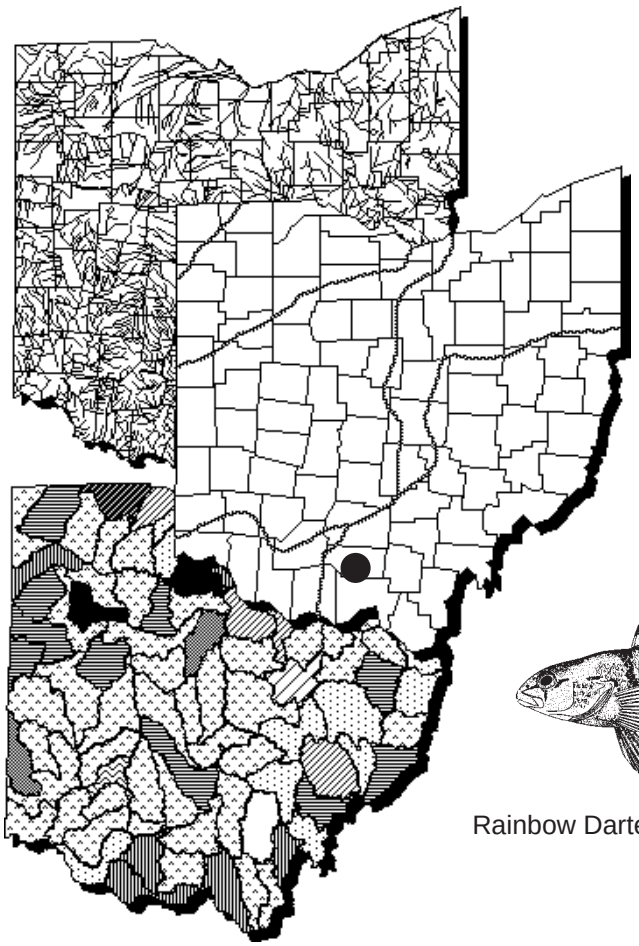
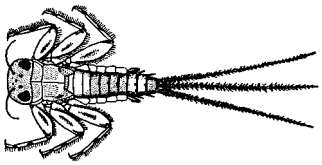
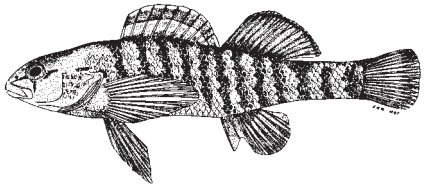
Biological and Water Quality Study of Little Beaver Creek and Big Beaver Creek - 1997

Portsmouth Gaseous Diffusion Plant
Pike County, Ohio





Mayfly *(Stenonema)*



Rainbow Darter *(Etheostoma caeruleum)*

June 4, 1998

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

Biological and Water Quality Study of Little Beaver Creek and Big Beaver Creek

1997

Portsmouth Gaseous Diffusion Plant

Pike County, Ohio

June 4, 1998

OEPA Technical Report MAS/1998-5-1

prepared for

State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response
Southeast 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 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. Div. Water Qual. Monit. & 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. Div. Water Qual. Monit. & 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. Div. 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. Div. 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. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Div. 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. 1995. 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. 1995. 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

An electronic copy of this report, as well as other Water Quality Technical Support Documents, can be obtained from the Ohio EPA web page (*www.epa.ohio.gov*).

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. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 10-15 different study areas with an aggregate total of 250-300 sampling sites.

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 use designations assigned in 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 key 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, evaluated, and synthesized in a biological and water quality 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 also addressed.

The findings and conclusions of a biological and 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 Ohio Water Resource Inventory (305[b] report).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively 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. This integrated approach is outlined in Figure 1 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

