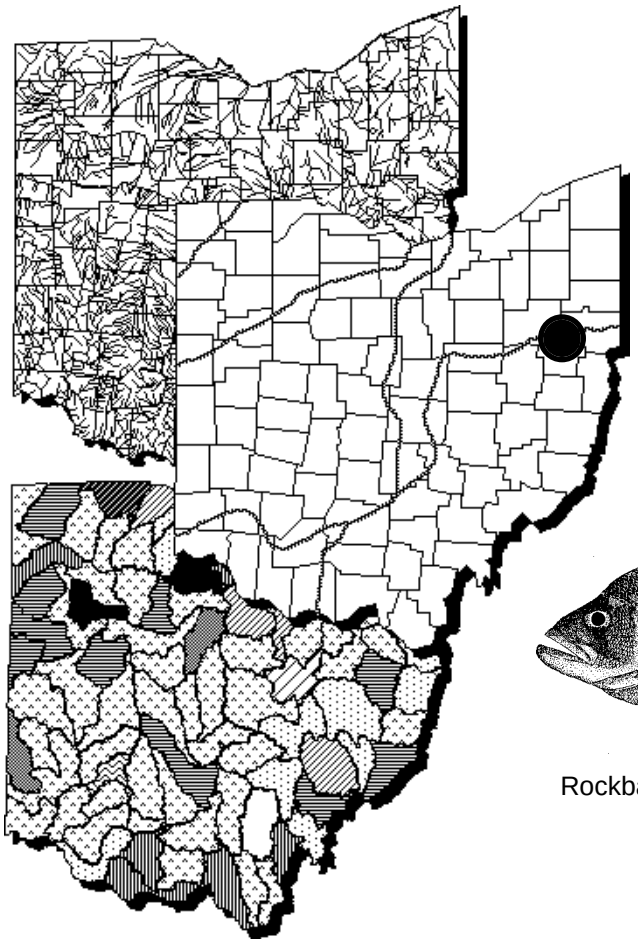
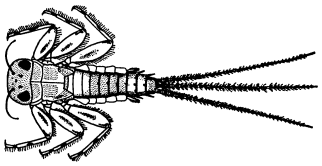
OhioEPA State of Ohio
Environmental Protection Agency

Ecological Assessment
Division of Surface Water

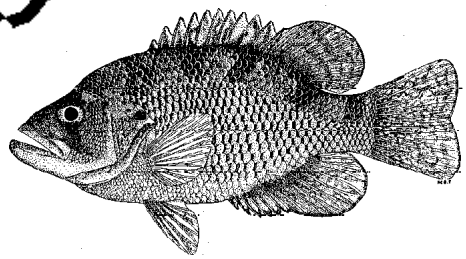
Biological and Water Quality Study of Sandy Creek 1996, 1997

Columbiana, Carroll and Stark Counties, Ohio





Mayfly *(Stenonema)*



Rockbass *(Ambloplites rupestis)*

March 4, 1998

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43266-1049

Biological and Water Quality Study of Sandy Creek

Minerva
1996, 1997

Carroll, Stark and Columbiana Counties, Ohio

March 4, 1998

OEPA Technical Report MAS/1997-3-1

prepared for

State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response
Northeast District Office

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Water
Monitoring and Assessment Section
1685 Westbelt Dr.
Columbus, Ohio 43228

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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 by writing to:

Ohio EPA, Division of Surface Water
Monitoring and Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228-3809
(614) 728-3377

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.

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

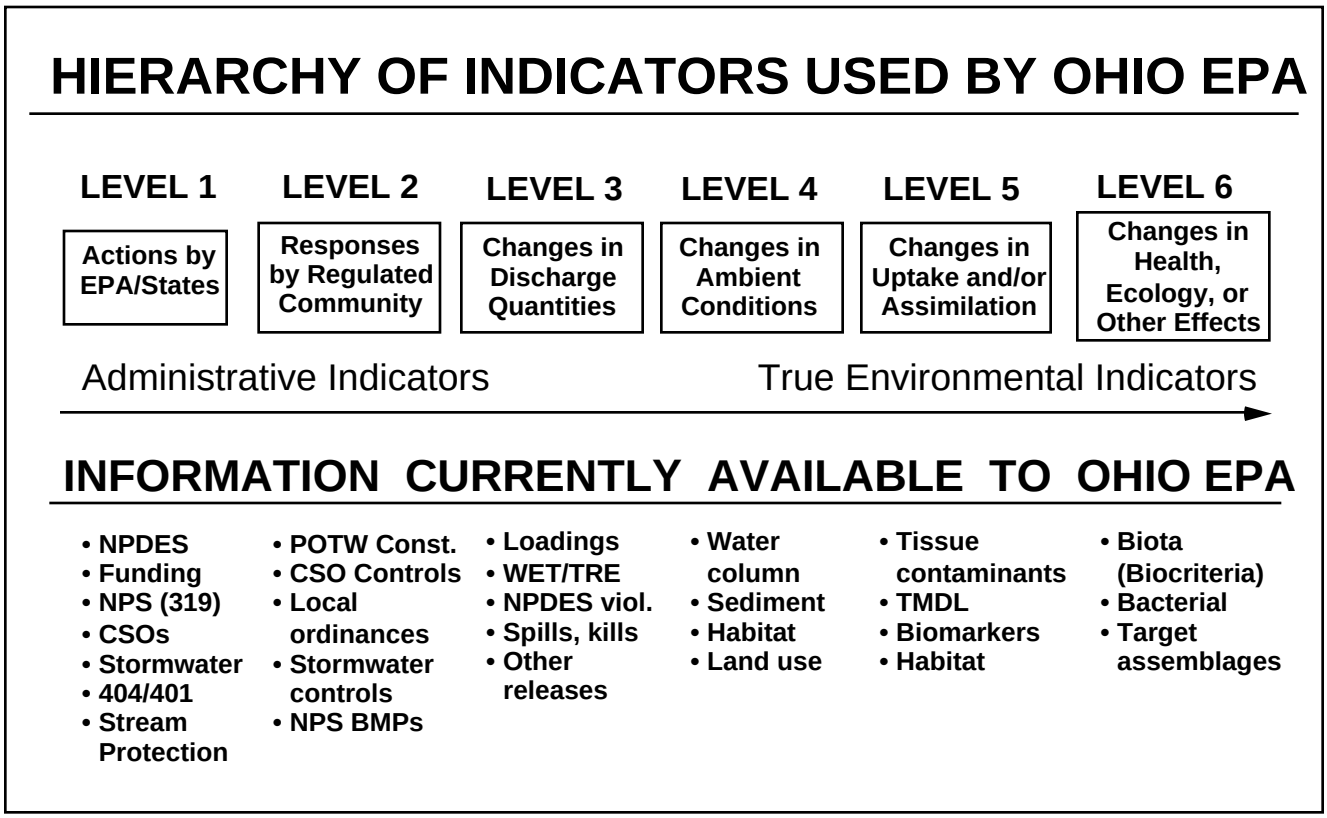

Figure I. Hierarchy of administrative and environmental indicators used by Ohio EPA for monitoring, assessment, reporting, and evaluating program effectiveness. This continuum is patterned after a model developed by U.S. EPA.

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 - David Altfater
Data Management - Dennis Mishne and Ed Rankin
Fish Data Analysis, Sediment, Pollutant Loadings - David Altfater
Macroinvertebrate Data Analysis - Bernie Counts
Reviewers - Chris Yoder, Jeff DeShon, and Marc Smith

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Biological and Sediment Quality Study of Sandy Creek (Carroll, Stark and Columbiana Counties, Ohio)

Ohio Environmental Protection Agency
Division of Surface Water
Monitoring and Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228

INTRODUCTION

The Sandy Creek study area included the mainstem river from East Rochester [river mile (RM) 35] to Waynesburg (RM 17).

Specific objectives of this evaluation were to:

1) measure and determine biological condition and sediment quality in Sandy Creek and the lower Still Fork in the vicinity of Minerva and Malvern,

2) determine the potential accumulation of contaminants in river sediments in the vicinity of Minerva,

3) measure and establish the level of bioaccumulative chemicals in selected bottom feeding and predator fish species from Sandy Creek and the lower Still Fork,

4) evaluate influences from municipal and industrial discharges to Sandy Creek,

5) determine the attainment status of the current WWH aquatic life use designation for Sandy Creek and the Still Fork within the study area, and

6) follow-up on conditions documented in the 1993 Ohio EPA survey (Ohio EPA 1995).

A fish tissue study was proposed for Sandy Creek in the Oneida area during May 1996. The study was initiated to collect fish for chemical analyses to supplement other types of sampling data (groundwater, surface water) from this area investigating a possible link between environmental contamination and a serious medical condition of two area infants. Results from this initial fish tissue study revealed a severely degraded fish community in Sandy Creek within the Oneida/Minerva section of stream. Additional sampling was proposed to determine both the extent and source of instream biological degradation in Sandy Creek.

The Sandy Creek watershed is located in the Erie-Ontario Lake Plain (EOLP) and Western Allegheny Plateau (WAP) ecoregions. Based on a review of stream attributes and ecoregion characteristics, Sandy Creek within the study area was evaluated using Erie-Ontario Lake Plain biocriteria (Ohio EPA 1995). Still Fork falls entirely within the WAP ecoregion. Sandy Creek and the Still Fork are currently assigned the Warmwater Habitat (WWH) aquatic life use.

SUMMARY / CONCLUSIONS

From June to October, 1996 staff from the Ohio EPA Divisions of Surface Water and Emergency and Remedial Response conducted biological community and fish tissue sampling on Sandy Creek and the Still Fork. In addition, sediment sampling was conducted in July 1996 by the U.S.EPA and the data are contained in this report. Three biological sampling locations were resampled in 1997 to evaluate potential stream improvements associated with the completion of upgrades at the Minerva WWTP. The results of these sampling events are summarized below.

- A substantial improvement in aquatic biological conditions occurred in Sandy Creek between 1996 and 1997, downstream from the Minerva WWTP. Fish and macroinvertebrate communities improved from non-attainment to partial attainment, and the improvement corresponded to a significant decrease in ammonia-N pollutant loadings from the Minerva WWTP during late 1996 and 1997.

- Non-attainment of the Warmwater Habitat (WWH) aquatic life use designation occurred during 1996 at all of the biological sampling sites located downstream from the Minerva Wastewater Treatment Plant (WWTP) (Table 2). Partial attainment of the WWH use was observed at the sampling location adjacent to the Minerva WWTP (RM 29.2) and full attainment was documented at all sites located upstream from the Minerva WWTP. Biological results from 1996 for the Sandy Creek study area indicated that 5.4 miles of river were in full attainment of the WWH use, 0.3 miles were in partial attainment, and 6.6 miles of river were not meeting the WWH use designation. The non-attainment status of the biological sampling locations was due primarily to the poor to very poor performance of the fish communities.

- The fish community sampling results indicated that prior to July 1996 (and possibly into July 1996) chemical contaminants were released into Sandy Creek in the vicinity of the Minerva WWTP, causing severely toxic conditions for at least 6.6 miles. The source or type of contamination is unknown. Chemical spills and wild animal kills have not been reported from Sandy Creek since 1994. However, highly toxic ammonia-N concentrations and loadings were discharged into Sandy Creek from the Minerva WWTP prior to 1997; this was particularly evident during the summer of 1995. Water quality modeling of the Minerva WWTP effluent calculated that the allowable average summer ammonia-N concentration discharged to Sandy Creek should be at or less than 4.0 mg/l; average concentrations during the summers of 1995 and 1996 were 28.1 mg/l and 8.3 mg/l, respectively.

- The macroinvertebrate community sampling in 1996 downstream from the Minerva WWTP indicated disturbed conditions with the community completely predominated by blackflies, organisms often found in high numbers in Ohio streams under degraded conditions. Conditions 3.6 miles downstream from the WWTP improved into the good range but still showed signs of a stressed community. The macroinvertebrate community at Malvern had declined back into the fair range with 84% of the community consisting of nutrient tolerant hydras. With the available data it was difficult to discern if the high numbers of blackflies

and hydras in Sandy Creek are indicators of a recovery from a recent kill-off or a community continuously stressed by high nutrient levels.

- Sediment and surface water sampling results were not reflective of contaminated conditions. Sediment results upstream and downstream from Minerva were comparable and were not considered excessively elevated. Overall water quality of the five surface water samples was good, with only fecal coliform from one sample exceeding Ohio's Water Quality Standards. Continuously recorded dissolved oxygen and conductivity measurements from Sandy Creek were within acceptable levels; however, a distinct decline in dissolved oxygen and increase in conductivity was noted downstream from the Minerva WWTP. Conductivity is a measure of the electrical resistance of water and is associated with the levels of various salts (eg. potassium, chloride, sulfate, calcium) in the water. The higher the level of salts (ionized) in water, the higher the conductivity.

- A previous study of Sandy Creek conducted in 1993 documented severe biological degradation immediately downstream from the Minerva WWTP. The impact during 1993 was primarily related to gross organic enrichment, although the severity of impact coupled with an observed fish kill suggested periodically lethal conditions downstream from the Minerva WWTP discharge. The condition of the biological communities during 1996, particularly fish communities, suggest that instream water quality conditions have not improved since 1993, and, in fact, have worsened.

- The highest PCB concentrations in fish occurred in common carp samples from RM 23.5, an area of Sandy Creek which is lake-like due to past quarrying operations in the stream channel and surrounding floodplain. All three common carp samples collected at RM 23.5 exceeded the Ohio Water Quality Standards for PCBs. Health effects from the consumption of fish from Sandy Creek is being evaluated by the Ohio Department of Health.

RECOMMENDATIONS

- Given the severe impacts observed in Sandy Creek downstream from Minerva and the highly elevated ammonia-N concentrations in the effluent of the Minerva WWTP prior to 1997, the requirement for ammonia-N limits at the facility should be investigated.

Table 1. Sampling locations in the Sandy Creek study area, 1996. Type of sampling included fish community (F), macroinvertebrate community (M), fish tissue (T), sediment (S), surface water chemistry (C) and dissolved oxygen (D).

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark	County	USGS 7.5 min. Quad. Map
Sandy Creek						
35.4	S	40°44'42"	81°02'06"	Augusta Road	Columbiana	Minerva, OH
34.7	F,T	40°44'46"	81°02'37"	West Township Park	Columbiana	Minerva, OH
30.5	F,M,T,D,S	40°44'00"	81°05'57"	Minerva City Park/ US30	Stark	Minerva, OH
29.5	F,M,D	40°43'20"	81°06'22"	NYC RR Trestle	Carroll	Minerva, OH
29.2	F,M,T	40°43'01"	81°06'29"	Ust. Minerva WWTP	Carroll	Minerva, OH
29.0	F,M	40°43'00"	81°06'30"	Minerva WWTP mix.zone	Carroll	Minerva, OH
28.9	F,M,D	40°43'00"	81°06'35"	Dst. Minerva WWTP	Carroll	Minerva, OH
28.2*	F,M,D	40°42'45"	81°07'08"	Summitville Tile	Carroll	Minerva, OH
27.8	F,T,S	40°42'51"	81°07'41"	State Route 183	Carroll	Malvern, OH
27.6	S	40°42'51"	81°07'54"	Dst. State Route 183	Carroll	Malvern, OH
25.4*	F,M	40°42'06"	81°09'00"	Oneida Sand/Gravel	Carroll	Malvern, OH
25.1	T,C,D,S	40°41'58"	81°09'04"	Blade Rd.	Carroll	Malvern, OH
24.1	F	40°41'31"	81°09'44"	Adj. ColForm	Carroll	Malvern, OH
23.5	T	40°41'31"	81°10'24"	Nat. Aggregates Quarry	Carroll	Malvern, OH
23.0	S	40°41'27"	81°10'51"	Reed Ave., Malvern	Carroll	Malvern, OH
22.4*	F,M,D	40°41'14"	81°11'11"	Malvern Ballfields	Carroll	Malvern, OH
22.1	T	40°41'08"	81°11'31"	Malvern WWTP	Carroll	Malvern, OH
18.1	D	40°40'17"	81°14'55"	Township 369	Stark	Malvern, OH
17.0	T	40°40'14"	81°15'47"	Waynesburg Park/ Dst. SR 183	Stark	Waynesburg, OH
Still Fork						
3.9	S	40°41'51"	81°04'11"	Arbor Road	Carroll	Minerva, OH
0.2	T	40°42'54"	81°06'23"	Minerva Sportsman Club	Carroll	Minerva, OH
0.1	F,M	40°42'59"	81°06'29"	At Mouth	Carroll	Minerva, OH
Middle Branch						
2.6	S	40°46'50"	81°04'14"	Essick Road	Columbiana	Homeworth, OH
Hugle Run						
0.7	S	40°43'10"	81°09'08"	Leisure Road	Carroll	Malvern, OH

* - fish and/or macroinvertebrate communities resampled during 1997.

Table 2. Aquatic life use attainment status for the Warmwater Habitat (WWH) use designation of Sandy Creek and the Still Fork based on data collected during June - August, 1996 and August - September, 1997.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI	QHEI[a]	Attainment Status[b]	Comment
Sandy Creek						
	Erie-Ontario Lake Plain - WWH Use Designation (Existing)					
1997						
28.2/28.2	28*	6.9*	32ns	-	PARTIAL	Improvement from 1996
25.4/25.4	30*	6.7*	36	-	PARTIAL	Improvement from 1996
- /22.4	-	-	38	-	(FULL)	Improvement from 1996
1996						
34.7/-	56	9.5	-	75.5	(FULL)	Upstream Minerva
30.5/30.7	46	8.9	44	74.0	FULL	Downstream TRW- Minerva
29.5/29.5	45	8.0	40	84.0	FULL	Upstream Minerva WWTP
29.2/29.2	35ns	7.1*	40	85.0	PARTIAL	Adjacent Minerva WWTP
29.0/29.0	*27*	*5.0*	*22*	*65.5*	*NA*	*Minerva WWTP mixing zone*
28.9/ -	25*	6.1*	-	77.5	**(NON)**	Downstream Minerva WWTP
28.2/28.2	17*	2.4*	26*	84.0	**NON**	Adj. Summitville Tile
27.8/ -	14*	3.5*	-	NA	**(NON)**	State Route 183
25.4/25.4	18*	3.7*	34	87.5	**NON**	@ Oneida
24.1/ -	12*	3.2*	-	NA	**(NON)**	Adj. Colform
22.4/22.4	22*	4.0*	26*	78.0	**NON**	Malvern
Still Fork						
	Western Allegheny Plateau - WWH Use Designation (Existing)					
1996						
0.1/0.1	30*	6.4*	28*	67.5	**NON**	@Mouth, dst. impoundments

Ecoregion Biocriteria: *Erie-Ontario Lake Plain (EOLP)*

INDEX	WWH	EWH	MWH[c]
IBI - Wading	38	50	24
MIwb - Wading	7.9	9.4	6.2
ICI	34	46	22

Ecoregion Biocriteria: *Western Allegheny Plateau (WAP)*

INDEX	WWH	EWH	MWH[c]
IBI - Wading	44	50	24/24
MIwb - Wading	8.4	9.4	6.2/5.5
ICI	36	46	22/30

(All criteria from the Ohio WQS: OAC 3745-1-07, Table 7-14)

* - Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns - Nonsignificant departure from ecoregion biocriterion for WWH (≤4 IBI or ICI units; ≤0.5 MIwb units).
NA -Biocriteria not applicable in mixing zones.
a - Qualitative Habitat Evaluation Index (QHEI) values based on Rankin (1989).
b - Attainment status based on one organism group is parenthetically expressed.
c - Modified Warmwater Habitat for channel modified areas/ mine affected areas.

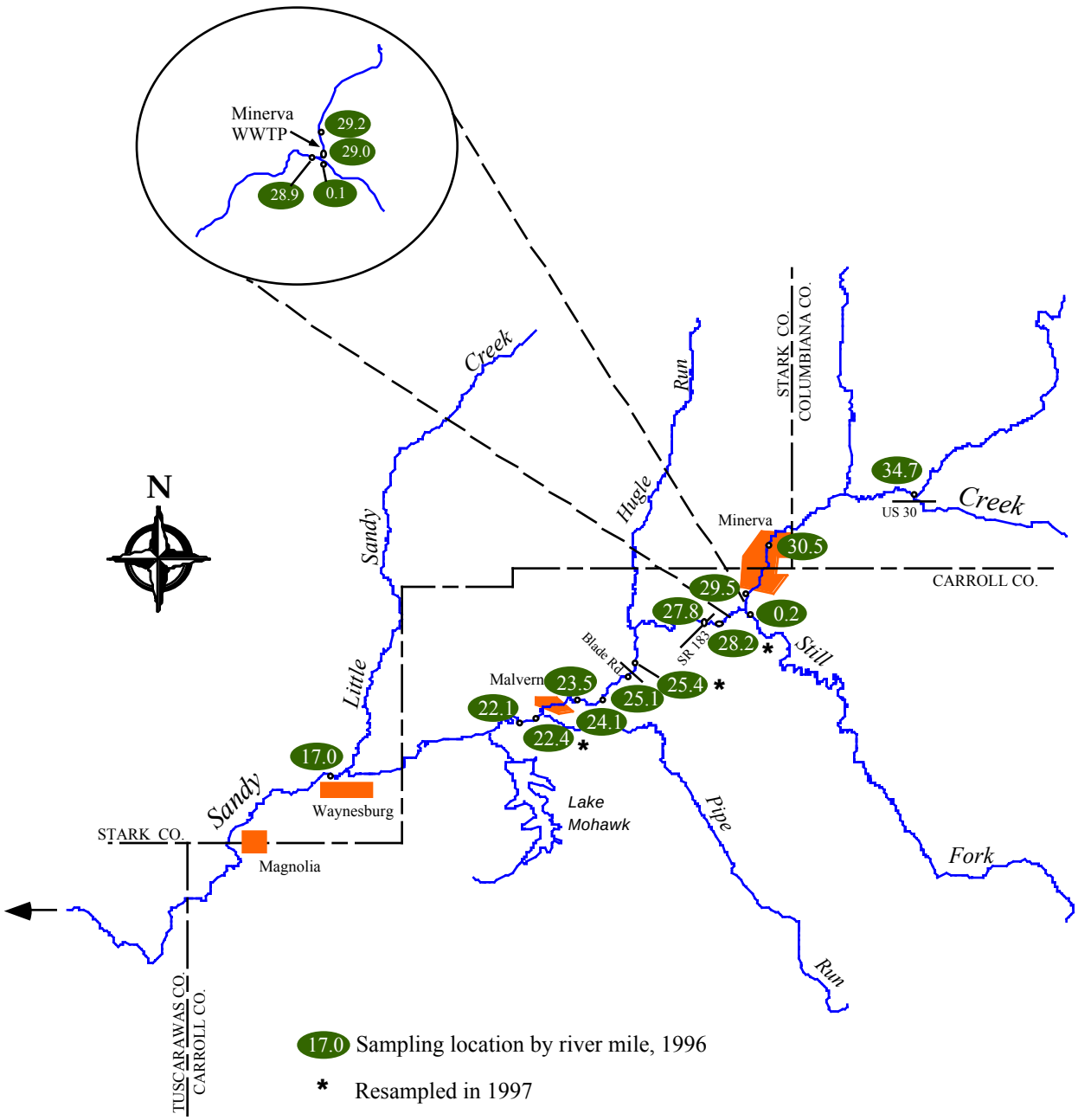

Figure 1. The upper Sandy Creek study area showing principal streams and tributaries, population centers, the Minerva WWTP, and stream sampling locations, 1996 and 1997.

