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GUIDELINES FOR THE PROTECTION AND MANAGEMENT OF AQUATIC SEDIMENT QUALITY IN ONTARIO

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Ministry of
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GUIDELINES
FOR THE PROTECTION AND MANAGEMENT
OF AQUATIC SEDIMENT QUALITY IN ONTARIO

Report prepared by:

D. Persaud, R. Jaagumagi and A. Hayton
Water Resources Branch
Ontario Ministry of the Environment and Energy

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The background

Contaminated sediment has been singled out as a major environmental problem. The concern is that persistent toxic substances - poisonous substances that take a long time to break down - in the sediment will accumulate in carp, catfish and other bottom-dwelling fish as well as in the bottom-dwelling organisms, such as worms and midges, that live in the sediments. These contaminants may be transferred to fish either because they have fed on the organisms or come into contact with the sediments. These chemicals may be transferred again to wildlife, birds and people who eat the fish. This process, by which organisms can accumulate levels of persistent chemicals higher than in sediments or water, is called biomagnification.

The source

The primary source of contaminants in sediments is toxic chemicals from industrial and municipal discharges of waste water. The runoff from cities, towns and agricultural areas may also contribute to the problem. Other sources include:

- Lakefilling or the practice of creating more land by building up the shoreline with rubble, bricks, stones, concrete and loose earth may also add to the problem unless the fill is free of contaminants.

- Chemicals in factory emissions which, attaching themselves to particles of dust or droplets of water, fall back to the earth in the form of dust, rain, sleet, hail or snow.

The response

The ministry has several programs in place which, either directly or indirectly, tackle the problem of contaminated sediment.

- The Municipal Industrial Strategy for Abatement (MISA) - The aim of the program is to reduce drastically the discharges of toxic chemicals from industry and municipalities either by improving treatment plants or by changing industrial processes so that toxic chemicals are no longer needed.

- The Remedial Action Plan (RAP) Program - The aim of the program is to help clean up the 17 Areas of Concern in Ontario identified by the International Joint Commission as being badly contaminated. The RAP teams have identified contaminated sediment as one of the factors contributing to poor water quality and living conditions for the sediment dwelling organisms - also known as the benthic community.

- Operation Lifelines and the Beaches Improvement Program - The aim of these programs is to help municipalities improve storm water management and reduce the amount of runoff from cities and towns.

- Fill Quality Guidelines for Lakefilling in Ontario - The aim of the guidelines is to protect the quality of the aquatic habitat. The guidelines regulate the quality of fill used, based on the Provincial Sediment Quality Guidelines and the Provincial Water Quality Objectives/Guidelines.

The Sediment Quality Guidelines

The purpose of the Sediment Quality Guidelines is to protect the aquatic environment by setting safe levels for metals, nutrients (substances which promote the growth of algae) and organic compounds.

The guidelines replace the ministry's 1976 Open Water Disposal Guidelines. Those guidelines originally were developed to determine whether or not dredged material was suitable for disposal in open water. Over time their use was expanded to include all aspects of sediment assessment.

The guidelines are designed to help environmental managers - ministry officials and environmental consultants - make decisions on a whole range of issues that affect the quality of sediment. For example, the guidelines will be used by RAP teams to determine which sediments are contaminated and how to manage the problem most effectively.

How the guidelines work

The guidelines establish three levels of effect - No Effect Level, Lowest Effect Level and Severe Effect Level. The Lowest Effect level and Severe Effect Level are based on the long-term effects which the contaminants may have on the sediment-dwelling organisms. The No Effect Level is based on levels of chemicals which are so low that no contaminants are passed through the food chain.

The levels of effect are designed to help environmental managers determine:

- when sediment may be considered clean;

- what levels of contamination are acceptable for short periods of time while the source of the contamination is being controlled and cleanup plans are being developed;

- what levels of contamination are considered severe enough to consider the possibility of either removing the sediment or covering it with a layer or two of cleaner sediment. This is called capping.

The three levels of effect are:

- **The No Effect Level:** This is the level at which the chemicals in the sediment do not affect fish or the sediment-dwelling organisms. At this level no transfer of chemicals through the food chain and no effect on water quality is expected.

  Sediment that has a No Effect Level rating is considered clean and no management decisions are required. Furthermore, it may be placed in rivers and lakes provided it does not physically affect the fish habitat or existing water uses - for example a water intake pipe.

- **The Lowest Effect Level:** This indicates a level of contamination which has no effect on the majority of the sediment-dwelling organisms. The sediment is clean to marginally polluted.

  Dredged sediments containing concentrations of organic contaminants - PCBs or pesticides, for example - that fall between the No Effect Level and the Lowest Effect Level may not be disposed of in an area where the sediment at the proposed disposal site has been rated at the No Effect Level or better.

  Contamination in sediment that exceeds the Lowest Effect Level may require further testing and a management plan.

- **The Severe Effect Level:** At this level, the sediment is considered heavily polluted and likely to affect the health of sediment-dwelling organisms. If the level of contamination exceeds the Severe Effect Level then testing is required to determine whether or not the sediment is acutely toxic.

  At the Severe Effect Level a management plan may be required. The plan may include controlling the source of the contamination and removing the sediment.

For more copies of the new Provincial Sediment Quality Guidelines, please contact the Ministry of the Environment, Public Information Centre, 135 St. Clair Ave. W., Toronto, Ont. M4V 1P5, (416) 323-4321.

FOREWORD

The guidelines provided in this document were developed for use in evaluating sediments throughout Ontario, and replace the Open Water Disposal Guidelines (published by the Ministry in 1976) currently used for sediment evaluation. The Provincial Sediment Quality Guidelines (PSQGs) are intended to provide guidance during decision-making in relation to sediment issues, ranging from prevention to remedial action.

The document provides a background to the PSQG development, the PSQGs, the application of the guidelines to sediment evaluation and the protocol used in establishing the guidelines. Companion volumes to the document (Jaagumagi 1992a, 1992b) provide more details on the actual derivation of the numeric values for various parameters.

SECTION 1

BACKGROUND.

Contaminated sediment has been singled out as a major environmental concern in many areas of Ontario, especially the Great Lakes (IJC 1985). Persistent toxic substances that have accumulated in bottom sediments from industrial, municipal and non-point sources are a threat to the survival of bottom-dwelling (benthic) organisms and their consumers, and can also impair the quality of the surrounding water.

Sediments contaminated by such substances have become a critical problem for environmental managers. In order to deal effectively with sediment contamination problems, managers need to know at what levels contaminants pose no risk to sediment-dwelling organisms as well as other water uses, and at what levels contaminants are detrimental to aquatic biota. At present, management decisions are seriously hampered due to a lack of criteria whereby acceptable and unacceptable levels of contaminants in sediments can be defined. A definition of sediment contamination needs to be developed before strategies for the management of contaminated sediments can be implemented.

Routine evaluation of the significance of contaminants in sediments is currently a difficult task because of the lack of adequate guidelines. The Open-Water Disposal Guidelines, developed during the early 1970's (Persaud & Wilkins 1976), were not designed to address the significance of contaminants in *in situ* sediment but were designed exclusively for the evaluation of dredged material for open-water disposal and only incidentally provide general guidance on environmental protection.

The need for biological effects-based guidelines for the evaluation of sediment is well recognized. Current sediment related issues are much broader than those identified in the early 1970's and knowledge based on information accumulated over the last decade or so requires that strategies be developed to manage sediment. Guidelines for the evaluation of sediment must provide the basis for determining when sediments are considered clean, what levels of contamination are acceptable in the short-term, and when contamination is severe enough to warrant significant remedial action.

The Provincial Sediment Quality Guidelines described in this document are a set of numerical guidelines developed for the protection of aquatic biological resources. These biologically based guidelines have been derived to protect those organisms that are directly impacted by contaminated sediment, namely the sediment-dwelling (benthic) species. To protect against biomagnification of contaminants through the food chain from sediment contaminant sources, as well as other water quality concerns (e.g., recreational uses), the Ministry has relied on Provincial Water Quality Objectives/Provincial Water Quality Guidelines (PWQO/PWQGs) as the basis for deriving sediment values that ensure these objectives and guidelines are not exceeded as a result of sediment contamination. The derivation of the PWQO/PWQGs is explained in detail in OMOE (1990).

The Sediment Quality Guidelines tabled in the document have been designed such that they are consistent with the goals and policies for the management of surface waters that the Ministry has detailed in its handbook, Water Management: Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment (MOE, 1984).

SECTION 2

SEDIMENT QUALITY GUIDELINES

The essence of the guideline levels and their significance are provided below. The guidelines as set out define three levels of ecotoxic effects and are based on the chronic, long term effects of contaminants on benthic organisms. These levels are:

1. A No Effect Level at which no toxic effects have been observed on aquatic organisms. This is the level at which no biomagnification through the food chain is expected. Other water quality and use guidelines will also be met at this level.
2. A Lowest Effect Level indicating a level of sediment contamination that can be tolerated by the majority of benthic organisms.
3. A Severe Effect Level indicating the level at which pronounced disturbance of the sediment-dwelling community can be expected. This is the sediment concentration of a compound that would be detrimental to the majority of benthic species.

Guideline Levels and Their Significance

Guideline Level	Sediment Quality	Potential Impact
	Grossly Polluted	Will significantly affect use of sediment by benthic organisms.
Severe Effect Level		
	Marginally - Significantly Polluted	Will affect sediment use by some benthic organisms.
Lowest Effect Level		
	Clean - Marginally Polluted	Potential to affect some sensitive water uses.
No Effect Level		
	Clean	No impact on water quality water uses or benthic organisms anticipated.

Details on these levels, and the protocols used in developing the guidelines are provided in section 4 of this document.

The No Effect and Lowest Effect guidelines compare closely with the lowest or no effect levels determined through a review of sediment toxicity bioassays by National Oceanic and Atmospheric Administration (NOAA) (Long and Morgan, 1990)

As is discussed in Section 4.4, it is not currently possible to calculate a No Effect value for all parameters. Where this is the case for the metals, an interim value based on the lower of the background or Lowest Effect Levels will be used as a lower practical limit for management decisions. For the organics, the background values in Table 5 define the lower practical limit for management decisions.

Table 1: Provincial Sediment Quality Guidelines for Metals and Nutrients.
(values* in ug/g (ppm) dry weight unless otherwise noted)

METALS	No Effect Level	Lowest Effect Level	Severe Effect Level
Arsenic	-	6	33
Cadmium	-	0.6	10
Chromium	-	26	110
Copper	-	16	110
Iron (%)	-	2	4
Lead	-	31	250
Manganese	-	460	1100
Mercury	-	0.2	2
Nickel	-	16	75
Zinc	-	120	820
NUTRIENTS			
TOC (%)	-	1	10
TKN	-	550	4800
TP	-	600	2000

* - values less than 10 have been rounded to 1 significant digit. Values greater than 10 have been rounded to two significant digits except for round numbers which remain unchanged (e.g., 400).

"-" - denotes insufficient data/no suitable method.

TOC - Total Organic Carbon TKN - Total Kjeldahl Nitrogen TP - Total Phosphorus

(June 1992)

Table 2a: Provincial Sediment Quality Guidelines for PCBs and Organochlorine Pesticides.
(values[a] in $\mu g/g$ (ppm) dry weight unless otherwise noted)

Compound	No Effect Level	Lowest Effect Level	Severe Effect Level ($\mu g/g$ organic carbon)*
Aldrin	-	0.002	8
BHC	-	0.003	12
α-BHC	-	0.006	10
β-BHC	-	0.005	21
γ-BHC	0.0002	(0.003)[b]	(1)[c]
Chlordane	0.005	0.007	6
DDT(total)	-	0.007	12
op+pp-DDT	-	0.008	71
pp-DDD	-	0.008	6
pp-DDE	-	0.005	19
Dieldrin	0.0006	0.002	91
Endrin	0.0005	0.003	130
HCB	0.01	0.02	24
Heptachlor	0.0003	-	-
H epoxide	-	0.005[b]	5[c]
Mirex	-	0.007	130
PCB(total)	0.01	0.07	530
PCB 1254[d]	-	(0.06)[b]	(34)[c]
PCB 1248[d]	-	(0.03)[b]	(150)[c]
PCB 1016[d]	-	(0.007)[b]	(53)[c]
PCB 1260[d]	-	(0.005)[b]	(24)[c]

Lowest Effect Levels and Severe Effect Levels are based on the 5th and 95th percentiles respectively of the Screening Level Concentration (SLC) (see Section 4.2.4) except where noted otherwise.

( ) Denotes tentative guidelines

[a] - Values less than 10 have been rounded to 1 significant digit. Values greater than 10 have been rounded to 2 significant digits except for round numbers which remain unchanged.

[b] - 10% SLC.

[c] - 90% SLC.

[d] - Analyses for PCB Arochlors are not mandatory unless specifically requested by MOE.

- Insufficient data to calculate guideline.

* Numbers in this column are to be converted to bulk sediment values by multiplying by the actual TOC concentration of the sediments (to a maximum of 10%), e.g. analysis of a sediment sample gave a PCB value of 30 ppm and a TOC of 5%. The value for PCB in the Severe Effects column is first converted to a bulk sediment value for a sediment with 5% TOC by multiplying 530 x 0.05 = 26.5 ppm as the Severe Effect Level guidelines for that sediment. The measured value of 30 ppm is then compared with this bulk sediment value and is found to exceed the guideline.

(March 1993)

Table 2b: Provincial Sediment Quality Guidelines for Polycyclic Aromatic Hydrocarbons.
(values in $\mu g/g$ (ppm) dry weight unless otherwise noted)

Compound	No Effect Level	Lowest Effect Level	Severe Effect Level ($\mu g/g$ organic carbon)*
Anthracene	-	0.220	370
Benz[a]anthracene	-	0.320	1,480
Benzo[k]fluoranthene	-	0.240	1,340
Benzo[a]pyrene	-	0.370	1,440
Benzo[g.h.i]perylene	-	0.170	320
Chrysene	-	0.340	460
Dibenzo[a,h]anthracene	-	0.060	130
Fluoranthene	-	0.750	1,020
Fluorene	-	0.190	160
Indeno[1,2,3-cd]pyrene	-	0.200	320
Phenanthrene	-	0.560	950
Pyrene	-	0.490	850
PAH (total)	-	4	10,000

(Guidelines could not be calculated for Acenaphthene, Acenaphthylene, Benzo[b]fluorene and Naphthalene due to insufficient data. These will be calculated when sufficient data is available.)

Lowest Effect Levels and Severe Effect Levels are based on the 5th and 95th percentiles respectively of the Screening Level Concentration (SLC) (see Section 4.2.4) except where noted otherwise.

- Insufficient data to calculate guideline.

* Numbers in this column are to be converted to bulk sediment values by multiplying by the actual TOC concentration of the sediments (to a maximum of 10%), e.g. analysis of a sediment sample gave a B[a]P value of 30 ppm and a TOC of 5%. The value for B[a]P in the Severe Effects column is first converted to a bulk sediment value for a sediment with 5% TOC by multiplying 1443 x 0.05 = 72 ppm as the Severe Effect Level guideline for that sediment. The measured value of 30 ppm is then compared with this bulk sediment value and is found to not exceed the guideline.

PAH (total) is the sum of 16 PAH compounds: Acenaphthene, Acenaphthylene, Anthracene, Benzo[k]fluoranthene, Benzo[b]fluorene, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[g,h,i]perylene, Chrysene, Dibenzo[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3-cd]pyrene, Naphthalene, Phenanthrene and Pyrene.

(March 1993)

sediments upstream of all discharges may

be acceptable for calculation of background values. Where it cannot be shown that such areas are unaffected by local discharges, the pre-colonial sediment horizon is used. Site specific background for metals is calculated as the mean of 5 replicate samples from surficial sediment that has not been directly affected by man's activities or from the 'pre-colonial' sediment horizon. The calculations are described in Section 4 of this document. Alternatively, the mean background values for the Great Lakes Basin as presented in Table 4 may be used.

NUTRIENTS: Areas of high natural organic matter content, such as marshes and other types of wetlands, can be readily distinguished from those resulting from anthropogenic sources. In such cases, for the nutrients listed in Table 1, the local background would serve as the practical lower limit for management action.

(h) It is also recognized that long-range sources such as atmospheric deposition have contributed to accumulation of organic compounds in areas remote from any specific source. Therefore, in those areas where specific sources cannot be determined, the practical lower limit for management action is the Upper Great Lakes deep basin surficial sediment concentration. These have been defined for a number of organic compounds and are presented in Table 5.

3.2 SPECIFIC APPLICATIONS

3.2.1 Placement of Fill Directly into a Watercourse

Fill refers to any type of solid material, other than those defined as inert (i.e., chemically clean) under MOE's Waste Management Guidelines described in Regulation 309 of the Environmental Protection Act, used in shoreline or nearshore development programs generally referred to as lakefilling.

As a minimum, chemical analyses shall be carried out for the Mandatory Parameters listed in the Fill Quality Guidelines (Hayton *et al.* 1992). In addition, chemical analysis may be required for some or all of the parameters in Tables 1, 2 and 3 on a site-specific basis.

Fill material equal to, or better than, the No Effect Level Guidelines can be used without restriction in a watercourse.

The conditions governing fill that exceed the No Effect Level are outlined in MOE's guidelines on lakefilling (Hayton *et al* 1992).

3.2.2 Areas of Potential Concern

When sediment quality in an area consistently exceeds the Lowest Effect Level Guideline, subject to the conditions in 3.1.1.(g) above, that area shall be considered as an area of potential concern, and the actions outlined below shall apply. The sediment evaluation procedure is shown in Figure 2.

In areas where contaminants in sediment are at or above the Lowest Effect Level, steps should be taken to *control all point and non-point contaminant sources* to the area. Consideration will be given to the provisions governing areas of high mineralization and atmospheric deposition as outlined in section 3.1.1.(g) and (h).

Application of Provincial Sediment Quality Guidelines to Sediment Assessment.

The sediment evaluation procedure described below outlines in detail the procedure in Figure 2.

1. The sediment concentrations for all parameters, based on a sampling program, are compared to the PSQGs. The concentrations of each parameter are compared to each of the guideline levels.

1a. If sediment analysis shows that the concentration of that parameter is below the No Effect Level, the sediment can be considered as clean and no further management decisions are required.

2. If the sediment concentration of a parameter exceeds the No Effect Level but is below the Lowest Effect Level then no further management decisions are needed. However, for the purposes of dredged material disposal, sediment at this level cannot be disposed of in an area where existing sediment concentrations are below the No Effect Level.

3. If the sediment concentration exceeds the Lowest Effect Level, then the concentration is compared with the local background values for that parameter. Background values can be derived from physically contiguous areas that are unaffected by point-source discharges, or if these do not exist, then from the "pre-colonial" sediment horizon. The latter would represent background levels in existence before European colonization of the area and is generally considered as the area below the *Ambrosia* pollen horizon. In those instances where local values are not available, the concentration may be compared to the background values listed in Tables 4 and 5. These are based on values from the Great Lakes and may not be applicable to inland sites.

3a. If the sediment concentration is below the natural background then no further management decisions need to be considered.

3b. If the sediment concentration also exceeds the local background value, then the next step is to determine whether the sediment poses a threat to aquatic life, and if so, the severity of this effect. Since the range of sediment concentrations that falls between the Lowest Effect Level and the Severe Effect Level is in most cases very large, it is necessary to distinguish between situations where a parameter may exceed the Lowest Effect Level only slightly, from one where the levels are close to the Severe Effect Level. The biological effects in such cases would be expected to differ widely. A number of biological assessment techniques would be expected to be used in such an assessment. These should encompass laboratory and field-based measures on both individual toxic effects as well as "e[illegible] system" measures. The types and complexity of analyses will differ according to the specific characteristics (sediment type, contaminant) of each site.

3c. Assessment of the biological effects in turn permits management decisions to be made on the need and potential effectiveness of the available remedial options including source control and sediment remediation. This step will include consideration of the environmental effects and will also incorporate the socio-economic impacts of both the sediment contamination and the remedial options. This step would be expected to proceed in most cases with considerable public involvement.

3d. The final choices made would involve source control and either the implementation of remedial action or a decision to leave and monitor. The basis for choosing the latter may be a lack of environmental effects or may be based on socio-economic considerations. In some situations leaving contaminated material in place is also an accepted and effective remedial option and may be less environmentally damaging. Where biological effects were found to be present but a decision has been made to leave the material in place, or where this is the accepted remedial action, monitoring may be required along with consideration of other actions that may be needed to restrict public exposure.

4. If the concentration of the contaminant in the sediment exceeds the Severe Effect Level then the sediment bioassay described in section 3.2.3, designed to assess whether the sediment is acutely toxic, is required.

4a. If on the basis of these tests the sediment has not been found to be acutely toxic, then the assessment procedure as described in steps 3b through 3d above are to be followed.

4b. Where the sediment has been found to be acutely toxic on the basis of the bioassay tests, it is necessary to evaluate source control and all remedial options, including leaving the material in place. In some cases, management decisions may involve the implementation of interim remedial action.

In areas where contaminants in sediment are at or above the Severe Effect Level, the sediment is deemed to be highly contaminated and measures in addition to source control may be require[illegible] up the sediment. Such measures shou[illegible] determined on the basis of the biological tests outlined below. If the sediment fails either of the tests, *in situ* remedial action is warranted. If the sediment passes both tests, efforts should be directed towards point and non-point source contr[illegible] *In situ* clean-up must not be a substitute for source control. The sediment evaluation proce[illegible] is outlined in Figure 2.

Biological Tests

The following acute lethality test, [illegible] an equivalent test approved by MOE, will be [illegible]ied out to determine the need for *in situ* sediment remedial action. Details on the following tests are provided in Bedard *et al.* (1992).

Sediment Bioassay Protocol

The experiments are run as static whole-sediment beaker tests, using two types of aquatic biota: 3-4 month old fathead minnows, *Pimephales promelas* (to assess effects of contaminated sediment on water column organisms) and 3-4 month old reared nymphs of the burrowing mayfly, *Hexagenia limbata* (to assess effects of contaminated sediment on a sediment-dwelling organism). The organisms are placed in jars (2 litre) with dechlorinated water and sediment (4:1 ratio) for a 10-day exposure period. At the end of the experiment, percent mortality is calculated.

Selection of Controls

Controls are very important and necessary for proper interpretation of bioassay results. Two types of control sediments are selected for the Sediment Bioassay Protocol and these are:

- Sediments in which test organisms are cultured.
- Control site from study location, upstream or removed from the pollution sources being assessed but as similar as possible in composition.

Data Interpretation

Data interpretation involves comparing bioassay results from test sediments to results from:

- replicate test sediments to address variability among replicates
- control sediments that organisms were cultured in
- upstream control sediments or sediments removed from pollution sources being assessed.

Statistically significant ($P<0.05$) differences between test and control sediments for the various endpoints indicate that test sediments have negatively impacted the biota. Control mortality is monitored and must not exceed 15% for the validation of test results.

3.2.3 Dredged Material Disposal

Dredged material refers to any material removed from the bottom of a watercourse as a result of capital or maintenance dredging, remedial action or spills clean-up. The conditions outlined below relate only to material being considered for disposal in open water and does not include material to be placed within Confined Disposal Facilities (CDFs). Analyses will be performed for all parameters listed in Tables 1 and 2, unless previous data suggest the absence of certain parameters. In addition, chemical analysis may be required for some or all of the parameters in Table 3.

A. Disposal in Areas With Sediment Quality Equal to or Better Than the No Effect Level Guidelines.

The dredged material to be disposed of must not exceed the No Effect Level Guidelines.

B. Disposal in Areas With Sediment Quality Exceeding the No Effect Level Guidelines.

The dredged material to be disposed of in such areas must be below the Lowest Effect Level Guidelines, subject to the conditions described in 3.1.1.(g). Detailed application of these guidelines is described below and is shown in Figure 3.

Sediment Evaluation for Dredged Material Disposal

Dredge material disposal in open water requires that both the material to be removed as well as the material in the disposal area be analyzed. Each parameter is compared to the PSQG levels. In practice, the material is matched to the disposal area, which in turn will be classified into one of three groups.

Group 1

1a. The concentrations of contaminants in sediments in the disposal area are below the No Effect Level. If the concentrations in the dredged material are also below the No Effect Level the material is suitable for disposal at this site.

1b. If the concentrations in the dredged sediments are above the No Effect Level then this material is not suitable for disposal at this site, since this would result in contamination of a clean site with sediment of a lesser quality. However, if the concentrations in the dredged material are below the Lowest Effect Level, it may be suitable for disposal at another site where existing sediment concentrations are above the No Effect Level.

1c. Material that exceeds the Lowest Effect Level for any parameter is not suitable for open water disposal at this site.

Group 2

2a. The sediments in the disposal area are above the No Effect Level but still below the Lowest Effect Level. If the concentrations in the dredged material are below the No Effect Level then the material is suitable for open water disposal at this site.

2b. Similarly, if the dredged material is above the No Effect Level but below the Lowest Effect Level, the material is also suitable for disposal at this site. Material that exceeds the Lowest Effect Level is not suitable for open water disposal at this site.

Group 3

3a. If the sediments in the disposal area are contaminated to above the Lowest Effect Level, material that is below the Lowest Effect Level is suitable for open water disposal at this site.

3b. Material that exceeds the Lowest Effect Level for organic compounds and mercury is not suitable for open water disposal. Material that exceeds the Lowest Effect Level for metals other than mercury is suitable for open water disposal under certain conditions. If the material is at or below the Great Lakes background (as defined in Table 4) and does not exceed ambient sediment levels then the material is suitable for open water disposal at this site.

3.2.4 Spills Clean-up

In areas where ambient or background sediment levels of the substance(s) spilled are below the No Effect Level, the clean-up level will, as a minimum, be to the No Effect Level. If the ambient sediment levels for that watercourse are above the No Effect Level, then cleanup will be, as a minimum, to the local ambient level. To clean up beyond the ambient level would be of no lasting benefit due to the long-term migration and cycling of sediment within the ecosystem.

SECTION 4

PROTOCOL FOR SETTING SEDIMENT QUALITY GUIDELINES

4.1 RATIONALE FOR SETTING SEDIMENT QUALITY GUIDELINES

In developing guidelines to provide adequate protection for biological resources, the Ministry has attempted to ensure that the methods employed consider the full range of natural processes governing the fate and distribution of contaminants in the natural environment. Since benthic organisms respond to a variety of stress-inducing factors they are, in essence, integrators of all the physical, chemical and biological phenomena being experienced in their environment and these organisms should form the basis of any method used in setting sediment guidelines.

Because individual species may respond differently to stress-inducing factors it is very difficult to study a specific organism (eg. a sensitive species) with the hope of developing guidelines that will protect the rest of the community. Sensitivity to chemical contaminants has not been fully evaluated for different benthic organisms and most sediment bioassay work has been concerned mainly with a few selected species (eg. the mayfly *Hexagenia*). While the mayfly has traditionally been used as a "sensitive" indicator organism for factors such as low dissolved oxygen, its sensitivity relative to other benthic organisms has not been clearly established for chemical contaminants. Therefore, in developing PSQGs, the Ministry has not relied on single-species data.

Similarly, a method that relies heavily on those species that are known to be extremely tolerant of contaminants in sediment cannot result in guidelines that will adequately protect less tolerant members of the aquatic community. It has been demonstrated that some populations can adapt to varying levels of environmental contamination with increasing tolerance to these contaminants occurring in succeeding generations. This can present difficulty in laboratory studies of reared populations since these may lack the genetic diversity found in natural populations and responses may not be consistent with those observable under field conditions.

Another concern in relation to placing heavy reliance on laboratory data stems from the fact that in most situations contaminants in sediments exist as mixtures of various substances. Laboratory tests have been geared towards examining the effects of single substances and laboratory data can be difficult to apply to field situations.

In developing the protocol for setting Sediment Quality Guidelines, the ministry considered a number of different approaches developed by state and federal agencies in North America that employed various degrees of biological assessment. The various suggestions for the development of Sediment Quality Guidelines can be summarized in five approaches as possible means of setting sediment quality guidelines. At present, no single approach can adequately account for all the factors that operate in natural sediments and each of the five approaches has positive attributes as well as limitations with regard to the development of biologically based guidelines. The rationale used in setting Sediment Quality Guidelines includes a number of considerations which are detailed below. These considerations provided the basis for selecting the best method or combination of methods for Sediment Quality Development.

1. Sediment Quality Guidelines should consider a range of contaminant concentrations that is wide enough to determine the level at which ecotoxic effects become noticeable. This can be achieved most effectively by looking at a large number of organisms under the widest possible range of contaminant exposure. Only then can the appropriate ecotoxic level be adequately determined. A restricted range may result in the setting of guidelines that are not reflective of actual ecotoxic effects on organisms and as such may be overprotective. This is especially important where the range of effects used may not cover the entire tolerance range of the species in question.

2. PSQGs should be based on cause-effect relationships between a specific contaminant and benthic organisms since it is necessary to demonstrate that at a certain concentration a contaminant results in adverse effects on benthic organisms.

3. PSQGs should account for contaminant effects in a multi-contaminant medium. Since contaminated sediments usually consist of mixtures of substances, the presence of a number of different contaminants, any or all of which may affect the response of the organisms to the contaminant being investigated must be considered. Since combinations of contaminants may evoke different responses than those occurring singly (through either synergistic or antagonistic effects) these effects must be accounted for as well. A PSQG method must incorporate this feature into the derivation of a number for specific contaminants.

4. PSQGs should consider chronic effects of contaminants on aquatic biota since these can affect the long term viability of aquatic organism populations. Methods that consider only acute effects do not offer adequate protection, since sediment concentrations reflect long-term conditions and are not subject to the extreme temporal variability of water column contaminant concentrations.

5. The PSQGs should be capable of incorporating and accounting for the range of environmental factors that could have a bearing on the presence or absence of organisms in a given area. Contaminant behaviour and organisms' well-being are governed by a variety of natural physical, chemical and biological processes. If these processes are not accounted for in a PSQG method then the resulting guidelines will be unrealistic. For example, organisms may be absent from a given area not because of the level of contaminants but because of unsuitable habitat, low dissolved oxygen, or interspecific competition. In formulating a guideline it is essential that these factors be considered along with the chemical data. If they are not considered, the numerical value obtained would not necessarily be protective of aquatic species. This will also reduce the need for site-specific guidelines, since a full range of environmental conditions will have been covered.

4.2 APPROACHES TO SEDIMENT QUALITY GUIDELINE DEVELOPMENT.

As part of the sediment guideline development process, the Ministry has carried out an extensive literature review of possible approaches to the development of sediment guidelines. This effort has resulted in the selection of five potential approaches for this purpose. These are:

1. Sediment Background Approach
2. Equilibrium Partitioning Approach (Water - Sediment and Biota - Water - Sediment Partitioning)
3. Apparent Effects Threshold Approach
4. Screening Level Concentration Approach
5. Spiked Bioassay Approach

The five approaches are discussed below and additional details can be found in the pertinent literature cited for each method.

4.2.1 Sediment Background Approach

In the Background Approach, sediment contaminant concentrations are compared to concentrations from reference background sites where contaminant levels are deemed to be acceptable (OMOE 1987, 1988). Using the Background Approach, levels are set according to a "suitable" reference site or "acceptable" level of contamination. A suitable reference site may be one where sediments are deemed to be relatively unaffected by anthropogenic inputs. Alternatively a suitable reference site may be derived through sediment profiles. In the latter, the pre-industrial sediment horizon, as determined through techniques such as palynology, could be used to determine background levels.

The basis of the Background method is the implicit assumption that concentrations above these background values have an adverse effect on aquatic organisms.

For the purposes of PSQG development a "pre-industrial" standard could be adopted only for metals. The strictly anthropogenic (man-made) organic contaminants, for which background levels should theoretically be zero, would require adoption of a contemporary surficial sediment standard, based on a suitable reference site.

Advantages:

The data requirements of the Background Approach are minimal in that the method requires only measurement of the chemical concentrations of contaminants in sediments. As such it can be used with the existing data, thus minimizing the need for additional data collection.

The method does not require quantitative toxicological data and avoids the need to seek mechanistic chemical explanations for contaminant behaviour or biological effects.

Background limits have advantages from an enforcement perspective since the Background Approach does provide an indication of the chemical concentration for metals that is expected to occur naturally. While it is possible that biological effects may occur in some species at metal concentrations indistinguishable from non-anthropogenic background, it is difficult to justify enforcement of a standard that has never been realized in nature. Thus background levels for metals can provide a practical lower limit for management decisions. For organic contaminants, which are largely anthropogenic, background should theoretically be zero. In most areas, however, contaminants have found their way into sediment and a contemporary benchmark based on current average concentrations for a suitable reference area may provide the practical lower limit for enforcement.

There is at present an adequate database for developing sediment guidelines for several contaminants using the Background Approach.

Limitations:

Since the Background Approach relies only on the chemical concentration of contaminants in sediments it has no biological basis. Because biological effects data are not considered, cause-effect relationships between sediment contaminant levels and sediment-dwelling organisms cannot be determined.

The exclusive use of chemical data implies that sediment characteristics have no influence on the resultant biological effects, but rather that chemical concentrations alone are responsible for the observed effects. However, sediment characteristics (i.e., grain size, organic content, dissolved oxygen levels) have been shown to be major factors affecting benthic community composition.

Implicit in the method is the assumption that the chemicals present are in their biologically available forms. The method therefore, makes no allowance for the occurrence of different chemical species with differing biological availability and toxicity.

A further limitation of this approach is that background levels tend to be highly site-specific. They therefore require the designation of a reference site, which itself is likely to be highly subjective.

4.2.2 Equilibrium Partitioning Approaches

Phase partitioning of organic compounds has been used to describe the distribution of certain organic compounds in aquatic compartments. Partitioning, like adsorption, is one of the processes by which organic compounds can be sorbed to sediments. A major difference however, is that partitioning is solubility dependent and therefore, reversible (i.e. equilibrium) partitioning of non-polar organic compounds is a function of their solubility in water. The very insoluble compounds, as a result, partition strongly to sediment with only very minor amounts in water. These compounds tend to have high partition coefficients, as measured by the octanol-water partition coefficient, K_{ow}. The K_{ow} is the ratio of the amount of the compound that is soluble in an organic solvent such as octanol relative to the amount soluble in water.

The partitioning approaches have been extensively investigated by the U.S. EPA (Pavlou & Weston 1984). A basic assumption of this approach is that the distribution of contaminants among different compartments in sediment is controlled in a predictable manner by a continuous equilibrium exchange among sediment solids and the interstitial water. Partitioning to these two phases can therefore be calculated by the quantity of sorbent in the sediment, for which organic carbon is the primary sorbent, and the partition coefficient K_{oc}. K_{oc} values, which can be estimated from K_{ow}, are normalized to sediment organic content.

The EP approaches also assume that interstitial water is the primary route of organism exposure to contaminants in sediments. Therefore, this approach assumes that only the amount of contaminant partitioning to the water is of interest, the amounts partitioning to the sediments being considered as unavailable.

Using this approach, contaminant-specific partition coefficients are determined (generally expressed in terms of organic carbon content of sediment) and used to predict the distribution of the contaminant between sediment and interstitial water. It must be pointed out that this approach can only be used for contaminants that partition between environmental phases. Contaminants that do not partition appreciably into sediment organic matter, and those whose chemical behaviour is highly unpredictable, such as the metals, cannot be considered using the partitioning approach.

Under the EP approach, a generic (i.e. equally applicable to all sites) organic carbon-normalized partition coefficient K_{oc} is developed and is then multiplied by an existing PWQO/G to derive a sediment guideline. In essence, the distribution coefficients for the non-polar organics are used to establish the chemical concentration in the sediments that, at equilibrium, will not exceed PWQO/Gs in the interstitial water.

Sediment Quality Guidelines based on the equilibrium partitioning of organics can be calculated in a number of ways, depending on the type of data available.

1. Water - Sediment Equilibrium Partitioning Approach

The water - sediment partitioning approach is a generic partitioning method which derives a sediment quality guideline from the partitioning of a chemical to the water and the sediment solid phases. There is sufficient evidence to show that sediment organic carbon is the primary environmental factor influencing partitioning (Di Toro *et al.* 1985 in OMOE 1988) he partition coefficient K_p is normalized for organic content and an organic carbon-normalized sediment-water partition coefficient is derived (K_{oc}). This can either be derived empirically, or calculated from the octanol-water partition coefficient. The partition coefficient is then multiplied by a water quality criterion (such as a PWQO) to derive a sediment quality guideline.

2. Biota - Water - Sediment Equilibrium Partitioning Approach

The Biota - Water - Sediment Partitioning Approach is a generic partitioning method which derives a sediment guideline from an existing tissue residue criterion. It is a two step approach utilizing a generic water - biota bioconcentration factor (BCF) to relate the tissue criterion to a corresponding water concentration. For bioaccumulable substances this relationship determines the tissue-water concentration level (TWCL). The TWCL is the value that must not be exceeded in water in order to prevent exceedance of the tissue residue criteria from which the TWCL was derived. The TWCL, therefore, is equivalent to a water-quality criterion. Following this step the approach is similar to that described for the water - sediment approach with the TWCL used in place of the water quality criterion.

Advantages:

Generic Partitioning Approaches are biologically based to the extent that existing water or tissue criteria are biologically based and, therefore, provide more defensible guidelines than the Background Approach. Since they make use of the virtual no-effect levels determined from existing Provincial Water Quality Objectives and Guidelines (PWQO/Gs) the sediment guidelines derived through generic partitioning approaches can be considered no-effect levels for the protection of those end-uses the water quality guidelines were designed to achieve.

The partitioning approach relies on an existing toxicological rationale which has been established during the development of the water quality criterion being used. Thus, a new toxicological evaluation is not required provided that the water quality criterion has been derived to protect those benthic organisms which are exposed to the interstitial water. However, a corresponding limitation to the approach is its applicability only to chemicals which have water quality criteria. Moreover, if the water and sediment criteria are meant to protect different organisms then an assumption is made that the two sets of organisms are of equal sensitivity to given levels of contaminants.

Limitations:

The basic assumption that availability of an organic compound to aquatic organisms is controlled by the amounts partitioning to the water ignores both the sediments and food chain effects as potential sources. It has not yet been proven that the interstitial water is the only significant route of exposure and for the highly hydrophobic compounds (those with high K_{ow}), all of these sources may be significant routes of exposure.

Tissue residue criteria are generally based on human health considerations and human food consumption patterns. Therefore, the tissue residue criteria apply to human food organisms such as fish rather than benthic organisms. Similarly, the BCF applies to fish, and the water concentration (TWCL) thus derived applies to the water column in which the fish lives. This approach is limited by the substantial gap that exists between the water column compartment and the interstitial water compartment that is assumed to be in equilibrium with the sediments.

The reduction in contaminant concentration from the interstitial water to the water column compartment is likely to be highly site-specific depending on local-circulation.

Current use of the Partitioning Approach is limited to those contaminants that exhibit predictable partitioning behaviour. Since the partitioning of metals in sediments is highly unpredictable (e.g., sediment-water partition coefficients for metals can span a wide range of values differing by orders of magnitude depending on such factors as redox potential, pH, dissolved oxygen and organic matter content of the sediment) and polar organics generally do not partition into sediment, the partitioning approaches are considered applicable only to non-polar organic compounds.

The scientific validity of a sediment guideline obtained through the partitioning approaches relies heavily on the accuracy of the partitioning coefficients (K_{ow}) used. The published values for partition coefficients obtained by different authors can differ by an order of magnitude. This presents great difficulty in choosing a representative value for use in guideline development work and unless a standard approach is used it will be difficult to obtain consistent or compatible guidelines using the EP approach.

At present the EP approach cannot account for all the forms a contaminant can exist in and all the possible sediment constituents it can partition to. This is currently a drawback to the EP approach since the various forms of a contaminant have their own toxicity and partitioning characteristics. Several species of a contaminant may be bioavailable and toxic, but often their concentrations are more or less linearly dependent on the concentration of a single species. While it has been possible to establish that one species correlates with the observed toxic effects for the non-polar organics, this has not been possible for the metals or the polar organics. The partitioning approach does not work for metals or polar organics due to the multiplicity of adsorption mechanisms these undergo. It is not even clear which sediment components are controlling partitioning.

4.2.3 Apparent Effects Threshold Approach (AET)

The AET, as developed by Tetra Tech (1986) is a statistically based approach that attempts to establish quantitative relationships between individual sediment contaminants and observed biological effects. The biological effects can be bot' field measured effects such as changes in benthic community structure and laboratory measured effects through the use of sediment bioassays. The basis of this technique is to find the sediment concentration of a contaminant above which significant biological effects are always observed. These effects can be any or all of a number of different types, such as chronic or acute toxicity, changes in community composition, and bioaccumulation and are considered in conjunction with the measured sediment contaminant levels. Inherent in the approach is the assumption that observed effects above this level of contamination are specifically related to the contaminant of interest, while below this level any effects observed could be due to other contaminants.

Advantages:

The AET Approach is effects based and therefore more defensible than the partitioning approaches in relation to the protection of benthic organisms. The method assumes a direct cause-effect relationship between sediment concentrations of a contaminant and the occurrence of significant biological effects.

Unlike the partitioning approach the AET makes no assumptions regarding contaminant availability from the various environmental compartments. Therefore the effects on biota can be due to contaminants available through both adsorption from sediments and interstitial water and through absorption from ingested matter.

Limitations:

The method is unable to separate the biological effects that may be due to a combination of contaminants.

While assuming a cause-effect relationship, the method cannot clearly demonstrate a cause-effect relationship for any single contaminant. Thus, while definite ecotoxic effects can be established, these cannot be attributed to any one chemical contaminant.

In using the AET approach care must be exercised in selecting the species of organism to be used and the particular type of effects (endpoints) to be considered. If the data used consist of mixed species and endpoints, the least sensitive of these will always predominate and the guidelines derived may not protect other more sensitive species. For example, if the data base for a particular contaminant contains data on acute toxicity to tubificid oligochaetes, then the AET will be designed to protect against acute toxicity to tubificids. It will not protect species that are more sensitive nor will it provide protection against chronic effects.

For most practical purposes this method requires chronic toxicity data since results from the existing database indicate guidelines tend to be higher than those calculated by other means, in some cases by an order of magnitude. This is usually due to the use of acute toxicity data which needs a correction factor to adjust to chronic toxicity. The development of a chronic toxicity database (i.e, one based on reproductive effects and effects on the most sensitive life stages) itself requires a very extensive set of information which at present does not exist in a standardized form. In order to obtain such information, considerable laboratory testing will have to be carried out. In addition, for data from different investigators to be useful, consistency in procedures and definition of endpoints will be necessary. To this end, results from single investigators are the most effective for attaining consistent results.

In practice, guidelines generated by the AET approach are likely to be underprotective since this method determines the contaminant level above which biological effects are always expected. Biological effects, however, can be and are observed at chemical concentrations lower than these values, though these effects may not occur in all samples.

The AET method is applicable for all types of contaminants, making use of both laboratory tests on sediments (spiked sediments) and field data. In laboratory tests of field-collected sediments it may not be possible to separate the effects of mixtures of chemicals. If spiked sediments are used, only single contaminant or known (specific) mixtures can be used and therefore this method suffers from some of the same limitations as the Spiked Bioassay method (discussed below). In using field collected sediments in conjunction with other field data (e.g. community composition), it is not possible to separate the effects of mixtures of contaminants and this method suffers from the limitations affecting the SLC method.

4.2.4 The Screening Level Concentration Approach (SLC)

The SLC, like the AET, is an effects based approach applicable mainly to benthic organisms. The SLC approach uses field data on the co-occurrence in sediments of benthic infaunal species and different concentrations of contaminants. The SLC is an estimate of the highest concentration of a contaminant that can be tolerated by a specific proportion of benthic species. In its original derivation and application, the 95th percentile was used.

The SLC, as developed by Neff *et al* (1986), is calculated through a two step process. First, for a large number of species (at least ten for each chemical) a species SLC (SSLC) is calculated by plotting the frequency distribution of the contaminant concentrations over all sites (at least ten) where the species is present. The 90th percentile of this distribution is then taken as the SSLC for that species. The 90th percentile was chosen to provide a more conservative estimate of the SSLC. Extreme sediment concentrations may be an aspect of specific sediment characteristics resulting in low biological availability relative to the sediment concentration. By choosing the 90th percentile, these values are excluded. In the second step, the SSLCs for each species are plotted as a frequency distribution and the 5th percentile is interpolated from this distribution. This is the SLC and represents the concentration which 95% of the species can tolerate.

A basic assumption in the method is that the data cover the full tolerance range of each species. This assumption requires that a large range of chemical concentrations be sampled in each case (at least two orders of magnitude) since an SLC will be generated whether or not this assumption is true. This is important though sometimes difficult to verify. The difficulty lies in the fact that the full tolerance range of most species is not known.

Sediment contaminant concentrations for the non-polar organics are normalized to TOC content of the sediments. Since these compounds generally partition strongly to organic matter, the normalized concentration should more closely represent contaminant availability to benthic organisms. For metals and polar organics, bulk sediment concentrations are used since the best normalization procedures for representation of metal availability are as yet unresolved.

Advantages:

Since the SLC approach does not make any assumptions about the absence of a species and considers only those species present, the SLC approach does not require *a priori* assumptions concerning cause-effect relationships between sediment contaminant concentrations and the presence or absence of benthic species. As no relationship is assumed it is not necessary to take into account the wide variety of environmental factors that affect benthic communities, such as substrate type, temperature and depth.

However, valid *a posteriori* inferences can be drawn from this type of analysis regarding the range of sediment contaminant concentrations that can be tolerated by the sediment infauna since field data on the co-occurrence of benthic infaunal species and sediment contaminant concentrations are used.

However, since the SLC Approach uses field data on the co-occurrence in the field of contaminants and benthic species, the environmental factors acting on the species distribution are already integrated into the data-set and the response determined is a measure of both the environmental factors and the contaminant levels. It also integrates changes in chronic responses such as reproduction/fecundity and sensitive life-stages, since it is a cumulative measure of effects. In addition, it integrates into the biological response any synergistic or additive effects from multiple contaminants as they would occur in natural sediments. Because of this, the SLC approach overcomes the difficulties of applying bioassay data to field situations, and the lack of uncertainty associated with partition coefficients.

While it was originally developed primarily for use with non-polar organics (using TOC normalization) it is also appropriate for metals and polar organics as well since it can be used with or without TOC normalization.

At present the size of the database has determined that the SLC level be set at the 5th percentile of the SLC frequency distribution. However, as the database continues to expand it should be possible to reliably calculate the 1st percentile (i.e. the level of a contaminant that 99% of the species present can tolerate). The precision of the SLC is directly related to the size of the database and the range of variability of the various factors within the database. Therefore great care must be taken to include data taken over the full range of conditions since a database skewed to either lightly or heavily contaminated areas will yield guidelines that are either too conservative (overprotective) or do not provide adequate protection for aquatic life (underprotective).

Limitations:

The major limitation of the SLC approach is the difficulty in determining a direct cause-effect relationship between any one contaminant and the benthic biota, since very rarely is a single contaminant present in natural situations. Therefore, the effects observed are related to the entire mixture of chemicals.

The range and distribution of contaminant concentrations and the particular species used to generate them can significantly affect the calculation of the SLC value. The use of only low values of contaminant concentration may not encompass the entire tolerance range of the species and the concentration would be below the level that would adversely affect the distribution of that species. In such situations, an SLC would still be generated but the value would be conservative and unrealistic. This can be overcome by ensuring that the database include values from heavily contaminated areas.

The SLC is also sensitive to the species used in the database. Unlike the Partitioning approach, the SLC does not make any assumptions regarding the possible routes of effect from aquatic contaminants. all possible modes of exposure are taken into account. Since contaminant availability from the sediments may differ in relation to the feeding habits of the organisms used, the proportion of species from each of the feeding groups will determine the shape of the SLC curve. This can also be overcome by limiting the database to those organisms living in or feeding on the sediment.

4.2.5 Spiked Bioassay Approach

In this approach. dose-response relationships are determined by exposing test organisms. under controlled laboratory conditions. to sediments that have been spiked with known amounts of contaminants (OMOE 1987, 1988). Sediment quality guideline values can then be determined using the sediment bioassay data in a manner similar to that in which aqueous bioassays are used to establish water quality criteria. Where chronic toxicity data are not available, an approximation can be obtained by using acute toxicity endpoints that have been adjusted downwards by a factor of ten to obtain a chronic protection level and then applying a suitable safety factor.

Advantages:

The major advantage of this approach is that a direct cause-effect relationship can be determined. at least under laboratory conditions, for a specific chemical or combination of chemicals for any species of organism.

Limitations:

Despite this advantage, limitations exist that, at present, preclude the use of this method for setting guidelines. Techniques have not been standardized for spiking sediments and differences in methods/techniques can strongly influence the results. In addition. laboratory bioassays performed under controlled conditions may not be directly applicable to field situations where conditions may vary considerably from those encountered in the laboratory. In order to derive realistic guidelines from the Bioassay Approach efforts will have to be made to test different sediments with various chemical mixtures in differing proportions and using different organisms, as would exist in field situations.

4.3 Summary Evaluations of the Various Approaches to PSQG Development

As pointed out earlier, the major objectives in the development of sediment quality guidelines are to provide protection to aquatic organisms and ensure water quality protection, as well as guidance in decision-making related to abatement efforts and remedial action. As such they are intended to be both proactive and reactive in application. The primary basis for such decisions is the protection of biological resources against the lethal and sublethal effects of contaminated sediment.

The biological resources that could potentially be impacted by contaminants in sediment span a wide range. These include organisms that could be impacted directly, namely the benthic species that live in or feed on the sediment, and water column organisms that could sorb contaminants released from the sediment to water and/or through the consumption of benthic organisms; and those impacted indirectly such as non-aquatic consumers (humans and wildlife) of top aquatic predators such as fish.

In reviewing the five approaches to setting sediment guidelines, it is apparent that each approach has certain merits as well as limitations.

The Background Approach while lacking a biological basis, does provide a good indication of the levels at which metals are expected to occur naturally and thus provides a realistic lower limit for guideline development.

The partitioning approaches to sediment guideline development use existing criteria such as a water quality or tissue residue criteria which can be considered as virtual no-effect values. The resulting sediment guidelines can therefore also be considered as virtual no-effect values for the protection of water column organisms from sediment-bound contaminants.

The partitioning approach is attractive because it is capable of providing a measure of contaminant availability from sediments with a minimum of data. Due to the incorporation of various safety factors in the generation of PWQOs, this approach is able to provide an estimate of the no-effect level of a contaminant in sediments. How protective this value may be depends on the sediment organisms, the size of the safety factor, and the type of sediment. The approach is limited by its assumption of a single route of exposure for aquatic organisms and its restriction to the non-polar organics.

The AET approach appears best suited to discriminating between contaminated and uncontaminated areas within a site, since the data used tend to be highly site specific. As a result, any guidelines derived will also be site-specific. The major limitation lies in the assumption of a cause-effect relationship that the methods proves unable to demonstrate. There is also a paucity of chronic effects data suitable for AET applications, particularly if consistency in level of protection (i.e. single species and endpoint) is desired. Therefore. the AET approach is judged less acceptable than the other effects-based approaches.

The SLC approach has an advantage in that no cause-effect relationships are assumed and therefore, it does not need to account for all of the natural environmental factors that can affect organisms. The effects of these are already integrated into the data. The effects of multi-contaminant interactions are also factored into the data set used in the calculations and, with a sufficiently large database, the effects of other contaminants can be minimized.

The SLC approach would be less defensible on a theoretical basis than the Spiked Bioassay Approach if the data bases for the two approaches were comparable. It has been found, however, that relevant information from bioassays is considerably lacking, especially in relation to the impacts of chemical mixtures on benthic populations. Due to the paucity of Spiked Bioassay data, it is difficult to achieve consistency in the level of protection (i.e. a variety of species and endpoints must be considered). The problem could be rectified with further chronic data acquisition, particularly if standard spiking techniques were adopted. In practice, the methodology has not been standardized and variations in experimental protocol can greatly influence the results. The ability to transpose laboratory derived results to natural situations is also questionable.

Since there is presently a significant lack of adequate data for use in the development of sediment quality guidelines using the spiked bioassay approach, the SLC approach offers the best means of developing sediment quality guidelines for the protection of the benthic community. This is especially true since there already exists a good database for the Great Lakes Region.

In accordance with the merits and limitations of the various approaches to sediment guideline development, their use can be summarized as follows:

- Partitioning approaches have been used to develop virtual no-effect levels for the protection of water quality and uses, and health risks associated with humans and wildlife through the consumption of fish. These can be used to set sediment contaminant levels that are also protective of these same uses.

- The effects-based approaches (AET, SLC and Bioassay) are being used to develop guidelines for the protection of benthic organisms. Based on the existing information base, only the SLC approach is of immediate use in the development of sediment quality guidelines.

- The Background Approach has been used to establish levels where adequate data do not exist for application of any of the other methods or where the methods used are inappropriate for the type of compound. In addition, background levels provide a practical lower limit for management decisions.

As sediment bioassay techniques are refined and standardized it may be necessary to revise the protocol to accommodate these techniques as well, though it is unlikely that these will ever supplant field based approaches such as the SLC, since some field verification of laboratory results will always be necessary.

4.4 CALCULATION OF SEDIMENT QUALITY GUIDELINES

The calculation of specific guideline values for the three levels of guidelines referred to in Section 2 are described in detail below.

4.4.1 THE NO EFFECT LEVEL

Since this is intended as the level at which contaminants in sediments do not present a threat to water quality and uses, benthic biota, wildlife or human health, the parameter values used in deriving the No Effect Levels must be the most stringent criteria.

The No Effect Level is principally designed to protect against biomagnification through the food chain. Since these effects are most often observed with the nonpolar organics, this guideline level is not applicable to most of the trace metals.

The partitioning approaches are used to set these guidelines since, with appropriate safety factors PWQOs/Gs are designed to protect against biomagnification of contaminants through the food chain, as well as all water quality uses and organisms.

At present, reliable partition coefficients can only be derived for the nonpolar organics, since only these compounds undergo predictable partitioning behaviour in sediments. No Effect Level Guidelines cannot be calculated for metals and polar organics.

Non-Polar Organics

The No Effect Level for non-polar organics is obtained through a chemical equilibrium partitioning approach using PWQOs.

The calculations for each criterion are as follows:

A PWQO/G value is multiplied by an organic carbon-normalized sediment-water partition coefficient, K_{oc}. Normalization was recommended by Pavlou and Weston (1984) and OMOE (1988) since sediment organic carbon has been found to be the primary environmental factor influencing partitioning.

A PSQG is then derived through the equation:

$$SQG = K_{oc} \times PWQO/G$$

where PSQG is the sediment quality guideline normalized to the sediment organic carbon content (TOC). This is converted to a bulk sediment basis by assuming a 1% TOC concentration. A 1% level for sediment organic carbon is used for converting to a bulk sediment basis, since calculations using the SLC approach have shown that this is the lowest effect level of organic carbon in the sediment. A bulk sediment calculation based on the actual organic carbon content of the sediment has been avoided for this reason.

The organic carbon-normalized partition coefficient is calculated from either an experimentally derived sediment-water partition coefficient:

$$K_{sed} = \frac{[X]_{sed} / o.c.}{[X]_{iw}}$$

where $[X]_{sed}$ is the concentration of compound X in the sediment (as mass of X/mass of organic carbon) and $[X]_{iw}$ is the concentration of the compound in the interstitial water (as gms/L) (Pavlou 1987)

or it can be reasonably accurately derived from the octanol-water partition coefficient according to the formula developed by Di Toro *et al*

(1985)(in OMOE 1988).

$$\log_{10} K_{oc} = 0.00028 + 0.983 \log_{10}(K_{ow})$$

The K_{oc} value used is derived by taking the geometric mean of the available K_{oc} values.

Both measured and calculated K_{oc} values can be used to derive a K_{oc} and a number of values are required to estimate the K_{oc} used.

K_{oc} values should be calculated from laboratory derived sediment - water partition coefficients whenever possible, rather than from values derived from the octanol-water partition coefficient (K_{ow}).

Since the No Effect Level Guidelines make use of the PWQO/Gs which employ safety factors to ensure conservative levels, it is anticipated that the sediment guidelines derived from these will be conservative as well. While the distribution of non-polar organics in the pre-colonial sediment horizon should technically be zero, it is recognized that a certain amount of sediment contamination has occurred from remote sources through atmospheric inputs. Since guidelines set below these background levels would be impractical, the background levels must form the lower limits of any sediment quality guidelines. To this end, Background levels for the non-polar organics are provided in this document for comparative purposes. These are based on the average of the upper Great Lakes, deep basin surficial (top 5 cm) sediment concentrations, or in some cases, on concentrations in bluff materials. It is expected that where the No Effect Level guidelines derived by the partitioning method fall below these background levels, the background levels will provide the practical lower limit for management purposes.