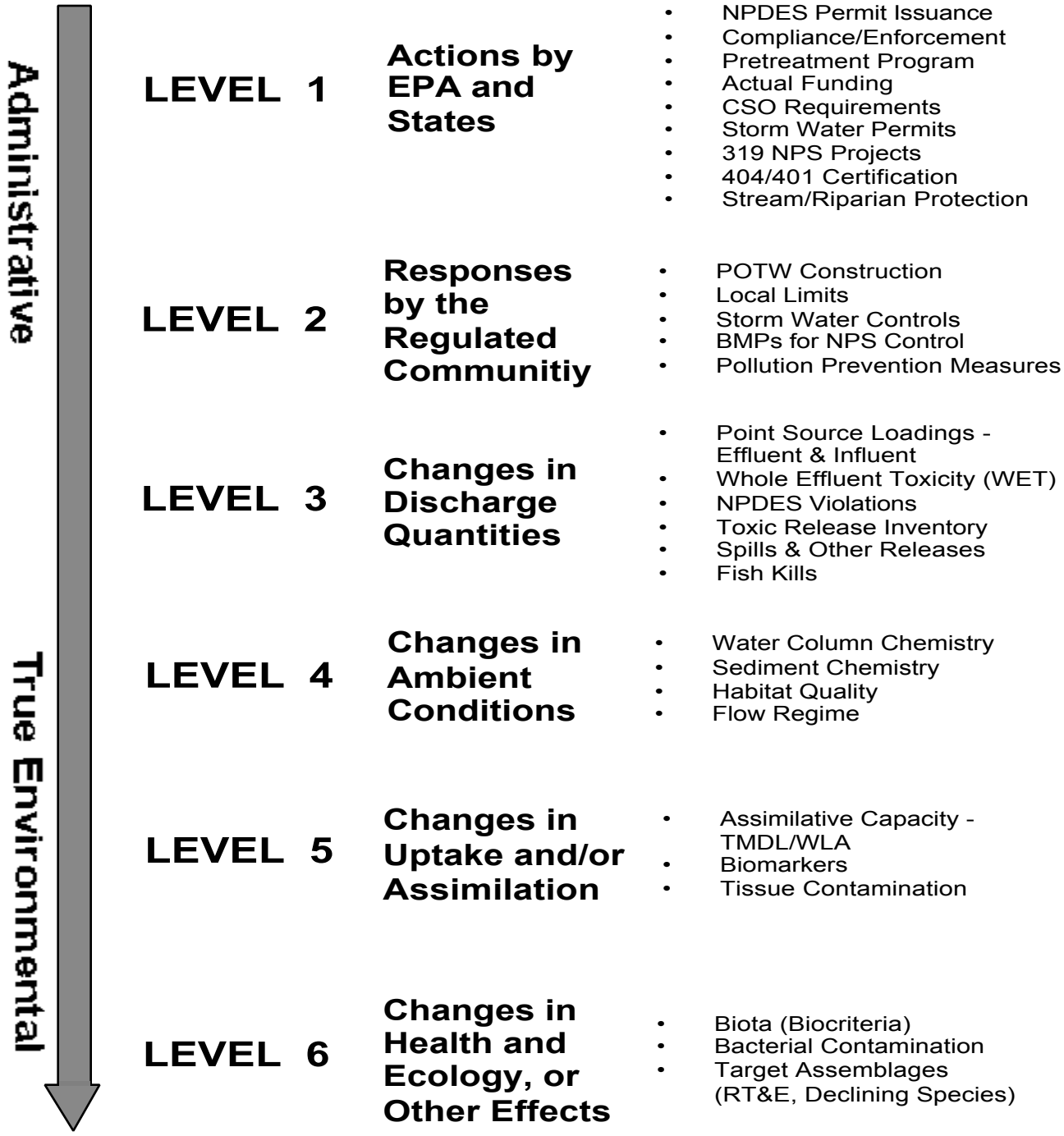

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

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 that 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.

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 water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Ohio Water Resource Inventory (305[b] report), the Ohio Nonpoint Source Assessment, and other technical bulletins.

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. Also, an

emphasis on protecting for aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

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 and permitted 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 small streams (usually <3 $mi.^2$ drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

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 water quality 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 recreation uses 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 are 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 an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. 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 and are detailed in other documents.

Biological and Water Quality Study of Little Beaver Creek (Pike County, Ohio)

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

INTRODUCTION

The Little Beaver Creek study area included the lower four miles of Little Beaver Creek and the lower six miles of Big Beaver Creek (Figure 2).