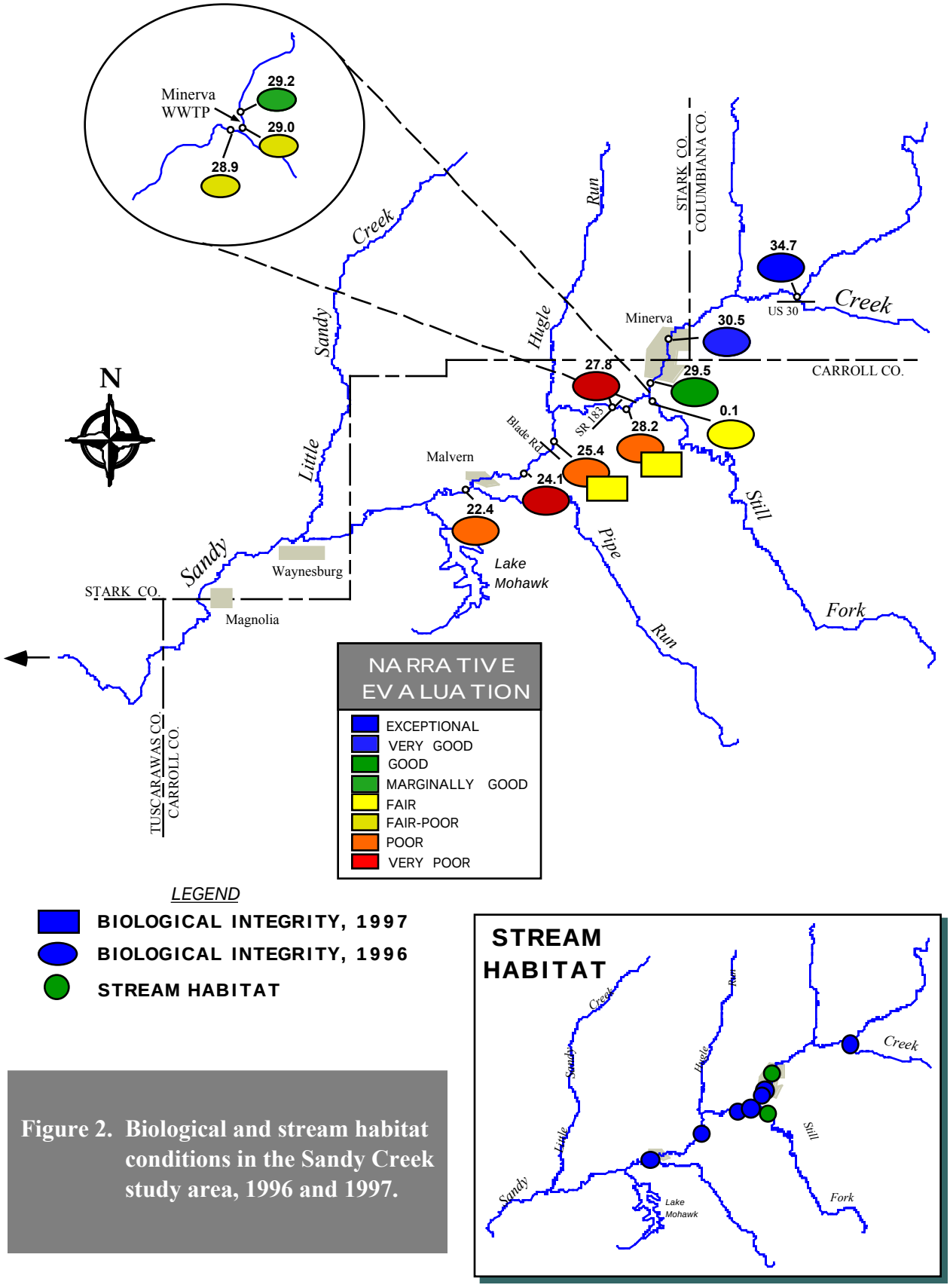

Figure 2. Biological and stream habitat conditions in the Sandy Creek study area, 1996 and 1997.

METHODS

All chemical, physical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to 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 of 1996 at eleven locations on Sandy Creek from river miles (RM) 34.7 to 22.4 and on the Still Fork at RM 0.1 (Table 1, Figure 1). Fish tissue samples were collected from eight sites on Sandy Creek and one location on the Still Fork. Sediment samples were collected by USEPA at six locations on Sandy Creek, and one location each from the Still Fork, Middle Branch and Hugle Run.Three sites (two for fish) were resampled in 1997 to assess any change in biological condition following completion of improvements at the Minerva WWTP. Three sites (two for fish) were resampled in 1997 to assess any change in biological condition following completion of improvements at the Minerva WWTP.

Determining Use Attainment Status

The attainment status of aquatic life uses (*i.e.,* full, partial, and non) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-17). The biological community performance measures which are 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 of the indices does not attain and performance is at least fair, and non-attainment 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 which 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 indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively by placing multiple-plate, artificial substrate samplers (modified Hester/Dendy) in stream for a six-week colonization period from July 10 to August 22, 1996; in conjunction, a qualitative assessment of the available natural substrates was conducted at the time of the artificial substrate retrieval. Macroinvertebrate sampling during 1997 occurred from August 15 to September 24 using the same methods as described for 1996.

Fish Community Assessment

Fish were sampled using the wading method pulsed DC electrofishing gear, used at a frequency of one or two samples at each site. Fish collections were made at each site from June to August using pulsed DC electrofishing gear, with sampling distances varying between 140 and 220 meters per location. Two fish sites from 1997 were sampled once (September 24) using the same methods and equipment as described for 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 arbiter of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (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 do not represent a true "cause and effect" analysis, but rather represent 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 which 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 at six locations on Sandy Creek, and one location each from the Still Fork, Middle Branch and Hugle Run by USEPA during July 1996. All sampling locations are indicated by river mile in Figure 1. Samples were analyzed for semivolatile organic compounds, volatile organic compounds, metals, PCBs and organochlorinated pesticides. Specific chemical parameters tested and results are listed in Table 3.

- Sediment samples 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. Based on the guidelines noted above, all Sandy Creek and Still Fork sediment samples exceeded the Lowest Effect Level for numerous metals and polycyclic aromatic hydrocarbon (PAH) compounds (Table 3). The guidelines detailed in Persaud *et al.* (1993) do not include evaluations of volatile organic compounds, several PAHs and metals, and most non-PAH semivolatile organic compounds.

- The sediment results from Sandy Creek did not indicate substantially increased levels of chemicals downstream from Minerva. Results upstream and downstream from Minerva were comparable and were not considered excessively elevated.

- Particle size and total organic carbon were not reported with test results. These parameters can have a substantial influence on the reported concentrations of chemicals in a sample.

Table 3. Chemical compounds detected in sediment samples collected by USEPA from Sandy Creek, the Middle Branch and the Still Fork, July 17-19, 1996. Measurements in **bold** exceed the Lowest Effect Level as detailed in Persaud *et al.* 1993. Parameters exceeding the Severe Effect Level are indicated by underlined **bold** numbers. Parameters in *italics* do not have review guidelines established in Persaud *et al.* 1993.

Parameter	Sandy Creek Sediment (River Mile) 35.4	30.4	27.8	27.6	25.1	23.0
Metals - Total (mg/kg)						
Aluminum	10,000	3,100	9,800	12,000	2,700	2,800
Barium	150	41	99	120	43	40
Beryllium	2.2	0.9	1.5	1.8	1.0	1.2
Chromium	16	**39**	19	21	4.8	5.7
Cobalt	25	6.6	12	21	5.6	5.6
Copper	**19**	5.5	**16**	**23**	7.7	8.5
Iron	**28,000**	17,000	**26,000**	**34,000**	**20,000**	**23,000**
Lead	25	**120**	**33**	**41**	10	20
Lithium	24	8.6	20	26	6.3	8
Manganese	**2,900**	**500**	**970**	**1,700**	**930**	**650**
Mercury	**0.2**	-	-	**0.2**	0.1	-
Nickel	**35**	13	**31**	**43**	13	12
Strontium	30	11	13	16	5.8	7.1
Titanium	47	16	27	17	16	16
Vanadium	23	7.4	20	21	8.4	8.1
Zinc	**150**	45	**120**	**160**	58	69
Volatile Organic Compounds (ug/kg)	NONE DETECTED					
Semivolatile Organic Compounds (ug/kg)						
4-Methylphenol	ND	ND	ND	350J	ND	ND
Naphthalene	580J	ND	ND	310J	ND	ND
2-Methylnaphthalene	1,600	ND	ND	490J	ND	ND
Acenaphthene	140J	ND	ND	ND	ND	ND
Dibenzofuran	530J	ND	ND	180J	ND	ND

Table 3. Continued.

Parameter	Sandy Creek Sediment (River Mile) 35.4	30.4	27.8	27.6	25.1	23.0
Semivolatile Organic Compounds (ug/kg)						
Fluorene	**200J**	ND	ND	140J	ND	ND
Phenanthrene	**2,700**	**630**	360J	**860J**	ND	ND
Anthracene	**550J**	200J	64J	ND	ND	ND
Di-n-butylphthalate	310J	130J	ND	270J	150J	120J
Fluoranthene	**3,100**	**1,100**	**800**	**1,200J**	130J	180J
Pyrene	**2,600**	**910**	**640J**	**940J**	110J	150J
Benzo(a)anthracene	**1,600**	**460J**	**340J**	**420J**	ND	99J
Bis(2-ethylhexyl)phthalate	720J	620	800	1,040J	250J	320J
Di-n-octylphthalate	ND	ND	160J	280J	ND	ND
Chrysene	**1,300**	**460J**	**350J**	**510J**	ND	90J
Carbazole	120J	97J	ND	ND	ND	ND
Benzo(b)fluoranthene	1,500	560J	400J	550J	84J	120J
Benzo(k)fluoranthene	**370J**	180J	170J	170J	ND	ND
Benzo(a)pyrene	**1,030J**	360J	270J	320J	ND	81J
Indeno(1,2,3-cd)pyrene	**920J**	**410J**	**330J**	**370J**	ND	107J
Benzo(g,h,i)perylene	**710J**	**340J**	**260J**	**310J**	ND	92J
Dibenzo(a,h)anthracene	**180J**	ND	ND	ND	ND	ND
PCBs (ug/kg)			NONE DETECTED			
Pesticides (ug/kg)						
Endosulfan sulfate	235D	6	563D	419D	10	20

Table 3. Continued.

Parameter	**Still Fork RM 3.9**	**Middle Branch RM 2.6**	**Hugle Run RM 0.7**
Metals - Total (mg/kg)			
Aluminum	12,000	2,200	2,900
Barium	120	26	19
Beryllium	1.5	0.6	0.5
Chromium	18	4.6	3.4
Cobalt	12	3.3	2.7
Copper	15	5.2	4.3
Iron	**22,000**	11,000	11,000
Lead	15	5.7	3.6
Lithium	27	4.8	6.4
Manganese	**980**	380	310
Mercury	**0.3**	0.06	-
Nickel	**22**	6.6	8
Strontium	17	7.2	3.9
Titanium	23	16	10
Vanadium	20	5.7	5.9
Zinc	92	25	25
Volatile Organic Compounds (ug/kg)		NONE DETECTED	
Semivolatile Organic Compounds (ug/kg)			
4-Methylphenol	ND	ND	ND
Naphthalene	ND	ND	ND
2-Methylnaphthalene	ND	ND	75J
Acenaphthene	ND	ND	ND
Dibenzofuran	ND	ND	ND

Table 3. Continued.

Parameter	Still Fork RM 3.9	Middle Branch RM 2.6	Hugle Run RM 0.7
Semivolatile Organic Compounds (ug/kg)			
Fluorene	ND	ND	ND
Phenanthrene	ND	ND	ND
Anthracene	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND
Fluoranthene	ND	ND	ND
Pyrene	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND
Bis(2-ethylhexyl)phthalate	ND	160J	720
Di-n-octylphthalate	ND	ND	ND
Chrysene	ND	ND	ND
Carbazole	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND
PCBs (ug/kg)		NONE DETECTED	
Pesticides (ug/kg)			
Endosulfan sulfate	ND	ND	7

ND - Not detected.
J - Estimated concentration.

Surface Water Chemistry

Surface water chemical analyses were conducted on samples collected from Sandy Creek at RM 25.1 (Blade Road) during 1996 and 1997. Four samples were collected between April 8 and December 4, 1996 and one was collected on March 15, 1997. Four samples were tested for ten different metal parameters, two samples were tested for organochlorinated pesticides, and one sample was tested for volatile organic compounds and semivolatile organic compounds. Results of these tests are reported in Table 4.

- The daily average flows as reported by the United States Geological Survey for October 1995 through September 1996 in Sandy Creek at RM 17.34 are shown in Figure 3. None of the stream flows during the June through September sampling period were less than Q7,10 or 80% flow duration values.

- Overall water quality of the five surface water samples was good, with only fecal coliform from one sample exceeding Ohio's WQS criteria. All other chemical parameters with associated water quality criteria were within acceptable levels. All PCB, pesticide, volatile and semivolatile organic compounds tested (143 measurements) were reported by the laboratory as non-detected. One cadmium value (1.0 ug/l) was elevated above background conditions; however, the concentration was less than the Ohio WQS criterion.

- Continuous dissolved oxygen, pH, and conductivity data were collected at seven locations in Sandy Creek from August 27 to 29, 1996 (Figure 4). Exceedances of Ohio WQS criteria were not detected; however, a distinct decline in dissolved oxygen and a well defined increase in conductivity were noted downstream from the Minerva WWTP and Still Fork confluence. Dissolved oxygen, conductivity, and pH measurements were representative of good water quality conditions. The data did appear to show distinct but relatively minor influences from the Minerva WWTP on the water quality of Sandy Creek.

Pollutant Loadings: 1986 - 1997

The Village of Minerva operates a wastewater treatment plant which provides secondary treatment of municipal and pretreated industrial wastewater. The plant discharges treated wastewater to Sandy Creek at RM 29.08, immediately upstream from the confluence with the Still Fork. Major improvements to the Minerva WWTP were completed in September, 1996. The improvements included influent pumps, fine screens, activated sludge aeration with new blowers and fine bubble diffusers, periphery feed circular final clarifiers, U-V disinfection, and effluent flow metering. Additional improvements included converting all abandoned settling tanks to sludge holding and digestion tanks. The Village is currently planning to install sludge dewatering equipment because the sludge can not be land applied due to nickel contamination. The production of a cake sludge will allow the disposal of the sludge at a nearby landfill. The design flow of the newly improved WWTP is 0.93 mgd; median effluent flow for 1996 and 1997 was 0.8 and 0.7 mgd, respectively.

Three major industrial contributors to the Minerva WWTP include Mascotech, PCC Airfoils and Minerva Dairy. Mascotech currently discharges all of its wastewater (0.03 mgd) into the Minerva sanitary sewers; only stormwater is now discharged to the Still Fork. Prior to 1996, Mascotech discharged 0.16 mgd of process wastewater to the Still Fork. The process wastewater from Mascotech is regulated by an Indirect Discharge Permit (IDP) issued by the Ohio EPA. The IDP includes local limits developed by the Village of Minerva. Effluent quality from the Mascotech facility has substantially improved since 1995, and the facility has demonstrated compliance with the local limits contained in the IDP. The Minerva Dairy discharges process wastewater into the

sanitary sewer system. Currently, Minerva Dairy is maintaining reasonable compliance with pretreatment permit limits. The Dairy is planning a significant improvement to their pretreatment wastewater plant which will allow the dairy to increase production. PCC Airfoil has experienced spikes in nickel discharged into the Minerva sanitary sewer system. During December 1995, a 24-hour composite sample of the PCC Airfoil discharge revealed a nickel concentration of approximately 5.0 mg/l. During the same time period, the Minerva WWTP influent had a nickel concentration of 0.5 mg/l. Recent improvements in waste stream segregation and pretreatment facilities at the PCC Airfoil facility have resulted in below detection readings for nickel in the discharge to the Minerva sanitary sewer.

A summary of the Minerva WWTP loadings of wastewater to Sandy Creek is depicted in Figures 5 and 6.

- Effluent loadings data from the Minerva WWTP revealed highly elevated levels of ammonia-N discharged into Sandy Creek from 1986 - 1989 and 1993 - 1996 . Particularly high was the ammonia-N third-quarter effluent loading during 1995, with 50th and 95th percentile values of 58.9 kg/day and 78.0 kg/day, respectively. The loadings results were based on ammonia-N 50th and 95th percentile effluent concentrations of 28.15 mg/l and 33.83 mg/l, respectively. These results revealed that little to no nitrification of effluent was occurring at the Minerva WWTP during 1995. Wastewater improvements completed in 1996 resulted in a substantial decline in both loadings and concentrations of ammonia-N in the effluent during 1997. Annual loadings of ammonia-N, based on 50th percentile values, declined from 58.9 kg/day in 1995, to 28.9 kg/day in 1996, and 1.1 kg/day in 1997. This decline represents a 98 percent reduction in ammonia-N loadings to Sandy Creek.

- $CBOD_5$ and TSS loadings data generally revealed a decline between 1986 and 1997, with the exception of highly elevated levels reported during 1993.

- Loadings of total nickel and total zinc did not reveal any consistent trend between 1986 and 1996. However, during 1997, total nickel concentrations in the effluent were reported at less than lab detection limits, resulting in no appreciable load of nickel into Sandy Creek.

Reports of chemical spills and wild animal kills are also indications of possible impacts due to pollutant loadings. Reviews were conducted for discharges and kills to Sandy Creek, Still Fork and other tributary streams to Sandy Creek within the study area as reported by the Ohio EPA Division of Emergency and Remedial Response and the Ohio DNR Division of Wildlife (Pollution Investigation Reports). Spills and kills are reported in Tables 5 and 6.

- Review of the reported spills revealed little available information, with the latest reported spill occurring in 1994. Wild animal kills have not been reported since 1993 (during the Ohio EPA survey).

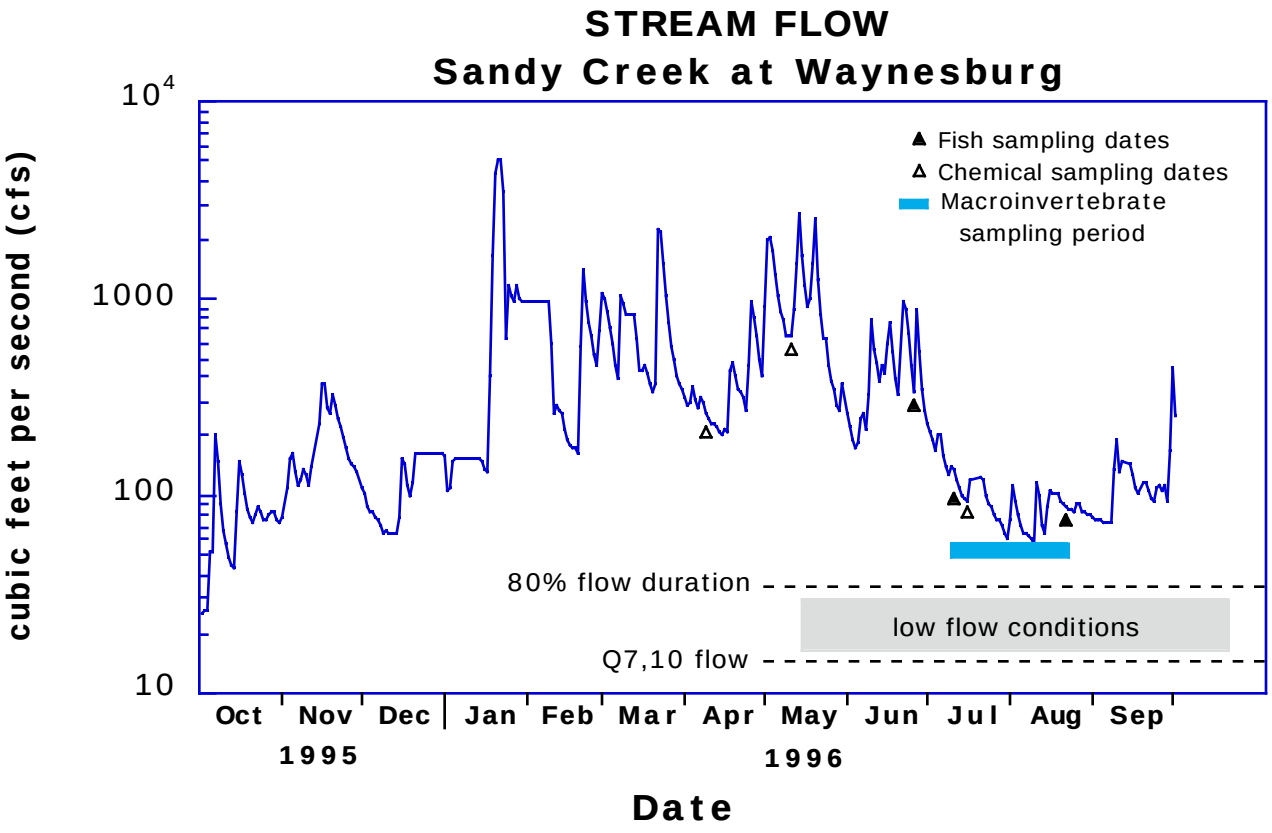

Figure 3. Flow hydrograph for Sandy Creek at Waynesburg (RM) October 1995 through September 1996. Sampling dates and May through November low-flow conditions ($Q_{7,10}$ to 80% duration flow) are indicated on the flow hydrograph.