The deep basin surficial sediment concentrations from the Upper Great Lakes can be considered as representative of atmospheric inputs of the persistent (generally nonpolar) organics. Table 5 gives the background levels for those compounds for which upper Great Lakes level have been calculated, and these can be considered as normal background levels for management purposes. This is not to be construed as a tacit acceptance of this level of contamination, but merely recognizes the ubiquitous distribution of these contaminants.

4.4.2 THE LOWEST EFFECT LEVEL

The Lowest Effect Level is the level at which actual ecotoxic effects become apparent. It is derived using field-based data on the co-occurrence of sediment concentrations and benthic species. The Screening Level Concentration method described in the previous section is used for all types of contaminants.

The calculation of the SLC is a two step process and is calculated separately for each parameter. In the first step, for each parameter the individual SLCs (termed Species SLCs) are calculated for each of the benthic species. The sediment concentrations at all locations at which that species was present are plotted in order of increasing concentration (Figure 1a). From this plot, the 90th percentile of this concentration distribution is determined. The 90th percentile was chosen to provide a conservative estimate of the tolerance range for that species. This would serve to eliminate extremes in concentrations that may be due to specific and unusual sediment characteristics. The 90th percentile is that locus below which 90 percent of the sediment concentrations fall.

In the second step, the 90th percentiles for all of the species present are plotted, also in order of increasing concentration (Figure 1b). From this plot, the 5th percentile and the 95th percentile are calculated. These represent the concentrations below which 5 percent and 95 percent of the concentrations fall.

1. <u>Metals, Nutrients, and Polar Organics</u>

Calculate the 5th percentile of the SLC based on bulk-chemistry sediment data. Since the guidelines are derived for province-wide application, the locations used should span a wide range of geographical areas within Ontario of varying sediment concentrations of the contaminant. It is important to ensure that both high sediment concentrations as well as low concentrations are used in the data set to ensure the result is not biased towards one end or the other, since this could bias the resulting SSLC. A minimum of 10 observations would be required to calculate a SSLC for any one species. This relatively low minimum has been chosen so as not to exclude less common species, or more importantly, the more sensitive species that may not be present at the more contaminated sites and thus may not be represented at the majority of sites. A minimum of 20 SSLCs (i.e. 20 species) would be required for calculation of an SLC.

2. Non-polar Organics

Calculate the SLC as above, but using contaminant concentrations normalized to the organic carbon content of the sediments (i.e. mass of contaminant/mass of organic carbon as expressed by TOC).

The organic carbon normalized sediment contaminant concentrations are converted back to a bulk sediment concentration assuming a 1% TOC. A limit of 1% TOC has been imposed on the calculation since calculations using the SLC approach have shown that this is the lowest effect level of organic carbon in the sediment.

The Ministry also recognizes that certain parameters addressed in these guidelines, such as the trace metals, occur naturally in aquatic environments. In an area as geologically diverse as Ontario, natural sediment levels can vary considerably from one region of the province to another as a result of differences in local geology. Therefore, the Ministry realizes that certain sites will naturally exceed the Lowest Effect Level. In such cases, the local background levels, based on the pre-colonial sediment horizon, will form the practical lower limit for management decisions as described in the Implementation Section of this document.

Calculation of Site-Specific Background:

The mean of 5 surficial sediment samples (top 5 cm) taken from an area contiguous to the area under investigation, but unaffected by any current or historical point source inputs.

or:

The mean of 5 samples taken by a sediment core from the pre-colonial sediment horizon. The pre-colonial horizon is generally determined as the sediment below the *Ambrosia* sediment horizon. Except in areas of high sedimentation, such as river mouths, this can be estimated as that sediment lying below the 10 cm sediment depth.

4.4.3 THE SEVERE EFFECT LEVEL

This level represents contaminant levels in sediments that could potentially eliminate most of the benthic organisms. It is obtained by calculating the 95th percentile of the SLC (the level below which 95% of all SSLCs fall).

1. Metals, Nutrients, and Polar Organics

Calculate the 95th percentile of all SSLCs using the bulk chemistry values.

2. Non-polar Organics

Calculate the SLC as for the metals, but normalizing the data to the organic carbon content (TOC) of the sediments. The TOC-normalized SLC is then converted to a bulk sediment value at the time of application to a specific site, based on the actual TOC concentration of the sediments at that site (to a maximum of 10%, the 95% SLC guideline for TOC (Table 1)).

The selected guidelines are inferred values, based on available data and are subject to revision as new data become available. Subsequent revisions will follow the same logical selection process, though using an expanded data-base.

4.5 DATA REQUIREMENTS

A PWQO or PWQG is required for setting levels according to the partitioning approach. In order to maintain consistency between sediment and water quality guidelines, levels set by other agencies will not be used.

At least three estimates of partitioning coefficients would be required to set a guideline using the partitioning approach. Guidelines based on fewer than the minimum number of estimates would be regarded as tentative.

The range of contaminant concentrations for the SLC calculations should span at least two orders of magnitude and include data from both heavily contaminated areas and relatively clean areas. Data from clean areas are needed to ensure that sensitive species are included in the SLC calculation, while heavily contaminated areas are needed to ensure that the full tolerance range of all the species is covered.

The database for the SLC calculations should be based on primarily benthic infaunal species and should minimize the reliance on epibenthic species. A minimum of 75% benthic infaunal species would be required to ensure that the observed effects are from sediment associated contaminants and not from water column effects.

Consistency in the species data used has to be ensured. This requires checking the data for synonymies, unusual species distributions, and level of identification. The minimum acceptable taxonomic level would be the genus, provided that species level identifications were also included in the data set from which the information was derived. Data using only generic level identifications could not be used.

The SLC database must include a large range of areas sampled in order to minimize the effects of unmeasured but co-varying contaminants. Since these are unlikely to occur in the same relation at all other areas, the effects of other contaminants can be reduced or excluded if a sufficiently large number of different areas are included.

A minimum of 10 observations are required to calculate an SSLC. A minimum of 20 SSLCs are required to calculated an SLC. This low number has been chosen so as not to exclude the less common or more sensitive species that may not be present at more highly contaminated sites.

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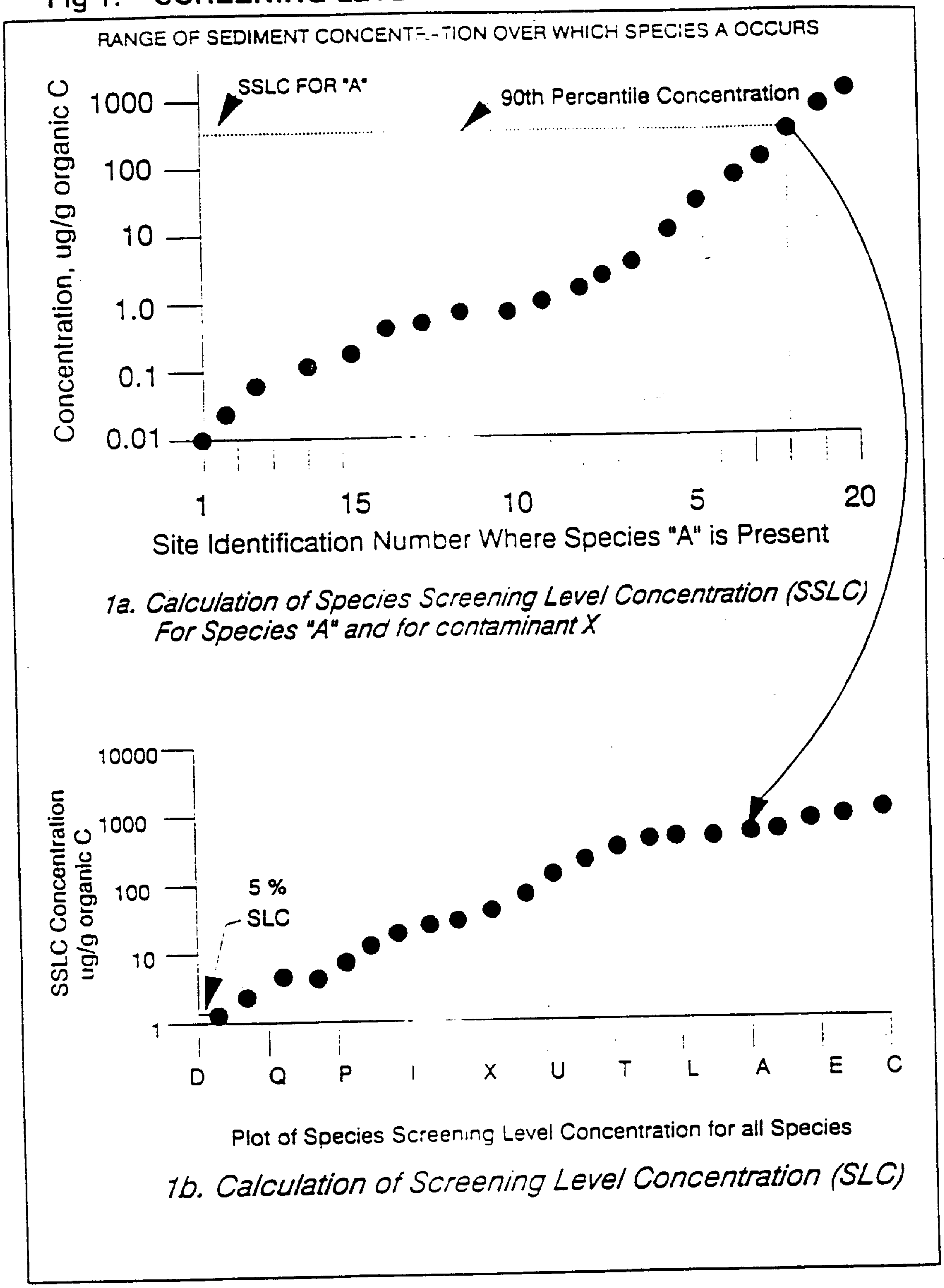
Fig 1: SCREENING LEVEL CONCENTRATION CALCULATION



1a. Calculation of Species Screening Level Concentration (SSLC) For Species "A" and for contaminant X

1b. Calculation of Screening Level Concentration (SLC)

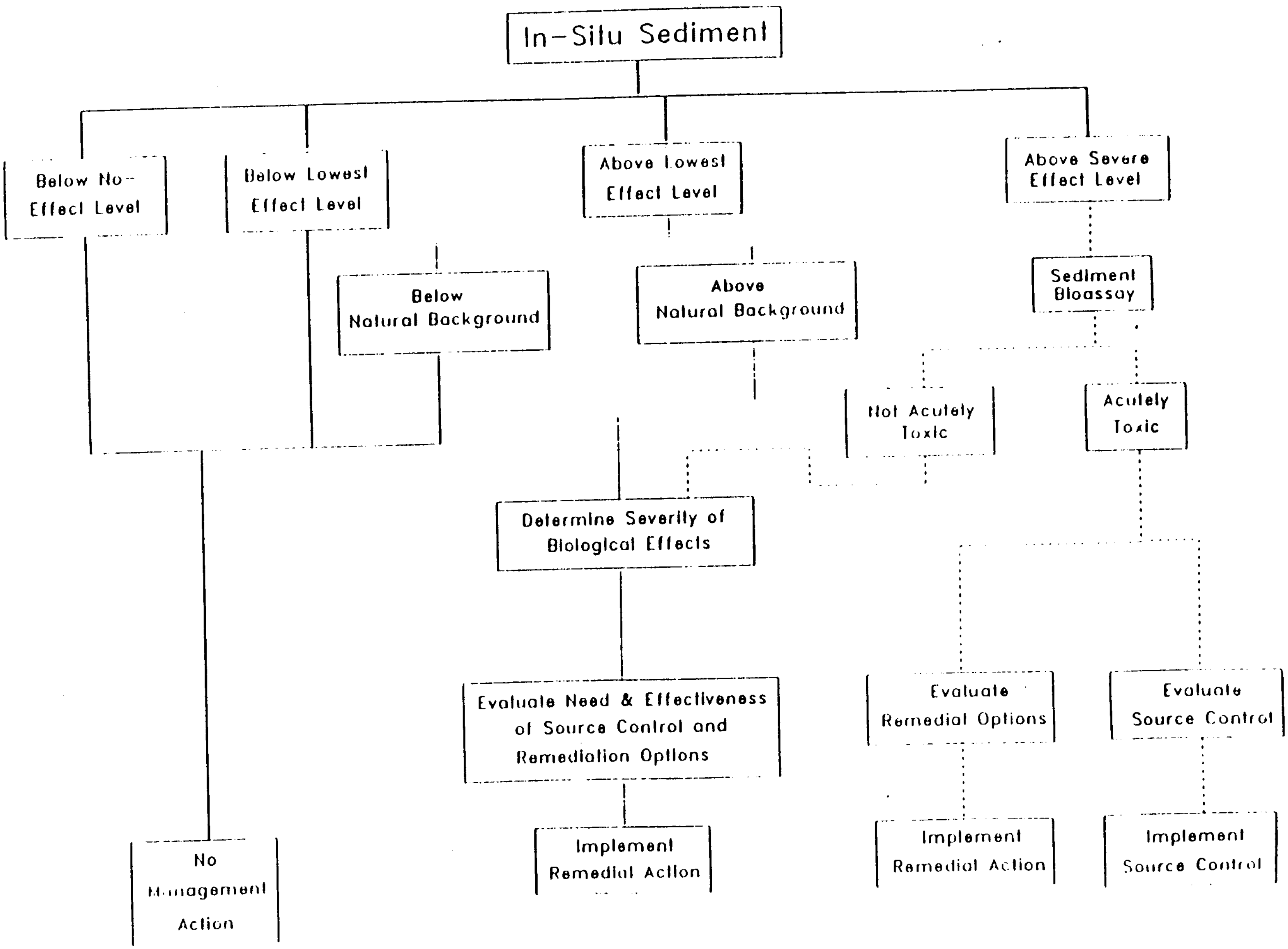


Figure 2: Application of Provincial Sediment Quality Guidelines to Sediment Assessment.

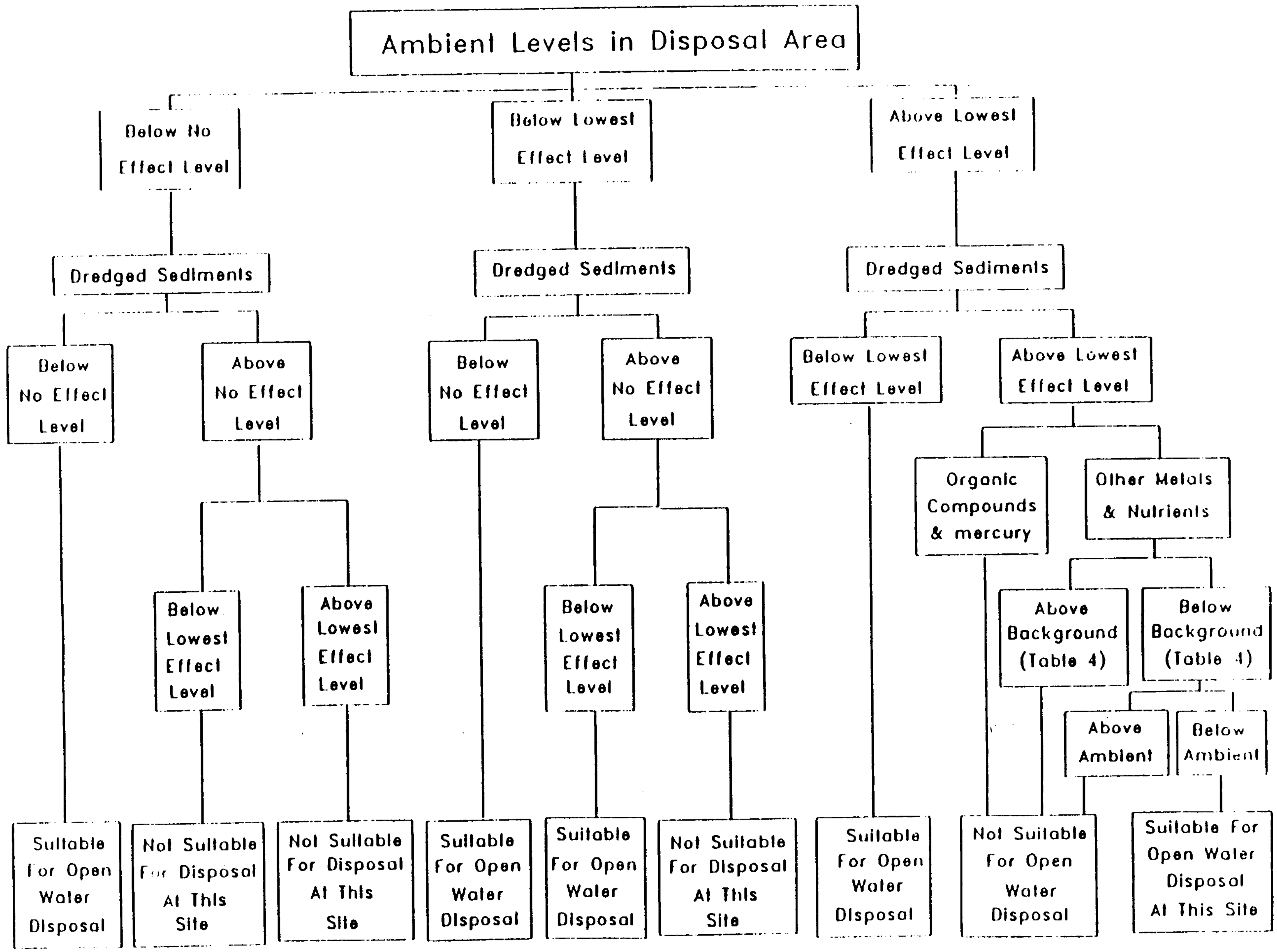


Figure 3: Application of Provincial Sediment Quality Guidelines to Dredging Activities

DEVELOPMENT OF THE ONTARIO PROVINCIAL SEDIMENT QUALITY GUIDELINES FOR ARSENIC, CADMIUM, CHROMIUM, COPPER, LEAD, MANGANESE, MERCURY, NICKLE, AND ZINC

AUGUST 1993

Ontario

Ministry of Environment and Energy

DEVELOPMENT OF THE ONTARIO PROVINCIAL SEDIMENT QUALITY GUIDELINES FOR ARSENIC, CADMIUM, CHROMIUM, COPPER, IRON, LEAD, MANGANESE, MERCURY, NICKEL, AND ZINC

Report prepared by:

R. Jaagumagi
Water Resources Branch
Ontario Ministry of the Environment and Energy

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ACKNOWLEDGMENTS

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PREAMBLE

The Provincial Sediment Quality Guidelines are a set of numerical guidelines developed for the protection of aquatic biological resources. The procedures used in setting the guidelines, and the calculation and data evaluation methods are described in detail in the Protocol for Setting Provincial Sediment Quality Guidelines (Persaud *et al* 1992).

The guidelines set out in this document have defined two levels of ecotoxic effects:

1. A Lowest Effect Level indicating a level of sediment contamination at which the majority of benthic organisms are unaffected.

2. A Severe Effect Level indicating a level at which pronounced disturbance of the sediment-dwelling community can be expected. This is the sediment concentration of a compound that would be detrimental to the majority of benthic species.

Both of these guideline levels are derived by the Screening Level Concentration method described in Persaud *et al* (1992). The SLC method makes use of field data on sediment concentrations of contaminants and the co-occurrence of benthic invertebrate species. The calculation of the SLC is a two step process and is calculated separately for each parameter. In the first step, for each parameter the individual SLCs (termed Species SLCs) are calculated for each of the benthic species. The sediment concentrations at all locations at which that species was present are plotted in order of increasing concentration. From this plot, the 90th percentile of this concentration distribution is determined. The 90th percentile was chosen to provide a conservative estimate of the tolerance range for that species. This would serve to eliminate extremes in concentrations that may be due to specific and unusual sediment characteristics. The 90th percentile is that locus below which 90 percent of the sediment concentrations fall.

In the second step, the 90th percentiles for all of the species present are plotted, also in order of increasing concentration. From this plot, the 5th percentile and the 95th percentile are calculated. These represent the concentrations below which percent and 95 percent of the concentrations fall. The concentration at the 5th percentile becomes the Lowest Effect Level and the concentration at the 95th percentile becomes the Severe Effect Level

This document details the derivation of the metals guidelines and summarizes the data used to derive the guideline values. The document also summarizes the properties and fate of the metals, describes the various forms in which metals can exist in sediments and provides the necessary details of the calculations used to arrive at the sediment quality guidelines (PSQGs).

INTRODUCTION

Metals in aquatic systems can originate from natural sources through the weathering of mineral-rich rock, and from anthropogenic sources, principally municipal or industrial discharges and urban runoff.

In aquatic systems most metals will form complexes with ligands and although they can remain in solution for extended periods of time, their ultimate fate is deposition in the sediments.

The behaviour of metals in sediments is very complex and cannot be easily characterized. Part of the difficulty in attempting to characterize metal behaviour lies with the number of different forms in which metals can exist. These forms, and the sediment components in which they can reside, have direct implications on their bioavailability and rate of uptake by aquatic biota.

The remainder of this document describes the fate of each metal in the aquatic system and details the derivation of the Lowest Effect Levels and the Severe Effect Levels.

ARSENIC

i. Aquatic Fate

Arsenic occurs naturally as arsenic minerals, generally in combination with sulphur, iron and nickel (CCREM 1987). It is released into aquatic systems through the natural weathering of arsenic minerals. Anthropogenic sources to the aquatic environment are the smelting of sulphide minerals and the combustion of fossil fuels, principally coal.

The major commercial uses of arsenic are in glassmaking and the manufacture of medicinal compounds, pesticides, electronics, and in alloys with lead and copper (CCREM 1987).

Arsenic most commonly exists in the oxidation states As(III) and As(V). In surface waters and sediments, the oxidation state of arsenic is sensitive to changes in pH, Eh and dissolved oxygen. While As(III) is the dominant form under anaerobic conditions, As(V) becomes more prevalent under aerobic conditions.

Arsenic in the water column can be sorbed to organic matter or coprecipitated with hydrated iron, manganese and aluminum oxides and deposited in the sediments. Iron and manganese oxides/hydroxides appear to be the most important scavengers of arsenic, particularly in coarser sediments low in organic matter. In fine grained sediments, sorption to organic matter appears to be the most significant fate (Brook & Moore 1988). In oxidized sediments both of these fractions serve to strongly bind arsenic in the sediments. Under reducing conditions arsenic can be released to the water column or can form sulphides as the Fe and Mn oxides dissolve. Under reducing conditions, organic bound arsenic generally forms insoluble sulphides.

Arsenic can also exist in sediments as free ions in the sediment pore water, as well as bound to other sediment fractions. Arsenic in the sediment pore water seems to be controlled by the solubility of iron and manganese oxyhydroxides in the oxidized layer (particularly as these dissolve under the advent of reducing conditions) and metal sulphides in the sulphide layer (Moore *et al* 1988). These differences account for the low concentrations of arsenic generally observed in the pore water in the oxidized zone and the relatively much higher levels in pore water below the redox boundary.

Arsenic can also form a number of organo-arsenical compounds in the presence of organic matter, of which the methylated arsenic(V) species (formed by the biological methylation of inorganic arsenic compounds) are the most important (CCREM 1987). The most common of the methylarsines is dimethylarsinic acid. Methylarsine compounds can also be demethylated in the sediments.

Availability of arsenic to biota from sediments appears to be low under oxidizing conditions. Bioaccumulation of arsenic has been observed in numerous aquatic organisms, though there is no evidence that arsenic can be biomagnified through the food chain. While the metallo-organic forms of As may be more bioavailable to organisms, these also appear to be more readily excreted.

ii <u>Sediment Guidelines</u>

Lowest Effect Level

The Lowest Effect Level for arsenic is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for arsenic was calculated on the basis of sediment concentrations from 442 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 2 μg/g to 56 μg/g. The SLC was calculated from the Species SLCs for 92 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 1. A detailed plot of the SLC is provided in Figure 1.

The 5th percentile of the SLC is calculated as 5.5 μg/g which is rounded to 6 μg/g and this value becomes the Lowest Effect Level.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level Concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 1. Figure 1 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 32.6 μg/g which is rounded to 33 μg/g and this value becomes the Severe Effect Level.

CADMIUM

i. Aquatic Fate

Cadmium in nature commonly occurs as a sulphide ore, usually found in association with zinc ores such as sphalerite (CCREM 1987). Cadmium is economically recoverable only when it occurs in association with zinc-, lead- and copper-bearing ores.

The principal use of cadmium is as an alloy in electroplating, in nickel-cadmium batteries, solders, electronic equipment, photography supplies, glass, ceramics, and plastics (CCREM 1987).

The major anthropogenic sources to the aquatic environment are through emissions to air and water from mining and smelting and in the manufacture of the products noted above. Additional losses occur from agricultural uses and from the burning of fossil fuels (CCREM 1987).

In water, cadmium generally occurs in the Cd(II) form as a constituent of inorganic (halides, sulphides, oxides) and organic compounds (CCREM 1987). Cadmium in the water column can exist as free ions (small amount) or complexed to various ligands such as humic acids, organic particles and various oxides. Transport of cadmium to the sediments occurs mainly through sorption to organic matter and subsequent settling, and through coprecipitation with iron, aluminum, and manganese oxides. Cadmium can also be deposited in sediments through ion exchange (mainly with calcium) on minerals. These phases account for most of the sediment-bound cadmium.

Cadmium can also exist in sediments as free ions in the sediment pore water, as well as bound to other sediment fractions. Sediment pore water concentrations seem to be controlled by the solubility of iron and manganese oxyhydroxides in the oxidized layer (particularly as these dissolve under the advent of reducing conditions) and metal sulphides in the sulphide layer (Moore *et al* 1988).

The availability of sediment cadmium to aquatic organisms depends on such factors as pH, redox potential, and water hardness (presence of calcium) and the presence of other complexing agents. Uptake by biota appears to depend on the availability of free ions (uptake through adsorption), and strength of binding to sediment solid phases (uptake through absorption). Studies suggest that cadmium generally has a long residence time in biological tissues.

ii. Sediment Quality Guidelines

Lowest Effect Level

The Lowest Effect Level for cadmium is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for cadmium was calculated on the basis of sediment concentrations from 429 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 2 µg/g to 46 µg/g. The SLC was calculated from the Species SLCs for 95 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 2. A detailed plot of the SLC is provided in Figure 2.

The 5th percentile of the SLC is calculated as 0.6 µg/g and this value becomes the Lowest Effect Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 2. Figure 2 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 9.5 µg/g, rounded to 10 µg/g and this value becomes the Severe Effect Level.

CHROMIUM

i. Aquatic Fate

The principal source of chromium is the mineral chromite (chromium-iron oxide). In rocks and soils, chromium is usually present as an insoluble chromium oxide (CCREM 1987).

The main commercial uses of chromium (Cr(VI)) are as a chrome alloy in chromium metal products and in chrome plating, and to a lesser extent, as compounds in paints, dyes, explosives, ceramics and paper. Cr(III) is used in dyeing, the manufacture of glass and ceramics, and in photography. Chromium can also be present in some fertilizers and pesticides (CCREM 1987).

The major anthropogenic sources of chromium to the aquatic environment are the ferrochromium production industry, metal plating, and to a lesser extent, cement production and the burning of fossil fuels.

In aquatic systems, chromium is present mainly in the Cr(III) (chromic compounds) and the Cr(VI) (chromate and dichromate) states (CCREM 1987). The Cr(VI) form is relatively soluble and is not sorbed to any significant degree by particulate matter. In water, Cr(VI) reacts strongly with oxidizable, usually organic, molecules with the resultant formation of Cr(III). Cr(III) can be transported to the sediments through sorption to organic particles and coprecipitation with hydrous iron and manganese oxides. Under anaerobic conditions Cr(VI) is reduced to Cr(III). Under anoxic conditions in the sediment, Cr can form insoluble sulphides.

Cr(VI) is more readily bioaccumulated than Cr(III) and is considered the more toxic form. Tissue residue levels however, are generally lower than sediment levels (CCREM 1987). There is no evidence that chromium can biomagnify through the food chain.

ii Sediment Quality Guidelines

Lowest-Effect Level

The Lowest Effect Level for chromium is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for chromium was calculated on the basis of sediment concentrations from 463 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 3 µg/g to 1700 µg/g. The SLC was calculated from the Species SLCs for 92 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 3. A detailed plot of the SLC is provided in Figure 3.

The 5th percentile of the SLC is calculated as 25.6 µg/g which is rounded to 26 µg/g. This value becomes the Lowest Effect Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 3. Figure 3 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 113.8 µg/g which is rounded to 110 µg/g and this value becomes the Severe Effect Level.

COPPER

i Aquatic Fate

Copper occurs naturally in rocks and minerals either as native copper, or, more commonly, as a mineral ore. More than 160 copper containing minerals have been described (CCREM 1987). Since copper is a common element in rock, weathering of rock can release significant amounts to water.

The uses of copper are highly varied, but principal uses are in alloys, electroplating, electrical wiring, paints, and pesticides.

Copper in aquatic systems can exist in four oxidation states, of which Cu(I) and Cu(II) are the most common. Cu(I) under aerobic conditions is readily oxidized to Cu(II). In natural waters copper undergoes complex reactions and can be present in solution, either as cupric ions or complexed with inorganic or organic ligands. Copper is transported to the sediments most often in association with organic matter, and as precipitates of hydroxides, phosphates and sulphides. Copper in sediments has a high affinity for hydrous iron and manganese oxides, clays, carbonate materials and organic matter, though the formation of these complexes is pH and redox dependent. Under normal pH and inorganic carbon, most of the copper appears to be present in the form of organic complexes, cupric carbonate complexes and coprecipitates with iron and manganese oxides (Brook & Moore 1988; CCREM 1987).

Copper in reducing sediments is primarily in the form of sulphide complexes, while in the oxidized zone it is mainly present as organic complexes or bound to hydrous iron and manganese oxides. Therefore, under anaerobic conditions, Cu is generally immobilized in the sediments.

Release of copper from sediments can be either through ion exchange, solubilization of the matrix (e.g. flux of Fe/Mn oxides under reducing conditions) or decomposition of the matrix (e.i. organic matter).

Since copper is an essential micronutrient it is readily accumulated by aquatic organisms, especially the lower animals, but no evidence exists for biomagnification. Some evidence exists to suggest that some organisms can limit the uptake of copper generally through increases in depuration rates (Luoma 1983).

ii Sediment Quality Guidelines

Lowest Effect Level

The Lowest Effect Level for copper is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for copper was calculated on the basis of sediment concentrations from 493 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 5 µg/g to 28,000 µg/g. The SLC was calculated from the Species SLCs for 95 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 4. A detailed plot of the SLC is provided in Figure 4.

The 5th percentile of the SLC is calculated as 16.4 µg/g which is rounded to 16 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 4. Figure 4 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 106.8 µg/g which is rounded to 110 µg/g and this value becomes the Severe Effect Level.

IRON

i Aquatic Fate

Iron is one of the most abundant elements in the earth's crust. Iron exists as iron oxides and sulphides in igneous, sedimentary and metamorphic rock.

Sources to the aquatic environment are through natural weathering of rock, while the principal anthropogenic sources are mineral processing, smelting and processing of iron, sewage, and burning of coke and coal.

Iron exists in two main oxidation states in water: Fe(II) and Fe(III). The Fe(III) form is insoluble in aerobic waters and usually forms precipitates (as hydrated oxides). Under anoxic conditions, the more highly soluble Fe(II) form predominates.

Iron in the water column forms oxides which themselves are important scavengers of other trace metals. Iron in aerobic sediments usually exists in the form of hydrated oxides. Under anaerobic conditions, it can form complexes with sulphides, and together with desorption and release of iron to the water column, appear to be the principal mechanisms under anaerobic conditions.

No information was available on the toxicity of iron to aquatic biota.

ii Sediment Quality Guidelines

Lowest Effect Level

The Lowest Effect Level for iron is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for iron was calculated on the basis of sediment concentrations from 493 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 13 μg/g to 210,000 μg/g. The SLC was calculated from the Species SLCs for 95 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 5. A detailed plot of the SLC is provided in Figure 5.

The 5th percentile of the SLC is calculated as 21,200 μg/g (2.0%) and this value becomes the Lowest Effect Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 5. Figure 5 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 43,766 μg/g (4%) and this value becomes the Severe Effect Level.

LEAD

i Aquatic Fate

Lead occurs naturally as a constituent in a variety of minerals. The single largest use of lead is in the production of lead-acid batteries, and secondarily, in the production of chemical compounds such as tetraethyllead. Other uses include ammunition manufacture, paints, glassware, electroplating, electronic equipment, plastics, solder, specialized containers and construction materials.

Weathering of lead minerals is the principal natural source of lead to the environment. Anthropogenic sources include street runoff, mining and smelting operations, and sewage treatment plants.

Three oxidation states are of particular environmental importance in aquatic systems, though of these, Pb(II) is the most stable ionic species. Transport of lead to sediments is mainly through coprecipitation with hydrous iron and manganese oxides, complexation with clays (which can also contain appreciable amounts of iron and manganese hydroxides) and sorption to organic matter. In sediments, much of the lead is found in association with the Fe/Mn hydroxides. In oxidized sediments lead is strongly bound to the hydroxide and organic matter fractions of the sediments. Under reducing conditions lead can be released to the water column or can form sulphides as the Fe and Mn oxides dissolve.

Lead can be bioaccumulated by aquatic organisms. Organisms held at lower pH (approx. 6.0) accumulated more lead than at higher pH presumably due to the greater availability of divalent lead at these pH levels. Pb(II) appears to be the most bioavailable species. In general, the organic forms (e.g. tetraethyllead) appear to be the most bioavailable.

ii Sediment Quality Guidelines

Lowest Effect Level

The Lowest Effect Level for lead is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for lead was calculated on the basis of sediment concentrations from 448 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 5 μg/g to 20,000 μg/g. The SLC was calculated from the Species SLCs for 95 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 6. A detailed plot of the SLC is provided in Figure 6.

The 5th percentile of the SLC is calculated as 31 μg/g and this value becomes the Lowest Effect Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 6. Figure 6 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 250 μg/g which is not rounded and this value becomes the Severe Effect Level.

MANGANESE

i Aquatic Fate

Manganese occurs naturally as oxide and carbonate minerals and as ferromanganese minerals.

Natural sources are soils, sediments and metamorphic and sedimentary rocks, all of which can contribute Mn to aquatic systems. Anthropogenic sources are primarily the iron and steel industry and mining activity. Municipal wastewater systems can also contribute significant amounts.

Though manganese can exist in a number of oxidation states, the most important forms in aquatic systems are Mn(II) and Mn (IV). Under anoxic conditions, the Mn(II) form predominates, while under oxic conditions the Mn(II) rapidly oxidizes to Mn(IV). In water, Mn(II) oxidizes to manganese oxides which are precipitated. In sediments manganese forms stable hydroxides under aerobic conditions (Moore *et al* 1988). Under anaerobic conditions, manganese can be released from the sediments and can form sulphides or be released back to the water column.

Manganese is an essential micronutrient. No information was available on the toxicity of manganese to aquatic biota.

ii Sediment Quality Guidelines

Lowest Effect Level

The Lowest Effect Level for manganese is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for manganese was calculated on the basis of sediment concentrations from 256 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 30 μg/g to 2,000 μg/g. The SLC was calculated from the Species SLCs for 38 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 7. A detailed plot of the SLC is provided in Figure 7.

The 5th percentile of the SLC is calculated as 457 μg/g which was rounded to 460 μg/g and this becomes the Lowest Effect Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 7. Figure 7 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 1060 μg/g which is rounded to 1100 μg/g and this value becomes the Severe Effect Level.

MERCURY

i Aquatic Fate

Mercury occurs most commonly as the or cinnabar, but can also be present in more than 3 other common ores and minerals.

Mercury is used in the production of chlorine, caustic soda and hydrogen, in the paint industry, the pulp and paper industry, for electrical equipment, in medicinal compounds and thermometers (CCREM 1987).

Significant anthropogenic sources to aquatic systems include mining and smelting, coal combustion, paints and, in the past, the chlor-alkali industry.

In aquatic systems mercury is generally sorbed to particulate matter. Mercury can exist in three oxidation states: elemental, Hg(I) and Hg(II). In natural waters at low redox potential, Hg(II) is the predominant species. Mercury tends to combine with sediment organic matter. In anaerobic sediments, mercury can combine with sulphur to produce insoluble sulphides (Rudd *et al* 1983). Both Hg(I) and Hg(II) can be methylated by microorganisms under aerobic and anaerobic conditions. Where pH is high and elemental mercury concentrations are low, the dimethyl form predominates, while under conditions of low pH and high concentrations of elemental mercury, the monomethyl form predominates. Both forms may also be demethylated by bacteria in sediments.

Rates of methylmercury production are strongly affected by oxygen. Production can be orders of magnitude higher in anoxic sediments, but this can be effectively reduced by the presence of sulphides through the binding of inorganic Hg.

The methylated forms of mercury are usually the more highly bioavailable forms. However, plankton appear to accumulate mostly the inorganic forms of mercury (Rudd *et al* 1983).

Bioaccumulation and bioconcentration of organic forms is high, and methylmercury can be biomagnified. Accumulation in most aquatic organisms occurs due to a rapid rate of uptake coupled with a slow depuration rate. Since rate of solubility and methylation increase at lower pH, uptake can be higher under acidic conditions (CCREM 1987). Uptake of elemental mercury appears to be low (Rudd *et al* 1983).

ii <u>Sediment Quality Guidelines</u>

Lowest Effect Level

The Lowest Effect Level for mercury is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for mercury was calculated on the basis of sediment concentrations from 473 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.1 μg/g to 304 μg/g. The SLC was calculated from the Species SLCs for 95 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 8. A detailed plot of the SLC is provided in Figure 8.

The 5th percentile of the SLC is calculated as 0.16 μg/g which is rounded to 0.2 μg/g and this value becomes the Lowest Effect Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 8. Figure 8 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 2.0 μg/g and this value becomes the Severe Effect Level.

NICKEL

i <u>Aquatic Fate</u>

Nickel occurs naturally as either sulphide ores or arsenides. In ore deposits it commonly occurs with iron and copper.

Nickel is used primarily in the manufacture of stainless steel and other nickel alloys. It is also used as a catalyst in industrial processes and in oil refining (CCREM 1987).

Natural sources of nickel to aquatic systems are through the weathering of minerals and rocks. Anthropogenic sources are the burning of fossil fuels, which can have high nickel content, smelting and refining of nickel ores and alloys, and the electroplating industry.

In aquatic systems nickel occurs primarily in the Ni(II) form. In the water column, nickel occurs as relatively soluble salts that form a large number of complexes with organic materials. Nickel is deposited in the sediments through coprecipitation with iron and manganese oxides and sorption to organic matter.

At neutral pH, nickel in sediments forms complexes with iron and manganese oxides, though mobility from the sediments increases below pH 6.0 (CCREM 1987). Under anaerobic conditions, nickel can form insoluble complexes with sulphides.

Nickel can be bioaccumulated by some organisms, though bioconcentration factors decrease from algae to fish. There is no evidence for biomagnification (CCREM 1987).

ii <u>Sediment Quality Guidelines</u>

Lowest Effect Level

The Lowest Effect Level for nickel is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for nickel was calculated on the basis of sediment concentrations from 422 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 4 μg/g to 930 μg/g. The SLC was calculated from the Species SLCs for 92 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 9. A detailed plot of the SLC is provided in Figure 9.

The 5th percentile of the SLC is calculated as 16 μg/g which is not rounded, and this value becomes the Lowest Effect Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 9. Figure 9 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 75.2 μg/g which is rounded to 75 μg/g and this value becomes the Severe Effect Level.

ZINC

i Aquatic Fate

Zinc occurs naturally as sulphide, carbonate and silicate minerals. In sulphides it is commonly found in combination with iron, copper and lead.

Zinc is used in the smelting and production of alloys for a variety of uses.

In aquatic systems, zinc occurs as Zn(II), which is amphoteric. It can also form organozinc compounds. At neutral pH, zinc is deposited in the sediments through sorption to hydrous iron and manganese oxides, clay minerals, and organic matter. Below pH 6.0, adsorption is very low.

Zinc in the water column can be sorbed to organic matter or coprecipitated with hydrated iron and aluminum oxides and deposited in the sediments. Iron and manganese oxides/hydroxides appear to be the most important scavengers of zinc, particularly in coarser sediments low in organic matter, while in fine grained sediments, sorption to organic matter appears to be the most significant fate (Brook & Moore 1988). In oxidized sediments both of these fractions serve to strongly bind zinc in the sediments. Under reducing conditions zinc can be released to the water column or can form sulphides as the Fe and Mn oxides dissolve(?). Under reducing conditions, organic bound zinc generally forms insoluble sulphides (Moore *et al* 1988).

Zinc can also exist in sediments as free ions in the sediment pore water, as well as bound to other sediment fractions. Zinc in the sediment pore water seems to be controlled by the solubility of iron and manganese oxyhydroxides in the oxidized layer (particularly as these dissolve under the advent of reducing conditions) and metal sulphides in the sulphide layer (Moore *et al* 1988).

Zinc is an essential micronutrient and uptake in most aquatic organisms appears to be independent of environmental concentrations. It has been found to bioaccumulate in some organisms, though there is no evidence of biomagnification.

ii Sediment Quality Guidelines

Lowest Effect Level

The Lowest Effect Level for zinc is calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for zinc was calculated on the basis of sediment concentrations from 493 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 4 μg/g to 11,000 μg/g. The SLC was calculated from the Species SLCs for 95 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 10. A detailed plot of the SLC is provided in Figure 10.

The 5th percentile of the SLC is calculated as 120 μg/g and this becomes the Lowest Effect

Level Guideline.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 10. Figure 10 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the SLC plot is calculated as 822 μg/g which is rounded to 820 μg/g and this value becomes the Severe Effect Level.

RESEARCH NEEDS

As is apparent, limitations of the data have in some cases resulted in conservative guideline values. In particular, the SLC method as described in Persaud *et al* (1992) requires that the full tolerance range for each species be sampled and that the data for the species are not biased towards lightly or heavily contaminated areas. It has not been possible in all cases to satisfy these requirements. The sediment concentrations for some of the metals were generally rather low, with only a few species present in areas of high contaminant concentrations. In those cases it is likely that the full tolerance range has not been sampled and the guideline, as derived, may be conservative.

Nonetheless, the values derived compare closely with the lowest effect levels as described from both laboratory studies and field co-occurence studies, similar to the SLC approach (Long and Morgan 1990).

This points to the necessity for future effort to be directed towards incorporating additional data, particularly data from highly contaminated sites. There is also a need to concentrate efforts towards sediment bioassay procedures to verify the results of the SLC process.

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APPENDIX I - TABLES

Species Screening Level Calculations

Explanation of Abbreviations:

N=	- Number of observations used for the calculation of the SSLC.
Mean	- Mean concentration (dry weight) at sites at which the species was present.
%	- Percentile at which the concentration is calculated.
Conc.	- Concentration (dry weight) of the contaminant at the percentile noted.
.	- Insufficient number of observations to calculate percentiles.

Table 1: ARSENIC - Species Screening Level Concentrations (ug/g).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	35	9.17	13.53	0.40	43.00	90	37.40
2	Aelosoma sp	14	4.33	3.37	2.08	12.09	90	12.05
3	Amnicola limosa	100	3.88	3.17	0.40	18.73	90	8.69
4	Asellus sp	79	5.81	5.66	0.60	36.00	90	12.40
5	Aulodrilus limnobius	26	3.93	3.25	1.11	14.00	90	10.49
6	Aulodrilus pigueti	32	2.93	1.48	1.11	8.07	90	5.32
7	Aulodrilus pleuriseta	30	4.71	3.68	0.01	14.00	90	11.87
8	Bithynia tentaculata	33	5.58	5.07	0.40	18.73	90	15.60
9	Branchiura sowerbyi	13	8.91	4.52	2.08	16.00	90	15.60
10	Caenis sp	34	5.64	9.44	0.96	56.00	90	11.35
11	Ceraclea sp	64	5.06	7.15	1.10	56.00	90	8.77
12	Chaetogaster diaphanus	32	3.19	1.94	0.79	8.90	90	6.67
13	Cheumatopsyche sp	87	4.65	6.37	1.11	56.00	90	8.76
14	Chironomus sp	103	6.01	5.46	1.00	27.00	90	14.80
15	Cladopelma sp	22	3.49	2.47	1.10	9.05	90	8.36
16	Cladotanytarsus sp	48	4.44	7.97	0.40	56.00	90	8.14
17	Coelotanypus sp	13	8.74	6.92	1.86	24.70	90	20.82
18	Cricotopus sp	60	6.46	9.15	0.01	43.00	90	12.35
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	128	4.37	4.43	0.40	27.00	90	10.00
21	Dicrotendipes sp	43	4.75	6.59	0.46	36.00	90	10.60
22	Eukiefferiella sp	53	4.49	7.48	1.21	56.00	90	6.16
23	Gammarus fasciatus	218	4.88	5.59	0.01	56.00	90	12.00
24	Glossiphonia heteroclita	4	6.05	2.77	3.60	10.00	90	.
25	Glossosoma sp	40	7.99	11.95	1.75	56.00	90	33.67
26	Glyptotendipes sp	19	5.49	7.00	0.94	27.00	90	19.00
27	Gyraulus parvus	33	4.64	3.24	0.40	12.40	90	9.92
28	Helisoma anceps	12	3.40	2.07	1.11	8.76	90	7.91
29	Heterotrissocladius sp	18	5.30	2.91	1.74	12.00	90	10.03
30	Hyalella azteca	44	5.18	3.64	0.60	15.00	90	11.00
31	Hydropsyche sp	50	3.79	2.29	1.21	12.70	90	5.89
32	Hydroptila sp	38	4.80	8.83	1.11	56.00	90	8.76
33	Ilyodrilus templetoni	18	3.44	2.45	1.11	9.05	90	8.79
34	Limnodrilus hoffmeisteri	189	4.41	4.12	0.01	30.00	90	9.40
35	Limnodrilus sp	63	14.94	11.82	1.00	46.00	90	37.00
36	Limnodrilus udekemianus	38	5.26	7.96	0.40	41.00	90	10.58
37	Lumbriculus variegatus	38	5.47	8.84	0.73	56.00	90	9.90
38	Manayunkia speciosa	68	4.55	4.49	0.57	27.00	90	9.83
39	Microtendipes sp	14	10.02	8.50	1.00	27.00	90	23.50
40	Mystacides sp	15	3.02	1.58	1.46	6.46	90	6.41
41	Nais behningi	27	3.76	2.23	1.21	12.68	90	6.06
42	Nais communis	38	3.55	2.57	0.40	12.68	90	6.48
43	Nais variabilus	70	3.87	2.56	0.01	12.68	90	8.46
44	Nanocladius sp	35	5.26	9.15	1.21	56.00	90	9.02
45	Neureclipsis sp	36	3.54	1.86	1.21	9.81	90	5.66
46	Oecetis sp	38	5.03	5.54	0.46	27.00	90	15.10
47	Parachironomus sp	21	3.47	2.68	0.01	12.00	90	7.60
48	Paralauterborniella sp	16	4.00	1.32	2.25	7.00	90	6.34
49	Paratendipes sp	25	4.05	2.84	0.40	14.00	90	7.16
50	Phaenopsectra sp	41	6.86	11.03	0.46	43.00	90	30.55
51	Phallodrilus sp	24	2.76	2.08	1.50	12.09	90	3.87
52	Physella gyrina	95	4.50	6.08	0.94	56.00	90	8.60
53	Piguetiella michiganensi	48	3.70	2.84	0.40	12.68	90	8.52

54	Pisidium casertanum	179	4.00	2.87	0.01	18.73	90	8.49
55	Pisidium compressum	17	4.26	3.77	0.01	14.00	90	12.40
56	Pisidium conventus	14	3.83	3.13	0.40	12.00	90	9.55
57	Pisidium fallax	94	4.61	6.45	0.57	56.00	90	8.63
58	Pisidium henslowanum	33	3.77	3.94	0.01	18.73	90	10.00
59	Pisidium lilljeborgi	24	3.89	3.29	0.40	14.00	90	9.50
60	Pisidium nitidum	23	3.59	2.12	0.40	8.00	90	7.00
61	Pisidium variabile	23	3.82	3.48	0.01	14.00	90	10.04
62	Pleurocera acuta	78	4.96	6.57	0.57	56.00	90	8.80
63	Polypedilum scalaenum	13	2.65	1.08	1.40	5.40	90	4.72
64	Polypedilum sp	115	6.80	9.55	0.65	56.00	90	13.80
65	Pontoporeia hoyi	41	3.92	3.12	0.40	14.00	90	8.54
66	Potamothrix moldaviensis	66	3.55	2.63	0.01	13.00	90	7.00
67	Potamothrix vejdovskyi	62	4.55	4.26	0.01	27.50	90	10.63
68	Pristina foreli	13	3.33	1.27	1.86	6.37	90	5.76
69	Pristina osborni	46	3.70	2.83	1.11	18.73	90	5.70
70	Procladius sp	215	7.51	8.32	0.01	46.00	90	16.00
71	Prostoma rubrum	116	4.26	5.58	0.57	56.00	90	8.29
72	Pseudocloeon sp	16	7.73	13.15	1.50	56.00	90	22.94
73	Quistadrilus multisetosu	[illegible]	5.20	4.54	0.46	25.40	90	10.30
74	Slavina appendiculata	36	3.60	2.59	1.40	12.09	90	8.59
75	Specaria josinae	29	3.16	2.76	0.40	14.00	90	8.07
76	Sphaerium nitidum	17	4.27	3.16	0.40	14.00	90	8.40
77	Sphaerium striatinum	65	5.24	7.24	0.65	56.00	90	9.73
78	Spirosperma ferox	105	4.37	3.32	0.01	18.73	90	9.18
79	Stenonema sp	55	5.14	7.66	0.57	56.00	90	8.76
80	Stictochironomus sp	14	2.88	2.51	0.46	10.00	90	8.03
81	Stylaria lacustris	55	3.87	2.82	0.01	15.00	90	8.03
82	Stylodrilus heringianus	86	4.92	6.45	0.40	56.00	90	9.17
83	Tanytarsus sp	95	3.58	2.50	0.40	14.00	90	6.86
84	Thienemannimyia sp	64	5.47	7.85	1.00	56.00	90	11.40
85	Tubifex sp	36	16.72	11.54	1.00	43.00	90	37.30
86	Turbellaria	100	4.41	5.94	0.57	56.00	90	8.46
87	Uncinais uncinata	21	2.83	1.58	0.79	7.00	90	5.36
88	Valvata sincera	75	3.59	2.70	0.60	14.00	90	7.00
89	Valvata tricarinata	68	4.38	4.54	0.40	27.00	90	10.00
90	Vejdovskyella intermedia	58	3.71	3.01	0.01	14.00	90	8.77
91	Elliptio complanata	1	3.60		3.60	3.60	90	.
92	Sphaerium simile	0						
93	Chironomus plumosus	79	4.97	4.09	0.90	24.70	90	11.00
94	Cricotopus bicinctus	5	3.54	1.56	1.70	5.19	90	.
95	Ephemera sp	3	3.36	2.37	1.86	6.10	90	.
96	Helobdella stagnalis	25	7.78	6.44	1.43	27.00	90	17.20
97	Hexagenia limbata	23	5.61	5.74	0.66	25.40	90	13.60
98	Hexagenia sp	1	0.65		0.65	0.65	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	62	5.40	4.50	0.73	24.70	90	10.79

Table 2: CADMIUM - Species Screening Level Concentrations (ug/g).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	36	3.68	8.89	0.08	46.00	90	14.30
2	Aelosoma sp	14	0.61	1.03	0.10	4.10	90	2.55
3	Amnicola limosa	89	0.48	0.44	0.01	2.50	90	1.20
4	Asellus sp	58	1.09	1.90	0.10	14.00	90	2.32
5	Aulodrilus limnobius	35	0.64	0.51	0.10	2.50	90	1.20
6	Aulodrilus pigueti	31	0.49	0.32	0.10	1.20	90	1.07
7	Aulodrilus pleuriseta	24	0.73	0.91	0.01	4.10	90	1.95
8	Bithynia tentaculata	43	0.61	0.65	0.10	4.00	90	1.00
9	Branchiura sowerbyi	14	0.82	0.56	0.05	2.00	90	1.75
10	Caenis sp	30	0.74	0.95	0.10	4.10	90	1.48
11	Ceraclea sp	61	0.61	0.81	0.01	3.90	90	1.16
12	Chaetogaster diaphanus	32	0.35	0.30	0.08	1.40	90	0.85
13	Cheumatopsyche sp	86	0.62	0.74	0.10	3.90	90	1.35
14	Chironomus sp	90	0.77	0.68	0.05	3.60	90	1.59
15	Cladopelma sp	22	0.58	0.68	0.05	3.30	90	1.13
16	Cladotanytarsus sp	47	0.61	0.69	0.05	3.30	90	1.64
17	Coelotanypus sp	17	1.11	0.92	0.12	3.40	90	2.68
18	Cricotopus sp	59	2.71	6.93	0.01	46.00	90	9.00
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	128	0.53	0.57	0.05	3.40	90	1.20
21	Dicrotendipes sp	36	1.01	2.29	0.05	14.00	90	1.58
22	Eukiefferiella sp	53	0.54	0.68	0.10	3.90	90	0.94
23	Gammarus fasciatus	227	0.68	0.74	0.01	4.00	90	1.54
24	Glossiphonia heteroclita	13	0.86	0.97	0.50	4.00	90	2.88
25	Glossosoma sp	40	2.43	7.59	0.10	46.00	90	3.84
26	Glyptotendipes sp	23	0.82	0.74	0.10	2.50	90	2.18
27	Gyraulus parvus	24	0.71	1.01	0.08	3.90	90	2.75
28	Helisoma anceps	11	0.64	0.64	0.05	2.20	90	2.00
29	Heterotrissocladius sp	17	0.53	0.95	0.05	4.10	90	1.54
30	Hyalella azteca	47	1.82	2.14	0.05	9.00	90	4.80
31	Hydropsyche sp	45	0.47	0.57	0.10	3.90	90	0.86
32	Hydroptila sp	38	0.49	0.54	0.01	3.30	90	0.91
33	Ilyodrilus templetoni	17	0.73	0.81	0.10	3.30	90	2.42
34	Limnodrilus hoffmeisteri	188	0.96	2.30	0.01	26.00	90	1.71
35	Limnodrilus sp	63	4.32	7.27	0.10	46.00	90	12.00
36	Limnodrilus udekemianus	33	1.13	2.27	0.10	12.00	90	1.80
37	Lumbriculus variegatus	37	0.53	0.61	0.01	3.30	90	1.04
38	Manayunkia speciosa	69	0.47	0.48	0.01	2.20	90	1.00
39	Microtendipes sp	13	0.93	0.70	0.10	2.00	90	2.00
40	Mystacides sp	12	0.51	0.22	0.10	0.85	90	0.81
41	Nais behningi	27	0.45	0.55	0.10	3.00	90	0.72
42	Nais communis	38	0.29	0.20	0.05	0.90	90	0.60
43	Nais variabilus	70	0.56	0.74	0.01	3.90	90	1.20
44	Nanocladius sp	35	0.43	0.41	0.01	2.20	90	0.91
45	Neureclipsis sp	36	0.39	0.37	0.10	2.20	90	0.86
46	Oecetis sp	38	0.57	0.56	0.10	2.20	90	1.55
47	Parachironomus sp	20	0.70	1.00	0.01	4.10	90	2.39
48	Paralauterborniella sp	16	0.55	0.71	0.05	3.00	90	1.53
49	Paratendipes sp	24	0.64	0.86	0.05	3.90	90	1.80
50	Phaenopsectra sp	40	2.76	8.17	0.10	46.00	90	11.02
51	Phallodrilus sp	24	0.32	0.19	0.01	0.95	90	0.55
52	Physella gyrina	91	0.51	0.62	0.01	4.10	90	0.89