Specific objectives of this evaluation were to:

1) measure and determine aquatic biological communities and sediment quality in Little Beaver Creek and lower Big Beaver Creek in the vicinity of the Portsmouth Gaseous Diffusion Plant (PORTS),

2) determine the potential accumulation of contaminants in stream sediments in the vicinity of PORTS,

4) evaluate influences from PORTS NPDES discharges to Little Beaver Creek,

5) determine the attainment status of the current WWH aquatic life use designation for Little Beaver Creek and Big Beaver Creek within the study area, and

6) follow-up on conditions documented in the 1992 Ohio EPA survey (Ohio EPA 1993).

The Big Beaver Creek and Little Beaver Creek watershed is located in the Western Allegheny Plateau (WAP) ecoregion. Little Beaver Creek and Big Beaver Creek are currently assigned the Warmwater Habitat (WWH) aquatic life use designation.

SUMMARY / CONCLUSIONS

From July to October, 1997, staff from the Ohio EPA Divisions of Surface Water and Emergency and Remedial Response conducted biological community and sediment sampling on Little Beaver Creek and Big Beaver Creek. The results of these sampling events and other relevant information are summarized below.

- Non-attainment of the Warmwater Habitat (WWH) aquatic life use designation occurred in Little Beaver Creek upstream and immediately downstream from the PORTS X-230-J7 (001) effluent discharge (Figure 3). Partial attainment was observed within 0.6 miles downstream from the X-230-J7 discharge and full attainment occurred at the lower two sites. Biological results from 1997 for Little Beaver Creek indicated that 2.0 miles of stream were in full attainment of the WWH use, 0.8 miles were in partial attainment, and 0.6 miles of river were not meeting the WWH use designation. The non-attainment status of the biological sampling locations was attributed to unknown pollution or natural aquatic conditions (intermittent flow conditions) upstream from the X-230-J7 outfall and physical limitations (lack of an appropriate food base) of the X-230-J7 (East Drainage Ditch) discharge. Chemical quality of the X-230-J7 discharge did not appear to be a contributing factor in the non-attainment status of the upper Little Beaver Creek.

- The three PORTS NPDES discharge points to Little Beaver Creek did not chemically impair the water quality of Little Beaver Creek. Monitored chemical/physical constituents in the effluent of outfalls X-230-J7 (001), X-230-J6 (011), and X-230-L (009) were generally low, and parameters with permit limits were all below either the 30-day or daily maximum limits during 1996 and 1997. Stream water quality sampling results from Little Beaver Creek during 1997 were generally within acceptable levels. All volatile organic compounds tested were reported by the laboratory as non-detected. Uranium was measured in the North Holding Pond Drainage Ditch (RM 1.52, 0.13) and in Little Beaver Creek downstream from the North Holding Pond Ditch (at RM 1.00) at average concentrations of 4.6 ug/l and 2.7 ug/l, respectively, exceeding the chronic toxicity benchmark of 2.6 ug/l (Suter and Tsao 1996).

- Fish communities in Little Beaver Creek ranged from fair to exceptional. Upstream from the X-230-J7 discharge, the fish community was in the fair range. The low flow condition in Little Beaver Creek upstream from the X-230-J7 discharge was the principal factor in the failure to achieve the fish WWH biocriterion. Fish communities in Little Beaver Creek located downstream from the X-230-J7 discharge exhibited good to exceptional biological condition. The discharge of wastewater from the X-230-J7 outfall does not have a negative impact on fish communities.

- Little Beaver Creek macroinvertebrate communities ranged from poor to exceptional. Intermittent flow conditions or unknown pollution in the upper Little Beaver Creek, upstream from the PORTS discharge, had a major negative influence on macroinvertebrate community diversity at RM 3.3. Downstream, the artificial nature of the effluent from the X-230-J7 discharge apparently did not provide the necessary nutrient base to sustain a small stream macroinvertebrate community immediately downstream from the outfall (RM 3.1). More natural stream conditions occurred within 0.5 miles of the X-230-J7 discharge, with macroinvertebrate communities improving to the fair range. Exceptional macroinvertebrate

communities occurred in the lower two miles of Little Beaver Creek, as represented by high taxa diversity and a predominance of pollution sensitive organisms.

