Biological, Fish Tissue, and Sediment Study of the Ottawa River

Dura Avenue Landfill 1996

Lucas County, Ohio

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OEPA Technical Report MAS/1997-12-8

prepared for

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NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio’s surface water resources.

The following Ohio EPA documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Division of Water Qual. Mont. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Qual. Mont. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Qual. Plan. & Assess., Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Division of Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Division of Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Since the publication of the preceding guidance documents new publications by Ohio EPA have become available. The following publications should also be consulted as they represent the latest information and analyses used by Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995a. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995b. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

These documents and this report can be obtained via the Ohio EPA web site at www.epa.state.oh.us or by writing to;

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FOREWORD

What is a Biological and Water Quality Survey?
A biological and water quality survey, or "biosurvey" is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which uses assigned under the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in the ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed into information and then synthesized into this report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are addressed as well.

The findings and conclusions of a biological water quality study may factor into regulatory actions taken by Ohio EPA (*e.g.,* NPDES permits, Director's Orders), the Ohio Water Quality Standards (OAC 3745-1), and are eventually incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Ohio Water Resource Inventory (305[b] report).

Hierarchy of Indicators
A carefully conceived ambient monitoring approach, which uses cost-effective indicators comprised of ecological, chemical, toxicological measures, can ensure that all relevant pollution sources are judged objectively and on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. Such an integrated approach is outlined in Figure I and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response and are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

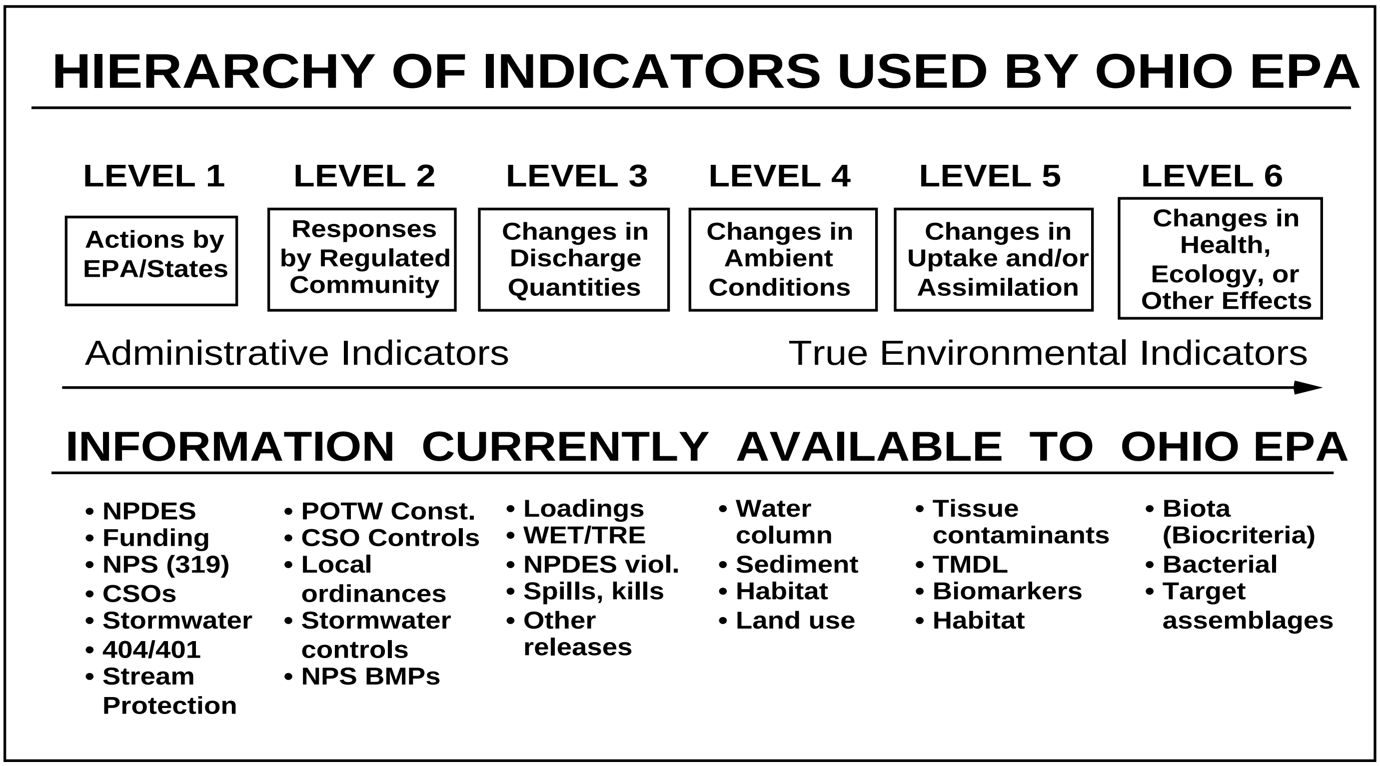

Figure I. Hierarchy of administrative and environmental indicators used by Ohio EPA for monitoring, assessment, reporting, and evaluating program effectiveness. This continuum is patterned aftera model developed by U.S. EPA.

In describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including the water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Ohio Water Resource Inventory (305[b] report, the Ohio Nonpoint Source Assessment, and technical bulletins covering a variety of subjects.

Ohio Water Quality Standards: Designated Aquatic Life Uses

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Five different aquatic life uses are currently defined in the Ohio WQS:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5)*Limited Resource Water (LRW)* - this use applies to streams (usually <3 $mi.^2$ drainage area) which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such streams generally includes small streams in extensively urbanized areas, small streams which lie in watersheds with extensive drainage modifications, and/or small streams which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams).

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The two recreation uses which are the most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.,* fecal coliforms, *E. Coli)* and the criteria for each as specified in the Ohio WQS.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be not designating AWS in an urban area where livestock watering or pasturing does not take place. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health outside of this report.

ACKNOWLEDGEMENTS

The following Ohio EPA staff are acknowledged for their significant contribution to this report.

Coordinator - Bernie Counts
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Macroinvertebrate Data Analysis - Bernie Counts
Reviewers - Chris Yoder, Jeff DeShon, and Marc Smith

Support during field collections was provided by Chris Skalski, Vanessa Steigerwald, Tim Christman, and Paul Jayko.

Biological, Fish Tissue, and Sediment Study of the Ottawa River (Lucas County, Ohio)

Ohio Environmental Protection Agency
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INTRODUCTION

The Ottawa River study area included the mainstem from the first railroad trestle upstream from Dura Avenue Landfill (RM 5.8) to Stickney Avenue (RM 5.2) and Sibley Creek from Lagrange Street (RM 0.8) to the mouth.

Specific objectives of this evaluation were:

1) look for improvements in sediment, fish tissue, and biological community conditions following installation of the Interim Remedial Measure Barrier Wall and leachate collection and treatment system in the Southeast Chemical Disposal Area of the Dura Avenue Landfill,

2) determine the attainment status of the current WWH aquatic life use designation for the Ottawa River and Sibley Creek within the study area,

3) identify the relative significance of Dura Avenue Landfill site contaminants on any demonstrated impairment of the Ottawa River and Sibley Creek biological communities and sediment quality,

4) follow-up on conditions documented in previous Ohio EPA studies.

The Ottawa River watershed is in the Huron-Erie Lake Plain (HELP) ecoregion. The aquatic life use in the Ottawa River currently is Warmwater Habitat (WWH). The aquatic life use of Sibley Creek has been recommended as Limited Resource Water (LRW) based on data collected in 1993. The Ottawa River in the lower nine miles exhibits lacustuary conditions. A lacustuary is defined as a transition zone in a river that flows into a large freshwater lake and is continuously affected by the water levels in the lake. At lacustuary sampling locations, the fish and macroinvertebrate communities were assessed using lacustuary biocriteria being developed by the Ohio EPA.

SUMMARY / CONCLUSIONS

- Biological community sampling of the macroinvertebrates and fish, summarized below, demonstrated positive, albeit incremental, results from the installation of the remedial barrier wall. However, a multitude of problems remain to be addressed including other measures needed at the Dura Avenue Landfill, high contaminant levels in sediments, and leachate seeps from the Stickney Avenue Landfill. There are also problems beyond the immediate area of the Dura Avenue Landfill including periodic CSO discharges containing industrial effluents.

- Macroinvertebrate communities in the Ottawa River were in the very poor range with indications that nutrient enrichment was the primary cause of impairment, but also mixed with signs of continued toxic impacts. Conditions in Sibley Creek ranged from poor to very poor with upstream conditions indicative of acutely toxic conditions.

- Fish communities in the Ottawa River were in the poor range. Although improvements were indicated relative to past results, substantial biological degradation still persists. The continued influence of multiple stressors was evidenced by high incidences of external DELT anomalies. Sibley Creek at Lagrange Street was completely devoid of fish indicating acutely toxic conditions. Conditions at the mouth of Sibley Creek improved but were still in the poor range.

- There were a number of semivolatile organic compounds and PCBs that exceeded their Lowest Effect Level (LEL) concentrations (Table 3) in collected sediments. The PCB congener 1242 exceeded the LEL in seven of eight samples collected. The Ohio Department of Health has issued a contact advisory for the Ottawa River from I-475 north of Wildwood Preserve Metropark (Tenmile Creek) to Maumee Bay (Ohio Department of Health 1997).

- Eleven of the twelve fish tissue samples collected exceeded the Ohio WQS criterion for total PCBs (0.64 ppm); values ranged from 0.13 to 510 ppm. Nine samples showed concentrations of PCB 1242 considered extremely elevated. The Ohio Department of Health has issued a fish consumption advisory for the Ottawa River from I-475 north of Wildwood Preserve Metropark (Tenmile Creek) to Maumee Bay (Ohio Department of Health 1997).

RECOMMENDATIONS

- Biological community, fish tissue, and sediment sampling should be conducted following completion of specific remedial activities to evaluate the effectiveness of these measures.

- Numerous areas with dead vegetation along the Stickney Avenue Landfill bank need to be assessed as sources of contaminants.

Table 1. Sampling locations from the Ottawa River study area, 1996. Type of sampling included fish community (F), macroinvertebrate community (M), fish tissue (T), and sediment (S).

