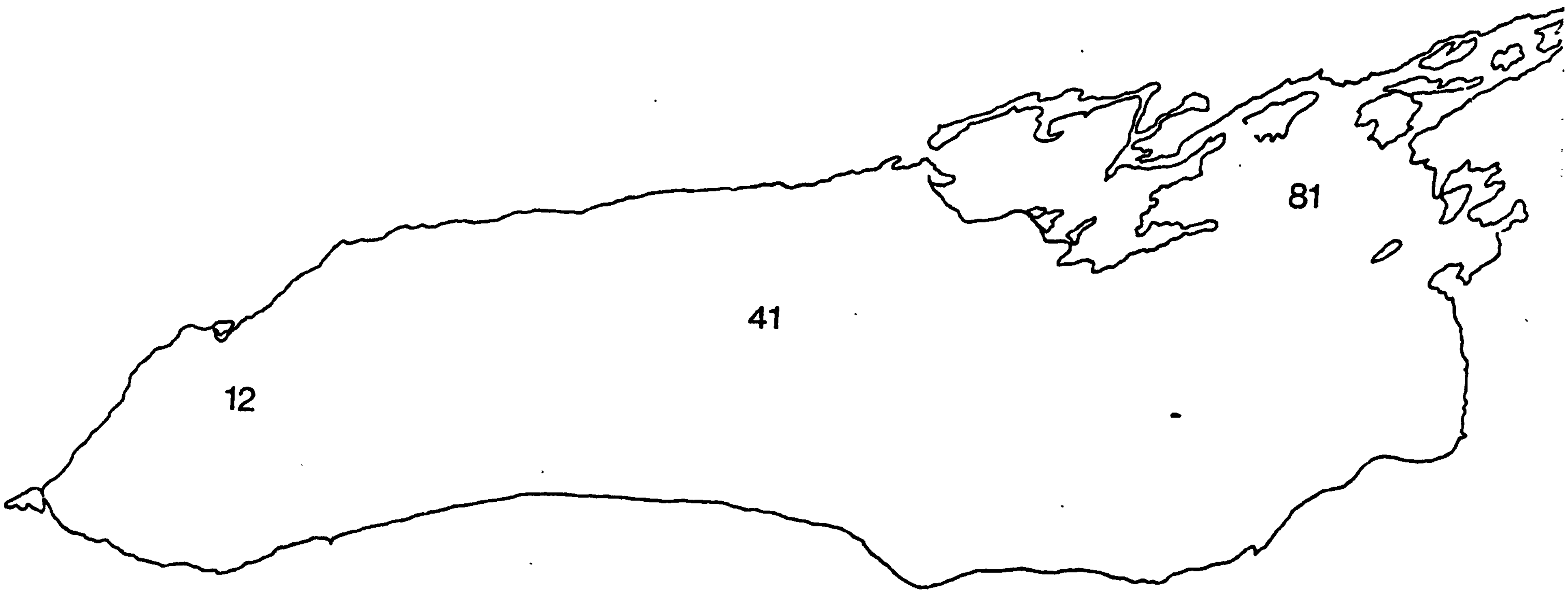


Figure 4. Stations to be sampled for temporal monitoring of trace organic contaminants (monthly, April - November at three depths, where applicable: epilimnion (1m), metalimnion and hypolimnion). 3 stations.

TABLE 1

REQUIRED DETECTION LIMITS FOR TRACE METAL ANALYSIS
(µg/L)

METAL	DETECTION LIMIT	SMALLEST REPORTABLE INCREMENT DESIRED	BACKGROUND LEVEL
Cadmium	0.01		0.01-0.09
Copper	0.1		1.0
Iron	0.1		35.0
Lead	0.1		0.2 -1.0
Mercury	0.01		0.01-1.0
Nickel	0.05		1.0
Selenium	0.01		<0.1
Zinc	0.05		<1.0

TABLE 2

SUBSTANCES FOR WHICH COMPLIANCE MONITORING IS REQUIRED

Aldrin/Dieldrin	Cadmium
Endrin	Lead
Lindane	Zinc
Toxaphene	Copper
Chlordane	Mercury
Heptachlor	Selenium*
Methoxychlor	Iron
Dibutyl phthalate	Nickel
DDT & metabolites	Radioactivity
Heptachlor epoxide	
Mirex	
Di(2-ethylhexyl)phthalate	

*Selenium, toxic at high concentrations, has an antagonistic effect on toxicity and bioaccumulation of toxic metals, particularly Hg, As, Cu, Pb, and Cd.
Thus, it was added to the list of metals for analysis.

TABLE 3

STATION LOCATIONS FOR OPEN LAKE CONTAMINANTS

STATION NUMBER	GRID CELL[a]	LATITUDE N.	LONGITUDE W.
1	802	43° 18' 48"	79° 45' 06"
2	703	43° 20' 24"	79° 39' 54"
3	803	43° 16' 06"	79° 37' 12"
5	703	43° 25' 30"	79° 39' 30"
7	604	43° 32' 48"	79° 29' 18"
8	604	43° 37' 24"	79° 27' 12"
9	604	43° 35' 12"	79° 23' 42"
10	505	43° 40' 06"	79° 16' 00"
12	604	43° 30' 12"	79° 21' 12"
17	805	43° 13' 30"	79° 16' 18"
21	806	43° 18' 00"	79° 07' 12"
22	806	43° 17' 48"	79° 00' 18"
29	507	43° 49' 48"	78° 52' 12"
31	410	43° 53' 12"	78° 27' 36"
33	608	43° 35' 48"	78° 48' 06"
35	708	43° 21' 36"	78° 23' 12"
37	710	43° 23' 30"	78° 22' 12"
41	512	43° 43' 00"	78° 01' 36"
44	413	43° 52' 54"	77° 54' 30"
55	716	43° 26' 36"	77° 26' 18"
57	815	43° 16' 30"	77° 35' 30"
63	518	43° 43' 54"	77° 01' 00"
66	719-819	43° 20' 00"	76° 50' 24"
71	721	43° 28' 36"	76° 31' 36"
76	424	43° 57' 00"	76° 10' 30"
78	322	44° 05' 00"	76° 24' 24"
81	320	44° 01' 00"	76° 40' 18"
85	506	43° 45' 00"	79° 05' 00"
86	805	43° 15' 18"	79° 11' 42"
90	320	44° 08' 11"	76° 49' 30"
97	424	43° 57' 42"	76° 07' 18"

[a]The grid cells are depicted on Figure ___ in Chapter 25.

TABLE 4

OPEN LAKE PARAMETERS TO BE MEASURED

ORGANIC SUBSTANCES	TRACE METALS[a]	RADIONUCLIDES
Aldrin	Cadmium	^{3}H
Dieldrin	Copper	^{90}Sr
Chlordane, α and γ	Iron	^{125}Sb
p,p'-DDT	Lead	^{137}Cs
o,p'-DDT	Mercury	
p,p'-TDE	Nickel	
p,p'-DDE	Selenium	
Endrin	Zinc	
Heptachlor		
Heptachlor epoxide		
Lindane		
Methoxychlor		
Mirex		
Toxaphene		
Dibutyl phthalate		
Di(2-ethylhexyl)phthalate		
PCB		

[a]Both total and filtered concentrations.

TABLE 5

ADDITIONAL CHEMICALS FOR WHICH OPEN LAKE MONITORING SHOULD BE CONSIDERED

ORGANIC SUBSTANCES

Benzene	Dioctylphthalate
Benzo (B) fluoranthene	Endosulphan
Benzo (K) fluoranthene	Ethylbenzene
Benzo (J) fluoranthene	Fluoranthene
Benz (A) anthracene	Hexachlorobenzene
Benz (A) pyrene	Hexachlorobutadiene
Bromoform	Hexachloroethane
Carbon tetrachloride	Methylene chloride
Chlorodibromomethane	Pentachlorophenol
Chloroform	Phenol
Chloronaphthalene	Pyrene
Chrysene	Styrene
2,4-D	TCDD
p,p-DDD	2,4,5-T
Dibenz (a,h) anthracene	Tetrachloroethene
2,3-dichlorobutadiene	Trichloroethylene
1,2-dichloroethane	2,4,5-trichlorophenol
1,2-dichloroethylene	

INORGANIC SUBSTANCES

Antimony	Cyanide
Berylium	Silver
Chromium	

TABLE 6

PARTICULARS ABOUT COLLECTION AND ANALYSIS OF OPEN LAKE WATER SAMPLES

PARAMETER	NUMBER OF SAMPLES	ANALYTICAL METHOD	SAMPLE PRESERVATION	HOLDING TIME
Aldrin	110	AMM*	cool, 4°C	extracted immediately
Chlordane (α,γ)	"	"	"	"
Dieldrin	"	"	"	"
p,p'-DDT	"	"	"	"
o,p'-DDT	"	"	"	"
p,p'-TDE	"	"	"	"
p,p'-DDE	"	"	"	"
Endrin	"	"	"	"
Heptachlor	"	"	"	"
Heptachlor epoxide	"	"	"	"
Lindane	"	"	"	"
Methoxychlor	"	"	"	"
Mirex	"	"	"	"
Toxaphene	"	"	"	"
Dibutyl phthalate	"	"	"	"
Di(2-ethylhexyl) phthalate	"	"	"	"
PCB	"	"	"	"
Cadmium	80	"	2 mL $cHNO_3$ (Ultrex)/litre	6 months
Copper	"	"	"	"
Iron	"	"		"
Lead	"	"	"	"
Mercury	"	"	1 mL cH_2SO_4, 1 mL 5% $K_2Cr_2O_7$/100 mL	1 month
Nickel	"	"	2 mL $cHNO_3$ (Ultrex)/litre	6 months
Selenium	"	"	cool, 4°C	6 months
Zinc	"	"	2 mL $cHNO_3$ (Ultrex)/litre	6 months

AMM* = Analytical Methods Manual (1978) Inland Waters Directorate, Ottawa, Ontario, Canada.

TABLE 7

SCHEDULE OF TASKS AND PRODUCTS

ACTIVITY/DATE	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Compliance monitoring for metals			⟷									
Spatial trace metal monitoring			⟷									
Trace organic compliance monitoring			⟷									
Tempor ' monitoring of trace organics				X	X	X	X	X	X	X	X	

TABLE 8

DATA QUALITY REQUIREMENTS AND ASSESSMENTS

	SAMPLE MATRIX	DETECTION* LIMIT (ug/L)	SMALLEST REPORTABLE INCREMENT DESIRED	PRECISION AND ACCURACY
Aldrin	Water	0.0004		
Chlordane (α,γ)	"	"		
Dieldrin	"	"		
p,p'-DDT	"	"		
o,p'-DDT	"	"		
p,p'-TDE	"	"		
p,p'-DDE	"	"		
Endrin	"	"		
Heptachlor	"	"		
Heptachlor epoxide	"	"		
Lindane	"	"		
Methoxychlor	"	"		
Mirex	"	"		
Toxaphene		?		
Dibutyl phthalate	"	0.05		
Di(2-ethylhexyl) phthalate	"	0.05		
PCB	"	0.009		
Cadmium	Water	0.1		C.V. = 3.5% @ 10 ug/L
Copper	"	0.1		C.V. = 1.6% @ 10 ug/L
Iron	"	1.0		(S.D.) 0.05±0.006 mg/L
Lead	"	0.5		C.V. = 2.2% @ 10 ug/L
Mercury	"	0.02		(rel. S.D.) 0.07±6.0% (ug/L)
Nickel	"	0.1		C.V. = 3.8% @ 10 ug/L
Selenium	"	0.1		C.V. = 8.9% @ 0.36 ug/L
Zinc	"	1.0		C.V. = 1.4% @ 10 ug/L

*This is dependent upon the sample size - the larger the sample size, effectively, the lower the detection limit.

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Nearshore

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: NEARSHORE

WATERBODY: Lake Huron

TABLE 1

ISSUE: CONTAMINANTS

COSYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
NPUTS	1. ATMOSPHERE	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
REAS OF EFFECT	3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	*4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AREAS OF CONCERN	Yes	Water, Sediments - Suspended and Bottom, Biota	Area specific lists, should include some of the above [illegible]ables
	6. WILDLIFE	Yes	Gull eggs	Above list & chlorinated benzenes, chlorinated styrenes
UTPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
ISC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

3.3 AREAS OF EFFECT - NEARSHORE

3.3.1 INTRODUCTION

While the previous section addresses the open water portion of the lake, the largest portion in terms of area and volume, it is the nearshore which is the most heterogeneous both spatially and temporally. The littoral region while representing the smallest area in most lakes is the most biologically productive and processes most materials. The nearshore in most cases receives point source and non-point source material before the open water and, therefore, is impacted sooner and more directly. And lastly, it is the most visible visited portion of the lake.

The nearshore has, therefore, been given special consideration and various components of the biological community are proposed for study in the first year to integrate and identify changes in condition of the nearshore region. From these results the most appropriate biomonitoring tools, if any, will be chosen for continuous surveillance

3.3.2 ATTACHED ALGAE

OBJECTIVES

1. To monitor the distribution and abundance, and contaminant burdens of the major attached filamentous algae in Lake Huron.

2. To evaluate these data as evidence of nearshore phosphorus enrichment and contaminants loadings.

3. To establish a data base for comparison of future change.

RATIONALE

There is a well defined sequential occurrence of attached filamentous algae in nearshore Lake Huron related to increasing phosphorus enrichment and general degradation in water quality. A first sign of phosphorus enrichment is a general increase in the distribution of Ulothrix, followed in order of increasing perturbation by fringing Cladophora, submerged Cladophora, and finally problem growths of submerged Cladophora (although Bangia is not strictly limited by phosphorus availability in Lake Huron, its occurrence is still a clear sign of advanced degradation in water quality). Because these algae are all highly conspicuous, synoptic evaluations of nearshore trophic status can be carried out rapidly and at low cost. Significantly, the Thirty Thousand Islands of eastern Georgian Bay are the greatest concentration of islands and potential Cladophora habitat in the world. It is expected that Georgian Bay will suffer excessive environmental degradation from the growth of Cladophora unless existing phosphorus levels are maintained indefinitely (i.e. <0.005 mg/L total P).

Investigations by MOE have shown that attached filamentous algae concentrate (10^3-10^5X) a variety of organic and inorganic contaminants. The algae aquire almost all of their contaminant load from the surrounding water through mechanisms of adsorption and absorption (both active and passive) while fine particulate material which can not be washed from the filaments accounts for the rest. This means that contaminant levels in filamentous algae are implicit of recent water quality.

DESIGN

Water. Temperature and wave height will be recorded at all shoreline sites.

Substrate. Substrate characteristics will be recorded at all shoreline sites.

Biota.

Eutrophication. Growth characteristics of the major attached filamentous algae will be recorded at shoreline sites throughout Lake Huron in mid-June and mid-August. The distribution of Ulothrix in remote areas will be monitored from a light aircraft in mid-July. All surveys will be carried out annually.

Contaminants. Biomass for contaminants analysis will be collected (about 100g wet wt. per replicate for all tests) from exposed and permanent substrates at shoreline sites throughout Lake Huron (i.e. areas of concern, tributaries, and above eutrophication sites). Surveys will be carried out in mid-June and mid-August annually. All samples will be rinsed in ambient water, squeezed dry, wrapped in absorbant paper, transported on ice to the lab, dried to a constant weight (at 50°C), powdered and stored in the dark until analysis.

DATA QUALITY

Appropriate timing and site selection is imperative. Field staff must be knowledgeable of basic filamentous algal ecology and field identification techniques.

It is recommended that one agency lab analyse all samples (Table 15) for a given group of parameters (e.g. inorganics). This will ensure greater consistency in the reported data. It will not, of course, reduce the need for satisfactory quality control and quality assurance procedures within each lab.

DATA OUTPUT

As a minimum, there will be an annual statement made regarding the changes observed with respect to the distribution and quantity of the algae observed.

In addition, annual changes in the contaminant burdens of the algae will be documented and interpreted.

TABLE 15

ATTACHED FILAMENTOUS ALGAE SAMPLING DETAILS - EUTROPHICATION/CONTAMINANTS

MEDIA	TESTS	SITES	DEPTH	FREQUENCY
Filamentous Algae				
Eutrophication	Species ID, % cover, health/colour, filament length, upper.lower depth, photographic record. Others. water temperature, wave height, substrate characteristics.	Survey	Shoreline	Mid-June and Mid-August annually.
	Ulothrix in remote areas , a photographic record	Air survey	Shoreline	Mid-July annually.
Contaminants	Organics. Total PCBs	Survey	Shoreline	Mid-June to Mid-August annually.
	As,Cd,Co,Cr,Cu,Fe,Pb, Hg,Ni,Se,Zn,N,P			
	Others. Loss on ignition.			

RESPONSIBLE AGENCY

MOE and Michigan DNR.

3.3.3 CAGED CLAMS

OBJECTIVES

1. To monitor contaminants in introduced clams (Elliptio complanatus) in Lake Huron.

2. To evaluate these data as evidence of nearshore contaminants loadings.

3. To establish a data base for comparison of future change.

RATIONALE

Investigations by MOE and the Great Lakes Institute have shown that introduced caged clams are a viable tool for detecting trace contaminants in aquatic systems. Importantly, the ability to place (and remove) clams at specific locations effectively defines their geographical range and period of exposure. Clams may also be placed in locations where resident biomonitors are precluded (because of habitat considerations, for example). In addition, clams are abundant, inexpensive to obtain and easily handled.

DESIGN

Biota. Caged clams will be introduced annually at nearshore sites throughout Lake Huron (i.e. areas of concern, tributaries, remote sites). Clams will be collected from a healthy population containing low background levels of the contaminants of interest and transported to the study sites in lake water. Clams will be measured and weighed, placed in galvanized metal or plastic cages (5-10 clams/cage) and then anchored (on bottom or suspended) at the desired station, the choice of either bottom or suspended must be consistent throughout the program - usually at approximately 2 m depth with a submerged marker. Studies have shown that organics such as PCBs can accumulate to detectable levels in as little as 2-4 days but that metals may take considerably longer. Recent studies have utilized exposure periods of three weeks, as this is more than adequate for bioaccumulation to occur and still allows the use of multiple exposures during the field season if significant temporal variability in contaminants loadings is suspected. Alternatively, clams can be left in for the whole field season, provided that the cages are checked and cleaned at regular intervals (three weeks) to remove aufwuchs. For this program, a minimum of one month exposure is recommended for accumulation of metals. After retrieval, clams will be rinsed, measured, weighed and then shucked. The soft tissues will then be rinsed in lake water, wrapped in Hexane-rinsed aluminum foil (organics analysis) or in plastic bags (inorganics) and frozen on dry ice for later analysis. Samples will be stored at -20°C before analysis (Table 16). Tissue from one clam (about 7 cm shell length) is sufficient for one replicate analysis.

DATA QUALITY

It is recommended that one agency lab analyse all samples for a given group of parameters (e.g. pesticides, etc.). This will ensure greater consistency in the reported data. It will not, of course, reduce the need for satisfactory quality control and quality assurance procedures within each lab.

DATA OUTPUT

As a minimum, annual changes in the contaminant burdens of clams will be documented and interpreted.

RESPONSIBLE AGENCY

MOE and Michigan DNR.

TABLE 16

CAGED CLAMS SAMPLING DETAILS - CONTAMINANTS

MEDIA	TESTS	SITES	DEPTH	FREQUENCY
Clams	Organics. PCBs (total), Organochlorine pesticides*, Chlorinated aromatics+	Survey	2 m	3 week exposure mid to late summer annually
	As,Cu,Hg,Zn			
	Others. Percent lipid			

* Aldrin, Dieldrin, BHC (alpha, beta, gamma), Chlordane (alpha, gamma chlordane, cis & trans nonachlor, oxychlordane), DDT, DDD, DDE, (op'pp') for each, Endrin, Endosulphan (alpha, beta), Heptachlor, Heptachlor epoxide, Hexachlorobenzene, Mirex.

\+ 1,2,3-Trichlorobenzene (TCB), 1,2,4-TCB, 1,3,5-TCB, 1,2,3,4-Tetrachlorobenzene (TeCB), 1,2,3,5-TeCB, 1,2,4,5-TeCB, Pentachlorobenzene, Hexachlorobenzene, Hexachloroethane, Hexachlorobutadiene, Octachlorostyrene, 2,3,6-Trichlorotoluene (TCT), 2,4,5-TCT, 2,6A-TCT.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: NEARSHORE

WATERBODY: Lake Erie

2.0 NEARSHORE SURVEILLANCE

2.1 INTRODUCTION

The nearshore area is an important component of the Lake Erie ecosystem. It is the principal source of water for municipal and industrial uses, it is used extensively for recreational purposes, and it provides habitat and food for various life-history stages of many invertebrates and vertebrates species. Unfortunately, these areas are usually the first impacted by point and diffuse sources of pollution.

Objectives

In general, the nearshore surveillance subcomponent is designed to meet the objectives of Annex 11 of the 1978 Great Lakes Water Quality Agreement through identification and measurement of physical, chemical and biological parameters in the water and sediments of inshore areas of Lake Erie. Specifically, historic information and ongoing data collection are required to (a) determine the degree of use impairment, (b) provide baseline data against which future changes in the environment can be measured, (c) provide trend-in-time results and interpretation, (d) evaluate sediment quality and (e) identify and measure contaminants in fish tissue for consumptive advisories.

Rationale

As surveillance of the entire nearshore zone of Lake Erie is neither feasible nor practical under current levels of funding, it is necessary to concentrate surveillance efforts on those projects that will yield required information at minimum expense. We suggest that surveillance of the following components will meet the foregoing objectives: (a) areas of concern, (b) water intakes, (c) tributaries and point source loading, (d) beaches, (e) Cladophora.

2.2 AREAS OF CONCERN

The Great Lakes Water Quality Board has identified five Class "A" (Raisin R., Maumee R., Black R., Cuyahoga R., Ashtabula R.) and one Class "B" (Wheatley Harbour) areas of concern located directly on Lake Erie's shoreline. Since 1974 all but the Raisin River have been reported annually to the IJC as areas with some type of environmental and/or human health concern.