53	Piguetiella michiganensi	46	0.48	0.70	0.05	3.30	90	1.03
54	Pisidium casertanum	160	0.77	2.14	0.01	26.00	90	1.39
55	Pisidium compressum	33	0.72	0.95	0.01	4.10	90	1.86
56	Pisidium conventus	14	0.53	1.06	0.08	4.10	90	2.60
57	Pisidium fallax	92	0.53	0.66	0.01	3.90	90	1.11
58	Pisidium henslowanum	31	0.46	0.83	0.01	4.10	90	1.29
59	Pisidium lilljeborgi	22	0.67	1.11	0.08	4.10	90	2.94
60	Pisidium nitidum	23	0.31	0.29	0.08	1.10	90	0.94
61	Pisidium variabile	36	0.57	0.75	0.01	4.10	90	1.13
62	Pleurocera acuta	77	0.57	0.74	0.01	3.90	90	1.04
63	Polypedilum scalaenum	13	0.10	0.06	0.05	0.20	90	0.20
64	Polypedilum sp	118	1.67	5.08	0.05	46.00	90	3.00
65	Pontoporeia hoyi	36	0.52	0.62	0.05	2.50	90	1.40
66	Potamothrix moldaviensis	57	1.24	3.98	0.01	26.00	90	2.20
67	Potamothrix vejdovskyi	56	0.49	0.70	0.01	4.10	90	1.10
68	Pristina foreli	13	0.52	0.33	0.20	1.20	90	1.10
69	Pristina osborni	46	0.46	0.49	0.10	3.30	90	0.83
70	Procladius sp	201	1.79	4.44	0.01	46.00	90	3.08
71	Prostoma rubrum	116	0.54	0.73	0.01	4.10	90	0.97
72	Pseudocloeon sp	16	0.97	1.15	0.01	3.90	90	3.48
73	Quistadrilus multisetosu	61	0.78	0.88	0.10	4.10	90	2.20
74	Slavina appendiculata	35	0.47	0.31	0.10	1.20	90	0.97
75	Specaria josinae	29	0.64	0.70	0.10	3.30	90	1.20
76	Sphaerium nitidum	16	0.46	0.61	0.10	2.50	90	1.52
77	Sphaerium striatinum	62	0.62	0.78	0.01	3.90	90	1.20
78	Spirosperma ferox	111	0.55	0.65	0.01	4.10	90	0.97
79	Stenonema sp	55	0.61	0.77	0.01	3.90	90	1.20
80	Stictochironomus sp	16	0.48	0.21	0.12	1.00	90	0.77
81	Stylaria lacustris	55	0.70	0.94	0.01	4.50	90	1.90
82	Stylodrilus heringianus	85	0.60	0.89	0.01	5.00	90	1.08
83	Tanytarsus sp	96	0.51	0.46	0.05	2.50	90	1.10
84	Thienemannimyia sp	59	0.63	0.85	0.05	3.90	90	1.90
85	Tubifex sp	36	5.23	8.51	0.10	46.00	90	14.30
86	Turbellaria	100	0.54	0.66	0.01	3.90	90	1.00
87	Uncinais uncinata	21	0.16	0.11	0.05	0.40	90	0.38
88	Valvata sincera	72	0.86	1.95	0.08	16.00	90	1.34
89	Valvata tricarinata	58	0.56	0.55	0.10	3.13	90	1.20
90	Vejdovskyella intermedia	58	0.40	0.68	0.01	4.10	90	0.92
91	Elliptio complanata	11	0.82	1.06	0.50	4.00	90	3.30
92	Sphaerium simile	20	0.68	0.78	0.50	4.00	90	0.50
93	Chironomus plumosus	66	1.67	2.61	0.05	16.00	90	4.50
94	Cricotopus bicinctus	1	0.15		0.15	0.15	90	.
95	Ephemera sp	1	0.10		0.10	0.10	90	.
96	Helobdella stagnalis	25	1.09	0.70	0.23	2.50	90	2.20
97	Hexagenia limbata	12	1.02	1.13	0.10	3.10	90	3.07
98	Hexagenia sp	4	0.39	0.09	0.28	0.50	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	48	1.58	4.27	0.10	26.00	90	2.30

Table 3: CHROMIUM - Species Screening Level Concentration (ug/g).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	37	38.39	45.29	5.20	240.00	90	98.00
2	Aelosoma sp	14	26.00	27.79	11.00	120.00	90	77.50
3	Amnicola limosa	100	28.60	29.31	4.10	200.00	90	56.30
4	Asellus sp	85	42.23	29.57	8.60	200.00	90	75.20
5	Aulodrilus limnobius	26	22.39	13.49	9.00	67.00	90	41.60
6	Aulodrilus pigueti	32	24.00	8.77	14.00	57.00	90	36.10
7	Aulodrilus pleuriseta	30	34.49	27.03	0.01	120.00	90	68.80
8	Bithynia tentaculata	33	28.54	14.92	7.00	67.00	90	46.60
9	Branchiura sowerbyi	14	29.35	16.44	13.00	62.00	90	61.00
10	Caenis sp	34	23.24	18.77	5.30	120.00	90	33.50
11	Ceraclea sp	64	19.05	12.16	6.90	100.00	90	28.50
12	Chaetogaster diaphanus	32	17.74	11.05	1.50	48.00	90	33.70
13	Cheumatopsyche sp	87	22.67	23.38	6.90	200.00	90	33.00
14	Chironomus sp	110	30.81	17.72	7.00	95.20	90	53.90
15	Cladopelma sp	22	25.37	18.29	5.20	100.00	90	36.10
16	Cladotanytarsus sp	48	25.38	29.31	6.60	200.00	90	38.30
17	Coelotanypus sp	17	34.51	20.42	9.67	83.00	90	77.40
18	Cricotopus sp	60	40.51	59.47	0.01	270.00	90	120.00
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	137	152.16	1450.23	4.10	17000.00	90	62.20
21	Dicrotendipes sp	46	29.89	23.70	4.10	106.40	90	62.67
22	Eukiefferiella sp	53	16.93	5.91	6.90	33.00	90	26.20
23	Gammarus fasciatus	219	25.48	22.39	0.01	200.00	90	47.00
24	Glossiphonia heteroclita	4	29.75	13.67	16.00	42.00	90	.
25	Glossosoma sp	40	26.24	39.34	7.10	240.00	90	27.00
26	Glyptotendipes sp	19	39.09	43.75	7.70	200.00	90	85.00
27	Gyraulus parvus	33	23.14	19.00	5.20	100.00	90	47.00
28	Helisoma anceps	12	25.56	14.11	5.20	58.00	90	51.70
29	Heterotrissocladius sp	24	35.03	35.73	5.20	122.90	90	106.75
30	Hyalella azteca	46	39.69	57.12	6.00	270.00	90	106.00
31	Hydropsyche sp	50	19.05	7.87	6.90	46.00	90	27.00
32	Hydroptila sp	38	19.98	8.20	5.20	37.00	90	33.10
33	Ilyodrilus templetoni	18	25.28	22.05	10.00	100.00	90	62.20
34	Limnodrilus hoffmeisteri	201	129.43	1197.51	0.01	17000.00	90	85.00
35	Limnodrilus sp	59	54.52	44.67	7.00	240.00	90	100.00
36	Limnodrilus udekemianus	40	53.90	108.66	5.50	670.00	90	145.00
37	Lumbriculus variegatus	54	35.71	34.81	7.10	157.90	90	96.55
38	Manayunkia speciosa	69	23.35	14.09	6.90	98.00	90	40.00
39	Microtendipes sp	14	30.24	16.87	6.90	54.00	90	53.00
40	Mystacides sp	15	20.06	9.77	9.90	37.00	90	34.60
41	Nais behningi	27	19.94	16.99	6.90	98.00	90	27.40
42	Nais communis	38	15.66	8.45	1.50	37.00	90	30.10
43	Nais variabilus	70	20.08	14.73	0.01	100.00	90	33.90
44	Nanocladius sp	35	19.47	15.38	6.90	98.00	90	32.40
45	Neureclipsis sp	36	16.59	6.08	6.90	33.00	90	27.00
46	Oecetis sp	38	22.68	14.88	4.10	74.00	90	42.10
47	Parachironomus sp	21	27.13	28.38	0.01	120.00	90	78.40
48	Paralauterborniella sp	16	17.63	8.07	9.00	34.00	90	33.30
49	Paratendipes sp	25	20.49	12.70	4.30	67.00	90	32.40
50	Phaenopsectra sp	41	31.66	42.39	4.10	240.00	90	91.00
51	Phallodrilus sp	24	21.67	17.07	11.00	98.00	90	27.00
52	Physella gyrina	95	19.86	14.36	4.50	120.00	90	33.00
53	Piguetiella michiganensi	48	12.80	5.31	3.50	27.00	90	20.10

54	Pisidium casertanum	195	34.24	53.62	0.01	670.00	90	69.04
55	Pisidium compressum	18	35.40	28.94	0.01	120.00	90	74.19
56	Pisidium conventus	16	27.97	35.90	4.50	120.00	90	110.48
57	Pisidium fallax	94	20.57	14.37	6.60	98.00	90	33.50
58	Pisidium henslowanum	45	35.45	33.35	0.01	122.90	90	95.94
59	Pisidium lilljeborgi	26	29.22	32.85	3.50	120.00	90	101.64
60	Pisidium nitidum	24	20.95	18.42	5.60	78.80	90	53.00
61	Pisidium variabile	24	24.07	26.11	0.01	120.00	90	58.45
62	Pleurocera acuta	78	20.02	14.48	6.90	100.00	90	31.10
63	Polypedilum scalaenum	13	10.03	4.02	4.30	19.00	90	17.00
64	Polypedilum sp	122	27.63	30.34	5.20	240.00	90	46.80
65	Pontoporeia hoyi	59	41.22	33.81	1.50	157.90	90	93.50
66	Potamothrix moldaviensis	76	264.40	1947.34	0.01	17000.00	90	87.41
67	Potamothrix vejdovskyi	69	30.82	33.12	0.01	157.90	90	93.50
68	Pristina foreli	13	20.28	9.13	8.60	37.00	90	35.40
69	Pristina osborni	46	19.84	13.72	6.90	98.00	90	29.30
70	Procladius sp	224	43.80	36.05	0.01	240.00	90	90.25
71	Prostoma rubrum	116	20.73	16.16	5.20	120.00	90	31.30
72	Pseudocloeon sp	16	15.23	5.32	8.60	30.00	90	24.40
73	Quistadrilus multisetosu	74	271.11	1971.71	4.10	17000.00	90	105.00
74	Slavina appendiculata	36	17.95	6.91	5.20	37.00	90	28.20
75	Specaria josinae	29	27.24	18.97	6.90	100.00	90	57.00
76	Sphaerium nitidum	26	39.76	36.15	5.60	122.90	90	101.64
77	Sphaerium striatinum	65	21.44	18.29	5.20	110.00	90	48.20
78	Spirosperma ferox	114	27.64	23.92	0.01	140.00	90	62.55
79	Stenonema sp	55	16.86	6.52	4.30	32.00	90	27.00
80	Stictochironomus sp	18	16.91	8.89	4.10	41.00	90	30.20
81	Stylaria lacustris	55	22.52	15.60	0.01	120.00	90	33.00
82	Stylodrilus heringianus	87	21.18	20.55	4.50	126.50	90	32.00
83	Tanytarsus sp	95	23.44	16.76	3.50	85.00	90	48.60
84	Thienemannimyia sp	64	20.72	21.61	4.30	160.00	90	32.00
85	Tubifex sp	36	59.38	49.53	7.00	240.00	90	127.55
86	Turbellaria	100	20.69	13.88	6.90	100.00	90	32.00
87	Uncinais uncinata	21	12.21	5.76	1.50	25.00	90	19.00
88	Valvata sincera	79	34.61	46.84	5.60	400.00	90	63.00
89	Valvata tricarinata	71	25.89	18.30	4.10	100.00	90	53.60
90	Vejdovskyella intermedia	58	17.00	18.38	0.01	120.00	90	31.10
91	Elliptio complanata	1	42.00		42.00	42.00	90	.
92	Sphaerium simile	0						
93	Chironomus plumosus	79	261.74	1908.30	5.50	17000.00	90	85.00
94	Cricotopus bicinctus	5	25.50	16.06	3.50	45.00	90	.
95	Ephemera sp	3	15.53	10.00	8.60	27.00	90	.
96	Helobdella stagnalis	25	32.12	13.63	12.00	55.00	90	53.40
97	Hexagenia limbata	23	27.67	19.91	9.50	79.00	90	62.20
98	Hexagenia sp	5	17.30	6.53	10.00	24.42	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	64	66.12	97.41	5.50	670.00	90	140.00

Table 4: COPPER - Species Screening Level Concentrations (ug/g).

Spp. No.	Species	N=	Mean	Std. Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	37	31.64	43.82	2.00	170	90	106
2	Aelosoma sp	14	17.07	26.50	1.25	92	90	77.5
3	Amnicola limosa	106	23.45	35.79	1.25	320	90	50.5
4	Asellus sp	85	36.01	22.21	3.30	100	90	69.8
5	Aulodrilus limnobius	26	14.79	14.65	1.25	67	90	40.5
6	Aulodrilus pigueti	32	15.27	10.15	1.25	44	90	32.4
7	Aulodrilus pleuriseta	30	25.96	25.18	0.01	100	90	65.4
8	Bithynia tentaculata	53	23.61	18.56	1.25	100	90	49.6
9	Branchiura sowerbyi	14	23.60	11.56	2.50	47	90	40.5
10	Caenis sp	34	16.02	16.41	2.50	92	90	25.5
11	Ceraclea sp	64	11.00	18.06	1.25	130	90	16.5
12	Chaetogaster diaphanus	32	12.69	11.13	1.50	51	90	26.8
13	Cheumatopsyche sp	87	13.62	18.85	1.25	130	90	33
14	Chironomus sp	119	26.07	21.89	2.50	160	90	50.5
15	Cladopelma sp	22	19.78	26.27	3.50	130	90	35.8
16	Cladotanytarsus sp	48	15.01	14.76	1.25	69	90	36.3
17	Coelotanypus sp	17	37.00	20.81	10.24	94	90	73.2
18	Cricotopus sp	59	38.33	77.69	0.01	390	90	150
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	146	139.71	1405.34	1.25	17000	90	47.6
21	Dicrotendipes sp	48	24.31	20.80	2.50	95	90	54.7
22	Eukiefferiella sp	53	9.99	11.65	1.25	63	90	21.2
23	Gammarus fasciatus	244	20.87	25.21	0.01	278	90	44
24	Glossiphonia heteroclita	15	24.33	15.16	4.00	61	90	53.8
25	Glossosoma sp	40	18.25	35.74	1.25	170	90	61.1
26	Glyptotendipes sp	25	25.27	17.89	3.90	74	90	51.9
27	Gyraulus parvus	33	21.97	22.19	2.10	100	90	50.8
28	Helisoma anceps	12	21.73	19.51	1.25	76	90	63.1
29	Heterotrissocladius sp	24	17.71	22.01	1.25	92	90	55.1
30	Hyalella azteca	56	43.51	74.28	3.70	390	90	93.7
31	Hydropsyche sp	50	14.77	14.70	1.25	63	90	35.7
32	Hydroptila sp	38	9.86	8.72	1.25	36	90	24
33	Ilyodrilus templetoni	18	23.28	31.82	1.25	130	90	81.4
34	Limnodrilus hoffmeisteri	220	115.41	1144.66	0.01	17000	90	75.4
35	Limnodrilus sp	64	486.90	3493.94	6.00	28000	90	110
36	Limnodrilus udekemianus	40	44.91	73.87	2.50	340	90	125.3
37	Lumbriculus variegatus	54	17.93	19.22	1.25	85	90	49.8
38	Manayunkia speciosa	69	15.63	19.95	1.25	113	90	40
39	Microtendipes sp	14	40.54	26.38	3.00	78	90	76
40	Mystacides sp	15	11.76	6.23	1.25	24	90	19.8
41	Nais behningi	27	9.19	10.84	1.25	44	90	33.6
42	Nais communis	38	10.93	17.99	2.00	113	90	17.7
43	Nais variabilus	69	14.72	19.37	0.01	130	90	36
44	Nanocladius sp	35	10.09	8.91	1.25	44	90	18.2
45	Neureclipsis sp	36	9.05	11.82	1.25	63	90	16
46	Oecetis sp	38	20.97	21.23	1.50	78	90	62
47	Parachironomus sp	21	21.41	21.69	0.01	92	90	49
48	Paralauterborniella sp	16	10.24	7.60	1.25	24	90	24
49	Paratendipes sp	25	11.63	13.26	1.25	67	90	23.2
50	Phaenopsectra sp	41	23.05	33.00	1.25	170	90	74.6
51	Phallodrilus sp	24	10.21	14.35	1.25	63	90	31
52	Physella gyrina	103	14.43	14.50	1.25	92	90	30.2

53	Piguetiella michiganensi	47	6.57	4.48	1.25	22	90	13.2
54	Pisidium casertanum	195	24.27	38.48	0.01	340	90	50.94
55	Pisidium compressum	37	20.91	17.85	0.01	92	90	41.2
56	Pisidium conventus	16	18.43	23.53	1.40	92	90	63.23
57	Pisidium fallax	94	13.02	18.85	1.25	113	90	35
58	Pisidium henslowanum	45	19.47	20.53	0.01	92	90	50.94
59	Pisidium lilljeborgi	26	22.34	22.88	1.50	92	90	55.73
60	Pisidium nitidum	24	11.21	10.86	1.25	38.2	90	29
61	Pisidium variabile	38	18.42	18.11	0.01	92	90	36.2
62	Pleurocera acuta	78	12.97	20.83	1.25	130	90	22.7
63	Polypedilum scalaenum	13	7.37	3.59	2.00	14	90	13.6
64	Polypedilum sp	123	21.97	32.33	1.25	170	90	45.8
65	Pontoporeia hoyi	59	24.30	20.93	1.40	85	90	51
66	Potamothrix moldaviensis	76	250.68	1947.54	0.01	17000	90	71.1
67	Potamothrix vejdovskyi	69	20.73	25.63	0.01	130	90	54
68	Pristina foreli	13	9.64	8.61	1.25	33	90	27
69	Pristina osborni	46	9.97	11.49	1.25	63	90	24.6
70	Procladius sp	229	159.74	1848.17	0.01	28000	90	86
71	Prostoma rubrum	116	13.32	20.09	1.25	130	90	25.3
72	Pseudocloeon sp	16	12.67	27.15	1.25	113	90	47.9
73	Quistadrilus multisetosu	74	271.29	1971.89	3.00	17000	90	93
74	Slavina appendiculata	36	12.05	9.29	2.50	39	90	29.5
75	Specaria josinae	29	20.23	25.30	1.25	130	90	44
76	Sphaerium nitidum	26	21.52	19.31	2.50	67	90	55.19
77	Sphaerium striatinum	66	13.53	17.17	1.25	100	90	35.9
78	Spirosperma ferox	127	19.69	19.85	0.01	130	90	41.6
79	Stenonema sp	55	9.63	11.82	1.25	63	90	18.2
80	Stictochironomus sp	19	15.86	14.81	1.25	61	90	33.81
81	Stylaria lacustris	54	17.14	15.03	0.01	92	90	35.65
82	Stylodrilus heringianus	93	12.71	16.20	1.25	113	90	25.6
83	Tanytarsus sp	99	17.36	14.10	1.40	67	90	39
84	Thienemannimyia sp	63	15.04	21.84	1.25	130	90	41.6
85	Tubifex sp	36	827.44	4658.32	6.00	28000	90	129
86	Turbellaria	100	13.47	19.33	1.25	130	90	33
87	Uncinais uncinata	20	7.30	4.02	1.40	16	90	13.9
88	Valvata sincera	86	25.53	32.01	1.25	260	90	50.5
89	Valvata tricarinata	71	21.06	19.11	1.25	100	90	41.8
90	Vejdovskyella intermedia	57	13.23	18.20	0.01	92	90	30.2
91	Elliptio complanata	12	19.17	5.59	11.00	33	90	30
92	Sphaerium simile	20	19.05	7.52	4.00	36	90	34.9
93	Chironomus plumosus	79	264.24	1908.23	3.90	17000	90	94
94	Cricotopus bicinctus	5	24.68	12.44	4.40	38	90	
95	Ephemera sp	3	15.30	18.03	3.00	36	90	
96	Helobdella stagnalis	27	38.89	20.77	11.00	100	90	71.6
97	Hexagenia limbata	23	25.79	19.57	3.90	82	90	59.4
98	Hexagenia sp	5	13.80	7.38	3.30	22.56	90	
99	Tanypus sp	0						
100	Tubifex tubifex	64	54.30	66.55	2.00	340	90	100

Table 5: IRON - Species Screening Level Concentrations (ug/g).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	37	16682.14	8522.41	19	35000	90	28400
2	Aelosoma sp	14	22214.29	7505.68	10000	31000	90	31000
3	Amnicola limosa	106	16202.07	9404.92	19	48000	90	30300
4	Asellus sp	85	18867.41	11300.51	29	79000	90	31664.3
5	Aulodrilus limnobius	26	19365.39	7986.94	10000	35000	90	34300
6	Aulodrilus pigueti	32	17376.00	7612.36	13	35000	90	30700
7	Aulodrilus pleuriseta	30	20806.67	14410.99	0.005	79000	90	33700
8	Bithynia tentaculata	53	21360.55	21164.86	2700	140000	90	35900
9	Branchiura sowerbyi	14	20236.43	6896.74	12000	35000	90	33500
10	Caenis sp	34	14348.54	8143.89	19	35000	90	26000
11	Ceraclea sp	64	20673.73	12191.03	19	85000	90	34500
12	Chaetogaster diaphanus	32	13000.00	7871.47	2700	35000	90	25200
13	Cheumatopsyche sp	87	19921.84	10984.66	6700	85000	90	34200
14	Chironomus sp	119	17869.21	9927.15	19	59000	90	30000
15	Cladopelma sp	22	16977.86	10156.67	13	36000	90	35000
16	Cladotanytarsus sp	48	15638.54	7687.24	2800	38000	90	29100
17	Coelotanypus sp	17	19229.50	9952.08	31.5	35000	90	33400
18	Cricotopus sp	59	19530.51	12334.80	0.005	85000	90	34000
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	146	16431.41	9303.46	1800	48000	90	30078.21
21	Dicrotendipes sp	48	16808.54	9910.42	4500	48000	90	31011.34
22	Eukiefferiella sp	53	19519.23	12353.81	19	85000	90	32000
23	Gammarus fasciatus	244	18451.52	17408.76	0.005	170000	90	31000
24	Glossiphonia heteroclita	15	21360.60	17153.89	1800	58000	90	56560
25	Glossosoma sp	40	20080.00	8649.83	9200	38000	90	31900
26	Glyptotendipes sp	25	12149.62	8229.70	31.5	29000	90	26800
27	Gyraulus parvus	33	15872.73	13596.88	4500	79000	90	30600
28	Helisoma anceps	12	17766.67	9365.73	3500	35000	90	33800
29	Heterotrissocladius sp	24	17802.77	8148.08	5700	39436.9	90	29703.7
30	Hyalella azteca	56	15507.66	12063.33	1800	79000	90	31300
31	Hydropsyche sp	50	19500.00	12829.53	6700	85000	90	31000
32	Hydroptila sp	38	19123.68	8429.50	3500	38000	90	34100
33	Ilyodrilus templetoni	18	18244.44	8812.71	7400	36000	90	35100
34	Limnodrilus hoffmeisteri	220	20497.79	20983.20	0.005	170000	90	34000
35	Limnodrilus sp	64	20735.96	10518.81	0.05	35000	90	31500
36	Limnodrilus udekemianus	40	20212.25	22391.38	4500	110000	90	34900
37	Lumbriculus variegatus	54	21479.42	11968.44	7900	85000	90	31997
38	Manayunkia speciosa	69	19828.68	8509.72	19	38000	90	34000
39	Microtendipes sp	14	17816.54	10245.36	31.5	31000	90	30500
40	Mystacides sp	15	15793.33	7297.01	6900	31000	90	30400
41	Nais behningi	27	22051.85	15738.62	6700	85000	90	36400
42	Nais communis	38	14260.53	7129.33	2700	35000	90	21600
43	Nais variabilus	69	15433.61	8308.54	0.005	36000	90	30000
44	Nanocladius sp	35	17131.43	7170.64	6700	34000	90	30400
45	Neureclipsis sp	36	19761.11	8605.52	6700	38000	90	32900
46	Oecetis sp	38	19121.05	10444.50	4100	48000	90	35000
47	Parachironomus sp	21	13209.52	7727.35	0.005	30000	90	25800
48	Paralauterborniella sp	16	14081.25	4179.03	8200	21000	90	21000
49	Paratendipes sp	25	15560.00	8135.47	2800	31000	90	29400
50	Phaenopsectra sp	41	17688.27	9198.11	19	48000	90	31800
51	Phallodrilus sp	24	22750.00	8409.36	10000	38000	90	36000
52	Physella gyrina	103	15957.55	9682.72	19	59400	90	29600

53	Piguetiella michiganensi	47	12108.51	5595.41	2800	28000	90	19400
54	Pisidium casertanum	195	17966.74	9408.62	0.005	48000	90	32000
55	Pisidium compressum	37	18866.11	15556.16	0.005	59400	90	42669.57
56	Pisidium conventus	16	12585.01	8203.73	2000	29127.5	90	26238.25
57	Pisidium fallax	94	18657.45	8569.21	4800	38000	90	33000
58	Pisidium henslowanum	45	16510.03	8793.58	0.005	31994	90	30556.42
59	Pisidium lilljeborgi	26	14789.15	9354.41	3700	34000	90	29821.4
60	Pisidium nitidum	24	16100.35	8308.00	3700	31000	90	30000
61	Pisidium variabile	38	14937.82	22279.88	0.005	140000	90	25300
62	Pleurocera acuta	78	18657.94	8349.25	19	38000	90	31100
63	Polypedilum scalaenum	13	9084.62	6045.36	2800	27000	90	21000
64	Polypedilum sp	123	18822.27	10513.72	13	85000	90	31000
65	Pontoporeia hoyi	59	17626.80	11131.87	2000	58096.3	90	31440.5
66	Potamothrix moldaviensis	76	16595.59	13341.09	0.005	85000	90	32300
67	Potamothrix vejdovskyi	69	16685.83	12152.68	0.005	93000	90	28000
68	Pristina foreli	13	17015.39	8629.97	8700	38000	90	34800
69	Pristina osborni	46	21265.22	12621.41	6700	85000	90	35000
70	Procladius sp	229	20190.65	11633.09	0.005	93000	90	33000
71	Prostoma rubrum	116	18907.92	10443.17	19	85000	90	32000
72	Pseudocloeon sp	16	16431.25	7715.59	9200	35000	90	32900
73	Quistadrilus multisetosu	74	20217.61	17016.62	13	130000	90	34500
74	Slavina appendiculata	36	14606.08	5797.50	19	30000	90	21200
75	Specaria josinae	29	17766.17	8450.85	19	36000	90	34000
76	Sphaerium nitidum	26	17220.76	8776.78	3700	33239.9	90	31606.55
77	Sphaerium striatinum	66	16757.58	8340.08	2900	38000	90	29600
78	Spirosperma ferox	127	18572.92	14884.14	0.005	140000	90	31289.52
79	Stenonema sp	55	17605.80	7798.86	19	38000	90	29800
80	Stictochironomus sp	19	15070.53	10615.18	6000	48000	90	35000
81	Stylaria lacustris	54	17109.61	7435.22	0.005	35000	90	28500
82	Stylodrilus heringianus	93	18367.19	16312.43	19	140000	90	31000
83	Tanytarsus sp	99	15683.02	8538.28	19	48000	90	27000
84	Thienemannimyia sp	63	17842.86	14732.41	3500	110000	90	31600
85	Tubifex sp	36	23428.59	9491.76	0.05	35000	90	33000
86	Turbellaria	100	19805.00	10499.29	6700	85000	90	33800
87	Uncinais uncinata	20	11175.00	7380.05	2000	31000	90	26100
88	Valvata sincera	86	15579.45	8694.81	19	35000	90	29300
89	Valvata tricarinata	71	17835.79	12188.63	19	79000	90	31000
90	Vejdovskyella intermedia	57	11950.88	7298.41	0.005	35000	90	21000
91	Elliptio complanata	12	33909.08	37888.36	5300	140000	90	115400
92	Sphaerium simile	20	25395.45	32931.09	1800	140000	90	59260
93	Chironomus plumosus	79	17747.63	8423.89	13	38000	90	28000
94	Cricotopus bicinctus	5	11300.00	5591.96	3700	17000	90	.
95	Ephemera sp	3	15333.33	10408.33	7000	27000	90	.
96	Helobdella stagnalis	27	18907.74	9147.69	5800	35000	90	34200
97	Hexagenia limbata	23	17143.48	16472.73	4700	67000	90	48200
98	Hexagenia sp	5	10362.00	3182.31	6300	14160	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	64	21835.33	18206.17	13	130000	90	35500

Table 6: LEAD - Species Screening Level Concentrations (ug/g).

Spp. No.	Species	N =	Mean	Std.Dev	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	36	104.03	333.69	0.75	2000	90	212.0
2	Aelosoma sp	14	41.84	55.36	2.00	180	90	145.0
3	Amnicola limosa	89	30.48	38.97	1.00	221	90	75.0
4	Asellus sp	62	63.93	64.31	3.62	350	90	154.0
5	Aulodrilus limnobius	35	32.40	37.78	2.50	180	90	81.8
6	Aulodrilus pigueti	31	33.38	40.85	3.00	221	90	71.0
7	Aulodrilus pleuriseta	24	37.28	46.82	0.01	221	90	101.0
8	Bithynia tentaculata	43	44.20	68.98	2.70	350	90	148.0
9	Branchiura sowerbyi	14	27.19	14.75	2.50	53	90	49.0
10	Caenis sp	30	24.47	30.33	3.00	134	90	72.5
11	Ceraclea sp	61	20.30	31.40	2.00	200	90	42.0
12	Chaetogaster diaphanus	32	25.52	39.12	0.75	221	90	42.0
13	Cheumatopsyche sp	86	29.78	44.42	2.00	221	90	76.3
14	Chironomus sp	95	44.35	55.36	3.00	350	90	118.0
15	Cladopelma sp	22	44.63	59.60	1.50	221	90	173.0
16	Cladotanytarsus sp	47	30.54	44.87	0.75	221	90	75.4
17	Coelotanypus sp	17	56.11	45.37	3.62	160	90	139.2
18	Cricotopus sp	58	72.78	154.10	0.01	760	90	247.0
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	131	37.28	52.39	0.01	350	90	95.0
21	Dicrotendipes sp	38	46.44	54.20	1.00	240	90	133.0
22	Eukiefferiella sp	53	18.66	21.82	2.00	110	90	42.0
23	Gammarus fasciatus	228	32.68	44.80	0.01	350	90	74.1
24	Glossiphonia heteroclita	13	42.04	55.27	5.00	190	90	166.0
25	Glossosoma sp	40	35.88	66.23	2.50	310	90	106.6
26	Glyptotendipes sp	23	60.99	58.05	8.10	190	90	160.0
27	Gyraulus parvus	24	28.82	39.24	1.80	160	90	93.5
28	Helisoma anceps	11	28.61	31.43	0.01	110	90	97.4
29	Heterotrissocladius sp	23	20.67	24.73	3.00	110	90	56.7
30	Hyalella azteca	47	80.66	159.60	3.00	760	90	192.0
31	Hydropsyche sp	45	24.80	25.65	2.00	110	90	72.8
32	Hydroptila sp	38	20.82	21.88	2.70	110	90	43.4
33	Ilyodrilus templetoni	17	38.35	51.38	3.00	200	90	128.0
34	Limnodrilus hoffmeisteri	194	44.97	50.87	0.01	430	90	110.0
35	Limnodrilus sp	64	120.44	252.63	0.06	2000	90	225.0
36	Limnodrilus udekemianus	33	41.25	77.72	1.00	430	90	98.8
37	Lumbriculus variegatus	53	22.67	23.50	2.50	114	90	54.3
38	Manayunkia speciosa	69	31.30	44.20	2.50	221	90	110.0
39	Microtendipes sp	13	107.69	82.34	3.00	230	90	218.0
40	Mystacides sp	12	13.42	9.34	3.00	32	90	31.1
41	Nais behningi	27	18.51	23.96	2.00	110	90	44.0
42	Nais communis	38	17.06	21.13	1.80	110	90	33.0
43	Nais variabilus	69	24.09	38.34	0.01	221	90	47.0
44	Nanocladius sp	35	19.40	20.77	3.00	77	90	54.2
45	Neureclipsis sp	36	19.14	37.68	2.50	221	90	39.2
46	Oecetis sp	38	44.20	61.58	1.00	230	90	162.0
47	Parachironomus sp	19	33.70	33.49	0.01	110	90	96.0
48	Paralauterborniella sp	16	23.89	53.15	0.01	221	90	85.9
49	Paratendipes sp	24	15.00	19.62	0.75	92	90	35.5
50	Phaenopsectra sp	40	45.66	73.23	3.00	310	90	197.0
51	Phallodrilus sp	24	34.48	47.77	2.70	221	90	93.0
52	Physella gyrina	91	23.09	28.85	2.00	140	90	55.8

53	Piguetiella michiganensi	45	8.86	8.13	0.01	35	90	20.4
54	Pisidium casertanum	176	34.39	41.78	0.01	221	90	92.5
55	Pisidium compressum	34	32.36	40.40	0.01	190	90	101.0
56	Pisidium conventus	16	22.21	29.17	2.80	110	90	79.9
57	Pisidium fallax	92	21.06	28.20	1.80	180	90	42.7
58	Pisidium henslowanum	43	28.08	35.03	0.01	180	90	69.4
59	Pisidium lilljeborgi	24	32.75	34.77	1.00	110	90	91.5
60	Pisidium nitidum	24	17.78	13.61	1.80	49.4	90	38.5
61	Pisidium variabile.	37	27.65	36.43	0.01	190	90	69.6
62	Pleurocera acuta	77	20.20	32.58	2.00	200	90	42.0
63	Polypedilum scalaenum	13	3.92	2.66	0.01	9	90	8.6
64	Polypedilum sp	121	37.96	63.73	2.00	320	90	76.8
65	Pontoporeia hoyi	54	30.81	31.34	1.00	130	90	81.5
66	Potamothrix moldaviensis	64	31.07	39.72	0.01	210	90	103.0
67	Potamothrix vejdovskyi	63	24.73	37.26	0.01	221	90	44.7
68	Pristina foreli	13	25.73	28.38	3.00	110	90	84.8
69	Pristina osborni	46	20.83	30.34	2.00	180	90	39.2
70	Procladius sp	206	67.37	149.32	0.01	2000	90	160.0
71	Prostoma rubrum	116	23.63	36.01	2.00	221	90	43.5
72	Pseudocloeon sp	16	8.70	8.56	2.50	37	90	23.4
73	Quistadrilus multisetosu	61	50.67	55.14	1.00	260	90	128.0
74	Slavina appendiculata	35	19.43	18.69	2.50	77	90	44.6
75	Specaria josinae	20	36.17	51.28	4.90	221	90	92.0
76	Sphaerium nitidum	25	26.89	23.52	3.50	92	90	64.8
77	Sphaerium striatinum	62	23.35	34.58	1.80	180	90	71.7
78	Spirosperma ferox	116	31.63	44.16	0.01	260	90	72.2
79	Stenonema sp	55	18.54	32.01	2.00	221	90	37.4
80	Stictochironomus sp	16	20.90	30.82	3.00	130	90	65.6
81	Stylaria lacustris	54	27.89	27.25	0.01	110	90	76.0
82	Stylodrilus heringianus	85	18.54	26.33	2.50	190	90	35.2
83	Tanytarsus sp	96	28.19	30.95	0.01	190	90	71.0
84	Thienemannimyia sp	58	19.53	29.82	0.01	190	90	42.1
85	Tubifex sp	36	139.60	327.59	11.00	2000	90	226.0
86	Turbellaria	100	24.16	36.55	2.00	221	90	42.9
87	Uncinais uncinata	20	11.23	16.01	0.01	71	90	30.9
88	Valvata sincera	76	41.27	48.14	1.80	260	90	100.2
89	Valvata tricarinata	61	38.27	46.40	1.00	200	90	120.2
90	Vejdovskyella intermedia	57	20.75	36.68	0.01	221	90	48.6
91	Elliptio complanata	11	19.32	11.70	8.50	51	90	45.8
92	Sphaerium simile	20	35.40	45.23	5.00	190	90	113.5
93	Chironomus plumosus	66	78.59	134.84	0.01	760	90	133.0
94	Cricotopus bicinctus	1	1.00		1.00	1	90	.
95	Ephemera sp	1	3.00		3.00	3	90	.
96	Helobdella stagnalis	25	84.68	79.90	8.10	350	90	188.0
97	Hexagenia limbata	12	42.03	47.01	6.70	160	90	139.3
98	Hexagenia sp	4	19.08	5.49	13.69	24.46	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	50	48.78	47.08	2.50	210	90	120.0

Table 7: MANGANESE - Species Screening Level Concentrations (ug/g).

Spp. No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	6	687.50	152.18	455	850	90	.
2	Aelosoma sp	0						
3	Amnicola limosa	29	242.52	137.56	30	620	90	440
4	Asellus sp	60	426.99	227.02	30	1250	90	668.08
5	Aulodrilus limnobius	9	253.33	39.05	180	290	90	.
6	Aulodrilus pigueti	0						
7	Aulodrilus pleuriseta	0						
8	Bithynia tentaculata	8	224.63	114.80	88	442	90	.
9	Branchiura sowerbyi	11	414.64	126.64	172	595	90	588
10	Caenis sp	8	222.13	118.96	77	465	90	.
11	Ceraclea sp	0						
12	Chaetogaster diaphanus	0						
13	Cheumatopsyche sp	7	346.71	249.37	30	660	90	.
14	Chironomus sp	54	438.90	320.74	88	2000	90	709.5
15	Cladopelma sp	4	335.00	91.47	200	400	90	.
16	Cladotanytarsus sp	11	319.55	197.14	30	595	90	582
17	Coelotanypus sp	10	443.70	155.39	170	710	90	704
18	Cricotopus sp	20	538.60	145.09	350	850	90	734.5
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	61	398.53	296.45	30	2000	90	694.16
21	Dicrotendipes sp	21	347.47	249.80	69	951.2	90	826.12
22	Eukiefferiella sp	0						
23	Gammarus fasciatus	73	336.17	172.42	30	951.2	90	586
24	Glossiphonia heteroclita	2	285.00	7.07	280	290	90	.
25	Glossosoma sp	3	750.00	111.36	630	850	90	.
26	Glyptotendipes sp	17	295.00	155.20	30	710	90	518
27	Gyraulus parvus	7	215.71	83.24	140	370	90	.
28	Helisoma anceps	0						
29	Heterotrissocladius sp	6	760.18	136.64	568	986.5	90	.
30	Hyalella azteca	29	493.62	216.93	150	1250	90	730
31	Hydropsyche sp	9	310.00	172.26	140	610	90	.
32	Hydroptila sp	0						
33	Ilyodrilus templetoni	0						
34	Limnodrilus hoffmeisteri	109	416.37	209.85	30	1143.6	90	700
35	Limnodrilus sp	64	414.31	263.25	88	2000	90	692.9
36	Limnodrilus udekemianus	15	306.67	230.42	130	1000	90	784
37	Lumbriculus variegatus	16	827.36	166.73	568	1143.6	90	1066.67
38	Manayunkia speciosa	3	326.67	40.42	290	370	90	.
39	Microtendipes sp	11	288.00	92.61	88	390	90	386
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	0						
43	Nais variabilus	0						
44	Nanocladius sp	0						
45	Neureclipsis sp	0						
46	Oecetis sp	20	274.45	150.35	69	640	90	463.5
47	Parachironomus sp	3	356.67	140.12	200	470	90	.
48	Paralauterborniella sp	0						
49	Paratendipes sp	0						
50	Phaenopsectra sp	9	484.44	224.95	170	850	90	.
51	Phallodrilus sp	0						
52	Physella gyrina	17	272.77	133.82	77	620	90	508

53	Piguetiella michiganensi	0						
54	Pisidium casertanum	67	484.09	250.56	33	1033.7	90	833.84
55	Pisidium compressum	1	986.50		986.5	986.5	90	.
56	Pisidium conventus	3	552.67	331.67	170	757.4	90	.
57	Pisidium fallax	1	660.00		660	660	90	.
58	Pisidium henslowanum	12	761.79	125.27	568	1033.7	90	991.55
59	Pisidium lilljeborgi	9	510.88	362.98	170	1250	90	.
60	Pisidium nitidum	3	446.93	149.08	330	614.8	90	.
61	Pisidium variabile	2	504.40	303.21	290	718.8	90	.
62	Pleurocera acuta	0						
63	Polypedilum scalaenum	0						
64	Polypedilum sp	34	441.01	221.87	94	1033.7	90	775.1
65	Pontoporeia hoyi	31	652.27	335.74	130	1591.2	90	1033.06
66	Potamothrix moldaviensis	20	524.77	404.31	33	1591.2	90	1033.38
67	Potamothrix vejdovskyi	14	555.16	304.18	170	986.5	90	981.35
68	Pristina foreli	0						
69	Pristina osborni	0						
70	Procladius sp	139	406.40	186.40	30	1033.7	90	650
71	Prostoma rubrum	0						
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	43	324.93	167.66	30	670	90	602
74	Slavina appendiculata	0						
75	Specaria josinae	0						
76	Sphaerium nitidum	9	780.20	106.14	650.8	1030.5	90	.
77	Sphaerium striatinum	15	331.33	172.83	140	630	90	624
78	Spirosperma ferox	21	446.41	250.81	140	1033.7	90	914.34
79	Stenonema sp	0						
80	Stictochironomus sp	4	342.00	220.07	88	620	90	.
81	Stylaria lacustris	9	580.56	262.14	380	1250	90	.
82	Stylodrilus heringianus	1	735.00		735	735	90	.
83	Tanytarsus sp	36	381.31	159.51	69	860	90	623
84	Thienemannimyia sp	10	334.00	329.18	30	1000	90	971
85	Tubifex sp	36	407.53	171.39	107	850	90	661.5
86	Turbellaria	0						
87	Uncinais uncinata	0						
88	Valvata sincera	31	361.42	218.55	33	1033.7	90	626.96
89	Valvata tricarinata	25	448.42	438.25	69	2000	90	1120.22
90	Vejdovskyella intermedia	0						
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	63	418.86	170.36	30	860	90	646
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	23	338.09	137.17	150	620	90	582
97	Hexagenia limbata	12	320.25	198.73	89	710	90	668
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	47	440.00	179.96	110	976.2	90	660

Table 8: MERCURY - Species Screening Level Concentrations (ug/g).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	37	0.233	0.293	0.005	1.5	90	0.554
2	Aelosoma sp	14	0.061	0.087	0.01	0.32	90	0.25
3	Amnicola limosa	106	0.218	0.349	0.001	2	90	0.496
4	Asellus sp	81	0.696	3.387	0.001	30.4	90	0.988
5	Aulodrilus limnobius	26	0.17	0.168	0.02	0.81	90	0.374
6	Aulodrilus pigueti	33	0.406	0.845	0.01	4.7	90	1.224
7	Aulodrilus pleuriseta	30	0.27	0.34	0.005	1.5	90	0.772
8	Bithynia tentaculata	53	0.856	4.169	0.005	30.4	90	0.848
9	Branchiura sowerbyi	14	0.131	0.141	0.01	0.49	90	0.445
10	Caenis sp	34	0.262	0.39	0.001	1.6	90	0.795
11	Ceraclea sp	64	0.105	0.253	0.005	1.5	90	0.205
12	Chaetogaster diaphanus	32	0.127	0.155	0.005	0.81	90	0.281
13	Cheumatopsyche sp	87	0.128	0.261	0.005	1.5	90	0.26
14	Chironomus sp	108	0.271	0.444	0	2.6	90	0.592
15	Cladopelma sp	23	0.505	1.014	0.005	4.7	90	1.5
16	Cladotanytarsus sp	48	0.189	0.33	0.005	1.5	90	0.378
17	Coelotanypus sp	15	0.398	0.41	0.05	1.6	90	1.126
18	Cricotopus sp	62	0.163	0.322	0.005	1.7	90	0.4
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	144	0.401	2.544	0.005	30.4	90	0.47
21	Dicrotendipes sp	47	1.032	4.447	0.005	30.4	90	1.5
22	Eukiefferiella sp	53	0.053	0.067	0.01	0.31	90	0.162
23	Gammarus fasciatus	245	0.345	1.986	0.001	30.4	90	0.494
24	Glossiphonia heteroclita	15	2.272	7.807	0.005	30.4	90	13.66
25	Glossosoma sp	40	0.05	0.065	0.01	0.25	90	0.197
26	Glyptotendipes sp	24	0.236	0.419	0.005	1.6	90	1
27	Gyraulus parvus	33	0.232	0.357	0.001	1.5	90	0.852
28	Helisoma anceps	12	0.363	0.441	0.005	1.5	90	1.293
29	Heterotrissocladius sp	18	0.119	0.097	0.005	0.32	90	0.284
30	Hyalella azteca	56	0.186	0.451	0.005	3.25	90	0.403
31	Hydropsyche sp	50	0.1	0.287	0.005	2	90	0.242
32	Hydroptila sp	38	0.308	0.809	0.005	4.7	90	0.879
33	Ilyodrilus templetoni	18	0.562	1.099	0	4.7	90	1.82
34	Limnodrilus hoffmeisteri	212	0.305	0.751	0	8.5	90	0.678
35	Limnodrilus sp	64	0.831	3.788	0.005	30.4	90	1.169
36	Limnodrilus udekemianus	42	0.595	1.475	0.005	8.5	90	1.346
37	Lumbriculus variegatus	38	0.06	0.074	0.01	0.25	90	0.2
38	Manayunkia speciosa	69	0.631	3.647	0.005	30.4	90	0.6
39	Microtendipes sp	15	2.535	7.73	0.005	30.4	90	13.12
40	Mystacides sp	15	0.497	1.194	0.01	4.7	90	2.54
41	Nais behningi	27	0.09	0.232	0.01	1.22	90	0.174
42	Nais communis	38	0.112	0.244	0.005	1.5	90	0.191
43	Nais variabilus	69	0.232	0.619	0.005	4.7	90	0.44
44	Nanocladius sp	35	0.12	0.256	0.01	1.5	90	0.254
45	Neureclipsis sp	36	0.048	0.055	0.01	0.2	90	0.153
46	Oecetis sp	39	1.033	4.841	0.005	30.4	90	1.3
47	Parachironomus sp	21	0.252	0.43	0.005	1.5	90	1.272
48	Paralauterborniella sp	16	0.137	0.103	0.005	0.33	90	0.316
49	Paratendipes sp	25	0.123	0.122	0.005	0.43	90	0.338
50	Phaenopsectra sp	43	0.122	0.1	0.005	0.44	90	0.22
51	Phallodrilus sp	24	0.098	0.172	0.01	0.81	90	0.255
52	Physella gyrina	101	0.122	0.25	0.005	1.8	90	0.282

53	Piguetiella michiganensi	47	0.162	0.69	0.005	4.7	90	0.166
54	Pisidium casertanum	178	0.167	0.271	0.001	1.8	90	0.382
55	Pisidium compressum	36	0.116	0.104	0.005	0.43	90	0.299
56	Pisidium conventus	14	0.063	0.088	0.005	0.32	90	0.25
57	Pisidium fallax	94	0.173	0.528	0.01	4.7	90	0.235
58	Pisidium henslowanum	33	0.087	0.126	0.005	0.49	90	0.28
59	Pisidium lilljeborgi	24	0.234	0.655	0.005	3.25	90	0.42
60	Pisidium nitidum	23	0.077	0.076	0.005	0.22	90	0.19
61	Pisidium variabile	37	0.092	0.12	0.005	0.48	90	0.312
62	Pleurocera acuta	78	0.091	0.153	0.005	0.92	90	0.2
63	Polypedilum scalaenum	13	0.013	0.01	0.005	0.03	90	0.03
64	Polypedilum sp	124	0.144	0.258	0.005	1.5	90	0.275
65	Pontoporeia hoyi	41	0.082	0.096	0.005	0.43	90	0.212
66	Potamothrix moldaviensis	70	0.153	0.296	0.001	2	90	0.356
67	Potamothrix vejdovskyi	60	0.123	0.187	0.005	1.1	90	0.22
68	Pristina foreli	13	0.252	0.43	0.01	1.5	90	1.224
69	Pristina osborni	46	0.118	0.276	0.01	1.5	90	0.193
70	Procladius sp	226	0.432	2.065	0	30.4	90	0.837
71	Prostoma rubrum	116	0.137	0.253	0.005	1.5	90	0.269
72	Pseudocloeon sp	16	0.048	0.066	0.01	0.25	90	0.173
73	Quistadrilus multisetosu	75	0.238	0.271	0.005	1.4	90	0.624
74	Slavina appendiculata	36	0.324	0.829	0.005	4.7	90	1.017
75	Specaria josinae	29	0.433	0.877	0.01	4.7	90	0.92
76	Sphaerium nitidum	17	0.083	0.113	0.005	0.43	90	0.262
77	Sphaerium striatinum	65	0.107	0.193	0.005	1	90	0.35
78	Spirosperma ferox	121	0.168	0.244	0.005	1.8	90	0.354
79	Stenonema sp	55	0.066	0.131	0.005	0.91	90	0.178
80	Stictochironomus sp	19	1.716	6.947	0.005	30.4	90	0.41
81	Stylaria lacustris	54	0.251	0.508	0.005	3.25	90	0.385
82	Stylodrilus heringianus	93	0.096	0.196	0.005	1.7	90	0.226
83	Tanytarsus sp	98	0.117	0.183	0.005	1.5	90	0.231
84	Thienemannimyia sp	63	0.104	0.248	0.005	1.5	90	0.344
85	Tubifex sp	36	0.268	0.375	0.05	1.7	90	0.9
86	Turbellaria	100	0.193	0.532	0.01	4.7	90	0.26
87	Uncinais uncinata	20	0.05	0.068	0.005	0.22	90	0.179
88	Valvata sincera	82	0.345	0.667	0.005	4.7	90	0.901
89	Valvata tricarinata	68	0.77	3.692	0.005	30.4	90	1.32
90	Vejdovskyella intermedia	58	0.087	0.123	0.005	0.72	90	0.202
91	Elliptio complanata	12	0.108	0.145	0.005	0.56	90	0.422
92	Sphaerium simile	20	0.05	0.028	0.005	0.1	90	0.089
93	Chironomus plumosus	82	0.169	0.188	0.001	0.8	90	0.435
94	Cricotopus bicinctus	5	0.214	0.193	0.01	0.45	90	.
95	Ephemera sp	3	0.025	0.03	0.005	0.06	90	.
96	Helobdella stagnalis	26	1.52	5.919	0.005	30.4	90	1.69
97	Hexagenia limbata	23	0.202	0.241	0.005	1.1	90	0.416
98	Hexagenia sp	5	0.244	0.178	0.01	0.49	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	60	0.212	0.283	0	1.4	90	0.713

Table 9: NICKEL - Species Screening Level Concentrations (ug/g).

Spp. No.	Species	N =	Mean	Std. Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	36	23.71	25.52	1.25	110	90	73.3
2	Aelosoma sp	14	16.64	20.65	5.3	81	90	61.0
3	Amnicola limosa	83	15.09	11.66	1	81	90	26.6
4	Asellus sp	62	23.52	16.22	3.3	85	90	41.1
5	Aulodrilus limnobius	35	16.08	9.72	3.6	56	90	25.2
6	Aulodrilus pigueti	31	17.47	16.21	3.6	96	90	32.6
7	Aulodrilus pleuriseta	24	17.43	13.18	0.005	56	90	38.5
8	Bithynia tentaculata	23	16.23	12.61	0.5	56	90	31.6
9	Branchiura sowerbyi	14	41.58	28.14	6.2	95	90	92.5
10	Caenis sp	30	15.45	8.22	5	41	90	25.9
11	Ceraclea sp	61	12.23	6.63	2.3	33	90	23.8
12	Chaetogaster diaphanus	32	11.97	10.95	1.25	61	90	22.5
13	Cheumatopsyche sp	86	13.35	10.39	2.3	81	90	27.3
14	Chironomus sp	87	18.48	10.31	0.5	50.2	90	34.2
15	Cladopelma sp	22	20.17	21.31	1.5	96	90	52.6
16	Cladotanytarsus sp	47	16.71	16.80	1.25	95	90	34.2
17	Coelotanypus sp	17	22.62	10.94	4.61	41	90	37.8
18	Cricotopus sp	58	58.09	172.89	0.005	930	90	81.2
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	122	15.24	10.17	0.005	46	90	29.0
21	Dicrotendipes sp	36	19.66	17.32	2	96	90	34.3
22	Eukiefferiella sp	53	10.64	4.50	4.4	30	90	16.2
23	Gammarus fasciatus	203	15.81	12.05	0.005	96	90	29.6
24	Glossiphonia heteroclita	2	24.50	2.12	23	26	90	.
25	Glossosoma sp	40	16.01	19.96	4.4	110	90	28.8
26	Glyptotendipes sp	17	18.30	8.94	7	37	90	30.6
27	Gyraulus parvus	24	12.48	8.67	1	40	90	25.5
28	Helisoma anceps	11	14.03	11.32	0.005	40	90	37.0
29	Heterotrissocladius sp	23	13.11	9.20	4.4	41	90	30.1
30	Hyalella azteca	37	94.54	210.38	3.9	930	90	250.0
31	Hydropsyche sp	45	13.20	12.20	4.4	81	90	23.8
32	Hydroptila sp	38	14.58	15.53	2.4	96	90	27.4
33	Ilyodrilus templetoni	17	20.69	21.65	3.6	96	90	51.2
34	Limnodrilus hoffmeisteri	174	18.64	13.80	0.005	96	90	36.0
35	Limnodrilus sp	64	38.83	21.75	0.5	110	90	73.5
36	Limnodrilus udekemianus	33	18.15	18.81	2.2	96	90	41.2
37	Lumbriculus variegatus	53	15.23	8.74	5.3	43.5	90	27.9
38	Manayunkia speciosa	69	14.48	11.26	2.3	81	90	27.0
39	Microtendipes sp	13	19.13	9.42	0.5	31	90	30.2
40	Mystacides sp	12	22.26	24.39	4.6	96	90	75.3
41	Nais behningi	27	10.97	5.00	4.4	30	90	15.6
42	Nais communis	38	11.05	7.25	1	31	90	24.1
43	Nais variabilus	69	14.48	14.37	0.005	96	90	30.0
44	Nanocladius sp	35	14.39	12.69	4.4	81	90	18.4
45	Neureclipsis sp	36	10.85	4.77	5.3	31	90	15.0
46	Oecetis sp	38	14.50	9.54	0.5	46	90	28.1
47	Parachironomus sp	18	13.44	12.21	0.005	41	90	34.7
48	Paralauterborniella sp	16	11.83	6.49	0.005	24	90	24.0
49	Paratendipes sp	24	13.37	11.86	1	56	90	26.5
50	Phaenopsectra sp	40	19.66	20.72	6.2	110	90	54.5
51	Phallodrilus sp	24	9.28	3.45	2.3	15	90	14.5
52	Physella gyrina	83	12.39	6.84	2.3	41	90	23.6

53	Piguetiella michiganensi	45	10.74	14.19	0.005	96	90	15.0
54	Pisidium casertanum	176	16.19	12.70	0.005	91	90	32.3
55	Pisidium compressum	15	17.55	15.18	0.005	56	90	47.0
56	Pisidium conventus	16	11.37	11.21	1	41	90	33.5
57	Pisidium fallax	92	13.73	13.48	1	96	90	26.7
58	Pisidium henslowanum	43	15.63	15.07	0.005	81	90	32.2
59	Pisidium lilljeborgi	24	14.82	14.23	1	56	90	35.7
60	Pisidium nitidum	24	11.14	7.88	1	29	90	25.9
61	Pisidium variabile	23	12.40	13.34	0.005	56	90	33.4
62	Pleurocera acuta	77	12.99	9.83	4.4	81	90	20.2
63	Polypedilum scalaenum	13	3.38	2.62	0.005	9.3	90	7.9
64	Polypedilum sp	120	23.61	35.63	4.26	250	90	56.3
65	Pontoporeia hoyi	54	16.48	13.51	1	61	90	37.0
66	Potamothrix moldaviensis	64	14.47	14.75	0.005	91	90	31.5
67	Potamothrix vejdovskyi	63	12.27	8.29	0.005	43.2	90	24.0
68	Pristina foreli	13	12.90	5.32	5.8	26	90	22.4
69	Pristina osborni	46	10.30	4.76	3.6	31	90	15.3
70	Procladius sp	201	24.11	17.83	0.005	110	90	41.0
71	Prostoma rubrum	116	12.28	9.33	1.25	81	90	18.0
72	Pseudocloeon sp	16	11.88	6.27	6.2	31	90	21.9
73	Quistadrilus multisetosu	61	18.60	10.41	2	41	90	35.8
74	Slavina appendiculata	35	14.58	15.09	2.4	96	90	18.4
75	Specaria josinae	29	18.98	18.53	2.2	96	90	36.0
76	Sphaerium nitidum	25	16.26	12.02	2.2	56	90	31.5
77	Sphaerium striatinum	61	15.71	14.93	1	81	90	34.0
78	Spirosperma ferox	103	[illegible]	11.12	0.005	81	90	28.2
79	Stenonema sp	55	11.61	5.54	4.6	31	90	18.0
80	Stictochironomus sp	15	10.10	5.93	0.5	26	90	20.0
81	Stylaria lacustris	54	21.52	22.34	0.005	95	90	57.5
82	Stylodrilus heringianus	79	13.62	12.49	1	81	90	27.0
83	Tanytarsus sp	92	14.03	10.30	0.005	56	90	29.0
84	Thienemannimyia sp	58	11.31	6.91	0.005	42	90	18.0
85	Tubifex sp	36	42.04	22.06	10	110	90	75.2
86	Turbellaria	100	13.13	10.62	2.3	96	90	23.5
87	Uncinais uncinata	20	9.14	17.37	0.005	81	90	13.7
88	Valvata sincera	69	18.15	14.73	1	96	90	32.0
89	Valvata tricarinata	61	15.73	8.61	0.5	39	90	27.8
90	Vejdovskyella intermedia	57	10.50	12.12	0.005	61	90	18.2
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	66	58.43	161.16	0.005	930	90	72.5
94	Cricotopus bicinctus	1	1.00		1	1	90	
95	Ephemera sp	1	14.00		14	14	90	
96	Helobdella stagnalis	23	29.44	20.18	10	85	90	71.0
97	Hexagenia limbata	12	17.37	11.57	5.6	44	90	40.4
98	Hexagenia sp	4	12.65	3.68	9.26	15.97	90	
99	Tanypus sp	0						
100	Tubifex tubifex	50	21.49	15.80	1.25	91	90	36.9

Table 10: ZINC - Species Screening Level Concentrations (ug/g).