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark	County	USGS 7.5 min. Quad. Map
Ottawa River						
5.78	S	41°41’37”	83°32’05”	Near RR Bridge/ River Right, Ust. Dura	Lucas	Toledo, OH
5.73	S	41°41’39”	83°32’05”	Near RR Bridge/ River Left, Ust. Dura	Lucas	Toledo, OH
5.7	F,M,T	41°41’41”	83°32’03”	Ust. Dura Ave. Landfill	Lucas	Toledo, OH
5.5	F,M,T	41°41’48”	83°31’49”	Adj. Dura Ave. Landfill	Lucas	Toledo, OH
5.45	S	41°41’48”	83°31’49”	Adj. IRM Barrier Wall/ River Left	Lucas	Toledo, OH
5.43	S	41°41’47”	83°31’49”	Across from IRM Barrier Wall/ River Right	Lucas	Toledo, OH
5.3	F,M,T	41°41’57”	83°31’47”	Dst. Dura Ave. Landfill	Lucas	Toledo, OH
5.22	S	41°41’59”	83°31’47”	Dst. Dura Ave. Landfill/ River Left	Lucas	Toledo, OH
5.20	S	41°42’00”	83°31’46”	Dst. Dura Ave. Landfill/ River Right	Lucas	Toledo, OH
Sibley Creek						
0.82	S	41°41’45”	83°32’51”	Lagrange Rd.	Lucas	Toledo, OH
0.8	F,M	41°41’45”	83°32’51”	Lagrange Rd.	Lucas	Toledo, OH
0.1	F,M,T	41°41’48”	83°32’04”	Near Mouth/ Adj. Dura Ave. Landfill	Lucas	Toledo, OH
0.04	S	41°41’48”	83°32’01”	Near Mouth/ Adj. Dura Ave. Landfill	Lucas	Toledo, OH

Table 2. Attainment status of existing or recommended aquatic life uses for the Ottawa River and Sibley Creek based on data collected from August-October, 1996. Attainment status is based on applicable fish and macroinvertebrate biocriteria for the Huron-Erie Lake Plain ecoregion of Ohio for inland streams and rivers and Interim Criterion for Lake Erie Lacustuaries.

RIVER MILE Fish/Invert.	IBI (LIBI)	MIwb (MIwb)	ICI[a] (LICI)	QHEI[b]	Attainment Status	Comment
Ottawa River (1996)						
WWH Lacustuarine Zone Interim Criteria						
5.7/5.7	(22*)	(6.3*)	(9*)	44.5	**NON**	Upstream Dura Ave. Landfill
5.5/5.5	(22*)	(6.4*)	(8*)	41.0	**NON**	Adjacent Dura Ave. Landfill
5.3/5.3	(18*)	(5.0*)	(6*)	41.5	**NON**	Downstream Dura Ave. Landfill
Sibley Creek (1996)						
Huron-Erie Lake Plain - LRW Use Designation (Recommended)						
0.8/0.8	12*	NA	VP*	40.0	**NON**	No fish present
0.1/0.1	19	NA	P	36.5	FULL	Adjacent Dura Ave. Landfill

Ecoregion Biocriteria: *Huron-Erie Lake Plain (HELP)*
(Applicable Stream Criteria from OAC 3745-1-07, Table 7-14)

INDEX	WWH	EWH	MWH[c]	LRW[d]
IBI - Headwater	28	50	20	18
LICI-Interim Lacustuary	42			
LIBI - Interim Lacustuary	42			
MIwb - Interim Lacustuary	8.6			

* - Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
NA -Not applicable.
a - The qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and predominant organisms and is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores (P- Poor, VP- Very Poor).
b - Qualitative Habitat Evaluation Index (QHEI) values based on Rankin (1989).
c - Modified Warmwater Habitat for channel modified areas.
d - Limited Resource Water benchmarks based on best professional judgment driven by the need to protect against acutely toxic (very poor) stream conditions.

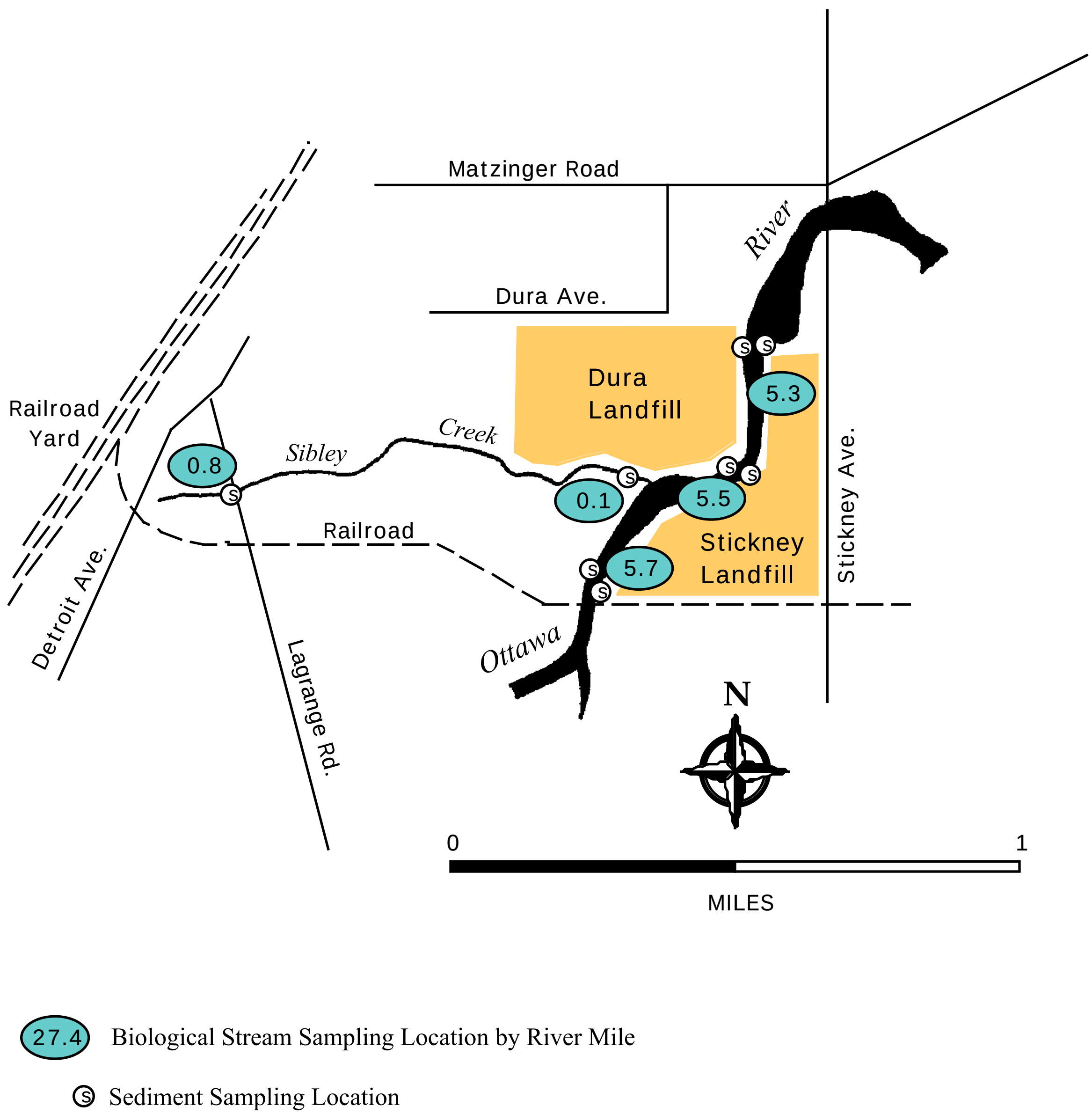

Figure 1. Map of the Ottawa River study area showing principal streams, landmarks, the Dura landfill, and Ohio EPA sampling locations, 1996.

METHODS

All chemical, physical, and biological field, laboratory, data processing, and data analysis methodologies and procedures follow those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), and The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989) for aquatic habitat assessment. Fish and macroinvertebrate communities were sampled during the summer and fall of 1996 at three locations on the Ottawa River from river miles (RM) 5.7 to 5.3 and on Sibley Creek at RM 0.8 and RM 0.1 (Table 1, Figure 1). Sediment samples were collected by Ohio EPA at six locations on the Ottawa River (RM 5.78 to 5.20), and two locations on Sibley Creek (RM 0.82 and 0.04). Fish tissue samples were collected from the same locations as fish community results; however, no fish were present in Sibley Creek at RM 0.8.

Determining Use Attainment Status

The attainment status of aquatic life uses (i.e., full, partial, and non) is decided by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-14). The biological community performance measures used include the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The ICI was developed by Ohio EPA (1987b) and further described by DeShon (1995). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information from the Wabash River (Gammon 1976; Gammon *et al.* 1981).

Performance expectations for the principal aquatic life uses in the Ohio WQS (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of the aquatic life use is full if all three indices (or those available) meet the applicable biocriteria, partial if at least one index does not attain and performance is at least fair, and nonattainment if all indices fail to attain or any index indicates poor or very poor performance. Partial and non-attainment indicate that the receiving water is impaired and does not meet the designated use criteria specified by the Ohio WQS.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score that generally ranges from 20 to 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have shown that values greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 frequently typify habitat conditions that have the ability to support exceptional warmwater faunas.

Macroinvertebrate Community Assessment

Macroinvertebrates in the Ottawa River were sampled quantitatively for a six-week period from August 15, 1996 to September 30, 1996 using multiple-plate, artificial substrate samplers (modified Hester/Dendy) with a qualitative assessment of the available natural substrates collected at the time of artificial substrate retrieval. A qualitative assessment of the macroinvertebrate communities of Sibley Creek was conducted on August 15, 1996.

Fish Community Assessment

Fish were sampled in the Ottawa River using the boat method pulsed DC electrofishing gear, used at a frequency of two samples at each site. Fish were sampled in Sibley Creek (twice at RM 0.1 and once at RM 0.8) using a backpack-mounted gasoline powered electrofishing unit (pulsed DC). Fish collections were made at each site from August to October, with sampling distances varying between 450 and 500 meters per location in the Ottawa River, and 140 to 150 meters in Sibley Creek.

Sediment Assessment

Fine grained sediment samples were collected in the upper four inches of bottom material at each location using either decontaminated stainless steel scoops or stainless steel Ekman dredge samplers. Collected sediment was placed into decontaminated clear glass jars with Teflon lined lids, placed on ice (to maintain 4˚C) and shipped to an Ohio EPA contract lab. Sample collection and decontamination procedures follow guidance provided in the Ohio EPA Sediment Sampling Guide and Methodologies (1996).