It is proposed that the Class "A" areas of concern and lake waters adjacent to these areas be included in nearshore surveillance. Since each area of concern differs in physical features, hydrology, and pollution problems, it is difficult to design a standard model for routine monitoring. A more pragmatic approach is to suggest a basic structure around which specific components can be designed to meet the surveillance requirements of each area. Basically, identification and quantification of important metals and organic contaminants could be made from an examination of several components of the system.

Based on the information collected by the Lake Erie Task Force the following recommendations are made:

1. The Historical Data Base available for each of the areas of concern be reviewed before any further field work is initiated.

   A review of what is already known about the area is an important first step in a specific design. Surveillance effort can then be concentrated on priority contaminants and pollution problems. Trends can be determined and responses to remedial measures ascertained. Chemical inventory information for the drainage area can also be used to concentrate effort on potential pollution problems.

2. The following system components need to be thoroughly evaluated in order to obtain a comprehensive data base which characterizes each region in terms of impaired usage.

Water

A knowledge of the hydrology of the problem area is a prerequisite to the design of sampling strategy. Location of sampling stations, sampling frequency and parameters should be selected in consideration of the requirements of Annex 11, but also in relation to historical data and existing monitoring of research programs. As far as possible stations should be site-selected to concentrate effort and to maintain valuable long-term data series. Lake stations located adjacent to areas of concern are required to measure the impact on offshore waters.

Sample frequency should be designed to accommodate hydrological and seasonal variability and remedial measures implementation. Further considerations are adequate statistical evaluation and interpretation of the data.

Parameters should be selected to provide an evaluation of eutrophication and toxic substances in the nearshore area.

Basic parameters to be considered:

- pH, conductivity, Secchi disc transparency, suspended solids, temperature (profile), dissolved oxygen (profile), total phosphorus, nitrate nitrogen, ammonia.

- selected metals (total mercury, total lead)

Sediments

Many pollutants of concern settle out of the water column and accumulate in sediments. Whereas determination of trace amounts of contaminants in water is often difficult and sometimes inaccurate, it is easier to measure concentrations of these substances in sediments. Cores from undisturbed sediments also provide a history of contaminant loading to the system.

Factors to be considered in location of sediment stations are historical data, hydrology, runoff, municipal and industrial outfalls, and dredged and depositional areas.

Frequency of sampling will be determined, to some extent, by the rate of sediment accumulation. Once every three years may be adequate.

Parameters to be considered:

- grain size, loss on ignition, COD, oil and grease

- metals - total mercury, total lead, total iron, total cadmium

- organics - PCBs, DDT metabolites, aldrin/dieldrin, PAHs, phenol, toxaphene

- broad scan for priority pollutants

Biota

The importance of biota as indicators of ecosystem quality in the Great Lakes has been established. Several components of the biological system have been used in surveillance: bacteria, phytoplankton, zooplankton, zoobenthos, fishes and fish eating birds. Sampling problems and "natural" variability of population abundance in space and time affect the usefulness of each of these components. The best candidates for inshore monitoring are the zoobenthos and fishes.

Zoobenthos. Because benthic macroinvertebrates are sedentary they reflect environmental conditions at specific locations. The environment may be reflected in the benthic community in two ways - (a) species composition, abundance and diversity, and (b) body burdens of contaminants.

Because invertebrates are important food for fishes, information on contaminant burdens is useful. Research projects (Eadie et al. 1982, Chapman et al. 1979) have linked the flow of PAHs and heavy metals from sediments to fish through oligochaetes and chironomids.

The factors which influence the selection of sites for sediment sampling should also be considered in the invertebrate sampling plan. Some sites may be sampled for both components. It may be opportune to also sample dredged areas as these are recolonized quickly by invertebrates. Sampling frequency should be influenced by information on life histories of the predominant invertebrate species. Spring and fall sampling for [illegible] consecutive years may be adequate. The use of caged clams has recently become a popular surveillance tool. Where appropriate, the use of caged clams should be considered as a useful adjunct to a comprehensive plan.

Parameters to be considered:

- metals and organics as listed under sediments

Fish. Sampling of fish for body burdens should include (a) species that live in or adjacent to areas of concern (b) species that are taken in local fisheries (if present). The young-of-the-year spottail shiner program may be part of this component.

Late summer and fall collections are preferable.

Parameters:

- percent lipid, tainting, tumors, lesions, etc. - metals - total mercury, total lead. - organics - PCB, DDT, locally used pesticides - broad organic scan (industrial chemicals)

Bioassay

The measurement of contaminant stress on ecosystem functions of bacteria, phytoplankton and zooplankton is a component of the Monroe Harbour/Raisin River Research Project. For example, inhibition of photosynthesis and bacterial uptake in Monroe Harbour water is being studied using offshore water as a control. Although this is an experimental research project we suggest that the routine bioassay of photosynthesis inhibition could be a useful adjunct to the surveillance program. The scientist working in this area with the Monroe Harbour Research Project could provide advice on a suitable design.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: NEARSHORE

WATERBODY: Lake Ontario

CHAPTER 7A
NEARSHORE WATER

BASIS FOR CONCERN

The term contaminant encompasses both organic and inorganic substances which can either directly or through the bioaccumulation process of the food chain potentially cause adverse effects to the reproduction, growth, or general health of aquatic organisms, including a shift in community structure; and to human health, through consumption of water and fish.

Over the years, Lake Ontario waters have been found to contain a number of inorganic and organic substances, most prominently heavy metals, industrial organic chemicals, and pesticides. Their presence has prompted concern among responsible health and environmental officials. Some of these substances bioaccumulate in the flesh of living organisms, particularly sport and game fish. This has resulted in widespread fisheries advisories and warnings not to consume (or to limit the consumption of) the flesh of potentially contaminated fish.

The substances of concern originate from many sources. These include discharges into the lake, discharges to tributary streams which ultimately reach the lake, atmospheric deposition, release from contaminated sediments, and leakage from disposal sites. Both direct discharges and discharges via tributaries impact the lake ecosystem at or near the shoreline. Point source monitoring programs (Chapter 6A) and tributary water programs (Chapter 8) are part of this Plan to catalogue and quantify the discharges as they reach the lake. It is also necessary to deal with the fate and distribution of the substances within the nearshore area of the lake, as this area is biologically more sensitive and productive than open lake waters, and fish and other organisms may be exposed to chemical contaminants during sensitive life stages.

It will ultimately be necessary to model nearshore lake dynamics in order to understand the transport of pollutants in nearshore waters. There are indications from previous studies that, particularly in the spring, a thermal bar and predominant currents effectively channel pollutants along the south shore of the lake in a west-to-east direction from the Niagara River towards the St. Lawrence River and, along the north shore in an east-to-west direction. At other times of the year, lake processes such as stratification and seasonal mixing, as well as the effects of significant storms, will complicate the mixing and distribution of wastes from the nearshore into the total lake system. The concern of this portion of the Plan is to provide continuity by doing lake sampling between areas which will be considered in other parts of the Plan.

Monitoring of direct municipal and industrial point source discharges is covered in Chapter 6A. Areas of concern will be studied on a regular basis to document contaminant problems and to monitor the progress of remedial activities; monitoring programs are described in Chapters 26 through 35. Tributary waters will be monitored on an increased frequency to document loads entering the lake from significant stream water bodies; programs are described in Chapter 8. There is a cross link between tributaries and areas of concern because each major cause of upstream pollutant loads has resulted in an area of concern being identified at the tributary mouth.

The questions which need to be considered for this chapter include the transition or gradient of pollutants in the nearshore area away from the tributaries and away from the areas of concern to a point where mixing has essentially provided a homogeneous distribution of the pollutant load. Other elements of the overall monitoring programs, such as the open lake section (Chapter 7) and the monitoring of water supply intakes (Chapter 4), would adequately document the further fate and distribution of these pollutants. The water supply intakes could provide the major source of nearshore data.

Many substances of concern or potential concern have been identified through the Agreement, through the Human Health Effects Committee, and through the Niagara River Toxics Committee. The 1978 Great Lakes Water Quality

Agreement established objectives for persistent and non-persistent toxic substances and specifies that monitoring is to be established to assess both spatial and temporal trends of such substances. There is also a concern to assure the existence of a statistically reliable and properly documented data baseline so that an agreed starting point exists with which to compare future results and from which to assess possible trends.

PROJECT DESCRIPTION

This element of the Plan is to provide for the establishment of monitoring stations which will be used to assess the fate and distribution of pollutants in the nearshore waters. This nearshore area is not rigidly defined and may be approached from a number of considerations. These include a fixed distance out from the shoreline, a distance to which a specific depth contour is reached, a distance at which homogeneous conditions are reached, or a distance offshore to the thermocline when stratification occurs.

The questions to be answered by this portion of the Plan include:

1. What waters of Lake Ontario shall be designated as falling within the nearshore area?

2. What are the concentrations of pollutants in nearshore waters and at water supply intakes away from point source discharges, areas of concern, and major tributaries?

3. Are there temporal and spatial variations of pollutants at transects in nearshore waters, and at water supply intakes?

4. Are there major embayments or other areas of the lake where current patterns would tend to concentrate and deposit pollutants, particularly those attached to suspended sediments?

5. Is there a statistical difference, considering presence, absence, and concentration of pollutants, between nearshore and open lake water?

Objective and Scope

1. To assess compliance with the objectives outlined in Annex 1 of the 1978 Agreement.

2. To establish pollutant concentration baseline conditions for both organic and trace metal substances in the nearshore waters and sediments of Lake Ontario.

3. To identify trends, both spatial and temporal, of contaminant levels in nearshore waters.

4. To identify potential problem areas away from known tributaries, areas of concern, or point source discharges.

5. Provide data to assist in the interpretation, development, or verification of mathematical models on the fate and distribution of pollutants in Lake Ontario.

Data Usage

Compliance with the Agreement objectives for metals and organic substances in water will be assessed. Existing data and reports will be evaluated to determine compatibility with the requirements of this Plan.

Baseline data as needed will be collected for an unspecified time period in order to reliably establish baseline conditions. The initial phase of the program may span two to five years and should lead not only to definition of the baseline but also to determinations on the timing, frequency, and distribution of sampling.

In moving away from identifiable pollutant sources, concentrations of parameters and chemicals of concern may drop below levels currently detectable by present analytical methodology. Presence or absence of pollutants at a specified level of detection can assist interpretation as to whether Agreement objectives are being met. "Less than" values will not help to determine whether the objectives and scope of the project to identify pollutants present are being met. Therefore, it will be necessary to consider either different laboratory methodologies than those currently available in some instances (detection limits to parts per trillion), or to contain the study in transition areas of higher pollutant concentrations for which positive results can be documented. Biomonitoring can take advantage of bioconcentration factors in detecting presence of pollutants which cannot otherwise be detected in water.

Monitoring Network Design and Rationale

The program design, by definition, presents certain difficulties, as it must capture events or circumstances which are dynamic and, in some cases, seasonally dependent. Some general facts are established concerning long shore transport of pollutants in Lake Ontario and possible areas of mixing and deposition. However, such phenomena in such areas are not yet sufficiently defined with certainty so that a fixed program can not yet be confidently recommended. Some adjustments will have to be made dynamically year to year, depending upon the circumstances and conditions within the lake.

Certain areas can be defined as starting points for the major elements of the program. These have been previously noted as significant tributaries, areas of concern, and point source discharges. Additionally, by studying current patterns, suspected areas of deposition of suspended sediments can be identified. From these beginnings, transects can be fixed east and west of those areas potentially impacted by point source discharges and by tributary inflows, in order to assess lake water entering or leaving those areas. From these points, a plume could be tracked aerially to provide, by visual observation, the location of additional sampling points, or, a fixed interval could be established at which samples could be taken. This interval should coincide with other lake stations which have been used in previous programs, or a variable interval and distance could be established depending upon speed and direction of the current and the seasonal circumstances of the lake.

Final decisions should be reached in consultation with the coordinators of other chapters, in order to make sampling points for this component of the Plan coincident, if possible, with those for such programs as the nearshore eutrophication study and the water supply intake study.

Other considerations include the timing of sample collection in relation to significant inputs to the water of Lake Ontario. High variability may be expected because of the dynamic nature of discharges and tributaries, and because of such climatic conditions as spring snow melt or major storms. Inputs which can affect nearshore waters include the resuspension of bottom sediments, river-transported particulates, shoreline runoffs, and bluff erosion. This variability can provide short-lived phenomena that will make data comparability extremely difficult from point to point even over the course of a single sampling run. In terms of year-to-year comparability of data, the problems are obvious, as these natural forces can provide variations that would obviate any analysis of trends over time.

Beyond selection of appropriate sampling transects and sampling points, and because of the high variability and dynamic situation of nearshore waters, careful documentation of events which may influence observed results must be made. This could include aerial overflights to show the location of visible plumes, current measurements before and at the time of sampling, analysis of wind records to understand the movement of surface currents, and coordination with the tributary sampling program to document precipitation events and their influence on contaminant loadings to the lake.

Before selecting a final monitoring program, preliminary studies of data variability should be undertaken. Previous study results suggest the data to be so variable that a reliable baseline may not be determinable unless very frequent (daily?) sampling is conducted. Analysis of phosphorus data from ongoing studies can be instructive. If variability cannot be sorted out for this much-studied parameter, it would be wise to reconsider the entire basis for this part of the Plan, which proposes measurements for over a hundred pollutants. It may lead to the conclusion that a transect program is not appropriate or accomplishable, and that the program element offering the most chance for success is at the water supply intakes.

The highest expected contributions to the lake are during spring snow melt conditions, at times of maximum runoff, and at times along the shore when the thermal bar will hold such pollutants in the nearshore waters. The intensity of the program should be weighted toward the springtime to gather data to assist in determining contaminant loadings and distribution, and in determining compliance with the objectives in nearshore waters. Summer sampling can document conditions where previously discharged suspended materials may become settling or settled sediments and there is major biological activity within the nearshore waters. [illegible] sampling may detect higher concentrations due to storm-induced resuspension and redistribution of previously discharged contaminants.

There are scant data available on trace organic contaminants in Lake Ontario waters. A statistically reliable baseline is essential for further project definition and against which to compute and evaluate trends over time. Due to the low levels at which these materials are expected to occur, sampling and extraction of samples presents a particular difficulty, as large volume samples are required. If proven successful and reliable, a continuous flow automatic sampler/extractor, presently being developed by Environment Canada, should be utilized in this part of the Plan (see Chapter 7). Initially, the spring isothermal condition should be selected as the time for sample collection, because this is the time of maximum contaminant loading.

Biomonitoring should be considered as having advantages for detecting substances that could missed by periodic sampling and biomagnification for quantities undetectable in water. The organisms also integrate pollutants over time. Biomonitoring would also document effects on lake aquatic organisms. See Chapters 11, 12, and 36 for further development of this concept.

<u>Monitoring Parameters and Frequency of Sample Collection</u>

The parameters to be measured include those in Tables 1 and 2. Consideration will also be given to other substances of potential concern. These will be drawn from several sources, including:

1. The list of chemicals developed by the Human Health Effects Committee and published in the "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Ecosystems," held in March 1982.

2. Other chemicals identified by the Human Health Effects Committee, as published in their annual reports.

3. The list of chemicals developed under the auspices of the Niagara River Toxics Committee.

Sampling should be conducted in the spring of the year to coincide with the maximum tributary loading from snow melt, isothermal conditions within the lake, and the presence of the thermal bar. Samples will include a number of runs at times and locations to be determined during this period, which covers two to three months. As a minimum, three sampling runs are recommended to coincide with the major factors mentioned above. These will capture the effect on the nearshore waters of the annual maximum loading conditions from the tributaries, will sample at isothermal and hopefully isochemical conditions of mixing within the lake, and will establish the nearshore transport mechanisms during the major long shore current conditions which prevail during the set to the thermal bar.

The analytical methodology, the sample preservation, holding time, and sampling protocols shall be specified by the quality assurance and quality control procedures established for the overall Plan.

Sampling Procedures

The samples will be collected along transects and at stations in the lake from shipboard and onshore at water supply intakes. If developed and available, the continuous flow automatic sampler/extractor will be utilized. Otherwise, large-volume samples must be taken and extracted. The actual protocols and methodologies will be as determined by the quality assurance and quality control procedures established for the overall Plan.

Sample Custody Procedures

No special custody procedures are recommended, as these samples are being taken for monitoring and surveillance and not for enforcement purposes. This can be re-evaluated, based upon the quality assurance and quality control procedures developed for the overall Plan.

Calibration Procedures and Preventative Maintenance

When the final equipment and methodologies are [illegible], the procedures can be specified. Additional procedures may be imposed by the quality assurance and quality control requirements to be developed for the overall Plan.

SCHEDULE OF TASKS AND PRODUCTS

Winter 1984/Spring 1985

1. Assemble data and review previous surveys and reports.

Summer 1985

1. Select and evaluate a few significant tran[illegible] and sampling points.
2. Prepare preliminary program design.

Winter 1985/86

1. Complete final design of program. Prepare comprehensive survey strategy for each selected station/transect.
2. Coordinate sampling schedule with other elements of program.

Spring 1986

1. Conduct initial program during spring isoth[illegible]mal lake period.

PROJECT ORGANIZATION AND RESPONSIBILITY

The jurisdictions should carry out the design of this element of the Plan and the collection of all samples under the guidance of the chapter coordinator. It will be necessary to provide for both boat-based collection of the samples, and it is desirable that the schedule be arranged to coincide with the open lake work so that dual purposes could be served by using the same boat at the same time to conduct more than one element of this Plan.

DATA QUALITY REQUIREMENTS AND ASSESSMENT

Data quality requirements and assessments will incorporate the quality assurance/quality control requirements established for the overall Plan.

DOCUMENTATION, DATA REDUCTION, DATA MANAGEMENT, AND REPORTING

These will incorporate the quality assurance/quality control requirements established for the overall Plan.

DATA VALIDATION

Data validation will incorporate the quality assurance/quality control requirements established for the overall Plan.

PERFORMANCE AND SYSTEMS AUDITS

Performance and systems audits will incorporate the quality assurance/quality control requirements established for the overall Plan.

CORRECTIVE ACTION

The program is designed to take samples in waters away from major impacts, in order to look at mass transport of pollutants and general water quality. Therefore, findings will not be specifically relatable to any particular discharge or situation that could result in abatement and corrective action. This element of the Plan is more designed to provide integrated overall lake data than it is to pinpoint sources of pollution.

PROJECT FISCAL INFORMATION

Three samples are recommended for each station, as previously described. However, the number of stations to be selected in the final project, based on the rationale, is presently undetermined; this will require further consideration and discussion. Analyses for all of the metallic and organic pollutants identified is approximately $1,800 per sample, and collection and analysis would place the sampling cost at $5,400 per station per year absent any requirements for quality assurance/quality control replicate samples or field blanks. As an order of magnitude, 50 stations in the base program would provide for a base project cost of $270,000.

DATA INTERPRETATION

The data should be evaluated to answer the specific questions posed above under Project Description. Interpretation should be done by the principal investigators under the supervision of the project coordinator.

REPORTS

A preliminary report containing the raw data and tentative conclusions should be available six months after the last sample of the annual program is taken. A final report to the standards established by the Task Force reporting should be available 12 months after taking the last sample.

COMMENTARY

Presently, Ontario does boat-based sampling for open lake and nearshore considerations. This project describes a more intensive program to provide statistically reliable data, to support interpretation of more areawide phenomena, to provide baseline data for trend analysis, and to provide information that could be used in modelling efforts related to transport mechanisms and mass distribution of various pollutants. New York does not presently have a vessel operational on Lake Ontario and does not expect one until spring 1986.

Serious concerns about the work proposed in this Chapter have been raised by both U.S. and Ontario commentors. The whole basis has been challenged as too complex, too extensive, too expensive, unworkable, too ambitious, not satisfying the objectives, too variable, more research than surveillance, and uncorrelatable for data analysis. Problems cited were inability to work with historical phosphorus data, let alone dozens or hundreds of parameters, frequent current reversals and upwellings, need for continuous or daily data to sort out variables, inability to track plumes, fixed transects which do not necessarily bracket a moving problem, and data point ability.

One reasonable compromise could be to make the raw water supply intakes the entire nearshore sampling network, and meld the nearshore off-boat sampling into the open lake program. This offers advantages of having fixed-base near-shore stations of known (or determinate) characteristics, and placing the whole-lake program on an equivalent basis for design of the sampling program, probably directed by the needs of modellers and researchers.

Due to the seriousness of the comments and problems, further discussion is needed; it should be drawn also from others in the peer review process.