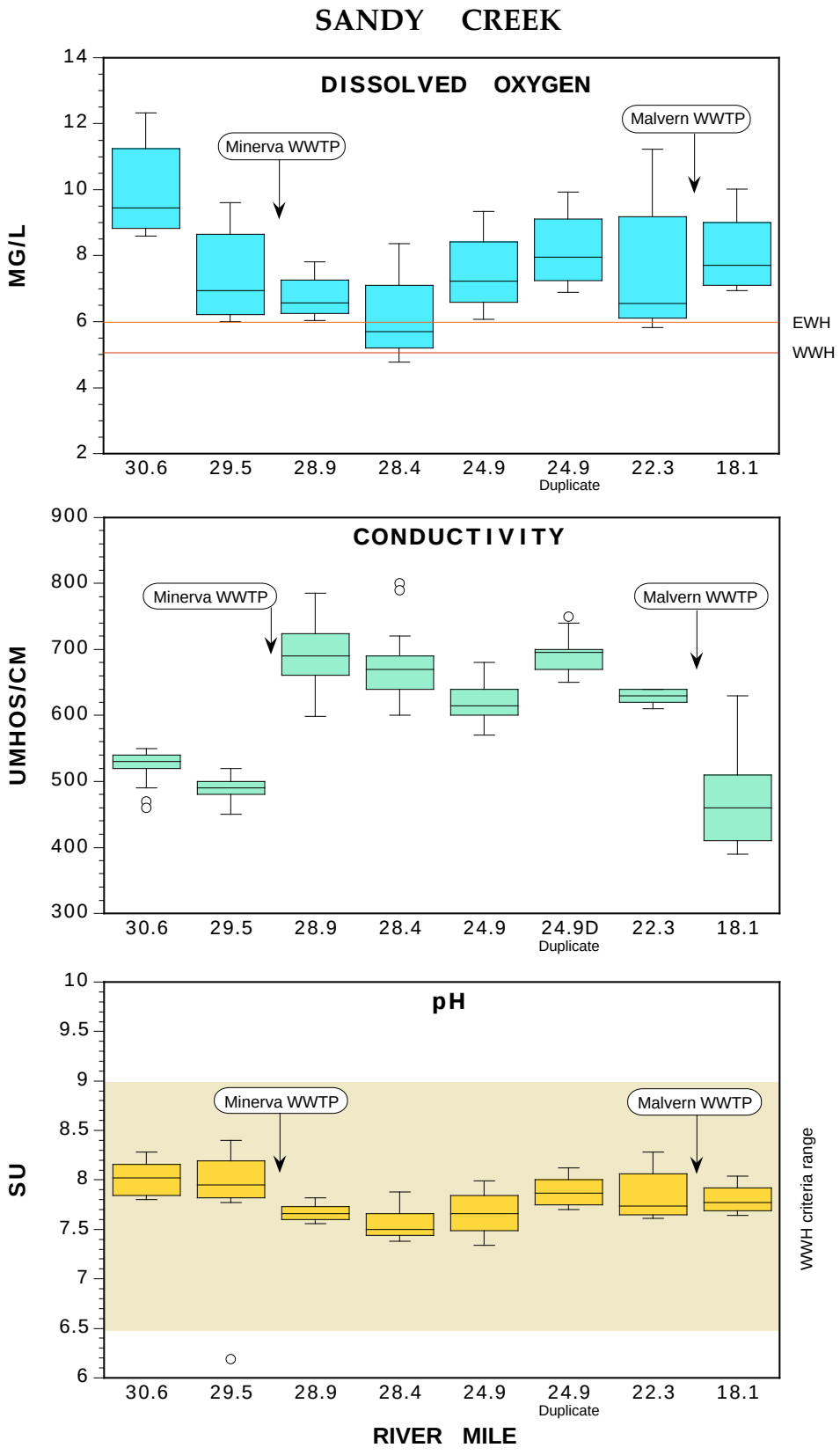

Figure 4. Boxplots of dissolved oxygen, pH, and conductivity recorded with Datasonde™ continuous monitors at seven locations in Sandy Creek during August 27-29, 1996. The dissolved oxygen criteria for WWH and EWH use designations are indicated by horizontal lines and the pH criteria range is shaded.

Table 4. Results of analyses of water samples collected by Ohio EPA from Sandy Creek during 1996 and March 1997 at RM 25.1 (Blade Road).

Parameter	Blade Road - Sandy Creek (RM 25.1) April 8 1996	May 10 1996	July 15 1996	Dec. 4 1996	March 5 1997
Semivolatile Organic Compounds (ug/l)					
Acenaphthene	ND	-	-	-	-
Acenaphthylene	ND	-	-	-	-
Anthracene	ND	-	-	-	-
Benzo(a)anthracene	ND	-	-	-	-
Benzo(a)pyrene	ND	-	-	-	-
Benzo(b)fluoranthene	ND	-	-	-	-
Benzo(g,h,i)perylene	ND	-	-	-	-
Benzo(k)fluoranthene	ND	-	-	-	-
Bis(2-chloroethoxy) methane	ND	-	-	-	-
Bis(2-chloroethyl) ether	ND	-	-	-	-
Bis(2-chloroisopropyl) ether	ND	-	-	-	-
Bis(2-Ethylhexyl) phthalate	ND	-	-	-	-
4-Bromophenyl phenyl ether	ND	-	-	-	-
Butyl benzyl phthalate	ND	-	-	-	-
4-Chloro-3-methylphenol	ND	-	-	-	-
2-Chloronaphthalene	ND	-	-	-	-
2-Chlorophenol	ND	-	-	-	-
4-Chlorophenyl phenyl ether	ND	-	-	-	-
Chrysene	ND	-	-	-	-
Di-n-butylphthalate	ND	-	-	-	-
Di-n-octyl phthalate	ND	-	-	-	-
Dibenz(a,h)anthracene	ND	-	-	-	-
1,3-Dichlorobenzene	ND	-	-	-	-
1,4-Dichlorobenzene	ND	-	-	-	-
1,2-Dichlorobenzene	ND	-	-	-	-
2,4-Dichlorophenol	ND	-	-	-	-
Diethylphthalate	ND	-	-	-	-
2,4-Dimethylphenol	ND	-	-	-	-
Dimethyl phthalate	ND	-	-	-	-
4,6-Dinitro-2-methylphenol	ND	-	-	-	-
2,4-Dinitrophenol	ND	-	-	-	-
2,6-Dinitrotoluene	ND	-	-	-	-
2,4-Dinitrotoluene	ND	-	-	-	-
Fluoranthene	ND	-	-	-	-
Fluorene	ND	-	-	-	-
Hexachlorobenzene	ND	-	-	-	-

Table 4. Continued.

Parameter	Blade Road - Sandy Creek (RM 25.1) April 8 1996	May 10 1996	July 15 1996	Dec. 4 1996	March 5 1997
Semivolatile Organic Compounds (ug/l)					
Hexachlorobutadiene	ND	-	-	-	-
Hexachlorocyclopentadiene	ND	-	-	-	-
Hexachloroethane	ND	-	-	-	-
Indeno(1,2,3-cd)pyrene	ND	-	-	-	-
Isophorone	ND	-	-	-	-
N-Nitroso-di-n-propylamine	ND	-	-	-	-
N-Nitrosodiphenylamine	ND	-	-	-	-
Naphthalene	ND	-	-	-	-
Nitrobenzene	ND	-	-	-	-
2-Nitrophenol	ND	-	-	-	-
4-Nitrophenol	ND	-	-	-	-
Pentachlorophenol	ND	-	-	-	-
Phenanthrene	ND	-	-	-	-
Phenol	ND	-	-	-	-
Pyrene	ND	-	-	-	-
1,2,4-Trichlorobenzene	ND	-	-	-	-
2,4,6-Trichlorophenol	ND	-	-	-	-
Volatile Organic Compounds (ug/l)					
Benzene	ND	-	-	-	-
Bromobenzene	ND	-	-	-	-
Bromochloromethane	ND	-	-	-	-
Bromodichloromethane	ND	-	-	-	-
Bromoform	ND	-	-	-	-
Bromomethane	ND	-	-	-	-
N-Butylbenzene	ND	-	-	-	-
Sec-Butylbenzene	ND	-	-	-	-
Tert-Butylbenzene	ND	-	-	-	-
Carbon tetrachloride	ND	-	-	-	-
Chlorobenzene	ND	-	-	-	-
Chloroethane	ND	-	-	-	-
Chloroform	ND	-	-	-	-
Chloromethane	ND	-	-	-	-
2-Chlorotoluene	ND	-	-	-	-
4-Chlorotoluene	ND	-	-	-	-
Dibromochloromethane	ND	-	-	-	-
1,2-Dibromo-3-chloropropane	ND	-	-	-	-
1,2-Dibromoethane	ND	-	-	-	-

Table 4.Continued.

Parameter	Blade Road - Sandy Creek (RM 25.1) April 8 1996	May 10 1996	July 15 1996	Dec. 4 1996	March 5 1997
Volatile Organic Compounds (ug/l)					
Dibromomethane	ND	-	-	-	-
1,2-Dichlorobenzene	ND	-	-	-	-
1,3-Dichlorobenzene	ND	-	-	-	-
1,4-Dichlorobenzene	ND	-	-	-	-
Dichlorodifluoromethane	ND	-	-	-	-
1,1-Dichloroethane	ND	-	-	-	-
1,2-Dichloroethane	ND	-	-	-	-
1,1-Dichloroethene	ND	-	-	-	-
Cis-1,2-dichloroethene	ND	-	-	-	-
Trans-1,2-dichloroethene	ND	-	-	-	-
1,2-Dichloropropane	ND	-	-	-	-
1,3-Dichloropropane	ND	-	-	-	-
2,2-Dichloropropane	ND	-	-	-	-
1,1-Dichloropropene	ND	-	-	-	-
Cis-1,3-dichloropropene	ND	-	-	-	-
Trans-1,3-dichloropropene	ND	-	-	-	-
Ethylbenzene	ND	-	-	-	-
Hexachlorobutadiene	ND	-	-	-	-
Isopropylbenzene	ND	-	-	-	-
4-Isopropyltoluene	ND	-	-	-	-
Methylene chloride	ND	-	-	-	-
Naphthalene	ND	-	-	-	-
N-Propylbenzene	ND	-	-	-	-
Styrene	ND	-	-	-	-
1,1,1,2-Tetrachloroethane	ND	-	-	-	-
1,1,2,2-Tetrachloroethane	ND	-	-	-	-
Tetrachloroethene	ND	-	-	-	-
Toluene	ND	-	-	-	-
1,2,3-Trichlorobenzene	ND	-	-	-	-
1,2,4-Trichlorobenzene	ND	-	-	-	-
1,1,1-Trichlorobenzene	ND	-	-	-	-
1,1,2-Trichlorobenzene	ND	-	-	-	-
Trichloroethene	ND	-	-	-	-
Trichlorofluoromethane	ND	-	-	-	-
1,2,3-Trichloropropane	ND	-	-	-	-
1,2,4-Trimethylbenzene	ND	-	-	-	-
1,3,5-Trimethylbenzene	ND	-	-	-	-
Vinyl chloride	ND	-	-	-	-
O-xylene	ND	-	-	-	-
Total m&p-xylenes	ND	-	-	-	-

Table 4. Continued.

Parameter	Blade Road - Sandy Creek (RM 25.1) April 8 1996	May 10 1996	July 15 1996	Dec. 4 1996	March 5 1997
Pesticides/ PCBs (ug/l)					
Aldrin	ND	ND	-	-	-
y-BHC	ND	ND	-	-	-
Dieldrin	ND	ND	-	-	-
Endrin	ND	ND	-	-	-
Heptachlor	ND	ND	-	-	-
Heptachlor epoxide	ND	ND	-	-	-
Hexachlorobenzene	ND	ND	-	-	-
Hexachlorocyclopentadiene	ND	ND	-	-	-
Methoxychlor	ND	ND	-	-	-
Alpha-chlordane	ND	ND	-	-	-
Gamma-chlordane	ND	ND	-	-	-
Cis-nonachlor	ND	ND	-	-	-
Trans-nonachlor	ND	ND	-	-	-
PCB-1016	ND	-	-	-	-
PCB-1221	ND	-	-	-	-
PCB-1232	ND	-	-	-	-
PCB-1242	ND	-	-	-	-
PCB-1248	ND	-	-	-	-
PCB-1254	ND	-	-	-	-
PCB-1260	ND	-	-	-	-
Metals					
Cadmium,total (ug/l)	<0.2	-	1.0	<0.2	<0.2
Calcium, total (mg/l)	42	-	60	27	26
Copper, total (ug/l)	<10	-	<10	<10	<10
Lead, total (ug/l)	3	-	4	2	<2
Magnesium, total (mg/l)	11	-	14	8	8
Mercury, total (ug/l)	<0.2	-	<0.2	<0.2	<0.2
Nickel, total (ug/l)	<40	-	<40	<40	<40
Potassium, total (mg/l)	3	-	3	4	3
Sodium, total (mg/l)	13	-	18	9	9
Zinc, total (ug/l)	51	-	<10	12	17
Field Measurements					
Conductivity (umhos/cm)	239	304	503	176	1814
Dissolved oxygen (mg/l)	11.3	8.3	7.5	11.3	10.9
pH (S.U.)	7.4	7.28	7.45	7.83	7.89
Water temperature (^{o}C)	4	18.5	20	3	5

Table 4. Continued.

Parameter	Blade Road - Sandy Creek (RM 25.1) April 8 1996	May 10 1996	July 15 1996	Dec. 4 1996	March 5 1997
Others					
Hardness, total $CaCO_3$ (mg/l)	150	-	207	100	98
Alkalinity, total $CaCO_3$ (mg/l)	77		128	44	49
Chloride (mg/l)	19	-	26	13	14
Nitrate-Nitrite, as N (mg/l)	1.60	1.76	1.00	2.89	2.49
Ammonia-nitrogen, as N (mg/l)	<0.05	0.06	<0.05	0.22	0.13
Total Kjeldahl Nitrogen (mg/l)	-	0.5	-	-	-
Phosphorus, total (mg/l)	-	0.12	-	-	-
Sulfate, SO_4 (mg/l)	74	-	80	50	41
Fecal coliform, MF (#/100 ml)	-	-	3,000*	200	-

ND - Compound not detected or less than detection limit.
* - Indicates an exceedance of the maximum Primary Contact Recreation criterion (set at 2,000 colonies/ 100 ml water).

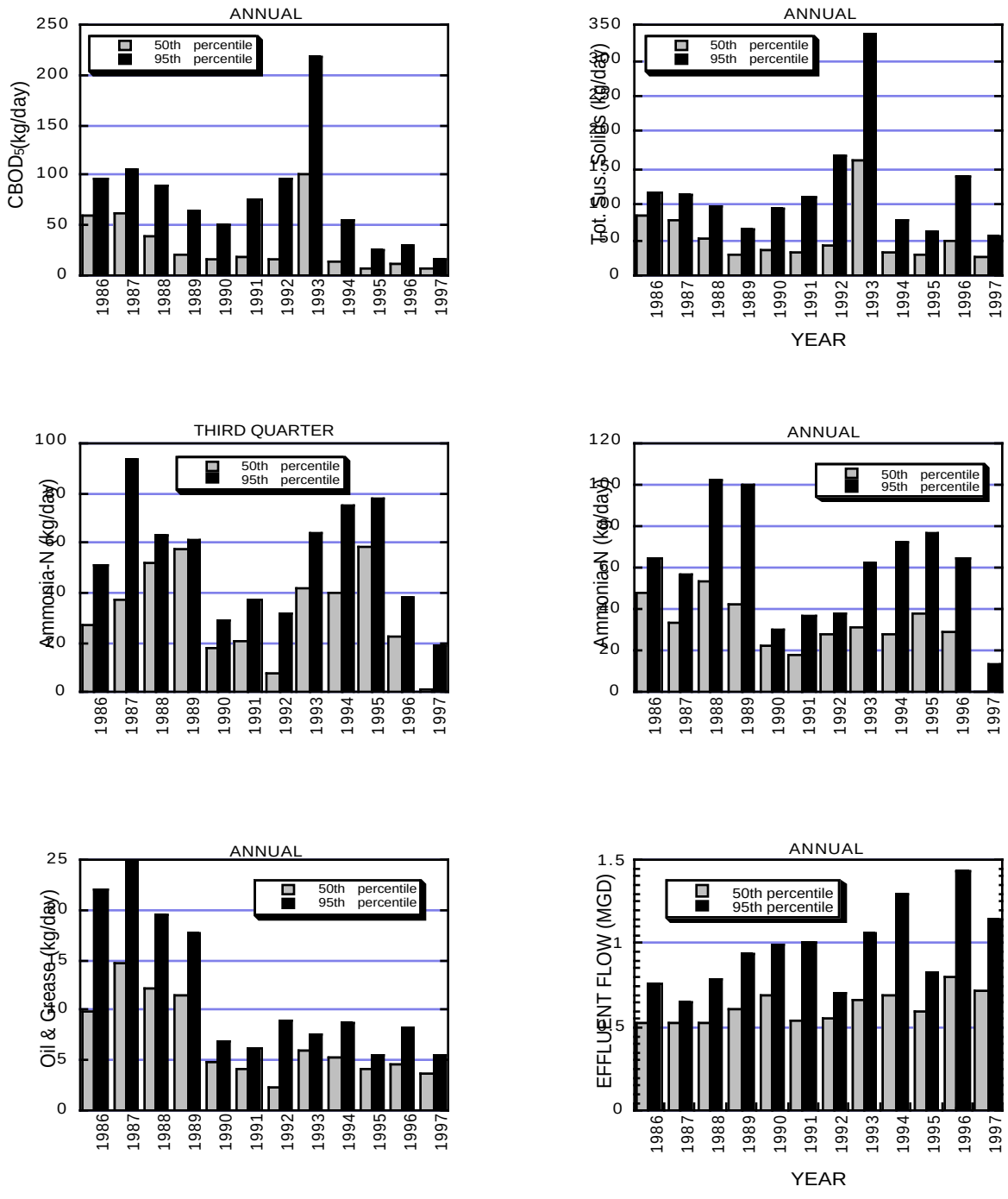

Figure 5. Annual loadings (kg/day) of ammonia-N, carbonaceous biochemical oxygen demand ($cBOD_5$), oil and grease, total suspended solids, and annual effluent flow from the Minerva WWTP, 1986-1997.

MINERVA WWTP

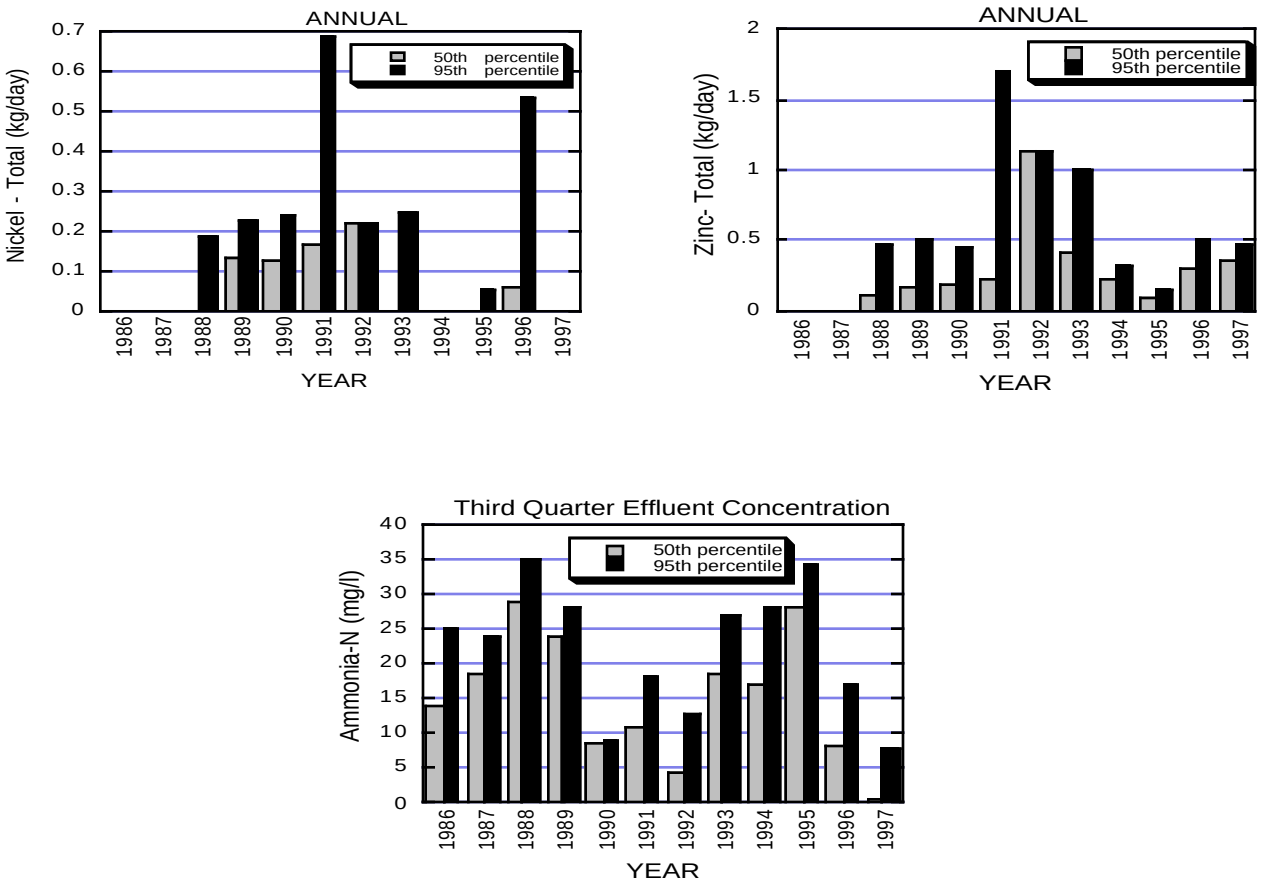

Figure 6. Annual loadings (kg/day) of total nickel and total zinc, and third-quarter ammonia-N concentrations of effluent from the Minerva WWTP, 1986-1997.