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward, the numerical biological criteria are the principal arbiters of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiters within a weight-of-evidence framework has been extensively discussed else where (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines-of-evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and the biological response signatures (Yoder and Rankin 1995) within the biological data itself. Thus the assignment of principal causes and sources of impairment in this report does not represent a true "cause and effect" analysis, but rather represents the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the biosurvey data are based on previous research or experience with analogous situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified. The process is similar to making a medical diagnosis in which a doctor relies on multiple lines of evidence concerning patient health. Such diagnoses are based on previous research that experimentally or statistically linked symptoms and test results to specific diseases or pathologies. Thus a doctor relies on previous experience in interpreting symptoms (*i.e.,* multiple lines from test results) to establish a diagnosis, potential causes and/or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. As in medical science, where the ultimate arbiter of success is the eventual recovery and the well-being of the patient, the ultimate measure of success in water resource management is restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem "health" compared to human patient "health" (Suter 1993) here we are referring to the process for identifying biological integrity and causes/sources associated with observed impairment, not whether human health and ecosystem health are analogous concepts.

RESULTS AND DISCUSSION

Sediment Chemistry

Sediment samples were collected from six locations on the Ottawa River and two on Sibley Creek in October 1996. Sediment results were evaluated in part using guidelines established by the Ontario Ministry of the Environment (Persaud *et al.* 1993). The guidelines define two levels of ecotoxic effects and are based on the chronic, long term effects of contaminants on benthic organisms. A *Lowest Effect Level* is a level of sediment contamination that can be tolerated by the majority of benthic organisms, and a *Severe Effect Level* indicates a level at which pronounced disturbance of the sediment-dwelling community can be expected. The Severe Effect Level is the sediment concentration of a compound that would be detrimental to the majority of benthic species. When any parameters are at or above the Severe Effect Level guideline, the material tested is considered highly contaminated and will likely have a significant effect on benthic biological resources.

- All sediment samples collected from the Ottawa River and Sibley Creek in this survey indicated arsenic levels below the estimated quantitation limit (EQL) of 10 mg/kg. The Lowest Effect Level for arsenic is 6.0 mg/kg which is lower than the EQL so this level cannot be evaluated. Arsenic's Severe Effect Level is 33.0 mg/kg, well above the EQL.

- All sediments samples collected from the Ottawa River and Sibley Creek exceeded the Lowest Effect Level for total PCBs and it is anticipated that these sediments may have an adverse effect on some benthic organisms (Persaud *et al.* 1993). The sediment sample collected from RM 5.78 on the Ottawa River exceeded the Lowest Effect Level for total PAHs.

- High levels of semi-volatile organic compounds in sediment collected from Sibley Creek at RM 0.82 interfered with chemical analyses resulting in very high quantitation limits. A precise evaluation of this group of chemical compounds was not possible; however, the presence of contaminant levels high enough to cause this interference is a concern.

- Historically, sediments were sampled in the Ottawa River in 1986, 1988, and 1990 (Ohio EPA 1991). Total PCB values ranged between 0.710 ppm and 110 ppm, with the highest concentrations occurring between RMs 5.0 and 6.0. Extremely elevated levels of PCB (56 ppm and 1,200 ppm) were recorded in a drainage ditch that is a tributary to the Ottawa River at RM 5.97 Ohio EPA (1991). The drainage ditch received storm water runoff and discharges of industrial wastewater. Remedial measures are being taken at this location.

Table 3. Chemical compounds detected at notable concentrations in sediment samples collected from the Ottawa River and Sibley Creek, 1996. A complete list of chemicals measured with results is listed in Appendix Tables 5 & 6.

	Ottawa River Sediment (River Mile)					
Parameter	**5.78**	**5.73**	**5.45**	**5.43**	**5.22**	**5.20**
Volatile Organic Compounds (ug/kg)						
Methylene chloride	<5.0	NA	<5.0	NA	<5.0	NA
Acetone	78^{B}	NA	70	NA	29	NA
2-Butanone	15	NA	15	NA	<10	NA
Ethyl benzene	<5.0	NA	<5.0	NA	<5.0	NA
Xylenes	<5.0	NA	<5.0	NA	<5.0	NA
Semivolatile Organic Compounds (ug/kg)						
Phenanthrene	940^{lel}	NA	<1300	NA	<1300	NA
Fluoranthene	2600^{lel}	NA	1900^{lel}	NA	1700^{lel}	NA
Pyrene	1200^{lel}	NA	<1300	NA	<1300	NA
Benzo(a)anthracene	770^{lel}	NA	<1300	NA	<1300	NA
bis(2-ethylhexyl)phthalate	4100^{D}	NA	4100	NA	2900	NA
chrysene	1200^{lel}	NA	<1300	NA	<1300	NA
di-n-octyl phthalate	1600	NA	1600	NA	1600	NA
Benzo(b)fluoranthene	1200	NA	<1300	NA	<1300	NA
Benzo(k)fluoranthene	470^{lel}	NA	<1300	NA	<1300	NA
Benzo(a)pyrene	790^{lel}	NA	<1300	NA	<1300	NA
Indeno(1,2,3-cd)pyrene	460^{lel}	NA	<1300	NA	<1300	NA
Benzo(g,h,i)perylene	470^{lel}	NA	<1300	NA	<1300	NA
PCBs (ug/kg)						
PCB-1242	2900^{lel}	1000^{lel}	$3000^{D\,lel}$	130^{lel}	$3000^{D\,lel}$	$2100^{D\,lel}$
PCB-1254	<770	<330	$290^{P\,lel}$	25^{P}	$250^{P\,lel}$	$160^{P\,lel}$
PCB-1260	<770	$200^{P\,lel}$	<160	<16	<170	$39^{P\,lel}$
Other (mg/kg)						
Total Organic Carbon	$24,500^{lel}$	$12,100^{lel}$	$19,000^{lel}$	$19,900^{lel}$	$34,500^{lel}$	9,060

Table 3. Continued.

Parameter	Sibley Creek Sediment (River Mile) 0.82	0.04	0.04 (Duplicate)
Volatile Organic Compounds (ug/kg)			
Methylene chloride	210[J]	230[JB]	210[J]
Acetone	<1200	<1200	<1200
2-Butanone	<1200	<1200	<1200
Ethyl benzene	<620	490[J]	500[J]
Xylenes	<620	1200	1200
Semivolatile Organic Compounds (ug/kg)			
Phenanthrene	<13,000	<1300	<1300
Fluoranthene	<13,000	<1300	<1300
Pyrene	<13,000	<1300	<1300
Benzo(a)anthracene	<13,000	<1300	<1300
bis(2-ethylhexyl)phthalate	<13,000	5900	5500
chrysene	<13,000	<1300	<1300
di-n-octyl phthalate	<13,000	<1300	<1300
Benzo(b)fluoranthene	<13,000	<1300	<1300
Benzo(k)fluoranthene	<13,000	<1300	<1300
Benzo(a)pyrene	<13,000	<1300	<1300
Indeno(1,2,3-cd)pyrene	<13,000	<1300	<1300
Benzo(g,h,i)perylene	<13,000	<1300	<1300
PCBs (ug/kg)			
PCB-1242	<160	2800[lel]	2000[lel]
PCB-1254	1400[P lel]	800[P lel]	600[P lel]
PCB-1260	<160	<800	180[lel]
Other (mg/kg)			
Total Organic Carbon	21,000[lel]	35,300[lel]	31,000[lel]

Results Flags:

B - Target compound was detected in the sample and was also found in the method blank above the normal Estimated Quantitation Limit.

D - Indicates that an additional dilution was necessary in order to quantitate the target result.

NA - Not Analyzed

J - Indicates results below the Estimated Quantitation Limit and are considered estimated values.

P - Indicates that there was a greater than 25% difference between the results determined from the primary and secondary GC columns. The value reported is the lower of the two results.

lel - Exceeds the Lowest Effect Level as reported in *Persaud et al. 1993*; a level of sediment contamination that can be tolerated by the majority of benthic organisms.

Physical Habitat for Aquatic Life

Physical habitat was evaluated in the Ottawa River and Sibley Creek at each biological sampling location. Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 4.

- Stream morphology in the Ottawa River within the study area consists of lacustuary flow conditions influenced by Maumee Bay. Bottom substrates are predominated by muck, with lesser amounts of sand, boulders, detritus, and artificial riprap. No riffles or runs occur within the Ottawa River study area. Qualitative Habitat Evaluation Index (QHEI) scores for the Ottawa River within the study area range between 41.0 and 44.5. These scores were indicative of fair stream and riparian habitat.

- Sibley Creek was evaluated near the mouth and at RM 0.8. Sibley Creek is a small stream, with shallow pools and very shallow riffles (less than 5 cm in depth). Bottom substrates are predominated by muck and sand, with smaller amounts of boulders and gravel. The stream bottom is extensively embedded with fine-grained material, resulting in reduced cover for aquatic organisms. The stream channel appeared to be unmodified in the lower section and recovering from past modifications at RM 0.8. The QHEI scores were 36.5 and 40.0, with modified warmwater habitat stream attributes predominating. Stream habitat quality was considered fair to poor.

- Below the surface layer of silt and muck, the bottom sediments of Sibley Creek at RM 0.8 are heavily saturated with a black material with a creosote odor. Disturbance of the bottom sediments released an oily substance that created an extensive oil sheen on the surface of the water.

Table 4. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Ottawa River and Sibley Creek, 1996.

Macroinvertebrate Community

In 1996, macroinvertebrate communities were sampled in the Ottawa River at three locations and Sibley Creek at two locations near the Dura Avenue Landfill. The Ottawa River data were analyzed using the Lacustuary Invertebrate Community Index (LICI) being developed at the Ohio EPA. Summarized results of the macroinvertebrate data are compiled in Tables 5 and 6. LICI metrics and scores and raw data tables by river mile are attached as Appendix Tables 1 and 2. Included in Table 5 are historical Ohio EPA macroinvertebrate data collected in 1993 and 1986.