TABLE 1

PARAMETERS FOR WATER SAMPLES

GENERAL CHEMISTRY (LABORATORY)

Hardness	Alkalinity
pH	Colour
Turbidity	Conductivity
Total Solids	Fluoride
Nitrite	Nitrate
Sodium	Chloride

GENERAL CHEMISTRY (FIELD)

Chlorine Residual	Free & Total

BACTERIOLOGICAL

Total Coliform	[illegible]liform
Standard Plant Count	

METAL SCAN

Copper	Nickel
Zinc	Cadmium
Cobalt	Chromium
Lead	Iron
Manganese	Aluminum
Magnesium	Calcium
Vanadium	Barium
Beryllium	Strontium
Tin	Uranium

VOLATILE ORGANICS

1,1-Dichloroethylene	Trans-1,2-Dichloroethylene
1,1-Dichloroethane	Chloroform
1,1,1-Trichloroethane	1,2-Dichloroethane
Carbon Tetrachloride	Benzene
1,2-Dichloropropane	Trichloroethylene
Dichlorobromomethane	Toluene
1,1,2-Trichloroethane	Chlorodibromomethane
Tetrachloroethylene	Chlorobenzene
Ethylbenzene	M[illegible]lene
Bromoform	O[illegible]
1,1,2,2-Tetrachloroethane	1,[illegible]hlorobenzene
1,3-Dichlorobenzene	1,[illegible]chlorobenzene
Dibromoethane	Styrene
Methylene Chloride	

PCB/ORGANOCHLORINE SCAN & PESTICIDES

PCB	Hexachlorobenzene
Heptachlor	Aldrin
Mirex	α-BHC
β-BHC	γ-BHC (Lindane)
α-Chlordane	γ-Chlordane
OP DDT	PP DDD
PP DDT	PP DDE
Heptachloroepoxide	Dieldrin
Endrin	Thiodan I
Thiodan II	Thiodan Sulphate
Methoxychlor	Toxaphene

CHLORO AROMATICS

Hexachlorobutadiene	Hexachloroethane
1,3,5-Trichlorobenzene	1,2,4-Trichlorobenzene
2,4,5-Trichlorotoluene	2,3,6-Trichlorotoluene
α-2,6-Trichlorotoluene	1,2,3,4-Tetrachlorobenzene
1,2,4,5-Tetrachlorobenzene	1,2,3,5-Tetrachlorobenzene
Pentachlorobenzene	Octachlorostyrene

TABLE 2

CHLOROPHENOLS	
2,4,6-Trichlorophenol	2,4,5-Trichlorophenol
2,3,4-Trichlorophenol	2,3,5,6-Tetrachlorophenol
2,3,4,5-Tetrachlorophenol	Pentachlorophenol
SPECIFIC PESTICIDES	
Carbaryl	Dia[illegible]
Methyl Parathion	Par[illegible]
2,4-D	2,4,5-TP

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Water Intakes

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: WATER INTAKES

WATERBODY: Lake Huron

TABLE 1

ISSUE: CONTAMINANTS

ECOSYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
INPUTS	1. ATMOSPHERE	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
AREAS OF EFFECT	3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AR[illegible] OF CONCERN	Yes	[illegible]ter, Sedimen[illegible]s - Sus[illegible]ded and Bottom, Biota	Area specif[illegible]ts, should include some of the abo[illegible]ables
	6. WILDLIFE	Yes	[illegible]ll eggs	Above list[illegible] chlorinated benzenes, chlorinated styrenes
OUTPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
MISC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

3.6 OUTPUTS

3.6.1 WATER INTAKES

OBJECTIVES

The major objective of this component of the Lake Huron Surveillance Plan is to monitor seasonal and long-term trends in tro[illegible] indicators and conservative parameters and contaminants at a site [illegible]ntative of the outflow of Lake Huron, in order to calculate annual loading estimates. These data can also be used to detect the presence of new chemicals in the Lake Huron ecosystem.

RATIONALE

A site which already exists at the Lambton water treatment plant seems ideally suited to monitor end-of-lake conditions in Lake Huron. The use of municipal intakes as a sampling source permits frequent year-round collections from a fixed site (without interference of weather) at a very reasonable cost. Because of location and high sampling frequency the data generated from this program can also be used in mass balance calculations and as an invaluable seasonal control for the extensive but [illegible]nt open lake surveillance program.

DESIGN

The design will be similar to other Great Lakes stations such as those on the Niagara and St. Lawrence Rivers.

Water. Water for chemical analyses will be collected as a grab sample at the plant weekly, year-round, except for contaminants, which will be continuously composited and analyzed weekly (Table 28).

Biota. Phytoplankton will be collected as a grab sample at the plant weekly, year-round (Table 28).

TABLE 28

WATER INTAKE SAMPLING DESIGN - EUTROPHICATION

MEDIA	TESTS	SITES	DEPTH	FREQUENCY
Water	Chloride, conductivity, chlorophyll a, chlorophyll b, corrected chlorophyll a, ammonia (filtered), nitrate-nitrite (filtered), Kjeldahl nitrogen (unfiltered), phosphate (filtered reactive), phosphorus (filtered total), phosphorus (unfiltered total), silicate (filtered reactive)	1	Grab	Weekly year-round
Biota				
Phytoplankton	Species, biomass	1	Grab	Weekly year-round

WATER INTAKE SAMPLING DESIGN - CONTAMINANTS

MEDIA		PARAMETERS
Water and Suspended Sediments	Organics.	PCBs, total organochlorine pesticides - aldrin, dieldrin, BHC (alpha, beta, gamma), chlordane (alpha, gamma), DD (o,p),) DDT (p,p), DDD, DDE, endrin, endosulfan (alpha, beta), heptachlor, helptachlor epoxide, hexachlorobenzene, mirex, toxaphene. chlorinated benzenes - 1,2,3-TCB, 1,2,4-TCB, 1,2,3,4-TCB, 1,2,3,5-TCB, 1,2,4,5-TCB, HCB, pentachlorobenzene, octachlorostyrene. chlorinated phenols - 2,4,5-TCP, 2,4,6-TCP, PCP. dioxin - 2,3,7,8-TCDD.
	Inorganics	As, Cd, Pb, Hg

Suspended Solids. These samples will be collected weekly, year-round.

DATA QUALITY

Data quality will be assured by having the proponents of this study take part in the overall data quality control program outlined in Chapter 4.

DATA OUTPUT

Annual loading estimates for the variables measured will be provided to the IJC.

In addition, comments on trends will be made annually, and other changes such as seasonal variation and species changes will be made when detected but certainly at 5 year intervals.

RESPONSIBLE AGENCY

Ontario MOE, Environment Canada (IWD Ontario Region), and Michigan DNR.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: WATER INTAKES

WATERBODY: Lake Erie

2.3 WATER INTAKES

Water supply intakes can provide water samp from the inshore zone on a year-round basis. As some intake programs hav in effect for many years, the historical data are useful as background information, trend analysis and model verification.

Objective

The Water Intake surveillance program for Lake Erie is designed to provide data for use in evaluating the trophic status of the nearshore region. In addition, identification and concentration of contaminants will be monitored providing a continuous record of select metals and organics in the nearshore.

Rationale

The Lake Erie network of Water Intake syst vides a spacially and economically valuable means of monitoring the hore region. Select Intakes located in the western, central and eastern basins will provide valuable information of seasonal cycles of nutrients and contaminant in the nearshore region as well as providing the data base necessary for long-term trend analysis. Due to; the extreme variability encountered in the nearshore zone, analysis of the results from previous nearshore programs employing conventional sampling schemes have demonstrated the need for a continuous sample collection. The Water Intake network provides an economical means of sampling several fixed nearshore locations on a frequent basis.

Current Program

Eleven Water Intakes on Lake Erie (listed below) have been monitored in the past.

Ohio - Oregon, Sandusky, Cleveland-Crown, O.W.S. Mentor, Ashtabula

Pennsylvania - Erie

Ontario - Union, Blenheim, Elgin, Dunnville, Bertie Twp.

Data from the Bertie Township intake are available from September 1978; data from the other intakes are available from January 1976.

Parameters and sampling frequency varied among agencies. The Ontario Ministry of the Environment (MOE) monitors the following parameters on a weekly basis:

Phosphorus - total, soluble reactive
Nitrogen - free ammonia, total Kjeldahl, nitrite, nitrate
Reactive silicon
Chloride
Conductivity
Chlorophyll α, Chlorophyll β
Phytoplankton biomass

The Ohio-EPA Water Intake Monitoring Program has monitored only "finished" water since 1974. Consequently, the current program is inadequate for routine monitoring of the nearshore region. In general, the parameters currently monitored are adequate for both nutrient and contaminant data bases, however, "raw water" samples must be analyzed.

The current Ontario Water Works Intake Monitoring Program seems to be adequate to provide the necessary data base for seasonal and long-term trends. Programs for Michigan, Pennsylvania and New York have as yet not been examined by the Task Force.

Recommendation

The numerous water intake facilities surrounding Lake Erie provide a potential source of valuable data. In the past this data base has not been extensively utilized particularly by the United States jurisdictions. Due to problems such as inaccessability of data, quality control, incomplete data sets and lack of any priority to utilize this source of data, little is actually known about the potential of water intake systems as a surveillance tool.

Since the south shore of Lake Erie, and to a lesser extent the north shore, is well represented with water intake systems, it could provide a valuable mechanism for routine surveillance of the nearshore region (exclusive of the rivers and harbors). A well designed and implemented program to collect and analyse samples routinely collected at select water intake systems around the lake would provide the information necessary to monitor this heavily utilized region and develop a data base for trend analysis.

The Task Force recommends:

1. The current data base for each of the Water Intake Systems in Lake Erie be evaluated as to:

   Parameters Monitored
      Listing of all parameters
      Period of record for each parameter
      Monitoring schedule

   Quality of Current Data Base
      Methods employed
      Detection limits
      Past quality assurance programs

   Quality Assurance Program (in place)
      Field collection
      Analytical methods
      Data reporting procedures
      Data analysis

2. Based on the quality of the current data base and studies conducted on water intake data bases by Richards (1983), Rush and Cooper (1983)

and Nichols (1980) determine if the data bases available are adequate for ions term trend analysis.

3. Using the water intake facilities and parameters listed below, develop a sampling program which will provide adequate data bases to be used for long-term trend analysis. In particular this program needs to determine if samples taken within the individual treatment facilities represent the water quality at intake site located in the nearshore zone.

Sample Locations

Jurisdiction: Michigan

*Monroe
Enrico Fermi

Ohio

*Toledo
Oregon
Port Clinton
Put-in-Bay
Kelleys Island
*Sandusky
Huron
Vermilion
Elyria
Lorain
Avon Lake
*Cleveland - Crown
Cleveland - Baldwin
Cleveland - Nottingham
Mentor
Painesville

Madison
*Ashtabula
Conneaut

Pennsylvania
*Erie

New York
*Dunkirk
*Buffalo

Ontario
*Kingsville (Union)
*Blenheim
*Port Stanley
*Dunnville

*Treatment plants considered as primary locations for sample collection.

Parameters

Principal Ions
Conductivity
Chloride

Nutrients
Total Phosphorus
Nitrate Plus Nitrite
Corrected Chlorophyll a

Contaminants
Metal(s) (site specific)
Organic(s) (site specific)

In addition, parameters such as temperature, dissolved oxygen, turbidity and iron are routinely measured for plant operation purposes providing supplementary data.

4. Samples collected at the Water Intake facilities around the lake should be analyzed by one United States and one Canadian laboratory using comparable methodologies. Both laboratories should comply to the Quality Assurance Program outlined by the Task Force.

References

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: WATER INTAKES

WATERBODY: Lake Ontario

note: refer to Nearshore Operational Component for information o[illegible] [illegible]ter intakes

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Areas of Concern

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: AREAS OF CONCERN

WATERBODY: Lake Huron

TABLE 1

ISSUE: CONTAMINANTS

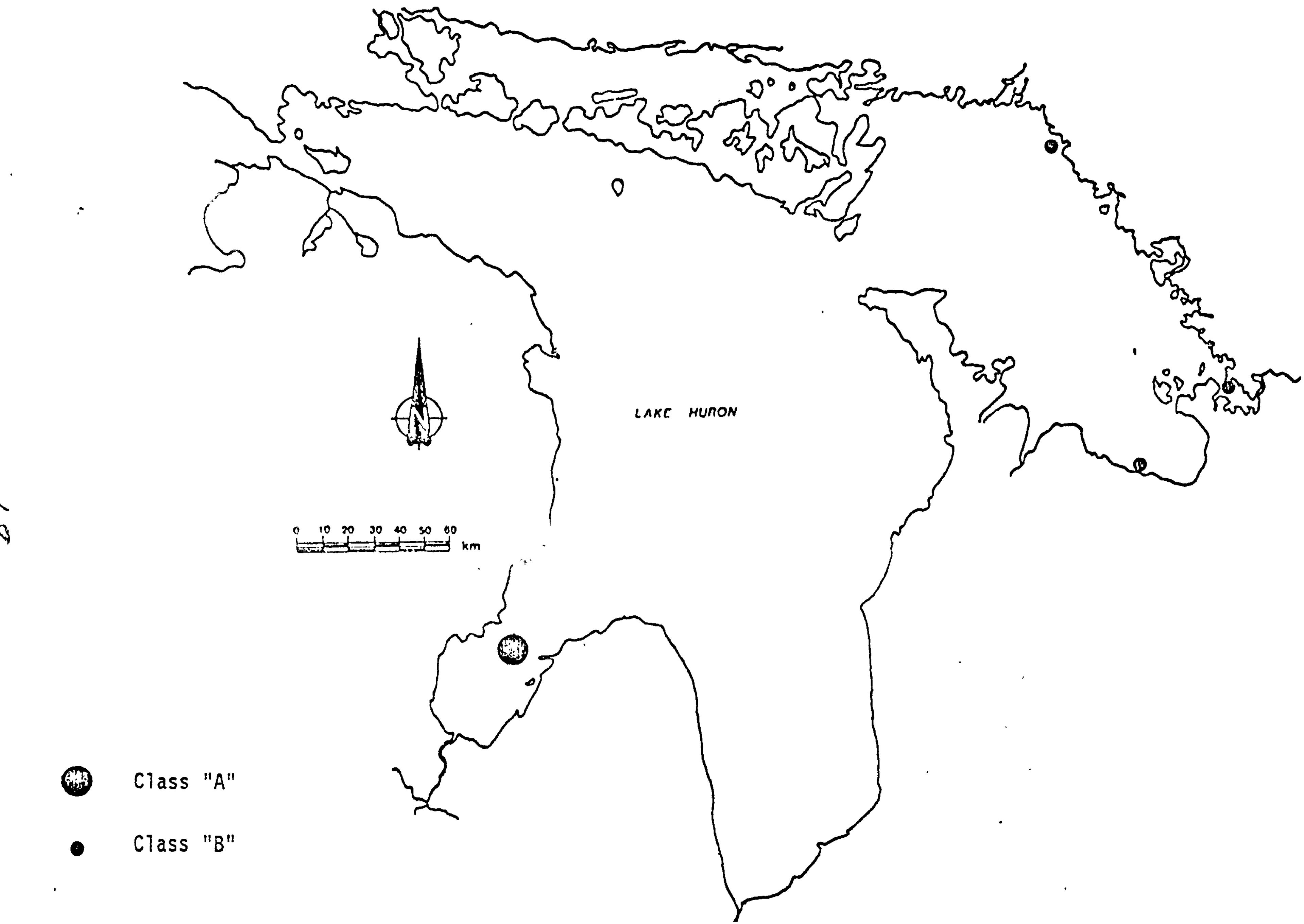
ECOSYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
INPUTS	1. ATMOSPHERE	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
AREAS OF EFFECT	3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AREAS OF CONCERN	Yes	[illegible]ter, Sediments - Sus[illegible]ded and Bottom, Biota	Area specifi[illegible]ts, should include some of the abov[illegible]bles
	6. WILDLIFE	Yes	[illegible]l eggs	Above list [illegible]chlorinated benzenes, chlorinated styrenes
OUTPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
MISC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

3.4 AREAS OF EFFECT - "AREAS OF CONCERN"

3.4.1 INTRODUCTION

The International Joint Commission has identified a number of areas in the Great Lakes where a Water Quality Agreement objective, a jurisdictional standard criteria or guideline has been exceeded as "Areas of Concern". These have been designated as Class "A" where significant environmental degradation has occurred and where impairment of beneficial uses is demonstrated as severe and Class "B" areas which exhibit environmental degradation and impaired use. The distinction between the two is, however, subjective and requires clarification.

In the Lake Huron basin there is one Class "A" area of concern and three Class "B" areas (Figure 5). As these are areas of clear environmental impact particular emphasis has been laid upon them and specific intensive monitoring programs designed to quantify conditions and trends.


LAKE HURON
0 10 20 30 40 50 60
km
Class "A"
Class "B"

3.4.2 SAGINAW BAY AND RIVER (CLASS "A")

INTRODUCTION

The Saginaw River System and Saginaw Bay have been designated as a Class "A" Area of Concern by the Great Lakes Water Quality Board. While the Bay has responded favorably to point source phosphorus control efforts, there is still a problem with agricultural runoff in the Basin. [illegible]s nonpoint source input not only contributes phosphorus to the Bay, but [illegible]spended solids, organic matter and pathogenic organisms as well. The sediments in the Saginaw River and its tributaries are contaminated with chlorinated organics. Fish consumption bans are in effect for most of the major rivers in this watershed, and a fish consumption advisory exists for Saginaw Bay.

SAGINAW RIVER SYSTEM

OBJECTIVES

1. To determine the nutrient contribution and the proportion of nonpoint contribution from each of the major tributaries of the Saginaw River.

2. To determine the levels of the toxic co[illegible]ts listed in Annex 1, Part I of the Agreement in water, sedime[illegible]nd resident sport fish in each of these tributaries.

RATIONALE

Efforts are currently underway to estimate the reduction in nonpoint source loading from the various sub-basins of the Saginaw River. Monitoring is required to determine which of these sub-basins should be concentrated on for reduction efforts and to establish a baseline against which future, post-control loading estimates can be compared.

Saginaw River water, sediment and resident sport fish have been contaminated with chlorinated organics. Monitoring of these media is necessary to identify which tributaries of the Saginaw are contributing which organics.

TABLE 18

POINT SOURCES IN SAGINAW RIVER BASIN TO BE SURVEYED

FACILITY	NPDES NO.	RECEIVING WATER
Municipal		
Alma STP[1]	MI0020265	Pine River
Bay City STP[1]	MI0022284	Saginaw River
Bridgeport Twp WTP[2]	MI0022446	Cass River
Buena Vista Twp WTP[2]	MI0022497	Saginaw River
Essexville WTP[2]	MI0022918	Saginaw River
Flint WTP[1]	MI0022926	Flint River
Flushing WTP[1]	MI0020281	Flint River
Frankemuth WTP[2]	MI0022942	Cass River
Genesee County Dist. No. 2[1]	MI0022977	Flint River
Genesee County Dist. No. 3[2]	MI0022993	Shiawassee River
Howell STP[3]	MI0021113	Marion Drain
Lapeer STP[1]	MI0020460	S.Br. Flint River
Midland WTP[1]	MI0023582	Tittabawassee River
Mount Pleasant STP[1]	MI0023655	Chippewa River
Owosso wtp[1]	MI0023752	Shiawassee River
Saginaw DPW[1]	MI0025577	Saginaw River
Saginaw Twp Sewer Dist[1]	MI0023973	Tittabawassee River
St. Louis STP[1]	MI0021555	Pine River
West Bay County Regional[1]	MI0042439	Saginaw River
West Branch[3]	MI0020095	Rifle River
Zilwaukee Regional[2]	MI0023981	Saginaw River
Gladwyn		
Industrial		
Dow Chemical[1]	MI0000858	Tittabawassee River
Michigan Sugar Co.[1]	MI0002224	TR to Saginaw River
Michigan Sugar Co.[2]	MI0002267	Cass River
G.M.C. Chevrolet - Bay City		Saginaw River

[1]Dischargers to be surveyed in 1984.
[2]Dischargers to be surveyed in 1985.
[3]Dischargers to be surveyed in 1986.

DETAILS

Point Source

The municipalities and industries in Table 18 will undergo point source surveys according to the schedule shown. Reported phosphorus loadings will be summed for point sources and subtracted from tributary loading estimates to obtain nonpoint source load estimates for phosphc

Reported loadings of organics will be compared to tributary loading estimates for organics and the major sources will be identified.

Water

The six major tributaries to the Saginaw River, as well as the Saginaw River itself will be sampled at the sites in Table 19 on a monthly basis and during storm events (as defined by East Central Michigan Planning and Development Region) for the parameters listed in Table 20.

Sediments

Sediment samples at sites listed in Table 19 [illegible] be collected every third year beginning in 1986. Analysis will be conduc[illegible] for the metals and organics specified in Annex 1, Part I of the Agreement.

Biomonitoring

Spottail shiners, caged clams, sports fish and filamentous algae, where possible, in each of the tributaries listed in Table 19 will be collected annually and analyzed for the organics listed in Annex 1, plus PCB, hexachlorobenzene, PBB, PCDD/PCDF, pentachlorophenols. After data evaluation the most suitable media will be selected for lon[illegible] term monitoring.

TABLE 19

SAMPLING SITES ON MAJOR TRIBUTARIES
IN THE SAGINAW RIVER BASIN

Tributary	Site
Shiawassee	Fergus
Chipewa	Mt. Ple[illegible]
Pine	Midland
Tittabawassee	Midland
Cass	Frankenmuth
Flint	Fosters
Saginaw	SB0054 (see Saginaw Bay Plan)

TABLE 20

TRIBUTARY PARAMETERS
SAGINAW RIVER SYSTEM

Parameters	Fr[illegible]
Phosphorus, total unfiltered	monthly plus storm events*
Phosphorus, filtered reactive	" " " "
Solids, total filterable	" " " "
Nitrate plus nitrite, filtered	" " " "
Metals[1]	" " " "
Organics[2]	" " " "

[1]See Saginaw Bay Element (total only).

[2]Saginaw River only, see Saginaw Bay Element.

*Storm events as defined in East Central Michigan Planning and Development Region Report, 1984.

Data Reporting

The results of all physical and chemical measurements of effluents, tributaries, sediment and fish will be stored in the U.S. EPA's data storage and retrieval system, STORET.

Data Interpretation

Estimated point source loadings will be compared with tributary loadings to calculate the nonpoint source contribution by river sub-basin. These estimates will be compared with estimates from nonpoint source modelling work ongoing in the Saginaw Basin. Major contributors of organic contaminants will be identified and future surveillance will be planned on the basis of these results. The status of the Saginaw River system as an Area of Concern will be evaluated on a yearly basis.

Responsible Agencies

Michigan DNR and EPA.

SAGINAW BAY

OBJECTIVE

To determine ambient conditions in Saginaw Bay water, sediment and biota with respect to eutrophication and contaminants.

RATIONALE

The Bay has shown significant improvement in its eutrophication problems. However, there is some indication that the biota in the Bay are still in a state of transition. The recommended objective for a total phosphorus concentration of 15 µg/L has not been met.