Spp. No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	37	155.55	183.89	8.70	690	90	554.0
2	Aelosoma sp	14	90.64	70.28	9.00	290	90	220.0
3	Amnicola limosa	106	102.85	105.07	0.01	650	90	280.0
4	Asellus sp	85	166.80	160.08	11.00	977.5	90	388.0
5	Aulodrilus limnobius	26	91.19	63.82	9.00	290	90	182.0
6	Aulodrilus pigueti	32	109.13	49.49	40.00	280	90	175.6
7	Aulodrilus pleuriseta	30	124.83	94.86	0.01	340	90	290.0
8	Bithynia tentaculata	53	143.83	199.49	20.00	1300	90	336.0
9	Branchiura sowerbyi	14	91.79	25.03	61.00	150	90	130.5
10	Caenis sp	34	116.49	140.05	13.00	830	90	221.5
11	Ceraclea sp	64	151.88	252.19	4.00	1200	90	215.0
12	Chaetogaster diaphanus	32	65.68	39.05	8.70	140	90	127.0
13	Cheumatopsyche sp	87	144.47	221.88	4.00	1200	90	222.0
14	Chironomus sp	119	122.97	146.26	6.50	1300	90	220.0
15	Cladopelma sp	22	126.43	175.11	9.50	880	90	199.0
16	Cladotanytarsus sp	48	112.61	163.43	4.00	1100	90	175.0
17	Coelotanypus sp	17	140.19	87.46	20.33	340	90	284.0
18	Cricotopus sp	59	303.47	669.01	0.01	3500	90	920.0
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	146	113.71	166.12	0.01	1300	90	243.0
21	Dicrotendipes sp	48	118.78	112.12	9.40	550	90	274.0
22	Eukiefferiella sp	53	132.53	219.02	4.00	1200	90	190.0
23	Gammarus fasciatus	244	117.82	153.62	0.01	1200	90	254.0
24	Glossiphonia heteroclita	15	99.10	92.13	6.50	340	90	302.8
25	Glossosoma sp	40	224.15	306.48	4.00	1200	90	816.0
26	Glyptotendipes sp	25	115.48	122.80	10.00	450	90	335.0
27	Gyraulus parvus	33	165.24	232.36	0.01	1100	90	340.0
28	Helisoma anceps	12	108.00	82.29	0.01	300	90	276.0
29	Heterotrissocladius sp	24	91.31	64.61	32.00	290	90	211.2
30	Hyalella azteca	56	308.05	682.52	4.00	3500	90	846.3
31	Hydropsyche sp	50	102.90	118.98	4.00	830	90	159.0
32	Hydroptila sp	38	124.66	168.29	14.00	1100	90	161.0
33	Ilyodrilus templetoni	18	144.89	192.95	20.00	880	90	358.0
34	Limnodrilus hoffmeisteri	220	143.96	193.43	0.01	1500	90	290.0
35	Limnodrilus sp	64	401.45	1363.41	20.00	11000	90	570.0
36	Limnodrilus udekemianus	40	180.79	258.65	10.00	1300	90	616.0
37	Lumbriculus variegatus	54	138.61	210.18	4.00	1200	90	225.6
38	Manayunkia speciosa	69	102.35	82.66	9.00	450	90	240.0
39	Microtendipes sp	14	280.43	332.76	20.00	1300	90	875.0
40	Mystacides sp	15	78.87	30.04	37.00	130	90	124.0
41	Nais behningi	27	164.82	270.19	4.00	1200	90	456.0
42	Nais communis	38	87.87	187.86	0.01	1200	90	112.0
43	Nais variabilus	69	121.66	187.23	0.01	1100	90	220.0
44	Nanocladius sp	35	86.29	51.65	25.00	220	90	158.0
45	Neureclipsis sp	36	108.06	193.16	4.00	1200	90	150.0
46	Oecetis sp	38	172.63	280.69	9.40	1300	90	450.0
47	Parachironomus sp	21	91.38	80.59	0.01	290	90	216.0
48	Paralauterborniella sp	16	129.31	214.33	0.01	920	90	[illegible]
49	Paratendipes sp	25	109.61	161.08	0.01	830	90	206.0
50	Phaenopsectra sp	41	121.38	144.58	4.00	690	90	355.6
51	Phallodrilus sp	24	92.25	49.74	26.00	220	90	155.0
52	Physella gyrina	103	110.79	180.60	4.00	1200	90	156.0

53	Piguetiella michiganensi	47	97.28	201.10	0.01	1100	90	163.6
54	Pisidium casertanum	195	126.02	184.02	0.01	1300	90	220.0
55	Pisidium compressum	37	74.25	62.36	0.01	290	90	130.0
56	Pisidium conventus	16	74.24	77.44	9.00	290	90	222.4
57	Pisidium fallax	94	126.01	200.57	0.01	1200	90	190.0
58	Pisidium henslowanum	45	85.94	69.69	0.01	290	90	188.2
59	Pisidium lilljeborgi	26	114.67	194.25	0.01	977.5	90	290.0
60	Pisidium nitidum	24	65.15	41.59	0.01	158.55	90	125.0
61	Pisidium variabile	38	70.61	77.45	0.01	320	90	146.0
62	Pleurocera acuta	78	141.15	230.58	4.00	1200	90	211.0
63	Polypedilum scalaenum	13	22.79	19.35	0.01	70	90	57.6
64	Polypedilum sp	123	161.22	243.10	4.00	1200	90	468.0
65	Pontoporeia hoyi	59	91.37	73.27	0.01	290	90	193.4
66	Potamothrix moldaviensis	76	114.16	191.40	0.01	1300	90	254.2
67	Potamothrix vejdovskyi	69	111.93	147.83	0.01	920	90	200.0
68	Pristina foreli	13	90.69	57.27	4.00	220	90	196.0
69	Pristina osborni	46	132.98	226.65	9.00	1200	90	178.0
70	Procladius sp	229	212.50	738.15	0.01	11000	90	420.0
71	Prostoma rubrum	116	126.52	194.96	4.00	1200	90	213.0
72	Pseudocloeon sp	16	269.19	393.88	4.00	1200	90	1130.0
73	Quistadrilus multisetosu	74	167.96	226.29	9.40	1500	90	370.0
74	Slavina appendiculata	36	85.61	47.55	14.00	220	90	156.0
75	Specaria josinae	29	138.45	156.22	20.00	880	90	280.0
76	Sphaerium nitidum	26	96.28	72.80	15.00	290	90	207.7
77	Sphaerium striatinum	66	127.11	198.86	0.01	1100	90	299.0
78	Spirosperma ferox	127	89.99	84.16	0.01	780	90	151.7
79	Stenonema sp	55	150.53	251.25	4.00	1200	90	214.0
80	Stictochironomus sp	19	90.40	107.11	9.40	420	90	340.0
81	Stylaria lacustris	54	119.38	142.38	0.01	977.5	90	199.0
82	Stylodrilus heringianus	93	117.47	200.10	4.00	1200	90	162.4
83	Tanytarsus sp	99	74.72	50.25	0.01	290	90	140.0
84	Thienemannimyia sp	63	149.34	247.40	0.01	1200	90	254.0
85	Tubifex sp	36	229.71	190.33	76.00	690	90	563.0
86	Turbellaria	100	134.79	206.21	4.00	1200	90	206.0
87	Uncinais uncinata	20	42.26	35.39	0.01	130	90	84.9
88	Valvata sincera	86	127.60	164.48	0.01	1100	90	281.6
89	Valvata tricarinata	71	134.11	198.32	9.40	1300	90	334.0
90	Vejdovskyella intermedia	57	63.37	65.17	0.01	300	90	122.0
91	Elliptio complanata	12	74.17	29.92	43.00	150	90	138.0
92	Sphaerium simile	20	51.78	25.01	6.50	110	90	87.2
93	Chironomus plumosus	79	243.69	573.15	0.01	3500	90	340.0
94	Cricotopus bicinctus	5	74.72	41.70	8.60	110	90	.
95	Ephemera sp	3	57.67	62.80	17.00	130	90	.
96	Helobdella stagnalis	27	199.15	158.11	21.00	580	90	426.0
97	Hexagenia limbata	23	121.09	149.93	20.00	580	90	416.0
98	Hexagenia sp	5	48.36	17.61	22.00	65.68	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	64	202.37	284.17	10.00	1500	90	535.0

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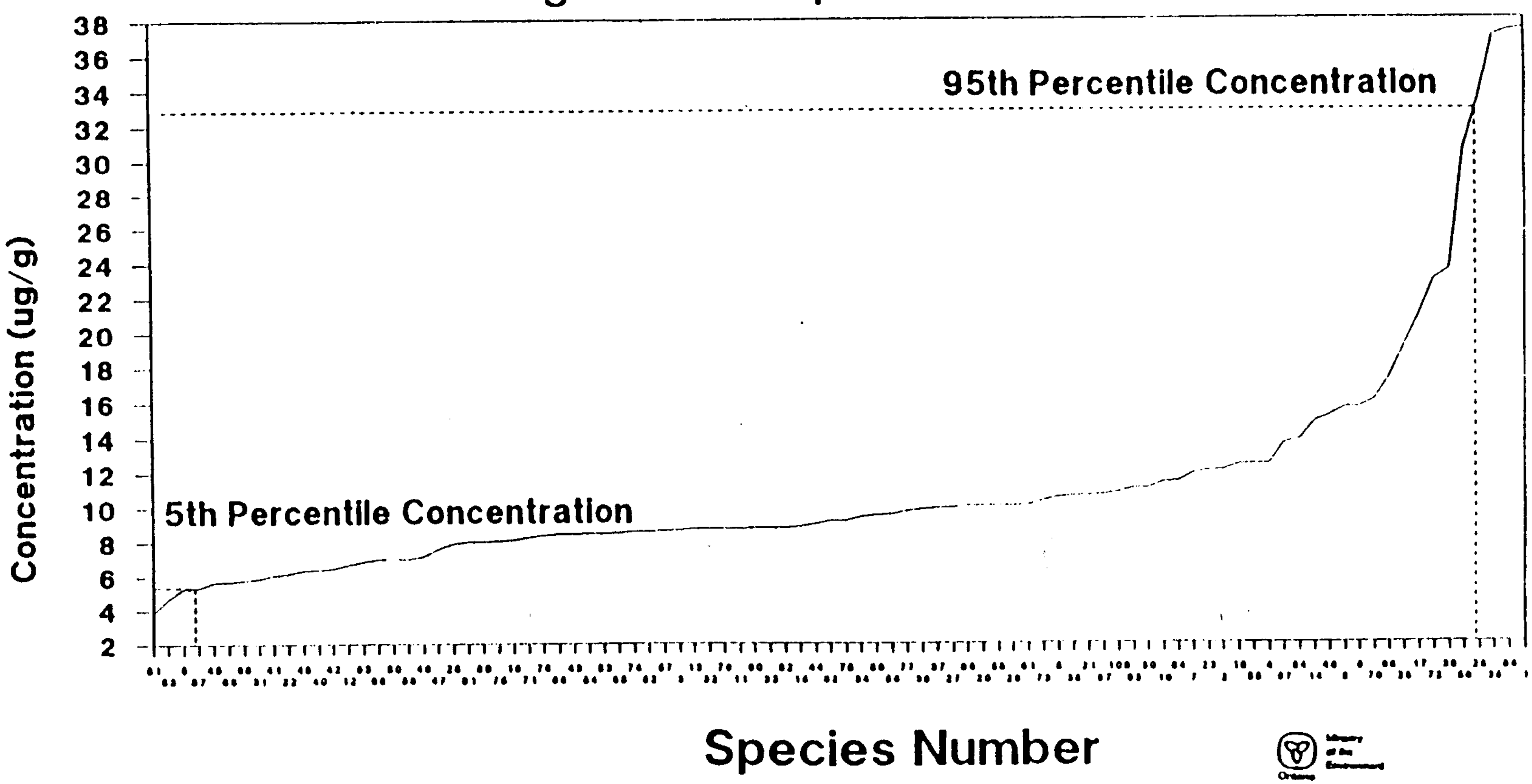
APPENDIX II - FIGURES

Calculation of the 5th and 95th Percentiles
of the Species Screening Level Concentrations

- Concentrations are expressed on a bulk sediment basis
- Species numbers correspond to those in the tables in Appendix I

Fig 1. SLC Graph For Arsenic



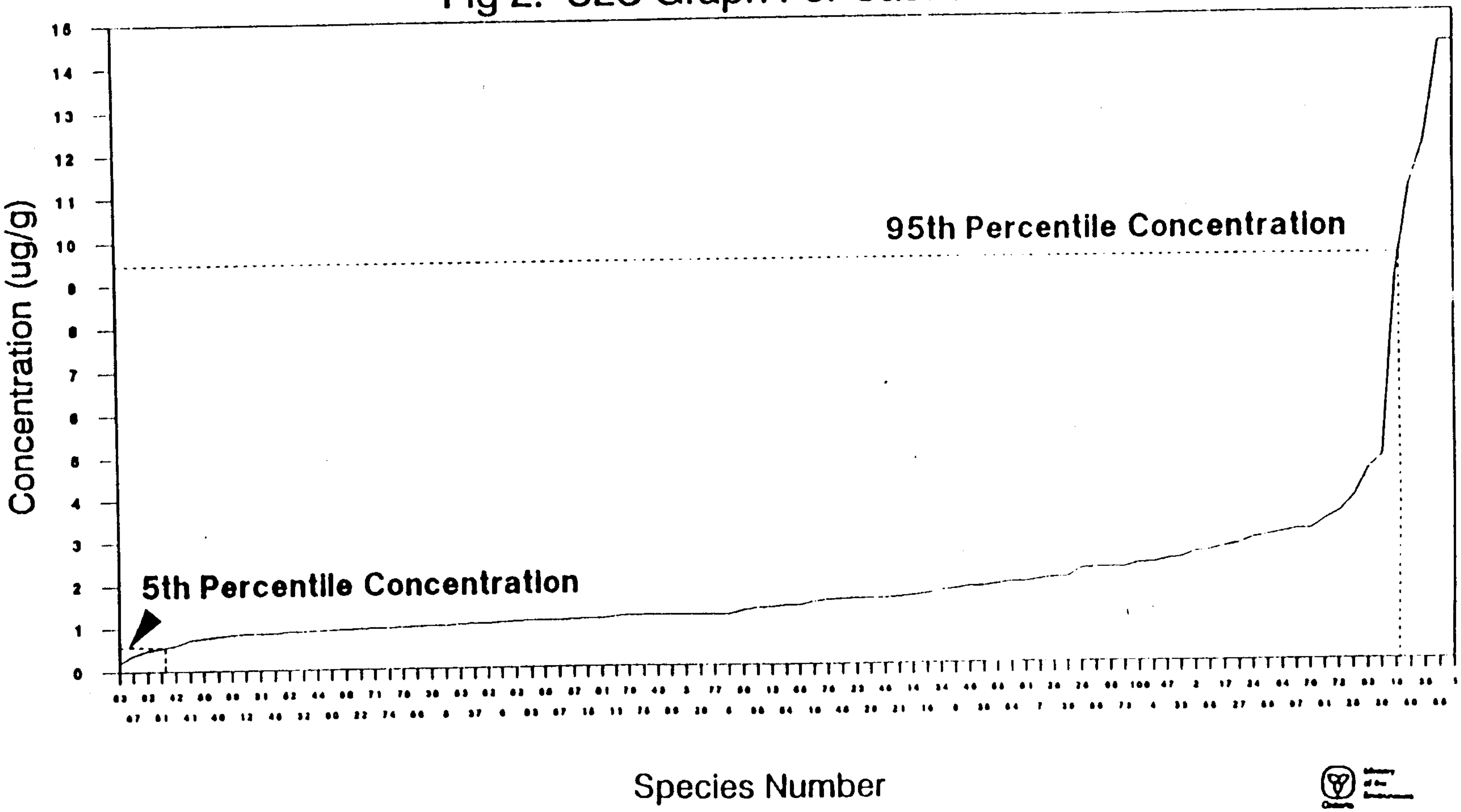


Fig 2. SLC Graph For Cadmium

Fig 4. SLC Graph For Copper

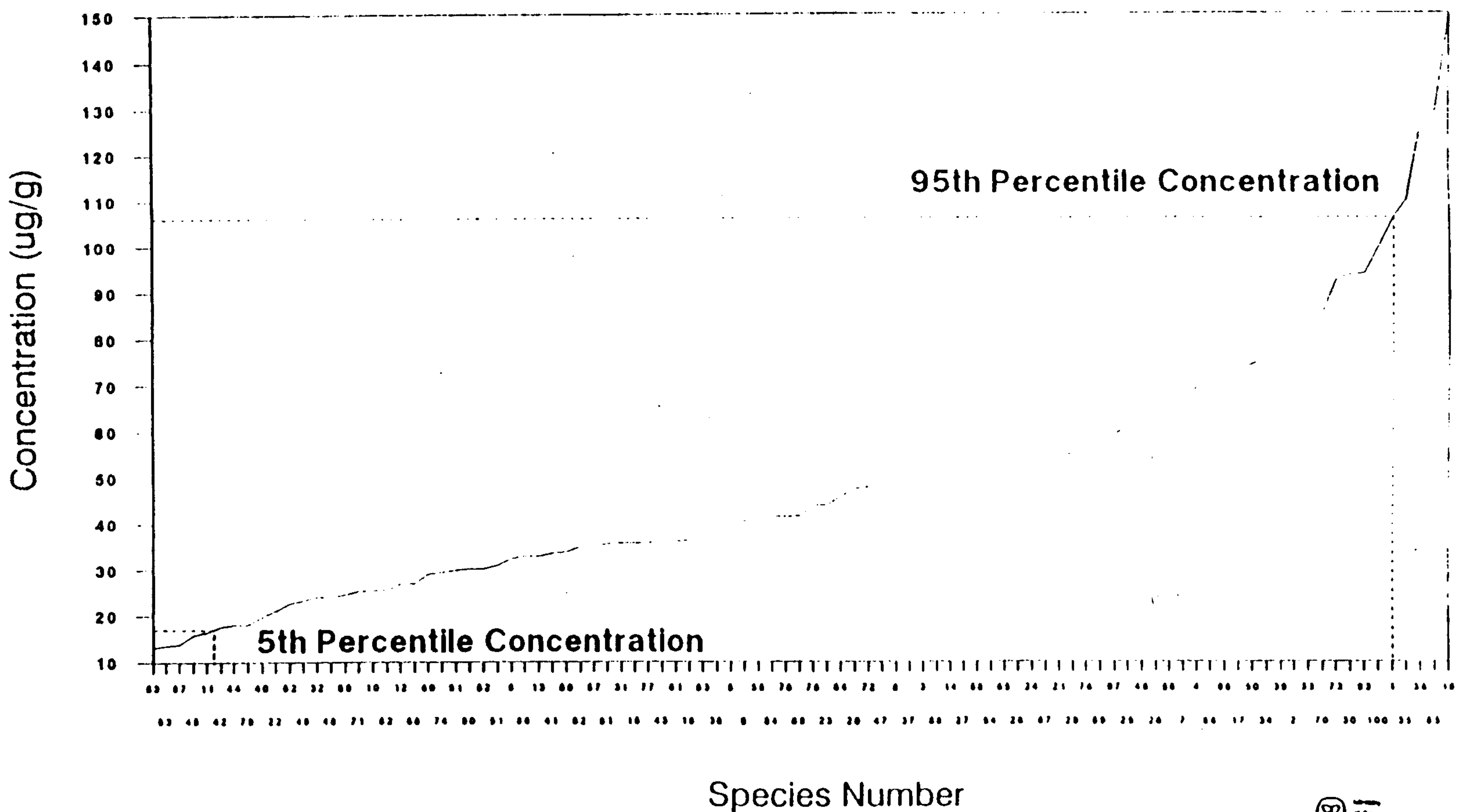


Fig 5. SLC Graph For Iron

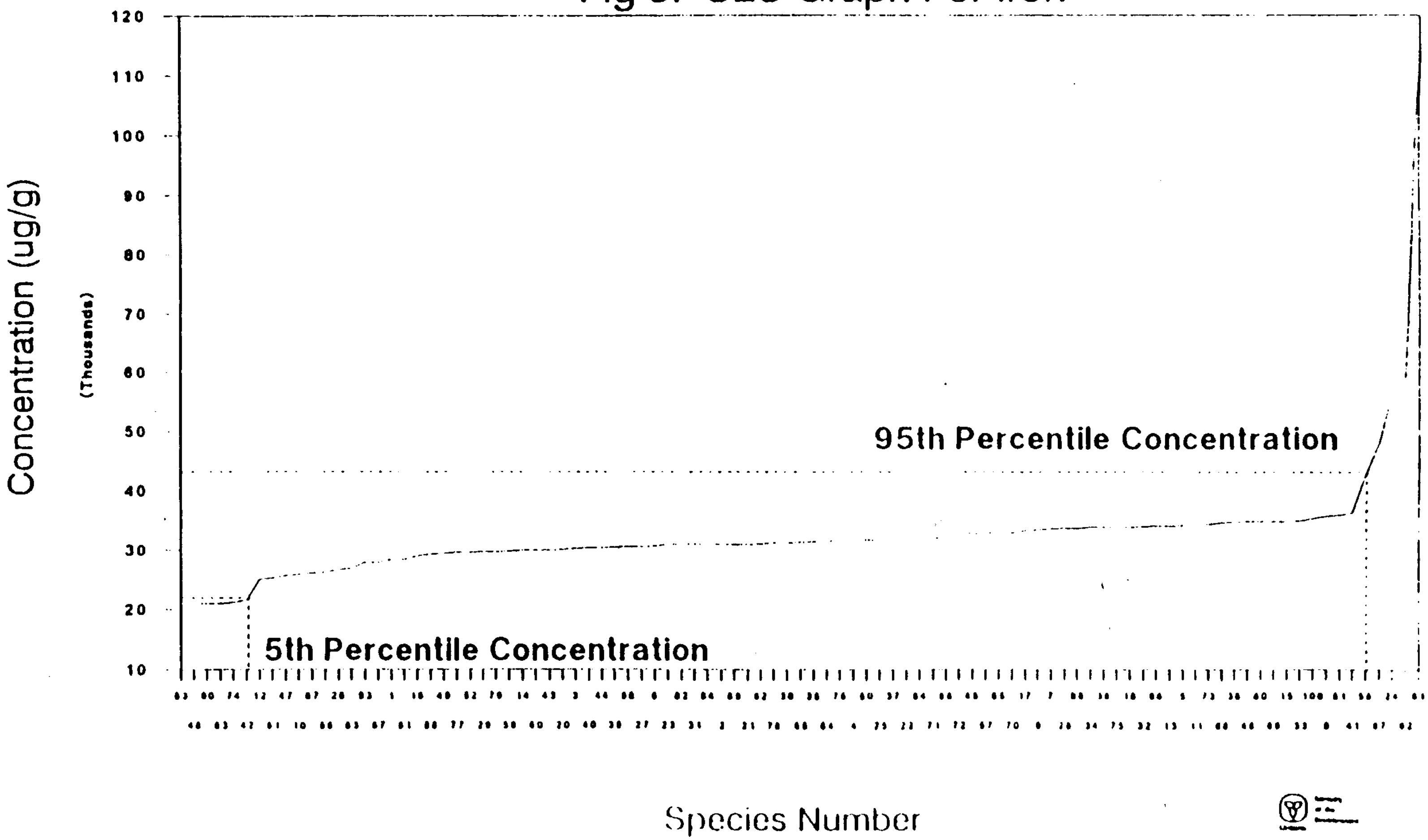


Fig 6. SLC Graph For Lead

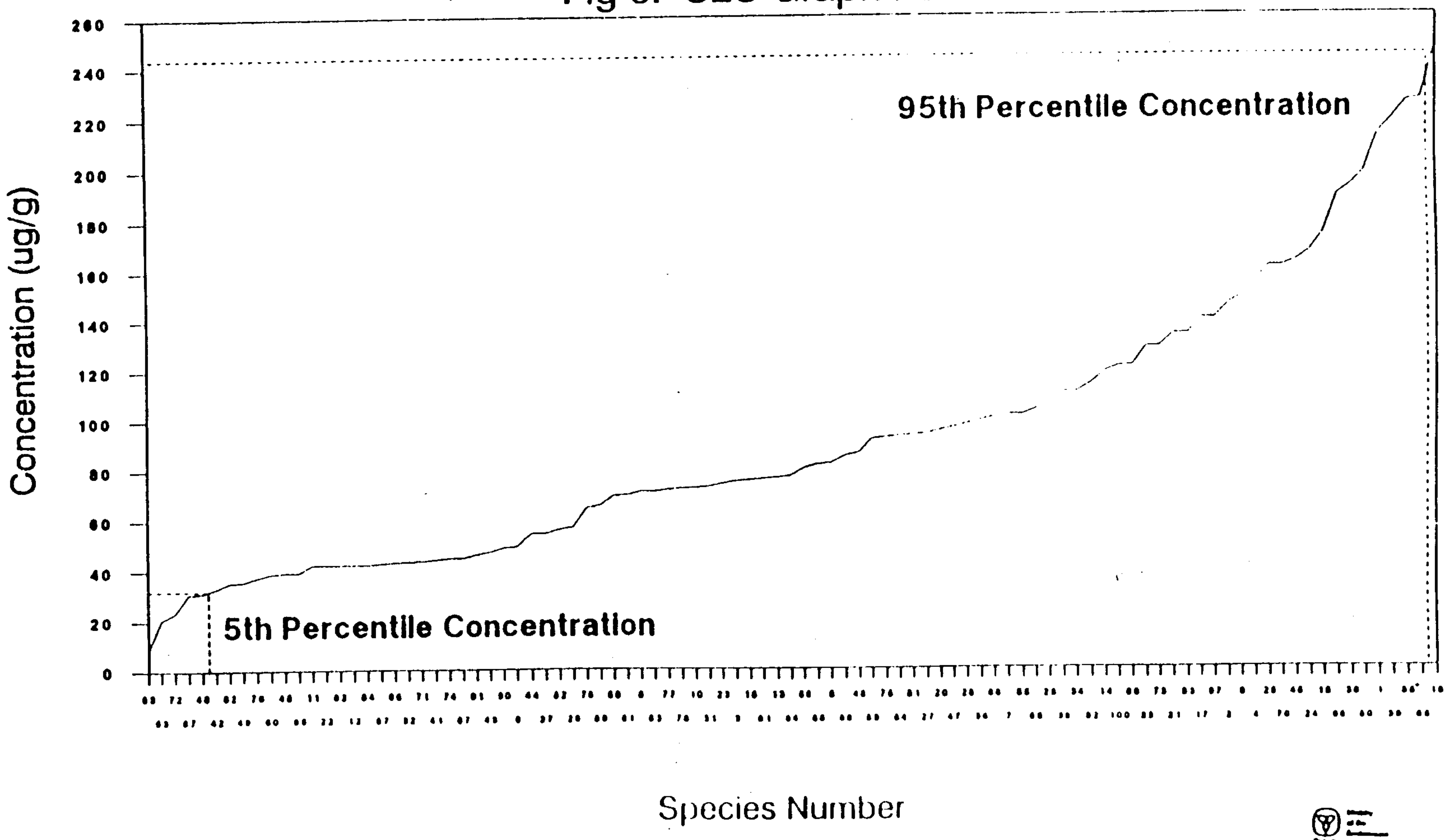


Fig 7. SLC Graph For Manganese

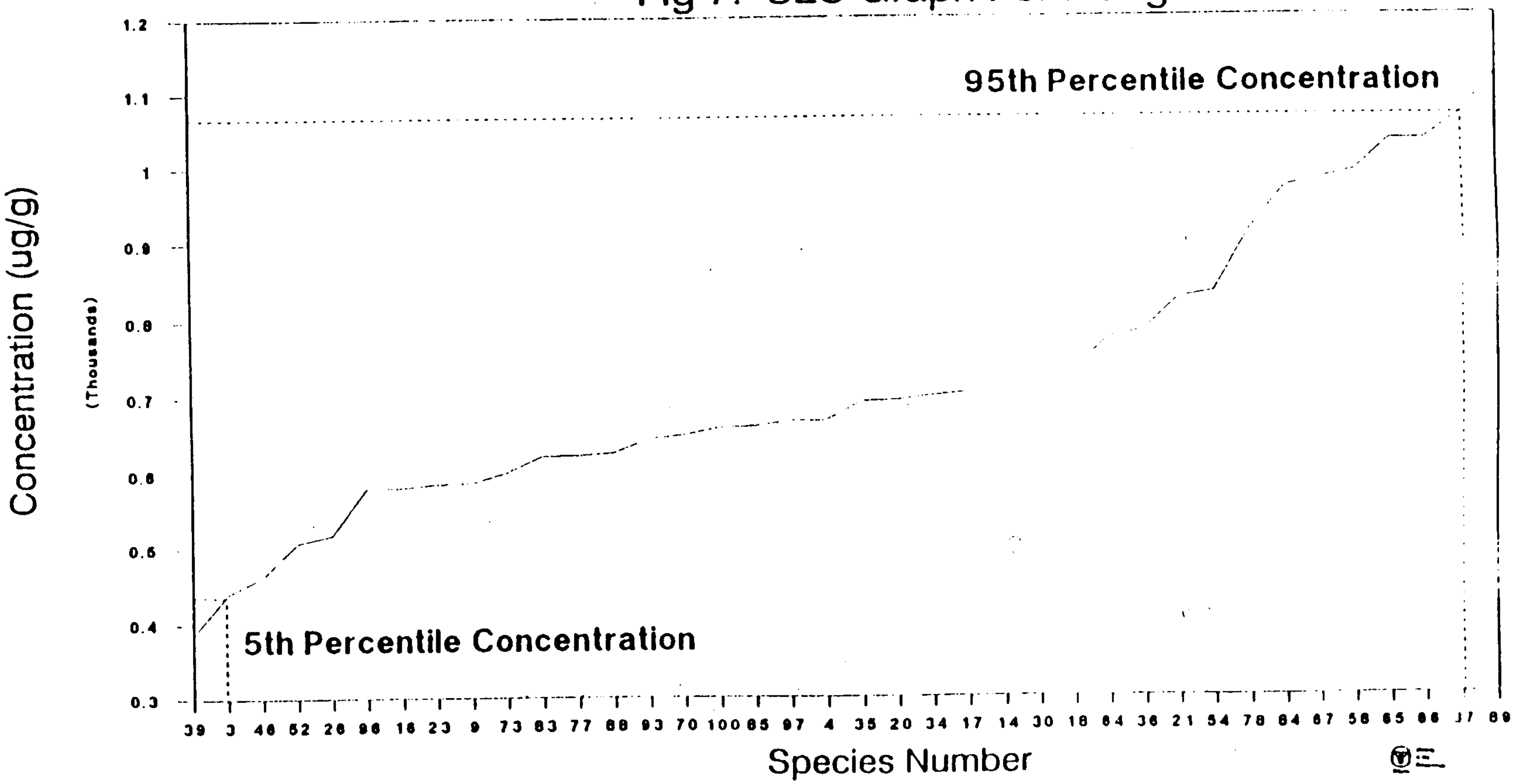


Fig 8. SLC Graph For Mercury

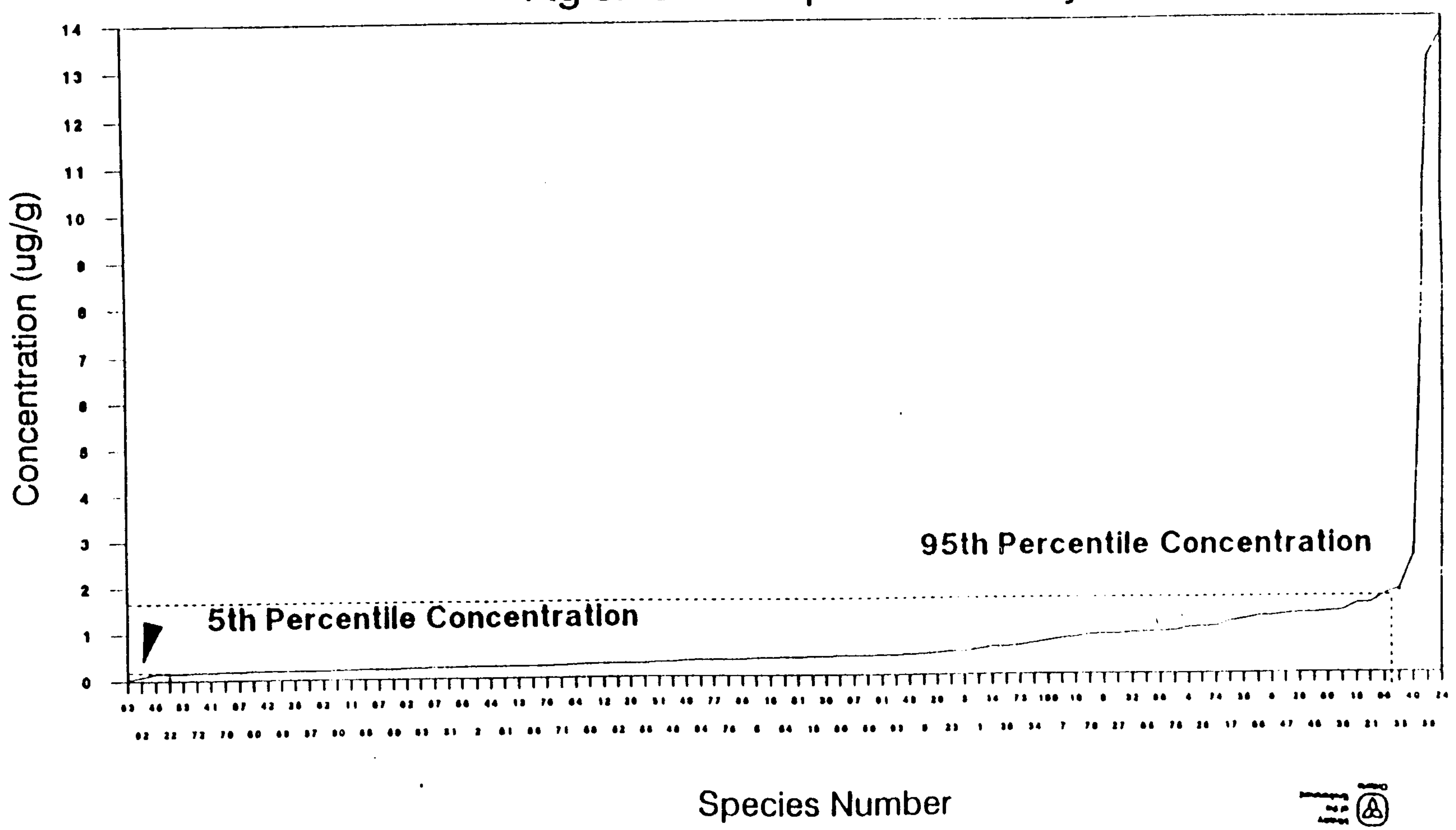


Fig 9. SLC Graph For Nickel

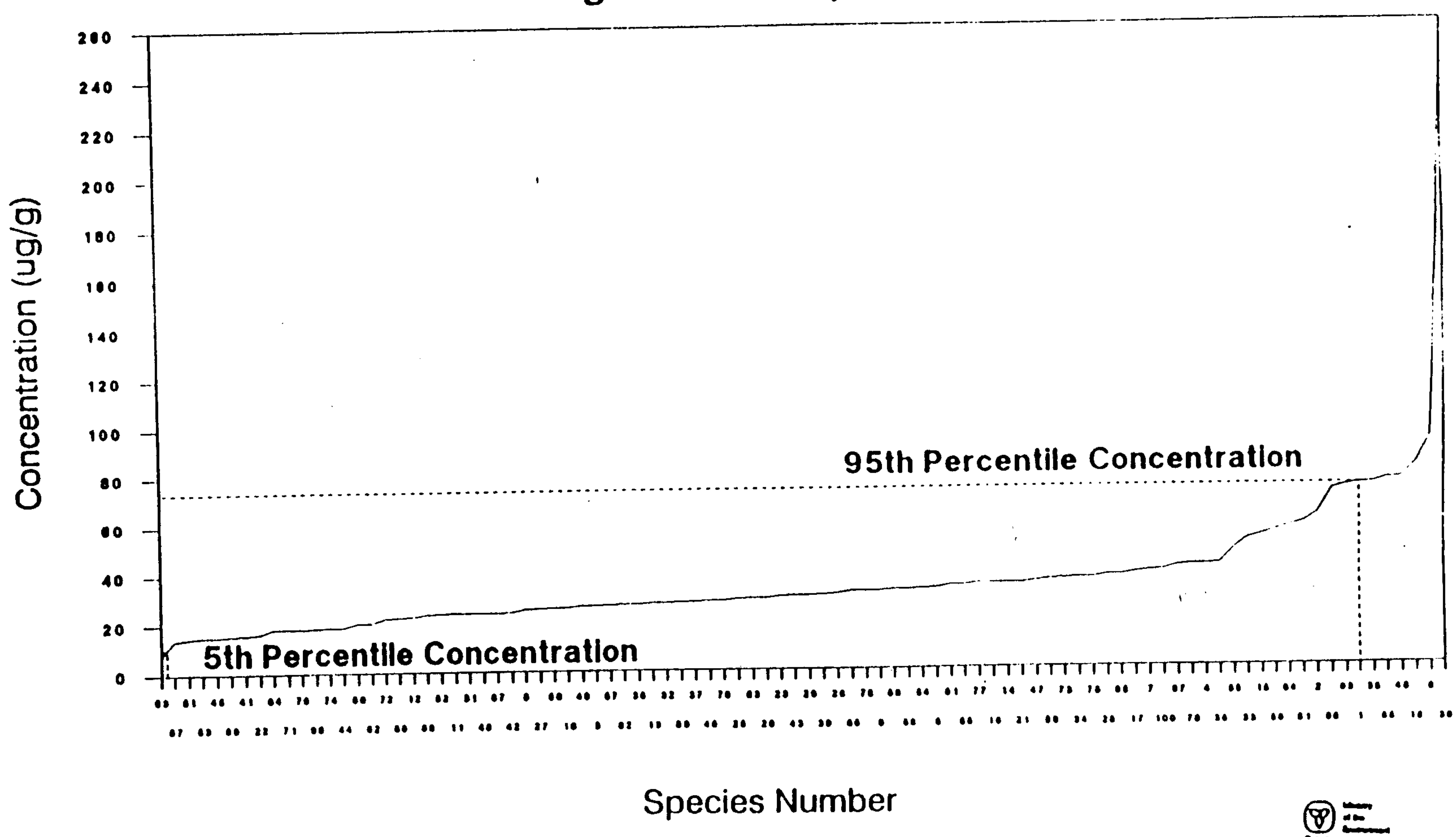
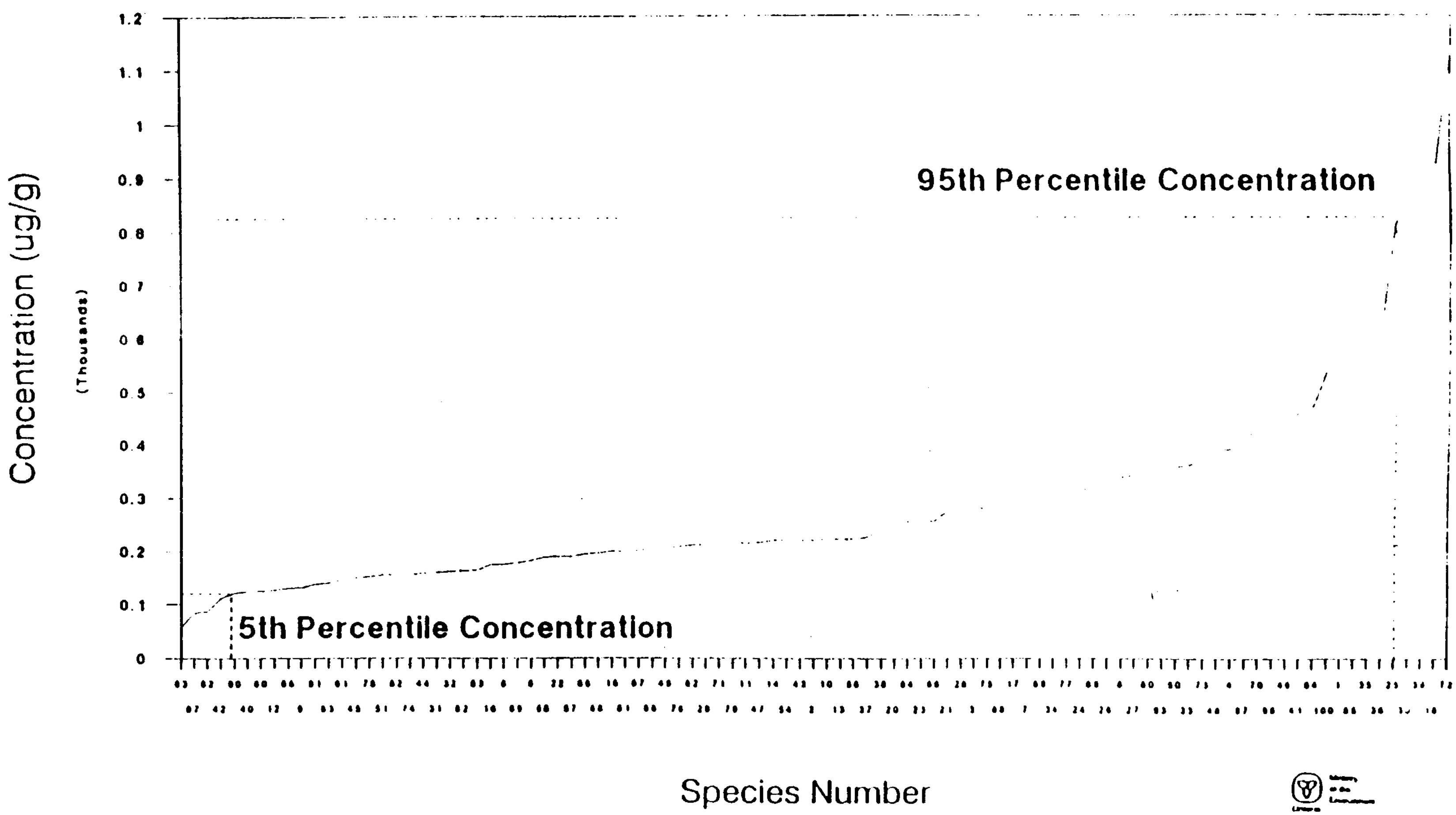


Fig 10. SLC Graph For Zinc



DEVELOPMENT OF THE ONTARIO PROVINCIAL SEDIMENT QUALITY GUIDELINES FOR THE PCBs AND THE ORGANOCHLORINE PESTICIDES

AUGUST 1993

Ontario

Ministry of Environment and Energy

DEVELOPMENT OF THE ONTARIO PROVINCIAL SEDIMENT QUALITY GUIDELINES FOR PCBS AND THE ORGANOCHLORINE PESTICIDES

Report prepared by:

R. Jaagumagi
Water Resources Branch
Ontario Ministry of the Environment and Energy

AUGUST 1993

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ACKNOWLEDGMENTS

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PREAMBLE

The Provincial Sediment Quality Guidelines are a set of numerical guidelines developed for the protection of aquatic biological resources. The methods used in setting those guidelines, and the calculation and data evaluation methods are described in detail in Persaud *et al* (1992).

The guidelines set out in this document have defined three levels of ecotoxic effects.

1. A No-Effect Level at which no toxic effects have been observed on aquatic organisms. This is the level at which all biological resources will be protected. Other water quality and use guidelines will also be met at this level. This level is also intended to protect against biomagnification through the food chain.

2. A Lowest Effect Level indicating a level of sediment contamination at which the majority of benthic organisms are unaffected.

3. A Severe Effect Level indicating the level at which pronounced disturbance of the sediment-dwelling community can be expected. This is the sediment concentration of a compound that would be detrimental to the majority of benthic species.

The No-Effect Level guideline is calculated on the basis of the Equilibrium Partitioning method described in Persaud *et al* (1992). The method uses Provincial Water Quality Objectives/Guidelines, which have been designed to protect against biomagnification as well as all other sensitive water uses. A guideline is derived by multiplying the PWQO or PWQG by organic carbon-normalized partition coefficients (K_{oc}) to derive a sediment guideline. The mean of these values becomes the No-Effect Level.

Both the Lowest Effect Level and the Severe Effect Level guideline levels are derived using the Screening Level Concentration method described in Persaud *et al* (1992). The SLC metho makes use of field data on sediment concentrations of contaminants and the co-occurrence of benthic invertebrate species. The calculation of the SLC is a two step process and is calculated separately for each parameter. In the first step, for each parameter the individual SLCs (termed Species SLCs) are calculated for each of the benthic species. The sediment concentrations at all locations at which that species was present are plotted in order of increasing concentration. From this plot, the 90th percentile of this concentration distribution is determined. The 90th percentile was chosen to provide a conservative estimate of the tolerance range for that species. This would serve to eliminate extremes in concentrations that may be due to specific and unusual sediment characteristics. The 90th percentile is that locus below which 90 percent of the sediment concentrations fall.

In the second step, the 90th percentiles for all of the species present are plotted, also in order of increasing concentration. From this plot, the 5th percentile and the 95th percentile are calculated. These represent the concentrations below which 5 percent and 95 percent of the concentrations fall. The concentration of a contaminant at the 5th percentile becomes the Lowest Effect Level whil the concentration at the 95th percentile becomes the Severe Effect Level.

This document details the derivation of the Provincial Sediment Quality Guidelines for PCBs and the organochlorine compounds, and summarizes the data used to derive these values. The document also summarizes the fate of the organochlorine pesticides and PCBs in sediments and provides the necessary details of the calculations of the sediment quality guidelines.

INTRODUCTION

PCBs and the organochlorine pesticides are not naturally occurring compounds; their presence in sediments. is due entirely to anthropogenic sources. The sources can be through direct input into water, as in the case of effluent discharges from manufacturing, or through indirect losses, such as non-point source runoff. The latter has been especially significant in the case of the organochlorine pesticides where aerial application has been common practice. Many of these compounds are so persistent and pervasive that atmospheric inputs can be considerable.

The ultimate fate of most of these compounds in aquatic systems is complexing to ligands and deposition in the sediments. The relative length of time that a compound remains in solution depends on its solubility and hydrophobicity. Highly insoluble compounds can rapidly partition to organic particles and settle to the sediments while the more water soluble compounds may remain in solution for longer periods of time. The solubility, therefore, has a direct bearing on the ultimate fate of a compound, with the more soluble compounds generally lost more readily from solution, through volatilization and transformation, than the insoluble compounds.

The remainder of this document describes the fate of each of the compounds in the aquatic system and details the derivation of the No-Effect Levels, the Lowest Effect Levels and the Severe Effect Levels.

ALDRIN

i. Aquatic Fate

Aldrin is a hexachloro compound formulated for use as a pest control agent. While originally used for control of soil, fruit and vegetable pests, its use is currently restricted to ground injection for termite control (CCREM 1987).

The major pathways to the aquatic environment are through sediment transport of eroded soil. Rainfall and snowfall can also contribute trace amounts.

Solubility of aldrin in water is very low and aldrin is expected to rapidly partition to organic matter. The persistence of aldrin in the environment is affected by its rapid biotransformation, through epoxidation, to dieldrin, which is highly stable in aquatic systems (Smith *et al* 1988).

Aldrin can be bioaccumulated by aquatic organisms, though biomagnification is not likely to be significant due to the rapid transformation to dieldrin.

ii. Sediment Guidelines

No-Effect Level

The No-Effect Level guideline for aldrin based on the equilibrium partitioning approach could not be calculated since only one partition coefficient for aldrin was available (log K_{oc} = 6.02) (OMOE 1987).

Lowest Effect Level

The Lowest Effect Level for aldrin was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for Aldrin was calculated on the basis of sediment concentrations from 117 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 µg/g to 0.01 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 39 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) for each species are presented in Table 1. A detailed plot of the SLC is provided in Figure 1.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.002 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic-carbon normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline, which are presented in Table 1. Figure 1 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the organic-carbon normalized SLC plot is calculated as 8.4 µg/g of organic carbon, which is rounded to 8 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline, this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied. For example, a sediment TOC content of 5% results in a bulk sediment guideline of 8 µg/g O.C. x 0.05

or 0.42 μg/g.

Since the sediment concentrations used in the calculations covered only a narrow range, the guidelines derived by the SLC method must be considered as conservative.

BENZENE HEXACHLORIDE (BHC)

i Aquatic Fate

BHC refers to a number of mixed isomers of hexachlorocyclohexane, of which the γ-isomer, lindane, is the only significant insecticide. Lindane has been used to control domestic, commercial, agricultural, silvicultural and livestock insect pests. The other isomers occur mainly as by-products of chemical manufacturing processes.

Sources to the environment are from industrial discharges and agricultural runoff. Atmospheric transport and deposition has ensured that these compounds occur even in remote areas.

Solubility in water is relatively high for lindane, and much of the compound can remain in the water column for extended periods of time. The partition coefficient has been measured as 3.7 (log K_{ow}) (Smith *et al* 1987) and suggests that lindane can sorb to organic matter and settle in this matrix. Though lindane does not partition strongly to sediment organic matter, it is relatively bioaccumulable, especially from the water column. Bioaccumulation factors have been measured at around 100 (Smith *et al* 1988).

Transformation (dechlorination) can occur in the sediments, particularly under anaerobic conditions.

ii. Sediment Guidelines

Total BHC

No-Effect Level

No PWQOs/Gs were available to calculate a No-Effect Level for total BHC.

Lowest Effect Level

The Lowest Effect Level for total BHC was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for total BHC was calculated on the basis of sediment concentrations from 171 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 μg/g to 0.145 μg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 67 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 2. A detailed plot of the SLC is provided in Figure 2.

The 5th percentile of the organic-carbon normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.003 μg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic-carbon normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline, which are presented in Table 2. Figure 2 also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the organic-carbon normalized SLC plot is calculated as 11.8 μg/g of organic carbon which is rounded to 12 μg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline, this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

α-BHC

No-Effect Level

No PWQOs were available to calculate guidelines for α-BHC by the partitioning method.

Lowest Effect Level

The Lowest Effect Level for α-BHC was calculated as the 5th percentile of the Species

Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for α-BHC was calculated on the basis of sediment concentrations from 39 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 μg/g to 0.04 μg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 26 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 2a. A detailed plot of the SLC is provided in Figure 2a.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.006 μg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic-carbon normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 2a. Figure 2a also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the organic-carbon normalized SLC plot is calculated as 10.3 μg/g of organic carbon which is rounded to 10 μg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline, this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied. For example, a sediment TOC content of 5% results in a bulk sediment guideline of 10 μg/g O.C. x 0.05 or 0.5 μg/g.

β-BHC

No-Effect Level

No PWQOs were available to calculate guidelines for β-BHC by the partitioning method.

Lowest Effect Level

The Lowest Effect Level for β-BHC was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for β-BHC was calculated on the basis of sediment concentrations from 83 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 μg/g to 0.145 μg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 25 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 2b. A detailed plot of the SLC is provided in Figure 2b.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.005 μg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level Concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 2b. Figure 2b also shows the 95th percentile of the Species SLC distribution.

The 95th percentile of the organic carbon-normalized SLC plot is calculated as 21 μg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

γ-BHC

No-Effect Level

The available partition coefficients (mean of log K_{oc} was 3.35) were used to calculate the No-Effect Level guideline. The mean of the calculated guidelines, using the existing PWQO of 0.01 μg/L and converted to a bulk sediment basis assuming a limit of 1% sediment TOC, was 0.0002 μg/g.

Lowest Effect Level

The Lowest Effect Level for γ-BHC was calculated as the 10th percentile of the Species Screening Level Concentrations (SSLCs) since the limited database precluded the use of the 5th percentile. Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for γ-BHC was calculated on the basis of sediment concentrations from 46 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 μg/g to 0.011 μg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 15 species, these guidelines must be regarded as tentative. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 2c. A detailed plot of the SLC is provided in Figure 2c.

Due to insufficient data to calculate the 5th percentile, the 10th percentile of the organic carbon-normalized SLC was calculated. The 10th percentile, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0 003 μg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 90th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 2c. Figure 2c also shows the 90th percentile of the Species SLC distribution.

The limited size of the database precluded the calculation of the 95th percentile of the SSLC distributions. The Severe Effect Level is therefore based on the 90th percentile of the organic carbon-normalized SLC plot, which was calculated as 0.9 μg/g of organic carbon which is rounded to 1.0 μg/g of organic carbon and this value must also be regarded as tentative. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied. While the use of the 90th percentile gives a conservative value, thi is warranted, given the restricted database.

The low value as compared to the other BHC isomers is likely due to the limited concentration range in the database from which this value was calculated and the limited size of the database. The Lowest Effect Level and the Severe Effect Level for this isomer should be regarded as tentative until additional data becomes available.

TOTAL CHLORDANE

i Aquatic Fate

Chlordane is an octachloro compound that occurs in a mixture of isomers, mainly α-Chlordane and -Chlordane. It has been formulated as an insecticide and has, in the past, been used for agricultural pest control and for control of wood-boring insects in structures. At present it is used only in the control of subterranean insects.

Sources to the aquatic environment are mainly through pesticide application to crops and losses related to the manufacturing process.

In water, sorption to organic matter and volatilization in the absence of organic matter appear to be the most important processes. OMOE (1988) noted partition coefficients (log K_{oc}) ranging from 2.99 to 4.89 with a mean of 3.94. Smith *et al* 1988 noted a partition coefficient (log K_{ow}) of 5.48. Sediment accumulation is likely to be a significant fate, given the affinity for organic matter.

Bioaccumulation factors were in the order of 1,000 to 10,000 suggesting that bioaccumulation can be significant. Though little appears to be known about biomagnification, chlordane in mammalian systems can be transformed and stored in tissues as oxychlordane, a toxic metabolite of chlordane.

ii Sediment Guidelines

No-Effect Level

The available partition coefficients (mean of log K_{oc} was 3.94) were used to calculate the No-Effect Level guideline. The mean of the calculated guidelines, using the existing PWQO of 0.06 μg/L and converted to a bulk sediment basis assuming limit of 1% sediment TOC, was 0.005 µg/g.

Lowest Effect Level

The Lowest Effect Level for chlordane was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for chlordane was calculated on the basis of sediment concentrations from 140 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 µg/g to 0.048 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 56 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 3. A detailed plot of the SLC is provided in Figure 3.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.007 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 3. Figure 3 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 5.9 µg/g of organic carbon which is rounded to 6 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

Both the Lowest Effect Level and the Severe Effect Level are likely to be conservative given the restricted concentration range sampled.

DDT

i Aquatic Fate

DDT (1,1,1,-trichloro-2,2-bis(4-chlorophenyl)ethane) occurs primarily as two isomers; p,p'-DDT and o,p'-DDT. It is a broad spectrum insecticide that has seen world-wide use since its commercial production began in the early 1940's.

The major sources are through direct release to water bodies in effluent from manufacturing, or as a result of aerial deposition through application.

Both DDT isomers are insoluble in water and their aquatic fate is usually adsorption to organic matter with subsequent deposition in the sediments. They also demonstrate a high affinity for animal lipids. Volatilization can also be relatively high as a result of the low water solubility, especially where organic content of the water is low. Partition coefficients for DDT are high. Smith *et al* (1988) give a value of log K_{ow} = 6.36 for p,p'-DDT, while OMOE (1988) give a mean of log K_{oc} = 5.92 for DDT.

Due to its solubility in lipids, DDT is bioaccumulated and concentrated at all trophic levels and can be biomagnified as well. Bioconcentration factors range from 10,000 to 1,000,000 (Smith *et al* 1988; CCREM 1987).

ii Sediment Guidelines

Total DDT (DDT and metabolites)

No-Effect Level

A No-Effect level was not calculated for DDT since the PWQO for DDT is currently under revision. When the revised values are available the No-Effect Level will be derived.