- Little Beaver Creek sediment samples exceeded the Lowest Effect Level (a level tolerated by most benthic organisms) for arsenic and one polychlorinated biphenyl (PCB) congener. These results were also observed in Big Beaver Creek downstream from the confluence with Little Beaver Creek. Radiological constituents in sediments showed gross beta and gross alpha values at or near background levels in both Little Beaver Creek and Big Beaver Creek. Total uranium values were near background levels in Little Beaver Creek and slightly above background levels in Big Beaver Creek. Technetium^{99} values, although lower overall in 1997 compared to previous years, still indicated elevated levels in Big Beaver Creek near the confluence with Little Beaver Creek. Very little published information on the fate and effects of low levels of technetium^{99} in aquatic systems is available to assess the relevance of the levels in the sediments around the Portsmouth DOE facility.

- A comparison of the 1997 study of Little Beaver Creek and Big Beaver Creek with a survey conducted in 1992 revealed similar WWH attainment status between the two sampling years, except in Little Beaver Creek upstream from the X-230-J7 discharge (1997: non-attainment, 1992: partial attainment). A decline in macroinvertebrate communities did occur in Little Beaver Creek between 1997 and 1992 at two locations (RMs 3.3 and 3.1 - upstream and downstream from the X-230-J7 outfall); this was attributed to reduced flow conditions during 1997. Sediment metal levels in Little Beaver Creek and Big Beaver Creek were comparable between 1997 and 1992, while all sediment radiological constituents showed significant reductions in 1997. Reductions of zinc and trichloroethylene were documented in the X-230-J7 discharge to Little Beaver Creek from 1992 to 1997.

RECOMMENDATIONS

Use Designations

The current Warmwater Habitat aquatic life use designation should be maintained for Big Beaver Creek and Little Beaver Creek. Little Beaver Creek currently is attaining the WWH use in the lower 1.4 miles of stream and Big Beaver Creek has shown the potential to fully attain the WWH use designation.

Both Big Beaver Creek and Little Beaver Creek presently have a use designation of State Resource Waters. The State Resource Waters designation was applied to these two streams in the 1978 Ohio Water Quality Standards. Streams and rivers designated as State Resource Waters in the 1978 WQS were based on inclusion in National, State and Metropolitan park systems, wildlife refuges and preserves, wild, scenic, and recreational rivers, and waters of exceptional recreational or ecological significance (e.g., waters which provide a habitat for identified threatened or endangered species). The current State Resource Water designation for Big Beaver Creek and Little Beaver Creek should be deleted because the above noted requirements do not exist for either stream.

Non-aquatic life uses of Agricultural Water Supply, Industrial Water Supply and Primary Contact Recreation should be retained.

Table 1. Sampling locations in the Little Beaver Creek study area, 1997. Type of sampling included fish community (F), macroinvertebrate community (M), and sediment (S).

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark	County	USGS 7.5 min. Quad. Map
Little Beaver Creek						
3.3	F,M	39°00'52"	82°59'00"	Dutch Rd./Fog Rd Inters.	Pike	Waverly South, OH
3.1	F,M	39°01'06"	82°59'07"	60 m. dst. X-230-J7 discharge	Pike	Waverly South, OH
3.00	S	39°01'11"	82°59'06"	200 m. dst. X-230-J7	Pike	Waverly South, OH
2.5	F,M	39°01'32"	82°59'17"	Fog Rd.	Pike	Waverly South, OH
1.43	F,M,S	39°01'51"	83°00'15"	Dst. C & O Railroad	Pike	Piketon, OH
0.1	F,M	39°02'01"	83°01'29"	Wakefield-Mound Rd.	Pike	Piketon, OH
Big Beaver Creek						
5.6	F,M	39°03'35"	82°59'55"	Shyville Rd.	Pike	Waverly South, OH
2.22	S	39°01'57"	83°01'36"	Immediately ust. L. Beaver Cr.	Pike	Piketon, OH
2.10	S	39°01'52"	83°01'40"	Dst. US 23/ L. Beaver Cr.	Pike	Piketon, OH
1.87	S	39°01'42"	83°01'43"	Adjacent sand & gravel co.	Pike	Piketon, OH
1.32	F,M,S	39°01'32"	83°02'10"	Farm Ford, 0.9 miles dst. LBC	Pike	Piketon, OH