Contaminant levels in Saginaw Bay water, fish and sediment have not shown a similar improvement. Of particular concern are the high level of chlorinated hydrocarbons in the sediment and sport fish. This element of the plan was designed to monitor the continued progress of the Bay's trophic state as well as assess ambient conditions of organic contaminant in all media. Data resulting from this work will be used to analyze trends in both eutrophication and toxic substances.

DETAILS

Point Source

The Michigan Sugar Company at Sebawaing on Saginaw Bay will undergo a point source survey. Reported phosphorus loadings will be compared with estimated nonpoint source loadings to the southwest corner of Saginaw Bay.

Water

Seven or eight cruises will be conducted annually, from April through November. Parameters and station locations appear on Figure 6 and Tables 21 and 22.

Sediment

Sediment core samples will be taken at least once every 5 years for stations 22, 27, 29, 35 and 54. This sediment will be analyzed for the parameters in Table 23 at 1 cm intervals for the 1st 10 cm and on a bulk basis thereafter.

Fish

Yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum vitreum*) should be sampled and analyzed for PCBs and other bioaccumulating contaminants (Table 24) due to their importance in the commercial and sport fishing industry. Outer bay station 52 and inner bay station 7 represent the extremes at either end of the PCB gradient found in Saginaw Bay yellow perch

SAGINAW BAY 1976 SAMPLING NETWORK AND SEGMENTATION

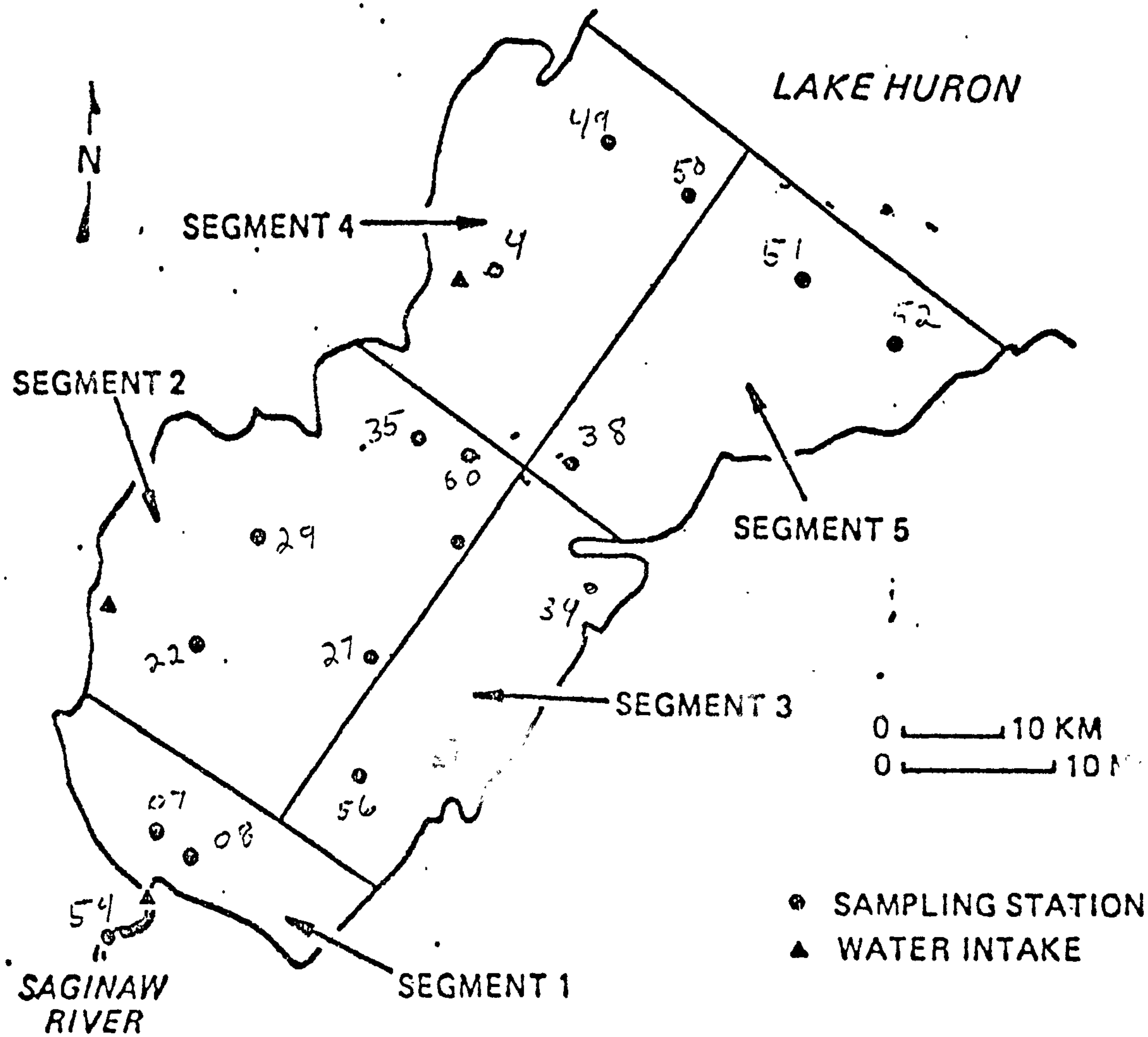


FIGURE 3 */6

TABLE 21

SAGINAW BAY STATION LOCATIONS

STATION	COORDINATES		DEPTHS							
	N. Latitude	W. Longitude	1m	5m	10m	15m	20m	25m	30m	Bot.-1m
SB0004[1]	44 06 30	83 31 45	X	X	X					X
SB0007	43 41 05	83 50 35	X							X
SB0008	43 40 00	83 48 25	X							X
SB0022	43 49 25	83 48 40	X	X						
SB0026*[1]	43 45 40	83 31 35	X							X
SB0027	43 49 10	83 37 10	X	X						
SB0029[1]	43 54 50	83 44 50	X	X						
SB0032	43 54 35	83 31 40	X							X
SB0034*	43 53 00	83 23 35	X							X
SB0035	43 58 45	83 34 40	X	X	X					
SB0038	43 58 10	83 24 55	X							X
SB0049[1]	44 12 40	83 22 40	X	X	X	X				X
SB0050	44 10 20	83 17 30	X	X	X	X				X
SB0051[1]	44 07 25	83 10 15	X	X	X	X				X
SB0052	44 04 10	83 04 50	X	X	[illegible]	[illegible]				X
SB0054	43 36 45	83 51 25	X							X
SB0056*	43 43 45	83 37 40	X							X
SB0060*	43 58 55	83 30 00	X							X

1 Selected stations for fluoride, metals and organics

* If these stations are too shallow to be reached by the main lake sampling vessel, they will be sampled by a small boat which will meet the large vessel for sample exchange.

TABLE 22

PARAMETERS FOR SAGINAW BAY WATER

PARAMETER	WHERE MEASURED
Depth Temperature	In situ
Oxygen, dissolved	In situ
Specific Conductivity	In situ
Chloride, filtered	In lab
Sulfate, filtered	In lab
Calcium, filtered	In lab
Magnesium, filtered	In lab
Potassium, filtered	In lab
Sodium, filtered	In lab
Fluoride, filtered (selected stations only)	In lab
Trace Metals (filtered and total, selected stations only, two cruises only)	
Arsenic	In lab
Cadmium	In lab
Chromium	In lab
Copper	In lab
Iron	In lab
Lead	In lab
Mercury	In lab
Nickel	In lab
Selenium	In lab
Zinc	In lab
Organic compounds (total water, selected stations only, two cruises only)	
Aldrin	In lab
Dieldrin	In lab
Chlordane	In lab
DDT and metabolites	In lab
Endrin	In lab
Heptachlor	In lab
Heptachlor Epoxide	In lab
Lindane	In lab
Methoxychlor	In lab
Toxaphene	In lab
PCBs	In lab
pH	In situ
Alkalinity, total	On Ship
Secchi Disc, depth	In situ
Chlorophyll a	In lab
Carbon, Particulate Organic	In lab
Solids, unfiltered total	In lab
Solids, total suspended	In lab
Silicate, filtered reactive	On Ship
Silica, amorphous	In lab
Ammonia, filtered	On Ship
Nitrate and nitrite, filtered	On Ship
Nitrogen, unfiltered Kjeldahl	In lab
Nitrogen, total particulate	In lab
Phosphate, filtered reactive	On Ship
Phosphorus, filtered total	In lab
Phosphorus, unfiltered total	In lab
Phosphorus, NaOH extractable	In lab
Phytoplankton, species counts & biomass estimates	In lab
Zooplankton, species counts & biomass estimates	In lab

TABLE 23

PARAMETERS FOR SAGINAW BAY BOTTOM SEDIMENT
AND SUSPENDED SEDIMENT AT SELECTED SITES

% Clay
% Silt
% Sand
Mean Grain Size
Porosity
Organic Carbon
Total Phosphorus
Total Nitrogen
Total Amorphous Silica
PCB
PBB
Hexachlorobenzene
PCDD/PCDF

TABLE 24

PARAMETERS FOR SAGINAW BAY FISH

Weight
Length
Age
Sex
% Lipid
Species
Total PCB
Aroclor 1254
Aroclor 1260
Total PBB
Hexachlorobenzene
PCDD/PCDF
Toxaphene
Chlorophenols
DDT & metabolites

(Hendricks-Mathews and Dolan, 1984) with inner bay fish containing higher concentrations of residues. Gill nets should be used at each station, with only one sampling period required, annually, preferably in the late summer.

Intakes

Threshold odor data will be obtained for the two intakes indicated on Figure 6 (Saginaw-Midland and Bay City). Daily readings made on the raw water supply (after chlorination) will be used.

Data Reporting

The results of all physical and chemical measurements will be stored in the U.S. EPA's storage and retrieval system, STORET. Biological data will be retained at the U.S. EPA's Large Lakes Research Station.

Data Interpretation

The total phosphorus, nitrate-nitrite, chlorophyll a, and threshold odor data for the water column will be compared to data from 1974-1980. Trends in these parameters or the lack of trend will be reported. Similarly, data on phytoplankton, zooplankton, fish and sediments will be compared to previous studies and to Agreement objectives where possible. The status of Saginaw Bay as an area of concern will be evaluated annually.

RESPONSIBLE AGENCY

EPA (LLRL).

3.4.3 PENETANG & STURGEON BAYS (CLASS "B")

OBJECTIVES

To determine the effect of phosphorus loadings on the trophic status of the Penetanguishene to Waubaushene area by monitoring ambient conditions in water, sediment and biota (Table 25).

TABLE 25

PENETANG - MIDLAND - HOG - STURGEON BAYS SAMPLING DESIGN

MEDIA	TESTS	SITES	DEPTH	FREQUENCY
Water	Temperature, Secchi depth, conductivity, chloride (filtered), alkalinity (total), chlorophyll a (corrected), solids (unfiltered total; total suspended), ammonia (filtered), nitrate-nitrite (filtered), Kjeldahl nitrogen (unfiltered), phosphate (filtered reactive), phosphorus (filtered total), phosphorus (unfiltered total), silicate (filtered reactive)	7	2x SD	Once every two weeks during ice free period each year
Sediments	Total phosphorus, total nitrogen, total amorphous silica, mean grain size, organic carbon, LOI	**	Top 3 cm.	Once every five years
Biota				
Benthos	Species, biomass	**	Top 10 cm.	Once every five years
Phytoplankton	Species, biomass	7	2x SD	Once every two weeks during ice free period each year
Zooplankton	Species, biomass	7	Vert. Haul.	Once every two weeks during ice free period each year
Macrophytes***	Species, biomass	16	1 to 4 m	Once every five years

**To be determined for each embayment. Additional sites to be allotted as circumstances warrant (e.g. seven additional sites for Sturgeon Bay re: new STP outfall).

***Sturgeon Bay only.

RATIONALE

Previous investigations by MOE indicated significant enrichment in Penetang and Midland Bays. Phosphorus removal is on line at sewage treatment plants at Penetanguishene, Midland and Port McNicholl. Midland has recently completed an expansion of plant facilities. A new plant has recently been constructed to serve Victoria Harbour and will discharge to Sturgeon Bay, a shallow area which already has extensive macroph[illegible] beds. A new plant has been proposed for Penetanguishene; this plant wou[illegible] also discharge to Penetang Bay, but downstream from the old plant.

DESIGN

Water. Water for chemical analyses will be collected as composite samples through twice the Secchi depth at seven sites (and at additional sites when necessary) once every two weeks throughout the ice-free period annually.

Sediment. The top 3 cm of sediment will be collected at a yet-to-be-determined number of sites in each embayment once every five years and analysed for major nutrients.

Biota. Phytoplankton and zooplankton sampl[illegible] be collected at seven sites (and at additional sites when necessary) [illegible] every two weeks throughout the ice-free period annually. Phytoplankton samples will be collected as composites through twice the Secchi depth, while zooplankton samples will be collected as vertical hauls from 1m off bottom to surface. Benthos will be collected from the top 10 cm of sediment at a yet-to-be-determined number of sites (three replicates per site) in each embayment once every five years. Macrophytes will be collected in Sturgeon Bay at 16 previously sampled locations.

DATA QUALITY

All samples will be analysed at MOE laboratories according to standard methods.

DATA OUTPUT

An annual assessment and report of the status of the area of concern and recommendations as to future activities. IJC/MOE/Journal publications.

RESPONSIBLE AGENCY

MOE

3.4.4 SPANISH RIVER MOUTH (CLASS "B")

OBJECTIVES

To determine the impact of pulp mill waste discharge from the Eddy Forest Company on the Spanish River mouth water, sediment and biota (Table 26).

RATIONALE

Following an investigation by MOE in 1980, it was apparent that fish tainting still existed in the Spanish River mouth area. Eddy Forest Company, a pulp and paper mill situated twenty four miles upstream, is the major source of contamination to the river and its mouth. A Control Order issued in 1978 required the company to reduce organic waste loading, eliminate toxic waste and odor-producing contaminants and to reduce loadings of suspended solids. The company is expected to comply with the Control Order requirements by the end of 1983.

DESIGN

Water. Water for chemical analyses (excluding chlorophyll a) will be collected at three sites as surface samples on five consecutive days once during high flow (spring) and once during low flow (summer) annually.

Sediment. The top 3 cm of sediment will be collected at nineteen sites once every five years and analysed for organic and inorganic contaminants.

DATA QUALITY

All samples will be analysed at MOE laboratories according to standard methods.

DATA OUTPUT

IJC/MOE/Journal publications.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: AREAS OF CONCERN

WATERBODY: Lake Erie

2.2 AREAS OF CONCERN

The Great Lakes Water Quality Board has identified five Class "A" (Raisin R., Maumee R., Black R., Cuyahoga R., Ashtabula R.) and one Class "B" (Wheatley Harbour) areas of concern located directly on Lake Erie's shoreline. Since 1974 all but the Raisin River have been reported annually to the IJC as areas with some type of environmental and/or human health concern.

It is proposed that the Class "A" areas of concern and lake waters adjacent to these areas be included in nearshore surveillance. Since each area of concern differs in physical features, hydrology, and pollution problems, it is difficult to design a standard model for routine monitoring. A more pragmatic approach is to suggest a basic structure around which specific components can be designed to meet the surveillance requirements of each area. Basically, identification and quantification of important metals and organic contaminants could be made from an examination of several components of the system.

Based on the information collected by the Lake Erie Task Force the following recommendations are made:

1. The Historical Data Base available for each of the areas of concern be reviewed before any further field work is initiated.

   A review of what is already known about the area is an important first step in a specific design. Surveillance effort can then be concentrated on priority contaminants and pollution problems. Trends can be determined and responses to remedial measures ascertained. Chemical inventory information for the drainage area can also be used to concentrate effort on potential pollution problems.

2. The following system components need to be thoroughly evaluated in order to obtain a comprehensive data base which characterizes each region in terms of impaired usage.

Water

A knowledge of the hydrology of the problem area is a prerequisite to the design of sampling strategy. Location of sampling stations, sampling frequency and parameters should be selected in consideration of the requirements of Annex 11, but also in relation to historical data and existing monitoring of research programs. As far as possible stations should be site-selected to concentrate effort and to maintain valuable long-term data series. Lake stations located adjacent to areas of concern are required to measure the impact on offshore waters.

Sample frequency should be designed to accommodate hydrological and seasonal variability and remedial measures implementation. Further considerations are adequate statistical evaluation and interpretation of the data.

Parameters should be selected to provide an evaluation of eutrophication and toxic substances in the nearshore area.

Basic parameters to be considered:

- pH, conductivity, Secchi disc transparency, suspended solids, temperature (profile), dissolved oxygen (profile), total phosphorus, nitrate nitrogen, ammonia.

- selected metals (total mercury, total lead)

Sediments

Many pollutants of concern settle out of the water column and accumulate in sediments. Whereas determination of trace amounts of contaminants in water is often difficult and sometimes inaccurate, it is easier to measure concentrations of these substances in sediments. Cores from undisturbed sediments also provide a history of contaminant loading to the system.

Factors to be considered in location of sediment stations are historical data, hydrology, runoff, municipal and industrial outfalls, and dredged and depositional areas.

Frequency of sampling will be determined, to some extent, by the rate of sediment accumulation. Once every three years may be adequate.

Parameters to be considered:

- grain size, loss on ignition, COD, oil and grease

- metals - total mercury, total lead, total iron, total cadmium

- organics - PCBs, DDT metabolites, aldrin/dieldrin, PAHs, phenol, toxaphene

- broad scan for priority pollutants

Biota

The importance of biota as indicators of ecosystem quality in the Great Lakes has been established. Several components of the biological system have been used in surveillance: bacteria, phytoplankton, zooplankton, zoobenthos, fishes and fish eating birds. Sampling problems and "natural" variability of population abundance in space and time affect the usefulness of each of these components. The best candidates for inshore monitoring are the zoobenthos and fishes.

Zoobenthos. Because benthic macroinvertebrates are sedentary they reflect environmental conditions at specific locations. The environment may be reflected in the benthic community in two ways - (a) species composition, abundance and diversity, and (b) body burdens of contaminants.

Because invertebrates are important food for fishes, information on contaminant burdens is useful. Research projects (Eadie et al. 1982, Chapman et al. 1979) have linked the flow of PAHs and heavy metals from sediments to fish through oligochaetes and chironomids.

The factors which influence the selection of sites for sediment sampling should also be considered in the invertebrate sampling plan. Some sites may be sampled for both components. It may be opportune to also sample dredged areas as these are recolonized quickly by invertebrates. Sampling frequency should be influenced by information on life histories of the predominant invertebrate species. Spring and fall sampling for two consecutive years may be adequate. The use of caged clams has recently become a popular surveillance tool. Where appropriate, the use of caged clams should be considered as a useful adjunct to a comprehensive plan.

Parameters to be considered:

- metals and organics as listed under sediments

Fish. Sampling of fish for body burdens should include (a) species that live in or adjacent to areas of concern (b) species that are taken in local fisheries (if present). The young-of-the-year spottail shiner program may be part of this component.

Late summer and fall collections are preferable.

Parameters:

- percent lipid, tainting, tumors, lesions, etc. - metals - total mercury, total lead - organics - PCB, DDT, locally used pesticides - broad organic scan (industrial chemicals)

Bioassay

The measurement of contaminant stress on ecosystem functions of bacteria, phytoplankton and zooplankton is a component of the Monroe Harbour/Raisin River Research Project. For example, inhibition of photosynthesis and bacterial uptake in Monroe Harbour water is being studied using offshore water as a control. Although this is an experimental research project we suggest that the routine bioassay of photosynthesis inhibition could be a useful adjunct to the surveillance program. The scientist working in this area with the Monroe Harbour Research Project could provide advice on a suitable design.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: AREAS OF CONCERN

WATERBODY: Lake Ontario

Presented below are the Water Quality Board's guidelines for areas of concern, as presented in an appendix to the Board's 1983 annual report. Using these guidelines, through consideration of available technical information, and through application of its professional judgement to help identify where the most severe problems exist, the Water Quality Board identified and reported on 18 Class "A" and 21 Class "B" areas of concern in its 1981 report. One Class "A" and six Class "B" areas of concern are located in the Lake Ontario Basin; a second Class "A" area (the Niagara River) impacts Lake Ontario. These areas of concern are listed in Table

Each area of concern or potential area of concern on Lake Ontario is unique. The amount of environmental information available for each is different, and the status of the jurisdictions' response, in the form of remedial measures, is also different. Therefore, the surveillance and monitoring program for each area must be tailored appropriately.

In-place pollutants deserve special attention for the design of both the surveillance and monitoring program and the remedial measures. For surveillance and monitoring, the Lake Ontario Task Force has adopted the philosophy espoused by the Dredging Subcommittee of the Great Lakes Water Quality Board. That philosophy is summarized at the end of this chapter.

Section 7 of this Plan describes a detailed surveillance and monitoring plan for each area of concern or potential area of concern on Lake Ontario:

1. Niagara River Mouth, New York and Ontario (Chapter 27).
2. Hamilton Harbour, Ontario (Chapter 28).
3. Toronto Waterfront, Ontario (Chapter 29).
4. Port Hope, Ontario (Chapter 30).
5. Bay of Quinte, Ontario (Chapter 31).
6. Oswego River and Harbor, New York (Chapter 32)
7. Rochester Embayment, New York (Chapter 33)
8. Eighteen Mile Creek, New York (Chapter 34)
9. Emerging Areas of Concern (Chapter 35).

The Lake Ontario Task Force considers the plan for each area of concern or potential area of concern to be that which is necessary and sufficient to meet the goals and purposes stated above.

GUIDELINES FOR AREAS OF CONCERN

Definition

An area of concern is identified when an Agreement objective or a jurisdictional standard, criterion, or guideline has been exceeded.

Procedure

To identify, evaluate, and classify each area of concern from a technical perspective, all available environmental data - fish, sediment, and water - are used to provide as complete a description as possible. The 1978 Agreement objectives, along with jurisdictional standards, criteria, and guidelines, provide the basis for review and evaluation of these data. To the extent possible, the Board has established the human and environmental significance of the observed ecosystem quality. The Board has also established a cause-effect relationship between observed environmental conditions and the sources of environmental insult. This leads to a description of regulatory and remedial measures which have been implemented in response to the degraded environmental conditions in each area of concern.