Lowest Effect Level

The Lowest Effect Level for total DDT was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for DDT was calculated on the basis of sediment concentrations from 561 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.0005µg/g to 6.030 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 83 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 4. A detailed plot of the SLC is provided in Figure 4.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.007µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level Concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 4. Figure 4 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 11.8 µg/g of organic carbon which is rounded to 12 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

DDT (p,p'-DDT and o,p'-DDT)

No-Effect Level

Since no PWQOs exist for the individual isomers of DDT a No-Effect Level could not be calculated.

Lowest Effect Level

The Lowest Effect Level for o,p' + p,p' DDT was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for DDT (including the isomers o,p'-DDT and p,p'-DDT) was calculated on the basis of sediment concentrations from 202 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.0005µg/g to 6.030 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 51 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 4a. A detailed plot of the SLC is provided in Figure 4a.

The 5th percentile of the organic carbon-normalized SLC for DDT, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.008 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution for each isomer. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 4a. Figure 4a also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level for DDT is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 70.9 µg/g of organic carbon which is rounded to 71µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

DDD

i <u>Aquatic Fate</u>

DDD (1,1-dichloro-2,2-bis(4-chlorophenyl)ethane) occurs principally as the isomer p,p'-DDD. Though used in the past as a pesticide, it most commonly appears as a contaminant in formulations of DDT.

The uses, and environmental pathways, are the same as for DDT. In the aquatic environment

DDD, like DDT has a low solubility, which results in significant amounts being sorbed to organic matter. DDD is also soluble in animal lipids. A partition coefficient of 5.99 (log K_{ow}) has been reported by the EPA (CCREM 1987).

Bioconcentration factors range from 1,000 to 100,000.

ii Sediment Guidelines

No-Effect Level

Since no PWQOs exist for DDD, a No-Effect Level could not be calculated.

Lowest Effect Level

The Lowest Effect Level for DDD was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for p,p'-DDD was calculated on the basis of sediment concentrations from 118 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.002 µg/g to 0.06 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 30 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 5. A detailed plot of the SLC is provided in Figure 5.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.008 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 5. Figure 5 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 6.0 µg/g. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied. Since the sediment concentrations did not span a wide concentration range, these values must be considered as conservative.

DDE

i Aquatic Fate

DDE is the primary metabolite of DDT and is formed by the dechlorination of DDT.

DDE is also sparingly soluble in water and most sorbs to organic matter and settles to the sediments. Like DDT, it is soluble in animal lipids. A partition coefficient of 5.69 (log KOw) has been reported for the p,p'-DDE isomer (Smith *et al* 1988).

Bioconcentration factors of 12,000 have been reported in fish (Smith *et al* 1988).

ii Sediment Guidelines

No-Effect Level

Since no PWQOs exist for DDE a No-Effect Level could not be calculated.

Lowest Effect Level

The Lowest Effect Level for DDE was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for p,p'-DDE was calculated on the basis of sediment concentrations from 241 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 µg/g to 0.057 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 72 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level

Concentration (SSLC) are presented in Table 6. A detailed plot of the SLC is provided in Figure 6.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.005 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 6. Figure 6 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 18.6 µg/g of organic carbon which is rounded to 19 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied. Since the sediment concentrations used in the calculations did not span a wide concentration range, these values must be considered as conservative.

DIELDRIN

i Aquatic Fate

Dieldrin is a hexachloro compound formulated for use as a pest control agent. It has been used for domestic and agricultural insect pest control. Dieldrin can also be formed in the environment as a result of the metabolism of aldrin by microorganisms.

Major pathways to aquatic systems are through manufacture and application of both dieldrin and aldrin, though in the latter case, this occurs mainly through runoff of sediment/eroded particles. Due to its low water solubility, dieldrin readily sorbs to organic matter.

Bioaccumulation factors of 1,000 to 10,000 have been observed (Smith *et al* 1988, CCREM 1987).

ii Sediment Guidelines

No-Effect Level

The available partition coefficients (mean of log K_{oc} was 4.84) were used to calculate the No-Effect Level guideline. The mean of the calculated guidelines, using the existing PWQO of 0.001 µg/L and converted to a bulk sediment basis assuming a limit of 1% sediment TOC, was 0.0006 µg/g.

Lowest Effect Level

The Lowest Effect Level for dieldrin was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for dieldrin was calculated on the basis of sediment concentrations from 279 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.001 µg/g to 11.6 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 81 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 7. A detailed plot of the SLC is provided in Figure 7.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.002 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon- normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 7. Figure 7 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon- normalized SLC plot, which was calculated as 91 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline, this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

ENDRIN

i Aquatic Fate

Endrin is a hexachloro compound used as a foliar insecticide for the control of agricultural pests.

Sources to aquatic systems are primarily through application as a pesticide. The low solubility and high partition coefficient (log K_{oc} = 3.59 to 5.6) favour the sorption of endrin to organic matter and accumulation in the sediments. Photolysis and volatilization do not appear to be major processes governing the fate of endrin.

Bioaccumulation appears to be a significant fate, with reported bioconcentration factors of 1000 to 10,000 (CCREM 1987).

ii Sediment Guidelines

No-Effect Level

The available partition coefficients (mean of log K_{oc} was 4.36) were used to calculate the No-Effect Level guideline. The mean of the calculated guidelines, using the existing PWQO of 0.002 µg/L and converted to a bulk sediment basis assuming a limit of 1% sediment TOC, was 0.0005 µg/g.

Lowest Effect Level

The Lowest Effect Level for endrin was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for endrin was calculated on the basis of sediment concentrations from 136 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.002 µg/g to 0.295 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 35 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 8. A detailed plot of the SLC is provided in Figure 8.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.003 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 8. Figure 8 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 127.5 µg/g of organic carbon which is rounded to 130 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

HEXACHLOROBENZENE (HCB)

i Aquatic Fate

HCB occurs primarily as a waste product of chemical manufacturing. It has also been used in the past as a fungicide (CCREM 1987).

Most chlorinated benzenes are hydrophobic compounds with high partition coefficients. The reported value for HCB is 5.5 (log K_{ow}). While volatilization of most chlorinated benzenes is the principal removal mechanism from water, HCB can sorb to organic matter and settle to the sediments.

Due to its solubility in lipids, HCB is also expected to accumulate in organism tissues. Little information is available on biomagnification.

ii Sediment Guidelines

No-Effect Level

The available partition coefficients (mean of log K_{oc} was 6.31) were used to calculate the No-Effect Level guideline. The mean of the calculated guidelines, using the existing PWQO of 0.00065 µg/L and converted to a bulk sediment basis assuming a limit of 1% sediment TOC, was 0.01

$\mu g/g$.

Lowest Effect Level

The Lowest Effect Level for HCB was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for HCB was calculated on the basis of sediment concentrations from 240 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.0005 $\mu g/g$ to 0.150 $\mu g/g$. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 81 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 9. A detailed plot of the SLC is provided in Figure 9.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.02 $\mu g/g$.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 9. Figure 9 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 24 $\mu g/g$ of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

HEPTACHLOR

i Aquatic Fate

Heptachlor has been used as an agricultural and domestic pesticide. Its principal sources to aquatic systems is through application as a pesticide.

Hydrolysis and sorption to particulate matter and sediment deposition appear to be the principal fates in water due to the low water solubility (Log K_{oc} = 3.59 to 5.34).

Bioaccumulation is also significant with bioconcentration factors of 10,000 reported (CCREM 1987).

ii Sediment Guidelines

No-Effect Level

The available partition coefficients (mean of log K_{oc} was 4.46) were used to calculate the No-Effect Level guideline. The mean of the calculated guidelines, using the existing PWQO of 0.001 $\mu g/L$ and converted to a bulk sediment basis assuming a limit of 1% sediment TOC, was 0.0003 $\mu g/g$.

Lowest Effect Level and Severe Effect Level

Due to the limited concentration range sampled and the small size of the database, Screening Level Concentrations could not be reliably calculated for heptachlor. These will be developed as additional data becomes available.

HEPTACHLOR EPOXIDE

i Aquatic Fate

In North America, heptachlor epoxide is used as a pesticide for agricultural uses. However, it is not registered for use in Canada.

Sources to aquatic systems are primarily through application as a pesticide. Hydrolysis does not appear to be a major fate and sorption and bioaccumulation appear to be the principal reservoirs.

ii Sediment Guidelines

No-Effect Level

Since no K_{ow} values could be found for heptachlor epoxide a No-Effect Level could not be calculated.

Lowest Effect Level

The Lowest Effect Level for heptachlor epoxide was calculated as the 10th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for heptachlor epoxide was calculated on the basis of sediment concentrations from 134 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.0005 µg/g to 0.045 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 26 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 10. A detailed plot of the SLC is provided in Figure 10.

The available data was insufficient to calculate the 5th percentile of the SLC distribution and therefore, the 10th percentile of the SLC distribution was used to arrive at the Lowest Effect Level. As a result, the value derived must be regarded as tentative. The organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.005 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 90th percentile of the organic carbon-normalized Species Screening Level concentration distribution since insufficient data were available to calculate the 95th percentile. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 10. Figure 10 also shows the 90th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 90th percentile of the organic carbon-normalized SLC plot, which was calculated as 5 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

MIREX

i Aquatic Fate

Mirex is a dodecachlorinated compound that in the past has been used as a pest control agent in the southern United States and also as an additive in plastics, paints, rodenticides and antioxidants (CCREM 1987).

The principal source to the environment has been through the manufacturing process, which accounts for the restricted distribution.

Mirex is relatively insoluble in water with sorption to organic matter (including lipids) and bioaccumulation being the predominant fates (CCREM 1987).

ii Sediment Guidelines

No-Effect Level

Since no PWQOs exist for mirex a No-Effect Level could not be calculated.

Lowest Effect Level

The Lowest Effect Level for mirex was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for mirex was calculated on the basis of sediment concentrations from 141 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.005 µg/g to 0.985 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 52 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 11. A detailed plot of the SLC is provided in Figure 11.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.007 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 11. Figure 11 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 128 µg/g of organic carbon which is rounded to 130 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

POLYCHLORINATED BIPHENYLS (PCBs)

i Aquatic Fate

PCBs have been used in heat-transfer fluids, hydraulic fluids, solvent extenders, plasticizers, dielectric fluids, as flame retardants, additives, waterproofing agents, paints, surface coatings, adhesives, printing inks and pesticide extenders.

Principal sources to the aquatic environment are through atmospheric deposition (through incomplete combustion), through sewage, losses of lubricants and other fluids, and leachate from dumps and landfills.

PCBs are highly persistent, stable compounds. Their solubility in water is low, and decreases with increasing chlorine substitution. Sorption to sediment matter is the predominant fate in aquatic systems (log K_{ow} ranges from 3.76 to 8.26, depending on the degree of chlorination) (CCREM 1987).

The solubility of PCBs in lipids accounts for their accumulation and biomagnification in animal tissues. Bioconcentration factors of 2,000 to 200,000 have been reported (Smith *et al* 1988, CCREM 1987).

ii Sediment Guidelines

No-Effect Level

The available partition coefficients (mean of log K_{oc} was 6.14) were used to calculate the No-Effect Level guideline. The mean of the calculated guidelines, using the existing PWQO of 0.001 µg/L and converted to a bulk sediment basis assuming a limit of 1% sediment TOC, was 0.01 µg/g.

Lowest Effect Level

The Lowest Effect Level for total PCBs was calculated as the 5th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for total PCBs was calculated on the basis of sediment concentrations from 660 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.01 µg/g to 7.310 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 85 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 12. A detailed plot of the SLC is provided in Figure 12.

The 5th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.07 µg/g.

Severe Effect Level

The Severe Effect Level has been calculated as the 95th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 12. Figure 12 also shows the 95th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 95th percentile of the organic carbon-normalized SLC plot, which was calculated as 529.6 µg/g of organic carbon which is rounded to 530 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

PCB 1254

No-Effect Level

No PWQOs were available for calculation of a No-Effect Level guideline for this Arochlor.

Lowest Effect Level

The Lowest Effect Level for PCB 1254 was calculated as the 10th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for PCB 1254 was calculated on the basis of sediment concentrations from 78 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.01 µg/g to 1.600 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 13 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 12a. A detailed plot of the SLC is provided in Figure 12a.

Since insufficient data were available to calculate the 5th percentile, the 10th percentile was calculated. The 10th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.06 µg/g.

Severe Effect Level

Due to the limited size of the database only the 90th percentile of the SSLC distributions could be calculated. Therefore, the Severe Effect Level has been calculated as the 90th percentile of the organic carbon- normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 12a. Figure 12a also shows the 90th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 90th percentile of the organic carbon-normalized SLC plot, which was calculated as 34 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

Both the Lowest Effect Level and the Severe Effect Level for this and all other PCB Arochlors must be regarded as tentative given the small size of the database from which the values were calculated.

PCB 1016

No-Effect Level

No PWQOs were available for calculation of a No-Effect Level guideline.

Lowest Effect Level

The Lowest Effect Level for PCB 1016 was calculated as the 10th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for PCB 1016 was calculated on the basis of sediment concentrations from 78 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.014 µg/g to 7.000 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 13 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 12b. A detailed plot of the SLC is provided in Figure 12b.

Since insufficient data were available to calculate the 5th percentile, the 10th percentile was obtained. The 10th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.007 µg/g.

Severe Effect Level

Due to the limited size of the database only the 90th percentile of the SSLC distributions could be calculated. Therefore, the Severe Effect Level has been calculated as the 90th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 12b. Figure 12b also shows the 90th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 90th percentile of the organic carbon-normalized SLC plot, which was calculated as 53 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

PCB 1248

No-Effect Level

No PWQOs were available for calculation of a No-Effect Level guideline.

Lowest Effect Level

The Lowest Effect Level for PCB 1248 was calculated as the 10th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for PCB 1248 was calculated on the basis of sediment concentrations from 78 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.01µg/g to 6.450 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 13 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 12c. A detailed plot of the SLC is provided in Figure 12c.

Since insufficient data were available to calculate the 5th percentile, the 10th percentile was obtained. The 10th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.03µg/g.

Severe Effect Level

Due to the limited size of the database only the 90th percentile of the SSLC distributions could be calculated. Therefore, the Severe Effect Level has been calculated as the 90th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 12c. Figure 12c also shows the 90th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 90th percentile of the organic carbon-normalized SLC plot, which was calculated as 150 µg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

PCB 1260

No-Effect Level

No PWQOs were available for calculation of a No-Effect Level guideline.

Lowest Effect Level

The Lowest Effect Level for PCB 1260 was calculated as the 10th percentile of the Species Screening Level Concentrations (SSLCs). Each SSLC is the calculated 90th percentile of the concentration distribution for that species. The Screening Level Concentration (SLC) is a plot of the concentration distribution of all the SSLCs for that compound, and for PCB 1260 was calculated on the basis of sediment concentrations from 79 locations in and adjacent to the Great Lakes region. The sediment concentrations ranged from 0.01µg/g to 1.482 µg/g. Sediment concentrations were normalized to the actual sediment organic carbon content (as denoted by TOC) before calculations were undertaken. Species Screening Level Concentrations were calculated for 13 species. The actual species used in the calculation, the concentration mean and range, and the 90th percentile of the Species Screening Level Concentration (SSLC) are presented in Table 12d. A detailed plot of the SLC is provided in Figure 12d.

Since insufficient data were available to calculate the 5th percentile, the 10th percentile was obtained. The 10th percentile of the organic carbon-normalized SLC, converted to a bulk sediment concentration assuming a limit of 1% sediment TOC concentration, is calculated as 0.005 μg/g.

Severe Effect Level

Due to the limited size of the database only the 90th percentile of the SSLC distributions could be calculated. Therefore, the Severe Effect Level has been calculated as the 90th percentile of the organic carbon-normalized Species Screening Level concentration distribution. The data used are the same as for the Lowest Effect Level Guideline which are presented in Table 12d. Figure 12d also shows the 90th percentile of the Species SLC distribution.

The Severe Effect Level is based on the 90th percentile of the organic carbon-normalized SLC plot, which was calculated as 24 μg/g of organic carbon. To arrive at the bulk sediment Severe Effect Level guideline this value is multiplied by the actual TOC content of the sediments to which the guideline is being applied.

RESEARCH NEEDS

It is apparent that in some cases, limitations of the data have precluded the use of some of the methods in calculating the guidelines. In a number of cases either K_{ow} values, or PWQOs/Gs were not available for calculation of No-Effect Levels. In addition, the SLC method described in the Protocol requires that the full tolerance range for each species be sampled and that the data for the species is not biased towards lightly or heavily contaminated areas. It has not been possible in all cases to satisfy these requirements. In particular, the concentrations for some of the compounds were generally rather low, often with levels in the sediments below the analytical detection limits. In many cases where sediment concentrations were high, only a few benthic invertebrate species were present, most likely due to other factors such as a high level of organic matter. Therefore, the guideline numbers in some cases may be rather conservative, though this should change as additional data is added to the database.

This points to the necessity for future effort to be directed towards incorporating additional data, particularly data from highly contaminated sites. There is also a need to concentrate efforts towards sediment bioassay procedures to verify the results of the SLC process.

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APPENDIX I - TABLES

Species Screening Level Calculations

Explanation of Abbreviations:

N=	- Number of observations used for the calculation of the SSLC.
Mean	- Mean concentration (dry weight and organic carbon normalized) at sites at which the species was present.
%	- Percentile at which the concentration is calculated.
Conc.	- Organic carbon normalized concentration (dry weight) of the contaminant at the percentile noted.
.	- Insufficient number of observations to calculate percentiles.

Table 1: ALDRIN - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	13	0.42	0.28	0.03	0.825	90	0.8
2	Aelosoma sp	2	0.046	0.052	0.01	0.083	90	.
3	Amnicola limosa	4	0.145	0.13	0.006	0.314	90	.
4	Asellus sp	15	0.927	1.769	0.121	6.579	90	4.686
5	Aulodrilus limnobius	2	0.018	0.016	0.006	0.03	90	.
6	Aulodrilus pigueti	1	0.019		0.019	0.019	90	.
7	Aulodrilus pleuriseta	8	0.055	0.053	0.006	0.122	90	.
8	Bithynia tentaculata	10	0.236	0.144	0.006	0.556	90	0.531
9	Branchiura sowerbyi	6	0.182	0.037	0.121	0.23	90	.
10	Caenis sp	4	0.223	0.17	0.01	0.417	90	.
11	Ceraclea sp	0						
12	Chaetogaster diaphanus	14	0.154	0.12	0.03	0.5	90	0.389
13	Cheumatopsyche sp	0						
14	Chironomus sp	31	1.731	6.86	0.102	38.462	90	2.282
15	Cladopelma sp	3	0.288	0.2	0.102	0.5	90	.
16	Cladotanytarsus sp	3	0.206	0.063	0.161	0.278	90	.
17	Coelotanypus sp	5	0.236	0.058	0.185	0.303	90	.
18	Cricotopus sp	20	1.305	2.707	0.011	9.091	90	8.374
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	31	0.239	0.172	0.063	0.893	90	0.47
21	Dicrotendipes sp	8	0.249	0.164	0.072	0.607	90	.
22	Eukiefferiella sp	0						
23	Gammarus fasciatus	44	1.266	5.782	0.006	38.462	90	1.933
24	Glossiphonia heteroclita	1	0.235		0.235	0.235	90	.
25	Glossosoma sp	3	0.648	0.16	0.513	0.825	90	.
26	Glyptotendipes sp	6	0.227	0.109	0.154	0.446	90	.
27	Gyraulus parvus	4	0.145	0.046	0.096	0.2	90	.
28	Helisoma anceps	3	0.283	0.214	0.072	0.5	90	.
29	Heterotrissocladius sp	7	0.095	0.064	0.01	0.208	90	.
30	Hyalella azteca	14	2.848	3.574	0.122	9.091	90	9.091
31	Hydropsyche sp	0						
32	Hydroptila sp	1	0.5		0.5	0.5	90	.
33	Ilyodrilus templetoni	0						
34	Limnodrilus hoffmeisteri	20	0.114	0.113	0.006	0.5	90	0.268
35	Limnodrilus sp	59	1.32	4.982	0.111	38.462	90	2.193
36	Limnodrilus udekemianus	4	0.274	0.302	0.089	0.725	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	4	0.171	0.065	0.083	0.235	90	.
39	Microtendipes sp	10	0.222	0.121	0.143	0.556	90	0.524
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	8	0.133	0.043	0.072	0.208	90	.
43	Nais variabilus	17	0.17	0.118	0.011	0.5	90	0.322
44	Nanocladius sp	0						
45	Neureclipsis sp	0						
46	Oecetis sp	13	0.246	0.13	0.122	0.556	90	0.524
47	Parachironomus sp	10	0.112	0.066	0.01	0.208	90	0.205
48	Paralauterborniella sp	3	0.154	0.107	0.083	0.278	90	.
49	Paratendipes sp	8	0.136	0.114	0.006	0.278	90	.
50	Phaenopsectra sp	5	0.521	0.264	0.072	0.725	90	.
51	Phallodrilus sp	0						
52	Physella gyrina	5	0.109	0.083	0.01	0.227	90	.

53	Piguetiella michiganensi	15	0.162	0.062	0.083	0.278	90	0.278
54	Pisidium casertanum	24	0.119	0.1	0.01	0.5	90	0.218
55	Pisidium compressum	5	0.062	0.074	0.006	0.161	90	.
56	Pisidium conventus	13	0.14	0.129	0.01	0.5	90	0.395
57	Pisidium fallax	3	0.132	0.042	0.096	0.179	90	.
58	Pisidium henslowanum	19	0.093	0.061	0.006	0.227	90	0.179
59	Pisidium lilljeborgi	16	0.504	1.621	0.006	6.579	90	2.133
60	Pisidium nitidum	10	0.13	0.076	0.019	0.296	90	0.284
61	Pisidium variabile	18	0.117	0.119	0.006	0.5	90	0.264
62	Pleurocera acuta	0						
63	Polypedilum scalaenum	13	0.2	0.116	0.083	0.5	90	0.411
64	Polypedilum sp	21	0.473	0.349	0.111	1.563	90	0.873
65	Pontoporeia hoyi	23	0.103	0.056	0.006	0.238	90	0.172
66	Potamothrix moldaviensis	19	0.097	0.051	0.01	0.208	90	0.161
67	Potamothrix vejdovskyi	19	0.112	0.112	0.01	0.5	90	0.278
68	Pristina foreli	0						
69	Pristina osborni	0						
70	Procladius sp	60	0.589	0.818	0.006	3.425	90	1.902
71	Prostoma rubrum	9	0.15	0.139	0.01	0.5	90	.
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	2	0.02	0.015	0.01	0.03	90	
74	Slavina appendiculata	4	0.155	0.231	0.019	0.5	90	.
75	Specaria josinae	3	0.066	0.084	0.006	0.161	90	
76	Sphaerium nitidum	12	0.094	0.054	0.006	0.161	90	0.158
77	Sphaerium striatinum	2	0.051	0.063	0.006	0.096	90	.
78	Spirosperma ferox	17	0.076	0.052	0.006	0.161	90	0.15
79	Stenonema sp	2	0.18	0.082	0.122	0.238	90	.
80	Stictochironomus sp	3	0.313	0.215	0.147	0.556	90	.
81	Stylaria lacustris	10	0.878	2.018	0.01	6.579	90	5.988
82	Stylodrilus heringianus	15	0.27	0.472	0.01	1.923	90	[illegible]
83	Tanytarsus sp	26	0.147	0.109	0.006	0.5	90	0.294
84	Thienemannimyia sp	6	0.251	0.145	0.072	0.5	90	.
85	Tubifex sp	36	1.941	6.328	0.111	38.462	90	2.944
86	Turbellaria	15	0.171	0.072	0.083	0.278	90	0.278
87	Uncinais uncinata	12	0.105	0.062	0.006	0.2	90	0.194
88	Valvata sincera	13	0.697	1.772	0.03	6.579	90	4.17
89	Valvata tricarinata	36	0.135	0.099	0.006	0.5	90	0.268
90	Vejdovskyella intermedia	0						
91	Elliptio complanata	0						
92	Sphaerium simile	7	0.157	0.055	0.122	0.278	90	.
93	Chironomus plumosus	1	0.161		0.161	0.161	90	
94	Cricotopus bicinctus	0						
95	Ephemera sp	12	0.268	0.191	0.121	0.671	90	0.671
96	Helobdella stagnalis	2	1.253	1.486	0.202	2.304	90	
97	Hexagenia limbata	0						
98	Hexagenia sp	0						
99	Tanypus sp	1	0.179		0.179	0.179	90	
100	Tubifex tubifex	0						

Table 2: BENZENE HEXACHLORIDE (BHC) - Species Screening Level Concentrations (ug/g organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	30	0.933	2.442	0.03	12.083	90	3.209
2	Aelosoma sp	1	0.769		0.769	0.769	90	.
3	Amnicola limosa	40	0.914	2.127	0.006	12.083	90	2.082
4	Asellus sp	26	0.601	1.42	0.007	6.579	90	2.186
5	Aulodrilus limnobius	11	0.83	1.819	0.006	6	90	5.218
6	Aulodrilus pigueti	33	2.208	4.707	0.019	22.368	90	9.185
7	Aulodrilus pleuriseta	15	0.883	1.583	0.006	6	90	3.655
8	Bithynia tentaculata	15	0.18	0.164	0.006	0.556	90	0.501
9	Branchiura sowerbyi	3	0.195	0.032	0.169	0.23	90	.
10	Caenis sp	15	2.777	6.235	0.065	22.368	90	16.197
11	Ceraclea sp	20	0.993	2.711	0.022	12.083	90	3.092
12	Chaetogaster diaphanus	9	1.041	1.97	0.03	6	90	.
13	Cheumatopsyche sp	33	1.465	4.317	0.003	22.368	90	2.8
14	Chironomus sp	58	1.627	5.937	0.016	38.462	90	2.407
15	Cladopelma sp	14	3.304	4.065	0.016	12.083	90	11.597
16	Cladotanytarsus sp	20	2.673	5.445	0.017	22.368	90	11.475
17	Coelotanypus sp	7	1.22	2.237	0.023	6	90	.
18	Cricotopus sp	24	1.325	2.671	0.045	12.083	90	4.545
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	34	1.405	4.257	0.003	22.368	90	2.494
21	Dicrotendipes sp	22	2.24	3.527	0.003	12.083	90	9.667
22	Eukiefferiella sp	15	0.211	0.203	0.089	0.769	90	0.623
23	Gammarus fasciatus	99	1.565	5.093	0.003	38.462	90	2.778
24	Glossiphonia heteroclita	1	0.078		0.078	0.078	90	.
25	Glossosoma sp	12	0.224	0.23	0.089	0.769	90	0.696
26	Glyptotendipes sp	7	0.052	0.016	0.024	0.067	90	.
27	Gyraulus parvus	8	2.149	4.161	0.067	12.083	90	.
28	Helisoma anceps	7	1.776	2.018	0.267	6	90	
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	1.782	2.256	0.064	6.579	90	5.766
31	Hydropsyche sp	11	0.452	0.537	0.089	1.655	90	1.559
32	Hydroptila sp	15	3.195	3.929	0.141	12.083	90	11.5
33	Ilyodrilus templetoni	9	6.383	7.549	0.022	22.368	90	.
34	Limnodrilus hoffmeisteri	75	1.051	3.271	0.003	22.368	90	2.036
35	Limnodrilus sp	47	1.426	5.592	0.04	38.462	90	2.399
36	Limnodrilus udekemianus	15	2.007	3.263	0.03	11.111	90	8.222
37	Lumbriculus variegatus	5	0.397	0.255	0.116	0.769	90	
38	Manayunkia speciosa	27	0.925	3.814	0.056	20	90	0.474
39	Microtendipes sp	10	0.126	0.159	0.048	0.556	90	0.522
40	Mystacides sp	4	4.468	5.272	0.2	11.111	90	.
41	Nais behningi	1	0.769		0.769	0.769	90	.
42	Nais communis	10	1.811	3.738	0.116	12.083	90	11.208
43	Nais variabilus	39	1.31	2.82	0.022	12.083	90	6
44	Nanocladius sp	16	1.195	3.013	0.069	12.083	90	5.958
45	Neureclipsis sp	13	0.248	0.218	0.089	0.769	90	0.672
46	Oecetis sp	14	0.214	0.178	0.048	0.556	90	0.516
47	Parachironomus sp	12	3.636	6.787	0.024	22.368	90	19.283
48	Paralauterborniella sp	2	0.312	0.277	0.116	0.508	90	.
49	Paratendipes sp	13	0.074	0.083	0.006	0.263	90	0.222
50	Phaenopsectra sp	24	0.179	0.128	0.069	0.508	90	0.441
51	Phallodrilus sp	7	4.68	8.053	0.273	22.368	90	.
52	Physella gyrina	24	0.218	0.251	0.055	1.136	90	0.604

53	Piguetiella michiganensi	26	1.214	2.592	0.089	11.111	90	6.089
54	Pisidium casertanum	57	0.332	0.83	0.017	6	90	0.512
55	Pisidium compressum	8	0.155	0.156	0.006	0.465	90	.
56	Pisidium conventus	6	0.097	0.071	0.019	0.161	90	.
57	Pisidium fallax	12	3.094	4.354	0.116	12.083	90	11.792
58	Pisidium henslowanum	14	0.272	0.357	0.006	1.176	90	1.029
59	Pisidium lilljeborgi	13	0.56	1.809	0.006	6.579	90	4.012
60	Pisidium nitidum	8	0.179	0.165	0.019	0.465	90	.
61	Pisidium variabile	12	0.058	0.063	0.006	0.161	90	0.161
62	Pleurocera acuta	28	0.9	3.747	0.022	20	90	0.551
63	Polypedilum scalaenum	0						
64	Polypedilum sp	54	0.638	1.84	0.056	12.083	90	0.843
65	Pontoporeia hoyi	17	0.194	0.33	0.006	1.176	90	0.941
66	Potamothrix moldaviensis	11	0.389	0.527	0.017	1.655	90	1.559
67	Potamothrix vejdovskyi	24	0.148	0.126	0.019	0.508	90	0.349
68	Pristina foreli	8	1.543	1.976	0.116	6	90	.
69	Pristina osborni	7	0.745	0.694	0.116	2	90	.
70	Procladius sp	110	0.768	1.832	0.006	12.083	90	2.082
71	Prostoma rubrum	43	0.958	3.128	0.022	20	90	1.733
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	7	0.132	0.137	0.017	0.385	90	.
74	Slavina appendiculata	34	2.139	4.653	0.019	22.368	90	8.704
75	Specaria josinae	39	1.47	4.064	0.006	22.368	90	6
76	Sphaerium nitidum	15	0.204	0.35	0.006	1.176	90	1
77	Sphaerium striatinum	17	0.139	0.129	0.003	0.526	90	0.287
78	Spirosperma ferox	45	0.366	0.931	0.006	6	90	0.658
79	Stenonema sp	19	0.198	0.196	0.069	0.769	90	0.526
80	Stictochironomus sp	8	0.45	0.394	0.078	1.176	90	.
81	Stylaria lacustris	32	1.943	4.505	0.069	22.368	90	6.405
82	Stylodrilus heringianus	29	0.278	0.353	0.089	1.923	90	0.526
83	Tanytarsus sp	48	1.163	3.687	0.003	22.368	90	2.215
84	Thienemannimyia sp	23	0.319	0.473	0.018	2	90	1.108
85	Tubifex sp	27	2.342	7.298	0.051	38.462	90	3.352
86	Turbellaria	23	3.215	5.37	0.022	22.368	90	11.694
87	Uncinais uncinata	0						
88	Valvata sincera	33	1.083	2.344	0.006	11.111	90	4.436
89	Valvata tricarinata	41	0.86	2.136	0.03	12.083	90	1.931
90	Vejdovskyella intermedia	14	0.105	0.141	0.006	0.508	90	0.386
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	21	0.146	0.304	0.003	1.176	90	0.765
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	12	0.127	0.112	0.038	0.336	90	0.336
97	Hexagenia limbata	6	0.43	0.921	0.003	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	13	0.132	0.109	0.017	0.304	90	0.303

Table 2a: a-BHC - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	10	0.663	1.123	0.03	3.333	90	3.209
2	Aelosoma sp	1	0.769		0.769	0.769	90	.
3	Amnicola limosa	16	0.608	0.906	0.013	3.333	90	2.464
4	Asellus sp	0						
5	Aulodrilus limnobius	5	0.556	0.872	0.013	2.091	90	.
6	Aulodrilus pigueti	15	1.419	2.834	0.039	11.111	90	6.444
7	Aulodrilus pleuriseta	7	0.66	0.772	0.013	2.091	90	.
8	Bithynia tentaculata	4	0.21	0.188	0.013	0.465	90	.
9	Branchiura sowerbyi	0						
10	Caenis sp	6	0.865	1.26	0.089	3.333	90	.
11	Ceraclea sp	10	0.587	0.994	0.022	3.333	90	3.077
12	Chaetogaster diaphanus	5	0.607	0.849	0.03	2.091	90	.
13	Cheumatopsyche sp	14	0.622	0.875	0.022	3.333	90	2.333
14	Chironomus sp	9	0.651	1.049	0.069	3.333	90	.
15	Cladopelma sp	6	3.067	4.112	0.022	11.111	90	.
16	Cladotanytarsus sp	9	1.022	1.086	0.141	3.333	90	.
17	Coelotanypus sp	1	2.091		2.091	2.091	90	.
18	Cricotopus sp	3	1.543	1.555	0.526	3.333	90	.
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	10	0.674	0.973	0.116	3.333	90	3.105
21	Dicrotendipes sp	4	4.467	4.505	1.333	11.111	90	.
22	Eukiefferiella sp	7	0.311	0.263	0.089	0.769	90	.
23	Gammarus fasciatus	30	1.534	4.048	0.013	20	90	3.209
24	Glossiphonia heteroclita	0						
25	Glossosoma sp	5	0.388	0.295	0.089	0.769	90	.
26	Glyptotendipes sp	0						
27	Gyraulus parvus	2	1.747	2.243	0.161	3.333	90	.
28	Helisoma anceps	3	1.296	0.814	0.465	2.091	90	.
29	Heterotrissocladius sp	0						
30	Hyalella azteca	0						
31	Hydropsyche sp	4	0.369	0.337	0.089	0.769	90	.
32	Hydroptila sp	7	2.708	3.872	0.141	11.111	90	.
33	Ilyodrilus templetoni	5	3.156	4.635	0.022	11.111	90	.
34	Limnodrilus hoffmeisteri	19	1.135	2.562	0.013	11.111	90	3.333
35	Limnodrilus sp	0						
36	Limnodrilus udekemianus	4	3.674	5.021	0.161	11.111	90	.
37	Lumbriculus variegatus	5	0.397	0.255	0.116	0.769	90	.
38	Manayunkia speciosa	14	1.656	5.281	0.069	20	90	10.254
39	Microtendipes sp	0						
40	Mystacides sp	3	3.858	6.281	0.2	11.111	90	.
41	Nais behningi	1	0.769		0.769	0.769	90	.
42	Nais communis	6	0.797	1.251	0.116	3.333	90	.
43	Nais variabilus	18	1.176	2.625	0.022	11.111	90	4.111
44	Nanocladius sp	8	0.669	1.103	0.069	3.333	90	.
45	Neureclipsis sp	7	0.344	0.26	0.089	0.769	90	.
46	Oecetis sp	3	0.282	0.175	0.116	0.465	90	.
47	Parachironomus sp	4	1.459	1.354	0.116	3.333	90	.
48	Paralauterborniella sp	2	0.312	0.277	0.116	0.508	90	.
49	Paratendipes sp	5	0.101	0.108	0.013	0.263	90	.
50	Phaenopsectra sp	10	0.233	0.158	0.069	0.508	90	0.504
51	Phallodrilus sp	4	1.029	0.757	0.465	2.091	90	.
52	Physella gyrina	9	0.262	0.222	0.069	0.682	90	.
53	Piguetiella michiganensi	10	1.549	3.411	0.089	11.111	90	10.209

54	Pisidium casertanum	22	0.346	0.466	0.022	2.091	90	0.981
55	Pisidium compressum	4	0.226	0.19	0.013	0.465	90	.
56	Pisidium conventus	2	0.1	0.087	0.039	0.161	90	.
57	Pisidium fallax	8	2.087	3.795	0.116	11.111	90	.
58	Pisidium henslowanum	6	0.372	0.435	0.013	1.176	90	.
59	Pisidium lilljeborgi	4	0.061	0.068	0.013	0.161	90	.
60	Pisidium nitidum	4	0.262	0.197	0.039	0.465	90	.
61	Pisidium variabile	4	0.061	0.068	0.013	0.161	90	.
62	Pleurocera acuta	14	1.661	5.283	0.022	20	90	10.385
63	Polypedilum scalaenum	0						
64	Polypedilum sp	19	0.538	0.815	0.069	3.333	90	2.091
65	Pontoporeia hoyi	5	0.284	0.503	0.013	1.176	90	.
66	Potamothrix moldaviensis	3	0.225	0.079	0.161	0.313	90	.
67	Potamothrix vejdovskyi	9	0.216	0.162	0.03	0.508	90	.
68	Pristina foreli	4	0.951	0.934	0.116	2.091	90	.
69	Pristina osborni	5	0.589	0.491	0.116	1.333	90	.
70	Procladius sp	21	1.039	2.452	0.013	11.111	90	3.085
71	Prostoma rubrum	22	1.318	4.2	0.022	20	90	1.864
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	3	0.183	0.185	0.022	0.385	90	.
74	Slavina appendiculata	14	[illegible]	2.923	0.03	11.111	90	7.222
75	Specaria josinae	17	[illegible]	2.65	0.013	11.111	90	3.895
76	Sphaerium nitidum	5	0.284	0.503	0.013	1.176	90	.
77	Sphaerium striatinum	6	0.19	0.182	0.013	0.526	90	.
78	Spirosperma ferox	19	0.347	0.499	0.013	2.091	90	1.176
79	Stenonema sp	9	0.292	0.252	0.069	0.769	90	.
80	Stictochironomus sp	2	0.688	0.69	0.2	1.176	90	.
81	Stylaria lacustris	12	0.774	1.023	0.069	3.333	90	2.961
82	Stylodrilus heringianus	12	0.285	0.208	0.089	0.769	90	0.696
83	Tanytarsus sp	14	0.709	0.958	0.013	3.333	90	2.712
84	Thienemannimyia sp	7	0.481	0.448	0.089	1.333	90	.
85	Tubifex sp	0						
86	Turbellaria	14	1.615	2.873	0.022	11.111	90	7.222
87	Uncinais uncinata	0						
88	Valvata sincera	13	1.283	3.013	0.013	11.111	90	7.503
89	Valvata tricarinata	13	0.541	0.903	0.03	3.333	90	2.533
90	Vejdovskyella intermedia	6	0.169	0.192	0.013	0.508	90	.
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	1	1.176		1.176	1.176	90	.
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	0						
97	Hexagenia limbata	0						
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	1	0.263		0.263	0.263	90	.

Table 2b: b-BHC - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	13	1.513	3.566	0.03	12.083	90	9.65
2	Aelosoma sp	0						
3	Amnicola limosa	10	2.137	3.954	0.013	12.083	90	11.475
4	Asellus sp	13	[illegible]	1.934	0.04	6.579	90	5.317
5	Aulodrilus limnobius	3	2.014	3.452	0.013	6	90	.
6	Aulodrilus pigueti	10	4.958	7.306	0.039	22.368	90	21.34
7	Aulodrilus pleuriseta	4	2.011	2.818	0.013	6	90	.
8	Bithynia tentaculata	9	0.188	0.171	0.013	0.556	90	.
9	Branchiura sowerbyi	3	0.195	0.032	0.169	0.23	90	.
10	Caenis sp	6	5.882	9.37	0.065	22.368	90	.
11	Ceraclea sp	5	2.516	5.349	0.089	12.083	90	.
12	Chaetogaster diaphanus	2	3.015	4.222	0.03	6	90	.
13	Cheumatopsyche sp	9	4.173	7.857	0.069	22.368	90	.
14	Chironomus sp	32	2.682	7.867	0.04	38.462	90	9.486
15	Cladopelma sp	4	6.595	4.15	2	12.083	90	.
16	Cladotanytarsus sp	5	8.523	8.989	0.161	22.368	90	.
17	Coelotanypus sp	3	2.044	3.426	0.065	6	90	.
18	Cricotopus sp	13	1.95	3.462	0.064	12.083	90	9.068
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	14	2.617	6.512	0.04	22.368	90	17.226
21	Dicrotendipes sp	9	2.973	4.274	0.051	12.083	90	.
22	Eukiefferiella sp	4	0.124	0.069	0.089	0.227	90	.
23.	Gammarus fasciatus	39	2.596	7.199	0.013	38.462	90	6.296
24	Glossiphonia heteroclita	1	0.078		0.078	0.078	90	.
25	Glossosoma sp	5	0.114	0.032	0.089	0.165	90	.
26	Glyptotendipes sp	5	0.061	0.007	0.051	0.067	90	.
27	Gyraulus parvus	3	4.104	6.911	0.067	12.083	90	.
28	Helisoma anceps	2	4	2.828	2	6	90	.
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	1.782	2.256	0.064	6.579	90	5.766
31	Hydropsyche sp	2	0.089	0	0.089	0.089	90	.
32	Hydroptila sp	4	6.595	4.15	2	12.083	90	.
33	Ilyodrilus templetoni	3	13.583	8.14	6.296	22.368	90	.
34	Limnodrilus hoffmeisteri	12	4.143	6.877	0.013	22.368	90	19.283
35	Limnodrilus sp	47	1.426	5.592	0.04	38.462	90	2.399
36	Limnodrilus udekemianus	5	2.921	3.043	0.145	6.296	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	8	0.125	0.074	0.056	0.227	90	.
39	Microtendipes sp	10	0.126	0.159	0.048	0.556	90	0.522
40	Mystacides sp	1	6.296		6.296	6.296	90	.
41	Nais behningi	0						
42	Nais communis	2	6.122	8.43	0.161	12.083	90	.
43	Nais variabilus	11	2.505	3.961	0.069	12.083	90	10.926
44	Nanocladius sp	4	3.117	5.978	0.069	12.083	90	.
45	Neureclipsis sp	3	0.135	0.08	0.089	0.227	90	.
46	Oecetis sp	11	0.195	0.183	0.048	0.556	90	0.54
47	Parachironomus sp	3	12.151	10.184	2	22.368	90	.
48	Paralauterborniella sp	0						
49	Paratendipes sp	4	0.061	0.068	0.013	0.161	90	.
50	Phaenopsectra sp	9	0.152	0.106	0.069	0.417	90	.
51	Phallodrilus sp	2	14.184	11.574	6	22.368	90	.
52	Physella gyrina	5	0.113	0.065	0.069	0.227	90	.
53	Piguetiella michiganensi	8	1.7	2.748	0.089	6.296	90	.

54	Pisidium casertanum	13	0.654	1.622	0.03	6	90	3.953
55	Pisidium compressum	2	0.087	0.105	0.013	0.161	90	.
56	Pisidium conventus	2	0.1	0.087	0.039	0.161	90	.
57	Pisidium fallax	2	9.19	4.092	6.296	12.083	90	.
58	Pisidium henslowanum	4	0.271	0.413	0.013	0.882	90	.
59	Pisidium lilljeborgi	5	1.364	2.916	0.013	6.579	90	.
60	Pisidium nitidum	2	0.1	0.087	0.039	0.161	90	.
61	Pisidium variabile	4	0.061	0.068	0.013	0.161	90	.
62	Pleurocera acuta	7	0.139	0.07	0.069	0.227	90	.
63	Polypedilum scalaenum	0						
64	Polypedilum sp	25	0.875	2.611	0.056	12.083	90	2.65
65	Pontoporeia hoyi	5	0.225	0.372	0.013	0.882	90	.
66	Potamothrix moldaviensis	1	0.161		0.161	0.161	90	.
67	Potamothrix vejdovskyi	6	0.123	0.083	0.03	0.227	90	.
68	Pristina foreli	2	4	2.828	2	6	90	.
69	Pristina osborni	1	2		2	2	90	.
70	Procladius sp	54	1.032	2.06	0.013	12.083	90	3.056
71	Prostoma rubrum	10	0.939	1.871	0.069	6	90	5.6
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	0						
74	Slavina appendiculata	11	4.511	7.088	0.03	22.368	90	20.311
75	Specaria josinae	12	3.154	6.473	0.013	22.368	90	17.547
76	Sphaerium nitidum	5	0.225	0.372	0.013	0.882	90	.
77	Sphaerium striatinum	5	0.122	0.087	0.013	0.227	90	.
78	Spirosperma ferox	12	0.684	1.692	0.013	6	90	4.465
79	Stenonema sp	5	0.113	0.065	0.069	0.227	90	.
80	Stictochironomus sp	3	0.505	0.404	0.078	0.882	90	.
81	Stylaria lacustris	12	4.225	6.849	0.069	22.368	90	19.283
82	Stylodrilus heringianus	9	0.378	0.588	0.089	1.923	90	.
83	Tanytarsus sp	13	3.298	6.721	0.013	22.368	90	18.254
84	Thienemannimyia sp	5	0.565	0.814	0.089	2	90	.
85	Tubifex sp	27	2.342	7.298	0.051	38.462	90	3.352
86	Turbellaria	5	9.75	7.917	2	22.368	90	.
87	Uncinais uncinata	0						
88	Valvata sincera	9	1.665	2.62	0.013	6.296	90	.
89	Valvata tricarinata	17	1.362	3.187	0.03	12.083	90	7.68
90	Vejdovskyella intermedia	4	0.061	0.068	0.013	0.161	90	.
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	5	0.232	0.364	0.064	0.882	90	.
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	9	0.141	0.126	0.04	0.336	90	.
97	Hexagenia limbata	2	1.253	1.486	0.202	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	0						

Table 2c: g-BHC - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	7	0.244	0.307	0.03	0.917	90	.
2	Aelosoma sp	0						
3	Amnicola limosa	10	0.249	0.254	0.006	0.917	90	0.856
4	Asellus sp	9	0.094	0.121	0.007	0.31	90	.
5	Aulodrilus limnobius	3	0.103	0.148	0.006	0.273	90	.
6	Aulodrilus pigueti	8	0.252	0.284	0.019	0.917	90	.
7	Aulodrilus pleuriseta	4	0.144	0.146	0.006	0.273	90	.
8	Bithynia tentaculata	2	0.084	0.11	0.006	0.161	90	.
9	Branchiura sowerbyi	0						
10	Caenis sp	3	0.391	0.457	0.089	0.917	90	.
11	Ceraclea sp	5	0.282	0.36	0.089	0.917	90	.
12	Chaetogaster diaphanus	2	0.151	0.172	0.03	0.273	90	.
13	Cheumatopsyche sp	10	0.206	0.266	0.003	0.917	90	0.852
14	Chironomus sp	15	0.167	0.223	0.016	0.917	90	0.547
15	Cladopelma sp	4	0.368	0.385	0.016	0.917	90	.
16	Cladotanytarsus sp	6	0.276	0.333	0.017	0.917	90	.
17	Coelotanypus sp	3	0.107	0.144	0.023	0.273	90	.
18	Cricotopus sp	7	0.239	0.31	0.045	0.917	90	.
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	7	0.209	0.331	0.003	0.917	90	.
21	Dicrotendipes sp	7	0.262	0.318	0.003	0.917	90	.
22	Eukiefferiella sp	4	0.124	0.069	0.089	0.227	90	.
23	Gammarus fasciatus	27	0.175	0.267	0.003	1.136	90	0.432
24	Glossiphonia heteroclita	0						
25	Glossosoma sp	2	0.089	0	0.089	0.089	90	.
26	Glyptotendipes sp	2	0.031	0.009	0.024	0.038	90	.
27	Gyraulus parvus	3	0.461	0.401	0.161	0.917	90	.
28	Helisoma anceps	2	0.27	0.004	0.267	0.273	90	.
29	Heterotrissocladius sp	0			.			
30	Hyalella azteca	0						
31	Hydropsyche sp	3	0.163	0.128	0.089	0.31	90	.
32	Hydroptila sp	4	0.648	0.446	0.267	1.136	90	.
33	Ilyodrilus templetoni	1	0.917		0.917	0.917	90	.
34	Limnodrilus hoffmeisteri	33	0.126	0.174	0.003	0.917	90	0.303
35	Limnodrilus sp	0						
36	Limnodrilus udekemianus	5	0.154	0.118	0.032	0.273	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	5	0.159	0.074	0.069	0.227	90	.
39	Microtendipes sp	0						
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	2	0.539	0.534	0.161	0.917	90	.
43	Nais variabilus	10	0.238	0.25	0.069	0.917	90	0.852
44	Nanocladius sp	4	0.326	0.4	0.069	0.917	90	.
45	Neureclipsis sp	3	0.135	0.08	0.089	0.227	90	.
46	Oecetis sp	0						
47	Parachironomus sp	4	0.308	0.421	0.024	0.917	90	.
48	Paralauterborniella sp	0						
49	Paratendipes sp	4	0.054	0.072	0.006	0.161	90	.
50	Phaenopsectra sp	5	0.121	0.054	0.069	0.192	90	.
51	Phallodrilus sp	1	0.273		0.273	0.273	90	.
52	Physella gyrina	8	0.264	0.362	0.069	1.136	90	.