Table 5. Summary of pollutant discharges to Sandy Creek and selected tributaries reported to the Ohio EPA Division of Emergency and Remedial Response from 1989 - 1996. Only spills to Sandy Creek which occurred from the headwaters to Malvern were included in this table.

Date	Stream	Entity	Material	Amount	Units
10/31/94	Sandy Creek	Unknown	Hydrocarbon	Unk.	Unk.
04/14/94	Storm Sewer to Sandy Creek	Unkefer Trucking	Ethylene Glycol	Unk.	Unk.
			Motor Oil	Unk.	Unk.
10/19/93	Sandy Creek	Oneida Sand & Gravel	-	Unk.	Unk.
08/27/93	Sandy Creek	Minerva WWTP	-	Unk.	Unk.
07/27/93	Sandy Creek	Snyder Construction	-	Unk.	Unk.
06/28/93	Sandy Creek	Unknown	-	Unk.	Unk.
07/09/92	Sandy Creek	Colfor	-	Unk.	Unk.
07/28/91	Sandy Creek	Harry Green	-	Unk.	Unk.
07/22/91	Sandy Creek	Buckeye Mining Co.	-	Unk.	Unk.
03/29/90	Sandy Creek	Summitville Tile	-	Unk.	Unk.
01/30/89	Sandy Creek	Minerva Dairy	-	Unk.	Unk.
09/09/91	Still Fork	Unknown	-	Unk.	Unk.
06/11/91	Still Fork	Unknown	-	Unk.	Unk.
03/29/89	Still Fork	Burns Cold Forge	-	Unk.	Unk.

Table 6. Summary of wild animal kills in Sandy Creek and select tributaries from 1983 - 1996 as reported by the Ohio Department of Natural Resources.

Date	Stream	Pollutant	Number Killed
08/27/93*	Sandy Creek	sewage	>100
10/15/89	Sandy Creek	alkaline wastes	11,065
05/25/88	Sandy Creek	anhydrous ammonia	7,540
07/17/83	Still Fork	coal pile runoff	36,287

*Reported by Ohio EPA fish sampling crew.

Physical Habitat for Aquatic Life

Physical habitat was evaluated in Sandy Creek and the Still Fork at each 1996 biological sampling location (excluding RMs 27.8 and 24.1 in Sandy Creek). Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 7.

- Stream morphology in Sandy Creek within the study area is free-flowing and consists of pools interspersed with well developed riffle and run habitats. Bottom substrates are predominated by cobble and gravel, with lesser amounts of sand. Qualitative Habitat Evaluation Index (QHEI) scores for Sandy Creek within the study area ranged between 74.0 and 87.5, with a mean value of 80.7. These scores are indicative of good to excellent stream and riparian habitat and reflect conditions which are easily capable of supporting WWH and probably EWH stream fish communities.

- Still Fork habitat conditions were evaluated at the mouth (RM 0.1). Gravel and sand predominated the bottom substrates, with a moderate level of silt covering the bottom and substrates showing moderate embeddedness. The sampling station was essentially a large pool, with the one riffle present composed of primarily fractured concrete (an old dam in disrepair). A QHEI score of 67.5 was recorded in the Still Fork at RM 0.1, indicating the potential to fully support WWH biotas.

Table 7. Qualitative Habitat Evaluation Index (QHEI) showing warmwater and modified warmwater habitat characteristics for the Sandy Creek study area, 1993 and 1996.

			WWH Attributes										MWH Attributes																					
			High Influence										*Moderate Influence*																					
Key QHEI Components			No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max. Depth > 40 cm	Low/No Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	**Total H.L MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total M.L MWH Attributes**	**MWH H.L/WWH Ratio**	**MWH M.L/WWH Ratio**
River Mile	QHEI	Gradient (ft/mile)																																
(17-450) Sandy Creek																																		
Year: 96																																		
34.7	**75.5**	6.90	■	■		■	■	■		■	■	■	8						0								▲	▲				2	0.11	0.33
30.5	**74.0**	8.37	■	■		■	■	■	■	■	■	■	9						0									▲				1	0.10	0.20
29.5	**84.0**	9.05	■	■		■	■	■	■		■	■	8						0		▲							▲				2	0.11	0.33
29.2	**85.0**	9.05	■	■		■	■	■	■	■	■	■	9						0									▲				1	0.10	0.20
29.0	**65.5**	9.05	■	■		■		■			■	■	6						0				▲	▲			▲	▲				4	0.14	0.71
28.9	**77.5**	9.05	■	■		■	■	■	■		■		8						0									▲	▲			2	0.11	0.33
28.2	**84.0**	9.05	■	■		■		■	■		■	■	7						0				▲					▲				2	0.13	0.38
25.4	**87.5**	7.63	■	■		■	■	■	■	■	■	■	9						0									▲				1	0.10	0.20
22.4	**78.0**	0.89	■	■		■	■	■	■	■	■	■	9						0				▲									1	0.10	0.20
Year: 93																																		
33.1	**66.5**	6.90	■	■		■	■	■	■		■		7						0		▲		▲				▲	▲	▲			5	0.13	0.75
30.3	**70.5**	8.37		■		■		■		■	■		6						0		▲		▲	▲			▲		▲			5	0.14	0.86
29.4	**77.0**	9.05	■	■		■	■	■	■		■		7						0		▲		▲				▲	▲	▲			5	0.13	0.75
28.2	**83.0**	9.05	■	■		■	■	■	■		■		7						0		▲		▲					▲	▲			4	0.13	0.63
25.2	**78.5**	7.63	■	■		■	■	■	■	■	■		9						0					▲						▲		2	0.10	0.30
(17-470) Still Fork Sandy Creek																																		
Year: 96																																		
0.1	**67.5**	0.10	■	■		■		■			■	■	6						0		▲		▲	▲			▲	▲				5	0.14	0.86
Year: 93																																		
0.5	**40.0**	0.10	■					■			■		3	●					1		▲		▲	▲			▲	▲		▲		6	0.50	2.00

Macroinvertebrate Community

Macroinvertebrate communities were sampled in 1996 at seven locations in Sandy Creek from RM 30.7 to RM 22.4 and one location on the Still Fork at RM 0.1 (Table 1). In 1997, sampling was repeated at three locations downstream from the Minerva WWTP at RMs 28.2, 25.4, and 22.4. Summarized results from the macroinvertebrate sampling are compiled in Table 8 and Figure 7. ICI metrics and scores and raw data tables by river mile are attached as Appendix Tables 1 and 2. Included in Table 8 and Figure 7 are macroinvertebrate results collected in 1993 by the Ohio EPA. A detailed discussion of the 1993 data is provided in Ohio EPA (1995).

Sandy Creek

- The sampling data, from 1996, showed the presence of macroinvertebrate communities in the very good range in the upper reach (RMs 30.7 - 29.2) of the study area. ICI scores ranged from 44 at the Minerva High School (RM 30.7) to 40 at RM 29.2, just upstream from the Minerva WWTP discharge. These three sites were characterized by moderately high numbers of taxa but relatively low numbers of pollution sensitive mayflies and caddisflies. High numbers of the relatively pollution sensitive Chironomidae (midge) tribe Tanytarsini were present, comprising approximately 60% of the total organisms sampled at each site. The sites had low numbers of both pollution tolerant individuals and non-Tanytarsini dipterans and non-insects; both are negative ICI metrics. All three upstream sites exceeded the WWH ecoregional ICI biocriterion.

- The 1996 Minerva WWTP mixing zone sample (RM 29.0) resulted in an ICI score of 22 (fair). Although mixing zone sites are not measured against the biocriterion, the data provided a measure of community condition compared with the surrounding conditions. Dipterans, excluding Tanytarsini midges, and non-insects predominated the community making up 95% of the total organisms sampled with pollution tolerant individuals comprising 31% of the sample. The more sensitive Tanytarsini midges were almost completely absent.

- The site downstream from the WWTP (near Summitville Tile, RM 28.2), in 1996 showed a macroinvertebrate community in the fair range with an ICI score of 26, well below the WWH ecoregional biocriterion of 34. Non-Tanytarsini dipterans and non-insects predominated, comprising 64% of the sample. The site had low numbers of mayflies, caddisflies, and Tanytarsini midges. In the stream blackflies were present in extremely large numbers covering nearly all available structure. The blackfly genus *Simulium* is considered a pioneer group that can quickly move into nutrient degraded systems, reaching large numbers until other taxa can reestablish, competitively check the number of blackflies, and develop a more balanced aquatic community (Ward 1992). In 1997 the community had improved into the marginally good range with an ICI score of 32. Non-Tanytarsini dipterans and non-insects still predominated, comprising 72% of the sample. The number of blackflies was greatly reduced and the number of caddisflies improved substantially. However, number of mayflies was reduced both in taxa present and as a percentage of the total sample. The site did not meet the WWH ecoregional biocriterion in 1996 but in 1997 was in the range of nonsignificant departure.

- The macroinvertebrates improved in 1996 into the good range (ICI=34) at RM 25.4, 3.6 miles downstream from the Minerva WWTP discharge. The number of mayfly and caddisfly taxa increased to seven and five, respectively, though their total numbers were still low. The number of Tanytarsini midges increased to 20% of the total sample but non-Tanytarsini dipterans and non-insects still predominated the sample at 66%. Tolerant individuals made up only 0.7% of

the sample and EPT taxa richness of the qualitative sample increased to 11. The macroinvertebrate community showed an improvement compared with the site closer to the WWTP but the number of pollution sensitive taxa, as a percent of the total sample, remained low. Additionally, community quality continued to be at a level well below what was observed at the sites upstream from the WWTP. In 1997 the ICI score increased slightly to 36. The overall diversity improved, the numbers of mayflies and caddisflies increased, and the percent of non-Tanytarsini and non-insects was reduced. This site met the WWH ecoregional biocriterion in both 1996 and 1997.

- The site at Malvern (RM 22.4) declined into the fair range with an ICI score of 26 in 1996. Pollution sensitive taxa were low both in the number of taxa present and as a percent of the total sample. Non-Tanytarsini dipterans and non-insects made up 85% of the sample with the Cnidarian genus *Hydra* comprising 74%. EPT taxa richness of the qualitative sample was low with only 8 taxa present. A large part of the decline in the ICI score was attributable to the very high number of hydra, reducing the contribution that other groups made in the proportional metrics of the ICI. According to Slobodkin and Bossert (1991), hydras are not tolerant of heavy metals but do tolerate high nutrient levels. In 1997, although overall diversity remained the same, the ICI score improved to 38. This is a result of the considerable decline in the number of hydra and a significant increase in the numbers of mayflies and caddisflies. A reasonable explanation of the high number of hydra at this location is the presence upstream of a sand and gravel quarry located in the stream channel at RM 23.5. In general, hydras eat small open water plankters, e.g., Cladocera and Copepoda. Cladocerans and copepods are generally only abundant in lotic (running water) systems downstream from the outflow of a lake or impoundment (Hynes 1970). This quarry would act as a sink for the processing of nutrients originating from the Minerva WWTP effluent and with the reduced current velocities produce high concentrations of phytoplankton and associated zooplankton, i.e., protozoa, Rotifera, cladocerans, copepods, and other microcrustaceans. This would provide the food source for the high number of hydra found in Sandy Creek at this location. Sandy Creek at RM 22.4 did not meet the WWH ecoregional biocriterion in 1996 but with the improvement in the macroinvertebrate community in 1997 it exceeded the biocriterion.

Still Fork

- The lower reach of the Still Fork is impounded by two old lowhead dams, which makes the interpretation of the ICI score somewhat subjective since the current velocity was below the required minimum velocity for a valid sample. The current velocity over the artificial substrates, when set, was above the minimum velocity (0.3 ft/sec); however, when they were retrieved the flow was lower and the current velocity had dropped below the minimum. The overriding characteristic of the sample was the complete predominance of the genus *Hydra* with 32,160 individuals (84% of the sample); this genus along with non-Tanytarsini dipteran and other non-insect taxa, comprised 98% of the sample. There was a good number of caddisfly taxa but their numbers made up a very low percentage of the sample. As at the Sandy Creek site at Malvern, the high density of hydras is likely indicative of high nutrient inputs.

Table 8. Summary of macroinvertebrate data collected from artificial (quantitative) and natural (qualitative) substrates in Sandy Creek, 1996 and 1997. Sandy Creek has a Warmwater Habitat (WWH) aquatic life use designation in the Ohio Water Quality Standards.

			Quantitative Evaluation				
Stream/ River Mile	Relative Density	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Narrative Evaluation
Sandy Creek (1997)							
28.2	1292	56	38	34	6	32	Marginally Good
25.4	2388	62	43	38	10	36	Good
22.4	3899	59	37	33	6	38	Good
Sandy Creek (1996)							
30.7	1335	62	39	46	11	44	Very Good
29.5	1092	58	32	49	10	40	Good
29.2	3130	50	27	42	10	40	Good
*29.0*mz	*855*	*40*	*25*	*32*	*6*	*22*	*Fair*
28.2	702	50	29	40	9	26*	Fair
25.4	726	54	29	45	11	34	Good
22.4	3769	59	35	44	8	26*	Fair
Sandy Creek (1993)							
33.1	1943	80	49	61	13	50	Exceptional
30.4	749	67	40	54	12	34	Good
29.6	568	76	41	60	13	36	Good
28.3	2275	40	26	34	1	10*	Poor
25.1	8740	63	32	54	9	40	Good
Still Fork (1996)							
0.1	7619	62	34	47	5	28	Fair

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

INDEX	WWH	EWH	MWH[b]
ICI	34	46	22

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

INDEX	WWH	EWH	MWH[b]
ICI	36	46	22

a - EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa richness.
b - Modified Warmwater Habitat for channel modified areas.
* - Significant departure from ecoregional biocriterion (>4 ICI units); poor and very poor results are underlined.
ns - Nonsignificant departure from WWH or EWH biocriterion (≤4 IBI units or ≤0.5 MIwb units).
mz - Mixing zone sample.

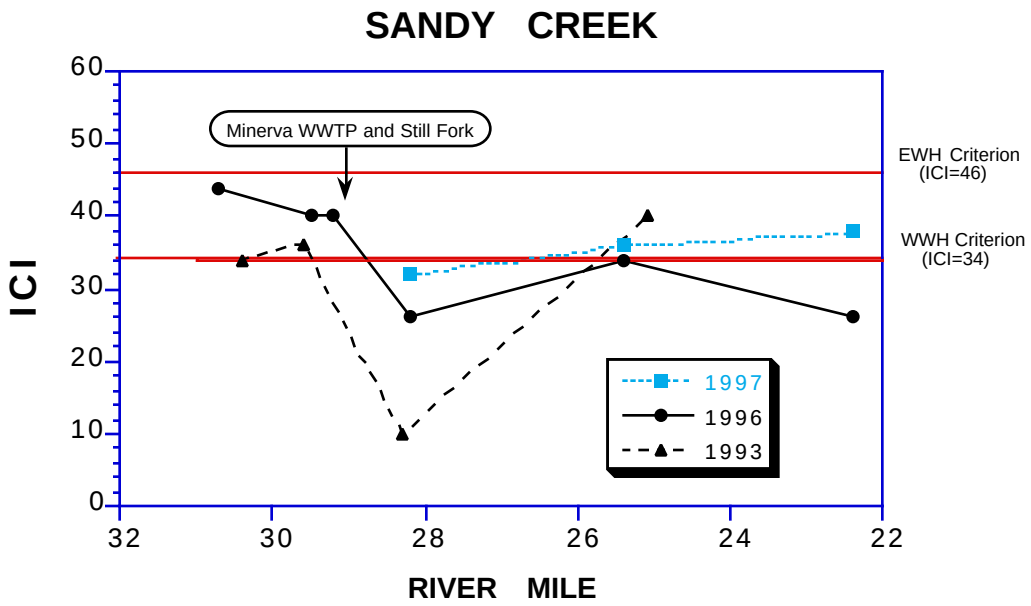

Figure 7. Longitudinal performance of the Invertebrate Community Index (ICI) in Sandy Creek for 1993, 1996 and 1997.

Fish Community

A total of 4,130 fish representing 36 species and four hybrids were collected from Sandy Creek and the Still Fork between June and August, 1996. The sampling effort included a cumulative distance electrofished of 3.65 km at twelve locations. (Table 9, Figure 8). Two sites were resampled in 1997. Relative numbers and species collected per location are presented in Appendix Table 3. Sampling locations were evaluated using Warmwater Habitat biocriteria.

Sandy Creek

- The fish communities from the three most upstream sampling locations (RMs 34.5 - 29.5; (West Township Park - East Rochester to NYC RR Trestle - Minerva) exhibited good to exceptional biological condition. The IBI (45 - 56) and MIwb (8.0 - 9.5) scores were good to exceptional and the entire stream reach achieved the applicable biocriteria.

- A decline in the fish community was noted at RM 29.2, an area immediately *upstream* from the Minerva WWTP 001 effluent discharge but influenced by sewage sludge overflows. The IBI (35) and MIwb (7.1) scores were marginally good to fair, and not fully achieving the appropriate biocriteria. Substantially lower scores were recorded for both indices from the sampling results in July compared to August.

- Fish communities exhibited substantial biological degradation downstream from the Minerva WWTP, where location averaged IBI (12-25) and MIwb (2.5-6.1) scores reflected very poor to fair conditions. Sampling at each location (downstream from the Minerva WWTP) in June and July produced extremely low index scores, with IBI (12-14) and MIwb (0.0-4.6) values indicating very poor water quality conditions, suggestive of toxic conditions instream. One station at RM 28.2 (0.8 miles downstream from the Minerva WWTP) was completely absent of fish during the July sampling, indicating acutely toxic conditions. Substantial improvement in the fish communities downstream from Minerva was noted in late August; however, results were still in the poor to fair range. Sandy Creek downstream from Minerva (RMs 28.9-22.4) was not achieving the applicable biocriteria.

- The fish community sampling results indicate that prior to July, 1996 (and possibly into July, 1996) chemical contaminants were released into Sandy Creek in the vicinity of the Minerva WWTP, causing severely toxic conditions instream.

- Fish community results from 1997 were improved from 1996. Index of Biotic Integrity and MIwb scores from the two sites resampled in 1997 (RMs 28.2 and 25.4) were in the fair range, a substantial increase from the very poor/poor results documented during 1996. However, the fish community results show that Sandy Creek downstream from the Minvera WWTP still is not achieving the applicable biocriteria.

Still Fork

- The fish community at the mouth of the Still Fork (RM 0.1) exhibited fair biological condition, with an IBI score of 30 and an MIwb score of 6.4. The lack of any well-developed riffles appeared to influence the results in this section of stream.

Table 9. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in Sandy Creek and Still Fork during July and August, 1996 and September, 1997. Additional historical data in presented for Sandy Creek and Still Fork from 1993. 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. Mixing zone samples are denoted by italics.

Stream RM	Sampling Method	Mean # Species	Total # Species	Mean Relative Number	Mean Relative Weight(kg)	QHEI	Mean Modified Index of Well Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Sandy Creek (1997)									
28.2	Wading -1	-	21	783	11.87	-	6.9*	28*	Fair
25.4	Wading -1	-	21	1115	8.60	-	6.7*	30*	Fair
Sandy Creek (1996)									
34.7	**Wading-1**	**-**	**25**	**987**	**16.75**	**75.5**	**9.5**	**56**	**Exceptional**
30.5	**Wading-2**	**21.5**	**25**	**1322**	**24.91**	**74.0**	**8.9**	**46**	**Very Good**
30.5 (July)			21	884	19.35		8.5	46	
30.5 (Aug)			22	1761	30.48		9.3	46	
29.5	**Wading-2**	**19.5**	**23**	**478**	**8.00**	**84.0**	**8.0**	**45**	**Good**
29.5 (July)			19	228	8.71		7.1	42	
29.5 (Aug)			20	727	7.29		8.9	48	
29.2	**Wading-2**	**15.5**	**20**	**241**	**4.31**	**85.0**	**7.1***	**35[ns]**	**Fair/Marg. Good**
29.2 (July)			12	110	2.85		6.2	30	
29.2 (Aug)			19	372	5.77		7.9	40	
29.0[mz]	***Wading-2***	***7.5***	***11***	***240***	***1.95***	***65.5***	***5.0***	***27***	***Mixing Zone***
28.9	**Wading-2**	**11.0**	**17**	**181**	**4.05**	**77.5**	**6.1***	**25***	**Poor/Fair**
28.9 (July)			6	41	0.29		4.6	14	
28.9 (Aug)			16	321	7.81		7.6	36	
28.2	**Wading-2**	**5.0**	**10**	**47**	**0.23**	**84.0**	**2.4***	**17***	**Very Poor**
28.2 (July)			0	0	0.00		0.0	12	
28.2 (Aug)			9	95	0.45		4.8	22	
27.8	**Wading-1**	**-**	**7**	**19**	**0.35**	**-**	**3.5***	**14***	**Very Poor**
25.4	**Wading-2**	**5.5**	**10**	**94**	**0.28**	**87.5**	**3.7***	**18***	**Very Poor/Poor**
25.4 (July)			3	6	0.15		1.9	12	
25.4 (Aug)			8	181	0.42		5.5	24	
24.1	**Wading-1**	**-**	**4**	**12**	**0.18**	**-**	**3.2***	**12***	**Very Poor**
22.4	**Wading-2**	**6.5**	**9**	**51**	**0.17**	**78.0**	**4.0***	**22***	**Very Poor/Poor**
22.4 (July)			5	50	0.06		2.7	14	
22.4 (Aug)			8	52	0.28		5.2	30	
Still Fork (1996)									
0.1	**Wading-2**	**15.5**	**19**	**259**	**7.68**	**67.5**	**6.4***	**30***	**Fair**
0.1 (July)			13	164	1.77		5.8	22	
0.1 (Aug)			18	354	13.59		6.9	38	

Table 9. Continued.