Ottawa River

- The condition of the macroinvertebrate communities upstream (RM 5.7), adjacent (RM 5.5), and downstream (RM 5.3) from the Dura Avenue Landfill were assessed based on results from artificial substrate samplers. All three sites indicated communities in the very poor range (LICI scores 6, 8, and 6, respectively); none attained the WWH use designation. Community performance expectations were influenced by lacustuary conditions of reduced or absent current and homogeneous substrate. The samples were predominated by the midge genus *Glyptotendipes* followed by aquatic worms with high organism densities. This differs from past results (1992, 1986) when low densities predominated by aquatic worms typified of toxic conditions. Although community performances were very poor the changes in the makeup of the communities, relative to past results, indicated a lessening of toxic impacts and an overriding impairment from nutrient enrichment. Additional stressors on the communities included the effects of contaminated sediment, combined sewer overflow discharges, and leachate from the Stickney Avenue landfill.

Sibley Creek

- Qualitative samples were collected from Sibley Creek adjacent to the Dura Avenue Landfill (RM 0.1) and upstream from Lagrange Street (RM 0.8). The macroinvertebrate community at RM 0.1 indicated poor conditions with 18 taxa collected predominated by pollution tolerant midges. Most organisms were collected from vegetation hanging into the water along the stream edges; substrates in the main channel yielded few organisms. The site at RM 0.8 indicated very poor conditions with only three taxa collected. The predominant organism was the larval dragonfly, *Libellula lydia,* a moderately pollution tolerant species; however, only early instars (very young) were present with no mature larvae collected. This species takes two years to develop in Ohio; thus, multiple age classes are usually present. The lack of older larvae may indicate that conditions are too toxic or food resources to scarce for completion of the larval stage.

Table 5. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Ottawa River, 1996, 1992, and 1986.

Stream/ River Mile	Relative Density	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	LICI	Evaluation[b]
Ottawa River (1996)							
5.7	1730	23	11	15	0	6*	Very Poor
5.5	2275	21	12	14	0	8*	Very Poor
5.3	5910	21	14	14	0	6*	Very Poor
Ottawa River (1992)							
6.4	472	25	19	9	0	12*	Poor
4.9	391	17	14	5	0	10*	Very Poor
Ottawa River (1986)							
6.9	551	29	21	16	0	12*	Poor
4.9	388	20	16	10	0	16*	Poor

Ecoregion Biocriteria: Huron-Erie Lake Plain (HELP)
(from OAC 3745-1-07, Table 7-14)

INDEX	WWH	EWH	MWH[c]	LRW[d]	WWH Lacustuary
ICI	36	46	22	8	-
LICI (interim)					42

a EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa richness.

b The qualitative narrative evaluation is based on best professional judgement utilizing sample attributes such as taxa richness, EPT richness, and predominant organisms and is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.

c Modified Warmwater Habitat for channel modified areas.

d Limited Resource Water.

* Significant departure from interim lacustuary biocriterion; poor and very poor results are underlined.

Table 6. Summary of qualitative macroinvertebrate data collected from natural substrates in Sibley Creek, 1996 and 1993.

Stream/ River Mile	No. Qualitative Taxa	Qualitative EPT[a]	Relative Density[b]	Predominant Organism	Narrative Evaluation[c]
Sibley Creek (1996)					
0.8	3	0	Very Low	*Libellula lydia*	Very Poor
0.1	18	0	Low	Midges	Poor
Sibley Creek (1993)					
0.8	4	0	Very Low	*Libellula lydia*	Very Poor

a EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa richness.

b Based on field observations.

c The qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and predominant organisms and is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.

Fish Community

A total of 730 fish representing 20 species and two hybrids were collected from the Ottawa River within the study area between August and October 1996. The sampling effort included a cumulative distance electrofished of 2.95 km at three locations (Table 7). Relative numbers and species collected per location are presented in Appendix Table 3, and LIBI/IBI metric results are presented in Appendix Table 4. Ottawa River sampling locations were evaluated using interim lacustuary biocriteria and Sibley Creek was evaluated using LRW benchmarks.

Ottawa River

Fish communities were sampled in the Ottawa River at three locations; one upstream from the Dura Ave. landfill, one adjacent to the remedial barrier wall, and one adjacent to the Dura Avenue Landfill downstream from the remedial barrier wall. The fish communities from all three sampling locations exhibited substantial biological degradation. The lacustuary IBI (LIBI: 17.5 - 21.5) and MIwb (5.0-6.4) scores were in the poor range and all three sites were not achieving the applicable biocriteria. The sampling location adjacent to the downstream end of the Dura Avenue Landfill (RM 5.3) had the lowest fish index scores among the three sites. However, all three locations were sampled on both sides of the river and included the river bank adjacent to the Stickney Avenue Landfill.

The physical condition of fish was monitored at each sampling site by recording the incidence of DELT (deformities, fin erosions, lesions/ulcers, and tumors) external anomalies. Biosurvey results collected by Ohio EPA from throughout the state show a high frequency of DELT anomalies to be an accurate indication of pollution stress usually caused by multiple sublethal stresses as the result of degraded water quality (*i.e.* often a combination of toxic impacts combined with marginal D.O. concentrations). Within Ohio, there are ample correlations between sites with chemically contaminated sediments (*e.g.* metals, PAHs), very high percent occurrence of DELT anomalies (>10-20%), and very low Index of Biotic Integrity and Modified Index of Well-Being scores (Yoder 1991). A high percentage of DELT anomalies were recorded at each Ottawa River sampling location, with site results ranging between 5.1% and 35.9%. The overwhelming majority of DELT anomalies were knothead deformities on adult and juvenile common carp.

Improvement in species richness, LIBI, and MIwb scores in the Ottawa River at the downstream end of the Dura Avenue landfill has occurred between 1990 and 1996 (Table 7). The biological results suggested that leachate controls implemented at the Dura Avenue Landfill contributed to the improvements in biological integrity. However, overall fish community results in the Ottawa River within the Dura Avenue Landfill study area remain in the poor range.

Sibley Creek

Fish communities were sampled at two locations in Sibley Creek, one adjacent to the Dura Avenue Landfill at RM 0.1 and one upstream at Lagrange Street (RM 0.8). Acutely toxic conditions existed in Sibley Creek at RM 0.8, where fish were completely absent during sampling in August (fish were sampled only once). Fish were also absent from the Lagrange Street site during sampling conducted in 1993. Improvement in the fish community occurred at RM 0.1, where a total of ten species was collected. The IBI score at RM 0.1 (19) indicated a poor quality community, with pollution tolerant species predominating. Sibley Creek at RM 0.8 did not reach the benchmark for Limited Resource Water but with the improved performance at RM 0.1 it did achieve the LRW benchmark of 18.

Table 7. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in the Ottawa River study area from August - October, 1996. The number of samples collected at each location is listed with the sampling method. Relative number and weight are per 0.3 km for wading sites and per 1.0 km for boat sampling sites. Previous Ohio EPA data results are included in the table.

Stream RM	Sampling Method[a]	Mean # Species	Total # Species	Mean Relative Number	Mean Relative Weight(kg)	QHEI	Mean MIwb	Mean IBI/(LICI)	Narrative Evaluation[b]
Ottawa River (1996)									
5.7	Boat-2	14.0	16	195	18.37	44.5	6.3*	(21.5*)	Poor
5.5	Boat-2	15.0	18	343	39.60	41.0	6.4*	(21.5*)	Poor
5.3	Boat-2	13.0	18	200	49.98	41.5	5.0*	(17.5*)	Very Poor/Poor
Ottawa River (1992)									
6.2	Boat-1	-	17	204	30.10	-	5.8*	(21*)	Poor
Ottawa River (1990)									
5.2	Boat-1	-	8	288	55.70	43.0	4.5*	(10*)	Very Poor
Sibley Creek (1996)									
0.8	Wading-1	-	0	0	NA	40.0	NA	12*	Very Poor
0.1	Wading-2	8.5	10	428	NA	36.5	NA	19*	Poor
Sibley Creek (1993)									
0.8	Wading-1	-	0	0	NA	31.0	NA	12*	Very Poor

Ecoregion Biocriteria: Huron-Erie Lake Plain (HELP)
(where applicable from OAC 3745-1-07, Table 7-14)

INDEX	WWH	EWH	MWH[c]	LRW[d]	WWH-Lacustuary
IBI - Headwater	28	50	20	18	
LIBI (interim)					42

* Significant departure from ecoregional or lacustuary biocriteria (>4 IBI units, >0.5 MIwb units); poor and very poor results are underlined.
NA Method not applicable to headwater streams.
a Sampling method is followed by the number of sampling passes per site.
b Narrative evaluation is based on MIwb and IBI/LIBI scores.
c Modified Warmwater Habitat for channel modified areas.
d Limited Resource Water.

Fish Tissue

Fish tissue samples were collected from three locations on the Ottawa River and one on Sibley Creek adjacent to the Dura Avenue Landfill on October 1, 1996. Twelve samples were analyzed for PCBs and percent lipids. The results are presented in Table 8.

- The concentrations of the PCB congener 1242, from tissue samples from the Ottawa River and Sibley Creek, ranged from 0.13 ppm (130 ug/kg) to 510 ppm (510,000 ug/kg). Any whole sample of any representative organism with a total PCB concentration exceeding 0.64 ppm (640 ug/kg) is an exceedance of the Ohio Water Quality Standards and any fish fillet sample exceeding 1.9 ppm (1,900 ug/kg) is considered extremely elevated (Ohio EPA 1997).

- A whole body composite sample of 121 fathead minnows from Sibley Creek (RM 0.1) showed a concentration of the PCB congener 1248 of 0.83 ppm (830 ug/kg). This is an exceedance of the Ohio Water Quality Standards for total PCB concentration as noted above.

Table 8. PCBs and lipid analyses of fish tissue collected from the Ottawa River and Sibley Creek adjacent to the Dura Avenue Landfill, 1996. Values in bold type exceed the Ohio Water Quality Standards criterion.

Sampling Location and Species - by River Mile						
	Ottawa Common Carp WBC(3)[1]	Ottawa Pumpkinseed Sunfish WBC(5)[1]	Ottawa Common Carp SOFC(4)[2]	Ottawa Common Carp WBC(3)[1]	Ottawa Pumpkinseed Sunfish WBC(5)[1]	Ottawa Common Carp SOFC(3)[2]
Parameter	**5.7**	**5.7**	**5.7**	**5.5**	**5.5**	**5.5**
PCBs (ug/kg)						
PCB-1016	<33000	<1600	<33000	<1700	<1600	<1600
PCB-1221	<66000	<3300	<66000	<3300	<3300	<3200
PCB-1232	<33000	<1600	<33000	<1700	<1600	<1600
PCB-1242	**240000**	**6100**	**510000**	**19000**	**5400**	**23000**
PCB-1248	<33000	<1600	<33000	<1700	<1600	<1600
PCB-1254	<33000	<1600	<33000	<1700	<1600	<1600
PCB-1260	<33000	<1600	<33000	<1700	<1600	<1600
Percent Lipid	10.60	5.23	5.75	3.65	5.82	2.52

Table 8. Continued.