Detailed information about present and proposed remedial programs is then evaluated, in order to decide whether environmental problems can be solved and beneficial uses restored.

Description of Concern

In order to provide as complete a description and evaluation of all potential areas of concern, the following have been considered to the extent necessary and possible:

1. Compilation of surveillance and monitoring data for fish and other biota, sediment, water column, and air, in order to develop a description of present and historical conditions.

2. Comparison of these data with Agreement objectives and jurisdictional values in order to establish and substantiate duration and extent of any violations. Values for sediment and fish are given in Tables 2 and 3, respectively. Agreement objectives and jurisdictional values for water are too extensive to tabulate here, but are referred to when appropriate in the various chapters of this Plan.

3. Discussion of potential and observed environmental and human health effects and uses affected.

4. Information about biological community structure, e.g. types, relative abundance, and absolute abundance of benthos and fish. Consideration of how the community structure reflects and is a consequence of observed ecosystem quality and anthropogenic inputs. Discussion about the direction in which the community structure might shift, and why, as a consequence of changes in ecosystem quality and in loadings.

5. Causes of violations. Specific point source dischargers and/or nonpoint inputs (including land runoff and the atmosphere) are named along with the loadings of substances for which violations are observed. If a violation is the result, in whole or in part, of a natural phenomenon, this is noted.

6. Remedial or corrective measures. Controls presently in place are described. These are evaluated to determine their present ability to control the release of a particular substance, the correctability of the problem, any modifications or additional measures required, and the probable cost. Observed and/or projected changes in ecosystem quality are described.

Consideration of the above information provides a common basis for selecting and evaluating areas of concern. This approach also establishes a comparable depth and breadth to the data base required to substantiate a concern.

Evaluation of Environmental Information

Through consideration of the above information, Water Quality Board has prioritized areas of concern into two classes:

1. A Class "A" designation is assigned to those areas exhibiting significant environmental degradation, where impairment of beneficial uses is severe.

2. A Class "B" desingation is assigned to those areas exhibiting environmental degradation, where uses may be impaired.

The Board employed a set of guidelines to evaluate, from a technical perspective, available information for each area of concern, in order to prioritize that concern. The initial questions asked were:

1. Are one or more Agreement objectives or jurisdictional values violated?

2. Are values exceeded for a significant number of parameters? Which ones?

3. For each parameter, is the violation persistent over a number of repeat observations?

4. How many samples were taken? Over what period of time and what geographic area?

5. Is the value for each parameter exceeded by a significant amount?

6. How old are the data? Are such data still relevant?

A positive response to most of these questions would suggest a Class "A" or a Class "B" classification. A negative response would suggest that no further evaluation is required at the present time.

To further rank the relative severity of a problem, additional questions were considered:

7. Is a use impacted? Which one or ones?

8. Is the violation related to current discharges or historic accumulation?

9. Are there any transboundary implications?

If the responses were positive, then a Class "A" classification would be suggested.

Evaluation of Remedial Program Information

In its 1982 report, the Water Quality Board evaluated specific information about present and proposed remedial programs, in order to decide whether environmental problems could be solved and beneficial uses restored. The Board considered:

1. The nature of the environmental problem.

2. The nature of the remedial programs in place or planned.

3. The schedule to initiate or complete these programs.

4. Factors which would preclude timely and satisfactory resolution of the problem and restoration of uses, including costs, technical considerations, and further definition of the issue.

5. Expected date by which the problems would be resolved and uses restored.

Based on its evaluation, the Board reached one of the following conclusions for each area of concern:

1. Remedial measures currently in operation will resolve the identified environmental problems and restore beneficial uses over the near term (5 to 10 years).

2. Remedial measures currently in operation will not resolve the identified problems and restore uses over the near term:

   A. However, additional programs and measures have been imposed, and these will be adequate and timely.

   B. Additional programs and measures have been imposed, and environmental problems will eventually be resolved and uses restored. However, there is a long lag time between completion and operation of the remedial measures and the response of the environmental system.

   C. Even though all reasonable remedial measures have been or are being taken, it is doubtful whether the environmental problems will be completely resolved and uses restored.

   D. There are apparently no firm programs additionally planned that will resolve problems and restore uses.

3. Insufficient information has been received or is available in order to make a reasonable judgement as to whether control measures are adequate, or to decide when such measures may be required.

In its 1982 and 1983 reports, the Water Quality Board presented information describing the environmental quality, discharges, and remedial measures for each Class "A" area of concern. This information was an update and expansion from the material presented in an appendix to the Board's 1981 report. Also in that 1981 report, the Board provided an evaluation of present and proposed remedial programs, and conclusions about whether and when environmental problems will be solved and beneficial uses restored.

Information about Class "B" areas of concern was also given in the Board's 1981 report. The Board is presently updating this information and will provide an assessment of each Class "B" area of concern. The environmental description and the assessment will be presented to the Commission in 1984.

IN-PLACE POLLUTANTS

For many of the areas of concern, the problem is sediment contaminated as a result of either historic or present discharges. The associated questions include: What are the environmental consequences of either moving the sediment or leaving it in place? If the contaminated sediment must be moved, then how? How should the dredged material be disposed of? How are alternatives assessed? What surveillance and monitoring must be considered in association with answering these questions?

The Dredging Subcommittee prepared a report entitled, "Guidelines and Register for Evaluation of Great Lakes Dredging Projects," published in January 1982. The Subcommittee concluded that, since each location is unique, a site-specific approach and evaluation is required in order to address the issue of in-place pollutants. The evaluation is based on the principle of non-degradation. The Subcommittee developed general guidelines based on this principle which are to be followed in the review of each geographic area.

The Lake Ontario Task Force has adopted this philosophy in the development of surveillance and monitoring programs associated with in-place pollutants in areas of concern.

TABLE 1

CLASS "A" AND CLASS "B" AREAS OF CONCERN IN THE LAKE ONTARIO BASIN

CLASS "A"	CLASS "B"
Niagara River, New York and Ontario	Eighteen Mile Creek, New York
Hamilton Harbour, Ontario	Rochester Embayment, New York
	Oswego River, New York
	Toronto Waterfront, Ontario
	Port Hope, Ontario
	Bay of Quinte, Ontario

TABLE 2

GUIDELINES FOR CLASSIFICATION OF GREAT LAKES SEDIMENTS[a]
(Concentrations in mg/kg dry weight)

	U. S. E P A[b]			ONTARIO[c]
	NONPOLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED	M O E
Volatile Solids	<50,000	50,000-80,000	>80,000	60,000
Chemical Oxygen Demand	<40,000	40,000-80,000	>80,000	50,000
Total Kjeldahl Nitrogen	<1,000	1,000- 2,[illegible]	>2,000	2,000
Oil and Grease	<1,000	1,000- 2,[illegible]	>2,000	1,500
Lead	<40	40- 60	>60	50
Zinc	<90	90- 200	>200	100
Mercury	<1	-	>1	0.3
Polychlorinated Biphenyl	<1	1- 10	>10	0.05
Ammonia	<75	75- 200	>200	100
Cyanide	<0.10	0.10- 0.25	>0.25	0.1
Phosphorus	<420	420- 650	>650	1,000
Iron	<17,000	17,000-25,000	>25,000	10,000
Nickel	<20	20- 50	>50	25
Manganese	<300	300- 500	>500	-
Arsenic	<3	3- 8	>8	8
Cadmium	-	-	>6	1
Chromium	<25	25- 75	>75	25
Barium	<20	20- 60	>60	-
Copper	<25	25- 50	>50	25

[a]The intended use of these guidelines is to help determine whether dredged material can be disposed of in the open waters of the Great Lakes. Discussion of their applicability and limitations is found in the report of the Dredging Subcommittee, "Guidelines and Register for Evaluation of Great Lakes Dredging Projects", 1982. The Subcommittee report also summarizes the average concentration of various constituents in surficial sediments in Lake Ontario, as well as average natural or pre-colonial concentrations from depositional zones.

[b]The U.S. EPA guidelines are from the report, "Guidelines for Pollutional Classification of Great Lakes Harbor Sediments", U.S. Environmental Protection Agency, Region V, Chicago, Illinois, 1977.

[c]The Ontario guidelines are from the report, "Evaluating the Impact of Marine Construction Activities on Water Resources," Ontario Ministry of the Environment, Toronto, 1976 and Addendum 1978.

TABLE 3

LIMITATIONS ON CONTAMINANTS IN FISH
(Concentrations in mg/kg wet weight)

PARAMETER	AGREEMENT OBJECTIVE (Edible portion)	U.S. FDA VALUE (Edible portion)[a]	CANADA HEALTH PROTECTION GUIDELINE (Edible portion)[b]
Aldrin/Dieldrin	0.3[d]	0.3[f]	-
DDT and Metabolites	1.0[c,e]	5.0[g]	5.0
Endrin	0.3[d]	3[f]	-
Heptachlor/Heptachlor epoxide	0.3[d]	0.3[f]	-
Lindane	0.3[d]	-	-
Mirex	Substantially Absent	0.1[f]	0.1[c]
Polychlorinated Biphenyls	0.1[c,e]	2.0[g]	2.0[c]
Kepone	-	0.3[f]	-
Mercury	0.5[c,e]	1.0[g]	0.5
Toxaphene	-	5.0[f]	-
2,3,7,8-TCDD (Dioxin)	-	0.00005[h]	0.00002
Diquat	-	0.1[f]	-
2,4-D	-	[illegible]	-
Simazine	-	[illegible]	-
Glyphosate	-	0.15[f]	-

[a]Fillet with skin but without scales.
[b]Fillet without skin.
[c]Whole fish.
[d]For the protection of human consumers of fish.
[e]For the protection of fish-consuming birds.
[f]Action level. Has not had a public review via a formal notice in the Federal Register.
[g]Tolerance. A final limit which has had public review.
[h]Guidance. Without legal standing.

Note: The information in this table has been updated from that which was used by the Water Quality Board to designate areas of concern. U.S. pesticide values from "The Pesticide Chemical News Guide," December 1, 1983. Published monthly by Food Chemical News, Inc., Washington, D.C.

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Fish

<u>SURVEILLANCE ISSUE:</u>	CONTAMINANTS
<u>OPERATIONAL COMPONENT:</u>	FISH

<u>WATERBODY:</u>	Lake Huron

TABLE 1

ISSUE: CONTAMINANTS

SYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
UTS	1. ATMOSPHERE	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
AS OF FECT	3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AREAS OF CONCERN	Yes	Water, Sediments - Suspended and Bottom, Biota	Area specifi[illegible]ts, should include some of the above [illegible]ables
	6. WILDLIFE	Yes	Gull eggs	Above list & chlorinated benzenes, chlorinated styrenes
TPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
SC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

3.2.4 RATIONALE & DESIGN - OPEN WATER FISHERY

Environmental contaminants are a major factor influencing the health and well-being of the Great Lakes fisheries. Since the early 1970s, these persistent, bioavailable and toxic substances have denied full utilization of the fisheries of Lake's Ontario, Erie, St. Clair, Huron and Michigan. Direct effects on the fishery are two fold: contaminants may accumulate in fish flesh to levels which are hazardous to human health; in addition they may cause acute and chronic effects on the aquatic ecosystem. The outcome of a contaminated fishery is a loss of livelihood for fishermen, a loss of revenue to the Great Lakes economy and in some cases, a significant impact on the lifestyles of native and fishing communities.

Less obvious are the direct effects on the fish themselves. Many of the chemicals identified in Great Lakes fish are known to induce physiological, pathological, biochemical and behavioural anomalies under laboratory conditions and it is reasonable to assume that similar responses may occur in the Great Lakes.

The open lake surveillance program is designed to address both of these issues. Traditionally, emphasis has been placed on monitoring organic and inorganic contaminant levels in aquatic biota to identify geographical and temporal trends in contaminants; new chemicals which may impact on the fishery or on human health; chemical sources and the effectiveness of contaminant regulations. Contaminant monitoring at several trophic levels also contributes to an understanding of contaminant dynamics within the ecosystem.

Surveillance programs have not developed suitable methods for monitoring the direct adverse effects of contaminants on biota. Many of the procedures used to measure these effects are in the development stage and some of the specific, sensitive tests which are available to mammalian toxicologists have not been applied to aquatic organisms. However, there are some health indicators which may have applicability to the Lake Huron fishery (such as abnormal skeletal development in response to toxaphene exposure, reproductive impairment in some lake trout stocks and tumour monitoring in nearshore species). Clearly there is a need to encourage research on effects monitoring at the individual, population and community levels and to incorporate suitable procedures into the surveillance program as they become available.

OBJECTIVES

1. To monitor contaminant levels in top predators (lake trout, walleye), forage fish (smelt), benthos and plankton.

2. To establish temporal and spatial trends of contaminant levels in these organisms.

3. To develop data describing contaminant dynamics between the different trophic levels.

4. To identify new contaminants in Lake Huron biota.

5. To collect archival tissue for retrospective analyses.

6. To evaluate the effectiveness of remedial programs in controlling the sources and distribution of toxic substances.

7. To make a preliminary assessment of the effects of contaminants on fish and fish populations.

RATIONALE

The Lake Huron open lake fish contaminants program is part of the IJC fish contaminants monitoring program undertaken by Canadian and United States agencies to determine the contaminant status of Great Lakes fish. Results from the 1979-1980 intensive surveillance year indicate that Lake Huron top predators are intermediate between the low contaminant burdens found in Lake Superior fish and the higher concentrations found in fish from the lower lakes. Comparisons with previous years indicate a decline in DDT concentrations in some lake species but an increasing trend in PCBs. Similarly the United States fisheries agencies reported an increase in mercury concentrations in open lake fish from 1968 to 1980.

These data, plus recent information that toxaphene and dioxin have been found in Lake Huron fish suggest that the open lake fish surveillance program should continue to monitor the traditional organochlorines and inorganics and that agencies should develop analytical capability for non-routine contaminant analyses.

DESIGN DETAILS

Sampling Locations:

There are 10 sampling locations (four United States and six Canadian) identified in Lake Huron for open lake fish contaminants monitoring (Figure 4). Two additional sites have been added to the United States program. One site is located in the northwest arm of the lake to monitor the effects of contaminant inputs from Lake Michigan and the St. Marys River. The second site has been added in southern Lake Huron in the vicinity of Port Sanilac to complement similar stations on the Canadian side.

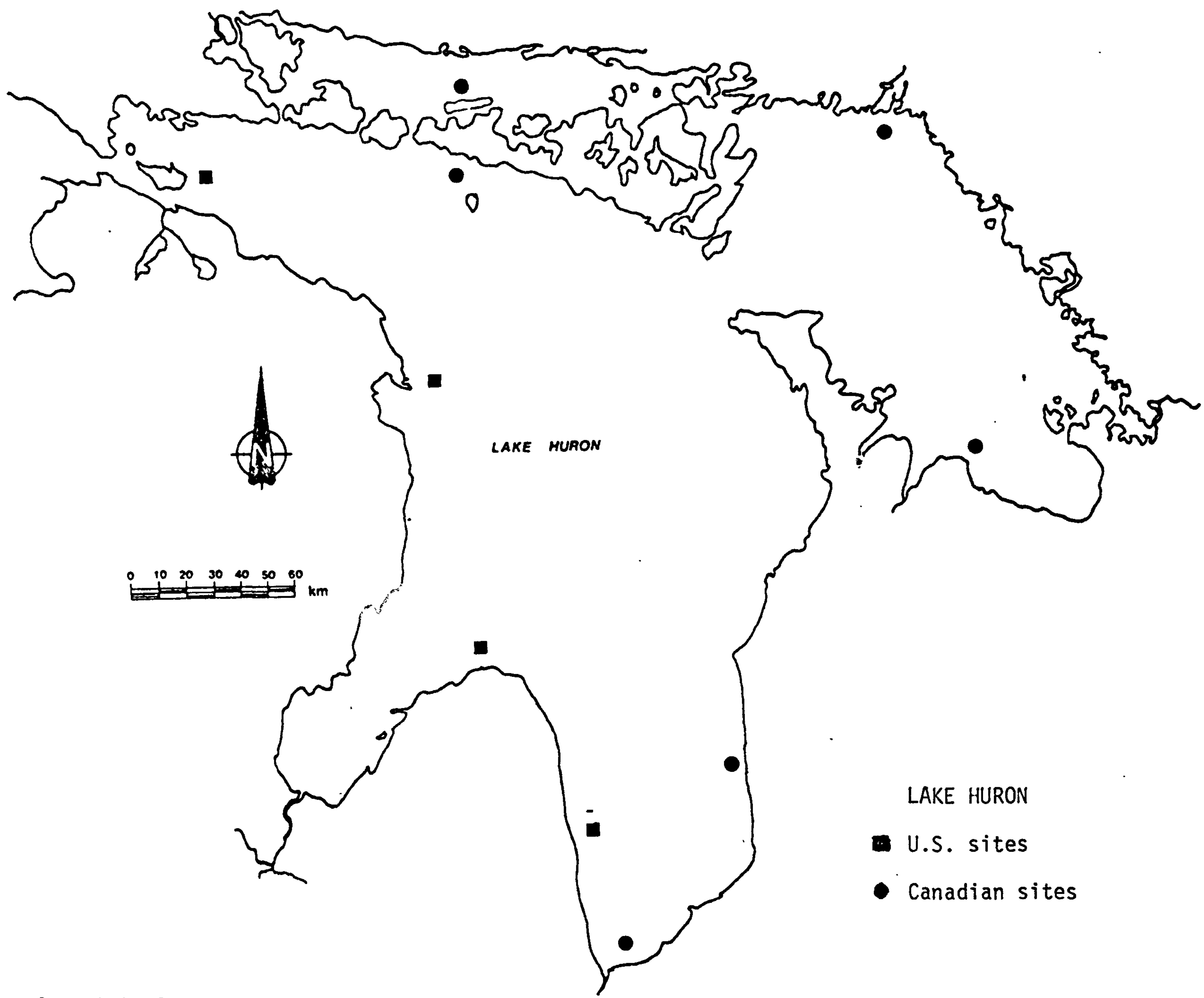


Figure 4. Open Lake Fish Contaminant Monitoring Sites

A minimum of two United States and two Canadian sites will be sampled each year and these sites will be repeated for two consecutive years. Site selection will be determined by the two agencies based on the results of the 1980 intensive year and subsequent surveillance data. The sites will be located at offshore fishing grounds. Where such grounds do not exist or are undependable, sites may be located closer to shore but removed from the direct influence of tributaries and at depths consistent with open water populations of fish.

Species Sampled:

Two fish species will be sampled at each site. Smelt will be the chosen representative of a planktivorous species and lake trout as the preferred top predator. Where lake trout are not available, splake, other salmonids or walleye may be substituted.

It has been suggested that the surveillance program consider the utility of monitoring contaminant levels in zooplankton (mysids), bottom invertebrates (Pontoporeia) and surface net plankton ($>153\mu$) to determine regional differences in contaminant levels and biomagnification in the food chain. These data are particularly useful for assessing the effectiveness of remedial measures. Whenever possible, these additional species should be collected at each site.

Number of Organisms Sampled:

The United States and Canada originally adopted different sample sizes and compositing methods for their open lake fish surveillace programs. Canada collected 50 fish over a large size range at each site and analyzed each fish individually. The United States collected 60 fish from three size ranges and prepared four, five-fish composites for each size range. In order to make the two programs compatible and maintain consistency within each program, Canadian agencies should continue to analyze 50 individual fish. The United States will collect 20 fish from three year classes (four, six, and eight years and over) and prepare four, five-fish composites for each year class. Both agencies will collect 60 smelt from three size groups and prepare four, five-fish composites for each size range. At least 100 grams (wet weight) of Mysis, Pontoporeia and net plankton are required from each site for organic or inorganic contaminant analyses.

Time of Year Sampled:

All organisms will be collected between August and November to maintain consistency with past fish sampling programs and to coincide with periods of maximum lipid accumulation.

Contaminants Monitored:

The routine organic and inorganic contaminants are described in Table 14. In addition, a small number of fish samples will be analyzed for 2,3,7,8-TCDD, toxaphene, chlorinated phenols, chlorinated benzenes, dibenzofurans, and chlorinated styrenes.

DATA QUALITY

Quality assurance will be maintained in the program through at least 10 per cent internal check samples and participation in interlaboratory round robins.

DATA OUTPUT

Results of the Lake Huron open lake fish contaminants program will be available through:

1. Computer storage (DFO in Canada and STORET in the United States).

2. Direct reporting of problem areas to responsible jurisdictions.

3. Publication in IJC reports, agency reports and conferences.

TABLE 14

CONTAMINANTS MONITORED

ROUTINE CONTAMINANTS MONITORED		*NON-ROUTINE CONTAMINANTS**
PCB	Hg	
Mirex	As	
p,p'-DDE	Se	Toxaphene
p,p'-DDD	Cu	
p,p'-DDT	Zn	
o,p'-DDT	Ni	Chlorinated phenols
ΣDDT	Cr	Chlorinated benzenes
Dieldrin	Cd	Dibenzofurans
Chlordane	Pb	Chlorinated styrenes
% Lipid		

* Only a small number of samples from select locations will be analyzed for these chemicals. Future analysis will be determined by results of the preliminary findings.

RECOMMENDED RESPONSIBLE AGENCY

Whole lake fish samples will be obtained by the United States Fish and Wildlife Service in United States waters and by the Ontario Ministry of Natural Resources in Ontario. Chemical analyses will be conducted by the EPA Central Regional Laboratory and in Canada by the Provincial Pesticides Laboratory (OMAF) and CCIW (DOE).

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: FISH

WATERBODY: Lake Erie

1.4 BIOCONTAMINANTS MONITORING PROGRAM

Fish Contaminant Monitoring

Goal

To detect (determine) environmental trends of certain substances that due to their proven deleterious effects on the ecosystem are listed in Annex 1 of the 1978 Water Quality Agreement (Water Quality Objectives).