Table 2. Aquatic life use attainment status for the Warmwater Habitat (WWH) use designation of Little Beaver Creek and Big Beaver Creek based on data collected during July-October, 1997.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI	QHEI[a]	Attainment Status[b]	Comment
Little Beaver Creek						
	Western Allegheny Plateau - WWH Use Designation (Existing)					
3.3/3.3	37*	NA	P[c]	56.5	NON	Intermittent stream flow
3.1/3.1	44	NA	4*	83.0	NON	Downstream X230-J7 outfall
2.5/2.5	48	NA	26*	77.0	PARTIAL	0.7 miles dst. X230-J7 outfall
1.4/1.4	55	NA	52	78.0	FULL	Exceptional communities
0.1/0.1	52	NA	58	82.0	FULL	Exceptional communities
Big Beaver Creek						
	Western Allegheny Plateau - WWH Use Designation (Existing)					
5.6/5.6	36*	8.8	46	77.5	PARTIAL	Upstream Little Beaver Creek
1.3/1.3	41[ns]	8.1[ns]	44	73.5	FULL	Downstream L. Beaver Creek/ Sand and Gravel operation

Ecoregion Biocriteria: *Western Allegheny Plateau (WAP)*

INDEX	WWH	EWH	MWH[d]
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 -Modified Index of Well-being not applicable for headwater streams (<20 sq. miles drainage).

a - Qualitative Habitat Evaluation Index (QHEI) values based on Rankin (1989).

b - Attainment status based on one organism group is parenthetically expressed.

c - The narrative evaluation using the qualitative sample (P=Poor) is based on best professional judgment utilizing sample attributes such as taxa richness, EPT taxa richness, and community composition and is used in lieu of the ICI when artifical substrates are lost or deemed not useable.

d - Modified Warmwater Habitat for channel modified areas/ mine affected areas.