	Sampling Location - by River Mile					
	Ottawa Smallmouth Bass SOF[3] **5.5**	Ottawa Common Carp WBC(4)[1] **5.3**	Ottawa Yellow Perch WBC(2)[1] **5.3**	Ottawa Common Carp SOFC(4)[2] **5.3**	Ottawa Freshwater Drum SOF[3] **5.3**	Sibley Fathead Minnows WBC(121)[1] **0.1**
PCBs (ug/kg)						
PCB-1016	<170	<1700	<1700	<1700	<17	<170
PCB-1221	<330	<3300	<3300	<3300	<33	<340
PCB-1232	<170	<1700	<1700	<1700	<17	<170
PCB-1242	**650**	**13000**	**7500**	**8700**	130	<170
PCB-1248	<170	<1700	<1700	<1700	<17	**830**
PCB-1254	<170	<1700	<1700	<1700	<17	<170
PCB-1260	<170	<1700	<1700	<1700	<17	<170
Percent Lipid	1.12	4.73	2.29	3.21	2.05	0.54

1 WBC whole body composite sample. Number in brackets is the number of fish in the sample.

2 SOFC skin on fillet composite sample. Number in brackets is the number of fish in the sample.

3 SOF skin on fillet sample of a single fish.

REFERENCES

DeShon, J.E. 1995. Development and application of the Invertebrate Community Index (ICI), pp. 217-243 (Chapter 15) *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, Fl.

Fausch, D.O., J.R. Karr, and P.R. Yant. 1984. Regional application of an index of biotic integrity based on stream fish communities. Trans. Amer. Fish. Soc. 113:39-55.

Gammon, J.R. 1976. The fish populations of the middle 340 km of the Wabash River. Tech Report No. 86 Purdue University. Water Resources Research Center, West Lafayette, Indiana. 73 pp.

Gammon, J.R., A. Spacie, J.L. Hamelink, and R.L. Kaesler. 1981. Role of electrofishing in assessing environmental quality of the Wabash River. pp. 307-324. In: Ecological assessments of effluent impacts on communities of indigenous aquatic organisms. ASTM STP 703, J.M. Bates and C.I.Weber (eds). Philadelphia, PA.

Hughes, R. M., D. P. Larsen, and J. M. Omernik. 1986. Regional reference sites: a method for assessing stream pollution. Env. Mgmt. 10(5): 629-635.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6 (6): 21-27.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. Env. Mgmt. 5(1): 55-68.

Karr, J.R., K.D. Fausch, P.L. Angermier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Ill. Nat. Hist. Surv. Spec. Publ. 5. 28 pp.

Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications 1(1):66-84.

Miner, R. and D. Borton. 1991. Considerations in the development and implementation of biocriteria. Pages 115-119 in G.H. Flock (editor). *Water Quality Standards for the 21st Century, Proceedings of a Conference*. U.S. Environmental Protection Agency, Office of Science and Technology, Washington D.C.

Ohio Department of Health. 1997. Ohio Department of Health Ohio Fish Consumption Fact Sheet on 9/25/97. 8pp. from ODH Revised Ohio Fish Consumtion Advisories for PCB's, Mercury, and Lead. Released 6/30/97.

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989a. Ohio EPA manual of surveillance methods and quality assurance practices, updated edition. Division of Environmental Services, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Addendum to biological criteria for the protection of aquatic life, Vol.II: Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning and Assessment, Columbus, Ohio.

Ohio Environmental Protection Agency. 1991. Fish tissue, bottom sediment, surface water: organic and metal chemical evaluation and biological community evaluation. Ottawa River/ Tenmile Creek. Toledo, Ohio. Division of Water Quality Planning and Assessment, Columbus, Ohio.

Ohio Environmental Protection Agency. 1997. 1996 Ohio Water Resource Inventory. Volume 2: Ohio Fish Tissue Contaminant Monitoring Program. Ohio EPA Technical Bulletin MAS/1997-10-1. Division of Surface Water, Columbus, Ohio.

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.

Persaud D., J. Jaagumagi, And A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of the Environment. Toronto. 24pp.

Rankin, E. T. 1989. The qualitative habitat evaluation index (QHEI): Rationale, methods, and application. Ohio Environmental Protection Agency. Division of Water Quality Planning and Assessment, Ecological Assessment Section, Columbus, Ohio.

Rankin, E.T. 1995. Habitat indices in water resource quality assessments, pp.181-208 (Chapter 13) *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, Fl.

Suter, G.W. 1993. A critique of ecosystem health concepts and indexes. Environmental Toxicology and Chemistry, 12: 1533-1539.

Yoder, C.O. 1989. The development and use of biological criteria for Ohio surface waters. U.S. EPA, Criteria and Standards Div., Water Quality Stds. 21st Century, 1989: 139-146.

Yoder, C. O. 1991. Answering some concerns about biological criteria based on experiences in Ohio. In: Gretchin H. Flock, editor. Water quality standards for the 21st century. Proceedings of a National Conference, U. S. EPA, Office of Water, Washington, D.C.

Yoder, C.O. 1995. Policy issues and management applications of biological criteria, pp.327-343 (Chapter 21). *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, Fl.

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multi-metric data, pp.263-286 (Chapter 17). *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, Fl.

Appendix Table 1. Raw macroinvertebrate data by river mile for the Ottawa River study area, 1996.

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/30/96 River Code: 04-300 River: Ottawa River RM: 5.70

Taxa Code	Taxa	Quan	Qual
01200	*Cordylophora lacustris*	4	
01320	*Hydra sp*	4	
01801	*Turbellaria*	4	
03600	*Oligochaeta*	2208	+
04666	*Helobdella triserialis*		+
22001	*Coenagrionidae*		+
28955	*Libellula lydia*		+
45300	*Sigara sp*		+
45400	*Trichocorixa sp*		+
63900	*Laccophilus sp*		+
68901	*Macronychus glabratus*	1	
82730	*Chironomus (C.) decorus group*		+
82800	*Cladopelma sp*	40	+
83051	*Dicrotendipes simpsoni*	909	
83300	*Glyptotendipes (G.) sp*	5412	+
84050	*Parachironomus "hirtalatus" (sensu Simpson & Bode, 1980)*		+
84315	*Phaenopsectra flavipes*		+
84470	*Polypedilum (P.) illinoense*		+
84790	*Tribelos fuscicorne*	40	
94400	*Fossaria sp*		+
95100	*Physella sp*		+
96120	*Menetus (Micromenetus) dilatatus*	24	
96900	*Ferrissia sp*	4	

No. Quantitative Taxa: 11 Total Taxa: 23

No. Qualitative Taxa: 15 ICI: **0**

Number of Organisms: 8650 Qual EPT: **0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/30/96 River Code: 04-300 River: Ottawa River RM: 5.50

Taxa Code	Taxa	Quan	Qual
01200	*Cordylophora lacustris*	4	
01801	*Turbellaria*	52	
03360	*Plumatella sp*	4	+
03600	*Oligochaeta*	4064	+
22001	*Coenagrionidae*		+
22300	*Argia sp*	4	
45300	*Sigara sp*	1	
45400	*Trichocorixa sp*		+
80510	*Cricotopus (Isocladius) sylvestris group*		+
81240	*Nanocladius (N.) distinctus*		+
82890	*Demeijerea sp*	67	
83051	*Dicrotendipes simpsoni*	806	+
83158	*Endochironomus nigricans*		+
83300	*Glyptotendipes (G.) sp*	6250	+
84030	*Parachironomus directus*		+
84050	*Parachironomus "hirtalatus" (sensu Simpson & Bode, 1980)*		+
84315	*Phaenopsectra flavipes*		+
84470	*Polypedilum (P.) illinoense*		+
95100	*Physella sp*	4	+
96120	*Menetus (Micromenetus) dilatatus*	116	
96900	*Ferrissia sp*	4	

No. Quantitative Taxa: 12 Total Taxa: 21

No. Qualitative Taxa: 14 ICI: **0**

Number of Organisms: 11376 Qual EPT: **0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/30/96 River Code: 04-300 River: Ottawa River RM: 5.30

Taxa Code	Taxa	Quan	Qual
01200	*Cordylophora lacustris*	4	
01801	*Turbellaria*	48	
03221	*Pectinatella magnifica*	13	+
03360	*Plumatella sp*	4	+
03600	*Oligochaeta*	7680	+
04666	*Helobdella triserialis*	1	
22001	*Coenagrionidae*	4	+
22300	*Argia sp*	5	
45400	*Trichocorixa sp*		+
51206	*Cyrnellus fraternus*	2	
67500	*Laccobius sp*		+
80510	*Cricotopus (Isocladius) sylvestris group*		+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*		+
83050	*Dicrotendipes lucifer*	276	
83051	*Dicrotendipes simpsoni*	1517	+
83158	*Endochironomus nigricans*		+
83300	*Glyptotendipes (G.) sp*	19858	+
84040	*Parachironomus frequens*		+
84050	*Parachironomus "hirtalatus" (sensu Simpson & Bode, 1980)*	138	+
84470	*Polypedilum (P.) illinoense*		+
96120	*Menetus (Micromenetus) dilatatus*	1	

No. Quantitative Taxa: 14 Total Taxa: 21

No. Qualitative Taxa: 14 ICI: **0**

Number of Organisms: 29551 Qual EPT: **0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/15/96 River Code: 04-310 River: Sibley Creek RM: 0.80

Taxa Code	Taxa	Quan/Qual	Taxa Code	Taxa	Quan/Qual
28955	*Libellula lydia*	+			
94400	*Fossaria sp*	+			
95100	*Physella sp*	+			

No. Quantitative Taxa: 0 Total Taxa: 3

No. Qualitative Taxa: 3 ICI:

Number of Organisms: 0 Qual EPT: **0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/15/96 River Code: 04-310 River: Sibley Creek RM: 0.10