Subgoal

a) To provide original (empirical) data that may be of use in understanding the pathways and mechanisms by which contaminant residues become distributed within the ecosystem, and

b) To provide an archive of material (tissue) that may be used for determining the presence of chemicals not currently a part of existing surveillance and monitoring assessment (emerging problems).

Rationale

The regulation of certain persistent toxic chemicals, either through restricted use, discharge or outright ban is an undeniable statement by the respective jurisdictions as to their level of concern regarding such chemicals. As such, a segment of Annex 11 of the 1978 Water Quality Agreement encourages the Parties to establish programs that will permit assessment of the effectiveness of regulation or need for additional remedial measures. One such method that has been employed within the Great Lakes basin (and, indeed, throughout the world) for making water quality assessments, is the use of biota as a surrogate for water quality. Surrogates are especially effective tools for toxic substances that have chemical properties causing them to bioconcentrate (bioaccumulate) in the tissue of animals (or plants) at concentrations that greatly exceed their water borne concentrations. This is advantageous, as it is often the case that water borne concentrations of many pollutants are so low as to prohibit their cost-effective determination.

Whole Lake Program

Since 1977, the United States and Canada have participated in a program to collect and analyze fish from the open waters of the Great Lakes. While there has been some departure from the original protocol, smelt and lake trout have been routinely collected from all five Great Lakes during this period (walleye are substituted for lake trout in Lake Erie). This activity should be considered an essential component of the surveillance and monitoring program for all the Great Lakes and continued without change through at least 1986. The detailed rationale for open lake fish contaminant monitoring appears within GLISP and the files of the Fish Contaminant Work Group and is repeated briefly in this text for continuity.

Specific Rationale

The integrity of the whole lake ecosystem is a result of the integration of its individual component parts (chemical, physical, biological and societal). An evaluation of the general health of the system necessitates an awareness and undertanding of all contributing ecological factors. Toxic and contaminating substances are known to have a detrimental effect on the Great Lakes system. A fish contaminant surveillance program conducted in the open waters of the lake provides a significant contribution to both the knowledge and understanding of the whole lake environmental quality and man's impact on the entire system. Mirex contamination of Lake Ontario is a vivid reminder of this fact.

The overall whole lake water quality program emphasizes long-term trends of lake conditions, the relative condition of the lakes to each other, protection of fish stocks, transboundary movement of contaminants, the impact of nearshore regulatory controls on the whole lake, and evaluation of non-point source (particularly atmospheric) contaminants. Since many contaminants accumulated by fish are concentrated in tissues other than the edible portions, the open lake contaminant in fish program samples whole fish as an indicator of the levels and trends of a broad spectrum of toxic contaminants as a reflection of environmental conditions and the potential effects on the fish and fishery resources.

Design Details

1. Fish sampling sites. A minimum of four stations are sampled per Great Lake (two Canadian and two United States; except Lake Michigan - with three United States stations), plus two stations in Lake St. Clair, one Canadian, one United States). Thus, the total minimum program consists of 21 sampling locations (nine Canadian, 12 United States). Stations are located at offshore fishing grounds, or where such grounds do not exist or are not dependable, stations are located closer to shore but remote from tributaries or other potential sources of contaminants and at depths consistent with open water populations of fish.

2. Species sampled. Two species are sampled per station. Smelt are collected at all stations as a representative planktivorous species available in all the lakes. Because of their general availability now and in the future, lake trout is the predator species of choice at each station. However, where lake trout are not available (as in Lake St. Clair and western Lake Erie) walleye are collected as the alternate species for lake trout.

3. Number of fish sampled. A major emphasis of the program is the detection of contaminant trends with time. In order to reliably detect approximately a 20% change from current levels by analysis of variance with =0.05 and =0.20, a minimum of 25 fish within a limited size range are required. However, in order to provide the most meaningful and useful data, three size ranges of each fish species should be sampled. Therefore, 60 fish (20 per size range) per species per station should be collected. Analysis of covariance will be employed to provide similar statistical efficiency in detecting temporal changes. In order to reduce analytical costs, the fish will be composited using five fish of similar size per sample. Thus, 24 composite samples representing 60 individual fish of each of two species will be obtained from each station (120 fish total).

4. Frequency and time of year sampled. All fish are collected annually during the fall (September-November) of the year. The selection of fall is based upon considerations of ease of sampling and comparability of incorporation of past programs. If, after continual review and evaluation of the program, the Task Forces find that annual sampling is not required to meet the program objectives, consideration will be given to biannual or less frequent sampling.

5. Minimum Ancillary Data (sample documentation)

Collection Site:

1. Lake
2. Station number
3. Latitude and longitude
4. Date of collection
5. Collector (crew or vessel)

Fish and Analytical:

1. Species
2. Mean and range of length and weight (metric) in each composite sample
3. Age
4. Fin clips, if present
5. Date of homogenization
6. Tissue portion analyzed (whole fish, fillet, dressed, etc.)

Contaminants monitored - (Lipid content determined on all samples)

a) All samples:

Organics

DDT and metabolites
Aldrin/Dieldrin

PCBs
Mirex (Lake Ontario only)
Chlordane (α, γ, oxy)
Heptachlor
Heptachlor epoxide
Toxaphene

Metals

Arsenic
Cadmium
Copper
Lead
Chromium
Mercury
Zinc

b) Selected samples will be scanned for organics using best available methods. These scans should include but not necessarily be limited to:

Endrin
Kepone
Lindane
Methoxychlor
Dichlorobenzenes
Trichlorobenzene
(HCBD) Tetrachlorobenzene
Pentachlorobenzene
Hexachlorobenzene
p-Bromoanisole
Chlorinated Napthalene
Methylnapthalene
Chlorinated Terphenyls
Trichlorophenol
Pentachlorophenol

Tetrachlorophenol
Tetrachloroethylene
Chlorinated Styrenes
(Octa Poly)
Hexachlorobutadiene
p-BHC (Benzene Hexachloride)
(BHC 1,2,3,4,5,6-Hexachlorocyclohenance)
Polybrominated Biphenyls
Polynuclear Aromatic Hydrocarbons

This list of contaminants monitored will change with time as current problem contaminants are reduced and new contaminants discovered. Appendix E (1983) provides a list of other known or potential contaminants that will be given consideration for routine, specific analysis on all samples if methodology permits and the analysis is appropriate.

6. Data quality assurance. A program of approximately 50% quality assurance will be maintained within the program. This will consist of routine and frequent (daily in most cases) use of intralaboratory check samples, spike recoveries, confirmatory analyses, and interlaboratory check samples.

7. Sample archive. A representative sample from each station will be preserved for future reference. The sample will consist of a homogenate of aliquots of samples representing the 25 largest lake trout or walleye collected at each station.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: FISH

WATERBODY: Lake Ontario

1984.09.12

CHAPTER 11
FISH

BASIS FOR CONCERN

The levels of contaminants in fish are studied for four basic reasons:

1. To determine the impact or the potential for impact on human health (Chapter 3).

2. To determine the effects of contaminants on the health of fish (Chapter 16).

3. To determine the effects of contaminants on the structure of the biotic community, of which fish are an integral component (Chapter 24).

4. To establish the presence and distribution of contaminants in the Lake Ontario ecosystem and to track changes with time (this chapter).

Fish are one of the best biological monitors of the Lake Ontario ecosystem. Various species of fish utilize the entire food chain from the micro and macro plankton, through the invertebrates and vertebrates (particularly other fish) up to the largest top predators (e.g. salmonids, bass, and pike). As the various components of the food chain are ingested by fish, much of the contaminants found in the food is retained by the fish, for fish are one of the most effective accumulators or biomagnifiers of contaminants in the aquatic system. Thus, the bigger and/or older fish provide the best contaminant monitor and a living documentary of the history of many contaminants in the lake.

As analytical methodology has improved, the number of non-natural chemicals identified in fish has expanded greatly. As recently as 1970, the number of chemicals reported in Lake Ontario fish was less than one dozen. In

1984, the number reported in Lake Ontario fish exceeded 300. However, the effects of the vast majority of these contaminants on the Lake Ontario resource, at the concentrations observed, have not been adequately addressed. To further complicate the issue, the accumulative, synergistic, and additive impacts, either positive or negative (sometimes one chemical will negate the effects of another) from two or more contaminants at low levels of concentrations are not known.

The introduction to Chapter 7 provides an account of the consequences of introducing a contaminant into the Lake Ontario ecosystem and the accumulation of mirex in fish. Fish provide an undesirable source of mirex and the other contaminants for creatures who eat them, such as other fish, aquatic scavengers (i.e. crayfish), amphibians, reptiles, birds (Chapter 13), and mammals (Chapter 14), such as man (Chapter 3). Therefore, contaminant levels in fish are of critical concern not only to fish, but to practically all users of Lake Ontario's aquatic resources.

Annex 1 of the 1978 Agreement establishes objectives for both persistent and non-persistent toxicants, and Annex 12 specifies that monitoring be established for those toxicants, in order to identify spatial and temporal trends. Thus, the study of fish is an integral component of this Plan.

In order to most effectively study fish in the ecosystem, one needs to first understand the life histories of the important individual fish species and also how these histories relate to either localized, regional, or lakewide fish communities in Lake Ontario. This includes:

1. Migratory habits. Do the fish stay in a limited (local) area throughout their life cycle, stay within a single basin of the lake (regional), or do they wander lakewide and beyond?

2. Feeding habits. Where do fish start feeding in the food chain? Are they plankton feeders, a predator or prey species, or both?

3. What are their spawning habits? Do they stay within the lake? Are they anadromous and move into streams to lay their eggs like salmon? Are they catadromous and move out to sea to spawn like the American eel?

The answers to these questions are available. This information is important for determining what, how, and when fish species should be sampled and analyzed for an effective ecosystem contaminant monitoring program.

The contaminants to be monitored and in which fish species is also a major consideration. However, scientists have considerable prior experience in monitoring contaminants in Lake Ontario fish and, thus, have the scientific basis upon which to develop practical long-term fish monitoring programs for a number of contaminants now under surveillance with the goal of determining compliance or non-compliance with the Agreement objectives. However, there are many other emerging or known, but unstudied, contaminants in the lake. This chapter describes a mechanism for general monitoring of fish stocks to address both chemicals of known concern as well as previously unstudied and/or new chemical compounds as they are identified in fish. Of necessity, the emphasis is on those compounds of known impact on the aquatic ecosystem and for which a historical data base exists. However, the chapter also describes a monitoring program for other chemicals known to be present, as well as a program to identify previously undetected or new chemicals.

It is suggested that the fish sampling and storage operations for this chapter also include those needs for the entire Lake Ontario surveillance program. Some species of fish that do not "school" are only available in adequate numbers and size at certain times of the year, usually at spawning time and location. A standard policy of collecting additional fish for emergency needs if time, funding, and storage space is available, should alleviate the common problem of inadequate fish samples, particularly when a new crisis arises.

PROJECT DESCRIPTION AND DESIGN

An extensive data base exists for a limited number of chemicals in fish. This data base was initiated with the analyses of DDT in the 1960's (5), mercury from 1969-71, and PCB in the early 1970's (2). The discovery of mirex (1) and 2,3,7,8-TCDD (dioxin) (4) has caused expansion of the data base. Other organochlorine pesticides have also been routinely monitored. Table 1 presents a summary of recent data for selected chemicals and fish species.

This surveillance program was designed to address known contaminants, but it also incorporates a means to examine new chemical compounds through expansion of a standard protocol to fit local, regional, or lakewide fisheries contaminant issues. Chemicals for which surveillance and monitoring will be considered will be drawn from several sources, for example, the list developed by the Human Health Effects Committee (6) and the report of the Niagara River Toxics Committee (7). These contaminants, as well as radionuclides, should be considered when finalizing the surveillance and monitoring targets in this element of the Plan.

There has been considerable cooperation and some coordination by the agencies most deeply involved in identifying the contaminant levels in Lake Ontario fish related to human health issues. Those agencies are the New York Department of Environmental Conservation, the New York Department of Health, the Ontario Ministry of Natural Resources, the Ontario Ministry of the Environment, the Ontario Ministry of Labour, the Canada Department of National Health and Welfare, and the U.S. Fish and Wildlife Service. Numerous academic and private laboratories and others have also been involved.

To meet the objectives of the program described in this chapter, the chemical analyses will be performed on whole fish, as opposed to fillets (Chapter 3), for which the principal objective is to address human health concerns. This will necessitate a somewhat different sample storage and preparation procedure for the programs described in this chapter, as compared with those described in Chapter 3.

The fish monitoring program described in this chapter must be conducted in conjunction with the program described in Chapter 3. In addition, the program must be coordinated with other components of the Plan, especially for consideration of the physical habitat (Chapter 25) and structure of the biological community (Chapter 24), in order to provide the desired ecosystem perspective. It will also help to reduce duplication and to cut costs and effort.

Certain other observations and options must a[illegible] recognized, in order to put the overall issue of fish contaminant surveillance, as it relates to the health of the aquatic ecosystem, into proper international perspective. These are:

1. The fish sampling and laboratory procedures employed by the Lake Ontario jurisdictions are often different. Each has years of good data that, under current procedures, might not blend easily into one common lakewide surveillance program.

2. At this time (1984), there is considerable merit in continuing the current approaches to fish stock surveillance. Practically and politically, the agencies involved could not make an abrupt change in their programs.

3. There is considerable blending of data among agencies that could become more effective through formalization under this Plan.

4. Quality control of all data is a paramount "must" throughout this element of the Plan.

5. The ultimate program, developed through practical experience, will select the best components (procedures/system) from ongoing surveillance programs, with the goal to finalize a permanent lakewide surveillance and monitoring program by 19[illegible].

Objective and Scope

The objectives are:

1. To measure the concentration, species distribution, and geographic distribution of contaminants known to be present in Lake Ontario fish.

2. To identify the presence and geographic distribution of new or previously unidentified contaminants.

3. To study the long-term changes in the concentration of contaminants in Lake Ontario's fish.

4. To determine if Agreement objectives and jurisdictional criteria, standards, and permit requirements are being met by point source dischargers and to evaluate the effectiveness of waste treatment control.

5. To identify new point sources of known contaminants.

6. To provide samples for achiving, for the retroactive analysis of fish for contaminants identified at a future date.

7. To provide fish specimen needs for all components of the Plan.

This project provides a generalized outline of a flexible study protocol which can be implemented for one or several fish species for local to lakewide fish populations. The determining factor for the scope of work is the perceived magnitude of the potential chemical contaminant problem. This sampling and analysis regime may be modified by the input of new data; thus, an iterative process is established to address the specific dynamic nature of a perceived problem. The scope of this element of the Plan includes consideration of the following factors.

Surveillance Area

The surveillance (sampling) area includes all of Lake Ontario and its tributaries up to the first barrier which is impassable to fish, except the Niagara River, which is included in the Surveillance Plan for the Niagara River. Samples may also be collected above the fish barrier to help identify suspected upstream sources of contaminants. Sampling sites are selected for areas with known sources of contaminants, known major fishing areas (commercial and recreational), and where sampling sites for other elements or chapters of this Plan are established in order to develop a practical ecosystem surveillance plan. Sampling sites will also be identified in each of the three basins (eastern, central, and western) of Lake Ontario, as well as at nearshore sites and such other sites as spawning areas, as necessary to meet sampling needs. Emphasis will be placed on lake and tributary sampling sites, to help ensure adequate samples with minimum effort and cost. Figure 1 provides locations of fish sampling sites on the standard Lake Ontario Commercial Fisheries grid map.

Species

Table 2 lists the fish species to be analyzed. The list includes not only species normally used for human consumption but also such non-food species as alewife and spottail shiners. See also Appendix [illegible]

In order to monitor annual changes in contaminant levels in a localized area, as well as to detect new contaminants in that area, short-lived fish species with a limited home range have been included in the monitoring program. The spottail shiner is one such indicator species. Reference (3) details the use of these fish by Ontario.

Alewife and smelt are the major forage species for salmon and trout, as well as for several other predator species. The contaminant levels in alewife and smelt determine, to a large degree, the bioaccumulative levels in the salmon and trout. Undoubtedly, the levels of contaminants in the plankton and invertebrates, as well as in the fry of other fishes that alewife and smelt feed on, determine, to a large degree, the contaminant levels in smelt and alewife. What the impact is from contaminants on the health of invertebrates, plankton, alewife, and smelt is not known, but there has to be some impact on part or all of the fish communities. At least until those relationships can be evaluated, it will be important to continue to monitor all trophic levels of fish species as well as their food supply.

Sample Size

The number of fish required for an adequate samp[illegible] for a similar size of each species may vary from 3 to 30. Generally, a 20 [illegible] sh sample for each size range, in order to produce five fish-composite samples from each sample site, will be adequate.

Cooperation and Coordination

To develop and implement a single long-term surveillance plan for Lake Ontario will require close consideration and cooperation among all involved agencies and with the other components of this Plan. The collection of the right fish species at the right time and in the right place must mesh with other ecosystem sampling needs, such as sediment, water, plankton, and other invertebrates. The Lake Ontario Committee of the Great Lakes Fishery Commission offers a proven unit to develop the fish sampling segment of this Plan. Similarly, the Work Groups and Task Forces o[illegible] International Joint Commission's Water Quality Board could provide such a conduit for the analytical and aquatic ecosystem health components of the Plan.

Flexibility

To maintain a successful surveillance program for Lake Ontario, this Plan must be flexible so that experience will allow revision and updating.

Data Usage

The data will be used to meet the objectives stated above. The data will also be used to help determine fish health status (Chapter 16) and identify possible research needs, particularly in relation to specific contaminants at specific sites that may be causing tumors, and specific contaminants that might impact successful spawning and threaten species perpetuation through natural spawning.

Fisheries management agencies have been mandated responsibility to protect and enhance the fish stocks and habitat under their jurisdiction. Until those agencies have adequate data that show the impact of contaminants on the health of fish populations, they will not be able to make accurate determinations as to what levels, if any, fish can contain without damage to their health. Such information will also be important in revising Agreement objectives and jurisdictional standards and criteria.

Monitoring Network Design and Rationale

The monitoring network design and rationale described in Chapter 3 is generally applicable to this chapter.

Only conceptual descriptions are provided. Detailed requirements for this component of the Plan will be developed which will outline step-by-step procedures for fish sampling, processing, data recording, transport, and storage of the specimens; laboratory preparation for specimen analysis and quality control; and data management (i.e. recording, evaluation, computerized storage, custody, and reporting). These requirements will be compared with the monitoring programs presently in place in the jurisdictions in the Lake Ontario Basin, in order to determine the extent to which they can be met by these present jurisdictional programs.

The detailed program, when developed, will also identify specific chemical parameters and monitoring frequency.

Most of the current Lake Ontario surveillance and monitoring programs have developed from agencies' responses to human health crises which have resulted when contaminants have been found at above-acceptable levels in certain Lake Ontario food fish. The experience gained has been invaluable in developing sampling, storage, and laboratory (analysis) protocols, but there is still much to be learned and perfected before the monitoring system(s) becomes standardized on a lakewide basis.

OTHER CONSIDERATIONS RELATED TO DEVELOPMENT OF THIS COMPONENT

Other considerations pertinent to the development of this component of the Plan are identical to those described in Chapter 3, please refer.

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7. Report of the Niagara River Toxics Committee, to be released in late 1984.

TABLE 1

SUMMARY OF RECENT DATA FOR SELECTED CHEMICALS IN SELECTED FISH SPECIES FROM LAKE ONTARIO

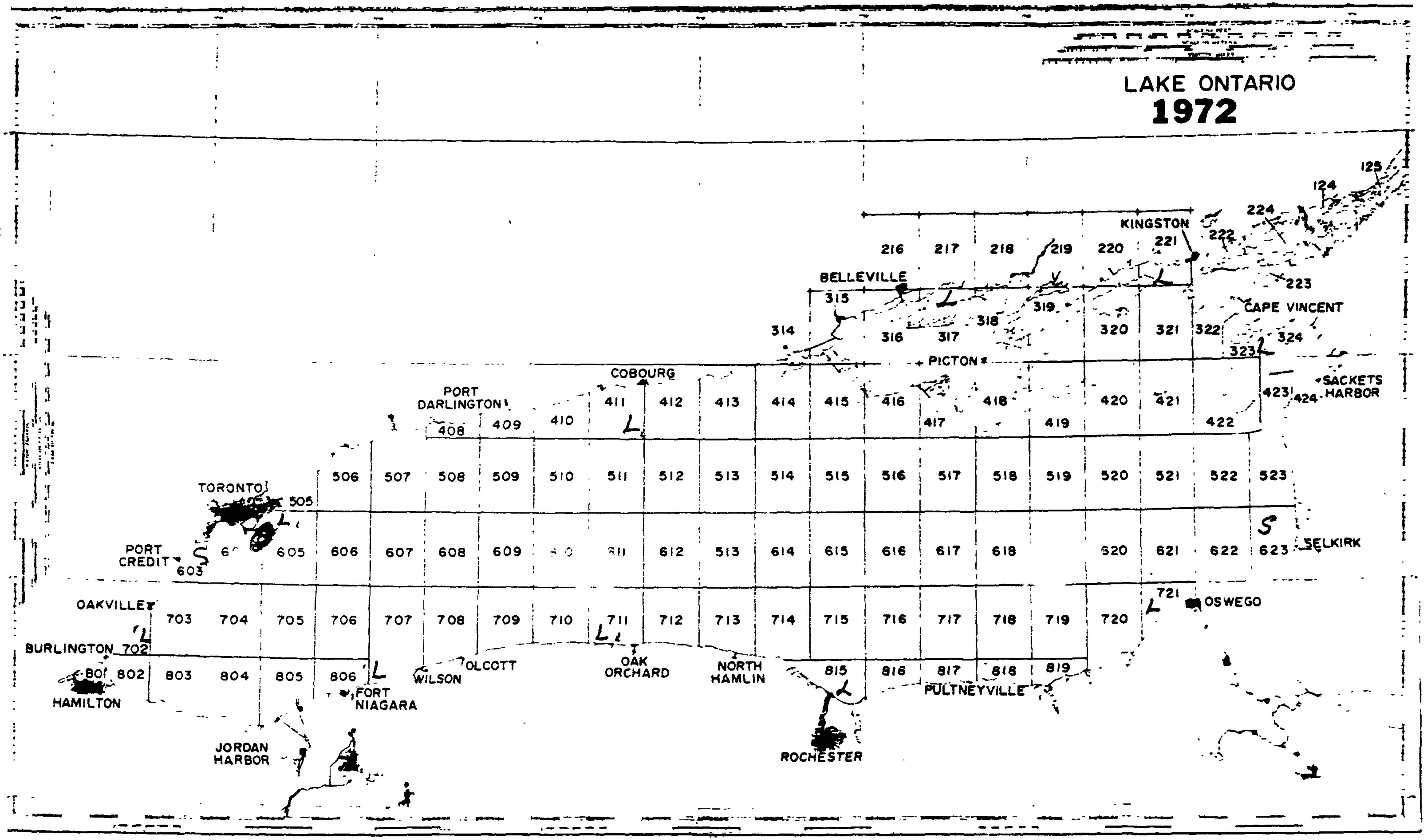
(To be provided)

TABLE 2

FISH SPECIES FOR WHICH CHEMICAL ANALYSES
WILL BE CONDUCTED

(To be provided)

FIGURE 3-1: Locations of n Collection Sites for *Aquatic Ecosystem [illegible]* Analyses Needs.