Stream RM	Sampling Method	Mean # Species	Total # Species	Mean Relative Number	Mean Relative Weight(kg)	QHEI	Mean Modified Index of Well Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Sandy Creek (1993)									
33.1		23.0	28	1463	26.93	66.5	7.6[ns]	44	Marg. Good/Good
30.3		22.0	25	1516	54.37	70.5	9.5	46	V.Good/Exceptional
29.4		23.5	28	938	46.08	77.0	8.4	39	Good
28.2		13.0	15	494	52.90	83.0	5.5*	23*	Poor
25.2		20.5	22	385	28.55	78.5	7.0*	33*	Fair
Still Fork (1993)									
5.7		17.0	20	297	24.55	29.5	7.1*	37*	Fair
0.5		12.5	13	618	46.56	40.0	7.9*	39[ns]	Fair/Marg. Good

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP)
(from Ohio Administrative Code 3745-1-07, Table 7-17)

INDEX	WWH	EWH	MWH[b]
IBI - Wading	38	50	24
MIwb - Wading	7.9	9.4	6.2

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

INDEX	WWH	EWH	MWH[b]
IBI - Wading	44	50	24
MIwb - Wading	8.4	9.4	6.2

* Significant departure from ecoregional biocriteria (>4 IBI units, >0.5 MIwb units); poor and very poor results are underlined.

ns Nonsignificant departure from biocriterion (≤4 IBI units, ≤0.5 MIwb units).

a Narrative evaluation is based on MIwb and IBI scores.

b Modified Warmwater Habitat for channel modified areas.

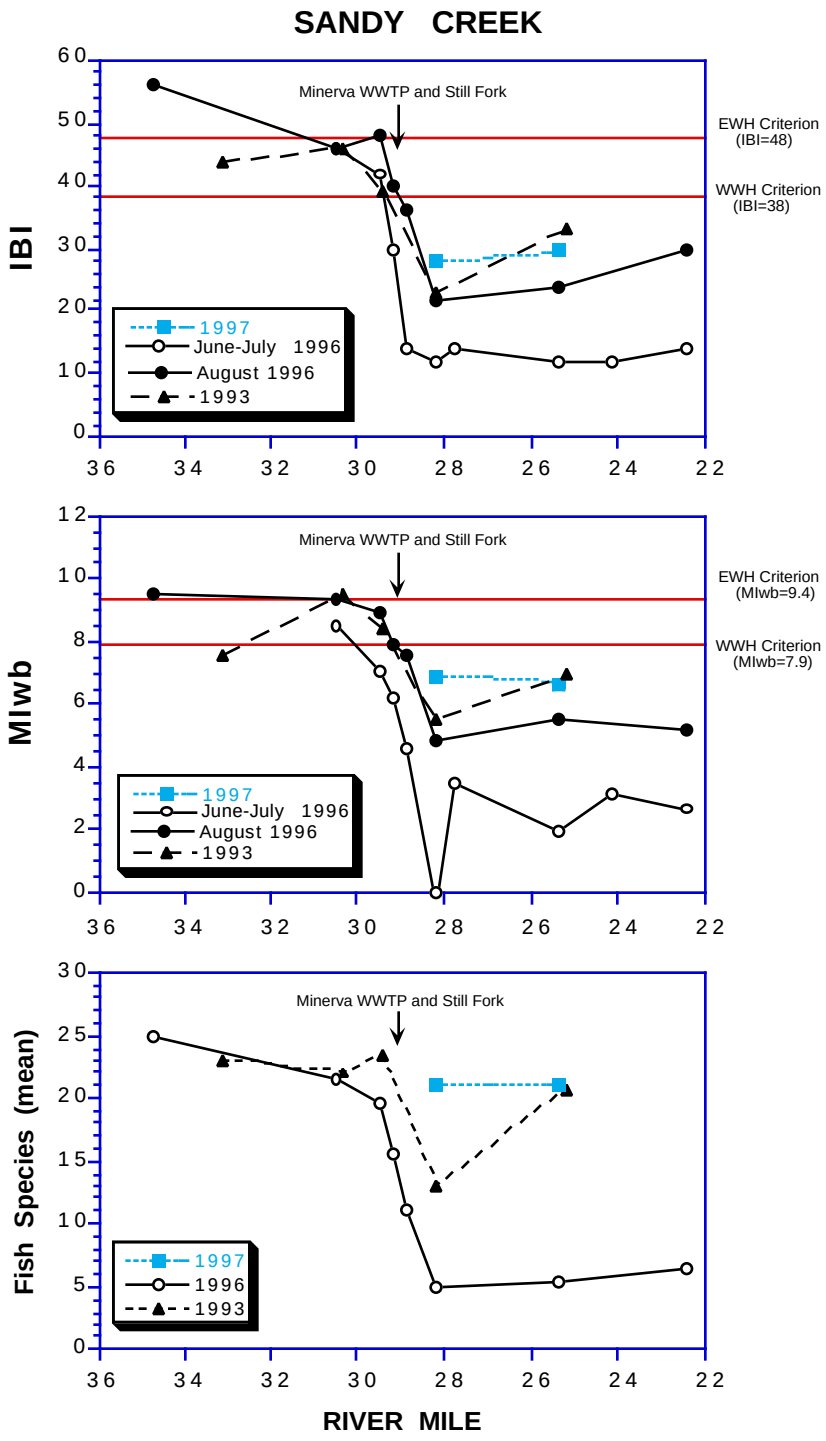

Figure 8. Longitudinal trend of the Index of Biotic Integrity (IBI), modified Index of Well-being (MIwb), and number of fish species from Sandy Creek, 1993,1996 and 1997.

Fish Tissue

Fish tissue samples were collected from eight locations in Sandy Creek and one location in the Still Fork during 1996 (Table 1). Whole body and fillet samples representing seven fish species were analyzed for PCBs, pesticides, semivolatile organic compounds, metals and percent lipid content (Appendix Tables 5 and 6).

- Percent lipid content was measured in all fish tissue samples collected. Lipids consist of fats and other substances of similar properties (insoluble in water, soluble in fat solvents, greasy to the touch). The ability of an organism to bioaccumulate lipophilic (compounds with a strong attraction for fats) organic chemicals is assumed to be proportional to its lipid content (USEPA 1993a). Since PCBs are lipophilic and lipid content varies between fish species and between individuals, lipid normalization is appropriate to characterize relative site contamination by PCBs.

- Table 10 and Figure 9 present a site-by-site comparison of lipid-normalized PCB concentrations, along with the actual total PCB concentration. The highest PCB normalized concentrations occur in common carp and white sucker; all largemouth bass samples (3 collected) did not have detectable levels of PCBs. Largemouth bass percent lipid contents were the lowest of all fish samples collected, with values ranging between 0.05% and 0.22%.

- The highest PCB concentrations occurred in common carp samples (fillets, whole body, and normalized) at RM 23.5, an area of Sandy Creek which is lake-like due to past quarrying operations in the stream channel and surrounding floodplain. All three common carp samples collected at RM 23.5 exceeded the Ohio WQS criterion for PCBs (any whole sample of any representative aquatic organism shall not exceed 640 ug/kg total PCBs, wet weight) .

- All other organic parameters appeared to be at low levels (most were reported as ‘non-detect’) in fish tissue, with detected organochlorine pesticides below screening values (concentrations of target analytes in fish that are of potential public health concern) recommended by USEPA (1993b).

- Arsenic and nickel measurements in fish tissue samples from Sandy Creek were all less than the lab detection limit. Most cadmium and lead samples were less than lab detection levels: of the detected values, the maximum cadmium and lead concentrations were 0.08 mg/kg and 0.7 mg/kg, respectively. Mercury and selenium were detected in all samples collected. A majority of the mercury values were detected at concentrations below 0.05 mg/kg and the majority of selenium concentrations were reported between 0.2 mg/kg and 0.3 mg/kg. All cadmium, mercury and selenium values were below USEPA screening values; arsenic, lead and nickel do not have USEPA screening values developed.

Table 10. Summary of PCB concentrations in fish tissue samples collected from Sandy Creek and the Still Fork during 1996. Tissue concentrations are in ug/kg. Underlined values exceed Ohio Water Quality Standards Criterion.

River Mile	Species	Fillet	Whole Body	PCB 1248	PCB 1254	PCB 1260	Total PCBs	PCBs Normalized[a]
Sandy Creek								
34.7	rockbass	-	√	nd	68	72	140	51
34.7	n. hog sucker	√	-	nd	nd	nd	nd	nd
34.7	white sucker	√	-	nd	30	20	50	114
30.5	n. hog sucker	√	-	nd	67	22	89	185
30.5	white sucker	√	-	nd	72	29	101	224
29.2	white sucker	-	√	nd	190	69	235	261
29.2	white sucker	√	-	nd	45	21	90	96
27.8	white sucker	√	-	nd	70	nd	70	51
27.8	common carp	√	-	nd	170	22	192	82
27.8	black bullhead	-	√	nd	33	nd	33	51
25.1	white sucker	√	-	nd	56	nd	56	37
23.5	white sucker	√	-	nd	33	nd	33	25
23.5	common carp	√	-	97	1300	140	<u>1537</u>	249
23.5	common carp	-	√	nd	900	320	<u>1220</u>	119
23.5	common carp	-	√	nd	1800	210	<u>2010</u>	557
23.5	bluegill	-	√	nd	120	110	230	91
23.5	largemouth bass	√	-	nd	nd	nd	nd	nd
23.5	largemouth bass	√	-	nd	nd	nd	nd	nd
22.1	n. hog sucker	√	-	nd	26	nd	26	22
22.1	white sucker	√	-	nd	33	nd	33	16
17.0	white sucker	√	-	nd	21	31	52	32
17.0	common carp	√	-	nd	120	33	153	40
Still Fork								
0.2	white sucker	√	-	nd	51	nd	51	38
0.2	largemouth bass	√	-	nd	nd	nd	nd	nd

a - Total PCB values are normalized to 1% lipids [(mg PCB/kg)/ % lipid].

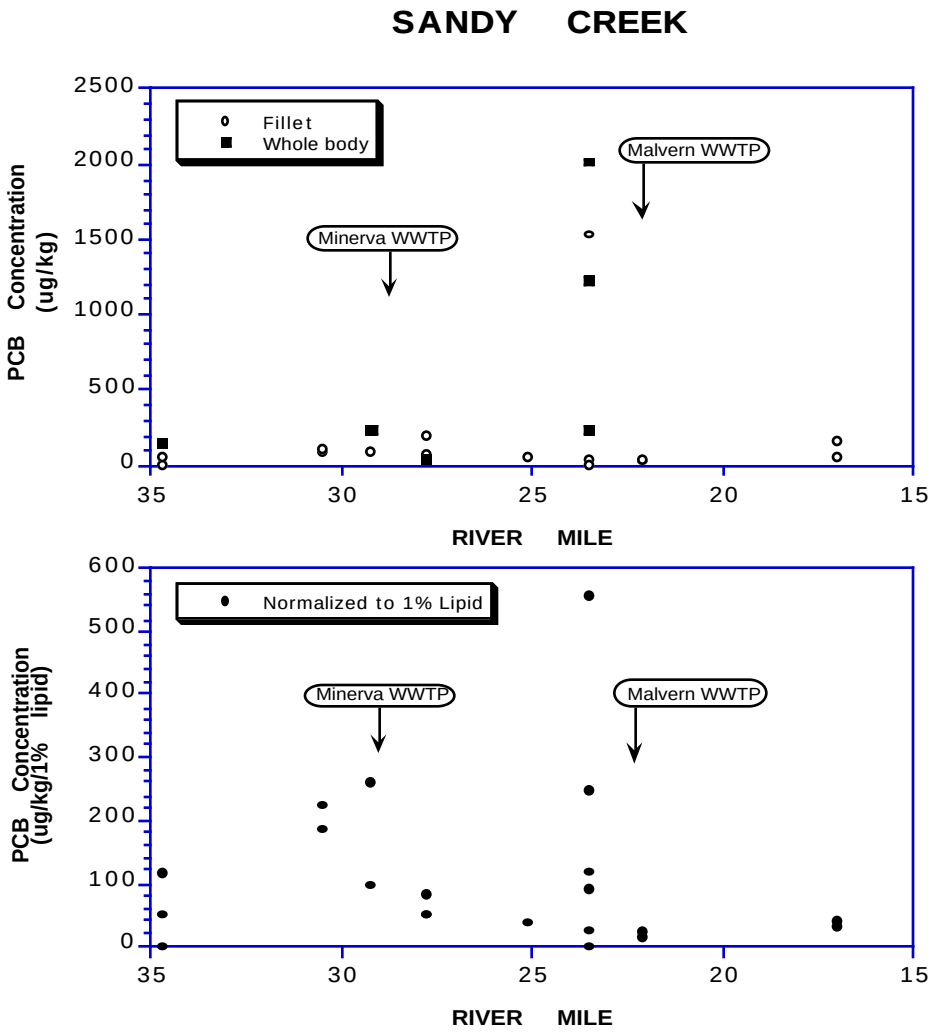

Figure 9. Scatter plots of PCB concentrations in fish tissue samples collected from Sandy Creek during 1996. The upper graph depicts actual PCB concentrations for fillet and whole body samples and the lower graph depicts all samples normalized to 1% lipid.

TREND ASSESSMENT

Changes in Macroinvertebrate Community Performance: 1993 - 1996, 1997

- The macroinvertebrate community in the upper reach of the study area (RM 29.6/29.5), consistently performed in the good range (1993 ICI = 36, 1996 ICI = 40). Immediately downstream from the Minerva WWTP (RM 28.3/28.2), the macroinvertebrate community improved from poor (1993 ICI = 10), to fair (1996 ICI = 26), to the good range in 1997 with an ICI score of 32. The macroinvertebrate community in the lower reach (RM 25.1/25.4) declined from an ICI score of 40 in 1993 to an ICI score of 34 in 1996 and improved slightly to an ICI score of 36 in 1997. Principally, the slight decline was the result of a steep drop in number of pollution sensitive Tanytarsini midges and a large increase in the number of blackflies (*Simulium sp.*) which suggested increased nutrient enrichment. The macroinvertebrate community at Malvern (RM 22.4) improved from the fair range (ICI = 26) in 1996 to the good range (ICI = 38) in 1997. This change was due primarially to a decline in the number of Hydra and an increase in the number of cadddisflies.

Changes in Fish Community Performance: 1993 - 1996, 1997

- The fish communities in Sandy Creek between RMs 34.5 and 22.4 were sampled during 1993 and 1996. The 1993 sampling revealed fish populations fully attaining the biological criteria upstream from the Minerva WWTP - sampling downstream documented communities in partial to non attainment of the WWH biocritera. Fish sampling during 1996 revealed similar results upstream from the Minerva WWTP, where full biological attainment prevailed. Downstream from the Minerva WWTP, significant degradation of the fish community was documented. The downstream fish communities during 1996 were more severely degraded than results reported for 1993. Area of Degradation Values (ADV) substantially increased during 1996 (Table 13), with 1996 IBI and MIwb ADVs per mile 2.8 to 3.8 times greater than from 1993.

- In Sandy Creek downstream from the Minerva WWTP, two sites sampled during 1996 were resampled in 1997. The 1997 data revealed a substantial improvement in community performance. Although the results from 1997 did not achieve the fish biocriteria, the communities improved from the very poor/poor range into the fair category.

Table 13. Area of Degradation (ADV) statistics for Sandy Creek, 1993 and 1996 (calculated using ecoregion biocriteria as the background community performance).

	Biological Index Scores				ADV Statistics		Attainment Status (miles)			
Stream Index	Upper RM .	Lower RM .	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	FULL	PARTIAL	**NON**	Poor/VP
Sandy Creek (1993)										
IBI			23	46	224	**28.0**				
MIwb	33.1	25.1	5.5	9.5	209	**26.1**	3.9	1.3	2.8	1.5
ICI			10	50	316	**39.5**				
Sandy Creek (1996)										
IBI			12	56	974	**79.2**				
MIwb	34.7	22.4	2.5	9.5	1229	**99.9**	5.4	0.3	6.6	6.5
ICI			22	44	108	**13.0**				

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Appendix Table 1. Raw macroinvertebrate data by river mile for the Sandy Creek study area, 1996 and 1997.

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/24/97 River Code: 17-450 River: Sandy Creek RM: 28.20

Taxa Code	Taxa	Quant/Qual
00556	*Ephydatia fluviatilis*	+
01320	*Hydra sp*	1
01801	*Turbellaria*	+
03121	*Paludicella articulata*	1
03600	*Oligochaeta*	28 +
06700	*Crangonyx sp*	4 +
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydracarina*	16 +
13400	*Stenacron sp*	+
17200	*Caenis sp*	21 +
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
45100	*Palmacorixa sp*	+
45300	*Sigara sp*	+
45400	*Trichocorixa sp*	+
47600	*Sialis sp*	+
52200	*Cheumatopsyche sp*	+
52430	*Ceratopsyche morosa group*	106 +
52530	*Hydropsyche depravata group*	153 +
52540	*Hydropsyche dicantha*	58 +
60300	*Dineutus sp*	+
65800	*Berosus sp*	1
68601	*Ancyronyx variegata*	1
68708	*Dubiraphia vittata group*	1
68901	*Macronychus glabratus*	5 +
69400	*Stenelmis sp*	6 +
71900	*Tipula sp*	2 +
74100	*Simulium sp*	24 +
74501	*Ceratopogonidae*	4
77500	*Conchapelopia sp*	61 +
77750	*Hayesomyia senata or Thienemannimyia norena*	30
77800	*Helopelopia sp*	357
78655	*Procladius (Holotanypus) sp*	+
80204	*Brillia flavifrons group*	46
80310	*Cardiocladius obscurus*	+
80420	*Cricotopus (C.) bicinctus*	15
80430	*Cricotopus (C.) tremulus group*	53
81465	*Orthocladius (O.) carlatus*	106 +
81631	*Parakiefferiella n.sp 1*	23
81632	*Parakiefferiella n.sp 2*	38
81825	*Rheocricotopus (Psilocricotopus) robacki*	15
82141	*Thienemanniella xena*	8
82220	*Tvetenia discoloripes group*	8
83040	*Dicrotendipes neomodestus*	30
83051	*Dicrotendipes simpsoni*	8
84460	*Polypedilum (P.) fallax group*	15 +
84888	*Xenochironomus xenolabis*	+
85500	*Paratanytarsus sp*	8
85800	*Tanytarsus sp*	8
86401	*Atherix lantha*	1 +
87540	*Hemerodromia sp*	27
94400	*Fossaria sp*	+
95100	*Physella sp*	+
96200	*Planorbella sp*	1
96900	*Ferrissia sp*	2 +

No. Quantitative Taxa: 38 Total Taxa: 56
No. Qualitative Taxa: 34 ICI: **32**
Number of Organisms: 1292 Qual EPT: 6

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/24/97 River Code: 17-450 River: Sandy Creek RM: 25.40

Taxa Code	Taxa	Quant/Qual
03600	*Oligochaeta*	116
06201	*Hyalella azteca*	+
06700	*Crangonyx sp*	12 +
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydracarina*	24 +
11130	*Baetis intercalaris*	68 +
11250	*Centroptilum sp (w/o hindwing pads)*	+
12200	*Isonychia sp*	1
13400	*Stenacron sp*	2
13561	*Stenonema pulchellum*	10 +
17200	*Caenis sp*	231 +
21200	*Calopteryx sp*	8 +
22300	*Argia sp*	4 +
23909	*Boyeria vinosa*	+
24900	*Gomphus sp*	+
45300	*Sigara sp*	+
45400	*Trichocorixa sp*	+
47600	*Sialis sp*	+
50804	*Lype diversa*	88
52200	*Cheumatopsyche sp*	124 +
52430	*Ceratopsyche morosa group*	259 +
52440	*Ceratopsyche slossonae*	40 +
52530	*Hydropsyche depravata group*	117 +
52540	*Hydropsyche dicantha*	62 +
56001	*Limnephilidae*	+
65800	*Berosus sp*	+
67750	*Sperchopsis tesselatus*	+
68130	*Helichus sp*	+
68700	*Dubiraphia sp*	4 +
68901	*Macronychus glabratus*	22 +
69400	*Stenelmis sp*	6 +
71900	*Tipula sp*	3 +
74100	*Simulium sp*	6 +
77355	*Clinotanypus pinguis*	+
77500	*Conchapelopia sp*	33
77750	*Hayesomyia senata or Thienemannimyia norena*	33
77800	*Helopelopia sp*	132
78450	*Nilotanypus fimbriatus*	22
80430	*Cricotopus (C.) tremulus group*	22
80570	*Doncricotopus bicaudatus*	44
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	22
81270	*Nanocladius (N.) spiniplenus*	22
81631	*Parakiefferiella n.sp 1*	11
81825	*Rheocricotopus (Psilocricotopus) robacki*	198
82200	*Tvetenia bavarica group*	11
82300	*Xylotopus par*	+
82730	*Chironomus (C.) decorus group*	+
84460	*Polypedilum (P.) fallax group*	66 +
84540	*Polypedilum (Tripodura) scalaenum group*	+
85500	*Paratanytarsus sp*	11
85615	*Rheotanytarsus distinctissimus group*	66
85625	*Rheotanytarsus exiguus group*	88
85800	*Tanytarsus sp*	132 +
85802	*Tanytarsus curticornis group*	+
85814	*Tanytarsus glabrescens group*	22
85840	*Tanytarsus guerlus group*	33
86100	*Chrysops sp*	+
86401	*Atherix lantha*	+
87540	*Hemerodromia sp*	66
95100	*Physella sp*	119
96264	*Planorbella (Pierosoma) pilsbryi*	1
96900	*Ferrissia sp*	27

No. Quantitative Taxa: 43 Total Taxa: 62
No. Qualitative Taxa: 38 ICI: **36**
Number of Organisms: 2388 Qual EPT: 10

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/24/97 River Code: 17-450 River: Sandy Creek RM: 22.40

Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	1144
01801	*Turbellaria*	+
03121	*Paludicella articulata*	7 +
03360	*Plumatella sp*	5
03600	*Oligochaeta*	66 +
05800	*Caecidotea sp*	+
06201	*Hyalella azteca*	3 +
06700	*Crangonyx sp*	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydracarina*	256
13400	*Stenacron sp*	+
13561	*Stenonema pulchellum*	6
17200	*Caenis sp*	324 +
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	4 +
24900	*Gomphus sp*	+
27500	*Somatochlora sp*	+
45100	*Palmacorixa sp*	+
45300	*Sigara sp*	+
47600	*Sialis sp*	+
50804	*Lype diversa*	26
52200	*Cheumatopsyche sp*	629 +
52430	*Ceratopsyche morosa group*	572 +
52530	*Hydropsyche depravata group*	126 +
52540	*Hydropsyche dicantha*	126
56001	*Limnephilidae*	+
59100	*Ceraclea sp*	2
60300	*Dineutus sp*	+
60900	*Peltodytes sp*	+
63300	*Hydroporus sp*	+
64050	*Liodessus sp*	+
65800	*Berosus sp*	2 +
68901	*Macronychus glabratus*	4
69400	*Stenelmis sp*	+
70600	*Antocha sp*	1
74100	*Simulium sp*	+
77750	*Hayesomyia senata or Thienemannimyia norena*	33
77800	*Helopelopia sp*	47
80430	*Cricotopus (C.) tremulus group*	2
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	12
81240	*Nanocladius (N.) distinctus*	2
81465	*Orthocladius (O.) carlatus*	12
81650	*Parametriocnemus sp*	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	36
83840	*Microtendipes pedellus group*	2
84300	*Phaenopsectra obediens group*	2
84460	*Polypedilum (P.) fallax group*	2
85500	*Paratanytarsus sp*	2
85615	*Rheotanytarsus distinctissimus group*	9
85625	*Rheotanytarsus exiguus group*	156 +
85800	*Tanytarsus sp*	9
85814	*Tanytarsus glabrescens group*	2
85840	*Tanytarsus guerlus group*	5
86401	*Atherix lantha*	1 +
87540	*Hemerodromia sp*	192
95100	*Physella sp*	+
96264	*Planorbella (Pierosoma) pilsbryi*	+
96900	*Ferrissia sp*	70
98600	*Sphaerium sp*	+

No. Quantitative Taxa: 37 Total Taxa: 59
No. Qualitative Taxa: 33 ICI: **38**
Number of Organisms: 3899 Qual EPT: 6

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/22/96 River Code: 17-450 River: Sandy Creek RM: 30.70

Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	8
03600	*Oligochaeta*	8
06700	*Crangonyx sp*	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydracarina*	4
11120	*Baetis flavistriga*	21 +
11130	*Baetis intercalaris*	123 +
13400	*Stenacron sp*	103 +
13540	*Stenonema mediopunctatum*	69 +
13561	*Stenonema pulchellum*	161 +
17200	*Caenis sp*	37 +
18600	*Ephemera sp*	+
21200	*Calopteryx sp*	1
22001	*Coenagrionidae*	4
23909	*Boyeria vinosa*	+
45100	*Palmacorixa sp*	+
47600	*Sialis sp*	1 +
52200	*Cheumatopsyche sp*	148 +
52430	*Ceratopsyche morosa group*	170 +
52530	*Hydropsyche depravata group*	5 +
57900	*Pycnopsyche sp*	+
60300	*Dineutus sp*	+
63900	*Laccophilus sp*	+
68708	*Dubiraphia vittata group*	+
68901	*Macronychus glabratus*	9 +
69400	*Stenelmis sp*	4 +
70600	*Antocha sp*	1
71900	*Tipula sp*	+
74100	*Simulium sp*	28 +
77500	*Conchapelopia sp*	33 +
77750	*Hayesomyia senata or Thienemannimyia norena*	67 +
77800	*Helopelopia sp*	100
78450	*Nilotanypus fimbriatus*	33 +
78650	*Procladius sp*	+
80310	*Cardiocladius obscurus*	+
80370	*Corynoneura lobata*	48
80420	*Cricotopus (C.) bicinctus*	+
80430	*Cricotopus (C.) tremulus group*	+
80440	*Cricotopus (C.) trifascia group*	+
80750	*Eukiefferiella devonica group*	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	133
82141	*Thienemanniella xena*	8
82220	*Tvetenia discoloripes group*	+
82820	*Cryptochironomus sp*	+
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	33 +
83840	*Microtendipes pedellus group*	+
84300	*Phaenopsectra obediens group*	133 +
84450	*Polypedilum (P.) convictum*	766 +
84460	*Polypedilum (P.) fallax group*	333
84470	*Polypedilum (P.) illinoense*	67
85261	*Cladotanytarsus vanderwulpi group Type 1*	+
85500	*Paratanytarsus sp*	+
85615	*Rheotanytarsus distinctissimus group*	33
85625	*Rheotanytarsus exiguus group*	3430 +
85800	*Tanytarsus sp*	200 +
85802	*Tanytarsus curticornis group*	100 +
85814	*Tanytarsus glabrescens group*	200
86100	*Chrysops sp*	+
87540	*Hemerodromia sp*	32 +
93200	*Hydrobiidae*	+
95100	*Physella sp*	4
96900	*Ferrissia sp*	19

No. Quantitative Taxa: 39 Total Taxa: 62
No. Qualitative Taxa: 46 ICI: **44**
Number of Organisms: 6677 Qual EPT: 11

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/22/96 River Code: 17-450 River: Sandy Creek RM: 29.50

Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	4
03600	*Oligochaeta*	+
06700	*Crangonyx sp*	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydracarina*	24 +
11120	*Baetis flavistriga*	4 +
11130	*Baetis intercalaris*	12 +
12200	*Isonychia sp*	4
13400	*Stenacron sp*	142
13510	*Stenonema exiguum*	7 +
13540	*Stenonema mediopunctatum*	12 +
13561	*Stenonema pulchellum*	92 +
16700	*Tricorythodes sp*	1
17200	*Caenis sp*	30 +
21200	*Calopteryx sp*	4 +
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
23909	*Boyeria vinosa*	1 +
43300	*Ranatra sp*	+
47600	*Sialis sp*	+
50315	*Chimarra obscura*	+
52200	*Cheumatopsyche sp*	73 +
52430	*Ceratopsyche morosa group*	116 +
52530	*Hydropsyche depravata group*	10 +
67700	*Paracymus sp*	+
68601	*Ancyronyx variegata*	12 +
68708	*Dubiraphia vittata group*	+
68901	*Macronychus glabratus*	10 +
69400	*Stenelmis sp*	5 +
70600	*Antocha sp*	+
71900	*Tipula sp*	+
74100	*Simulium sp*	+
77500	*Conchapelopia sp*	387 +
77800	*Helopelopia sp*	+
78401	*Natarsia species A (sensu Roback, 1978)*	+
80310	*Cardiocladius obscurus*	+
80420	*Cricotopus (C.) bicinctus*	+
80430	*Cricotopus (C.) tremulus group*	+
80440	*Cricotopus (C.) trifascia group*	+
80470	*Cricotopus (C.) or Orthocladius (O.) sp*	43
81825	*Rheocricotopus (Psilocricotopus) robacki*	+
82141	*Thienemanniella xena*	16 +
82220	*Tvetenia discoloripes group*	43 +
83840	*Microtendipes pedellus group*	+
84450	*Polypedilum (P.) convictum*	344 +
84460	*Polypedilum (P.) fallax group*	258 +
84470	*Polypedilum (P.) illinoense*	+
84520	*Polypedilum (Tripodura) halterale group*	+
85500	*Paratanytarsus sp*	172
85615	*Rheotanytarsus distinctissimus group*	301
85625	*Rheotanytarsus exiguus group*	2924 +
85802	*Tanytarsus curticornis group*	43
85814	*Tanytarsus glabrescens group*	86
86401	*Atherix lantha*	+
87190	*Odontomyia (Catatasina) sp*	+
87540	*Hemerodromia sp*	17 +
95100	*Physella sp*	+
96900	*Ferrissia sp*	265 +

No. Quantitative Taxa: 32 Total Taxa: 58

No. Qualitative Taxa: 49 ICI: **40**

Number of Organisms: 5462 Qual EPT: 10

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/21/96 River Code: 17-470 River: Still Fork RM: 0.10

Taxa Code	Taxa	Quan/Qual
00401	*Spongillidae*	+
01200	*Cordylophora lacustris*	5
01320	*Hydra sp*	32160 +
01801	*Turbellaria*	1
03121	*Paludicella articulata*	2
03221	*Pectinatella magnifica*	1
03600	*Oligochaeta*	71 +
04666	*Helobdella triserialis*	+
06201	*Hyalella azteca*	23 +
08601	*Hydracarina*	22 +
13400	*Stenacron sp*	3 +
17200	*Caenis sp*	245 +
22001	*Coenagrionidae*	+
22630	*Enallagma signatum*	+
23804	*Basiaeschna janata*	+
27610	*Epitheca (Tetragoneuria) cynosura*	+
28955	*Libellula lydia*	+
45100	*Palmacorixa sp*	+
47600	*Sialis sp*	+
51206	*Cyrnellus fraternus*	2
52200	*Cheumatopsyche sp*	92 +
52430	*Ceratopsyche morosa group*	+
53800	*Hydroptila sp*	16
54200	*Orthotrichia sp*	4
59570	*Oecetis nocturna*	+
60300	*Dineutus sp*	1 +
60900	*Peltodytes sp*	+
60910	*Peltodytes edentulus*	+
65800	*Berosus sp*	+
66500	*Enochrus sp*	+
68601	*Ancyronyx variegata*	+
68702	*Dubiraphia bivittata*	+
68708	*Dubiraphia vittata group*	+
68901	*Macronychus glabratus*	6 +
69400	*Stenelmis sp*	1
74100	*Simulium sp*	+
74501	*Ceratopogonidae*	13 +
77120	*Ablabesmyia mallochi*	43
77130	*Ablabesmyia rhamphe group*	860 +
77355	*Clinotanypus pinguis*	+
77800	*Helopelopia sp*	+
78650	*Procladius sp*	+
82730	*Chironomus (C.) decorus group*	+
83002	*Dicrotendipes modestus*	+
83050	*Dicrotendipes lucifer*	473
83051	*Dicrotendipes simpsoni*	172
83158	*Endochironomus nigricans*	129 +
83300	*Glyptotendipes (G.) sp*	1634 +
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	+
84002	*Parachironomus n.sp 2*	387 +
84010	*Parachironomus "abortivus" (sensu Simpson & Bode, 1980)*	731 +
84404	*Polypedilum (Pentapedilum) n.sp 1*	86 +
84450	*Polypedilum (P.) convictum*	387 +
84460	*Polypedilum (P.) fallax group*	+
84470	*Polypedilum (P.) illinoense*	+
84700	*Stenochironomus sp*	+
85800	*Tanytarsus sp*	129 +
85814	*Tanytarsus glabrescens group*	43
85840	*Tanytarsus guerlus group*	86
95100	*Physella sp*	208 +
96120	*Menetus (Micromenetus) dilatatus*	51
96900	*Ferrissia sp*	10

No. Quantitative Taxa:	34	Total Taxa:	62
No. Qualitative Taxa:	47	ICI:	**28**
Number of Organisms:	38097	Qual EPT:	**5**

Appendix Table 2. Invertebrate Community Index (ICI) metrics and scores for the Sandy Creek study area, 1996 and 1997.

Sandy Creek ICI Table

River Mile	Drainage Area (sq mi)	Number of				Percent:					Qual. EPT	Eco-region	ICI
		Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms			
(17-450)													
Year: 97													
28.20 6	135.0	38(6)	1(0)	3(4)	22(6)	1.6(2)	24.5(6)	1.2(2)	71.5(0)	5.3(4)	6(2)	3	32
25.40 0	162.0	43(6)	5(2)	6(6)	21(6)	13.1(2)	28.9(6)	14.7(2)	41.5(4)	13.7(0)	10(2)	3	36
22.40 6	191.0	37(6)	2(0)	6(6)	19(6)	8.5(2)	38.0(6)	4.7(2)	48.6(2)	3.6(6)	6(2)	3	38
Year: 96													
30.70 1	62.0	39(6)	6(4)	3(4)	20(6)	7.7(2)	4.8(2)	59.4(6)	27.8(6)	6.5(4)	11(4)	3	44
29.50 0	63.0	32(4)	9(6)	3(4)	12(2)	5.6(2)	3.6(2)	64.6(6)	25.7(6)	9.6(4)	10(4)	3	40
29.20 0	63.0	27(4)	5(2)	3(4)	15(4)	2.0(2)	8.6(4)	56.9(6)	32.2(4)	0.9(6)	10(4)	3	40
29.00 6	63.0	25(4)	4(2)	3(4)	15(4)	0.3(2)	1.3(2)	3.6(2)	94.5(0)	31.0(0)	6(2)	3	22
28.20 9	135.0	29(4)	5(2)	4(4)	14(4)	15.7(2)	2.0(2)	16.7(2)	64.1(0)	6.7(4)	9(2)	3	26
25.40 1	162.0	29(4)	7(4)	5(6)	8(2)	10.5(2)	2.2(2)	20.5(4)	66.0(0)	0.7(6)	11(4)	3	34
22.40 8	191.0	35(4)	5(2)	2(2)	17(4)	0.2(2)	0.0(2)	14.4(2)	85.3(0)	1.9(6)	8(2)	3	26
Year: 93													
30.40 2	62.0	40(6)	7(4)	2(4)	18(4)	19.6(4)	3.7(2)	28.5(4)	46.1(2)	25.5(0)	12(4)	3	34
29.60 3	63.0	41(6)	6(4)	7(6)	18(4)	23.8(4)	2.6(2)	25.3(4)	46.4(2)	25.0(0)	13(4)	3	36
28.30 1	135.0	26(4)	1(0)	0(0)	14(4)	0.0(2)	0.0(0)	0.0(0)	99.8(0)	53.2(0)	1(0)	3	10
25.10 9	162.0	32(4)	4(2)	6(6)	12(4)	0.0(2)	2.5(2)	78.2(6)	19.3(6)	2.1(6)	9(2)	3	40
(17-470)													
Year: 96													
0.10 5	71.0	34(4)	2(0)	4(6)	14(4)	0.7(2)	0.3(2)	0.7(2)	98.4(0)	1.2(6)	5(2)	4	28
Year: 93													
0.50 3	70.0	28(4)	1(0)	4(6)	14(4)	1.0(2)	0.4(2)	0.0(0)	95.3(0)	33.5(0)	3(0)	4	18

Appendix Table 3. Summary of relative numbers and weight of fish and species collected at each location by river mile sampled in the Sandy Creek area, 1996 and 1997. Relative numbers are per 0.3 km.