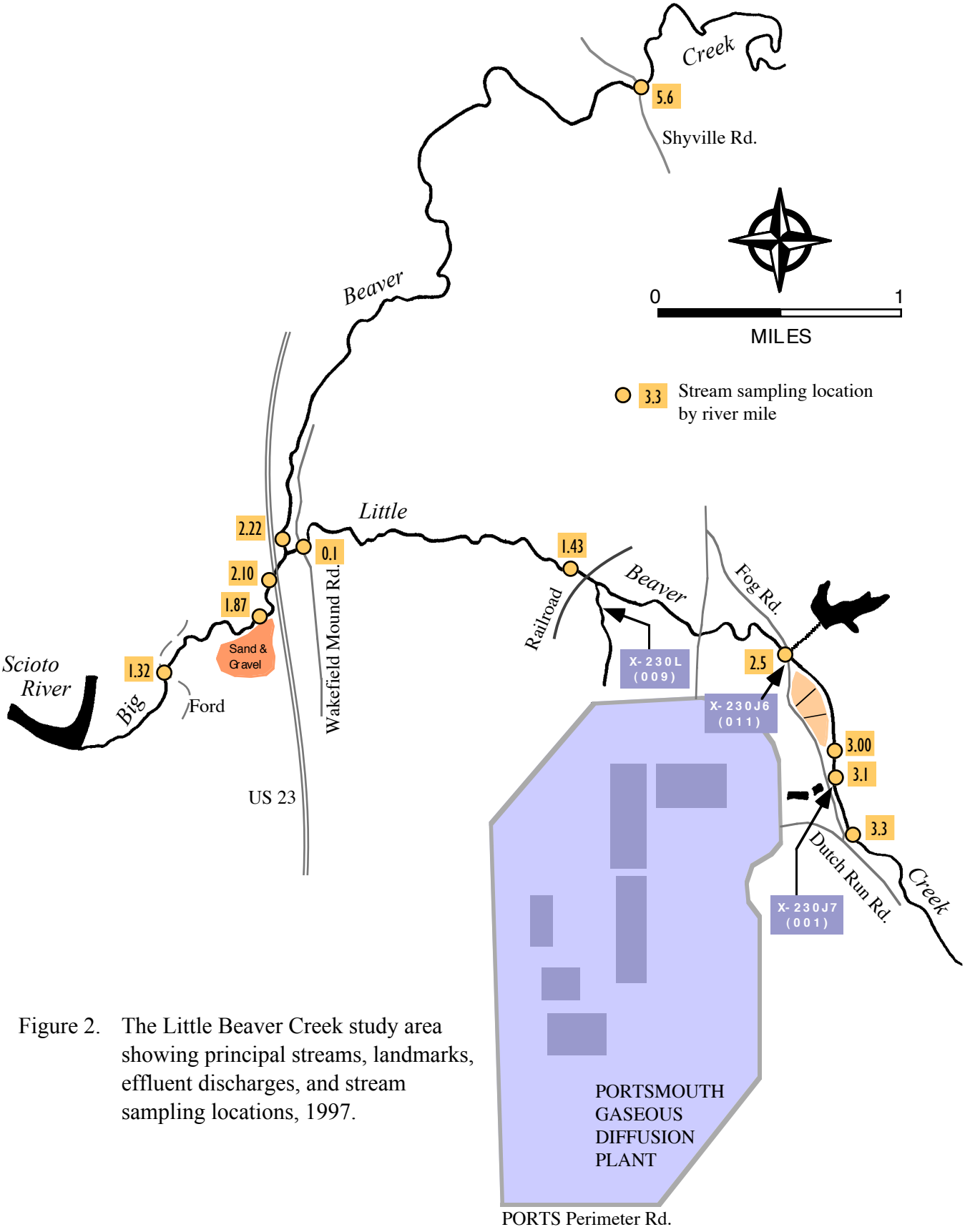

Figure 2. The Little Beaver Creek study area showing principal streams, landmarks, effluent discharges, and stream sampling locations, 1997.