L. = localized species sampling sites
S. = Salmon/lakewide species sampling sites
R. = Regionalized species sampling site

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Wildlife

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: WILDLIFE

WATERBODY: Lake Huron

TABLE 1

ISSUE: CONTAMINANTS

ECOSYSTEM	OPERATIONAL COMPONENT	NECESSARY	SAMPLING MEDIA	VARIABLES TO BE SAMPLED
INPUTS	1. ATMOSPHERE	Yes	Water	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, aldrin, dieldrin, chlordane, DDT & metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide
	2. TRIBUTARIES	Selected ones only	Water, Sediments - Suspended and Bottom, Biota	Specific, depending on media being sampled
AREAS OF EFFECT	3. OPEN LAKE	Yes	Water, Sediments - Suspended and Bottom, Fish, Biota	As, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Se, Zn, Mn, PCB, toxaphene, a-BHC, b-BHC, dieldrin, DDT and metabolites, methoxychlor, endrin, heptachlor, heptachlor epoxide, chlordane, PCDD, mirex, community structure
	4. NEARSHORE	Yes	Spottail shiners, caged clams, attached filamentous algae	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, PCDD, selected metals
	5. AREAS OF CONCERN	Yes	Water, Sediments - Suspended and Bottom, Biota	Area speci[illegible] lists, should include some of the ab[illegible]ariables
	* 6. WILDLIFE	Yes	[illegible]ull eggs	Above list & chlorinated benzenes, chlorinated styrenes
OUTPUTS	7. WATER INTAKES	Yes	Water, Suspended Sediments	PCBs, organochlorine pesticides, chlorinated aromatics, chlorinated phenols, selected metals
MISC.	8. RESEARCH	Yes	Water, Sediments - Suspended and Bottom, Biota	To be specified in project design

3.5 AREAS OF EFFECT - WILDLIFE

3.5.1 INTRODUCTION

The surveillance plan outlined to this point addresses the lake and its aquatic biota as the focus of impact. While valid, this does not, however, entirely summarize impacts and conditions within Lake Huron and its basin. Effects on wildlife are equally of concern within the basin and the vector of impact may not solely be the lake and its tributaries. Wildlife population migrations and feeding patterns are not restricted to watershed boundaries. However, the condition of these populations does reflect overall quality of the environment.

3.5.2 HERRING GULL EGGS

OBJECTIVES

To determine contaminant levels in gull eggs and provide biological data as a measure of long-term trends of contaminants burdens and their effects on the gull population of the Lake Huron ecosystem.

RATIONALE

The Herring Gull has proven to be an extremely reliable and effective monitor species for the evaluation of water quality trends and the identification of emerging problems (as specified in Annex 11). Trend data are available annually since 1974 and emerging problems are often first noted in this top-of-the-food web predator where contaminants accumulate to a greater degree than in most other biota (e.g. dioxin was first found in the Great Lakes in gull eggs).

DESIGN

To sample and analyze, individually, eggs of Herring Gulls for persistent toxic substances and to search for biological eff[illegible] of these compounds in gull populations.

a) Sampling locations are noted on Figure 8.

b) Sampling will consist of one visitation (April/May) for collection of 10 eggs for contaminant analysis, and 2-3 visits for biological/population parameters.

c) The following parameters have been selected for analysis: Hg, Pb, PCB, DDT and metabolites, HCB, dieldrin, mirex, chlordane, toxaphene, heptachlor epoxide, chlorinated benzenes, α- and β-BHD, PCDD, chlorinated styrene, endrin and lindane.

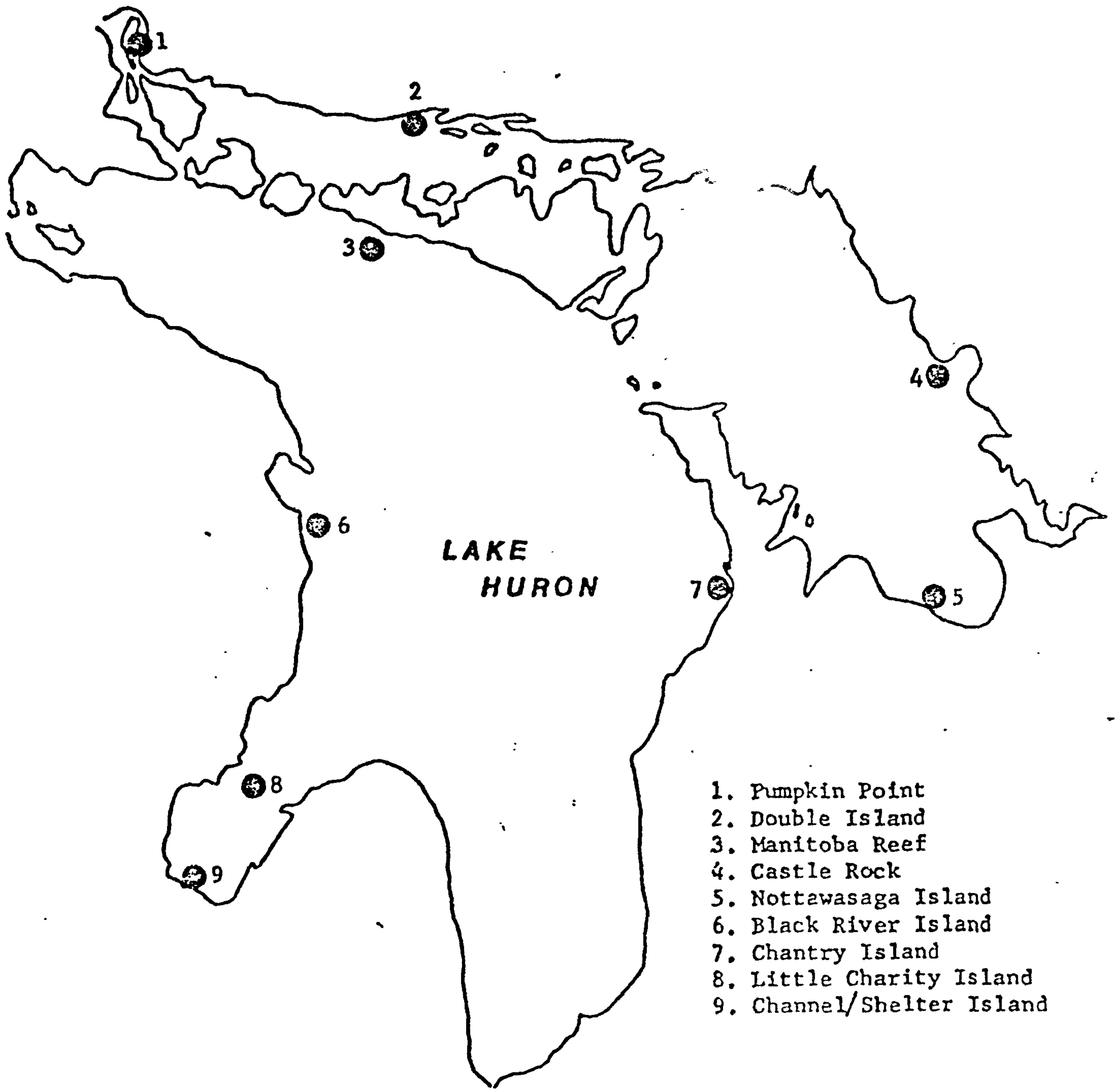
Data Quality - the responsible agency wi[illegible]ure that adequate quality control is built into the program

Reporting - all data will be reported within 18 months of collection in the form of an interpretive report.

Archive samples will be retained in the tissue bank for possible future analyses.

RESPONSIBILITY

Environment Canada (Canadian Wildlife Service) and U.S. Fish and Wildlife Service where appropriate.



1. Pumpkin Point
2. Double Island
3. Manitoba Reef
4. Castle Rock
5. Nottawasaga Island
6. Black River Island
7. Chantry Island
8. Little Charity Island
9. Channel/Shelter Island

FIGURE 8

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: WILDLIFE

WATERBODY: Lake Erie

Herring Gull Eggs

Since 1974, the Canadian Wildlife Service has analyzed herring gull eggs collected from two nesting colonies in Lake Erie. Eggs from the Pt. Colborne Lighthouse vicinity and Middle Island have been routinely analyzed for DDE, DDT, Dieldrin, HCB, mirex and PCBs. This activity should be considered an essential component of the surveillance and monitoring program for all the Great Lakes and continue without change through at least 1986.

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: WILDLIFE

WATERBODY: Lake Ontario

1984.09.27

CHAPTER 13
AVIAN POPULATIONS

BASIS FOR CONCERN

In the early 1970's, reproductive success of herring gull colonies on Lake Ontario was essentially zero. Failure of eggs to was attributed to the very high levels of chlorinated hydrocarbons accum by this species. Herring gulls were reproducing normally in most other lakes, which had lower levels of contamination. Only Lake Michigan appeared to have problems of similar magnitude.

Levels of PCB in Lake Ontario herring gulls in the early 1970's were in the order of 200-300 mg/kg fresh weight, which is 0.25% of the lipid weight.

Other species of fish-eating birds in Lake Ontario were also affected. For example, common terns were found with a high incidence of congenital abnormalities (crossed bills), and cormorants disappeared from the lake, presumably because of the sensitivity of this species to egg shell thinning from DDE contamination.

The herring gull was thought to have the highest levels of contaminants because it is the only species of fish-eating bird which did not migrate. Recent information has shown that herring gulls from the ice-covered Great Lakes move south to Lakes Erie and Ontario for a few months in the winter, but that breeding adult birds in Lake Ontario and Lake Erie remain on their lakes year round. Recruitment to these lower lake populations was also found to be low.

Monitoring of chlorinated hydrocarbon contamination in gull eggs began in 1968 because of reproductive failure, and formally became part of the Water Quality Agreement Surveillance Program in 1973. At that time, 10 eggs from each of two colonies in each of the five Great Lakes were analyzed, and reproductive success monitored on all colonies. The program has continued unbroken since that time, and this decade worth of data constitutes the largest set of historical information on contaminants in Lake Ontario.

Reproductive success improved dramatically in the period from 1973 to 1975, and has remained normal since that time. Trends of levels of all contaminants were down, with a half-life in the order of two to three years until approximately 1980, when levels ceased to change. In the last two years, there has been a slight increase, which may be due to random oscillations, or which may signal a real increase in contaminant flux to Lake Ontario.

The value of the herring gull egg as a monitoring tool was shown for the recently discovered 2,3,7,8-TCDD contamination problem in the Great Lakes. Analysis of pooled samples showed conclusively that Lake Ontario was the most contaminated lake, and analysis of archived samples from the Canadian Wildlife Service National Specimen Bank showed a decreasing trend from the early 1970's exactly paralleling that of the other contaminants.

Preliminary models using the herring gull data have successfully predicted chemical contaminant concentrations in alewives and rainbow smelt, common food items of the gull. The gull has been an effective contaminant trend monitoring tool and predictor of future contaminant levels through use of observed depuration rates. In addition, the program is relatively inexpensive and easy to conduct, thus adding to the desirability of maintaining the program.

PROJECT DESCRIPTION

Objectives and Scope

1. To monitor trends in chemical contaminant concentrations found in Lake Ontario herring gulls.

2. To identify the presence of "new" chemical compounds in the Lake Ontario drainage.

3. To assess the health and well being of herring gull populations on Lake Ontario as an indicator for other fish-eating bird species occurring on the lake.

Data Usage

The data may be used to direct future monitoring efforts in other species of aquatic fauna, as well as to provide a basis for instituting contaminant control measures at their source(s). The informati[illegible] also useful for providing public information on progress of contamin[illegible]ontrol.

Monitoring Network Design and Rationale

The herring gull's catholic eating habits, particularly its preference for consuming fish, make it a prime study candidate for examining chemical contaminants in the Lake Ontario ecosystem. It is well known that the major source of chemical contaminants from water-borne sources for predators and scavengers is through consumption of fish. The long history of chemical contaminant data on the species (since 1968) adds to the desirability for continued surveillance. This project provides for surveillance of herring gulls from selected locations on an annual basis for specific chemical compounds.

The sampling strategy involves collection of 10 [illegible]rring gull egg samples from two colonies on Lake Ontario (Mugg's Island and Snake Island - See Figure 1) during April/May of each year for chemical analyses. Following egg collection, the relative success of gull colony reproduction is examined on each colony through measurements of egg clutch size (at time of initial visit), mortality or morbidity during and following hatching, the rate and types of abnormalities observed, and rate of fledgling production. The latter measurements are made in future visits to one colony (Snake Island) in late spring/early summer of each year.

Monitoring Variables

The variables measured during gull colony site visits are outlined in the monitoring network design above. Chemical surveillance on herring gull eggs includes analyses for the compounds given in Table 1 on an individual egg basis from Mugg's Island and Snake Island. A detailed statistical analysis of existing data is being carried out, and the sampling design may be modified in 1985 to maximize information obtained and minimize cost. This may be achieved by analyses of pooled samples of ten or more eggs per colony, taken on one sampling date.

For pooled samples from each colony, determine the concentrations of the compound complexes given in Table 2. Other specialized chemical analyses may be conducted through use of GC/MS or other techniques on these samples and on samples which are archived. The purpose of these analyses would be to detect the presence of "new" or previously unreported chemical compounds. The additional chemical parameters for which analyses will be considered will be drawn from several sources, including:

1. The list of chemicals developed by the Human Health Effects Committee and published in the "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Ecosystem," held in March 1982.

2. Other chemicals identified by the Human Health Effects Committee, as published in their annual reports.

3. Chemicals identified as the result of studies conducted under the auspices of the Niagara River Toxics Committee.

<u>Analytical Methodologies</u>

Analytical methodologies should be those published in standard techniques manuals or published methods which have undergone peer review and acceptance, e.g. methods in the Journal of the Association of Official Analytical Chemists. During chemical analyses, quality control including blanks, replicate samples, and spiked samples should be conducted at a recommended rate of 15% of samples analyzed for standard compound analyses. A higher rate of quality assurance may be required for specialized analyses.

Sampling Procedures

Random selection of egg samples from each colony is required. No more than one egg from each clutch is removed. Samples are chilled and later frozen to prevent sample deterioration.

Sample Custody

At each site, collection and data records must [illegible]aintained. Samples are individually packaged to prevent breakage in shipment [illegible] are labelled to include sampling data, sample location, collector's name, and identifying number. Continuity of evidence forms should accompany all samples from the point of collection to the laboratory and document any change in custody during that period. Standard laboratory operating procedures require maintenance of sample logging to document receipt and handling of all samples received.

Calibration Procedures and Preventative Maintenance

To be provided.

SCHEDULE OF TASKS AND PRODUCTS

See Table 3.

PROJECT ORGANIZATION AND RESPONSIBILITY

Environment Canada (Canadian Wildlife Service) and U.S. Fish and Wildlife Service, where appropriate.

PROJECT FISCAL INFORMATION

All costs for the project outlined are summarized in Table 4.

TABLE 1

CHEMICAL ANALYSES FOR INDIVIDUAL EGGS FROM MUGGS ISLAND AND SNAKE ISLAND

CHEMICAL	RECOMMENDED DETECTION LIMITS (μg/kg)	SMALLEST REPORTABLE INCREMENT DESIRED (μg/kg)
PCB	50	
BHC isomers	10	
Mirex	10	
Photo-mirex	10	
DDT and metabolites particularly p,p'-DDE	10	
Heptachlor epoxide	10	
Oxychlordane	10	
Dieldrin	10	
Tetra chlorobenzenes	50	
Penta chlorobenzenes	50	
Hexachlorobenzene	10	
Mercury	10	

TABLE 2

CHEMICAL ANALYSES FOR POOLED EGG SAMPLES FROM EACH HERRING GULL COLONY

CHEMICAL GROUP	RECOMMENDED DETECTION LIMITS	SMALLEST REPORTABLE INCREMENT DESIRED
Chlorinated dioxins	5 ng/kg for 2,3,7,8-TCDD	
Total organic chlorine	To be determined	
Total organic bromine	To be determined	
Chlorophenols	To be determined	
Chlorostyrenes	To be determined	

le 3 Schedule of tasks for the herring gull contaminant surveillance project.

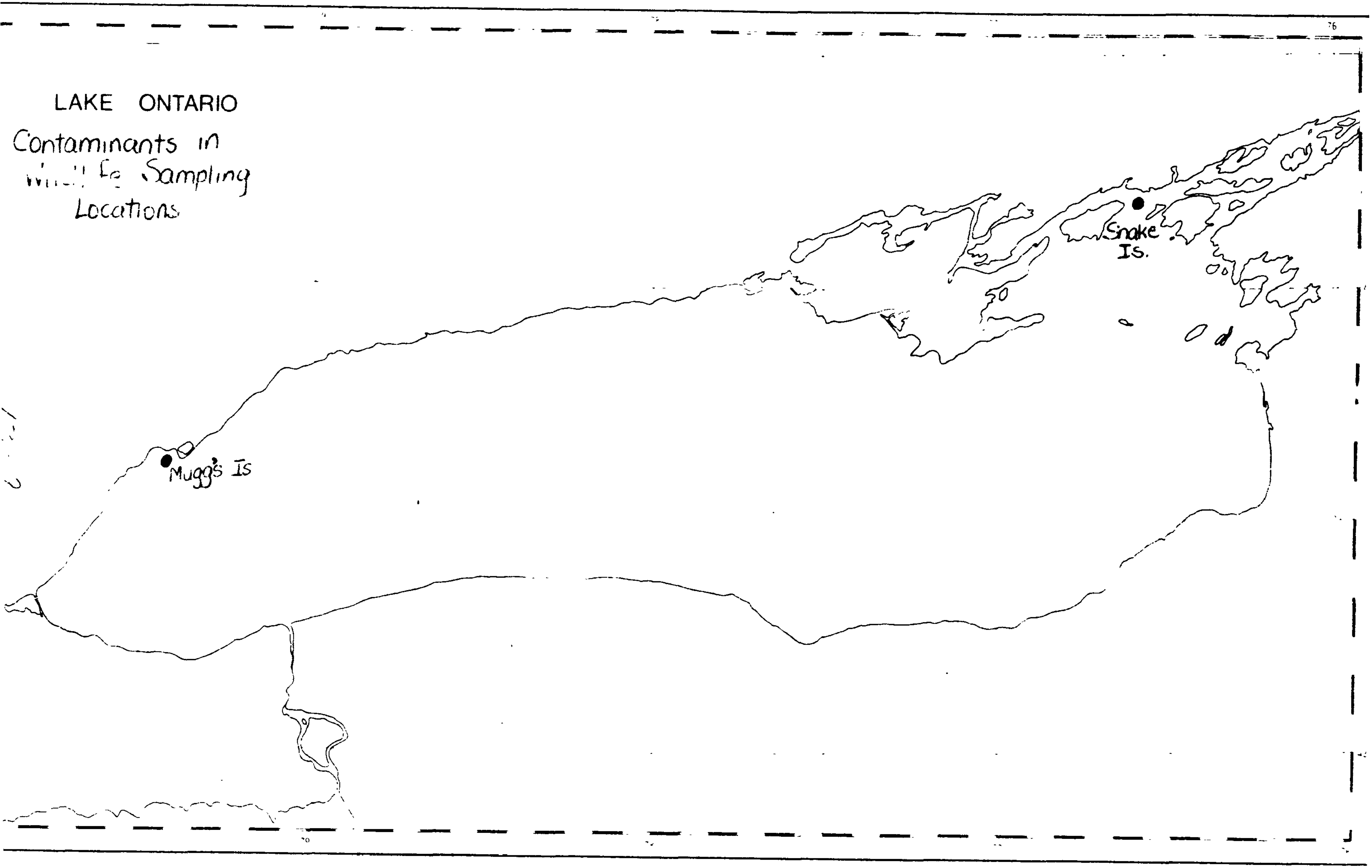
CTIVITY/DATE	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
ample collection	1——	——1										
eproductive status data collection	1——	————	————	——1								
hemical analyses												
Individual eggs		1——	————	————	——1							
Composite samples				1——	————	————	————	——1				
ata analyses and reporting								1——	————	——1		

TABLE 4

SUMMARY OF PROJECT COSTS

TASK	COST($)
Sample collection and transport	400
Reproductive status data collection	1,600
Sample preparation and chemical analyses	
Individual eggs	6,500
Composite samples	5,000
Data analyses and reporting	1,200
Specimen banking (20 years)	1,200
TOTAL	15,900

Figure 1


LAKE ONTARIO
Contaminants in
Sampling
Locations
Snake Is.
Mugg's Is

1984.09.27

CHAPTER 14
MAMMALIAN POPULATIONS

BASIS FOR CONCERN

Chemical contaminants in water affect not only fish and other aquatic life contained therein, they may also affect consumers of fish and aquatic invertebrates as well. Chapter 13 addresses herring gulls as one primary fish consumer. The mammalian realm is addressed by the following surveillance protocol.