Taxa Code	Taxa	Quan/Qual
04664	*Helobdella stagnalis*	+
08220	*Orconectes (Gremicambarus) immunis*	+
22001	*Coenagrionidae*	+
28955	*Libellula lydia*	+
45300	*Sigara sp*	+
45400	*Trichocorixa sp*	+
48200	*Chauliodes sp*	+
61100	*Acilius sp*	+
63702	*Ilybius biguttulus*	+
63900	*Laccophilus sp*	+
67000	*Helophorus sp*	+
67800	*Tropisternus sp*	+
74501	*Ceratopogonidae*	+
78655	*Procladius (Holotanypus) sp*	+
78702	*Psectrotanypus dyari*	+
82730	*Chironomus (C.) decorus group*	+
82820	*Cryptochironomus sp*	+
95100	*Physella sp*	+

No. Quantitative Taxa: 0 Total Taxa: 18

No. Qualitative Taxa: 18 ICI:

Number of Organisms: 0 Qual EPT: **0**

Appendix Table 2. Lacustuary Invertebrate Community Index (LICI) metrics and scores for the Ottawa River study area, 1996.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Taxa	Qual. EPT	Eco-region	ICI
OTTAWA RIVER — 04-300													
Year: 96													
5.70	152.0	11(2)	0(0)	0(0)	4(4)	0.0(0)	0.0(0)	0.0(0)	99.9(0)	36.1(0)	0(0)	1	**6**
5.50	153.0	12(2)	0(0)	0(0)	3(2)	0.0(0)	0.0(0)	0.0(0)	99.9(0)	42.9(0)	0(0)	1	**4**
5.30	155.0	14(2)	0(0)	1(0)	4(4)	0.0(0)	0.1(0)	0.0(0)	99.9(0)	31.6(0)	0(0)	1	**6**
Year: 92													
6.40	146.0	19(2)	0(0)	0(0)	13(6)	0.0(0)	0.0(0)	0.0(0)	99.9(0)	95.0(0)	0(0)	1	**8**
4.90	155.0	14(2)	0(0)	0(0)	9(6)	0.0(0)	0.0(0)	0.0(0)	99.8(0)	91.4(0)	0(0)	1	**8**
Year: 86													
6.90	144.0	21(4)	0(0)	0(0)	10(6)	0.0(0)	0.0(0)	0.0(0)	99.5(0)	93.3(0)	0(0)	1	**10**
4.90	155.0	16(2)	0(0)	0(0)	9(6)	0.0(0)	0.0(0)	0.0(0)	99.4(0)	88.5(0)	0(0)	1	**8**

Appendix Table 3. Summary of relative numbers and weight of fish and species collected at each location by river mile sampled in the Ottawa River study area, 1996.

Species List

River Code: **04-300**	Stream: **Ottawa River**		Sample Date: **1996**
River Mile: **5.70**	Basin: Maumee River		Date Range: 08/15/96
	Time Fished: 3937 sec	Drain Area: 10000.0 sq mi	Thru: 10/01/96
	Dist Fished: 0.95 km	No of Passes: 2	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		57	58.67	30.05	0.56	3.07	9.44
BIGMOUTH BUFFALO	C	I	M		1	1.11	0.57	2.00	10.89	1,800.00
WHITE SUCKER	W	O	S	T	3	3.11	1.59	0.16	0.89	52.67
COMMON CARP	G	O	M	T	9	9.78	5.01	10.11	55.05	1,024.78
GOLDFISH	G	O	M	T	3	3.33	1.71	0.30	1.61	89.00
EMERALD SHINER	N	I	S		26	26.11	13.38	0.05	0.27	1.92
SPOTTAIL SHINER	N	I	M	P	6	6.33	3.24	0.02	0.10	2.83
FATHEAD MINNOW	N	O	C	T	30	32.44	16.62	0.07	0.38	2.23
BLUNTNOSE MINNOW	N	O	C	T	22	22.44	11.50	0.08	0.44	3.59
COM. CARP X GOLDFISH	G	O		T	2	2.22	1.14	2.86	15.57	1,287.50
WHITE BASS	F	P	M		6	6.33	3.24	0.48	2.62	72.67
LARGEMOUTH BASS	F	C	C		4	4.22	2.16	0.47	2.57	107.75
GREEN SUNFISH	S	I	C	T	2	2.11	1.08	0.07	0.39	34.00
BLUEGILL SUNFISH	S	I	C	P	6	6.33	3.24	0.11	0.59	17.67
PUMPKINSEED SUNFISH	S	I	C	P	5	5.22	2.67	0.13	0.72	25.80
GR'N SF X PUMPKINS'D					1	1.00	0.51	0.04	0.19	35.00
LOGPERCH	D	I	S	M	3	3.33	1.71	0.01	0.07	4.00
FRESHWATER DRUM			M	P	1	1.11	0.57	0.84	4.55	752.00
Mile Total					187	195.22		18.37		
Number of Species					16					
Number of Hybrids					2					

Species List

River Code: **04-300**	Stream: **Ottawa River**		Sample Date: **1996**
River Mile: **5.50**	Basin: Maumee River		Date Range: 08/15/96
	Time Fished: 2866 sec	Drain Area: 10000.0 sq mi	Thru: 10/01/96
	Dist Fished: 1.00 km	No of Passes: 2	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		118	118.00	34.40	1.00	2.52	8.46
BIGMOUTH BUFFALO	C	I	M		1	1.00	0.29	1.78	4.48	1,775.00
WHITE SUCKER	W	O	S	T	11	11.00	3.21	1.09	2.74	98.73
COMMON CARP	G	O	M	T	38	38.00	11.08	29.04	73.32	764.18
GOLDFISH	G	O	M	T	5	5.00	1.46	0.74	1.87	147.80
GOLDEN SHINER	N	I	M	T	4	4.00	1.17	0.02	0.05	4.75
EMERALD SHINER	N	I	S		32	32.00	9.33	0.04	0.11	1.34
SPOTTAIL SHINER	N	I	M	P	5	5.00	1.46	0.02	0.04	3.20
FATHEAD MINNOW	N	O	C	T	29	29.00	8.45	0.05	0.12	1.69
BLUNTNOSE MINNOW	N	O	C	T	7	7.00	2.04	0.04	0.10	5.71
COM. CARP X GOLDFISH	G	O		T	3	3.00	0.87	2.39	6.03	795.67
WHITE BASS	F	P	M		3	3.00	0.87	0.02	0.04	5.33
SMALLMOUTH BASS	F	C	C	M	1	1.00	0.29	0.25	0.63	248.00
LARGEMOUTH BASS	F	C	C		6	6.00	1.75	0.86	2.17	143.33
GREEN SUNFISH	S	I	C	T	17	17.00	4.96	0.29	0.72	16.89
BLUEGILL SUNFISH	S	I	C	P	22	22.00	6.41	0.59	1.49	26.91
PUMPKINSEED SUNFISH	S	I	C	P	34	34.00	9.91	1.15	2.90	33.76
GR'N SF X PUMPKINS'D					3	3.00	0.87	0.12	0.29	38.33
YELLOW PERCH			M		2	2.00	0.58	0.14	0.34	68.00
LOGPERCH	D	I	S	M	2	2.00	0.58	0.01	0.03	5.00
Mile Total					343	343.00		39.60		
Number of Species					18					
Number of Hybrids					2					

Species List

River Code: **04-300**	Stream: **Ottawa River**		Sample Date: **1996**
River Mile: **5.30**	Basin: Maumee River		Date Range: 08/15/96
	Time Fished: 2959 sec	Drain Area: 10000.0 sq mi	Thru: 09/30/96
	Dist Fished: 1.00 km	No of Passes: 2	Sampler Type: A

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		62	62.00	31.00	0.54	1.08	8.74
WHITE SUCKER	W	O	S	T	2	2.00	1.00	0.05	0.11	26.50
COMMON CARP	G	O	M	T	53	53.00	26.50	46.88	93.79	884.51
GOLDFISH	G	O	M	T	3	3.00	1.50	0.30	0.60	99.67
GOLDEN SHINER	N	I	M	T	2	2.00	1.00	0.03	0.06	16.00
EMERALD SHINER	N	I	S		30	30.00	15.00	0.04	0.08	1.31
SPOTTAIL SHINER	N	I	M	P	2	2.00	1.00	0.01	0.01	3.00
FATHEAD MINNOW	N	O	C	T	6	6.00	3.00	0.01	0.02	1.67
BLUNTNOSE MINNOW	N	O	C	T	2	2.00	1.00	0.01	0.01	3.50
WHITE BASS	F	P	M		5	5.00	2.50	0.72	1.45	144.60
WHITE CRAPPIE	S	I	C		1	1.00	0.50	0.07	0.13	65.00
LARGEMOUTH BASS	F	C	C		1	1.00	0.50	0.04	0.07	35.00
GREEN SUNFISH	S	I	C	T	4	4.00	2.00	0.10	0.21	25.75
BLUEGILL SUNFISH	S	I	C	P	2	2.00	1.00	0.10	0.19	48.00
PUMPKINSEED SUNFISH	S	I	C	P	19	19.00	9.50	0.33	0.65	17.09
GR'N SF X PUMPKINS'D					1	1.00	0.50	0.03	0.05	26.00
YELLOW PERCH			M		3	3.00	1.50	0.26	0.53	88.00
LOGPERCH	D	I	S	M	1	1.00	0.50	0.00	0.01	4.00
FRESHWATER DRUM			M	P	1	1.00	0.50	0.47	0.95	473.00
Mile Total					200	200.00		49.98		
Number of Species					18					
Number of Hybrids					1					

Species List

River Code: **04-310**	Stream: **Sibley Creek**		Sample Date: **1996**
River Mile: **0.80**	Basin: Maumee River		Date Range: 08/15/96
	Time Fished: 1825 sec	Drain Area: 2.5 sq mi	
	Dist Fished: 0.14 km	No of Passes: 1	Sampler Type: F

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NO FISH					0	0.00	0			
	Mile Total				0					
	Number of Species				0					
	Number of Hybrids				0					

Species List

River Code: **04-310**	Stream: **Sibley Creek**	Sample Date: **1996**
River Mile: **0.10**	Basin: Maumee River	Date Range: 08/15/96
	Time Fished: 3716 sec Drain Area: 2.6 sq mi	Thru: 10/01/96
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: F

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		6	6.00	1.40			
WHITE SUCKER	W	O	S	T	30	30.00	7.01			
GOLDFISH	G	O	M	T	1	1.00	0.23			
CREEK CHUB	N	G	N	T	99	99.00	23.13			
FATHEAD MINNOW	N	O	C	T	247	247.00	57.71			
BLUNTNOSE MINNOW	N	O	C	T	10	10.00	2.34			
CENTRAL STONEROLLER	N	H	N		21	21.00	4.91			
COM. CARP X GOLDFISH	G	O		T	7	7.00	1.64			
LARGEMOUTH BASS	F	C	C		3	3.00	0.70			
GREEN SUNFISH	S	I	C	T	3	3.00	0.70			
BLUEGILL SUNFISH	S	I	C	P	1	1.00	0.23			
Mile Total					428	428.00				
Number of Species					10					
Number of Hybrids					1					

Appendix Table 4. Index of Biotic Integrity (IBI) metrics and scores and Modiified Index of Well-being (MIwb) scores by river m i l e for locations samped in the Ottawa River study area, 1996.