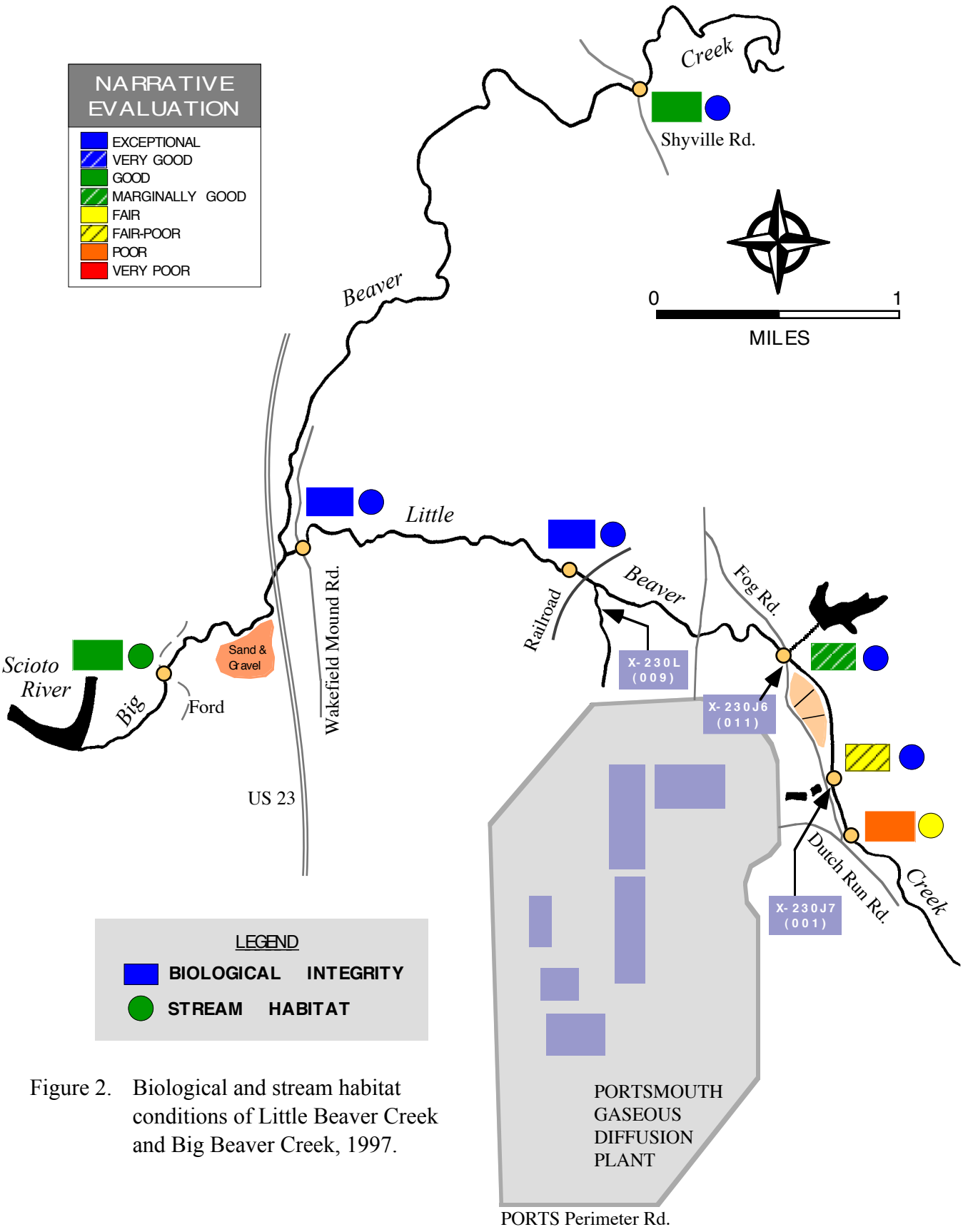

Figure 2. Biological and stream habitat conditions of Little Beaver Creek and Big Beaver Creek, 1997.

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 and fall of 1997 at five locations on Little Beaver Creek from river miles (RM) 3.3 to 0.1 and on Big Beaver Creek at RMs 5.6 and 1.3 (Table 1, Figure 2). Sediment samples were collected at two locations on Little Beaver Creek, and four locations from Big Beaver Creek.

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 7-14). 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) instream for a six-week colonization period from July 31 to September 11, 1997; in conjunction, a qualitative assessment of the available natural substrates was conducted at the time of the artificial substrate retrieval.

Fish Community Assessment

Fish were sampled using the wading method pulsed DC electrofishing gear, used at a frequency of two samples at each site. Fish collections were made at each site from August to October using pulsed DC electrofishing gear, with sampling distances varying between 150 and 200 meters per location.

Sediment Assessment

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

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are the principal 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 two locations from Little Beaver Creek, and four locations from Big Beaver Creek during October, 1997. All sampling locations are indicated by river mile in Figure 2. Samples were analyzed for volatile organic compounds, metals, PCBs, TOC, and radiologicals. Specific parameters tested and results are listed in Tables 3 and 4.

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, Little Beaver Creek sediment samples exceeded the Lowest Effect Level for arsenic and one polychlorinated biphenyl (PCB) congener (Table 3). These results were also observed in Big Beaver Creek downstream from the confluence with Little Beaver Creek. The guidelines detailed in Persaud *et al.* (1993) do not include evaluations of volatile organic compounds, several metals, and radiological parameters. Metal sediment levels from 1997 in Little Beaver Creek and Big Beaver Creek were comparable to similar locations sampled in 1992 (Ohio EPA 1993); however, a slight increase in arsenic was observed in Little Beaver Creek during 1997.

Radiological constituents in sediments were compared with the average of four background values from upstream sites on Little Beaver Creek (1) and Big Beaver Creek (3). Three of the four samples were collected in 1992 and one sample was collected in 1997. These background values were: gross alpha - 15.5 pCi/g, gross beta - 21.3 pCi/g, and total uranium - 2.2 µg/g. The background value for technetium^{99} was assumed to be 0.0 pCi/g since there is no natural source of this element. All radiological constituents showed significant reductions in 1997 compared to 1992 results (Figures 4 and 5). Gross beta values were at background levels in both Little Beaver Creek and Big Beaver Creek. Gross alpha values were at background levels in Little Beaver Creek but slightly above background levels in Big Beaver Creek near the confluence with Little Beaver Creek and returned to background levels at the lower site (RM 1.32). Total uranium values were near background levels in Little Beaver Creek and slightly above background levels in Big Beaver Creek. Technetium^{99} values although lower overall, still indicated elevated levels in Big Beaver Creek near the confluence with Little Beaver Creek. The site specific final remediation level for technetium^{99} for the DOE Fernal plant is 200,000 pCi/g in sediment. The low levels found at the PORTS site would not be expected to pose a risk based on the goal established for the Fernald plant. Two samples were analyzed for plutonium and both showed very low levels of plutonium ^{238}. Both values were within the range of analytical error so there is some uncertainty in the actual presence of plutonium ^{238} at these locations; in future sampling plutonium will be included in all analyses.