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1997**
River Mile: **28.20**	Basin: Muskingum River	Date Range: 09/24/97
	Time Fished: 2288 sec Drain Area: 135.0 sq mi	
	Dist Fished: 0.19 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	9	14.21	1.81	0.58	4.85	40.56
WHITE SUCKER	W	O	S	T	93	146.84	18.75	7.64	64.38	52.06
HORNYHEAD CHUB	N	I	N	I	12	18.95	2.42	0.14	1.17	7.33
CREEK CHUB	N	G	N	T	67	105.79	13.51	1.40	11.75	13.19
ROSYFACE SHINER	N	I	S	I	2	3.16	0.40	0.01	0.08	3.00
STRIPED SHINER	N	I	S		64	101.05	12.90	0.59	4.99	5.87
COMMON SHINER	N	I	S		9	14.21	1.81	0.07	0.60	5.00
SAND SHINER	N	I	M	M	4	6.32	0.81	0.02	0.16	3.00
BLUNTNOSE MINNOW	N	O	C	T	120	189.47	24.19	0.72	6.05	3.79
CENTRAL STONEROLLER	N	H	N		10	15.79	2.02	0.06	0.48	3.60
STRIPED SH X COMMON SH		I			2	3.16	0.40	0.06	0.51	19.00
ROCK BASS	S	C	C		1	1.58	0.20	0.01	0.09	7.00
SMALLMOUTH BASS	F	C	C	M	1	1.58	0.20	0.04	0.35	26.00
LARGEMOUTH BASS	F	C	C		1	1.58	0.20	0.03	0.24	18.00
GREEN SUNFISH	S	I	C	T	4	6.32	0.81	0.06	0.46	8.75
PUMPKINSEED SUNFISH	S	I	C	P	2	3.16	0.40	0.02	0.19	7.00
LOGPERCH	D	I	S	M	1	1.58	0.20	0.03	0.27	20.00
GREENSIDE DARTER	D	I	S	M	28	44.21	5.65	0.17	1.47	3.93
BANDED DARTER	D	I	S	I	31	48.95	6.25	0.07	0.60	1.45
RAINBOW DARTER	D	I	S	M	16	25.26	3.23	0.06	0.52	2.44
FANTAIL DARTER	D	I	C		9	14.21	1.81	0.03	0.27	2.22
MOTTLED SCULPIN		I	C		10	15.79	2.02	0.06	0.53	4.00
Mile Total					496	783.16		11.87		
Number of Species					21					
Number of Hybrids					1					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1997**
River Mile: **25.40**	Basin: Muskingum River	Date Range: 09/24/97
	Time Fished: 3659 sec Drain Area: 162.0 sq mi	
	Dist Fished: 0.20 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	5	7.50	0.67	0.14	1.64	18.80
WHITE SUCKER	W	O	S	T	244	366.00	32.84	4.95	57.51	13.51
BLACKNOSE DACE	N	G	S	T	25	37.50	3.36	0.15	1.77	4.04
CREEK CHUB	N	G	N	T	73	109.50	9.83	1.14	13.26	10.41
STRIPED SHINER	N	I	S		28	42.00	3.77	0.34	3.94	8.08
COMMON SHINER	N	I	S		10	15.00	1.35	0.04	0.42	2.40
SAND SHINER	N	I	M	M	4	6.00	0.54	0.01	0.07	1.00
SILVERJAW MINNOW	N	I	M		1	1.50	0.13	0.00	0.03	2.00
BLUNTNOSE MINNOW	N	O	C	T	160	240.00	21.53	0.70	8.19	2.93
CENTRAL STONEROLLER	N	H	N		67	100.50	9.02	0.47	5.48	4.69
ROCK BASS	S	C	C		1	1.50	0.13	0.03	0.35	20.00
GREEN SUNFISH	S	I	C	T	1	1.50	0.13	0.01	0.07	4.00
BLUEGILL SUNFISH	S	I	C	P	3	4.50	0.40	0.09	1.05	20.00
PUMPKINSEED SUNFISH	S	I	C	P	3	4.50	0.40	0.06	0.70	13.33
LOGPERCH	D	I	S	M	1	1.50	0.13	0.03	0.31	18.00
JOHNNY DARTER	D	I	C		1	1.50	0.13	0.00	0.03	2.00
GREENSIDE DARTER	D	I	S	M	9	13.50	1.21	0.02	0.27	1.67
BANDED DARTER	D	I	S	I	1	1.50	0.13	0.00	0.02	1.00
RAINBOW DARTER	D	I	S	M	7	10.50	0.94	0.02	0.24	2.00
FANTAIL DARTER	D	I	C		1	1.50	0.13	0.00	0.03	2.00
MOTTLED SCULPIN		I	C		98	147.00	13.19	0.40	4.62	2.70
Mile Total					743	1,114.50		8.60		
Number of Species					21					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **34.70**	Basin: Muskingum River	Date Range: 08/22/96
	Time Fished: 2216 sec Drain Area: 36.0 sq mi	
	Dist Fished: 0.20 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CENTRAL MUDMINNOW		I	C	T	1	1.50	0.15	0.01	0.03	3.00
GRASS PICKEREL		P	M	P	1	1.50	0.15	0.03	0.16	18.00
NORTHERN HOG SUCKER	R	I	S	M	21	31.50	3.19	2.60	15.52	82.50
WHITE SUCKER	W	O	S	T	37	55.50	5.62	3.75	22.42	67.65
HORNYHEAD CHUB	N	I	N	I	19	28.50	2.89	0.98	5.86	34.44
RIVER CHUB	N	I	N	I	14	21.00	2.13	0.60	3.59	28.62
CREEK CHUB	N	G	N	T	29	43.50	4.41	1.55	9.28	35.71
ROSYFACE SHINER	N	I	S	I	30	45.00	4.56	0.24	1.42	5.28
STRIPED SHINER	N	I	S		80	120.00	12.16	1.66	9.88	13.79
COMMON SHINER	N	I	S		4	6.00	0.61	0.06	0.38	10.67
SAND SHINER	N	I	M	M	13	19.50	1.98	0.08	0.48	4.17
SILVERJAW MINNOW	N	I	M		20	30.00	3.04	0.18	1.07	6.00
BLUNTNOSE MINNOW	N	O	C	T	50	75.00	7.60	0.40	2.36	5.28
CENTRAL STONEROLLER	N	H	N		43	64.50	6.53	1.20	7.17	18.62
STR SHIN X HORNYHEAD CH		I			1	1.50	0.15	0.03	0.18	20.00
ROCK BASS	S	C	C		10	15.00	1.52	1.30	7.78	86.80
LARGEMOUTH BASS	F	C	C		1	1.50	0.15	0.01	0.05	5.00
GREEN SUNFISH	S	I	C	T	2	3.00	0.30	0.03	0.18	10.00
BLUEGILL SUNFISH	S	I	C	P	4	6.00	0.61	0.06	0.36	10.00
PUMPKINSEED SUNFISH	S	I	C	P	1	1.50	0.15	0.01	0.07	8.00
JOHNNY DARTER	D	I	C		1	1.50	0.15	0.00	0.02	2.00
GREENSIDE DARTER	D	I	S	M	43	64.50	6.53	0.39	2.35	6.09
BANDED DARTER	D	I	S	I	15	22.50	2.28	0.07	0.39	2.87
RAINBOW DARTER	D	I	S	M	8	12.00	1.22	0.05	0.29	4.00
FANTAIL DARTER	D	I	C		26	39.00	3.95	0.11	0.66	2.86
MOTTLED SCULPIN		I	C		184	276.00	27.96	1.35	8.06	4.89
Mile Total					658	987.00		16.75		
Number of Species					25					
Number of Hybrids					1					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **30.50**	Basin: Muskingum River	Date Range: 07/11/96
	Time Fished: 5395 sec Drain Area: 62.0 sq mi	Thru: 08/22/96
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	78	58.50	4.42	4.33	17.37	73.96
WHITE SUCKER	W	O	S	T	24	18.00	1.36	1.30	5.22	72.29
COMMON CARP	G	O	M	T	1	0.75	0.06	0.15	0.59	195.00
HORNYHEAD CHUB	N	I	N	I	25	18.75	1.42	0.49	1.95	25.96
RIVER CHUB	N	I	N	I	72	54.00	4.08	1.07	4.28	19.75
BLACKNOSE DACE	N	G	S	T	1	0.75	0.06	0.00	0.01	2.00
CREEK CHUB	N	G	N	T	33	24.75	1.87	0.62	2.50	25.15
ROSYFACE SHINER	N	I	S	I	26	19.50	1.47	0.10	0.40	5.15
STRIPED SHINER	N	I	S		56	42.00	3.18	0.68	2.73	16.21
COMMON SHINER	N	I	S		10	7.50	0.57	0.12	0.49	16.30
BLUNTNOSE MINNOW	N	O	C	T	54	40.50	3.06	0.22	0.87	5.34
CENTRAL STONEROLLER	N	H	N		575	431.25	32.61	10.30	41.32	23.87
STRIPED SH X COMMON SH		I			7	5.25	0.40	0.09	0.38	18.00
YELLOW BULLHEAD		I	C	T	3	2.25	0.17	0.18	0.73	81.00
BROWN BULLHEAD		I	C	T	1	0.75	0.06	0.19	0.75	250.00
ROCK BASS	S	C	C		14	10.50	0.79	1.04	4.16	98.79
SMALLMOUTH BASS	F	C	C	M	1	0.75	0.06	0.20	0.80	265.00
LARGEMOUTH BASS	F	C	C		2	1.50	0.11	0.05	0.19	31.50
GREEN SUNFISH	S	I	C	T	31	23.25	1.76	0.16	0.63	6.76
LOGPERCH	D	I	S	M	1	0.75	0.06	0.01	0.03	10.00
JOHNNY DARTER	D	I	C		1	0.75	0.06	0.00	0.00	1.00
GREENSIDE DARTER	D	I	S	M	173	129.75	9.81	0.82	3.28	6.29
BANDED DARTER	D	I	S	I	10	7.50	0.57	0.03	0.11	3.50
RAINBOW DARTER	D	I	S	M	54	40.50	3.06	0.17	0.70	4.31
FANTAIL DARTER	D	I	C		6	4.50	0.34	0.02	0.09	5.17
MOTTLED SCULPIN		I	C		504	378.00	28.59	2.59	10.41	6.86
Mile Total					1,763	1,322.25		24.91		
Number of Species					25					
Number of Hybrids					1					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **29.50**	Basin: Muskingum River	Date Range: 07/10/96
	Time Fished: 5049 sec Drain Area: 63.0 sq mi	Thru: 08/22/96
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	40	30.00	6.28	0.91	11.39	30.35
WHITE SUCKER	W	O	S	T	34	25.50	5.34	0.64	7.97	24.98
COMMON CARP	G	O	M	T	1	0.75	0.16	2.63	32.83	3,500.00
HORNYHEAD CHUB	N	I	N	I	1	0.75	0.16	0.01	0.08	8.00
RIVER CHUB	N	I	N	I	12	9.00	1.88	0.32	4.03	35.75
BLACKNOSE DACE	N	G	S	T	1	0.75	0.16	0.00	0.02	2.00
CREEK CHUB	N	G	N	T	18	13.50	2.83	0.13	1.63	9.64
ROSYFACE SHINER	N	I	S	I	25	18.75	3.92	0.06	0.70	2.98
STRIPED SHINER	N	I	S		52	39.00	8.16	0.46	5.69	11.66
COMMON SHINER	N	I	S		31	23.25	4.87	0.13	1.66	5.71
SAND SHINER	N	I	M	M	1	0.75	0.16	0.00	0.03	3.00
SILVERJAW MINNOW	N	I	M		4	3.00	0.63	0.02	0.29	7.75
BLUNTNOSE MINNOW	N	O	C	T	62	46.50	9.73	0.19	2.35	4.03
CENTRAL STONEROLLER	N	H	N		133	99.75	20.88	1.17	14.60	11.70
ROCK BASS	S	C	C		14	10.50	2.20	0.61	7.58	57.64
WARMOUTH SF	S	C	C		1	0.75	0.16	0.02	0.24	25.00
GREEN SUNFISH	S	I	C	T	14	10.50	2.20	0.06	0.74	5.64
LOGPERCH	D	I	S	M	3	2.25	0.47	0.03	0.38	13.33
GREENSIDE DARTER	D	I	S	M	47	35.25	7.38	0.16	2.04	4.64
BANDED DARTER	D	I	S	I	13	9.75	2.04	0.03	0.33	2.62
RAINBOW DARTER	D	I	S	M	8	6.00	1.26	0.03	0.36	4.75
FANTAIL DARTER	D	I	C		5	3.75	0.78	0.02	0.22	4.60
MOTTLED SCULPIN		I	C		117	87.75	18.37	0.39	4.90	4.47
	Mile Total				637	477.75		8.00		
	Number of Species				23					
	Number of Hybrids				0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **29.20**	Basin: Muskingum River	Date Range: 07/11/96
	Time Fished: 4919 sec Drain Area: 63.0 sq mi	Thru: 08/21/96
	Dist Fished: 0.36 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	11	9.17	3.81	1.08	25.15	118.18
WHITE SUCKER	W	O	S	T	20	16.67	6.92	0.90	20.89	54.00
BLACKNOSE DACE	N	G	S	T	8	6.67	2.77	0.03	0.58	3.71
CREEK CHUB	N	G	N	T	31	25.83	10.73	0.25	5.86	9.77
ROSYFACE SHINER	N	I	S	I	1	0.83	0.35	0.00	0.06	3.00
STRIPED SHINER	N	I	S		22	18.33	7.61	0.40	9.26	21.77
COMMON SHINER	N	I	S		11	9.17	3.81	0.20	4.70	22.05
BLUNTNOSE MINNOW	N	O	C	T	2	1.67	0.69	0.00	0.09	2.50
CENTRAL STONEROLLER	N	H	N		21	17.50	7.27	0.17	3.97	9.76
YELLOW BULLHEAD		I	C	T	4	3.33	1.38	0.20	4.69	60.50
ROCK BASS	S	C	C		5	4.17	1.73	0.44	10.25	106.00
LARGEMOUTH BASS	F	C	C		1	0.83	0.35	0.01	0.12	6.00
GREEN SUNFISH	S	I	C	T	12	10.00	4.15	0.07	1.54	6.67
BLUEGILL SUNFISH	S	I	C	P	1	0.83	0.35	0.00	0.09	5.00
PUMPKINSEED SUNFISH	S	I	C	P	1	0.83	0.35	0.01	0.29	15.00
GREENSIDE DARTER	D	I	S	M	11	9.17	3.81	0.05	1.11	5.27
BANDED DARTER	D	I	S	I	5	4.17	1.73	0.01	0.20	2.00
RAINBOW DARTER	D	I	S	M	3	2.50	1.04	0.01	0.14	2.33
FANTAIL DARTER	D	I	C		2	1.67	0.69	0.00	0.06	1.50
MOTTLED SCULPIN		I	C		117	97.50	40.48	0.47	10.98	4.85
Mile Total					289	240.83		4.31		
Number of Species					20					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **29.00**	Basin: Muskingum River	Date Range: 07/11/96
	Time Fished: 1211 sec Drain Area: 63.0 sq mi	Thru: 08/21/96
	Dist Fished: 0.08 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	7	26.25	10.94	0.12	6.14	4.57
BLACKNOSE DACE	N	G	S	T	1	3.75	1.56	0.01	0.38	2.00
CREEK CHUB	N	G	N	T	16	60.00	25.00	0.87	44.73	14.56
STRIPED SHINER	N	I	S		1	3.75	1.56	0.08	3.84	20.00
BLUNTNOSE MINNOW	N	O	C	T	1	3.75	1.56	0.00	0.20	1.00
YELLOW BULLHEAD		I	C	T	13	48.75	20.31	0.08	3.84	1.54
ROCK BASS	S	C	C		1	3.75	1.56	0.38	19.19	100.00
SMALLMOUTH BASS	F	C	C	M	2	7.50	3.13	0.01	0.38	1.00
GREEN SUNFISH	S	I	C	T	11	41.25	17.19	0.33	16.71	7.91
BLUEGILL SUNFISH	S	I	C	P	2	7.50	3.13	0.01	0.59	1.50
MOTTLED SCULPIN		I	C		9	33.75	14.06	0.08	4.04	2.33
Mile Total					64	240.00		1.95		
Number of Species					11					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **28.90**	Basin: Muskingum River	Date Range: 07/11/96
	Time Fished: 3324 sec Drain Area: 135.0 sq mi	Thru: 08/21/96
	Dist Fished: 0.28 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	8	8.57	4.73	0.53	13.06	61.75
WHITE SUCKER	W	O	S	T	4	4.29	2.37	0.11	2.66	25.25
HORNYHEAD CHUB	N	I	N	I	1	1.07	0.59	0.04	1.00	38.00
CREEK CHUB	N	G	N	T	9	9.64	5.33	0.32	7.88	33.11
STRIPED SHINER	N	I	S		20	21.43	11.83	0.56	13.74	26.00
CENTRAL STONEROLLER	N	H	N		49	52.50	28.99	1.97	48.54	37.48
YELLOW BULLHEAD		I	C	T	20	21.43	11.83	0.04	1.04	1.95
ROCK BASS	S	C	C		1	1.07	0.59	0.04	1.00	38.00
LARGEMOUTH BASS	F	C	C		3	3.21	1.78	0.05	1.13	14.33
GREEN SUNFISH	S	I	C	T	21	22.50	12.43	0.12	3.01	5.43
BLUEGILL SUNFISH	S	I	C	P	5	5.36	2.96	0.09	2.32	17.60
LOGPERCH	D	I	S	M	2	2.14	1.18	0.05	1.27	24.00
GREENSIDE DARTER	D	I	S	M	8	8.57	4.73	0.06	1.57	7.38
BANDED DARTER	D	I	S	I	5	5.36	2.96	0.00	0.10	0.75
RAINBOW DARTER	D	I	S	M	1	1.07	0.59	0.00	0.02	1.00
FANTAIL DARTER	D	I	C		2	2.14	1.18	0.00	0.07	1.50
MOTTLED SCULPIN		I	C		10	10.71	5.92	0.06	1.55	5.90
Mile Total					169	181.07		4.05		
Number of Species					17					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **28.20**	Basin: Muskingum River	Date Range: 07/11/96
	Time Fished: 3334 sec Drain Area: 135.0 sq mi	Thru: 08/21/96
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	1	0.75	1.54	0.00	0.66	2.00
CREEK CHUB	N	G	N	T	6	4.50	9.23	0.01	5.27	2.67
COMMON SHINER	N	I	S		20	15.00	30.77	0.01	3.74	0.55
BLUNTNOSE MINNOW	N	O	C	T	6	4.50	9.23	0.01	2.42	1.17
YELLOW BULLHEAD		I	C	T	18	13.50	27.69	0.15	67.69	11.39
ROCK BASS	S	C	C		2	1.50	3.08	0.00	0.44	0.50
GREEN SUNFISH	S	I	C	T	3	2.25	4.62	0.04	17.14	17.33
GREENSIDE DARTER	D	I	S	M	2	1.50	3.08	0.00	1.10	1.50
BANDED DARTER	D	I	S	I	4	3.00	6.15	0.00	0.66	0.50
FANTAIL DARTER	D	I	C		3	2.25	4.62	0.00	1.32	1.33
NO FISH					0	0.00	0.00			
Mile Total					65	48.75		0.23		
Number of Species					10					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **27.80**	Basin: Muskingum River	Date Range: 06/27/96
	Time Fished: 1889 sec Drain Area: 137.0 sq mi	
	Dist Fished: 0.20 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	4	6.00	30.77	0.10	27.35	16.00
COMMON CARP	G	O	M	T	1	1.50	7.69	0.00	0.57	1.00
GOLDEN SHINER	N	I	M	T	1	1.50	7.69	0.00	0.85	2.00
BLACK BULLHEAD		I	C	P	1	1.50	7.69	0.21	58.97	138.00
LARGEMOUTH BASS	F	C	C		1	1.50	7.69	0.01	3.13	7.00
GREEN SUNFISH	S	I	C	T	4	6.00	30.77	0.03	8.55	5.00
BLUEGILL SUNFISH	S	I	C	P	1	1.50	7.69	0.00	0.85	2.00
Mile Total					13	19.50		0.35		
Number of Species					7					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **25.40**	Basin: Muskingum River	Date Range: 07/10/96
	Time Fished: 4949 sec Drain Area: 162.0 sq mi	Thru: 08/21/96
	Dist Fished: 0.42 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	3	2.14	2.29	0.06	20.21	27.00
BLACKNOSE DACE	N	G	S	T	15	10.71	11.45	0.02	5.80	1.54
CREEK CHUB	N	G	N	T	33	23.57	25.19	0.05	15.99	1.94
COMMON SHINER	N	I	S		41	29.29	31.30	0.06	20.91	2.02
BLUNTNOSE MINNOW	N	O	C	T	7	5.00	5.34	0.00	1.41	0.75
CENTRAL STONEROLLER	N	H	N		28	20.00	21.37	0.06	20.39	2.89
YELLOW BULLHEAD		I	C	T	1	0.71	0.76	0.02	7.73	31.00
ROCK BASS	S	C	C		1	0.71	0.76	0.00	0.18	1.00
LARGEMOUTH BASS	F	C	C		1	0.71	0.76	0.00	0.53	2.00
GREEN SUNFISH	S	I	C	T	1	0.71	0.76	0.02	6.85	27.00
Mile Total					131	93.57		0.28		
Number of Species					10					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **24.10**	Basin: Muskingum River	Date Range: 06/27/96
	Time Fished: 2400 sec Drain Area: 163.0 sq mi	
	Dist Fished: 0.17 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	1	1.77	14.29	0.06	36.57	36.00
CREEK CHUB	N	G	N	T	2	3.53	28.57	0.03	14.29	7.00
FATHEAD MINNOW	N	O	C	T	1	1.77	14.29	0.01	4.00	4.00
CENTRAL STONEROLLER	N	H	N		3	5.29	42.86	0.08	45.14	15.00
Mile Total					7	12.35		0.18		
Number of Species					4					
Number of Hybrids					0					

River Code: **17-450**	Stream: **Sandy Creek**	Sample Date: **1996**
River Mile: **22.40**	Basin: Muskingum River	Date Range: 07/10/96
	Time Fished: 3290 sec Drain Area: 191.0 sq mi	Thru: 08/21/96
	Dist Fished: 0.44 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	6	4.09	8.00	0.06	35.21	14.50
WHITE SUCKER	W	O	S	T	29	19.77	38.67	0.02	8.88	0.76
BLUNTNOSE MINNOW	N	O	C	T	2	1.36	2.67	0.00	0.59	1.00
LARGEMOUTH BASS	F	C	C		1	0.68	1.33	0.01	3.25	8.00
GREEN SUNFISH	S	I	C	T	10	6.82	13.33	0.06	37.57	9.30
JOHNNY DARTER	D	I	C		7	4.77	9.33	0.00	2.37	0.86
GREENSIDE DARTER	D	I	S	M	8	5.45	10.67	0.01	6.80	2.13
FANTAIL DARTER	D	I	C		7	4.77	9.33	0.00	2.37	0.86
MOTTLED SCULPIN		I	C		5	3.41	6.67	0.00	2.66	1.40
Mile Total					75	51.14		0.17		
Number of Species					9					
Number of Hybrids					0					

River Code: **17-470**	Stream: **Still Fork**	Sample Date: **1996**
River Mile: **0.10**	Basin: Muskingum River	Date Range: 07/11/96
	Time Fished: 3583 sec Drain Area: 71.0 sq mi	Thru: 08/21/96
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	8	8.00	3.09	0.45	5.83	56.00
WHITE SUCKER	W	O	S	T	12	12.00	4.63	1.02	13.25	84.83
SPOTTED SUCKER	R	I	S		1	1.00	0.39	0.00	0.05	4.00
COMMON CARP	G	O	M	T	4	4.00	1.54	3.42	44.50	854.50
GOLDEN SHINER	N	I	M	T	4	4.00	1.54	0.07	0.96	18.50
STRIPED SHINER	N	I	S		3	3.00	1.16	0.07	0.96	24.67
CENTRAL STONEROLLER	N	H	N		4	4.00	1.54	0.13	1.69	32.50
YELLOW BULLHEAD		I	C	T	12	12.00	4.63	0.21	2.72	17.42
ROCK BASS	S	C	C		1	1.00	0.39	0.00	0.03	2.00
LARGEMOUTH BASS	F	C	C		27	27.00	10.42	0.52	6.82	19.41
WARMOUTH SF	S	C	C		1	1.00	0.39	0.05	0.68	52.00
GREEN SUNFISH	S	I	C	T	93	93.00	35.91	0.49	6.35	5.24
BLUEGILL SUNFISH	S	I	C	P	73	73.00	28.19	1.13	14.73	15.49
PUMPKINSEED SUNFISH	S	I	C	P	1	1.00	0.39	0.01	0.16	12.00
GREEN SF X BLUEGILL					1	1.00	0.39	0.01	0.08	6.00
GR'N SF X PUMPKINS'D					2	2.00	0.77	0.02	0.23	9.00
LOGPERCH	D	I	S	M	2	2.00	0.77	0.05	0.62	24.00
JOHNNY DARTER	D	I	C		1	1.00	0.39	0.00	0.01	1.00
GREENSIDE DARTER	D	I	S	M	3	3.00	1.16	0.01	0.10	2.50
FANTAIL DARTER	D	I	C		4	4.00	1.54	0.01	0.16	3.00
MOTTLED SCULPIN		I	C		2	2.00	0.77	0.00	0.05	2.00
Mile Total					259	259.00		7.68		
Number of Species					19					
Number of Hybrids					2					

Appendix Table 4. Index of Biotic Integrity (IBI) metrics and scores and Modified Index of Well-being (MIwb) scores by river mile for locations sampled in the Sandy Creek study area, 1996 and 1997.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
Sandy Creek - (17450)																	
Year: 97																	
28.20	D	09/24/97	135	21(3)	3(3)	2(1)	3(3)	5(3)	51(5)	57(1)	43(1)	0.6(1)	41(3)	6.4(1)	335(3)	28	6.9
25.40	D	09/24/97	162	21(3)	4(5)	2(1)	1(1)	6(5)	44(5)	68(1)	54(1)	0.1(1)	23(1)	0.6(3)	360(3)	30	6.7
Year: 96																	
34.70	D	08/22/96	36	25(5)	4(5)	2(3)	4(5)	5(5)	36(5)	18(5)	13(5)	1.8(3)	74(5)	0.0(5)	809(5)	56	9.5
30.50	D	07/11/96	62	20(3)	2(3)	2(3)	4(3)	5(5)	22(3)	5(5)	3(5)	2.0(3)	44(3)	0.0(5)	843(5)	46	8.5
30.50	D	08/22/96	62	22(5)	2(3)	2(3)	4(3)	5(5)	26(3)	10(5)	5(5)	0.4(1)	68(5)	0.2(3)	1580(5)	46	9.3
29.50	D	07/10/96	63	18(3)	3(3)	2(3)	4(3)	3(3)	36(3)	12(5)	9(5)	4.6(3)	63(5)	0.7(3)	201(3)	42	7.1
29.50	D	08/22/96	63	20(3)	2(3)	2(3)	3(3)	5(5)	41(5)	23(5)	17(5)	1.7(3)	57(5)	0.0(5)	560(3)	48	8.9
29.20	D	07/11/96	63	12(3)	3(3)	2(3)	0(1)	1(1)	33(3)	27(3)	20(3)	4.5(3)	64(5)	1.5(3)	80(1) *	32	6.2
29.20	D	08/21/96	63	19(3)	3(3)	2(3)	2(1)	4(3)	31(3)	26(3)	4(5)	1.4(3)	71(5)	0.0(5)	273(3)	40	7.9
29.00	D	07/11/96	63	5(1)	2(3)	0(1)	0(1)	0(1)	5(1)	75(1)	0(5)	0.0(1)	55(5)	0.0(5)	38(1) *	26	4.1
29.00	D	08/21/96	63	10(1)	3(3)	1(1)	0(1)	0(1)	18(3)	77(1)	18(5)	6.8(5)	57(5)	2.3(5)	75(1)	32	5.8
28.90	D	07/11/96	135	6(1)	3(3)	0(1)	0(1)	1(1)	16(1)	58(1)	0(1)	10.5(1)	74(1)	0.0(1)	17(1)**	14	4.6
28.90	D	08/21/96	135	16(3)	2(3)	2(1)	2(1)	5(3)	30(3)	29(3)	3(5)	1.3(3)	59(5)	0.7(3)	229(3)	36	7.6
28.20	D	07/11/96	135	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1)	0.0(1)	0(1)**	12	0.0
28.20	D	08/21/96	135	9(1)	1(1)	1(1)	1(1)	3(3)	43(5)	52(1)	10(3)	0.0(1)	81(5)	0.0(1)	45(1) *	22	▲ 4.8
27.80	D	06/27/96	137	6(1)	2(3)	1(1)	0(1)	0(1)	31(1)	77(1)	38(1)	7.7(1)	54(1)	7.7(1)	5(1)**	14	▲ 3.5
25.40	D	07/10/96	162	3(1)	0(1)	1(1)	0(1)	0(1)	50(1)	75(1)	50(1)	25.0(1)	25(1)	0.0(1)	1(1)**	12	▲ 1.9
25.40	D	08/21/96	162	8(1)	2(3)	1(1)	0(1)	0(1)	45(5)	45(1)	6(3)	0.8(1)	33(3)	0.0(3)	100(1) *	24	▲ 5.5
24.10	D	06/27/96	163	4(1)	0(1)	1(1)	0(1)	0(1)	14(1)	57(1)	29(1)	0.0(1)	0(1)	57.1(1)	5(1)**	12	3.2
22.40	D	07/10/96	191	5(1)	1(1)	2(1)	0(1)	0(1)	84(3)	89(1)	81(1)	0.0(1)	19(1)	0.0(1)	5(1) *	14	▲ 2.7

na - Qualitative data, Modified Iwb not applicable.
▲ - IBI is low-end adjusted.
● - One or more species excluded from IBI calculation.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)		IBI	Modified Iwb
22.40	D	08/21/96	191	8(1)	1(1)	1(1)	0(1)	3(3)	32(3)	21(3)	3(5)	2.6(3)	95(5)	0.0(3)	41(1)	*	30	▲ 5.2
Still Fk. Sandy Cr. - (17470)																		
Year: 96																		
0.10	D	07/11/96	71	12(3)	3(3)	2(3)	0(1)	2(1)	10(1)	61(1)	7(1)	6.1(5)	83(1)	2.4(1)	64(1)	*	22	▲ 5.8
0.10	D	08/21/96	71	17(3)	4(5)	3(3)	0(1)	4(3)	12(1)	42(3)	6(5)	13.6(5)	79(5)	1.7(1)	204(3)		38	6.9

na - Qualitative data, Modified Iwb not applicable.
▲ - IBI is low-end adjusted.
● - One or more species excluded from IBI calculation.