IBI table for sites in the Ottawa River at Toledo.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Centrarch. species	Sensitive species	Benthic species	Cyprinid species	Percent of Individuals: Exotics	Tolerant fishes	Omni-vores	Top carnivores	Phyto phils
Ottawa River - (04-300)													
Year: 96													
5.70	A	08/15/96	10000	14(3)	4(3)	1(1)	3(1)	4(3)	14(3)	68(0)	66(1)	8(1)	5.4(
5.70	A	10/01/96	10000	11(3)	5(3)	0(0)	2(1)	4(3)	2(5)	44(1)	42(1)	7(1)	4.4(
5.50	A	08/15/96	10000	12(3)	5(3)	1(1)	2(1)	3(3)	22(1)	76(0)	63(1)	6(1)	9.4(
5.50	A	10/01/96	10000	14(3)	6(3)	1(1)	2(1)	5(5)	8(5)	37(3)	30(1)	3(1)	15.2
5.30	A	08/15/96	10000	9(3)	1(1)	1(1)	3(1)	3(3)	30(1)	63(1)	63(1)	12(1)	14.1
5.30	A	09/30/96	10000	13(3)	6(3)	0(0)	2(1)	4(3)	27(1)	47(1)	41(1)	1(1)	11.8
Year: 92													
6.20	A	08/19/92	10000	14(3)	5(3)	0(0)	5(3)	6(5)	14(3)	85(0)	65(1)	6(1)	6.9(
Year: 90													
5.20	A	09/20/90	10000	6(1)	0(0)	0(0)	2(1)	4(3)	19(1)	52(1)	50(1)	0(0)	1.4(

♦ - IBI is low end adjusted.

Appendix Table 5. Chemical analysis results of sediment collected in the Ottawa River , 1996.

Appendix Table 5. Ottawa River sediment results from samples collected in October, 1996.

SAMPLE NUMBERS	OTR1	ORT7	ORT4	ORT8	ORT5	ORT9
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**5.78**	**5.73**	**5.45**	**5.43**	**5.22**	**5.20**
LATITUDE	414137	414139	414148	414147	414159	414200
LONGITUDE	833205	833205	833149	833149	833147	833146

VOLATILE ORGANIC COMPOUNDS (ug/kg)

chloromethane	<10	-	<10	-	<10	-
bromomethane	<10	-	<10	-	<10	-
vinyl chloride	<10	-	<10	-	<10	-
chloroethane	<10	-	<10	-	<10	-
methylene chloride	<5.0	-	<5.0	-	<5.0	-
acetone	78B	-	70	-	29	-
carbon disulfide	<5.0	-	<5.0	-	<5.0	-
1,1-dichloroethene	<5.0	-	<5.0	-	<5.0	-
1,1-dichloroethane	<5.0	-	<5.0	-	<5.0	-
1,2-dichloroethene (total)	<5.0	-	<5.0	-	<5.0	-
chloroform	<5.0	-	<5.0	-	<5.0	-
1,2-dichloroethane	<5.0	-	<5.0	-	<5.0	-
2-butanone	15	-	15	-	<10	-
1,1,1-trichloroethane	<5.0	-	<5.0	-	<5.0	-
carbon tetrachloride	<5.0	-	<5.0	-	<5.0	-
vinyl acetate	<20	-	<20	-	<20	-
bromodichloromethane	<5.0	-	<5.0	-	<5.0	-
1,1,2,2-tetrachloroethane	<5.0	-	<5.0	-	<5.0	-
1,2-dichloropropane	<5.0	-	<5.0	-	<5.0	-
trans-1,3-dichloropropene	<5.0	-	<5.0	-	<5.0	-
trichloroethene	<5.0	-	<5.0	-	<5.0	-
dibromochloromethane	<5.0	-	<5.0	-	<5.0	-
1,1,2-trichloroethane	<5.0	-	<5.0	-	<5.0	-
benzene	<5.0	-	<5.0	-	<5.0	-
cis-1,3-dichloropropene	<5.0	-	<5.0	-	<5.0	-
2-chloroethyl vinyl ether	<200	-	<200	-	<200	-
bromoform	<5.0	-	<5.0	-	<5.0	-
2-hexanone	<10	-	<10	-	<10	-
4-methyl-2-pentanone	<10	-	<10	-	<10	-
tetrachloroethene	<5.0	-	<5.0	-	<5.0	-
toluene	<5.0	-	<5.0	-	<5.0	-
chlorobenzene	<5.0	-	<5.0	-	<5.0	-
ethyl benzene	<5.0	-	<5.0	-	<5.0	-
styrene	<5.0	-	<5.0	-	<5.0	-
xylenes	<5.0	-	<5.0	-	<5.0	-

Appendix Table 5. Continued.

SAMPLE NUMBERS	OTR1	ORT7	ORT4	ORT8	ORT5	ORT9
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**5.78**	**5.73**	**5.45**	**5.43**	**5.22**	**5.20**

SEMI-VOLATILE ORGANIC COMPOUNDS (ug/kg)

phenol	<330	-	<1300	-	<1300	-
bis(2-chloroethyl)ether	<330	-	<1300	-	<1300	-
2-chlorophenol	<330	-	<1300	-	<1300	-
1,3-dichlorobenzene	<330	-	<1300	-	<1300	-
1,4-dichlorobenzene	<330	-	<1300	-	<1300	-
benzyl alcohol	<660	-	<2600	-	<2700	-
1,2-dichlorobenzene	<330	-	<1300	-	<1300	-
2-methylphenol	<330	-	<1300	-	<1300	-
bis(2-chloroisopropyl) ether	<330	-	<1300	-	<1300	-
3+4-methylphenol	<330	-	<1300	-	<1300	-
n-nitroso-di-n-propylamine	<330	-	<1300	-	<1300	-
hexachloroethane	<330	-	<1300	-	<1300	-
nitrobenzene	<330	-	<1300	-	<1300	-
isophorone	<330	-	<1300	-	<1300	-
2-nitrophenol	<330	-	<1300	-	<1300	-
2,4-dimethylphenol	<330	-	<1300	-	<1300	-
benzoic acid	<1700	-	<6600	-	<6600	-
bis(2-chloroethoxy)methane	<330	-	<1300	-	<1300	-
2,4-dichlorophenol	<330	-	<1300	-	<1300	-
1,2,4-trichlorobenzene	<330	-	<1300	-	<1300	-
naphthalene	<330	-	<1300	-	<1300	-
4-chloroaniline	<660	-	<2600	-	<2700	-
hexachlorobutadiene	<330	-	<1300	-	<1300	-
4-chloro-3-methylphenol	<660	-	<2600	-	<2700	-
2-methylnaphthalene	<330	-	<1300	-	<1300	-
hexachlorocyclopentadiene	<330	-	<1300	-	<1300	-
2,4,6-trichlorophenol	<330	-	<1300	-	<1300	-
2,4,5-trichlorophenol	<330	-	<1300	-	<1300	-
2-chloronaphthalene	<330	-	<1300	-	<1300	-
2-nitroaniline	<1700	-	<6600	-	<6600	-
dimethylphthalate	<330	-	<1300	-	<1300	-
acenaphthylene	<330	-	<1300	-	<1300	-
3-nitroaniline	<1700	-	<6600	-	<6600	-
acenaphthene	<330	-	<1300	-	<1300	-
2,4-dinitrophenol	<1700	-	<6600	-	<6600	-
4-nitrophenol	<1700	-	<6600	-	<6600	-
dibenzofuran	<330	-	<1300	-	<1300	-
2,4-dinitrotoluene	<330	-	<1300	-	<1300	-

Appendix Table 5. Continued.

SAMPLE NUMBERS	OTR1	ORT7	ORT4	ORT8	ORT5	ORT9
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**5.78**	**5.73**	**5.45**	**5.43**	**5.22**	**5.20**

SEMI-VOLATILE ORGANIC COMPOUNDS (ug/kg)

2,6-dinitrotoluene	<330	-	<1300	-	<1300	-
diethylphthalate	<330	-	<1300	-	<1300	-
4-chlorophenyl-phenyl ether	<330	-	<1300	-	<1300	-
fluorene	<330	-	<1300	-	<1300	-
4-nitroaniline	<330	-	<1300	-	<1300	-
4,6-dinitro-2-methylphenol	<1700	-	<6600	-	<6600	-
n-nitrosodiphenylamine	<330	-	<1300	-	<1300	-
4-bromophenyl-phenyl ether	<330	-	<1300	-	<1300	-
hexachlorobenzene	<330	-	<1300	-	<1300	-
pentachlorophenol	<1700	-	<6600	-	<6600	-
phenanthrene	940	-	<1300	-	<1300	-
anthracene	<330	-	<1300	-	<1300	-
di-n-butylphthalate	<330	-	<1300	-	<1300	-
fluoranthene	2600	-	1900	-	1700	-
pyrene	1200	-	<1300	-	<1300	-
butylbenzylphthalate	<330	-	<1300	-	<1300	-
3,3'-dichlorobenzidine	<660	-	<2600	-	<2700	-
benzo(a)anthracene	770	-	<1300	-	<1300	-
bis(2-ethylhexyl) phthalate	4100D	-	4100	-	2900	-
chrysene	1200	-	<1300	-	<1300	-
di-n-octyl phthalate	1600	-	1600	-	1600	-
benzo(b)fluoranthene	1200	-	<1300	-	<1300	-
benzo(k)fluoranthene	470	-	<1300	-	<1300	-
benzo(a)pyrene	790	-	<1300	-	<1300	-
indeno(1,2,3-cd)pyrene	460	-	<1300	-	<1300	-
dibenz(a,h)anthracene	<330	-	<1300	-	<1300	-
benzo(g,h,i)perylene	470	-	<1300	-	<1300	-

Appendix Table 5. Continued.