53	Piguetiella michiganensi	8	0.308	0.339	0.089	1.136	90	.
54	Pisidium casertanum	21	0.126	0.1	0.017	0.3	90	0.29
55	Pisidium compressum	2	0.084	0.11	0.006	0.161	90	.
56	Pisidium conventus	2	0.09	0.1	0.019	0.161	90	.
57	Pisidium fallax	2	1.027	0.155	0.917	1.136	90	.
58	Pisidium henslowanum	4	0.123	0.133	0.006	0.294	90	.
59	Pisidium lilljeborgi	4	0.054	0.072	0.006	0.161	90	.
60	Pisidium nitidum	2	0.09	0.1	0.019	0.161	90	.
61	Pisidium variabile	4	0.054	0.072	0.006	0.161	90	.
62	Pleurocera acuta	7	0.139	0.07	0.069	0.227	90	.
63	Polypedilum scalaenum	0						
64	Polypedilum sp	10	0.233	0.25	0.069	0.917	90	0.852
65	Pontoporeia hoyi	7	0.109	0.12	0.006	0.294	90	.
66	Potamothrix moldaviensis	3	0.163	0.147	0.017	0.31	90	.
67	Potamothrix vejdovskyi	8	0.096	0.085	0.019	0.227	90	.
68	Pristina foreli	2	0.27	0.004	0.267	0.273	90	.
69	Pristina osborni	1	0.267		0.267	0.267	90	.
70	Procladius sp	29	0.13	0.181	0.006	0.917	90	0.294
71	Prostoma rubrum	11	0.256	0.301	0.069	1.136	90	0.964
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	3	0.093	0.123	0.017	0.235	90	.
74	Slavina appendiculata	9	0.229	0.276	0.019	0.917	90	.
75	Specaria josinae	10	0.147	0.095	0.006	0.273	90	0.272
76	Sphaerium nitidum	5	0.102	0.124	0.006	0.294	90	.
77	Sphaerium striatinum	6	0.101	0.093	0.003	0.227	90	.
78	Spirosperma ferox	14	0.119	0.1	0.006	0.294	90	0.283
79	Stenonema sp	5	0.113	0.065	0.069	0.227	90	.
80	Stictochironomus sp	3	0.237	0.109	0.111	0.304	90	.
81	Stylaria lacustris	8	0.275	0.27	0.069	0.917	90	.
82	Stylodrilus heringianus	8	0.154	0.058	0.089	0.227	90	.
83	Tanytarsus sp	20	0.143	0.207	0.003	0.917	90	0.299
84	Thienemannimyia sp	7	0.126	0.097	0.018	0.267	90	.
85	Tubifex sp	0						
86	Turbellaria	4	0.648	0.446	0.267	1.136	90	.
87	Uncinais uncinata	0						
88	Valvata sincera	9	0.137	0.12	0.006	0.31	90	.
89	Valvata tricarinata	9	0.249	0.267	0.03	0.917	90	.
90	Vejdovskyella intermedia	4	0.054	0.072	0.006	0.161	90	.
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	13	0.045	0.076	0.003	0.294	90	0.203
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	2	0.074	0.052	0.038	0.111	90	.
97	Hexagenia limbata	3	0.016	0.012	0.003	0.026	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	10	0.127	0.114	0.017	0.304	90	0.304

Table 3: CHLORDANE - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	22	0.478	0.404	0.083	1.613	90	1.077
2	Aelosoma sp	2	1.175	0.515	0.811	1.538	90	.
3	Amnicola limosa	25	0.484	0.47	0.013	1.613	90	1.432
4	Asellus sp	21	0.648	1.539	0.019	6.579	90	2.861
5	Aulodrilus limnobius	5	0.303	0.496	0.013	1.182	90	.
6	Aulodrilus pigueti	20	0.416	0.378	0.039	1.333	90	1.147
7	Aulodrilus pleuriseta	7	0.483	0.558	0.013	1.333	90	.
8	Bithynia tentaculata	11	0.317	0.461	0.013	1.613	90	1.401
9	Branchiura sowerbyi	3	0.195	0.032	0.169	0.23	90	.
10	Caenis sp	10	0.296	0.264	0.065	0.833	90	0.817
11	Ceraclea sp	19	0.829	1.591	0.179	7.143	90	1.579
12	Chaetogaster diaphanus	4	0.764	0.73	0.118	1.579	90	.
13	Cheumatopsyche sp	27	0.718	1.352	0.083	7.143	90	1.547
14	Chironomus sp	53	1.19	5.336	0.022	38.462	90	1.649
15	Cladopelma sp	7	0.794	0.383	0.2	1.333	90	.
16	Cladotanytarsus sp	10	0.85	0.545	0.2	1.613	90	1.61
17	Coelotanypus sp	3	0.438	0.644	0.065	1.182	90	.
18	Cricotopus sp	22	1.173	1.867	0.022	7.143	90	4.545
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	20	0.431	0.456	0.04	1.613	90	1.504
21	Dicrotendipes sp	10	0.541	0.478	0.051	1.333	90	1.318
22	Eukiefferiella sp	16	0.878	1.734	0.179	7.143	90	3.248
23	Gammarus fasciatus	68	1.153	4.712	0.013	38.462	90	1.652
24	Glossiphonia heteroclita	1	0.078		0.078	0.078	90	.
25	Glossosoma sp	12	1.042	1.966	0.179	7.143	90	5.462
26	Glyptotendipes sp	5	0.061	0.007	0.051	0.067	90	.
27	Gyraulus parvus	6	0.598	0.585	0.067	1.613	90	.
28	Helisoma anceps	3	1.016	0.425	0.533	1.333	90	.
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	1.782	2.256	0.064	6.579	90	5.766
31	Hydropsyche sp	10	1.214	2.16	0.179	7.143	90	6.546
32	Hydroptila sp	8	1.76	2.203	0.533	7.143	90	
33	Ilyodrilus templetoni	3	0.567	0.328	0.2	0.833	90	
34	Limnodrilus hoffmeisteri	51	0.267	0.343	0.013	1.613	90	0.743
35	Limnodrilus sp	47	1.528	5.572	0.04	38.462	90	2.399
36	Limnodrilus udekemianus	11	0.666	0.531	0.019	1.613	90	1.557
37	Lumbriculus variegatus	2	4.341	3.963	1.538	7.143	90	.
38	Manayunkia speciosa	20	0.368	0.343	0.056	1.579	90	0.775
39	Microtendipes sp	11	0.258	0.463	0.048	1.579	90	1.374
40	Mystacides sp	0						
41	Nais behningi	3	1.309	0.432	0.811	1.579	90	
42	Nais communis	6	0.971	0.518	0.323	1.613	90	.
43	Nais variabilus	30	0.671	1.295	0.083	7.143	90	1.518
44	Nanocladius sp	13	0.533	0.506	0.139	1.579	90	1.563
45	Neureclipsis sp	11	0.505	0.536	0.179	1.579	90	1.571
46	Oecetis sp	11	0.195	0.183	0.048	0.556	90	0.54
47	Parachironomus sp	4	0.842	0.35	0.533	1.333	90	.
48	Paralauterborniella sp	0						
49	Paratendipes sp	8	0.298	0.541	0.013	1.613	90	.
50	Phaenopsectra sp	20	0.367	0.349	0.083	1.579	90	0.721
51	Phallodrilus sp	2	0.996	0.262	0.811	1.182	90	.
52	Physella gyrina	20	0.65	1.568	0.022	7.143	90	1.502

53	Piguetiella michiganensi	19	0.507	0.449	0.083	1.613	90	1.579
54	Pisidium casertanum	50	0.359	0.469	0.039	2.647	90	0.775
55	Pisidium compressum	4	0.493	0.76	0.013	1.613	90	.
56	Pisidium conventus	4	0.513	0.744	0.039	1.613	90	.
57	Pisidium fallax	5	2.207	2.782	0.667	7.143	90	.
58	Pisidium henslowanum	9	0.754	0.95	0.013	2.647	90	.
59	Pisidium lilljeborgi	9	0.996	2.154	0.013	6.579	90	.
60	Pisidium nitidum	4	0.513	0.744	0.039	1.613	90	.
61	Pisidium variabile	8	0.298	0.541	0.013	1.613	90	.
62	Pleurocera acuta	25	0.652	1.403	0.139	7.143	90	1.555
63	Polypedilum scalaenum	0						
64	Polypedilum sp	46	0.563	1.053	0.056	7.143	90	0.938
65	Pontoporeia hoyi	16	0.428	0.701	0.013	2.647	90	1.923
66	Potamothrix moldaviensis	10	0.306	0.465	0.086	1.613	90	1.484
67	Potamothrix vejdovskyi	17	0.329	0.362	0.039	1.613	90	0.686
68	Pristina foreli	4	0.965	0.362	0.533	1.333	90	.
69	Pristina osborni	6	2.156	2.478	0.533	7.143	90	.
70	Procladius sp	83	0.581	0.765	0.013	3.425	90	1.712
71	Prostoma rubrum	32	0.648	1.254	0.083	7.143	90	1.477
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	11	0.212	0.107	0.056	0.391	90	0.391
74	Slavina appendiculata	22	0.427	0.434	0.039	1.538	90	1.288
75	Specaria josinae	26	0.427	0.463	0.013	1.613	90	1.407
76	Sphaerium nitidum	10	0.533	0.883	0.013	2.647	90	2.544
77	Sphaerium striatinum	17	0.353	0.349	0.013	1.579	90	0.679
78	Spirosperma ferox	34	0.395	0.553	0.013	2.647	90	1.38
79	Stenonema sp	17	0.71	1.692	0.139	7.143	90	2.659
80	Stictochironomus sp	6	0.614	1.015	0.022	2.647	90	.
81	Stylaria lacustris	24	0.694	1.295	0.083	6.579	90	1.258
82	Stylodrilus heringianus	26	0.714	1.395	0.083	7.143	90	1.706
83	Tanytarsus sp	32	0.449	0.616	0.013	2.647	90	1.567
84	Thienemannimyia sp	16	0.5	0.511	0.083	1.579	90	1.551
85	Tubifex sp	27	2.462	7.264	0.051	38.462	90	3.352
86	Turbellaria	10	1.582	2.004	0.2	7.143	90	6.586
87	Uncinais uncinata	0						
88	Valvata sincera	22	0.319	0.445	0.013	1.579	90	1.288
89	Valvata tricarinata	29	0.572	1.213	0.051	6.579	90	1.333
90	Vejdovskyella intermedia	8	0.298	0.541	0.013	1.613	90	.
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	19	0.306	0.583	0.022	2.647	90	0.4
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	10	0.129	0.125	0.022	0.336	90	0.336
97	Hexagenia limbata	2	1.253	1.486	0.202	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	21	0.135	0.111	0.022	0.4	90	0.376

Table 4: Total DDT - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	56	0.67	0.612	0.042	2.475	90	1.701
2	Aelosoma sp	4	0.709	1.156	0.01	2.432	90	.
3	Amnicola limosa	68	0.536	0.541	0.01	2.881	90	1.17
4	Asellus sp	108	4.045	29.027	0.003	301.5	90	3.425
5	Aulodrilus limnobius	12	3.569	11.474	0.032	40	90	28.16
6	Aulodrilus pigueti	32	0.579	0.619	0.042	2.881	90	1.087
7	Aulodrilus pleuriseta	25	1.919	7.953	0.01	40	90	1.553
8	Bithynia tentaculata	44	0.467	0.428	0.032	2.273	90	0.985
9	Branchiura sowerbyi	24	0.598	1.77	0.121	8.897	90	0.436
10	Caenis sp	35	0.499	0.365	0.01	1.6	90	1.03
11	Ceraclea sp	29	0.602	0.583	0.015	2.432	90	1.163
12	Chaetogaster diaphanus	25	1.954	7.946	0.03	40	90	1.542
13	Cheumatopsyche sp	49	0.574	0.579	0.003	2.881	90	1.136
14	Chironomus sp	171	3.351	23.658	0.011	301.5	90	2.282
15	Cladopelma sp	19	0.671	0.764	0.016	2.881	90	2.432
16	Cladotanytarsus sp	26	0.43	0.568	0.006	2.881	90	0.815
17	Coelotanypus sp	27	0.381	0.305	0.006	1.335	90	0.745
18	Cricotopus sp	77	5.682	34.284	0.011	301.5	90	7.418
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	135	0.831	3.524	0.003	40	90	1.133
21	Dicrotendipes sp	49	0.494	0.441	0.003	1.82	90	1.214
22	Eukiefferiella sp	22	0.621	0.585	0.015	2.432	90	1.591
23	Gammarus fasciatus	240	1.507	5.575	0.003	40	90	1.77
24	Glossiphonia heteroclita	4	0.667	0.623	0.157	1.57	90	.
25	Glossosoma sp	25	0.778	0.709	0.015	2.475	90	2.065
26	Glyptotendipes sp	35	0.417	0.38	0.003	1.335	90	1.188
27	Gyraulus parvus	22	1.602	3.554	0.01	16.304	90	5.061
28	Helisoma anceps	10	0.42	0.321	0.072	1.163	90	1.113
29	Heterotrissocladius sp	12	3.521	11.489	0.01	40	90	28.18
30	Hyalella azteca	59	3.043	4.315	0.01	13.636	90	9.091
31	Hydropsyche sp	24	0.621	0.69	0.089	2.7	90	2.109
32	Hydroptila sp	14	0.56	0.577	0.015	2.432	90	1.633
33	Ilyodrilus templetoni	6	0.497	0.216	0.187	0.833	90	.
34	Limnodrilus hoffmeisteri	164	2.748	23.752	0.003	301.5	90	1.233
35	Limnodrilus sp	236	1.532	4.96	0.111	38.462	90	2.304
36	Limnodrilus udekemianus	26	1.163	2.927	0.048	15.283	90	1.772
37	Lumbriculus variegatus	2	0.164	0.21	0.015	0.313	90	.
38	Manayunkia speciosa	44	1.636	5.955	0.069	40	90	2.029
39	Microtendipes sp	41	0.511	0.374	0.157	1.57	90	1.264
40	Mystacides sp	0						
41	Nais behningi	6	0.889	0.979	0.091	2.432	90	.
42	Nais communis	19	2.546	9.086	0.072	40	90	2.432
43	Nais variabilus	58	1.19	5.242	0.011	40	90	1.136
44	Nanocladius sp	19	0.555	0.457	0.015	1.786	90	1.136
45	Neureclipsis sp	15	0.689	0.699	0.089	2.881	90	1.834
46	Oecetis sp	57	0.587	0.494	0.01	2.7	90	1.257
47	Parachironomus sp	20	0.229	0.231	0.006	0.833	90	0.653
48	Paralauterborniella sp	9	5.183	13.097	0.083	40	90	.
49	Paratendipes sp	24	0.532	1.036	0.032	5.238	90	0.806
50	Phaenopsectra sp	46	0.747	0.708	0.01	2.881	90	1.894
51	Phallodrilus sp	8	1.056	1.034	0.227	2.881	90	.
52	Physella gyrina	51	6.652	42.128	0.01	301.5	90	2.4

53	Piguetiella michiganensi	42	1.414	6.11	0.042	40	90	1.122
54	Pisidium casertanum	136	3.092	26.029	0.006	301.5	90	1.136
55	Pisidium compressum	13	0.364	0.395	0.01	1.163	90	1.02
56	Pisidium conventus	21	0.417	0.465	0.01	1.63	90	1.304
57	Pisidium fallax	23	2.302	8.246	0.015	40	90	2.369
58	Pisidium henslowanum	32	0.664	2.155	0.01	12.353	90	0.806
59	Pisidium lilljeborgi	38	1.524	3.62	0.01	13.158	90	7.237
60	Pisidium nitidum	24	2.04	8.091	0.053	40	90	0.985
61	Pisidium variabile	30	0.295	0.337	0.01	1.429	90	0.806
62	Pleurocera acuta	38	0.605	0.499	0.015	2.273	90	1.139
63	Polypedilum scalaenum	13	0.585	1.403	0.083	5.238	90	3.343
64	Polypedilum sp	136	0.637	0.559	0.015	2.881	90	1.529
65	Pontoporeia hoyi	50	0.561	1.73	0.03	12.353	90	0.806
66	Potamothrix moldaviensis	44	1.258	5.991	0.01	40	90	0.887
67	Potamothrix vejdovskyi	51	1.237	5.564	0.006	40	90	1.136
68	Pristina foreli	7	6.354	14.857	0.133	40	90	.
69	Pristina osborni	11	4.264	11.883	0.091	40	90	32.486
70	Procladius sp	329	0.746	1.074	0.003	12.353	90	1.923
71	Prostoma rubrum	63	1.181	5.003	0.01	40	90	1.152
72	Pseudocloeon sp	2	0.121	0.15	0.015	0.227	90	.
73	Quistadrilus multisetosu	43	0.401	0.553	0.01	2.7	90	1.278
74	Slavina appendiculata	37	0.424	0.293	0.042	1.136	90	0.894
75	Specaria josinae	40	0.52	0.498	0.032	2.881	90	1.074
76	Sphaerium nitidum	30	0.738	2.211	0.032	12.353	90	0.806
77	Sphaerium striatinum	35	0.447	0.478	0.003	2.273	90	1.136
78	Spirosperma ferox	83	1.081	4.549	0.01	40	90	1.136
79	Stenonema sp	27	0.726	1.091	0.015	5.238	90	2.005
80	Stictochironomus sp	18	2.678	4.521	0.157	16.304	90	12.748
81	Stylaria lacustris	52	1.454	3.135	0.01	13.158	90	4.396
82	Stylodrilus heringianus	54	0.588	0.537	0.01	1.923	90	1.296
83	Tanytarsus sp	112	3.764	28.699	0.003	301.5	90	0.988
84	Thienemannimyia sp	36	0.564	0.908	0.015	5.238	90	1.285
85	Tubifex sp	144	2.087	6.245	0.111	38.462	90	2.959
86	Turbellaria	24	0.735	0.793	0.015	2.881	90	2.353
87	Uncinais uncinata	19	2.637	9.124	0.083	40	90	5.238
88	Valvata sincera	63	0.365	0.449	0.006	2.881	90	0.797
89	Valvata tricarinata	83	0.962	2.495	0.01	13.158	90	1.152
90	Vejdovskyella intermedia	55	1.151	5.401	0.01	40	90	1.055
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	76	0.391	1.417	0.006	12.353	90	0.651
94	Cricotopus bicinctus	1	0.161		0.161	0.161	90	.
95	Ephemera sp	0						
96	Helobdella stagnalis	58	0.495	0.42	0.003	2.111	90	1.134
97	Hexagenia limbata	15	0.924	0.968	0.003	2.304	90	2.304
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	52	6.895	41.741	0.011	301.5	90	5.315

Table 4a: o,p'+p,p'-DDT Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	25	1.054	0.718	0.148	2.475	90	2.154
2	Aelosoma sp	0						
3	Amnicola limosa	19	0.535	0.351	0.032	1.163	90	1.136
4	Asellus sp	36	10.649	50.019	0.056	301.5	90	13.158
5	Aulodrilus limnobius	5	0.163	0.173	0.032	0.455	90	.
6	Aulodrilus pigueti	14	0.485	0.317	0.097	1.087	90	1.087
7	Aulodrilus pleuriseta	6	0.191	0.17	0.032	0.455	90	.
8	Bithynia tentaculata	21	0.477	0.349	0.032	1.335	90	1.092
9	Branchiura sowerbyi	12	0.984	2.494	0.121	8.897	90	6.366
10	Caenis sp	12	0.574	0.288	0.208	1.302	90	1.161
11	Ceraclea sp	11	0.669	0.327	0.417	1.163	90	1.158
12	Chaetogaster diaphanus	3	0.25	0.177	0.148	0.455	90	.
13	Cheumatopsyche sp	15	0.62	0.336	0.208	1.136	90	1.136
14	Chironomus sp	[illegible]	5.694	34.246	0.057	301.5	90	2.674
15	Cladopelma sp	4	0.509	0.222	0.333	0.833	90	.
16	Cladotanytarsus sp	[illegible]	0.608	0.23	0.333	0.833	90	.
17	Coelotanypus sp	11	0.579	0.386	0.185	1.335	90	1.329
18	Cricotopus sp	35	11.101	50.662	0.056	301.5	90	10.909
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	37	0.851	1.402	0.157	8.897	90	1.197
21	Dicrotendipes sp	16	0.719	0.461	0.157	1.82	90	1.481
22	Eukiefferiella sp	8	0.619	0.319	0.446	1.136	90	.
23	Gammarus fasciatus	57	1.701	5.78	0.032	38.462	90	2.304
24	Glossiphonia heteroclita	2	0.353	0.278	0.157	0.549	90	.
25	Glossosoma sp	11	1.152	0.679	0.446	2.475	90	2.344
26	Glyptotendipes sp	12	0.799	0.406	0.359	1.335	90	1.335
27	Gyraulus parvus	5	3.436	5.581	0.417	16.304	90	.
28	Helisoma anceps	3	0.65	0.448	0.333	1.163	90	.
29	Heterotrissocladius sp	0						
30	Hyalella azteca	26	4.202	5.12	0.127	13.636	90	13.301
31	Hydropsyche sp	4	0.446	0	0.446	0.446	90	.
32	Hydroptila sp	4	0.509	0.222	0.333	0.833	90	.
33	Ilyodrilus templetoni	2	0.625	0.295	0.417	0.833	90	.
34	Limnodrilus hoffmeisteri	33	11.168	52.273	0.032	301.5	90	11.97
35	Limnodrilus sp	118	1.754	4.972	0.111	38.462	90	2.506
36	Limnodrilus udekemianus	9	2.502	4.834	0.079	15.283	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	17	0.772	0.384	0.157	1.335	90	1.197
39	Microtendipes sp	20	0.659	0.4	0.157	1.335	90	1.332
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	4	0.716	0.2	0.417	0.833	90	.
43	Nais variabilus	[illegible]	0.578	0.29	0.208	1.136	90	1.136
44	Nanocladius sp	5	0.639	0.344	0.347	1.136	90	.
45	Neureclipsis sp	6	0.676	0.356	0.446	1.136	90	.
46	Oecetis sp	23	0.69	0.374	0.157	1.429	90	1.266
47	Parachironomus sp	3	0.528	0.268	0.333	0.833	90	.
48	Paralauterborniella sp	0						
49	Paratendipes sp	8	0.271	0.334	0.032	0.806	90	.
50	Phaenopsectra sp	19	1.001	0.614	0.208	2.174	90	2.066
51	Phallodrilus sp	2	0.809	0.501	0.455	1.163	90	.
52	Physella gyrina	14	22.685	80.267	0.347	301.5	90	154.25

53	Piguetiella michiganensi	13	0.779	0.317	0.208	1.136	90	1.136
54	Pisidium casertanum	29	11.227	55.841	0.097	301.5	90	1.364
55	Pisidium compressum	5	0.568	0.511	0.032	1.163	90	.
56	Pisidium conventus	4	0.452	0.41	0.097	0.806	90	.
57	Pisidium fallax	3	0.804	0.374	0.417	1.163	90	.
58	Pisidium henslowanum	9	0.512	0.422	0.032	1.163	90	.
59	Pisidium lilljeborgi	10	2.848	5.442	0.032	13.158	90	13.158
60	Pisidium nitidum	7	0.551	0.405	0.097	1.163	90	.
61	Pisidium variabile	8	0.271	0.334	0.032	0.806	90	.
62	Pleurocera acuta	15	0.727	0.344	0.347	1.163	90	1.147
63	Polypedilum scalaenum	0						
64	Polypedilum sp	62	0.836	0.581	0.111	2.381	90	1.58-
65	Pontoporeia hoyi	10	0.364	0.353	0.032	0.806	90	0.806
66	Potamothrix moldaviensis	2	0.806	0	0.806	0.806	90	.
67	Potamothrix vejdovskyi	12	0.599	0.414	0.097	1.136	90	1.136
68	Pristina foreli	2	0.394	0.086	0.333	0.455	90	.
69	Pristina osborni		0.333		0.333	0.333	90	.
70	Procladius sp	117	1.063	1.03	0.032	6.8	90	2.32
71	Prostoma rubrum	19	0.657	0.34	0.208	1.163	90	1.136
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	0						
74	Slavina appendiculata	16	0.449	0.33	0.097	1.136	90	1.136
75	Specaria josinae	18	0.513	0.356	0.032	1.087	90	1.087
76	Sphaerium nitidum	10	0.364	0.353	0.032	0.806	90	0.806
77	Sphaerium striatinum	10	0.605	0.419	0.032	1.136	90	1.136
78	Spirosperma ferox	24	0.53	0.368	0.032	1.163	90	1.136
79	Stenonema sp	10	0.565	0.304	0.347	1.136	90	1.136
80.	Stictochironomus sp	10	2.956	5.047	0.157	16.304	90	15.326
81	Stylaria lacustris	20	1.914	3.856	0.208	13.158	90	11.956
82	Stylodrilus heringianus	19	0.866	0.481	0.208	1.923	90	1.923
83	Tanytarsus sp	30	11.511	54.857	0.032	301.5	90	6.98
84	Thienemannimyia sp	9	0.576	0.333	0.208	1.136	90	.
85	Tubifex sp	72	2.301	6.231	0.111	38.462	90	3.275
86	Turbellaria	5	0.64	0.35	0.333	1.163	90	.
87	Uncinais uncinata	0						
88	Valvata sincera	14	0.381	0.323	0.032	1.335	90	0.959
89	Valvata tricarinata	34	1.28	3.034	0.148	13.158	90	1.249
90	Vejdovskyella intermedia	8	0.271	0.334	0.032	0.806	90	.
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	11	0.264	0.238	0.056	0.735	90	0.735
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	26	0.66	0.488	0.157	2.111	90	1.335
97	Hexagenia limbata	4	1.557	0.924	0.405	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	11	31.125	89.809	0.056	301.5	90	244.461

Table 5: p,p'-DDD - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	13	0.359	.164	0.148	0.806	90	0.666
2	Aelosoma sp	0						
3	Amnicola limosa	16	0.689	.420	0.203	1.63	90	1.402
4	Asellus sp	20	0.967	1.545	0.083	6.579	90	3.245
5	Aulodrilus limnobius	3	0.269	.163	0.148	0.455	90	.
6	Aulodrilus pigueti	8	0.557	.240	0.347	1.087	90	.
7	Aulodrilus pleuriseta	4	0.368	.240	0.148	0.667	90	.
8	Bithynia tentaculata	10	0.475	.429	0.202	1.57	90	1.494
9	Branchiura sowerbyi	6	0.211	.080	0.121	0.356	90	.
10	Caenis sp	8	0.58	.289	0.326	1.075	90	.
11	Ceraclea sp	5	0.578	.312	0.417	1.136	90	.
12	Chaetogaster diaphanus	2	0.301	.217	0.148	0.455	90	.
13	Cheumatopsyche sp	11	0.599	.328	0.167	1.136	90	1.126
14	Chironomus sp	40	1.475	6.037	0.083	38.462	90	2.107
15	Cladopelma sp	5	0.495	.148	0.313	0.667	90	.
16	Cladotanytarsus sp	5	0.486	.275	0.083	0.806	90	.
17	Coelotanypus sp	6	0.316	.086	0.185	0.455	90	.
18	Cricotopus sp	13	1.092	1.636	0.064	4.545	90	4.545
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	23	0.601	.458	0.161	1.63	90	1.464
21	Dicrotendipes sp	11	0.537	.408	0.243	1.57	90	1.456
22	Eukiefferiella sp	4	0.619	.345	0.446	1.136	90	.
23	Gammarus fasciatus	50	1.684	5.600	0.111	38.462	90	2.237
24	Glossiphonia heteroclita	1	1.57		1.57	1.57	90	.
25	Glossosoma sp	5	0.334	.112	0.205	0.446	90	.
26	Glyptotendipes sp	6	0.329	.066	0.257	0.446	90	.
27	Gyraulus parvus	4	0.797	.593	0.334	1.63	90	.
28	Helisoma anceps	2	0.561	.150	0.455	0.667	90	.
29	Heterotrissocladius sp	0						
30	Hyalella azteca	14	1.669	2.209	0.064	6.579	90	5.562
31	Hydropsyche sp	5	0.46	.091	0.345	0.6	90	.
32	Hydroptila sp	3	0.513	.135	0.417	0.667	90	.
33	Ilyodrilus templetoni	1	0.417		0.417	0.417	90	.
34	Limnodrilus hoffmeisteri	29	0.37	.274	0.071	1.075	90	0.806
35	Limnodrilus sp	59	1.292	4.985	0.111	38.462	90	2.193
36	Limnodrilus udekemianus	5	0.491	.243	0.238	0.806	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	8	0.77	.482	0.278	1.57	90	.
39	Microtendipes sp	10	0.437	.409	0.219	1.57	90	1.468
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	2	0.612	.276	0.417	0.806	90	.
43	Nais variabilus	10	0.574	.266	0.347	1.136	90	1.119
44	Nanocladius sp	4	0.587	.369	0.347	1.136	90	.
45	Neureclipsis sp	3	0.676	.398	0.446	1.136	90	.
46	Oecetis sp	12	0.595	.447	0.219	1.57	90	1.47
47	Parachironomus sp	2	0.542	.177	0.417	0.667	90	.
48	Paralauterborniella sp	0						
49	Paratendipes sp	4	0.444	.320	0.148	0.806	90	.
50	Phaenopsectra sp	10	0.526	.443	0.205	1.63	90	1.564
51	Phallodrilus sp	1	0.455		0.455	0.455	90	.
52	Physella gyrina	8	0.74	.464	0.347	1.63	90	.

53	Piguetiella michiganensi	7	0.758	.316	0.417	1.136	90	.
54	Pisidium casertanum	22	1.135	2.534	0.083	12.353	90	1.482
55	Pisidium compressum	2	0.505	.426	0.203	0.806	90	.
56	Pisidium conventus	3	1.019	.538	0.62	1.63	90	.
57	Pisidium fallax	2	0.292	.177	0.167	0.417	90	.
58	Pisidium henslowanum	4	3.378	5.991	0.148	12.353	90	.
59	Pisidium lilljeborgi	6	1.665	2.466	0.148	6.579	90	.
60	Pisidium nitidum	3	0.574	.258	0.296	0.806	90	.
61	Pisidium variabile	4	0.444	.320	0.148	0.806	90	.
62	Pleurocera acuta	7	0.696	.348	0.347	1.136	90	.
63	Polypedilum scalaenum	0						
64	Polypedilum sp	31	0.459	.338	0.074	1.563	90	1.062
65	Pontoporeia hoyi	8	1.898	4.233	0.083	12.353	90	.
66	Potamothrix moldaviensis	6	0.501	.405	0.071	1.075	90	.
67	Potamothrix vejdovskyi	6	0.686	.359	0.148	1.136	90	.
68	Pristina foreli	2	0.561	.150	0.455	0.667	90	
69	Pristina osborni	1	0.667		0.667	0.667	90	.
70	Procladius sp	73	0.795	1.552	0.071	12.353	90	1.806
71	Prostoma rubrum	10	0.641	.304	0.347	1.136	90	1.131
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	8	0.591	.575	0.074	1.63	90	
74	Slavina appendiculata	9	0.517	.276	0.148	1.136	90	.
75	Specaria josinae	10	0.554	.316	0.148	1.087	90	1.074
76	Sphaerium nitidum	5	2.826	5.333	0.148	12.353	90	.
77	Sphaerium striatinum	5	0.639	.392	0.203	1.136	90	.
78	Spirosperma ferox	15	1.288	3.075	0.083	12.353	90	5.623
79	Stenonema sp	5	0.565	.323	0.347	1.136	90	.
80	Stictochironomus sp	3	4.826	6.538	0.556	12.353	90	.
81	Stylaria lacustris	11	1.1	1.837	0.336	6.579	90	5.49
82	Stylodrilus heringianus	9	0.852	.498	0.417	1.923	90	
83	Tanytarsus sp	16	1.185	2.988	0.071	12.353	90	4.379
84	Thienemannimyia sp	7	0.701	.508	0.167	1.63	90	
85	Tubifex sp	36	1.839	6.347	0.111	38.462	90	2.944
86	Turbellaria	3	0.513	.135	0.417	0.667	90	
87	Uncinais uncinata	0						
88	Valvata sincera	11	0.451	.237	0.148	1	90	0.933
89	Valvata tricarinata	20	0.841	1.418	0.148	6.579	90	1.624
90	Vejdovskyella intermedia	4	0.444	.320	0.148	0.806	90	
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	15	1.101	3.138	0.064	12.353	90	5.724
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	14	0.366	.366	0.096	1.57	90	1.085
97	Hexagenia limbata	2	1.253	1.486	0.202	2.304	90	
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	8	0.203	.194	0.071	0.625	90	

Table 6: p,p'-DDE - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	18	0.361	0.271	0.042	0.825	90	0.768
2	Aelosoma sp	4	0.709	1.156	0.01	2.432	90	.
3	Amnicola limosa	33	0.462	0.666	0.01	2.881	90	1.456
4	Asellus sp	52	0.657	1.895	0.003	13.158	90	1.227
5	Aulodrilus limnobius	4	10.302	19.799	0.244	40	90	.
6	Aulodrilus pigueti	10	0.728	1.044	0.042	2.881	90	2.836
7	Aulodrilus pleuriseta	15	3.024	10.254	0.01	40	90	17.729
8	Bithynia tentaculata	13	0.446	0.561	0.145	2.273	90	1.586
9	Branchiura sowerbyi	6	0.211	0.08	0.121	0.356	90	.
10	Caenis sp	15	0.396	0.444	0.01	1.6	90	1.221
11	Ceraclea sp	13	0.553	0.816	0.015	2.432	90	2.369
12	Chaetogaster diaphanus	20	2.374	8.878	0.03	40	90	2.658
13	Cheumatopsyche sp	23	0.533	0.779	0.003	2.881	90	2.174
14	Chironomus sp	52	1.236	5.308	0.011	38.462	90	1.939
15	Cladopelma sp	10	0.823	1.042	0.016	2.881	90	2.836
16	Cladotanytarsus sp	15	0.339	0.715	0.006	2.881	90	1.468
17	Coelotanypus sp	10	0.203	0.11	0.006	0.334	90	0.333
18	Cricotopus sp	29	1.199	2.297	0.011	9.091	90	2.5
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	75	0.892	4.631	0.003	40	90	0.917
21	Dicrotendipes sp	22	0.308	0.369	0.003	1.6	90	0.798
22	Eukiefferiella sp	10	0.625	0.824	0.015	2.432	90	2.368
23	Gammarus fasciatus	103	1.256	5.431	0.003	40	90	1.711
24	Glossiphonia heteroclita	1	0.392		0.392	0.392	90	.
25	Glossosoma sp	9	0.568	0.749	0.015	2.432	90	.
26	Glyptotendipes sp	17	0.178	0.136	0.003	0.446	90	0.356
27	Gyraulus parvus	10	0.457	0.622	0.01	1.652	90	1.647
28	Helisoma anceps	5	0.226	0.171	0.072	0.5	90	.
29	Heterotrissocladius sp	12	3.521	11.489	0.01	40	90	28.18
30	Hyalella azteca	19	2.469	4.04	0.01	13.158	90	9.091
31	Hydropsyche sp	15	0.722	0.867	0.089	2.7	90	2.539
32	Hydroptila sp	7	0.609	0.827	0.015	2.432	90	.
33	Ilyodrilus templetoni	3	0.438	0.22	0.187	0.6	90	.
34	Limnodrilus hoffmeisteri	102	0.7	3.959	0.003	40	90	0.798
35	Limnodrilus sp	59	1.328	4.977	0.111	38.462	90	2.193
36	Limnodrilus udekemianus	12	0.439	0.455	0.048	1.6	90	1.36
37	Lumbriculus variegatus	2	0.164	0.21	0.015	0.313	90	.
38	Manayunkia speciosa	19	2.774	9.06	0.069	40	90	2.881
39	Microtendipes sp	11	0.309	0.099	0.208	0.556	90	0.523
40	Mystacides sp	0						
41	Nais behningi	6	0.889	0.979	0.091	2.432	90	.
42	Nais communis	13	3.407	11.013	0.072	40	90	24.973
43	Nais variabilus	30	1.763	7.296	0.011	40	90	2.649
44	Nanocladius sp	7	0.44	0.63	0.015	1.786	90	.
45	Neureclipsis sp	6	0.708	1.084	0.089	2.881	90	.
46	Oecetis sp	22	0.475	0.612	0.01	2.7	90	1.406
47	Parachironomus sp	15	0.128	0.127	0.006	0.526	90	0.336
48	Paralauterborniella sp	9	5.183	13.097	0.083	40	90	.
49	Paratendipes sp	12	0.736	1.43	0.096	5.238	90	3.876
50	Phaenopsectra sp	17	0.593	0.862	0.01	2.881	90	2.736
51	Phallodrilus sp	5	1.276	1.275	0.227	2.881	90	.
52	Physella gyrina	29	0.543	0.823	0.01	2.7	90	2.432

53	Piguetiella michiganensi	22	1.998	8.489	0.042	40	90	0.504
54	Pisidium casertanum	85	0.823	4.335	0.006	40	90	0.791
55	Pisidium compressum	6	0.147	0.155	0.01	0.432	90	.
56	Pisidium conventus	14	0.279	0.381	0.01	1.429	90	1.063
57	Pisidium fallax	18	2.775	9.321	0.015	40	90	6.189
58	Pisidium henslowanum	19	0.165	0.168	0.01	0.588	90	0.533
59	Pisidium lilljeborgi	22	0.884	2.77	0.01	13.158	90	1.48
60	Pisidium nitidum	14	3.098	10.623	0.053	40	90	20.349
61	Pisidium variabile	18	0.272	0.351	0.01	1.429	90	0.771
62	Pleurocera acuta	16	0.451	0.642	0.015	2.273	90	1.932
63	Polypedilum scalaenum	13	0.585	1.403	0.083	5.238	90	3.343
64	Polypedilum sp	43	0.479	0.57	0.015	2.881	90	0.853
65	Pontoporeia hoyi	32	0.288	0.311	0.03	1.429	90	0.759
66	Potamothrix moldaviensis	36	1.409	6.629	0.01	40	90	0.85
67	Potamothrix vejdovskyi	33	1.569	6.926	0.006	40	90	1.684
68	Pristina foreli	3	14.189	22.383	0.133	40	90	.
69	Pristina osborni	9	5.1	13.121	0.091	40	90	.
70	Procladius sp	139	0.454	0.65	0.003	3.425	90	1.2
71	Prostoma rubrum	34	1.632	6.818	0.01	40	90	2.353
72	Pseudocloeon sp	2	0.121	0.15	0.015	0.227	90	.
73	Quistadrilus multisetosu	35	0.358	0.547	0.01	2.7	90	1.216
74	Slavina appendiculata	12	0.32	0.238	0.042	0.698	90	0.655
75	Specaria josinae	12	0.502	0.774	0.042	2.881	90	2.184
76	Sphaerium nitidum	15	0.291	0.224	0.053	0.698	90	0.639
77	Sphaerium striatinum	20	0.32	0.504	0.003	2.273	90	0.776
78	Spirosperma ferox	44	1.311	6.005	0.01	40	90	1.936
79	Stenonema sp	12	0.929	1.619	0.015	5.238	90	4.531
80	Stictochironomus sp	5	0.833	0.506	0.392	1.652	90	.
81	Stylaria lacustris	21	1.201	2.984	0.01	13.158	90	4.677
82	Stylodrilus heringianus	26	0.294	0.438	0.01	1.923	90	0.849
83	Tanytarsus sp	66	0.869	4.905	0.003	40	90	0.62
84	Thienemannimyia sp	20	0.51	1.175	0.015	5.238	90	1.657
85	Tubifex sp	36	1.906	6.332	0.111	38.462	90	2.944
86	Turbellaria	16	0.806	0.955	0.015	2.881	90	2.567
87	Uncinais uncinata	19	2.637	9.124	0.083	40	90	5.238
88	Valvata sincera	38	0.334	0.532	0.006	2.881	90	0.8
89	Valvata tricarinata	29	0.671	2.408	0.01	13.158	90	0.556
90	Vejdovskyella intermedia	43	1.381	6.101	0.01	40	90	1.935
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	50	0.207	0.235	0.006	1.239	90	0.574
94	Cricotopus bicinctus	1	0.161		0.161	0.161	90	.
95	Ephemera sp	0						
96	Helobdella stagnalis	18	0.357	0.25	0.003	0.978	90	0.702
97	Hexagenia limbata	9	0.569	0.821	0.003	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	33	0.44	0.525	0.011	2.5	90	1.199

Table 7: DIELDRIN - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	28	2.219	3.83	0.059	19.107	90	4.917
2	Aelosoma sp	8	4.013	4.579	0.089	13.077	90	.
3	Amnicola limosa	60	2.436	5.252	0.007	34.091	90	6.176
4	Asellus sp	46	0.257	0.969	0.001	6.579	90	0.36
5	Aulodrilus limnobius	19	9.284	27.17	0.038	120	90	19.107
6	Aulodrilus pigueti	26	2.365	3.688	0.116	19.107	90	4.638
7	Aulodrilus pleuriseta	16	10.048	29.672	0.038	120	90	49.375
8	Bithynia tentaculata	19	2.871	7.737	0.038	34.091	90	6.25
9	Branchiura sowerbyi	8	0.551	0.969	0.121	2.941	90	.
10	Caenis sp	29	6.606	25.906	0.009	140	90	4.444
11	Ceraclea sp	45	8.412	25.318	0.089	140	90	13.179
12	Chaetogaster diaphanus	16	9.376	29.527	0.059	120	90	38.763
13	Cheumatopsyche sp	63	3.984	12.794	0.001	100	90	8.107
14	Chironomus sp	74	1.319	2.722	0.002	19.107	90	3.897
15	Cladopelma sp	17	2.476	4.834	0.003	19.107	90	11.155
16	Cladotanytarsus sp	35	1.981	3.81	0.001	19.107	90	4.146
17	Coelotanypus sp	13	0.283	0.412	0.001	1.46	90	1.135
18	Cricotopus sp	39	17.864	59.549	0.002	340.176	90	34.091
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	77	2.63	13.651	0.001	120	90	3.546
21	Dicrotendipes sp	30	0.753	1.171	0.001	4.444	90	3.076
22	Eukiefferiella sp	36	5.057	16.546	0.089	100	90	7.003
23	Gammarus fasciatus	149	4.334	17.244	0.001	140	90	4.444
24	Glossiphonia heteroclita	1	0.078		0.078	0.078	90	.
25	Glossosoma sp	28	2.498	3.46	0.134	13.333	90	7.736
26	Glyptotendipes sp	17	0.063	0.11	0.001	0.446	90	0.246
27	Gyraulus parvus	16	0.944	1.149	0.004	3.529	90	3.45
28	Helisoma anceps	5	1.999	2.394	0.545	6.25	90	.
29	Heterotrissocladius sp	10	14.78	37.025	0.111	120	90	108.714
30	Hyalella azteca	19	2.061	3.35	0.011	13.333	90	6.579
31	Hydropsyche sp	30	5.4	18.207	0.01	100	90	12.644
32	Hydroptila sp	30	6.963	25.21	0.134	140	90	6.074
33	Ilyodrilus templetoni	14	2.072	1.892	0.111	6.25	90	5.347
34	Limnodrilus hoffmeisteri	109	1.908	11.639	0.001	120	90	3.171
35	Limnodrilus sp	59	6.127	44.243	0.04	340.176	90	0.556
36	Limnodrilus udekemianus	21	0.627	0.998	0.002	3.611	90	2.686
37	Lumbriculus variegatus	28	11.87	31.345	0.111	140	90	27.196
38	Manayunkia speciosa	53	8.403	25.009	0.056	140	90	12.111
39	Microtendipes sp	13	0.41	0.773	0.006	2.632	90	2.15
40	Mystacides sp	12	1.607	1.585	0.111	4.444	90	4.311
41	Nais behningi	21	8.042	21.439	0.089	100	90	13.282
42	Nais communis	27	12.557	34.168	0.323	140	90	39.286
43	Nais variabilus	44	7.92	27.116	0.156	140	90	4.469
44	Nanocladius sp	27	7.964	26.589	0.111	140	90	10.838
45	Neureclipsis sp	25	3.052	3.016	0.375	13.077	90	7.952
46	Oecetis sp	31	2.118	4.125	0.01	19.107	90	4.436
47	Parachironomus sp	8	1.006	1.214	0.001	3.417	90	
48	Paralauterborniella sp	13	13.923	33.074	0.575	120	90	55.636
49	Paratendipes sp	20	1.36	1.467	0.038	4.494	90	3.914
50	Phaenopsectra sp	33	2.216	3.602	0.006	19.107	90	4.359
51	Phallodrilus sp	14	1.82	2.582	0.111	10.278	90	6.539
52	Physella gyrina	55	2.383	5.235	0.002	34.091	90	4.364

53	Piguetiella michiganensi	27	11.555	34.349	0.25	140	90	34.667
54	Pisidium casertanum	108	4.108	17.816	0.001	140	90	4.242
55	Pisidium compressum	9	2.137	1.772	0.038	4.494	90	.
56	Pisidium conventus	3	0.161	0.145	0.043	0.323	90	.
57	Pisidium fallax	64	7.097	22.898	0.001	140	90	9.722
58	Pisidium henslowanum	13	2.037	2.329	0.038	8.75	90	6.583
59	Pisidium lilljeborgi	8	0.95	2.279	0.038	6.579	90	.
60	Pisidium nitidum	14	9.749	31.754	0.005	120	90	61.806
61	Pisidium variabile	7	3.293	7.031	0.038	19.107	90	.
62	Pleurocera acuta	53	5.962	19.502	0.089	140	90	9.833
63	Polypedilum scalaenum	0						
64	Polypedilum sp	93	4.442	17.721	0.005	140	90	4.296
65	Pontoporeia hoyi	16	0.139	0.363	0.006	1.471	90	0.667
66	Potamothrix moldaviensis	29	10.256	28.451	0.002	120	90	34.091
67	Potamothrix vejdovskyi	37	5.92	20.108	0.001	120	90	7.77
68	Pristina foreli	10	13.495	37.45	0.476	120	90	108.449
69	Pristina osborni	36	10.093	25.438	0.089	120	90	19.561
70	Procladius sp	145	2.958	27.944	0.001	340.176	90	2.313
71	Prostoma rubrum	80	7.517	23.093	0.089	140	90	12.797
72	Pseudocloeon sp	13	2.381	2.651	0.111	9.167	90	7.704
73	Quistadrilus multisetosu	[illegible]	[illegible]	1.719	0.001	9.167	90	2.55
74	Slavina appendiculata	[illegible]	7.774	26.774	0.059	140	90	14.283
75	Specaria josinae	26	1.667	1.543	0.038	6.25	90	4.032
76	Sphaerium nitidum	9	1.036	1.086	0.038	3	90	.
77	Sphaerium striatinum	41	2.539	5.661	0.001	34.091	90	6.613
78	Spirosperma ferox	67	6.217	22.477	0.001	140	90	6.75
79	Stenonema sp	38	6.353	22.646	0.089	140	90	13.103
80	Stictochironomus sp	10	0.689	1.243	0.002	4	90	3.747
81	Stylaria lacustris	34	2.471	3.522	0.111	19.107	90	5.512
82	Stylodrilus heringianus	51	5.44	19.476	0.134	140	90	9.083
83	Tanytarsus sp	64	3.631	15.196	0.001	120	90	5.819
84	Thienemannimyia sp	37	5.538	22.92	0.001	140	90	6.135
85	Tubifex sp	36	9.872	56.628	0.051	340.176	90	1.316
86	Turbellaria	72	6.379	20.251	0.089	140	90	9.944
87	Uncinais uncinata	6	23.394	47.387	2.43	120	90	.
88	Valvata sincera	41	1.083	1.318	0.001	6.25	90	2.926
89	Valvata tricarinata	46	1.849	3.297	0.007	19.107	90	4.986
90	Vejdovskyella intermedia	21	9.155	26.41	0.038	120	90	28.701
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	41	0.073	0.253	0.001	1.471	90	0.076
94	Cricotopus bicinctus	0						
95	Ephemera sp	1	1.429		1.429	1.429	90	.
96	Helobdella stagnalis	18	0.108	0.11	0.001	0.336	90	0.336
97	Hexagenia limbata	11	0.243	0.686	0.001	2.304	90	1.884
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	41	0.169	0.713	0.001	3.947	90	0.061

Table 8: ENDRIN - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	13	0.507	0.697	0.118	2.769	90	1.92
2	Aelosoma sp	0						
3	Amnicola limosa	20	1.045	1.581	0.069	5.254	90	4.359
4	Asellus sp	27	0.817	2.596	0.067	13.158	90	1.188
5	Aulodrilus limnobius	4	7.217	12.391	0.118	25.714	90	.
6	Aulodrilus pigueti	7	1.501	1.878	0.167	5.254	90	.
7	Aulodrilus pleuriseta	4	2.944	3.198	0.118	6.136	90	.
8	Bithynia tentaculata	10	0.292	0.18	0.081	0.645	90	0.636
9	Branchiura sowerbyi	6	0.182	0.037	0.121	0.23	90	.
10	Caenis sp	9	0.353	0.23	0.13	0.8	90	.
11	Ceraclea sp	8	25.894	55.449	0.357	160	90	.
12	Chaetogaster diaphanus	5	3.639	2.289	0.118	5.844	90	.
13	Cheumatopsyche sp	18	13.715	37.738	0.017	160	90	47.607
14	Chironomus sp	41	1.119	4.01	0.069	25.714	90	2.111
15	Cladopelma sp	4	1.63	2.433	0.091	5.254	90	.
16	Cladotanytarsus sp	5	2.22	2.325	0.357	5.254	90	.
17	Coelotanypus sp	8	0.711	1.483	0.014	4.375	90	.
18	Cricotopus sp	8	20.606	56.335	0.147	160	90	.
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	38	0.925	1.545	0.014	6.136	90	4.227
21	Dicrotendipes sp	9	0.289	0.26	0.069	0.8	90	.
22	Eukiefferiella sp	9	23.404	52.403	0.357	160	90	.
23	Gammarus fasciatus	71	4.094	19.484	0.069	160	90	5.078
24	Glossiphonia heteroclita	1	0.157		0.157	0.157	90	.
25	Glossosoma sp	7	8.904	14.945	0.205	35.119	90	.
26	Glyptotendipes sp	11	0.167	0.124	0.014	0.446	90	0.429
27	Gyraulus parvus	2	0.389	0.362	0.134	0.645	90	.
28	Helisoma anceps	0						
29	Heterotrissocladius sp	1	25.714		25.714	25.714	90	.
30	Hyalella azteca	1	13.158		13.158	13.158	90	.
31	Hydropsyche sp	12	17.455	45.946	0.069	160	90	122.536
32	Hydroptila sp	2	2.423	2.528	0.635	4.211	90	.
33	Ilyodrilus templetoni	1	0.635		0.635	0.635	90	.
34	Limnodrilus hoffmeisteri	44	0.497	1.041	0.014	5.254	90	0.829
35	Limnodrilus sp	59	0.362	0.574	0.078	3.846	90	0.476
36	Limnodrilus udekemianus	4	2.46	2.684	0.29	6.136	90	.
37	Lumbriculus variegatus	3	63.064	84.682	3.478	160	90	.
38	Manayunkia speciosa	15	3.505	6.46	0.111	25.714	90	13.968
39	Microtendipes sp	12	0.712	1.293	0.103	4.211	90	3.697
40	Mystacides sp	1	0.635		0.635	0.635	90	.
41	Nais behningi	4	51.366	73.789	4.211	160	90	.
42	Nais communis	4	2.441	1.679	0.645	4.211	90	.
43	Nais variabilus	12	4.324	9.857	0.167	35.119	90	26.16
44	Nanocladius sp	8	9.489	13.306	0.278	35.119	90	.
45	Neureclipsis sp	8	9.721	13.197	0.357	35.119	90	.
46	Oecetis sp	13	0.31	0.231	0.103	0.8	90	0.734
47	Parachironomus sp	0						
48	Paralauterborniella sp	2	2.945	3.266	0.635	5.254	90	.
49	Paratendipes sp	4	0.461	0.323	0.118	0.814	90	.
50	Phaenopsectra sp	13	1.014	1.673	0.143	5.254	90	4.837
51	Phallodrilus sp	3	14.617	17.777	3.478	35.119	90	.
52	Physella gyrina	10	1.389	1.501	0.278	4.211	90	4.137

53	Piguetiella michiganensi	7	1.132	1.384	0.167	4.211	90	.
54	Pisidium casertanum	31	3.318	7.662	0.014	35.119	90	8.051
55	Pisidium compressum	3	0.516	0.216	0.267	0.645	·90	.
56	Pisidium conventus	2	0.73	0.119	0.645	0.814	90	.
57	Pisidium fallax	6	3.007	2.143	0.017	6.136	90	.
58	Pisidium henslowanum	5	2.754	3.642	0.118	8.529	90	.
59	Pisidium lilljeborgi	5	3	5.685	0.118	13.158	90	.
60	Pisidium nitidum	4	0.465	0.323	0.105	0.814	90	.
61	Pisidium variabile	4	0.461	0.323	0.118	0.814	90	.
62	Pleurocera acuta	13	6.13	11.086	0.278	35.119	90	31.357
63	Polypedilum scalaenum	0						
64	Polypedilum sp	38	6.846	26.436	0.091	160	90	8.094
65	Pontoporeia hoyi	5	2.075	3.619	0.118	8.529	90	.
66	Potamothrix moldaviensis	9	19.023	52.899	0.069	160	90	.
67	Potamothrix vejdovskyi	9	3.931	8.314	0.118	25.714	90	.
68	Pristina foreli	0						
69	Pristina osborni	4	43.279	77.826	2.769	160	90	.
70	Procladius sp	91	0.521	1.168	0.014	8.529	90	0.811
71	Prostoma rubrum	17	13.43	38.656	0.167	160	90	60.095
72	Pseudocloeon sp	1	1.429		1.429	1.429	90	.
73	Quistadrilus multisetosu	18	0.469	0.996	0.059	4.375	90	1.158
74	Slavina appendiculata	7	4.051	9.558	0.118	25.714	90	.
75	Specaria josinae	10	1.294	1.846	0.118	5.254	90	5.15
76	Sphaerium nitidum	5	2.075	3.619	0.118	8.529	90	.
77	Sphaerium striatinum	9	4.027	8.268	0.182	25.714	90	.
78	Spirosperma ferox	21	1.548	2.379	0.014	8.529	90	5.726
79	Stenonema sp	9	5.431	11.272	0.278	35.119	90	.
80	Stictochironomus sp	3	3.081	4.723	0.157	8.529	90	.
81	Stylaria lacustris	8	2.38	4.432	0.167	13.158	90	.
82	Stylodrilus heringianus	12	2.937	7.229	0.167	25.714	90	19.043
83	Tanytarsus sp	15	2.836	6.725	0.071	25.714	90	15.403
84	Thienemannimyia sp	8	1.232	1.644	0.017	4.211	90	.
85	Tubifex sp	36	0.411	0.695	0.078	3.846	90	0.58
86	Turbellaria	10	24.995	48.746	1.429	160	90	147.512
87	Uncinais uncinata	0						
88	Valvata sincera	14	3.363	9.288	0.069	35.119	90	20.187
89	Valvata tricarinata	18	1.013	3.04	0.069	13.158	90	2.134
90	Vejdovskyella intermedia	7	5.184	9.255	0.118	25.714	90	.
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	23	0.832	1.948	0.017	8.529	90	3.625
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	12	0.148	0.054	0.077	0.243	90	0.232
97	Hexagenia limbata	4	0.708	1.065	0.143	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	22	0.309	0.536	0.014	2.5	90	0.837

Table 9: HEXACHLOROBENZENE (HCB) - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	30	1.052	2.128	0.103	10.704	90	2.499
2	Aelosoma sp	5	0.459	0.733	0.057	1.765	90	.
3	Amnicola limosa	45	2.402	4.298	0.037	20	90	7.801
4	Asellus sp	26	1.824	6.445	0.017	32.895	90	3.913
5	Aulodrilus limnobius	24	7.209	28.508	0.026	140	90	10.304
6	Aulodrilus pigueti	23	2.17	4.101	0.116	17.66	90	8.2
7	Aulodrilus pleuriseta	21	7.508	30.38	0.011	140	90	3.785
8	Bithynia tentaculata	18	1.73	4.144	0.04	17.66	90	5.857
9	Branchiura sowerbyi	7	0.209	0.08	0.121	0.375	90	.
10	Caenis sp	22	1.623	2.325	0.027	8.103	90	6.836
11	Ceraclea sp	16	1.523	1.891	0.089	6.327	90	5.08
12	Chaetogaster diaphanus	27	7.203	26.821	0.03	140	90	12.095
13	Cheumatopsyche sp	26	1.934	3.981	0.037	17.66	90	7.64
14	Chironomus sp	61	1.5	5.065	0.02	38.462	90	2.662
15	Cladopelma sp	18	1.944	4.119	0.021	17.66	90	5.766
16	Cladotanytarsus sp	22	1.49	2.471	0.051	10.704	90	5.058
17	Coelotanypus sp	7	0.329	0.327	0.065	1.022	90	.
18	Cricotopus sp	30	1.893	4.144	0.011	16.364	90	5.455
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	67	3.409	17.147	0.026	140	90	3.446
21	Dicrotendipes sp	20	1.535	2.42	0.051	8.103	90	7.284
22	Eukiefferiella sp	14	1.471	1.783	0.089	6.327	90	4.83
23	Gammarus fasciatus	117	3.498	14.533	0.011	140	90	4.647
24	Glossiphonia heteroclita	2	0.052	0.037	0.026	0.078	90	.
25	Glossosoma sp	11	1.19	1.927	0.089	6.327	90	5.573
26	Glyptotendipes sp	7	0.115	0.146	0.051	0.446	90	.
27	Gyraulus parvus	14	1.602	2.734	0.037	8.103	90	7.852
28	Helisoma anceps	11	0.78	0.828	0.037	2.558	90	2.472
29	Heterotrissocladius sp	15	10.337	35.887	0.057	140	90	58
30	Hyalella azteca	14	6.496	9.829	0.064	32.895	90	24.629
31	Hydropsyche sp	13	2.227	5.602	0.05	20	90	14.531
32	Hydroptila sp	19	2.462	2.753	0.143	10.704	90	6.327
33	Ilyodrilus templetoni	11	3.028	5.019	0.037	17.66	90	15.017
34	Limnodrilus hoffmeisteri	97	2.319	14.309	0.011	140	90	2.744
35	Limnodrilus sp	59	1.164	5.006	0.02	38.462	90	2.193
36	Limnodrilus udekemianus	24	0.88	1.838	0.031	7.6	90	3.889
37	Lumbriculus variegatus	11	1.76	1.873	0.156	6.327	90	5.861
38	Manayunkia speciosa	42	6.649	23.11	0.037	140	90	8.857
39	Microtendipes sp	11	0.117	0.154	0.029	0.556	90	0.488
40	Mystacides sp	6	1.906	1.475	0.545	4.444	90	.
41	Nais behningi	8	1.72	1.249	0.045	3.333	90	.
42	Nais communis	22	7.228	29.668	0.072	140	90	2.882
43	Nais variabilus	48	4.343	20.101	0.011	140	90	4.556
44	Nanocladius sp	12	2.393	2.904	0.089	10.704	90	8.693
45	Neureclipsis sp	11	1.469	2.04	0.089	6.327	90	5.841
46	Oecetis sp	26	2.033	3.952	0.027	17.66	90	7.751
47	Parachironomus sp	15	0.57	0.742	0.011	2.727	90	1.928
48	Paralauterborniella sp	15	10.988	35.714	0.083	140	90	58.727
49	Paratendipes sp	17	1.328	1.552	0.096	5.556	90	3.778
50	Phaenopsectra sp	26	1.68	3.472	0.029	17.66	90	3.503
51	Phallodrilus sp	8	1.938	1.694	0.143	4	90	.