Appendix Table 5. Pesticides, PCBs, metals, and lipid analyses of fish tissue collected from the Sandy Creek study area, 1996, by Ohio EPA. **Bold** values exceed Ohio Water Quality Standards criteria.

		Sampling Location (Sandy Creek) - by River Mile						
		34.7	**34.7**	**34.7**	**30.5**	**30.5**	**29.2**	**29.2**
		Rock bass	N. Hog sucker	White sucker	N. hog sucker	White sucker	White sucker	White sucker
Parameter		WBC	SOFC	SOFC	SOFC	SOFC	WBC	SOFC
Pesticides (ug/kg)								
Aldrin		ND	ND	ND	ND	ND	ND	ND
alpha-BHC		ND	ND	ND	ND	ND	ND	ND
beta-BHC		ND	ND	ND	ND	ND	ND	ND
delta-BHC		ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)		ND	ND	ND	ND	ND	ND	ND
4,4'-DDD		ND	ND	ND	ND	ND	ND	ND
4,4'-DDE		ND	ND	ND	ND	ND	ND	ND
4,4'-DDT		ND	ND	ND	ND	ND	ND	ND
Dieldrin		ND	ND	ND	ND	ND	ND	ND
Endosulfan I		ND	ND	ND	ND	ND	ND	ND
Endosulfan II		ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate		ND	ND	ND	ND	ND	ND	ND
Endrin		ND	ND	ND	ND	ND	ND	ND
Heptachlor		ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide		ND	ND	ND	ND	ND	ND	ND
Methoxychlor		ND	ND	ND	ND	ND	ND	ND
Mirex		ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene		ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane		5.7	ND	ND	ND	ND	ND	ND
gamma-Chlordane		ND	ND	ND	ND	ND	ND	ND
Oxychlordane		ND	ND	ND	ND	ND	ND	ND
cis-Nonachlor		ND	ND	ND	ND	ND	ND	ND
trans-Nonachlor		6.8	ND	ND	ND	ND	ND	ND
Toxaphene		ND	ND	ND	ND	ND	ND	ND
PCBs (ug/kg)	TOTAL PCBs	140	ND	50	89	101	235	90
PCB-1016		ND	ND	ND	ND	ND	ND	ND
PCB-1221		ND	ND	ND	ND	ND	ND	ND
PCB-1232		ND	ND	ND	ND	ND	ND	ND
PCB-1242		ND	ND	ND	ND	ND	ND	ND
PCB-1248		ND	ND	ND	ND	ND	ND	ND
PCB-1254		68	ND	30	67	72	190	69
PCB-1260		72	ND	20	22	29	45	21
Metals (mg/kg)								
Arsenic		<0.188	<0.196	<0.189	<0.172	<0.175	<0.168	<0.200
Cadmium		<0.0188	<0.0196	<0.0189	<0.0172	<0.0175	0.0457	<0.0200
Lead		<0.188	0.216	<0.189	<0.172	<0.175	0.418	<0.200
Mercury		0.0319	0.0292	0.0378	0.0636	0.0756	0.0212	0.0480
Nickel		<3.77	<3.92	<3.77	<3.45	<3.51	<3.39	<4.00
Selenium		0.462	0.529	0.368	0.375	0.281	0.305	0.300
Lipids(Percent)		2.74	0.49	0.44	0.48	0.45	0.90	0.94

Appendix Table 5. Continued.

Parameter	Sampling Location (Sandy Creek)- by River Mile 27.8 White sucker SOFC	27.8 Common carp SFFC	27.8 Black bullhead WBC	25.1 White sucker SOFC	23.5 White sucker SOFC	23.5 Common carp SFFC	23.5 Largemouth bass SOF
Pesticides (ug/kg)							
Aldrin	ND	ND	ND	ND	ND	ND	ND
alpha-BHC	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	5.8	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND
alpha-Chlordane	ND	ND	ND	ND	ND	12	ND
gamma-Chlordane	ND	ND	ND	ND	ND	ND	ND
Oxychlordane	ND	ND	ND	ND	ND	ND	ND
cis-Nonachlor	ND	ND	ND	ND	ND	ND	ND
trans-Nonachlor	ND	ND	ND	ND	ND	11	ND
Toxaphene	ND	ND	NA	ND	ND	ND	ND
PCBs (ug/kg) TOTAL PCBs	70	192	33	56	33	**1537**	ND
PCB-1016	ND	ND	ND	ND	ND	ND	ND
PCB-1221	ND	ND	ND	ND	ND	ND	ND
PCB-1232	ND	ND	ND	ND	ND	ND	ND
PCB-1242	ND	ND	ND	ND	ND	ND	ND
PCB-1248	ND	ND	ND	ND	ND	97	ND
PCB-1254	70	170	33	56	33	1300	ND
PCB-1260	ND	22	ND	ND	ND	140	ND
Metals (mg/kg)							
Arsenic	<0.182	<0.185	<0.0990	<0.167	<0.167	<0.189	<0.167
Cadmium	<0.0182	<0.0185	0.0841	<0.0167	<0.0167	<0.0189	<0.0167
Lead	<0.182	<0.185	0.188	<0.167	<0.167	<0.189	<0.167
Mercury	0.0245	0.0335	0.0197	0.0443	0.0355	0.0824	0.374
Nickel	<3.64	<3.70	NA	<3.33	<3.33	<3.77	<3.33
Selenium	0.200	0.361	0.723	0.217	0.383	0.321	0.258
Lipids (Percent)	1.37	2.33	0.65	1.49	1.34	6.18	0.16

Appendix Table 5. Continued.

Parameter	Sampling Location (Sandy Creek) - by River Mile 23.5 Largemouth bass SOFC	23.5 Common carp WB	23.5 Blue-gill WBC	23.5 Common carp WBC	22.1 N. hog sucker SOFC	22.1 White sucker SOFC	17.0 White sucker SOFC
Pesticides (ug/kg)							
Aldrin	ND	ND	ND	ND	ND	ND	ND
alpha-BHC	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	11	ND	7.1	ND	ND	ND
4,4'-DDE	ND	31	10	19	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	4.5	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	6.8	ND	ND	ND	ND	ND
alpha-Chlordane	ND	24	ND	9.1	ND	ND	ND
gamma-Chlordane	ND	ND	ND	ND	ND	ND	ND
Oxychlordane	ND	ND	ND	ND	ND	ND	ND
cis-Nonachlor	ND	ND	ND	ND	ND	ND	ND
trans-Nonachlor	ND	28	4.2	12	ND	ND	ND
Toxaphene	ND	NA	NA	NA	ND	ND	ND
PCBs (ug/kg) TOTAL PCBs	ND	**1220**	230	**2010**	26	33	52
PCB-1016	ND	ND	ND	ND	ND	ND	ND
PCB-1221	ND	ND	ND	ND	ND	ND	ND
PCB-1232	ND	ND	ND	ND	ND	ND	ND
PCB-1242	ND	ND	ND	ND	ND	ND	ND
PCB-1248	ND	ND	ND	ND	ND	ND	ND
PCB-1254	ND	900	120	1800	26	33	21
PCB-1260	ND	320	110	210	ND	ND	31
Metals (mg/kg)							
Arsenic	<0.185	NA	NA	NA	<0.196	<0.178	<0.169
Cadmium	<0.0185	0.0532	0.0738	0.0289	<0.0196	<0.0178	<0.0169
Lead	<0.185	0.710	0.383	0.570	<0.196	<0.178	<0.169
Mercury	0.107	0.0569	0.0356	0.0438	0.0321	0.0319	0.0278
Nickel	<3.70	NA	NA	NA	<3.92	<3.57	<3.39
Selenium	0.241	NA	NA	NA	0.363	0.303	0.297
Lipids (Percent)	0.22	10.21	2.54	3.61	1.18	2.11	1.62

Appendix Table 5. Continued.

Parameter	Sandy Creek 17.0 Common carp SFFC	Still Fork 0.2 White sucker SOFC	Still Fork 0.2 Largemouth bass SOF
	Sampling Location - by River Mile		
Pesticides (ug/kg)			
Aldrin	ND	ND	ND
NDalpha-BHC	ND	ND	ND
beta-BHC	ND	ND	ND
delta-BHC	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND
4,4'-DDD	ND	ND	ND
4,4'-DDE	ND	ND	ND
4,4'-DDT	ND	ND	ND
Dieldrin	ND	ND	ND
Endosulfan I	ND	ND	ND
Endosulfan II	ND	ND	ND
Endosulfan sulfate	ND	ND	ND
Endrin	ND	ND	ND
Heptachlor	ND	ND	ND
Heptachlor epoxide	ND	ND	ND
Methoxychlor	ND	ND	ND
Mirex	ND	ND	ND
Hexachlorobenzene	ND	ND	ND
alpha-Chlordane	ND	ND	ND
gamma-Chlordane	ND	ND	ND
Oxychlordane	ND	ND	ND
cis-Nonachlor	ND	ND	ND
trans-Nonachlor	4.4	ND	ND
Toxaphene	ND	ND	ND
PCBs (ug/kg) TOTAL PCBs	153	51	ND
PCB-1016	ND	ND	ND
PCB-1221	ND	ND	ND
PCB-1232	ND	ND	ND
PCB-1242	ND	ND	ND
PCB-1248	ND	ND	ND
PCB-1254	120	51	ND
PCB-1260	33	ND	ND
Metals (mg/kg)			
Arsenic	<0.187	<0.172	<0.164
Cadmium	<0.0189	<0.0172	<0.0164
Lead	<0.189	<0.172	<0.164
Mercury	0.0702	0.0634	0.256
Nickel	<3.77	<3.45	<3.28
Selenium	0.387	0.276	0.188
Lipids (Percent)	3.84	1.34	0.05

SFFC - skin off fillet composite; SOFC - skin on fillet composite; WBC - whole body composite.

Appendix Table 6. Semivolatile organic compounds analyses of fish tissue collected from the Sandy Creek study area, 1996 by Ohio EPA.

	Sampling Location (Sandy Creek) - by River Mile						
	34.7	**34.7**	**34.7**	**30.5**	**30.5**	**29.2**	**29.2**
	Rock bass	N. Hog sucker	White sucker	N. hog sucker	White sucker	White sucker	White sucker
Parameter	WBC	SOFC	SOFC	SOFC	SOFC	WBC	SOFC
Semivolatile Organic Compounds (ug/kg)							
Acenaphthene	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND
Bis(2-chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND
Bis(2-chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND
Bis(2-chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND
Bis(2-Ethylhexyl) phthalate	ND	ND	ND	ND	ND	ND	3.8
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND

Appendix Table 6. Continued.

	Sampling Location (Sandy Creek) - by River Mile						
	34.7	34.7	34.7	30.5	30.5	29.2	29.2
	Rock bass	N. Hog sucker	White sucker	N. hog sucker	White sucker	White sucker	White sucker
Parameter	WBC	SOFC	SOFC	SOFC	SOFC	WBC	SOFC
Semivolatile Organic Compounds (ug/kg)							
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND

Appendix Table 6. Continued.

Parameter	**Sampling Location (Sandy Creek)**- by River Mile **27.8** White sucker SOFC	**27.8** Common carp SFFC	**27.8** Black bullhead WBC	**25.1** White sucker SOFC	**23.5** White sucker SOFC	**23.5** Common carp SFFC	**23.5** Largemouth bass SOF
Semivolatile Orgamic Compounds (ug/kg)							
Acenaphthene	ND	ND	NA	ND	ND	ND	ND
Acenaphthylene	ND	ND	NA	ND	ND	ND	ND
Anthracene	ND	ND	NA	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	NA	ND	ND	ND*	ND
Benzo(a)pyrene	ND	ND	NA	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	NA	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	NA	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	NA	ND	ND	ND	ND
Bis(2-chloroethoxy) methane	ND	ND	NA	ND	ND	ND	ND
Bis(2-chloroethyl) ether	ND	ND	NA	ND	ND	ND	ND
Bis(2-chloroisopropyl) ether	ND	ND	NA	ND	ND	ND	ND
Bis(2-Ethylhexyl) phthalate	ND	ND	NA	ND	ND	ND*	8.2*
4-Bromophenyl phenyl ether	ND	ND	NA	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	NA	ND	ND	ND*	ND
4-Chloro-3-methylphenol	ND	ND	NA	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	NA	ND	ND	ND	ND
2-Chlorophenol	ND	ND	NA	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	NA	ND	ND	ND	ND
Chrysene	ND	ND	NA	ND	ND	ND*	ND
Di-n-butylphthalate	ND	ND	NA	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	NA	ND	ND	ND	ND*
Dibenz(a,h)anthracene	ND	ND	NA	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	NA	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	NA	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	NA	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	NA	ND	ND	ND	ND*
Diethylphthalate	ND	ND	NA	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	NA	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	NA	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	NA	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	NA	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	NA	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	NA	ND	ND	ND	ND
Fluoranthene	ND	ND	NA	ND	ND	ND	ND
Fluorene	ND	ND	NA	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	NA	ND	ND	ND	ND

Appendix Table 6. Continued.

Parameter	**Sampling Location (Sandy Creek)**- by River Mile **27.8** White sucker SOFC	**27.8** Common carp SFFC	**27.8** Black bullhead WBC	**25.1** White sucker SOFC	**23.5** White sucker SOFC	**23.5** Common carp SFFC	**23.5** Largemouth bass SOF
Semivolatile Orgamic Compounds (ug/kg)							
Hexachlorobutadiene	ND	ND	NA	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	NA	ND	ND	ND	ND*
Hexachloroethane	ND	ND	NA	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	NA	ND	ND	ND	ND*
Isophorone	ND	ND	NA	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	ND	NA	ND	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	NA	ND	ND	ND	ND
Naphthalene	ND	ND	NA	ND	ND	ND	ND
Nitrobenzene	ND	ND	NA	ND	ND	ND	ND
2-Nitrophenol	ND	ND	NA	ND	ND	ND	ND
4-Nitrophenol	ND	ND	NA	ND	ND	ND	ND*
Pentachlorophenol	ND	ND	NA	ND	ND	ND	ND*
Phenanthrene	ND	ND	NA	ND	ND	ND	ND
Phenol	ND	ND	NA	ND	ND	ND	ND
Pyrene	ND	ND	NA	ND	ND	ND*	ND
1,2,4-Trichlorobenzene	ND	ND	NA	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	NA	ND	ND	ND	ND

Appendix Table 6. Continued.

Parameter	Sampling Location (Sandy Creek) - by River Mile 23.5 Largemouth bass SOFC	23.5 Common carp WB	23.5 Blue-gill WBC	23.5 Common carp WBC	22.1 N. hog sucker SOFC	22.1 White sucker SOFC	17.0 White sucker SOFC
Semivolatile Orgamic Compounds (ug/kg)							
Acenaphthene	ND	NA	NA	NA	ND	ND	ND
Acenaphthylene	ND	NA	NA	NA	ND	ND	ND
Anthracene	ND	NA	NA	NA	ND	ND	ND
Benzo(a)anthracene	ND	NA	NA	NA	ND	ND	ND
Benzo(a)pyrene	ND	NA	NA	NA	ND	ND	ND
Benzo(b)fluoranthene	ND	NA	NA	NA	ND	ND	ND
Benzo(g,h,i)perylene	ND	NA	NA	NA	ND	ND	ND
Benzo(k)fluoranthene	ND	NA	NA	NA	ND	ND	ND
Bis(2-chloroethoxy) methane	ND	NA	NA	NA	ND	ND	ND
Bis(2-chloroethyl) ether	ND	NA	NA	NA	ND	ND	ND
Bis(2-chloroisopropyl) ether	ND	NA	NA	NA	ND	ND	ND
Bis(2-Ethylhexyl) phthalate	ND	NA	NA	NA	ND	ND	ND
4-Bromophenyl phenyl ether	ND	NA	NA	NA	ND	ND	ND
Butyl benzyl phthalate	ND	NA	NA	NA	ND	ND	ND
4-Chloro-3-methylphenol	ND	NA	NA	NA	ND	ND	ND
2-Chloronaphthalene	ND	NA	NA	NA	ND	ND	ND
2-Chlorophenol	ND	NA	NA	NA	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	NA	NA	NA	ND	ND	ND
Chrysene	ND	NA	NA	NA	ND	ND	ND
Di-n-butylphthalate	ND	NA	NA	NA	ND	ND	ND
Di-n-octyl phthalate	ND	NA	NA	NA	ND	ND	ND
Dibenz(a,h)anthracene	ND	NA	NA	NA	ND	ND	ND
1,3-Dichlorobenzene	ND	NA	NA	NA	ND	ND	ND
1,4-Dichlorobenzene	ND	NA	NA	NA	ND	ND	ND
1,2-Dichlorobenzene	ND	NA	NA	NA	ND	ND	ND
2,4-Dichlorophenol	ND	NA	NA	NA	ND	ND	ND
Diethylphthalate	ND	NA	NA	NA	ND	ND	ND
2,4-Dimethylphenol	ND	NA	NA	NA	ND	ND	ND
Dimethyl phthalate	ND	NA	NA	NA	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	NA	NA	NA	ND	ND	ND
2,4-Dinitrophenol	ND	NA	NA	NA	ND	ND	ND
2,6-Dinitrotoluene	ND	NA	NA	NA	ND	ND	ND
2,4-Dinitrotoluene	ND	NA	NA	NA	ND	ND	ND
Fluoranthene	ND	NA	NA	NA	ND	ND	ND
Fluorene	ND	NA	NA	NA	ND	ND	ND
Hexachlorobenzene	ND	NA	NA	NA	ND	ND	ND

Appendix Table 6. Continued.

Parameter	Sampling Location (Sandy Creek) - by River Mile 23.5 Largemouth bass SOFC	23.5 Common carp WB	23.5 Blue-gill WBC	23.5 Common carp WBC	22.1 N. hog sucker SOFC	22.1 White sucker SOFC	17.0 White sucker SOFC
Semivolatile Orgamic Compounds (ug/kg)							
Hexachlorobutadiene	ND	NA	NA	NA	ND	ND	ND
Hexachlorocyclopentadiene	ND	NA	NA	NA	ND	ND	ND
Hexachloroethane	ND	NA	NA	NA	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	NA	NA	NA	ND	ND	ND
Isophorone	ND	NA	NA	NA	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	NA	NA	NA	ND	ND	ND
N-Nitrosodiphenylamine	ND	NA	NA	NA	ND	ND	ND
Naphthalene	ND	NA	NA	NA	ND	ND	ND
Nitrobenzene	ND	NA	NA	NA	ND	ND	ND
2-Nitrophenol	ND	NA	NA	NA	ND	ND	ND
4-Nitrophenol	ND	NA	NA	NA	ND	ND	ND
Pentachlorophenol	ND	NA	NA	NA	ND	ND	ND
Phenanthrene	ND	NA	NA	NA	ND	ND	ND
Phenol	ND	NA	NA	NA	ND	ND	ND
Pyrene	ND	NA	NA	NA	ND	ND	ND
1,2,4-Trichlorobenzene	ND	NA	NA	NA	ND	ND	ND
2,4,6-Trichlorophenol	ND	NA	NA	NA	ND	ND	ND

Appendix Table 6. Continued.

	Sampling Location - by River Mile		
	Sandy Creek	**Still Fork**	
	17.0	**0.2**	**0.2**
	Common carp	White sucker	Largemouth bass
Parameter	SFFC	SOFC	SOF
Semivolatile Orgamic Compounds (ug/kg)			
Acenaphthene	ND	ND	ND
Acenaphthylene	ND	ND	ND
Anthracene	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND*
Benzo(a)pyrene	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND
Bis(2-chloroethoxy) methane	ND	ND	ND
Bis(2-chloroethyl) ether	ND	ND	ND
Bis(2-chloroisopropyl) ether	ND	ND	ND
Bis(2-Ethylhexyl) phthalate	ND	ND	ND*
4-Bromophenyl phenyl ether	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND*
4-Chloro-3-methylphenol	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND
2-Chlorophenol	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND
Chrysene	ND	ND	ND*
Di-n-butylphthalate	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND
Diethylphthalate	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND
Dimethyl phthalate	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND*
2,6-Dinitrotoluene	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND
Fluoranthene	ND	ND	ND
Fluorene	ND	ND	ND
Hexachlorobenzene	ND	ND	ND

Appendix Table 6. Continued.

Parameter	Sandy Creek 17.0 Common carp SFFC	Still Fork 0.2 White sucker SOFC	Still Fork 0.2 Largemouth bass SOF
	Sampling Location - by River Mile		
Semivolatile Orgamic Compounds (ug/kg)			
Hexachlorobutadiene	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND*
Hexachloroethane	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND
Isophorone	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	ND	ND
N-Nitrosodiphenylamine	ND	ND	ND
Naphthalene	ND	ND	ND
Nitrobenzene	ND	ND	ND
2-Nitrophenol	ND	ND	ND
4-Nitrophenol	ND	ND	ND*
Pentachlorophenol	ND	ND	ND
Phenanthrene	ND	ND	ND
Phenol	ND	ND	ND
Pyrene	ND	ND	ND*
1,2,4-Trichlorobenzene	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND

SFFC - skin off fillet composite; SOFC - skin on fillet composite; WBC - whole body composite.
* - results cannot be validated because of matrix interference.