Reproduction of mink has been adversely affected by polychlorinated biphenyl (PCB) concentrations as low as 0.64 mg/kg in the diet (Henny et al., 1980; Platnow and Karstad, 1973) and was primarily related to Aroclor 1254 (Aulerich and Ringer, 1977). However, reproductive impairment was not permanent; once feeding on foods containing PCB ceased, at least partial reproductive capacity returned (Aulerich and Ringer, 1977). The toxicity of PCB to mink varied inversely with chlorine content (Aulerich et al., 1973; Aulerich and Ringer, 1977). Concentrations of Aroclor 1254 as low as 10 mg/kg produced retarded growth (Aulerich et al., 1973).

DDT in combination with PCB has also produced reproductive impairment in mink (Jensen et al., 1977).

In livers of female mink, PCB residue levels up to 2.4 mg/kg have been reported, with average concentrations of 1.4 ± 0.37 mg/kg in Maryland mink. The elevated PCB levels are comparable to residue levels which produced reproductive failure in ranch mink. Henny et al. (1980) notes mink populations in the lower Columbia River system appear to be declining and speculates a link with elevated PCB levels found in that system.

In livers of wild mink from the northeastern United States, mercury levels averaged 0.73 ± 0.47 mg/kg (O'Connor et al., 1980). While no data were available on impacts to mink, they noted dietary mercury levels of 2.0 mg/kg methyl mercury were lethal to river otter.

The contaminant levels reported to cause reproductive and growth impairment in mink are particularly pertinent to Lake Ontario. Residue levels of Aroclor 1254 in standard fillets from coho and chinook salmon caught from the Salmon River averaged, respectively, 9.31 and 6.98 mg/kg in 1975 and 7.50 and 4.15 mg/kg in 1979 (Spagnoli and Skinner, 1977; NYSDEC, 1981). Further declines in PCB are indicated for salmon collected in 1982; however, contaminant levels remain above those thought to affect mink. Chemical analyses of 1983 fish collections, including salmon and alewives, are underway.

Reproductive failure of ranch mink fed a 30% diet of Lake Michigan coho salmon (containing PCB and other chemicals) has been reported by Platnow and Karstad (1973) and Aulerich et al. (1973). In initial studies by the New York State Department of Environmental Conservation of mink in the Lake Ontario watershed, collection of mink within a limited distance of the lake has been almost impossible, although historically mink were common (R. Foley, personal communication).

PROJECT DESCRIPTION

This project is an outgrowth of projects currently underway by the New York State Department of Environmental Conservation and the Canadian Wildlife Service. Whether this project should be included in this Plan is dependent on the results of chemical analyses currently being undertaken (Spring 1984). A tentative project description is offered below.

Objectives and Scope

1. To describe relative concentrations of selected contaminants in trapped mink from environments having known food source chemical contamination levels.

2. To attempt correlation of environmental contaminants to reproductive impairment of wild mink populations.

Data Usage

The findings from initial studies being conducted by the above mentioned agencies will be used to assess whether the objectives can be met and, if so, to describe to what extent. Future efforts, if they are undertaken, are dependent upon this initial work.

Monitoring Network Design and Rationale

The potential impairment of wild mink reproduction and growth as outlined above is the major thrust of this protocol. Certain characteristics of mink cause them to be particularly suitable for examination. As a predator and scavenger,

1. Mink maintain a relatively high position in the food web.

2. Mink have a relatively limited home range.

3. Mink consume fish and shellfish as parts of their normal diet. Thus, specimens taken near the Lake Ontario shoreline or major tributaries are likely to have been exposed to elevated chemical contaminant levels which originated from Lake Ontario.

However, due to mink sensitivity to certain chemical pollutants, population impairment along the Lake Ontario shoreline and major tributaries may already have occurred. This is suggested since New York's collections in 1982 and 1983 within five miles of Lake Ontario produced only two animals. Thus, current collections may reflect only animals originating from upland sites.

Due to personnel limitations, the most productive use of agency personnel time is based on use and coordination of trapper collections of wild mink. This may be supplemented by use of professional time to augment collection efforts where trapper pressure is low. Collections should be made within the township bordering Lake Ontario or any major tributaries where migrating fish are present. Mink specimens should be females of similar age, preferably adults; it is recognized that this may be the most difficult group to collect. Suggested sample sizes for each jurisdiction are dependent upon results of preliminary studies currently underway. Sampling frequency is to be determined, although annual collections are the most frequent that could be anticipated.

Skinned carcasses will be sent to the analytical laboratories. Care must be taken by the trapper to avoid surface contamination of the carcass. Therefore, trappers are requested to skin their animals over aluminum foil, then wrap the samples in clean aluminum foil and attach labels with collection date, location of collection (including distance from the lake), and their name. Trappers would then freeze the samples and call personnel in charge of collections to pick up the sample.

Female mink were selected since reproductive effects are most apparent for that sex when exposed to Aroclor 1254. Sperm motility in males is apparently unaffected by PCB concentrations up to 30 mg/kg in the diet (Aulerich and Ringer, 1977; Aulerich et al., 1973).

Monitoring Variables

The following variables should be included on collection records at the time of sample collection:

Date of collection
Location of collection (include mapped location)
Sample identification
Species and sex
Trapper identification and address
Date of sample pick up
Person picking up sample
Condition of sample

All samples should be aged and ages recorded on the collection sheets. Each individual sample should have its reproductive status determined and recorded, including number of corpora lutea and number of placental scars.

Chemical analyses should be conducted on several organs including brain, liver, rear leg muscle, and combined fat from mesenteries and renal structures. Table 1 lists the chemicals to be analyzed for, along with respective detection limits.

Additional chemical parameters for which analyses will be considered will be drawn from several sources, including:

1. The list of chemicals developed by the Human Health Effects Committee and published in the "Proceedings of the Roundtable on the Surveillance and Monitoring Requirements for Assessing Human Health Hazards Posed by Contaminants in the Great Lakes Ecosystem," held in March 1982.

2. Other chemicals identified by the Human Health Effects Committee, as published in their annual reports.

3. Chemicals identified as the result of studies conducted under the auspices of the Niagara River Toxics Committee.

<u>Analytical Methodologies</u>

Sample analyses will be conducted by standardized techniques which have received peer review and have been published.

<u>Sampling Procedures</u>

Mink collection is by trapper harvest, and supplemented by collections by wildlife agency staff. Special handling by trappers and the records required are both described above. Specific samples for chemical analysis shall be prepared by or under the direction of the project coordinator.

<u>Sample Custody Procedures</u>

All samples must be accompanied by sample collection record forms and continuity of evidence from the time of sample pick up to delivery at the laboratory. Laboratories are required to maintain records for sample logging, storage, security, and handling during chemical analyses.

Calibration Procedures and Preventative Maintenance

To be supplied.

SCHEDULE OF TASKS AND PRODUCTS

See Table 2.

PROJECT ORGANIZATION AND RESPONSIBILITY

New York State Department of Environmental Conservation and Environment Canada (Canadian Wildlife Service), as appropriate.

PROJECT FISCAL INFORMATION

All costs for the project are summarized in Table 3.

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TABLE 1

CHEMICAL ANALYSES FOR MINK AND DETECTION LIMITS

CHEMICAL	SUGGESTED DETECTION LIMIT (µg/kg)	SMALLEST REPORTABLE INCREMENT DESIRED (µg/kg)
Mercury	10	
Cadmium	10	
Lead	10	
PCB (by Aroclor)	20	
Mirex	5	
Photo-mirex	5	
DDT & metabolites	5	
Chlordane (cis + trans)	1	
Dieldrin/Aldrin	1	
BHC isomers	1	
Endrin	4	
Heptachlor	1	
Heptachlor epoxide	1	
Oxychlordane	2	

TABLE 3

SUMMARY OF PROJECT COSTS

TASK	COST ($)
Sample collection and transport	$ 2.0K
Sample preparation and data collection	4.0K
Chemical analyses	
Metals	4.0K
Organics	12.0K
Data analyses and reporting	3.6K
TOTAL	$25.6K

Table: 2 Schedule of Tasks for Wild Mink Contaminant Surve lance.

ACTIVITY/DATE	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Collection and transport of samples	1———	———	———	———	———	———1						
Sample preparation and data collection				1———	———	———	———1					
Chemical analyses					1———	———	———	———1				
Data analyses and reporting								1———	———	———1		

SURVEILLANCE ISSUE

CONTAMINANTS

OPERATIONAL COMPONENT

Acute Toxicity

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: ACUTE TOXICITY

WATERBODY: Lake Huron

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: ACUTE TOXICITY

WATERBODY: Lake Erie

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: ACUTE TOXICITY

WATERBODY: Lake Ontario

1984.09.27

CHAPTER 15
ACUTE TOXICITY

BASIS FOR CONCERN

Many human activities produce waste products that, when added to water, may be deleterious to water usage. Certain wastes, such as pesticides, chlorine, and oil-fractionation products, can produce lethality to aquatic life when added to water in small quantities.

Surrounding Lake Ontario, major inputs of municipal and industrial wastes occur on the Niagara River; Hamilton Harbour, Toronto, Port Hope, and the Bay of Quinte, Ontario; and Rochester, Oswego Harbor, and Eighteen Mile Creek, New York. The Niagara River inputs are the subject of a separate surveillance plan and will not be addressed here.

One basic goal of the 1978 Agreement and the several governments is that effluents to Lake Ontario waters will not contain quantities of chemical compounds in toxic amounts. In addition, persistent accumulative chemical compounds should not be present in quantities which will cause violation of human health and environmental standards for consumption of fish.

PROJECT DESCRIPTION

This project is designed to ascertain the toxicity of individual effluents to waters of Lake Ontario, with particular emphasis on effluents with a high potential for causing lethality to sensitive indicator organisms.

Objectives

1. To determine the toxicity of selected individual effluents to waters of Lake Ontario.

2. To assure that toxic or deleterious substances are not present in quantities which would cause impairment of the water for usage by aquatic life.

3. Where effluent biomonitoring is imposed by permit authorities, provide quality assurance checks on permittee's biomonitoring.

Data Usage

The data will allow attention to be directed by regulatory agencies to the reduction of toxicity of effluents, where appropriate.

Monitoring Network Design and Rationale

The effluents monitored should have a significant probability for containing toxicity, or be of significant complexity that an evaluation by chemical analyses alone will not adequately assess the potential impacts on aquatic organisms. The selections are necessary on a case-by-case basis; however, certain classes of effluents are prime candidates for toxicity testing. These are:

1. Chemical production industries.
2. Fossil fuel processing facilities.
3. Chlorine discharges.
4. Metals production industries.

Monitoring Variables and Frequency of Sample Collection

Monitoring is directed at toxic limits of an effluent; thus, measurements are of lethal concentrations or effect concentrations (as percent effluent) which affects a given percentage of the test population (usually 50%), and given as an LC_{50} or EC_{50}, respectively. Tests would be performed on representative test organisms such as fathead minnow (Pimephales promelas), rainbow trout (Salmo gairdneri) and/or the water flea (Daphnia magna).

If effluent toxicity testing is a requirement in a permit, then only quality assurance testing is required; thus, frequency of testing would be reduced. Where no effluent toxicity testing is required in permits, frequency of sampling will be dependent upon the results obtained. Frequency of monitoring is also affected by the place where the testing occurs. If on-site testing is conducted, a maximum of three effluents can be examined per month. However, if testing is to be conducted in a laboratory, based on grab sampling or 24-hour composite sampling of the effluent, then a larger number of effluents can be examined by the same personnel. Th[illegible]ation of testing is dependent upon the purpose for examination, generally:

1. Laboratory testing - quality assurance or screening of effluent toxicity.

2. On-site testing - definitive toxicity testing.

Sampling Procedures

Procedures for effluent toxicity testing are provided in the report entitled, "Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms" (1), or equivalent methodology should be used.

Sample Custody

Sample custody from point of collection through testing and reporting of results should be maintained, since the results have the potential for use in legal proceedings as well as for modification of discharge permits.

Calibration Procedures and Preventative Maintenance

These activities are provided in Reference (1).

SCHEDULE OF TASKS AND PRODUCTS

Scheduling is dependent upon the results obtained at a given site. If on-site testing is conducted, a maximum of three sites may be examined per month. If laboratory testing is conducted, as many as four or five sites may be examined per week for equivalent personnel time expenditure.

DATA QUALITY REQUIREMENTS AND ASSESSMENTS

Reference (1) provides the procedures necessary to assure data quality.

Documentation, Data Reduction, Data Management, and Reporting

Reference (1) provides guidance for these operations. It is essential that full documentation be obtained both on the laboratory forms necessary to characterize the sample and test results, and in any final reports generated for each site tested.

DATA VALIDATION

Methods are provided in Reference (1).

PERFORMANCE AND SYSTEMS AUDITS

Methods are provided in Reference (1).

PROJECT FISCAL INFORMATION

Estimated costs are dependent upon the purpose and methods used. Approximate costs are provided in Table 1 for one on-site test and four laboratory tests.

DATA INTERPRETATION

To be developed.

REPORTS

Fully written reports are necessary for each site examined for the purpose of definitive testing. However, for quality assurance and screening purposes, less formal reports may be required, provided all information gathered will be reported with interpretation to appropriate personnel and the discharger.

COMMENTARY

Effluent biomonitoring will be incorporated in limited numbers of discharge permits issued to New York State discharges in the near future. New York currently conducts effluent bioassays for toxicity screening purposes and has the capability for on-site definitive toxicity testing (i.e. equipment) but lacks personnel and funding to conduct this effort. In addition, a quality assurance program must be devised to assure discharger's testing methods are appropriate, documentation is completed, and test results are reliable.

The Ontario Ministry of the Environment and U.S. Environmental Protection Agency have conducted on-site toxicity testing at selected sites within the Lake Ontario basin. However, current and planned efforts are unknown.

REFERENCE

1. "Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms," U.S. Environmental Protection Agency, Washington, D.C., January 1978. Environmental Monitoring Series, Report No. EPA 600/4-78-012.

TABLE 1

APPROXIMATE COSTS FOR ACUTE TOXICITY TESTING

COST TYPE	ONE ON-SITE TEST ($000)	FOUR LABORATORY TESTS ($000)
Personnel	2.4	2.4
Travel	[illegible]	0.3
Supplies	0.[illegible]	0.3
Equipment - (amortized over 8 years)	0.3	0.2
TOTAL	4.5	3.2

Note: Indirect costs and fringe benefits are not included.

<u>SURVEILLANCE ISSUE</u>

CONTAMINANTS

<u>OPERATIONAL COMPONENT</u>

Sublethal Effects

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: SUBLETHAL EFFECTS

WATERBODY: Lake Huron

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: SUBLETHAL EFFECTS

WATERBODY: Lake Erie

SURVEILLANCE ISSUE: CONTAMINANTS

OPERATIONAL COMPONENT: SUBLETHAL EFFECTS

WATERBODY: Lake Ontario

1984.09.27

CHAPTER 16
SUBLETHAL EFFECTS

BASIS FOR CONCERN

Mammalian and aquatic toxicology data indicate that many of the organic and inorganic contaminants present in the Great Lakes ecosystem have the potential to impact adversely on all trophic levels. Laboratory toxicological data indicate that the effects include inducement of tumours, papillomas, fin erosion, and skeletal deformities; impairment of reproduction; or interference with a number of biological processes.

The total number of hazardous or potentially hazardous chemicals is uncertain. In its 1982 annual report, the Great Lakes Water Quality Board identified 381 chemicals in the Great Lakes Basin. The Human Health Effects Committee reported that 292 of these 381 chemicals had insufficient biological or human health effects data to assess their potential hazard. An increasing number of previously unidentified chemicals, metabolic by-products, and isomers of previously identified substances can be added to this list. In its 1983 report, "An Inventory of Chemical Substances Identified in the Great Lakes Ecosystem," the Water Quality Board reported [illegible]3 chemicals have now been identified in the ecosystem.

Field studies have reported several observations of impairment, but a direct cause-and-effect relationship between chemical contaminants and biological response has not necessarily been demonstrated. For example, in the early years of the coho program, Black and co-workers found goiter-like tumours that were not cancerous. In recent years, the "tumours in fish" issue has come up again. There is a definite need to monitor such situations to find out if, in fact, such problems are being caused by contaminants.

There is also reason to believe that some declines in fish species, such as spottail shiners (which suffered major population decreases in the late 1950's and the 1960's), were caused at least partially from contaminants. As levels of certain contaminants (DDT, PCB, mirex) decreased in recent years, the spottail shiner population has increased. But, several other adverse habitat problems such as eutrophication have also been reduced due to better control of phosphorus. Any one of such factors or a combination of environmental (habitat) factors may have caused fish health problems.

Burdick and co-workers were the first to show (in 1958) that high levels of DDT and metabolites prevented successful hatching and/or survival of lake trout fry from New York's Lake George, a historic source of Adirondack strain lake trout eggs for state hatchery needs. During the same period, successful, natural lake trout reproduction also stopped in that lake. When the source of DDT was shut off, the levels dropped dramatically and by the late 1970's Lake George once again provided viable lake trout eggs.

Because of the numerous contaminants known to accumulate in the long-lived, high-fat-content lake trout, there were (and still are to some degree) similar concerns over Lake Ontario lake trout capabilities to spawn successfully. Very successful hatching and rearing of lake trout from Lake Ontario eggs in 1982 and 1983 (Schneider, et al.) indicates contaminants are not now a major limiting factor in attaining self-sustaining lake trout stocks from naturally spawned fish from the lake. If contaminant levels continue to decrease in Lake Ontario fish, earlier serious concerns over the impact of contaminants on fish health may be reduced in importance. Continued good monitoring of various fish stocks throughout the lake will be necessary, if accurate correlations are to be made between contaminant levels and the health of individual fish species as well as local and lakewide fish communities.

As noted above, laboratory studies have demonstrated causative effects on biological processes, but there have been few unequivocable field observations to support the laboratory studies. This reflects the critical absence of systematic bio-effects and ecosystem health monitoring programs. The need for such causative information is critical, for instance, for the management of the fishery resource. Impairment of any one component of the food web as a result of chemical contamination (whether it be a reduction in the spawning success of a particular fish species or a change in the food base), can have an impact on individual fish species as well as local and lakewide fish communities. But there has been no concerted, systematic effort to address fish health contaminant-related issues. Systematic bioeffects and ecosystem health monitoring programs will not only indicate the present status of ecosystem health, but will also provide an early warning of adverse contaminant effects at all trophic levels.

There are both immediate and long-term needs for an ecosystem monitoring program. The immediate requirement is to identify existing laboratory and field programs that may contribute information. Ultimately, the long-range objective is to develop a comprehensive effects monitoring program which will assess ecosystem health at the individual, population, and community levels and be sensitive enough to detect contaminant effects before they emerge as crisis issues.

PROJECT DESCRIPTION

Objectives and Scope

The objective is to integrate laboratory and field studies which measure contaminant levels and detect morphological and physiological anomalies at several trophic levels in the Great Lakes ecosystem. This will require:

1. Development and application of a suitable [illegible] of diagnostic techniques which are sensitive to low levels of contaminants, selective to single chemicals (or classes of chemicals), and relevant to individual or population survival.

2. Field testing of laboratory techniques, which have been successfully used in the laboratory or in other species, but have not yet been applied to wild populations.

3. Field observations of stressed populations, when combined with chemical exposure and residue data, can be used to suggest causative agents. However, in many studies, these correlations are the only indicators of contaminant involvement. There is a need to establish protocols for laboratory studies which can confirm the relationship between field observations and chemical exposure.

The ultimate objective, then, is to provide data for the assessment of potential sub-lethal effects on the health of fish and other aquatic organisms.

Direction for these activities should originate from the reports and recommendations of the International Joint Commission's Toxic Substances Committee, Aquatic Ecosystem Objectives Committee, Human Health Effects Committee, and the Surveillance Work Group, as well as from the scientific and research community in both Canada and the United State

Current Activities

A wide range of responses, from biochemical to morphological, can be used to measure sublethal effects. The following examples of current activities are illustrative:

1. Clinical methods for the diagnosis of contaminant effects on fish:

    a. Mixed function oxidase (MFO) activity of Great Lakes fish.
    b. Erythrocyte δ-amino levulinic acid dehydratase activity in lead-exposed fish.
    c. Bone composition and skeletal anomalies of fish exposed to organochlorine compounds.

2. Surveys of the occurrence of pathological anomalies in fish, including epidermal papillomas, gonadal and liver tumors, and thyroid hyperplasia.

PROJECT ORGANIZATION AND RESPONSIBILITY

To date, fish health issues have been considered on an individual basis, i.e. lake trout spawning vs. contaminant concerns, tumours in coho salmon. Some health concerns should be studied from a holistic approach that includes the basic habitats (sediments, water column, vegetation) and the entire food chain from micro-organisms through the top predator species. This would provide a good snapshot in time to document present conditions (habitat quality) as a base to monitor against.

PROJECT FISCAL INFORMATION

The estimated annual cost is $104,000. A breakdown is given in Table 1.

DATA INTERPRETATION

Interpretation of such data should be done by a select group that includes both research and management staff.

TABLE 1

ESTIMATED COST FOR SUB-LETHAL EFFECTS STUDIES

ITEM	COST ($) OPERATION AND MAINTENANCE	CAPITAL
Sample Collection	$5,000	$1,000
Tumour Monitoring	1,500	
Histology Contract	3,000	
Contaminant Bioassays	6,000	2,000
Skeletal Anomalies	5,500	500
Enzyme Assays	4,000	
Dioxin Effects	10,000	5,000
Report Preparation	500	
Salary (2 PY)	60,000	
TOTALS	$95,500	$8,500