52	Physella gyrina	39	1.14	1.777	0.026	8.103	90	4
53	Piguetiella michiganensi	29	6.052	25.818	0.083	140	90	5.556
54	Pisidium casertanum	91	2.923	14.845	0.011	140	90	3.785
55	Pisidium compressum	12	1.001	1.04	0.011	2.558	90	2.553
56	Pisidium conventus	14	0.585	0.856	0.057	2.727	90	2.475
57	Pisidium fallax	34	6.082	23.871	0.037	140	90	5.114
58	Pisidium henslowanum	22	0.564	0.909	0.011	2.949	90	2.457
59	Pisidium lilljeborgi	18	2.672	7.764	0.057	32.895	90	10.129
60	Pisidium nitidum	18	8.905	32.74	0.026	140	90	17
61	Pisidium variabile	22	0.469	0.713	0.011	2.222	90	2.091
62	Pleurocera acuta	27	3.567	11.352	0.089	60	90	4.109
63	Polypedilum scalaenum	13	1.081	1.72	0.083	5.556	90	4.667
64	Polypedilum sp	61	1.424	3.093	0.02	20	90	3.256
65	Pontoporeia hoyi	31	0.221	0.397	0.029	2.222	90	0.283
66	Potamothrix moldaviensis	42	4.025	21.527	0.011	140	90	3.113
67	Potamothrix vejdovskyi	44	4.321	20.977	0.011	140	90	3.616
68	Pristina foreli	8	18.468	49.114	0.143	140	90	.
69	Pristina osborni	16	10.321	34.626	0.045	140	90	46.429
70	Procladius sp	127	1.076	2.76	0.011	20	90	2.812
71	Prostoma rubrum	54	5.451	20.479	0.037	140	90	6.004
72	Pseudocloeon sp	2	2.612	1.963	1.224	4	90	.
73	Quistadrilus multisetosu	29	1.989	4.408	0.022	20	90	8.103
74	Slavina appendiculata	22	1.121	1.204	0.116	4.444	90	3.218
75	Specaria josinae	23	2.456	4.064	0.102	17.66	90	8.2
76	Sphaerium nitidum	14	0.699	1.009	0.089	2.727	90	2.664
77	Sphaerium striatinum	20	1.245	1.463	0.043	4.545	90	3.933
78	Spirosperma ferox	61	4.141	18.083	0.011	140	90	6.989
79	Stenonema sp	16	0.976	1.417	0.089	4	90	3.929
80	Stictochironomus sp	4	4.647	8.677	0.078	17.66	90	.
81	Stylaria lacustris	37	2.754	6.087	0.011	32.895	90	6.585
82	Stylodrilus heringianus	36	1.143	1.398	0.057	6.327	90	2.885
83	Tanytarsus sp	54	3.235	18.984	0.018	140	90	2.646
84	Thienemannimyia sp	18	1.282	2.31	0.072	8.103	90	6.504
85	Tubifex sp	36	1.76	6.366	0.027	38.462	90	2.944
86	Turbellaria	37	2.356	3.401	0.045	17.66	90	5.811
87	Uncinais uncinata	20	8.115	31.082	0.083	140	90	5.333
88	Valvata sincera	47	1.866	4.151	0.034	20	90	5.076
89	Valvata tricarinata	44	2.625	6.311	0.036	32.895	90	9.404
90	Vejdovskyella intermedia	50	3.731	19.711	0.011	140	90	3.333
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	24	0.323	1.012	0.018	5.054	90	0.329
94	Cricotopus bicinctus	1	0.161		0.161	0.161	90	.
95	Ephemera sp	0						
96	Helobdella stagnalis	18	0.259	0.474	0.019	1.544	90	1.544
97	Hexagenia limbata	7	2.64	3.653	0.02	8.103	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	27	0.115	0.167	0.012	0.841	90	0.237

Table 10: HEPTACHLOR EPOXIDE - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	8	0.126	0.044	0.03	0.165	90	.
2	Aelosoma sp	0						
3	Amnicola limosa	12	0.201	0.229	0.006	0.703	90	0.675
4	Asellus sp	29	0.555	1.317	0.003	6.579	90	0.789
5	Aulodrilus limnobius	2	0.018	0.016	0.006	0.03	90	.
6	Aulodrilus pigueti	1	0.019		0.019	0.019	90	.
7	Aulodrilus pleuriseta	2	0.018	0.016	0.006	0.03	90	.
8	Bithynia tentaculata	10	0.254	0.142	0.006	0.556	90	0.531
9	Branchiura sowerbyi	6	0.182	0.037	0.121	0.23	90	.
10	Caenis sp	6	0.208	0.142	0.045	0.417	90	.
11	Ceraclea sp	0						
12	Chaetogaster diaphanus	1	0.03		0.03	0.03	90	.
13	Cheumatopsyche sp	6	0.065	0.079	0.003	0.2	90	.
14	Chironomus sp	36	1.537	6.37	0.016	38.462	90	2.226
15	Cladopelma sp	4	0.207	0.375	0.016	0.769	90	.
16	Cladotanytarsus sp	3	0.086	0.078	0.006	0.161	90	.
17	Coelotanypus sp	10	0.203	0.22	0.004	0.703	90	0.663
18	Cricotopus sp	12	1.106	1.721	0.064	4.545	90	4.545
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	31	0.233	0.229	0.003	0.893	90	0.598
21	Dicrotendipes sp	11	0.163	0.125	0.003	0.347	90	0.341
22	Eukiefferiella sp	0						
23	Gammarus fasciatus	54	1.066	5.228	0.003	38.462	90	1.222
24	Glossiphonia heteroclita	1	0.314		0.314	0.314	90	.
25	Glossosoma sp	3	0.13	0.032	0.103	0.165	90	.
26	Glyptotendipes sp	13	0.144	0.142	0.003	0.446	90	0.375
27	Gyraulus parvus	2	0.214	0.075	0.161	0.267	90	.
28	Helisoma anceps	0						
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	1.782	2.256	0.064	6.579	90	5.766
31	Hydropsyche sp	2	0.098	0.008	0.093	0.103	90	.
32	Hydroptila sp	0						
33	Ilyodrilus templetoni	0						
34	Limnodrilus hoffmeisteri	39	0.159	0.232	0.003	0.789	90	0.606
35	Limnodrilus sp	59	1.247	4.994	0.078	38.462	90	2.193
36	Limnodrilus udekemianus	2	0.153	0.012	0.145	0.161	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	3	0.268	0.046	0.222	0.314	90	.
39	Microtendipes sp	10	0.271	0.107	0.19	0.556	90	0.531
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	1	0.161		0.161	0.161	90	.
43	Nais variabilus	0						
44	Nanocladius sp	0						
45	Neureclipsis sp	0						
46	Oecetis sp	12	0.283	0.116	0.19	0.556	90	0.532
47	Parachironomus sp	2	0.016	0.014	0.006	0.026	90	.
48	Paralauterborniella sp	0						
49	Paratendipes sp	4	0.054	0.072	0.006	0.161	90	.
50	Phaenopsectra sp	5	0.108	0.044	0.036	0.145	90	.
51	Phallodrilus sp	0						

52	Physella gyrina	2	0.146	0.076	0.093	0.2	90	.
53	Piguetiella michiganensi	1	0.161		0.161	0.161	90	.
54	Pisidium casertanum	15	0.137	0.229	0.004	0.882	90	0.578
55	Pisidium compressum	2	0.084	0.11	0.006	0.161	90	.
56	Pisidium conventus	2	0.09	0.1	0.019	0.161	90	.
57	Pisidium fallax	1	0.004		0.004	0.004	90	.
58	Pisidium henslowanum	4	0.27	0.414	0.006	0.882	90	.
59	Pisidium lilljeborgi	5	1.359	2.919	0.006	6.579	90	.
60	Pisidium nitidum	4	0.317	0.335	0.019	0.789	90	.
61	Pisidium variabile	4	0.054	0.072	0.006	0.161	90	.
62	Pleurocera acuta	0						
63	Polypedilum scalaenum	0						
64	Polypedilum sp	23	0.288	0.333	0.023	1.563	90	0.714
65	Pontoporeia hoyi	5	0.22	0.376	0.006	0.882	90	.
66	Potamothrix moldaviensis	5	0.071	0.061	0.018	0.161	90	.
67	Potamothrix vejdovskyi	6	0.079	0.08	0.019	0.2	90	.
68	Pristina foreli	0						
69	Pristina osborni	0						
70	Procladius sp	86	0.425	0.722	0.003	3.425	90	1.54
71	Prostoma rubrum	0						
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	12	0.287	0.282	0.004	0.789	90	0.764
74	Slavina appendiculata	2	0.024	0.007	0.019	0.03	90	.
75	Specaria josinae	3	0.066	0.084	0.006	0.161	90	.
76	Sphaerium nitidum	5	0.22	0.376	0.006	0.882	90	.
77	Sphaerium striatinum	2	0.005	0.003	0.003	0.006	90	.
78	Spirosperma ferox	11	0.213	0.327	0.004	0.882	90	0.864
79	Stenonema sp	0						
80	Stictochironomus sp	3	0.584	0.285	0.314	0.882	90	.
81	Stylaria lacustris	3	2.417	3.605	0.336	6.579	90	.
82	Stylodrilus heringianus	2	1.042	1.246	0.161	1.923	90	.
83	Tanytarsus sp	16	0.136	0.236	0.003	0.882	90	0.527
84	Thienemannimyia sp	4	0.031	0.04	0.004	0.089	90	.
85	Tubifex sp	36	1.855	6.349	0.103	38.462	90	2.944
86	Turbellaria	0						
87	Uncinais uncinata	0						
88	Valvata sincera	8	0.128	0.138	0.006	0.375	90	.
89	Valvata tricarinata	13	0.705	1.77	0.03	6.579	90	4.17
90	Vejdovskyella intermedia	4	0.054	0.072	0.006	0.161	90	.
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	28	0.133	0.235	0.003	0.882	90	0.618
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	14	0.232	0.092	0.003	0.346	90	0.341
97	Hexagenia limbata	7	0.376	0.853	0.003	2.304	90	
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	17	0.187	0.255	0.004	0.789	90	0.773

Table 11: MIREX - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N=	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	19	7.392	20.095	0.148	82.083	90	39.091
2	Aelosoma sp	2	0.232	0.261	0.048	0.417	90	.
3	Amnicola limosa	14	13.787	25.054	0.076	82.083	90	65.708
4	Asellus sp	16	1.543	3.426	0.078	13.158	90	7.684
5	Aulodrilus limnobius	5	9.029	16.873	0.076	39.091	90	.
6	Aulodrilus pigueti	11	30.22	46.593	0.097	144.737	90	132.206
7	Aulodrilus pleuriseta	11	9.091	17.722	0.048	49.333	90	47.285
8	Bithynia tentaculata	12	0.72	1.1	0.076	3.704	90	3.231
9	Branchiura sowerbyi	6	1.042	2.105	0.121	5.338	90	.
10	Caenis sp	9	26.176	51.899	0.048	144.737	90	.
11	Ceraclea sp	5	16.912	36.433	0.446	82.083	90	.
12	Chaetogaster diaphanus	18	3.587	9.121	0.111	39.091	90	12.299
13	Cheumatopsyche sp	11	26.802	47.252	0.347	144.737	90	132.206
14	Chironomus sp	38	7.624	27.019	0.081	144.737	90	7.221
15	Cladopelma sp	9	21.11	29.16	0.51	82.083	90	.
16	Cladotanytarsus sp	8	40.957	51.156	0.806	144.737	90	.
17	Coelotanypus sp	6	6.69	15.873	0.13	39.091	90	.
18	Cricotopus sp	21	4.976	17.716	0.056	82.083	90	4.545
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	38	6.993	26.497	0.078	144.737	90	5.736
21	Dicrotendipes sp	12	14.75	27.143	0.078	82.083	90	72.258
22	Eukiefferiella sp	5	1.236	1.412	0.446	3.704	90	.
23	Gammarus fasciatus	60	6.781	22.758	0.056	144.737	90	8.924
24	Glossiphonia heteroclita	1	0.078		0.078	0.078	90	.
25	Glossosoma sp	5	0.568	0.158	0.446	0.825	90	.
26	Glyptotendipes sp	6	0.176	0.133	0.103	0.446	90	.
27	Gyraulus parvus	6	14.636	33.068	0.134	82.083	90	.
28	Helisoma anceps	6	16.063	22.071	0.362	49.333	90	.
29	Heterotrissocladius sp	7	0.477	0.319	0.048	1.042	90	.
30	Hyalella azteca	14	2.168	3.582	0.064	13.158	90	8.852
31	Hydropsyche sp	2	0.446	0	0.446	0.446	90	.
32	Hydroptila sp	4	43.252	32.776	2.5	82.083	90	.
33	Ilyodrilus templetoni	4	58.163	68.734	2.128	144.737	90	.
34	Limnodrilus hoffmeisteri	36	9.615	28.506	0.048	144.737	90	42.164
35	Limnodrilus sp	59	1.346	5.014	0.078	38.462	90	2.304
36	Limnodrilus udekemianus	7	13.145	21.429	0.446	49.333	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	12	1.656	2.631	0.078	9.322	90	7.637
39	Microtendipes sp	10	0.166	0.142	0.078	0.556	90	0.522
40	Mystacides sp	1	3.704		3.704	3.704	90	.
41	Nais behningi	0						
42	Nais communis	9	9.713	27.139	0.362	82.083	90	.
43	Nais variabilus	28	7.208	18.626	0.056	82.083	90	40.115
44	Nanocladius sp	5	17.543	36.105	0.347	82.083	90	.
45	Neureclipsis sp	4	2.838	4.335	0.446	9.322	90	.
46	Oecetis sp	15	0.666	1.002	0.078	3.704	90	2.758
47	Parachironomus sp	13	21.675	44.737	0.048	144.737	90	119.675
48	Paralauterborniella sp	5	3.068	3.739	0.417	9.322	90	.
49	Paratendipes sp	8	0.688	0.562	0.076	1.389	90	.
50	Phaenopsectra sp	13	1.846	2.551	0.347	9.322	90	7.093
51	Phallodrilus sp	3	64.383	71.162	9.322	144.737	90	.
52	Physella gyrina	10	0.554	0.351	0.048	1.136	90	1.136

53	Piguetiella michiganensi	21	2.792	8.346	0.417	39.091	90	3.278
54	Pisidium casertanum	44	1.838	5.945	0.048	39.091	90	3.102
55	Pisidium compressum	5	0.319	0.362	0.048	0.806	90	.
56	Pisidium conventus	13	0.702	0.661	0.048	2.5	90	1.976
57	Pisidium fallax	5	17.239	36.255	0.481	82.083	90	.
58	Pisidium henslowanum	19	0.468	0.323	0.048	1.136	90	0.893
59	Pisidium lilljeborgi	16	1.293	3.183	0.048	13.158	90	4.743
60	Pisidium nitidum	10	0.487	0.286	0.097	0.893	90	0.884
61	Pisidium variabile	19	0.752	0.926	0.048	3.704	90	2.5
62	Pleurocera acuta	7	0.696	0.348	0.347	1.136	90	.
63	Polypedilum scalaenum	13	1	0.578	0.417	2.5	90	2.056
64	Polypedilum sp	32	4.651	15.746	0.074	82.083	90	7.65
65	Pontoporeia hoyi	29	0.537	0.303	0.076	1.19	90	1
66	Potamothrix moldaviensis	23	0.499	0.285	0.048	1.042	90	0.938
67	Potamothrix vejdovskyi	24	0.982	1.855	0.048	9.322	90	1.944
68	Pristina foreli	2	44.212	7.242	39.091	49.333	90	.
69	Pristina osborni	1	49.333		49.333	49.333	90	.
70	Procladius sp	75	3.074	11.723	0.048	82.083	90	3.37
71	Prostoma rubrum	22	5.386	12.828	0.048	49.333	90	30.16
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	3	0.225	0.224	0.048	0.476	90	.
74	Slavina appendiculata	12	27.043	45.622	0.097	144.737	90	125.941
75	Specaria josinae	14	18.281	39.569	0.076	144.737	90	97.035
76	Sphaerium nitidum	12	0.435	0.281	0.076	0.806	90	0.792
77	Sphaerium striatinum	8	0.693	0.379	0.076	1.136	90	.
78	Spirosperma ferox	27	2.514	7.553	0.048	39.091	90	4.864
79	Stenonema sp	8	1.743	3.08	0.347	9.322	90	.
80	Stictochironomus sp	4	0.874	0.88	0.078	2.128	90	.
81	Stylaria lacustris	21	16.469	36.17	0.048	144.737	90	75.533
82	Stylodrilus heringianus	23	1.09	0.993	0.048	3.75	90	3.222
83	Tanytarsus sp	35	8.267	28.105	0.076	144.737	90	17.886
84	Thienemannimyia sp	11	5.693	14.509	0.362	49.333	90	40.217
85	Tubifex sp	36	1.854	6.343	0.103	38.462	90	2.944
86	Turbellaria	6	54.449	52.823	2.128	144.737	90	.
87	Uncinais uncinata	15	0.857	0.358	0.417	1.389	90	1.389
88	Valvata sincera	22	5.05	12.93	0.048	49.333	90	30.16
89	Valvata tricarinata	21	7.627	20.198	0.078	82.083	90	42.098
90	Vejdovskyella intermedia	37	0.909	1.505	0.048	9.322	90	1.389
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	10	0.466	0.465	0.064	1.389	90	1.35
94	Cricotopus bicinctus	1	0.806		0.806	0.806	90	.
95	Ephemera sp	0						
96	Helobdella stagnalis	12	0.176	0.09	0.078	0.336	90	0.336
97	Hexagenia limbata	2	1.253	1.486	0.202	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	7	0.612	0.387	0.085	1	90	.

Table 12: Total PCB - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	53	15.199	15.619	0.103	59.191	90	42.743
2	Aelosoma sp	4	16.154	15.969	1.667	34.615	90	.
3	Amnicola limosa	76	11.299	27.424	0.128	196	90	22.386
4	Asellus sp	141	7.992	21.869	0.04	196	90	15.124
5	Aulodrilus limnobius	15	113.653	383.941	1.667	1500	90	643.404
6	Aulodrilus pigueti	29	17.117	24.409	0.455	119.492	90	32.051
7	Aulodrilus pleuriseta	28	64.809	282.232	0.227	1500	90	47.949
8	Bithynia tentaculata	59	4.102	10.287	0.04	72.34	90	9.375
9	Branchiura sowerbyi	30	5.798	14.638	0.121	64.84	90	8.478
10	Caenis sp	34	6.811	8.159	0.065	28.947	90	22.343
11	Ceraclea sp	18	34.427	66.979	1.786	285.065	90	117.588
12	Chaetogaster diaphanus	28	77.064	284.592	0.111	1500	90	136.049
13	Cheumatopsyche sp	32	29.008.	54.429	0.667	285.065	90	90.988
14	Chironomus sp	213	7	16.35	0.04	173.272	90	22.106
15	Cladopelma sp	20	19.288	28.497	0.156	119.492	90	67.539
16	Cladotanytarsus sp	24	15.235	24.629	0.263	119.492	90	34.474
17	Coelotanypus sp	33	3.605	4.701	0.065	22.449	90	7.419
18	Cricotopus sp	82	16.345	42.237	0.064	281.154	90	34.154
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	175	17.288	116.052	0.04	1500	90	21.619
21	Dicrotendipes sp	62	5.979	8.953	0.028	53.034	90	19.211
22	Eukiefferiella sp	15	43.256	71.194	1.786	285.065	90	173.414
23	Gammarus fasciatus	264	20.782	110.066	0.028	1500	90	32.222
24	Glossiphonia heteroclita	8	1.245	1.387	0.078	4.082	90	
25	Glossosoma sp	22	21.918	23.84	0.103	98.98	90	55.138
26	Glyptotendipes sp	43	3.138	4.504	0.051	23.214	90	7.921
27	Gyraulus parvus	25	3.876	6.288	0.067	22.685	90	16.653
28	Helisoma anceps	11	9.758	5.743	3.148	22.685	90	21.404
29	Heterotrissocladius sp	13	121.126	414.343	0.833	1500	90	908.889
30	Hyalella azteca	80	5.364	14.421	0.064	92.105	90	8.054
31	Hydropsyche sp	22	16.927	23.366	0.208	98.98	90	42.42
32	Hydroptila sp	18	22.281	22.446	3.646	98.98	90	48.469
33	Ilyodrilus templetoni	15	17.491	17.587	2.353	72.34	90	46.305
34	Limnodrilus hoffmeisteri	174	17.845	116.386	0.028	1500	90	22.056
35	Limnodrilus sp	298	12.849	31.143	0.04	281.154	90	33.615
36	Limnodrilus udekemianus	38	10.01	15.765	0.094	81.739	90	22.277
37	Lumbriculus variegatus	9	31.137	29.713	0.769	98.98	90	
38	Manayunkia speciosa	50	60.097	241.139	0.056	1500	90	41.8
39	Microtendipes sp	53	1.928	2.38	0.048	12.526	90	5.557
40	Mystacides sp	10	9.63	8.462	1.042	22.685	90	22.56
41	Nais behningi	8	22.208	10.929	7.317	40	90	
42	Nais communis	20	84.379	333.306	1.923	1500	90	31.279
43	Nais variabilus	51	43.076	209.258	0.278	1500	90	38.923
44	Nanocladius sp	14	33.916	73.27	1.786	285.065	90	163.532
45	Neureclipsis sp	8	69.034	98.904	1.786	285.065	90	.
46	Oecetis sp	73	6.177	15.16	0.048	98.98	90	14.778
47	Parachironomus sp	20	22.298	71.174	0.284	323.158	90	27.703
48	Paralauterborniella sp	12	142.818	428.626	1.667	1500	90	1085.847
49	Paratendipes sp	15	10.507	11.226	0.278	40	90	29.355
50	Phaenopsectra sp	44	18.041	23.127	0.103	119.492	90	51.705
51	Phallodrilus sp	7	36.159	38.394	8.182	119.492	90	.
52	Physella gyrina	50	8.025	12.194	0.111	42.857	90	32.364

53	Piguetiella michiganensi	29	59.858	277.134	0.278	1500	90	32.051
54	Pisidium casertanum	128	22.903	135.587	0.111	1500	90	22.301
55	Pisidium compressum	13	10.259	11.523	0.756	40	90	32.903
56	Pisidium conventus	14	6.198	6.617	0.111	22.258	90	19.65
57	Pisidium fallax	33	61.452	258.765	1.308	1500	90	45.12
58	Pisidium henslowanum	23	9.611	11.804	0.111	46.629	90	28.134
59	Pisidium lilljeborgi	28	11.115	23.435	0.111	92.105	90	29.243
60	Pisidium nitidum	22	75.269	318.335	0.111	1500	90	29.113
61	Pisidium variabile	22	7.827	9.843	0.111	40	90	22.557
62	Pleurocera acuta	23	63.841	184.246	0.667	866.667	90	188.182
63	Polypedilum scalaenum	13	4.914	5.661	0.278	21.905	90	17.143
64	Polypedilum sp	144	12.862	28.48	0.056	285.065	90	27.224
65	Pontoporeia hoyi	41	6.31	8.113	0.111	46.629	90	15.114
66	Potamothrix moldaviensis	55	38.096	204.409	0.357	1500	90	22.237
67	Potamothrix vejdovskyi	50	47.15	215.023	0.111	1500	90	31.772
68	Pristina foreli	6	260.983	607.021	8.182	1500	90	.
69	Pristina osborni	15	120.464	382.379	4.673	1500	90	659.388
70	Procladius sp	382	12.924	33.859	0.04	323.158	90	27.257
71	Prostoma rubrum	[illegible]	[illegible]	237.782	0.111	1500	90	90.988
72	Pseudocloeon sp	2	26.012	21.762	11.224	42	90	.
73	Quistadrilus multisetosu	69	9.346	24.743	0.135	196	90	22.111
74	Slavina appendiculata	21	12.719	9.972	1.786	34.615	90	31.43
75	Specaria josinae	27	20.049	24.884	1.667	119.492	90	46.468
76	Sphaerium nitidum	15	6.257	5.969	0.111	22.258	90	16.103
77	Sphaerium striatinum	26	12.892	38.54	0.028	196	90	28.156
78	Spirosperma ferox	73	34.661	177.731	0.111	1500	90	36.821
79	Stenonema sp	14	22.666	31.685	1.786	119.492	90	81.174
80	Stictochironomus sp	18	5.853	16.806	0.078	72.34	90	16.499
81	Stylaria lacustris	49	14.335	20.559	0.278	92.105	90	28.947
82	Stylodrilus heringianus	43	23.607	53.903	0.476	281.154	90	43.234
83	Tanytarsus sp	87	22.475	160.417	0.094	1500	90	17.095
84	Thienemannimyia sp	25	23.232	65.658	0.128	323.158	90	60.361
85	Tubifex sp	179	18.001	38.415	0.051	281.154	90	38.462
86	Turbellaria	34	32.346	51.702	1.667	285.065	90	85.66
87	Uncinais uncinata	20	82.218	333.854	0.278	1500	90	38.222
88	Valvata sincera	71	8.663	17.551	0.067	119.492	90	19.939
89	Valvata tricarinata	92	7.488	16.068	0.051	92.105	90	15.807
90	Vejdovskyella intermedia	46	41.209	220.629	0.111	1500	90	22.233
91	Elliptio complanata	1	0.278		0.278	0.278	90	.
92	Sphaerium simile	0						
93	Chironomus plumosus	82	9.834	41.437	0.064	323.158	90	11.164
94	Cricotopus bicinctus	5	1.002	1.254	0.256	3.226	90	.
95	Ephemera sp	2	1.646	0.153	1.538	1.754	90	.
96	Helobdella stagnalis	73	2.586	3.388	0.04	18.214	90	6.212
97	Hexagenia limbata	30	14.547	36.045	0.028	173.272	90	44.055
98	Hexagenia sp	1	1.724		1.724	1.724	90	.
99	Tanypus sp	0						
100	Tubifex tubifex	59	7.869	26.033	0.1	196	90	18.214

Table 12a: PCB-1254 - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	6	19.531	6.009	9.055	27.306	90	.
2	Aelosoma sp	0						
3	Amnicola limosa	1	1.415		1.415	1.415	90	.
4	Asellus sp	15	7.706	10.672	1.415	38.356	90	31.726
5	Aulodrilus limnobius	0						
6	Aulodrilus pigueti	0						
7	Aulodrilus pleuriseta	0						
8	Bithynia tentaculata	8	2.98	2.364	0.556	7.742	90	.
9	Branchiura sowerbyi	6	3.633	2.716	1.553	8.79	90	.
10	Caenis sp	3	4.167	2.093	2.279	6.417	90	.
11	Ceraclea sp	0						
12	Chaetogaster diaphanus	0						
13	Cheumatopsyche sp	0						
14	Chironomus sp	30	7.846	10.385	0.556	38.462	90	25.463
15	Cladopelma sp	0						
16	Cladotanytarsus sp	0						
17	Coelotanypus sp	5	3.283	1.009	2.279	4.806	90	.
18	Cricotopus sp	12	11.571	11.654	0.064	33.077	90	31.346
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	16	4.131	2.995	0.556	9.018	90	8.858
21	Dicrotendipes sp	6	7.032	9.991	1.848	27.306	90	.
22	Eukiefferiella sp	0						
23	Gammarus fasciatus	28	9.258	11.041	1.553	38.462	90	32.836
24	Glossiphonia heteroclita	1	1.884		1.884	1.884	90	.
25	Glossosoma sp	3	18.116	9.126	9.055	27.306	90	.
26	Glyptotendipes sp	6	3.819	2.791	1.736	9.018	90	.
27	Gyraulus parvus	1	4.806		4.806	4.806	90	.
28	Helisoma anceps	0						
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	2.65	1.895	0.064	6.579	90	5.766
31	Hydropsyche sp	0						
32	Hydroptila sp	0						
33	Ilyodrilus templetoni	0						
34	Limnodrilus hoffmeisteri	0						
35	Limnodrilus sp	59	12.072	16.418	0.556	106.667	90	32.222
36	Limnodrilus udekemianus	1	19.014		19.014	19.014	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	3	2.282	0.821	1.736	3.226	90	.
39	Microtendipes sp	10	2.552	1.686	0.556	6.057	90	5.932
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	0						
43	Nais variabilus	0						
44	Nanocladius sp	0						
45	Neureclipsis sp	0						
46	Oecetis sp	11	3.29	2.159	0.556	7.619	90	7.307
47	Parachironomus sp	0						
48	Paralauterborniella sp	0						
49	Paratendipes sp	0						
50	Phaenopsectra sp	4	18.803	7.493	9.055	27.306	90	.
51	Phallodrilus sp	0						
52	Physella gyrina	0						
53	Piguetiella michiganensi	0						

54	Pisidium casertanum	0						
55	Pisidium compressum	0						
56	Pisidium conventus	0						
57	Pisidium fallax	0						
58	Pisidium henslowanum	0						
59	Pisidium lilljeborgi	1	6.579		6.579	6.579	90	.
60	Pisidium nitidum	1	3.077		3.077	3.077	90	.
61	Pisidium variabile	0						
62	Pleurocera acuta	0						
63	Polypedilum scalaenum	0						
64	Polypedilum sp	21	9.378	7.935	1.039	27.306	90	21.278
65	Pontoporeia hoyi	0						
66	Potamothrix moldaviensis	0						
67	Potamothrix vejdovskyi	0						
68	Pristina foreli	0						
69	Pristina osborni	0						
70	Procladius sp	45	13.614	17.876	0.556	106.667	90	32.564
71	Prostoma rubrum	0						
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	0						
74	Slavina appendiculata	0						
75	Specaria josinae	0						
76	Sphaerium nitidum	0						
77	Sphaerium striatinum	0						
78	Spirosperma ferox	0						
79	Stenonema sp	0						
80	Stictochironomus sp	2	1.22	0.939	0.556	1.884	90	.
81	Stylaria lacustris	3	3.535	2.636	2.013	6.579	90	.
82	Stylodrilus heringianus	1	33.077		33.077	33.077	90	.
83	Tanytarsus sp	2	4.669	1.223	3.804	5.533	90	.
84	Thienemannimyia sp	0						
85	Tubifex sp	36	16.652	19.377	1.553	106.667	90	35.37
86	Turbellaria	0						
87	Uncinais uncinata	0						
88	Valvata sincera	1	4.806		4.806	4.806	90	.
89	Valvata tricarinata	9	2.978	2.296	0.556	6.579	90	.
90	Vejdovskyella intermedia	0						
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	4	0.551	0.563	0.064	1.039	90	.
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	12	2.916	1.763	1.687	7.742	90	6.861
97	Hexagenia limbata	2	14.725	15.671	3.644	25.806	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	0						

Table 12b: PCB-1248 - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	6	0.136	0.022	0.103	0.165	90	.
2	Aelosoma sp	0						
3	Amnicola limosa	1	0.314		0.314	0.314	90	.
4	Asellus sp	15	1.841	2.039	0.121	6.579	90	5.97
5	Aulodrilus limnobius	0						
6	Aulodrilus pigueti	0						
7	Aulodrilus pleuriseta	0						
8	Bithynia tentaculata	8	1.358	1.844	0.219	5.565	90	.
9	Branchiura sowerbyi	6	0.182	0.037	0.121	0.23	90	.
10	Caenis sp	3	2.131	1.954	0.272	4.167	90	.
11	Ceraclea sp	0						
12	Chaetogaster diaphanus	0						
13	Cheumatopsyche sp	0						
14	Chironomus sp	30	5.787	19.358	0.111	101.382	90	6.378
15	Cladopelma sp	0						
16	Cladotanytarsus sp	0						
17	Coelotanypus sp	5	0.841	0.814	0.185	1.953	90	.
18	Cricotopus sp	12	23.867	71.068	0.064	248.077	90	182.188
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	16	1.492	1.592	0.161	5.565	90	4.586
21	Dicrotendipes sp	6	1.531	1.103	0.121	2.892	90	.
22	Eukiefferiella sp	0						
23	Gammarus fasciatus	28	6.353	19.966	0.111	101.382	90	9.668
24	Glossiphonia heteroclita	1	2.198		2.198	2.198	90	.
25	Glossosoma sp	3	0.13	0.032	0.103	0.165	90	.
26	Glyptotendipes sp	6	1.775	0.811	0.446	2.892	90	.
27	Gyraulus parvus	1	1.469		1.469	1.469	90	.
28	Helisoma anceps	0						
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	1.782	2.256	0.064	6.579	.90	5.766
31	Hydropsyche sp	0						
32	Hydroptila sp	0						
33	Ilyodrilus templetoni	0						
34	Limnodrilus hoffmeisteri	0						
35	Limnodrilus sp	59	11.627	39.658	0.078	248.077	90	28.446
36	Limnodrilus udekemianus	1	0.145		0.145	0.145	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	3	2.275	0.582	1.736	2.892	90	.
39	Microtendipes sp	10	2.127	1.713	0.219	6.468	90	6.111
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	0						
43	Nais variabilus	0						
44	Nanocladius sp	0						
45	Neureclipsis sp	0						
46	Oecetis sp	11	1.691	1.837	0.219	6.468	90	5.753
47	Parachironomus sp	0						
48	Paralauterborniella sp	0						
49	Paratendipes sp	0						
50	Phaenopsectra sp	4	0.127	0.019	0.103	0.145	90	.
51	Phallodrilus sp	0						
52	Physella gyrina	0						

Table 12c: PCB-1016 - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	6	20.687	7.556	8.953	26.173	90	.
2	Aelosoma sp	0						
3	Amnicola limosa	1	0.314		0.314	0.314	90	.
4	Asellus sp	15	8.598	23.378	0.202	92.105	90	44.808
5	Aulodrilus limnobius	0						
6	Aulodrilus pigueti	0						
7	Aulodrilus pleuriseta	0						
8	Bithynia tentaculata	8	0.631	0.628	0.202	2.061	90	.
9	Branchiura sowerbyi	6	1.539	0.999	0.51	3.292	90	.
10	Caenis sp	3	1.005	1.223	0.272	2.417	90	.
11	Ceraclea sp	0						
12	Chaetogaster diaphanus	0						
13	Cheumatopsyche sp	0						
14	Chironomus sp	30	4.265	10.479	0.202	46.083	90	5.561
15	Cladopelma sp	0						
16	Cladotanytarsus sp	0						
17	Coelotanypus sp	5	1.134	0.946	0.326	2.249	90	.
18	Cricotopus sp	12	9.905	9.832	1.271	25.806	90	25.555
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	16	1.053	1.185	0.202	3.482	90	3.349
21	Dicrotendipes sp	6	2.608	5.236	0.257	13.277	90	.
22	Eukiefferiella sp	0						
23	Gammarus fasciatus	28	4.64	10.783	0.202	46.083	90	8.947
24	Glossiphonia heteroclita	1	0.392		0.392	0.392	90	.
25	Glossosoma sp	3	16.035	8.792	8.953	25.875	90	.
26	Glyptotendipes sp	6	0.835	1.297	0.257	3.482	90	.
27	Gyraulus parvus	1	0.334		0.334	0.334	90	.
28	Helisoma anceps	0						
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	11.368	24.392	1.271	92.105	90	58.996
31	Hydropsyche sp	0						
32	Hydroptila sp	0						
33	Ilyodrilus templetoni	0						
34	Limnodrilus hoffmeisteri	0						
35	Limnodrilus sp	59	7.869	12.726	0.202	56.818	90	26.173
36	Limnodrilus udekemianus	1	22.145		22.145	22.145	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	3	0.335	0.057	0.278	0.392	90	.
39	Microtendipes sp	10	0.319	0.099	0.219	0.556	90	0.539
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	0						
43	Nais variabilus	0						
44	Nanocladius sp	0						
45	Neureclipsis sp	0						
46	Oecetis sp	11	0.397	0.252	0.219	1.087	90	0.981
47	Parachironomus sp	0						
48	Paralauterborniella sp	0						
49	Paratendipes sp	0						
50	Phaenopsectra sp	4	17.313	7.455	8.953	24.876	90	.
51	Phallodrilus sp	0						
52	Physella gyrina	0						

53	Piguetiella michiganensi	0						
54	Pisidium casertanum	0						
55	Pisidium compressum	0						
56	Pisidium conventus	0						
57	Pisidium fallax	0						
58	Pisidium henslowanum	0						
59	Pisidium lilljeborgi	1	92.105		92.105	92.105	90	
60	Pisidium nitidum	1	2.249		2.249	2.249	90	
61	Pisidium variabile	0						
62	Pleurocera acuta	0						
63	Polypedilum scalaenum	0						
64	Polypedilum sp	21	7.546	8.943	0.272	27.143	90	24.951
65	Pontoporeia hoyi	0						
66	Potamothrix moldaviensis	0						
67	Potamothrix vejdovskyi	0						
68	Pristina foreli	0						
69	Pristina osborni	0						
70	Procladius sp	45	9.198	13.612	0.202	56.818	90	26.561
71	Prostoma rubrum	0						
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	0						
74	Slavina appendiculata	0						
75	Specaria josinae	0						
76	Sphaerium nitidum	0						
77	Sphaerium striatinum	0						
78	Spirosperma ferox	0						
79	Stenonema sp	0						
80	Stictochironomus sp	2	0.474	0.115	0.392	0.556	90	
81	Stylaria lacustris	3	34.729	49.69	6.04	92.105	90	
82	Stylodrilus heringianus	1	1.923		1.923	1.923	90	
83	Tanytarsus sp	2	1.436	1.646	0.272	2.6	90	
84	Thienemannimyia sp	0						
85	Tubifex sp	36	10.607	14.846	0.257	56.818	90	35.032
86	Turbellaria	0						
87	Uncinais uncinata	0						
88	Valvata sincera	1	0.334		0.334	0.334	90	
89	Valvata tricarinata	9	10.567	30.577	0.219	92.105	90	
90	Vejdovskyella intermedia	0						
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	4	2.49	1.408	1.271	3.709	90	
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	12	1.423	2.171	0.202	6.04	90	6.04
97	Hexagenia limbata	2	25.875	28.578	5.668	46.083	90	
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	0						

Table 12d: PCB-1260 - Species Screening Level Concentrations (ug/g of organic carbon).

Spp No.	Species	N =	Mean	Std.Dev.	Minimum	Maximum	%	Conc.
1	Ablabesmyia sp	6	10.018	3.346	3.511	12.451	90	.
2	Aelosoma sp	0						
3	Amnicola limosa	1	0.314		0.314	0.314	90	.
4	Asellus sp	16	4.937	13.183	0.04	52.74	90	24.538
5	Aulodrilus limnobius	0						
6	Aulodrilus pigueti	0						
7	Aulodrilus pleuriseta	0						
8	Bithynia tentaculata	9	0.207	0.172	0.04	0.556	90	.
9	Branchiura sowerbyi	6	9.278	21.298	0.169	52.74	90	.
10	Caenis sp	3	5.362	8.997	0.065	15.75	90	.
11	Ceraclea sp	0						
12	Chaetogaster diaphanus	0						
13	Cheumatopsyche sp	0						
14	Chironomus sp	31	1.743	6.861	0.04	38.462	90	2.282
15	Cladopelma sp	0						
16	Cladotanytarsus sp	0						
17	Coelotanypus sp	5	0.583	0.903	0.065	2.185	90	.
18	Cricotopus sp	12	4.116	4.534	0.064	12.451	90	12.05
19	Cricotopus vierriensis	0						
20	Cryptochironomus sp	17	5.053	13.061	0.04	52.74	90	23.148
21	Dicrotendipes sp	6	2.175	5.036	0.051	12.451	90	.
22	Eukiefferiella sp	0						
23	Gammarus fasciatus	29	4.346	11.962	0.04	52.74	90	15.75
24	Glossiphonia heteroclita	1	0.078		0.078	0.078	90	.
25	Glossosoma sp	3	9.38	5.085	3.511	12.451	90	.
26	Glyptotendipes sp	6	1.837	4.349	0.051	10.714	90	.
27	Gyraulus parvus	1	0.067		0.067	0.067	90	.
28	Helisoma anceps	0						
29	Heterotrissocladius sp	0						
30	Hyalella azteca	13	1.782	2.256	0.064	6.579	90	5.766
31	Hydropsyche sp	0						
32	Hydroptila sp	0						
33	Ilyodrilus templetoni	0						
34	Limnodrilus hoffmeisteri	0						
35	Limnodrilus sp	60	4.007	8.865	0.04	52.74	90	11.558
36	Limnodrilus udekemianus	1	9.217		9.217	9.217	90	.
37	Lumbriculus variegatus	0						
38	Manayunkia speciosa	3	0.067	0.011	0.056	0.078	90	.
39	Microtendipes sp	10	0.126	0.159	0.048	0.556	90	0.522
40	Mystacides sp	0						
41	Nais behningi	0						
42	Nais communis	0						
43	Nais variabilus	0						
44	Nanocladius sp	0						
45	Neureclipsis sp	0						
46	Oecetis sp	11	0.195	0.183	0.048	0.556	90	0.54
47	Parachironomus sp	0						
48	Paralauterborniella sp	0						
49	Paratendipes sp	0						
50	Phaenopsectra sp	4	8.685	3.742	3.511	12.451	90	.
51	Phallodrilus sp	0						
52	Physella gyrina	0						

53	Piguetiella michiganensi	0						
54	Pisidium casertanum	0						
55	Pisidium compressum	0						
56	Pisidium conventus	0						
57	Pisidium fallax	0						
58	Pisidium henslowanum	0						
59	Pisidium lilljeborgi	1	6.579		6.579	6.579	90	.
60	Pisidium nitidum	1	0.296		0.296	0.296	90	.
61	Pisidium variabile	0						
62	Pleurocera acuta	0						
63	Polypedilum scalaenum	0						
64	Polypedilum sp	21	4.576	5.463	0.056	15.75	90	12.279
65	Pontoporeia hoyi	0						
66	Potamothrix moldaviensis	0						
67	Potamothrix vejdovskyi	0						
68	Pristina foreli	0						
69	Pristina osborni	0						
70	Procladius sp	46	2.441	3.953	0.04	12.451	90	11.194
71	Prostoma rubrum	0						
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	0						
74	Slavina appendiculata	0						
75	Specaria josinae	0						
76	Sphaerium nitidum	0						
77	Sphaerium striatinum	0						
78	Spirosperma ferox	0						
79	Stenonema sp	0						
80	Stictochironomus sp	2	0.317	0.337	0.078	0.556	90	.
81	Stylaria lacustris	3	2.417	3.605	0.336	6.579	90	.
82	Stylodrilus heringianus	1	1.923		1.923	1.923	90	.
83	Tanytarsus sp	2	0.303	0.044	0.272	0.333	90	.
84	Thienemannimyia sp	0						
85	Tubifex sp	36	4.327	7.349	0.051	38.462	90	11.847
86	Turbellaria	0						
87	Uncinais uncinata	0						
88	Valvata sincera	1	0.067		0.067	0.067	90	.
89	Valvata tricarinata	9	0.898	2.137	0.051	6.579	90	.
90	Vejdovskyella intermedia	0						
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	4	0.069	0.006	0.064	0.074	90	.
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	13	0.545	0.815	0.04	2.188	90	2.187
97	Hexagenia limbata	2	1.253	1.486	0.202	2.304	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	0						

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APPENDIX II - FIGURES

Calculation of the 5th and 95th Percentiles of the Species Screening Level Concentrations

- Concentrations are expressed on the basis of unit mass per mass of organic carbon.
- Species numbers correspond to those in the tables in Appendix I

Fig 1. SLC Graph For Aldrin

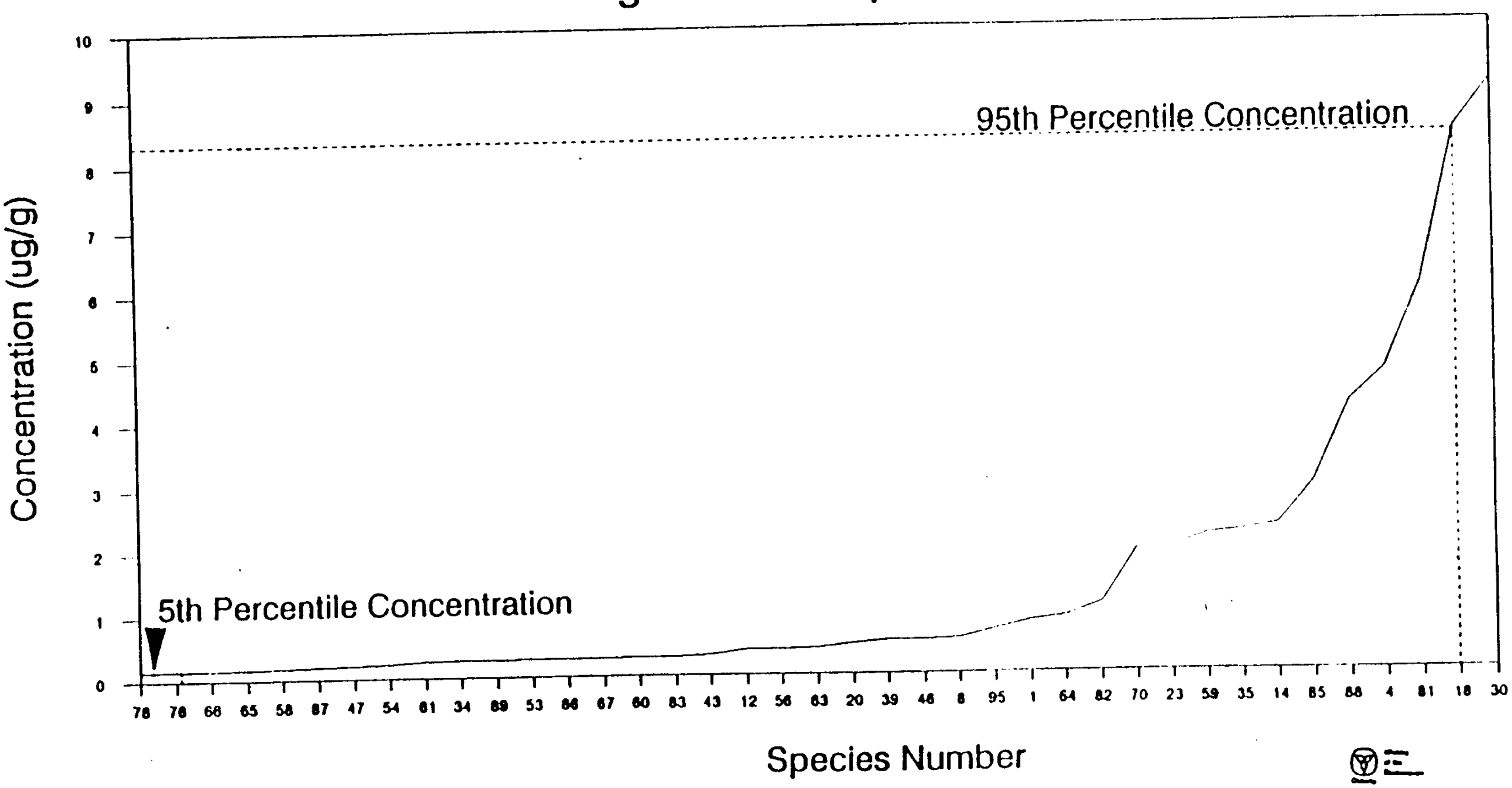


Fig 2. SLC Graph For Total Benzene Hexachloride (BHC)