SAMPLE NUMBERS	OTR1	ORT7	ORT4	ORT8	ORT5	ORT9
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**5.78**	**5.73**	**5.45**	**5.43**	**5.22**	**5.20**
PCBs (ug/kg)						
PCB-1016	<770	<330	<160	<16	<170	<16
PCB-1221	<1500	<670	<310	<32	<330	<31
PCB-1232	<770	<330	<160	<16	<170	<16
PCB-1242	2900	1000	3000D	130	3000D	2100D
PCB-1248	<770	<330	<160	<16	<170	<16
PCB-1254	<770	<330	290P	25P	250P	160P
PCB-1260	<770	200P	<160	<16	<170	39P
OTHER ANALYSES						
arsenic - total (mg/kg)	<10	-	<10	-	<10	-
total organic carbon (mg/kg)	24,500	12,100	19,000	19,900	34,500	9,060
Grain size: percent sand/gravel	40.0	29.0	21.3	10.0	32.8	46.5
percent silt	51.9	58.5	66.3	66.3	56.2	45.2
percent clay	8.1	12.5	12.4	23.7	11.0	8.3

Results Flags:

B - Target compound was detected in the sample and was also found in the method blank above the normal Estimated Quantitation Limit.

D - Indicates that an additional dilution was necessary in order to quantitate the target result.

P - Indicates that there was a greater than 25% difference between the results determined from the primary and secondary G C columns. The value reported is the lower of the two results.

Appendix Table 6. Chemical analysis results of sediment collected in Sibley Creek , 1996.

Appendix Table 6. Sibley Creek sediment results from samples collected in October, 1996.

SAMPLE NUMBERS	ORT6	ORT2	ORT3	ORT10
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**0.82**	**0.04**	**0.04**	
LATITUDE	414145	414148	Duplicate	**Equipment**
LONGITUDE	833251	833201	of ORT2	**Rinsate**
VOLATILE ORGANIC COMPOUNDS (ug/kg)				**ug/l**
chloromethane	<1200	<1200	<1200	<10
bromomethane	<1200	<1200	<1200	<10
vinyl chloride	<1200	<1200	<1200	<10
chloroethane	<1200	<1200	<1200	<10
methylene chloride	210J	230JB	210J	<5.0
acetone	<1200	<1200	<1200	<10
carbon disulfide	<620	<620	<620	<5.0
1,1-dichloroethene	<620	<620	<620	<5.0
1,1-dichloroethane	<620	<620	<620	<5.0
1,2-dichloroethene (total)	<620	<620	<620	<5.0
chloroform	<620	<620	<620	<5.0
1,2-dichloroethane	<620	<620	<620	<5.0
2-butanone	<1200	<1200	<1200	<10
1,1,1-trichloroethane	<620	<620	<620	<5.0
carbon tetrachloride	<620	<620	<620	<5.0
vinyl acetate	<2500	<2500	<2500	<20
bromodichloromethane	<620	<620	<620	<5.0
1,1,2,2-tetrachloroethane	<620	<620	<620	<5.0
1,2-dichloropropane	<620	<620	<620	<5.0
trans-1,3-dichloropropene	<620	<620	<620	<5.0
trichloroethene	<620	<620	<620	<5.0
dibromochloromethane	<620	<620	<620	<5.0
1,1,2-trichloroethane	<620	<620	<620	<5.0
benzene	<620	<620	<620	<5.0
cis-1,3-dichloropropene	<620	<620	<620	<5.0
2-chloroethyl vinyl ether	<25,000	<25,000	<25,000	<200
bromoform	<620	<620	<620	<5.0
2-hexanone	<1200	<1200	<1200	<10
4-methyl-2-pentanone	<1200	<1200	<1200	<10
tetrachloroethene	<620	<620	<620	<5.0
toluene	<620	<620	<620	<5.0
chlorobenzene	<620	<620	<620	<5.0
ethyl benzene	<620	490J	500J	<5.0
styrene	<620	<620	<620	<5.0
xylenes	<620	1200	1200	<5.0

Appendix Table 6. Continued.

SAMPLE NUMBERS	ORT6	ORT2	ORT3	ORT10
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**0.82**	**0.04**	**0.04**	**Equipment Rinsate**
SEMI-VOLATILE ORGANIC COMPOUNDS (ug/kg)				**ug/l**
phenol	<13,000	<1300	<1300	<10
bis(2-chloroethyl)ether	<13,000	<1300	<1300	<10
2-chlorophenol	<13,000	<1300	<1300	<10
1,3-dichlorobenzene	<13,000	<1300	<1300	<10
1,4-dichlorobenzene	<13,000	<1300	<1300	<10
benzyl alcohol	<26,000	<2700	<2700	<20
1,2-dichlorobenzene	<13,000	<1300	<1300	<10
2-methylphenol	<13,000	<1300	<1300	<10
bis(2-chloroisopropyl) ether	<13,000	<1300	<1300	<10
3+4-methylphenol	<13,000	<1300	<1300	<10
n-nitroso-di-n-propylamine	<13,000	<1300	<1300	<10
hexachloroethane	<13,000	<1300	<1300	<10
nitrobenzene	<13,000	<1300	<1300	<10
isophorone	<13,000	<1300	<1300	<10
2-nitrophenol	<13,000	<1300	<1300	<10
2,4-dimethylphenol	<13,000	<1300	<1300	<10
benzoic acid	<66,000	<6600	<6700	<50
bis(2-chloroethoxy)methane	<13,000	<1300	<1300	<10
2,4-dichlorophenol	<13,000	<1300	<1300	<10
1,2,4-trichlorobenzene	<13,000	<1300	<1300	<10
naphthalene	<13,000	<1300	<1300	<10
4-chloroaniline	<26,000	<2700	<2700	<20
hexachlorobutadiene	<13,000	<1300	<1300	<10
4-chloro-3-methylphenol	<26,000	<2700	<2700	<20
2-methylnaphthalene	<13,000	<1300	<1300	<10
hexachlorocyclopentadiene	<13,000	<1300	<1300	<10
2,4,6-trichlorophenol	<13,000	<1300	<1300	<10
2,4,5-trichlorophenol	<13,000	<1300	<1300	<10
2-chloronaphthalene	<13,000	<1300	<1300	<10
2-nitroaniline	<66,000	<6600	<6700	<50
dimethylphthalate	<13,000	<1300	<1300	<10
acenaphthylene	<13,000	<1300	<1300	<10
3-nitroaniline	<66,000	<6600	<6700	<50
acenaphthene	<13,000	<1300	<1300	<10
2,4-dinitrophenol	<66,000	<6600	<6700	<50
4-nitrophenol	<66,000	<6600	<6700	<50
dibenzofuran	<13,000	<1300	<1300	<10

Appendix Table 6. Continued.

SAMPLE NUMBERS	ORT6	ORT2	ORT3	ORT10
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**0.82**	**0.04**	**0.04**	**Equipment Rinsate**
SEMI-VOLATILE ORGANIC COMPOUNDS (ug/kg)				**ug/l**
2,4-dinitrotoluene	<13,000	<1300	<1300	<10
2,6-dinitrotoluene	<13,000	<1300	<1300	<10
diethylphthalate	<13,000	<1300	<1300	<10
4-chlorophenyl-phenyl ether	<13,000	<1300	<1300	<10
fluorene	<13,000	<1300	<1300	<10
4-nitroaniline	<13,000	<1300	<1300	<10
4,6-dinitro-2-methylphenol	<66,000	<6600	<6700	<50
n-nitrosodiphenylamine	<13,000	<1300	<1300	<10
4-bromophenyl-phenyl ether	<13,000	<1300	<1300	<10
hexachlorobenzene	<13,000	<1300	<1300	<10
pentachlorophenol	<66,000	<6600	<6700	<50
phenanthrene	<13,000	<1300	<1300	<10
anthracene	<13,000	<1300	<1300	<10
di-n-butylphthalate	<13,000	<1300	<1300	<10
fluoranthene	<13,000	<1300	<1300	<10
pyrene	<13,000	<1300	<1300	<10
butylbenzylphthalate	<13,000	<1300	<1300	<10
3,3'-dichlorobenzidine	<26,000	<2700	<2700	<20
benzo(a)anthracene	<13,000	<1300	<1300	<10
bis(2-ethylhexyl) phthalate	<13,000	5900	5500	<10
chrysene	<13,000	<1300	<1300	<10
di-n-octyl phthalate	<13,000	<1300	<1300	<10
benzo(b)fluoranthene	<13,000	<1300	<1300	<10
benzo(k)fluoranthene	<13,000	<1300	<1300	<10
benzo(a)pyrene	<13,000	<1300	<1300	<10
indeno(1,2,3-cd)pyrene	<13,000	<1300	<1300	<10
dibenz(a,h)anthracene	<13,000	<1300	<1300	<10
benzo(g,h,i)perylene	<13,000	<1300	<1300	<10

Appendix Table 6. Continued.

SAMPLE NUMBERS	ORT6	ORT2	ORT3	ORT10
DATE SAMPLE COLLECTED	10/01/96	10/01/96	10/01/96	10/01/96
RIVER MILE	**0.82**	**0.04**	**0.04**	**Equipment Rinsate**
PCBs (ug/kg)				**ug/l**
PCB-1016	<160	<800	<160	<0.50
PCB-1221	<330	<1600	<320	<1.0
PCB-1232	<160	<800	<160	<0.50
PCB-1242	<160	2800	2000	<0.50
PCB-1248	<160	<800	<160	<0.50
PCB-1254	1400P	800P	600P	<0.50
PCB-1260	<160	<800	180	<0.50
OTHER ANALYSES				
arsenic - total (mg/kg)	<10	<10	<10	<0.1 mg/l
total organic carbon (mg/kg)	21,000	35,300	31,000	0.628 mg/l
Grain size: percent sand/gravel	49.5	3.4	3.1	-
percent silt	46.7	85.0	85.3	-
percent clay	3.8	11.6	11.6	-

Results Flags:

B - Target compound was detected in the sample and was also found in the method blank above the normal Estimated Quantitation Limit.

J - Indicates results below the Estimated Quantitation Limit and are considered estimated values.

P - Indicates that there was a greater than 25% difference between the results determined from the primary and secondary GC columns. The value reported is the lower of the two results.