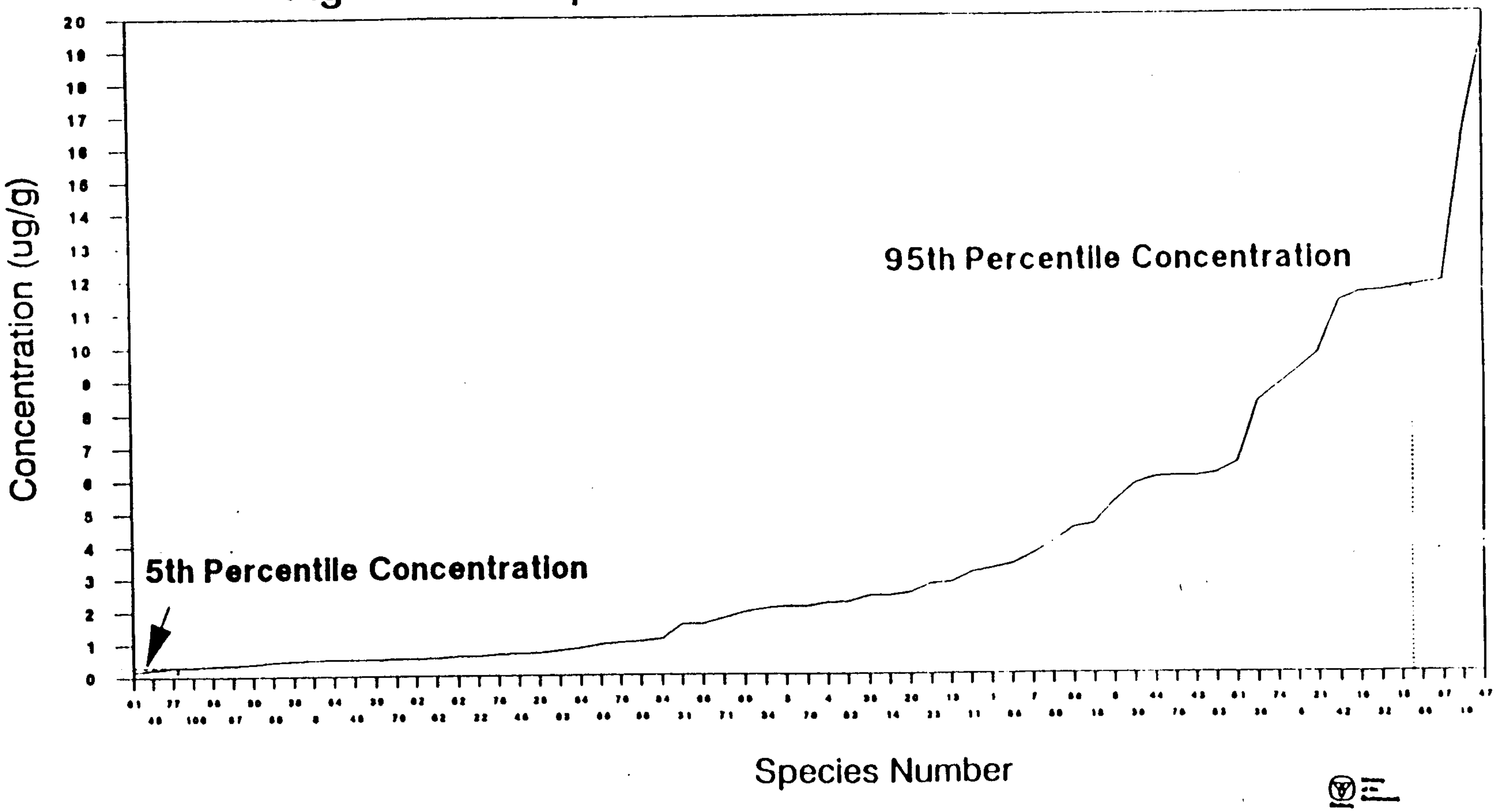


Fig 2a. SLC Graph For α-BHC

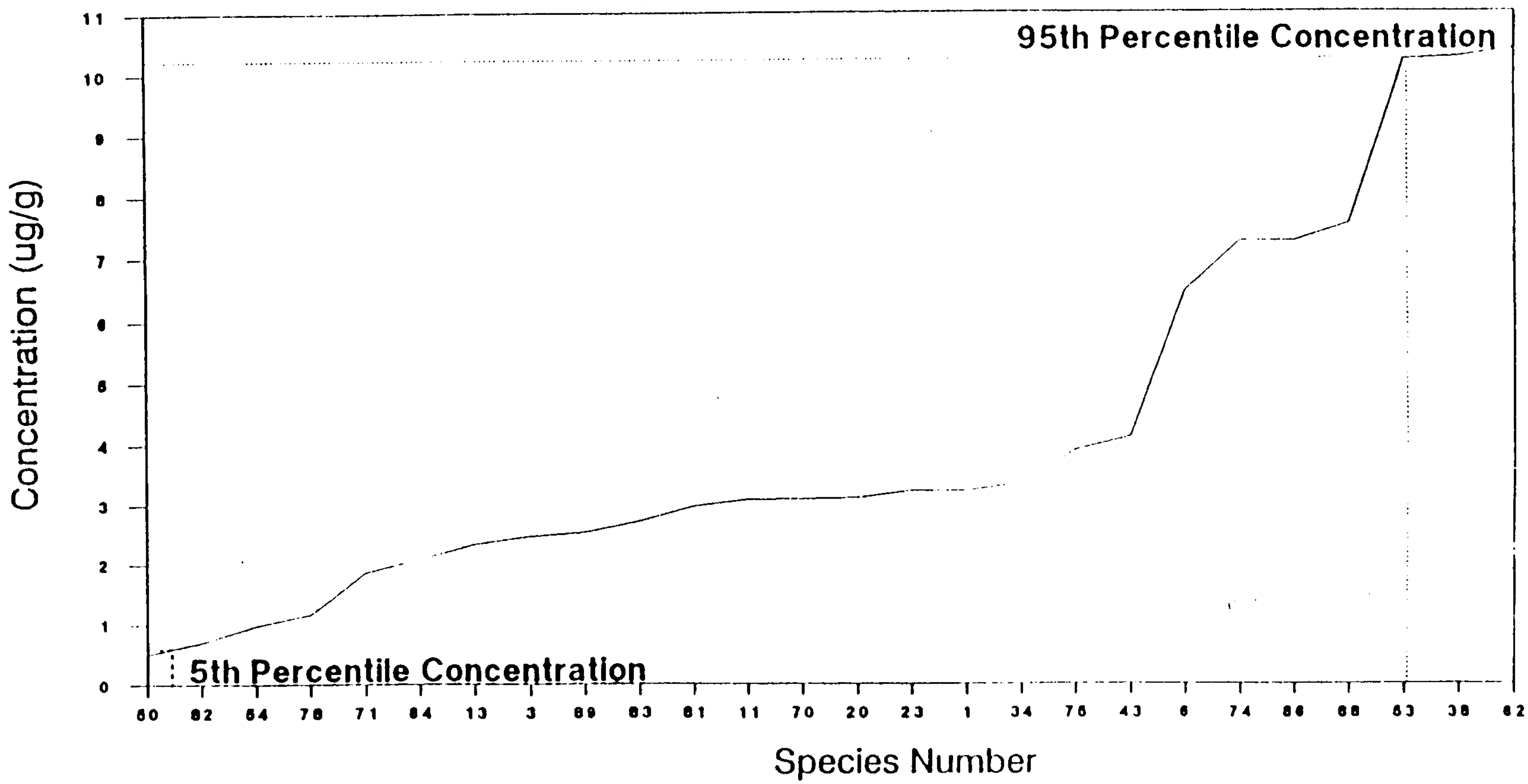


Fig 2b. SLC Graph For ß-BHC

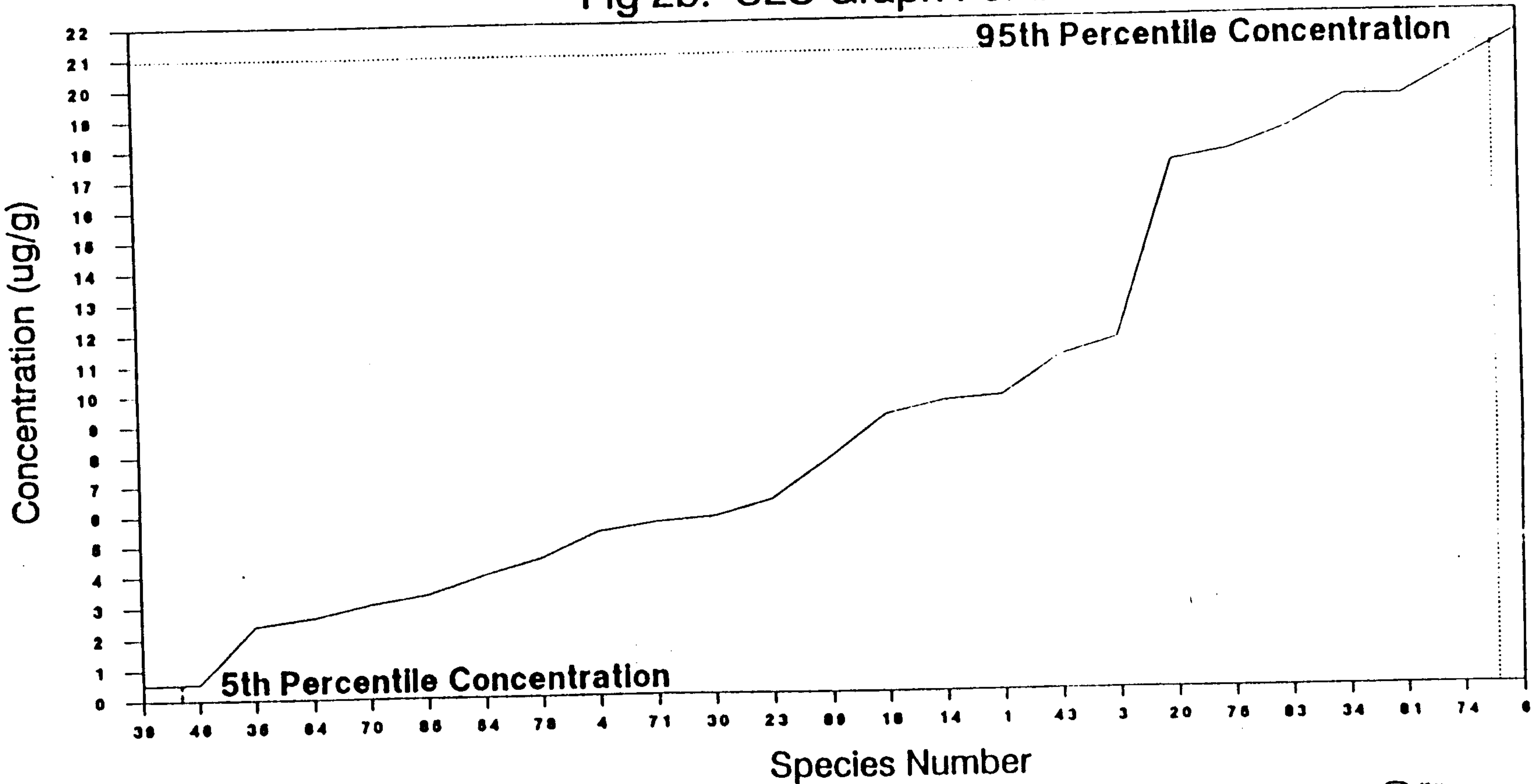


Fig 2c. SLC Graph For ɣ-BHC

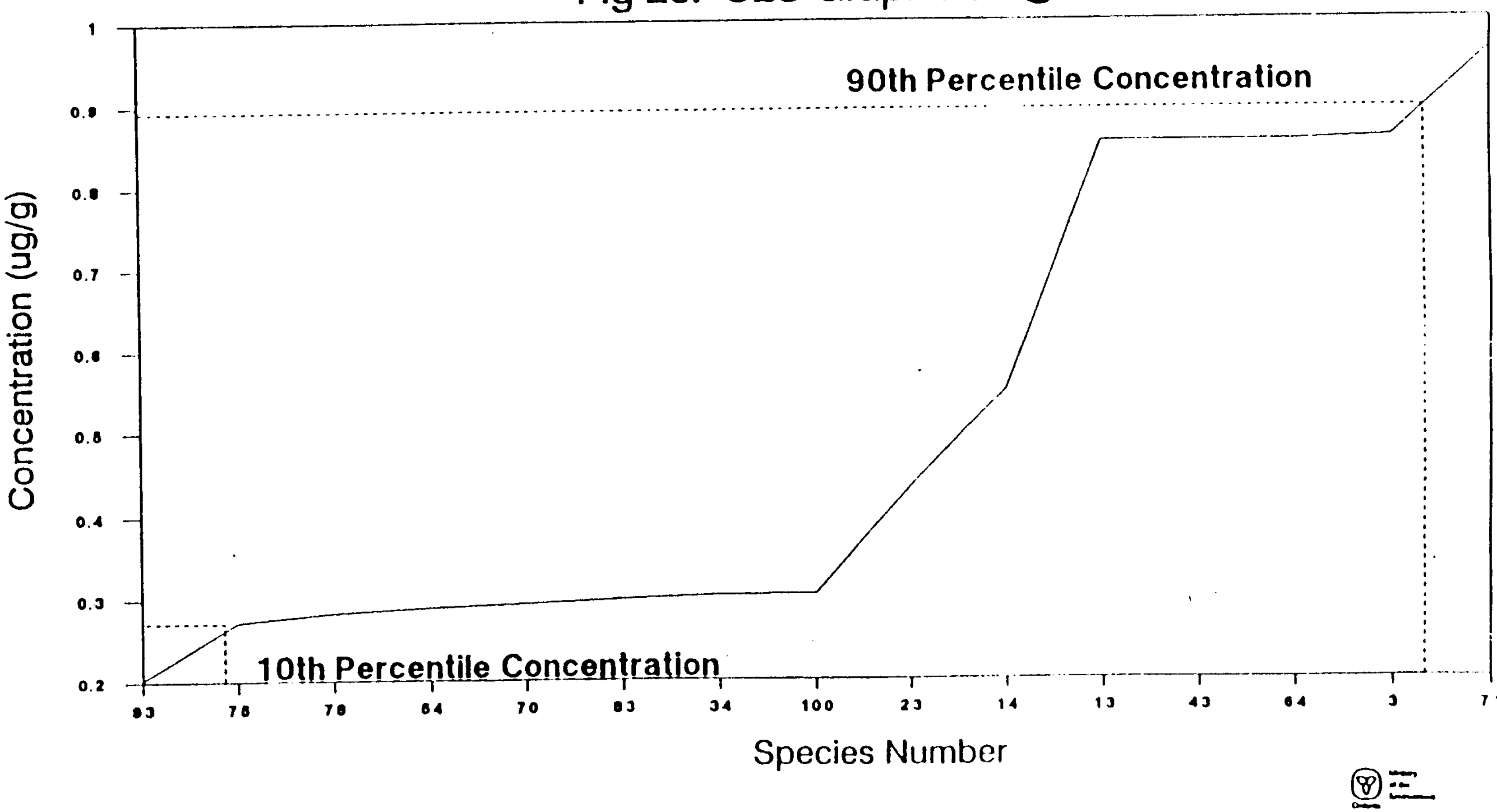


Fig 3. SLC Graph For Chlordane

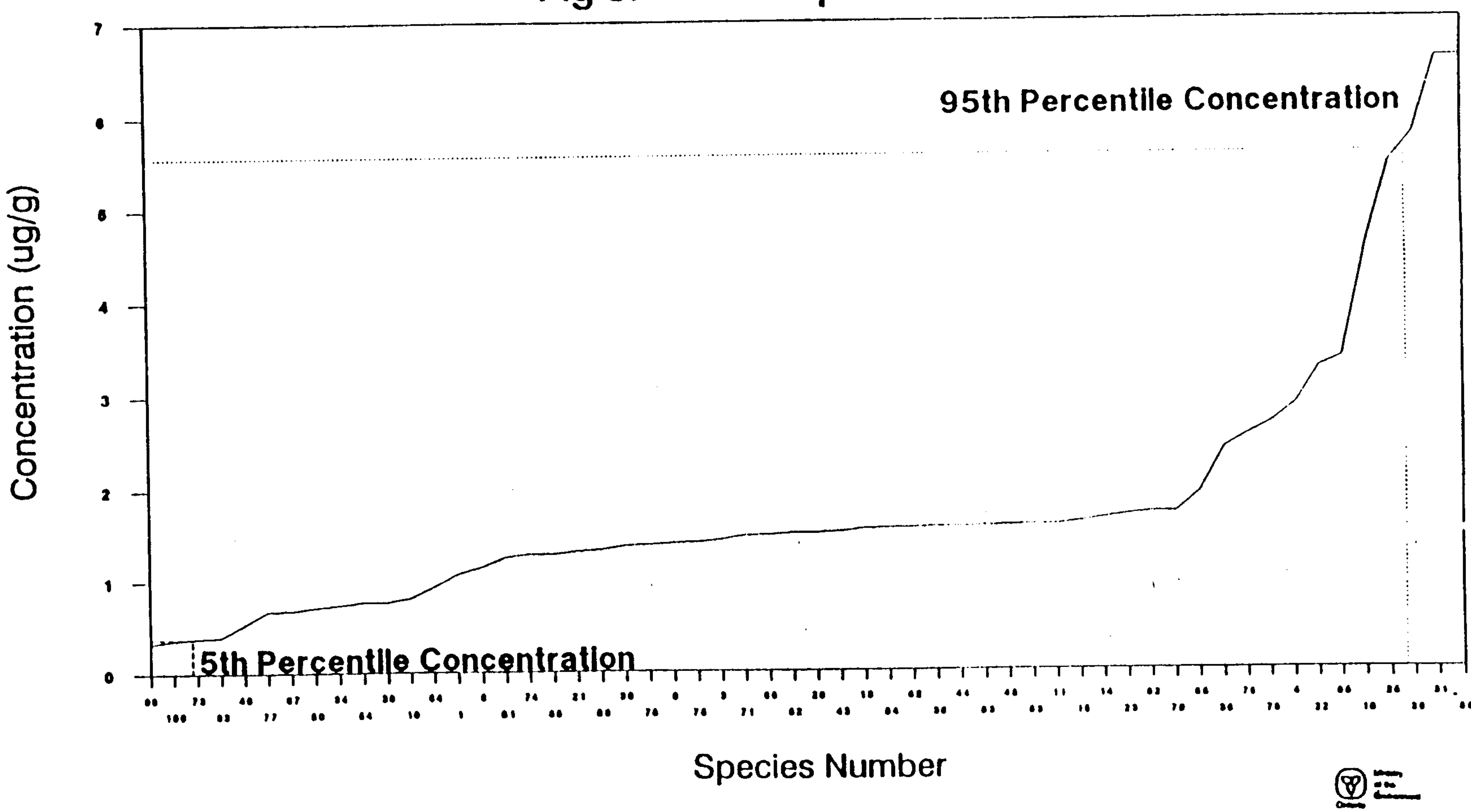


Fig 4. SLC Graph For Total DDT

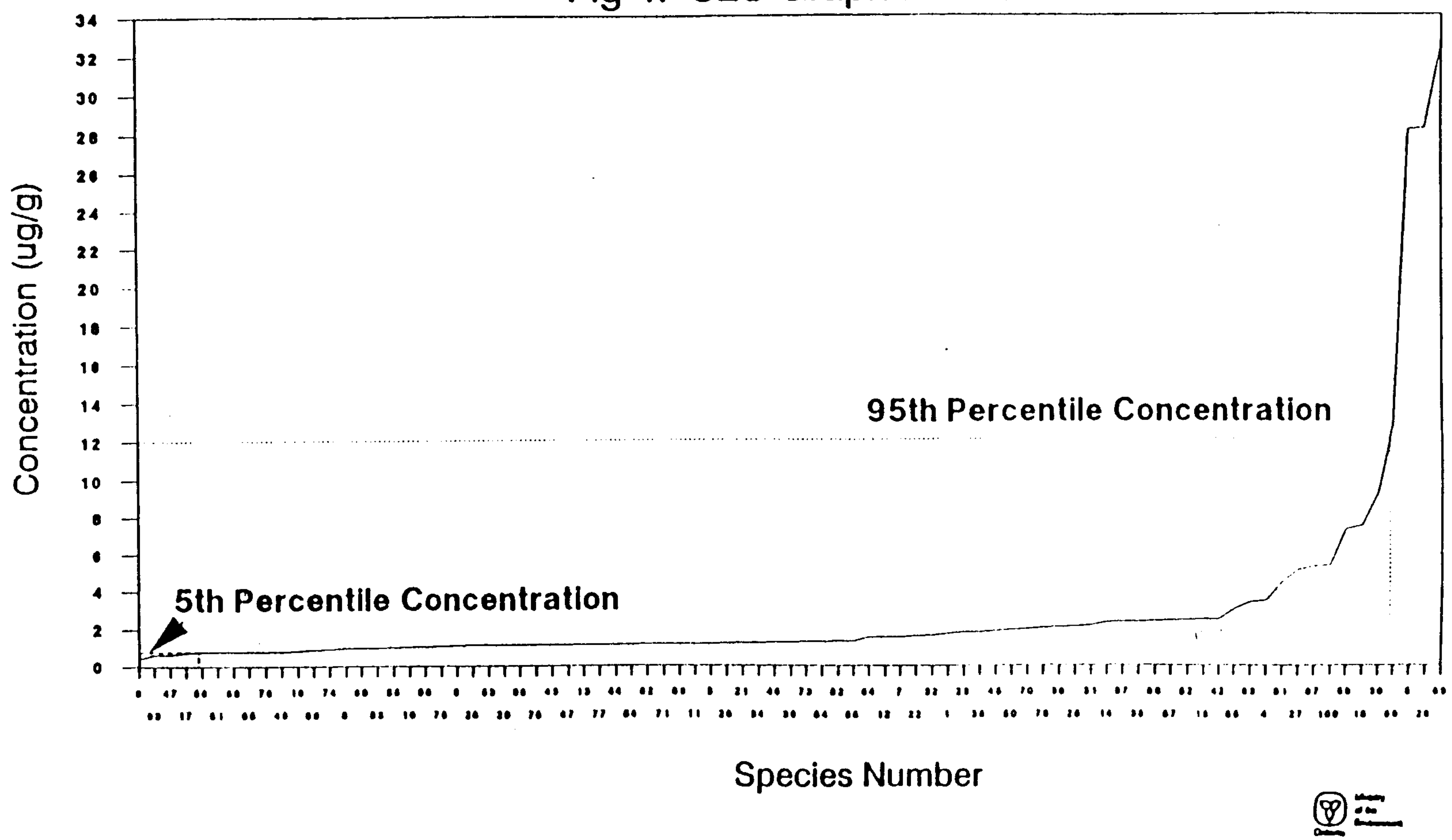


Fig. 4a. SLC Graph for o,p´+p,p´-DDT

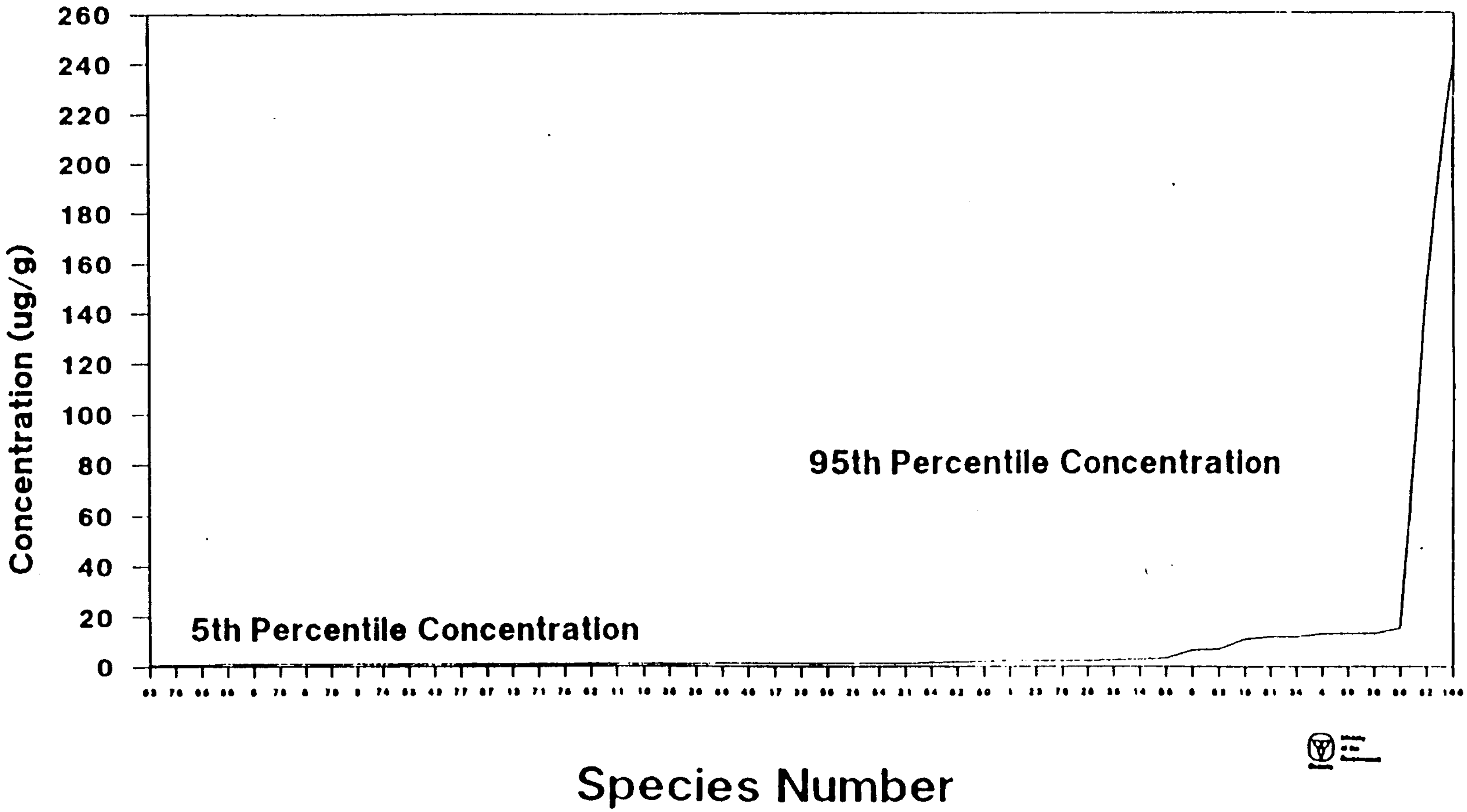


Fig 5. SLC Graph For p,p´-DDD

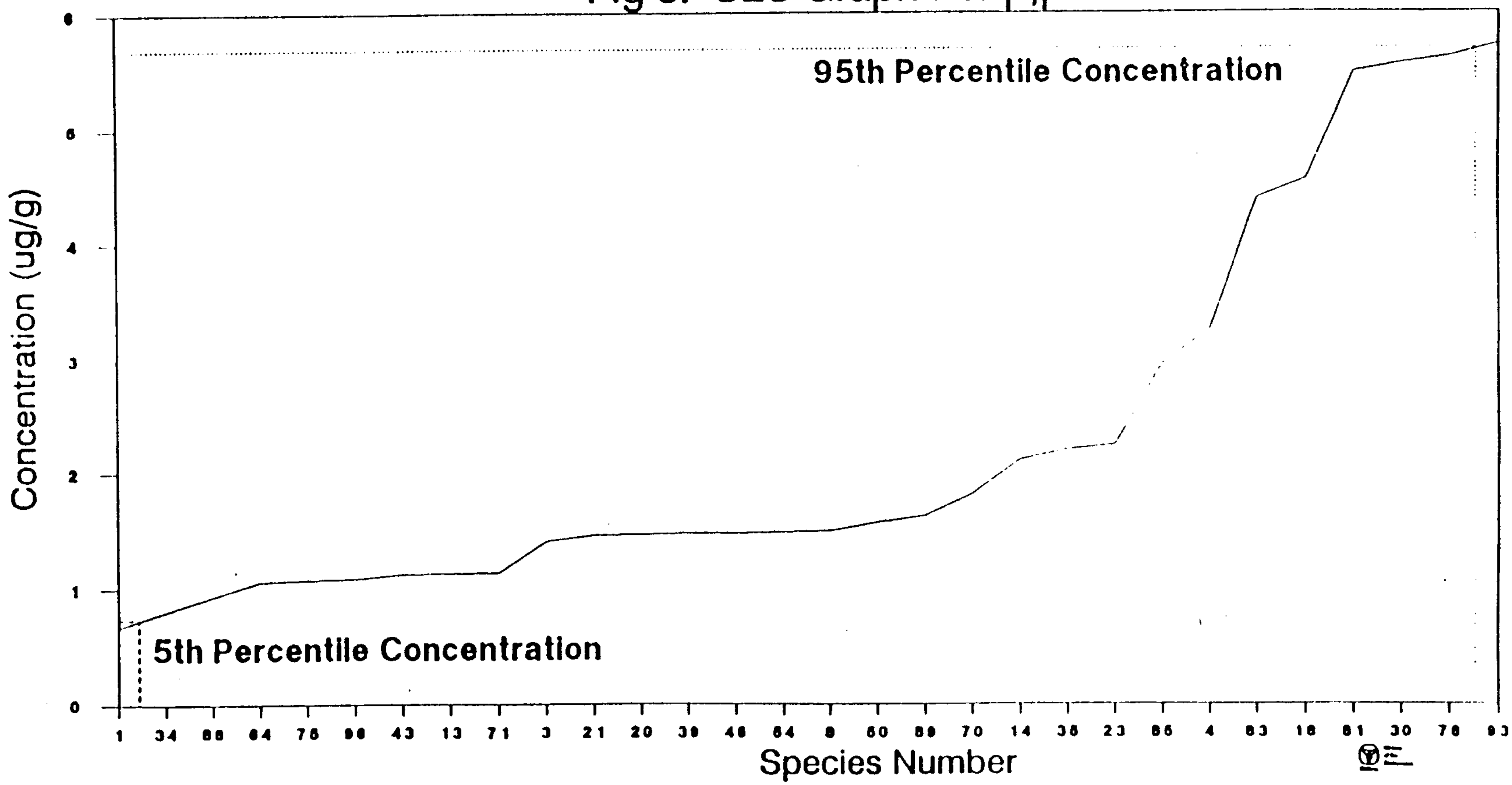


Fig 6. SLC Graph For p,p′-DDE

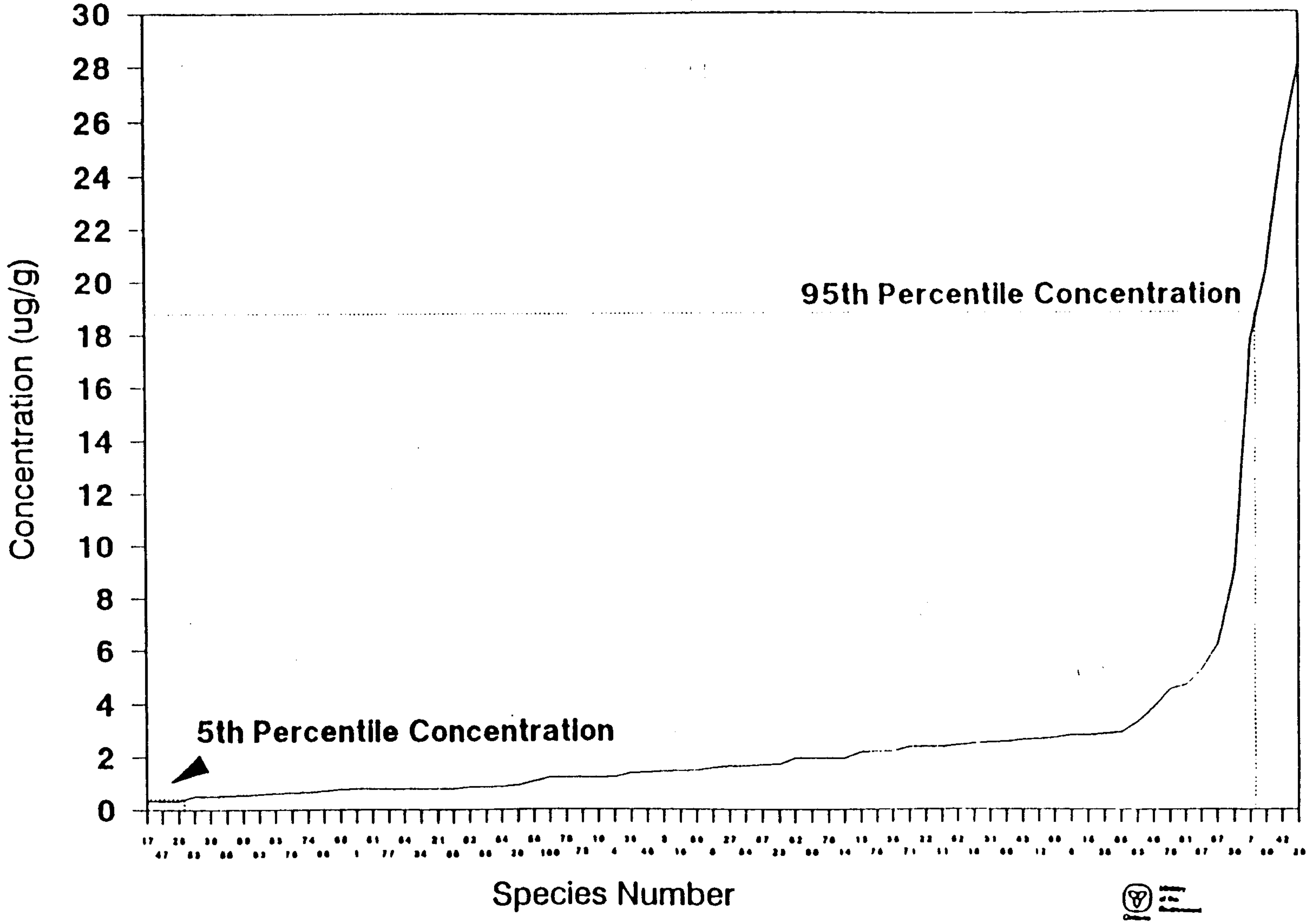


Fig 7. SLC Graph For Dieldrin

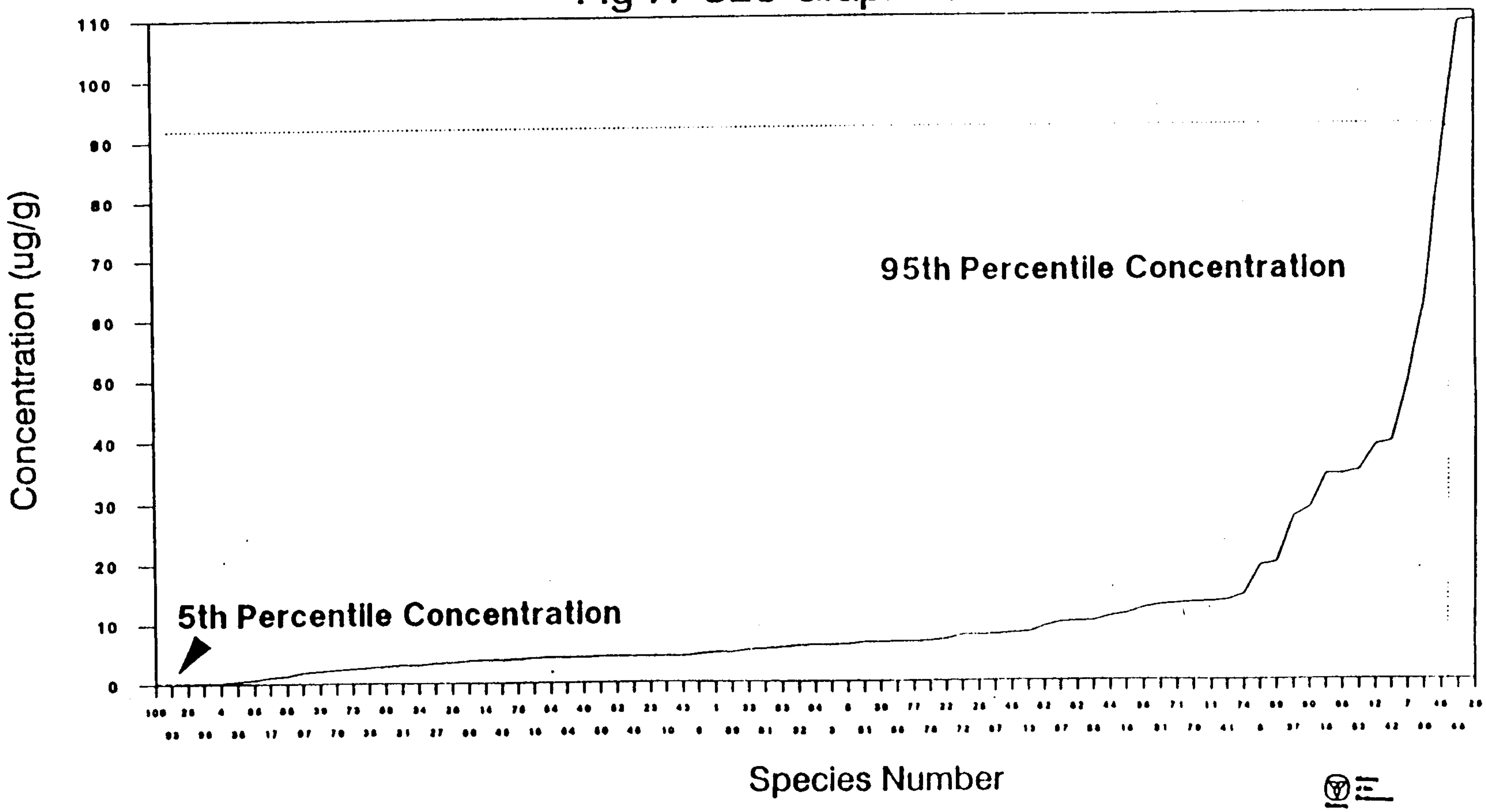


Fig 8. SLC Graph For Endrin

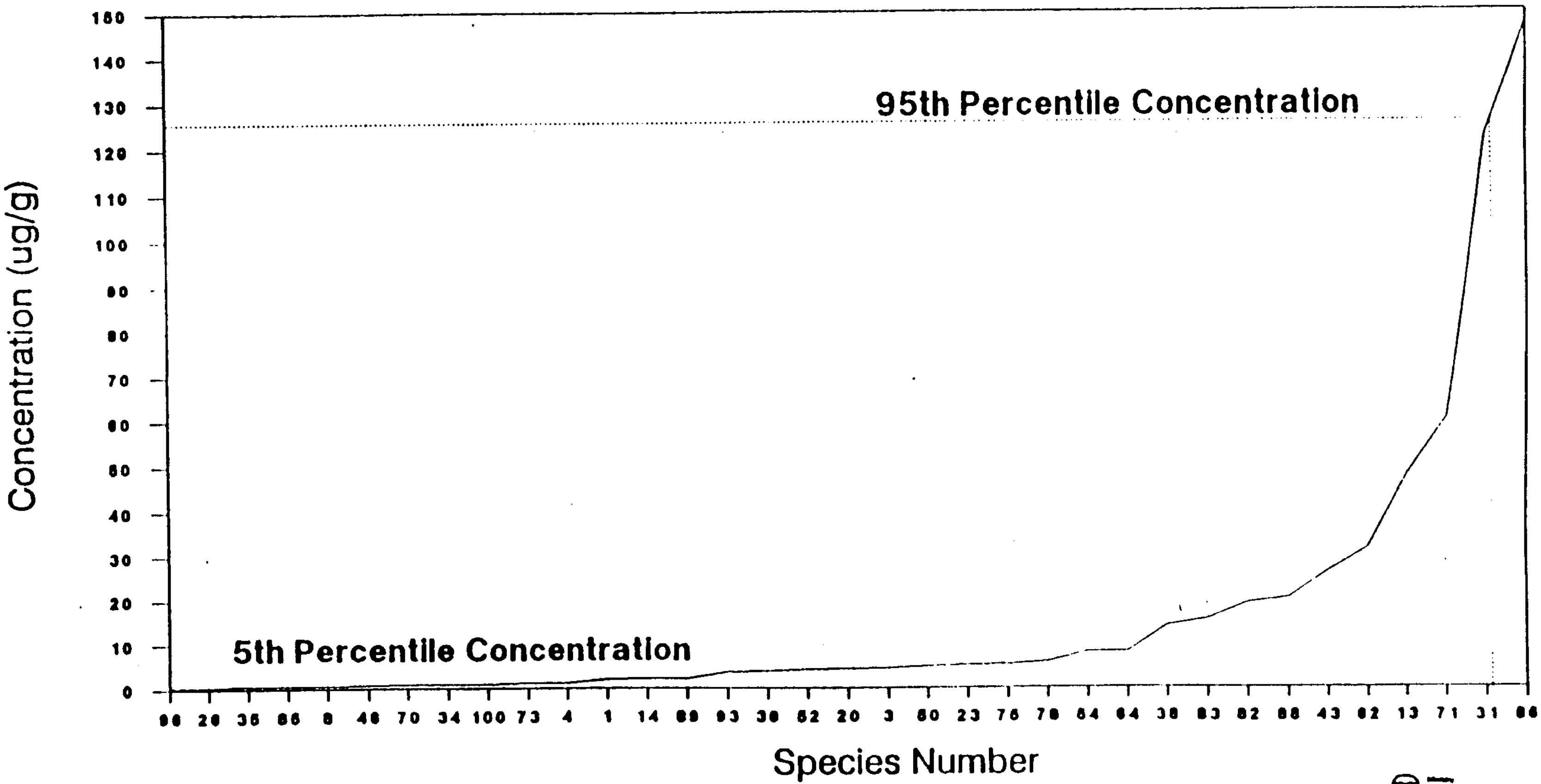
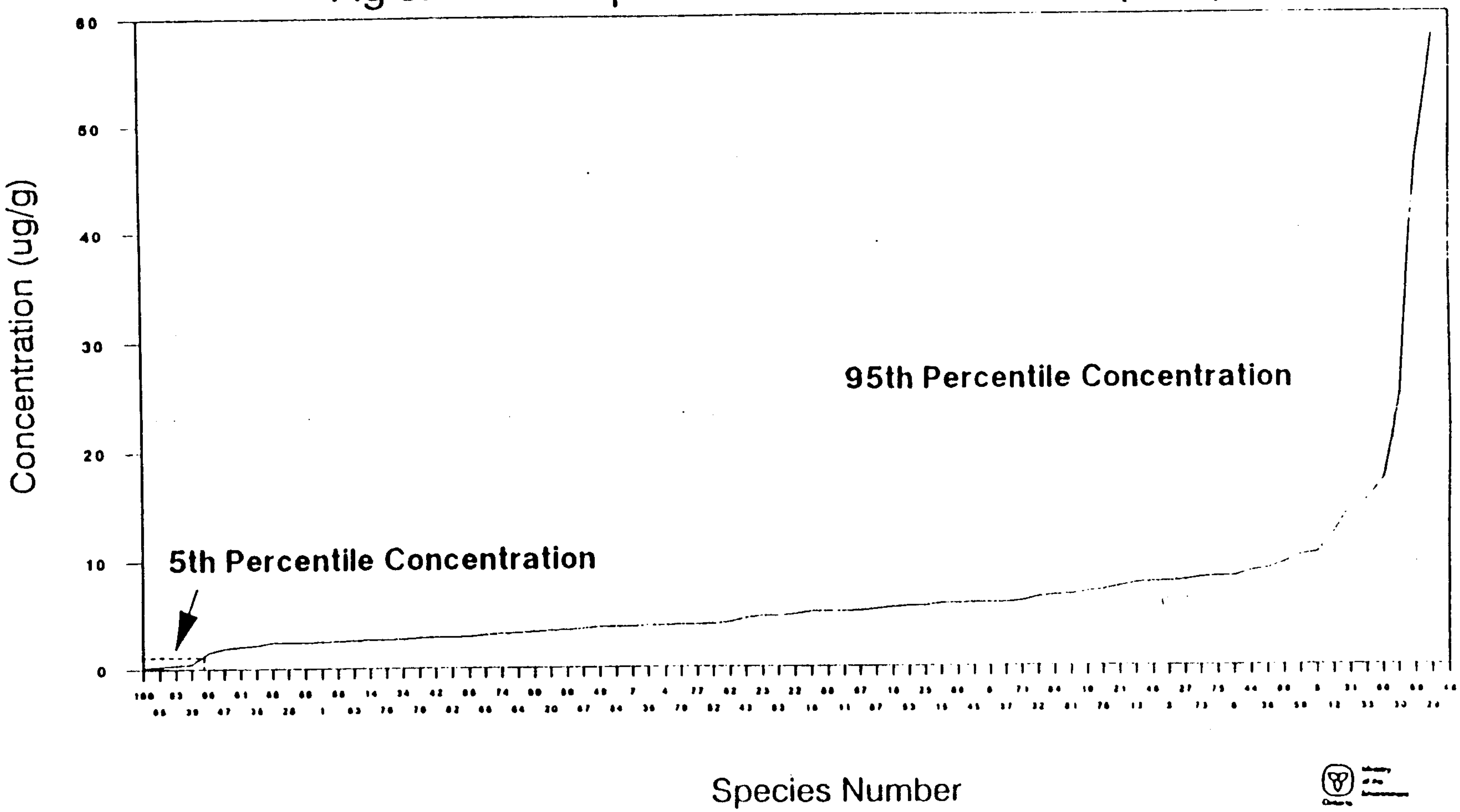


Fig 9. SLC Graph For Hexachlorobenzene (HCB)



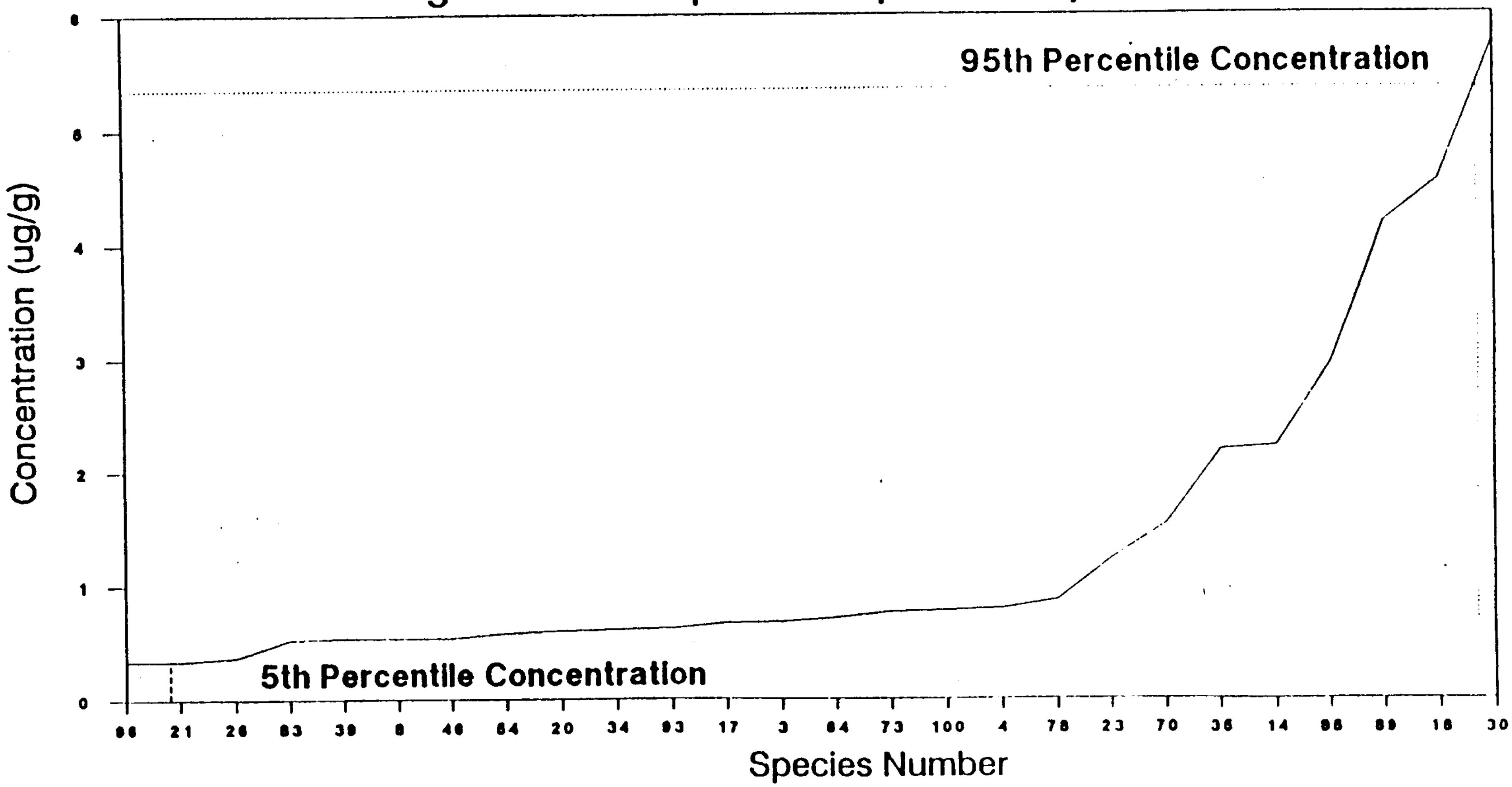


Fig 10. SLC Graph For Heptachlor Epoxide

Fig 11. SLC Graph For Mirex

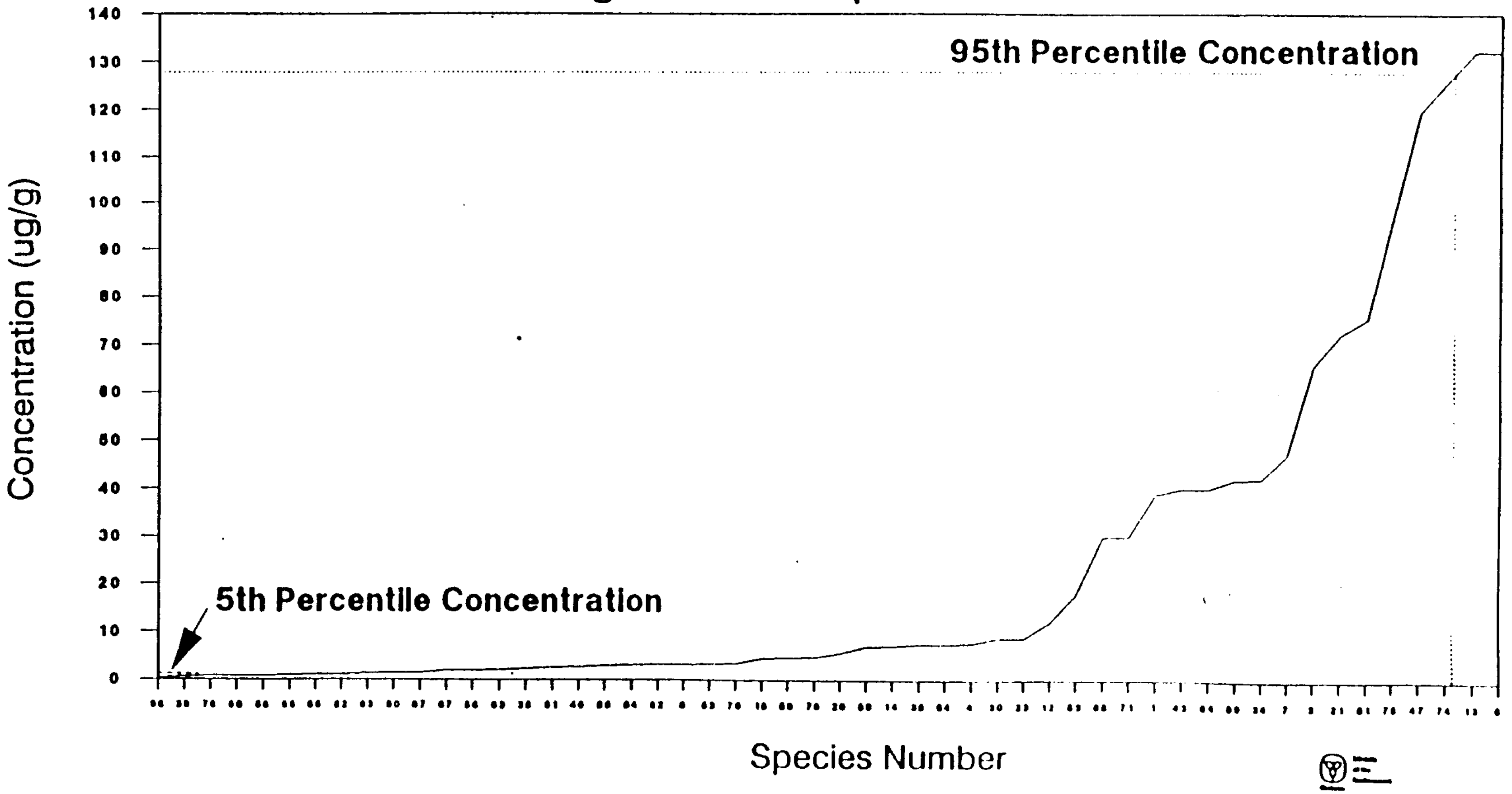


Fig 12. SLC Graph For Total PCB

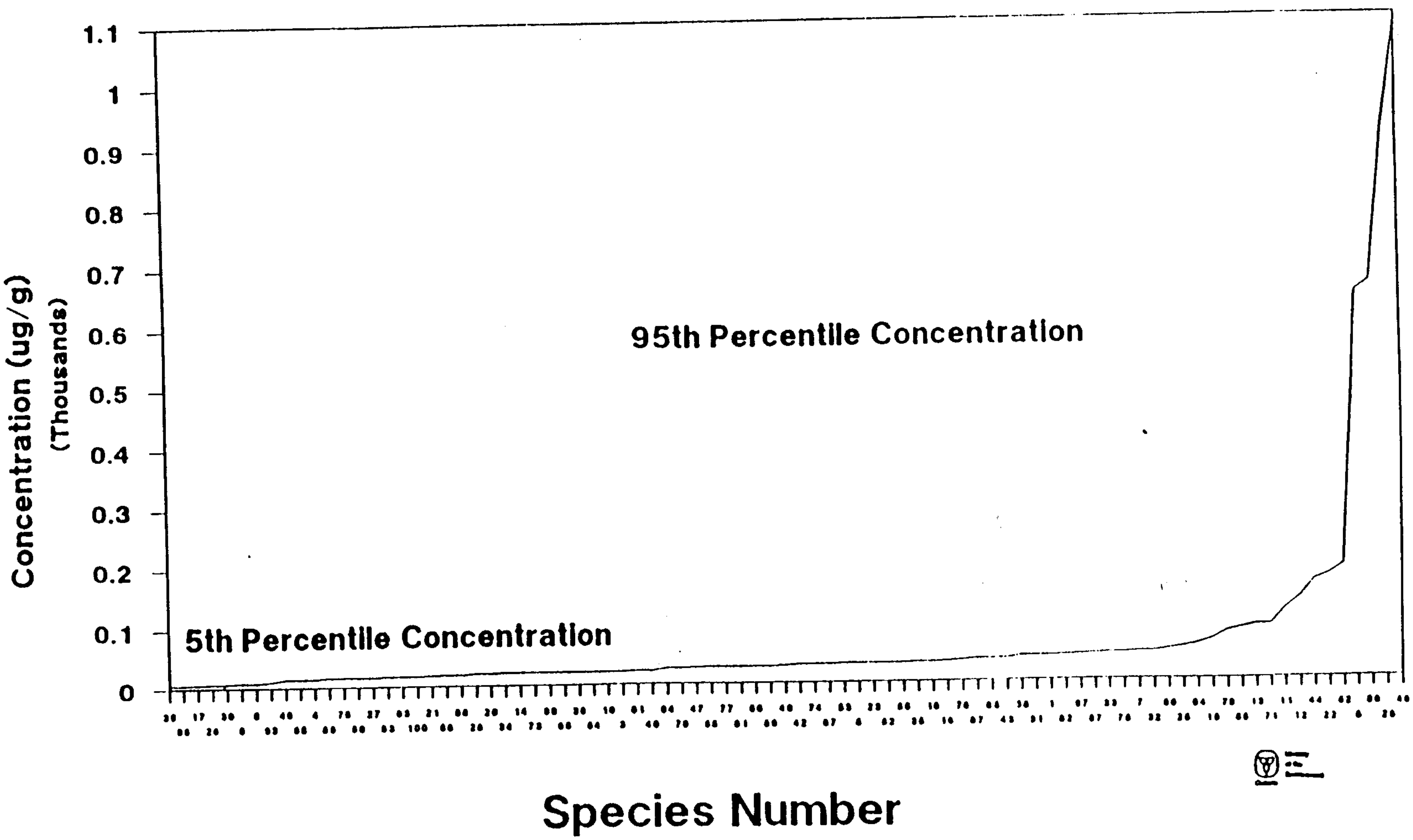


Fig 12a. SLC Graph For PCB-1254

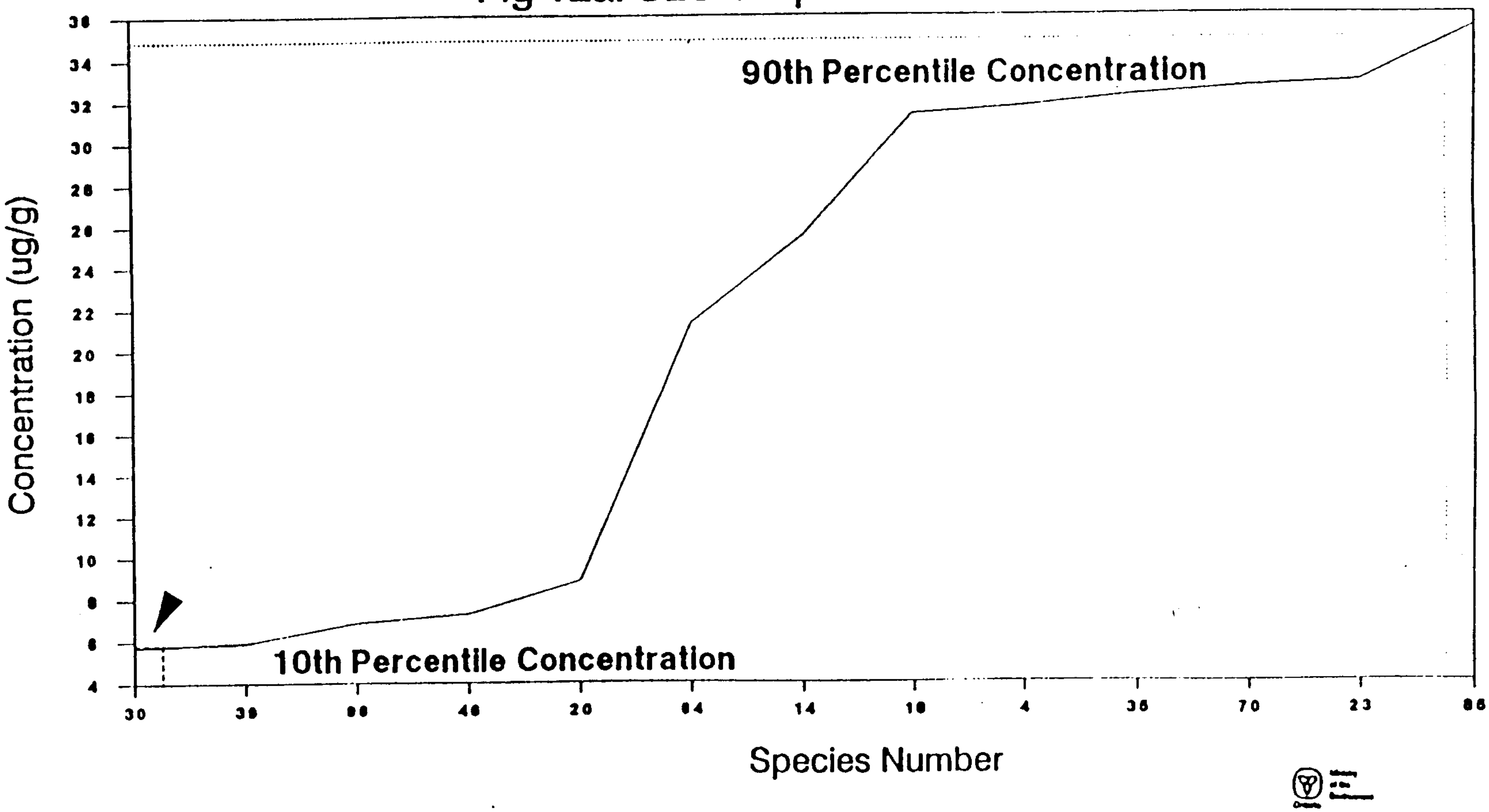


Fig 12b. SLC Graph For PB-1016

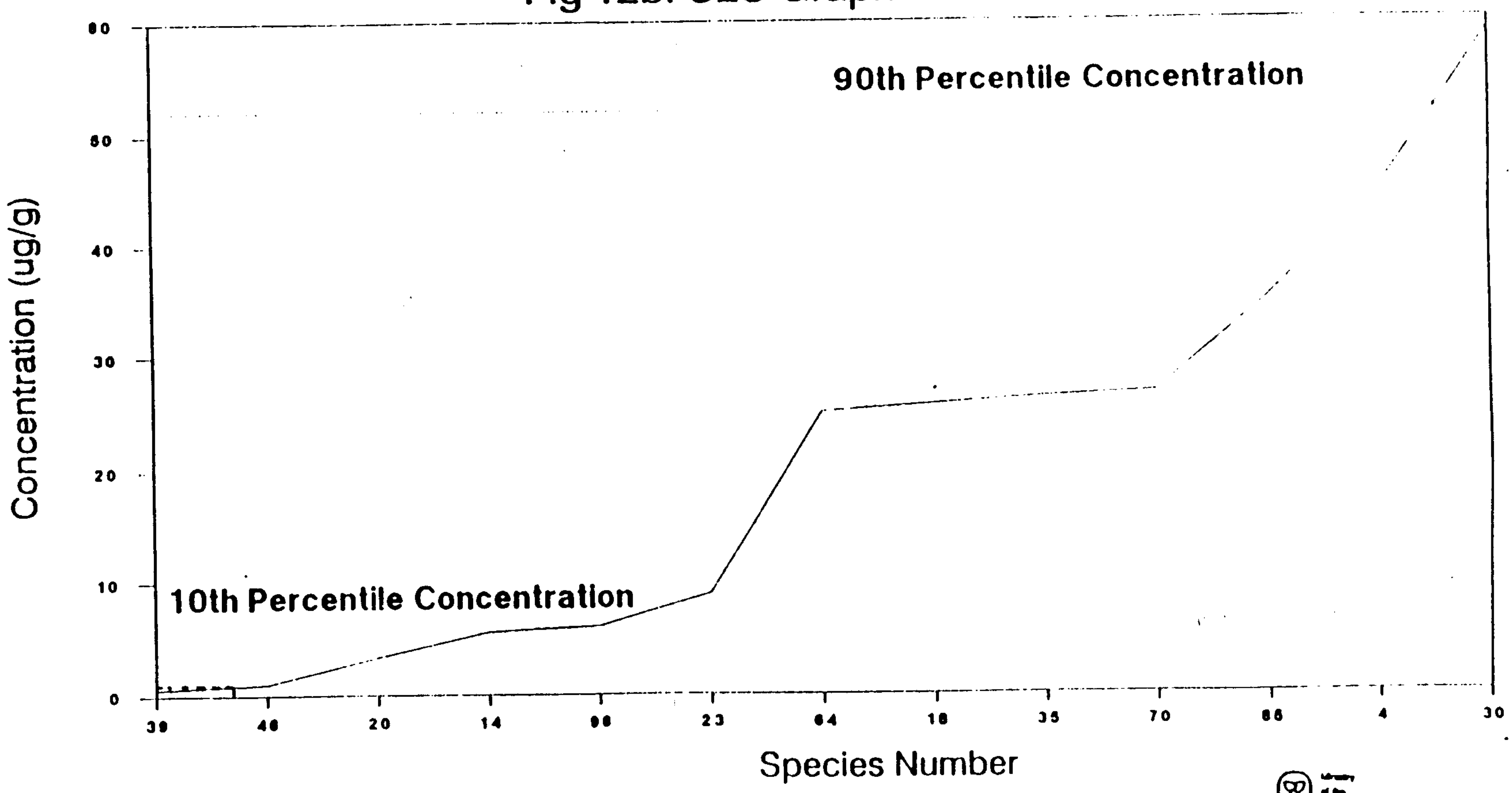
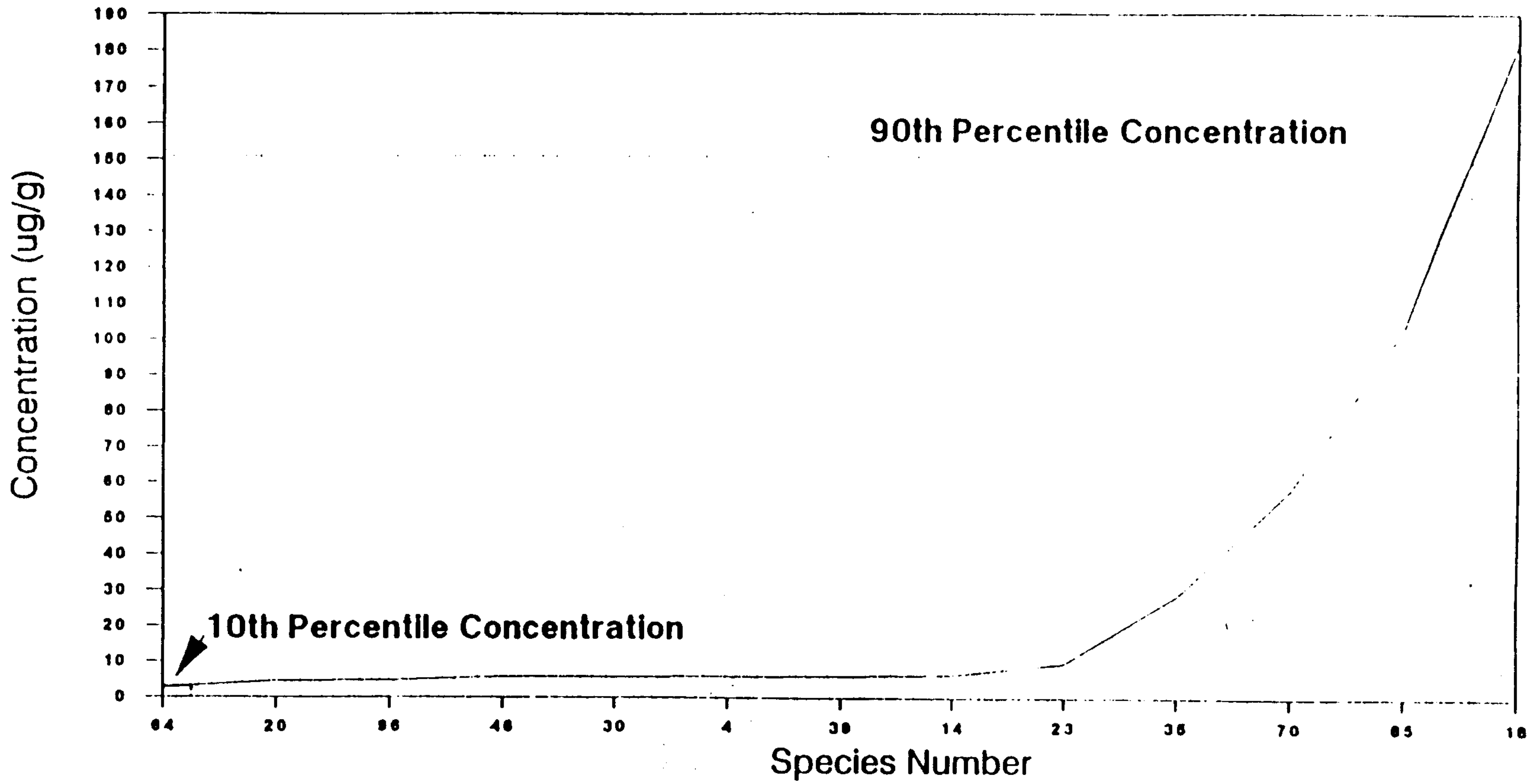


Fig 12c. SLC Graph For PCB-1248



53	Piguetiella michiganensi	0						
54	Pisidium casertanum	0						
55	Pisidium compressum	0						
56	Pisidium conventus	0						
57	Pisidium fallax	0						
58	Pisidium henslowanum	0						
59	Pisidium lilljeborgi	1	6.579		6.579	6.579	90	.
60	Pisidium nitidum	1	0.296		0.296	0.296	90	.
61	Pisidium variabile	0						
62	Pleurocera acuta	0						
63	Polypedilum scalaenum	0						
64	Polypedilum sp	21	0.617	1.045	0.074	4.167	90	2.626
65	Pontoporeia hoyi	0						
66	Potamothrix moldaviensis	0						
67	Potamothrix vejdovskyi	0						
68	Pristina foreli	0						
69	Pristina osborni	0						
70	Procladius sp	45	14.216	44.875	0.078	248.077	90	57.62
71	Prostoma rubrum	0						
72	Pseudocloeon sp	0						
73	Quistadrilus multisetosu	0						
74	Slavina appendiculata	0						
75	Specaria josinae	0						
76	Sphaerium nitidum	0						
77	Sphaerium striatinum	0						
78	Spirosperma ferox	0						
79	Stenonema sp	0						
80	Stictochironomus sp	2	1.377	1.161	0.556	2.198	90	.
81	Stylaria lacustris	3	2.417	3.605	0.336	6.579	90	.
82	Stylodrilus heringianus	1	248.077		248.077	248.077	90	.
83	Tanytarsus sp	2	0.303	0.044	0.272	0.333	90	.
84	Thienemannimyia sp	0						
85	Tubifex sp	36	18.484	49.812	0.078	248.077	90	102.968
86	Turbellaria	0						
87	Uncinais uncinata	0						
88	Valvata sincera	1	1.469		1.469	1.469	90	.
89	Valvata tricarinata	9	2.317	2.565	0.161	6.579	90	.
90	Vejdovskyella intermedia	0						
91	Elliptio complanata	0						
92	Sphaerium simile	0						
93	Chironomus plumosus	4	0.069	0.006	0.064	0.074	90	.
94	Cricotopus bicinctus	0						
95	Ephemera sp	0						
96	Helobdella stagnalis	12	1.413	1.606	0.174	5.565	90	4.763
97	Hexagenia limbata	2	50.792	71.545	0.202	101.382	90	.
98	Hexagenia sp	0						
99	Tanypus sp	0						
100	Tubifex tubifex	0						

Fig 12d. SLC Graph For PCB-1260