Table 3. Chemical compounds detected in sediment samples collected by Ohio EPA from Little Beaver Creek and Big Beaver Creek, October 27, 1997. 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.

	Little Beaver Creek		Big Beaver Creek			
Parameter	**3.00**	**1.43**	**2.22**	**2.10/Dup**	**1.87**	**1.32**
Metals - Total (mg/kg)						
Arsenic	**12**	**16**	<10	<10/<10	<10	**14**
Barium	29.0	40.9	24.9	32.4/36.0	17.6	33.4
Cadmium	<0.48	<0.49	<0.49	<0.50/<0.48	<0.48	<0.50
Chromium	7.1	11.6	5.3	6.5/7.2	7.3	6.4
Lead	12.6	14.4	8.0	10.4/10.6	8.0	11.3
Mercury	<0.08	<0.08	<0.08	<0.08/<0.08	<0.08	<0.08
Selenium	<10	<10	<10	<10/<10	<10	<10
Silver	<1.0	<1.0	<1.0	<1.0/<1.0	<1.0	<1.0
PCBs (ug/kg)						
Aroclor 1221	<33.1	<33.0	<33.3	<33.0/<33.1	<33.3	<33.2
Aroclor 1016	<16.6	<16.6	<16.7	<16.6/<16.6	<16.7	<16.7
Aroclor 1232	<16.6	<16.6	<16.7	<16.6/<16.6	<16.7	<16.7
Aroclor 1242	<16.6	<16.6	<16.7	<16.6/<16.6	<16.7	<16.7
Aroclor 1248	<16.6	<16.6	<16.7	<16.6/<16.6	<16.7	<16.7
Aroclor 1254	<16.6	<16.6	<16.7	<16.6/<16.6	<16.7	<16.7
Aroclor 1260	**11.4J**	**83.1**	<16.7	**16.0**/**26.4**	**21.6**	<16.7
Volatile Organic Compounds (ug/kg)						
Acetone	119	NA	NA	NA	NA	NA
2-Butanone	19.5	NA	NA	NA	NA	NA
34 other VOCs	ND	NA	NA	NA	NA	NA
Other						
TOC (mg/kg)	**15,400**	**15,200**	9,150	**21,100**/**20,100**	**11,400**	**16,400**
Particle Size (%)						
Gravel	0.4	3.6	1.1	0.1/0.0	5.7	15.6
Sand	32.9	25.5	59.5	2.7/2.4	76.3	32.8
Silt	57.4	60.9	31.5	81.1/81.6	15.3	39.8
Clay	9.3	10.0	7.9	16.1/16.0	2.7	11.8

NA - Not analyzed.

ND - Not detected.

J - Estimated concentration (detected at a concentration below the Estimated Quantitation Limit - EQL).

Table 4. Results of radiological measurements of sediment samples collected by Ohio EPA from Little Beaver Creek and Big Beaver Creek, October 27, 1997.

Parameter	Little Beaver Creek		Big Beaver Creek			
	3.00	**1.43**	**2.22**	**2.10/Dup**	**1.87**	**1.32**
Gross Alpha (pCi/g)	16	15	20	40/19	38	16
Gross Beta (pCi/g)	11	14	24	22/19	18	18
Plutonium 238 (pCi/g)	0.16	NA	NA	NA	NA	0.074J
Plutonium 239/240 (pCi/g)	0U	NA	NA	NA	NA	0U
Uranium 233/234 (pCi/g)	3.9	9.9	2.0	3.5/3.4	6.7	2.5
Uranium 235 (pCi/g)	0.079J	0.30	0.096J	0.14/0.099J	0.24	0.086J
Uranium 238 (pCi/g)	1.3	2.2	1.3	1.5/1.7	1.9	1.3
Total Uranium (ug/g dry)	3.2	5.7	3.2	3.7/3.7	4.7	3.2
Technetium 99 (pCi/g)	4.8	8.8	1.4	6.8/6.6	12	3.6

NA - Not analyzed.
J - The result is less than the Required Detection Limit (RDL).
U - The result is less than the Minimum Detectable Activity (MDA).

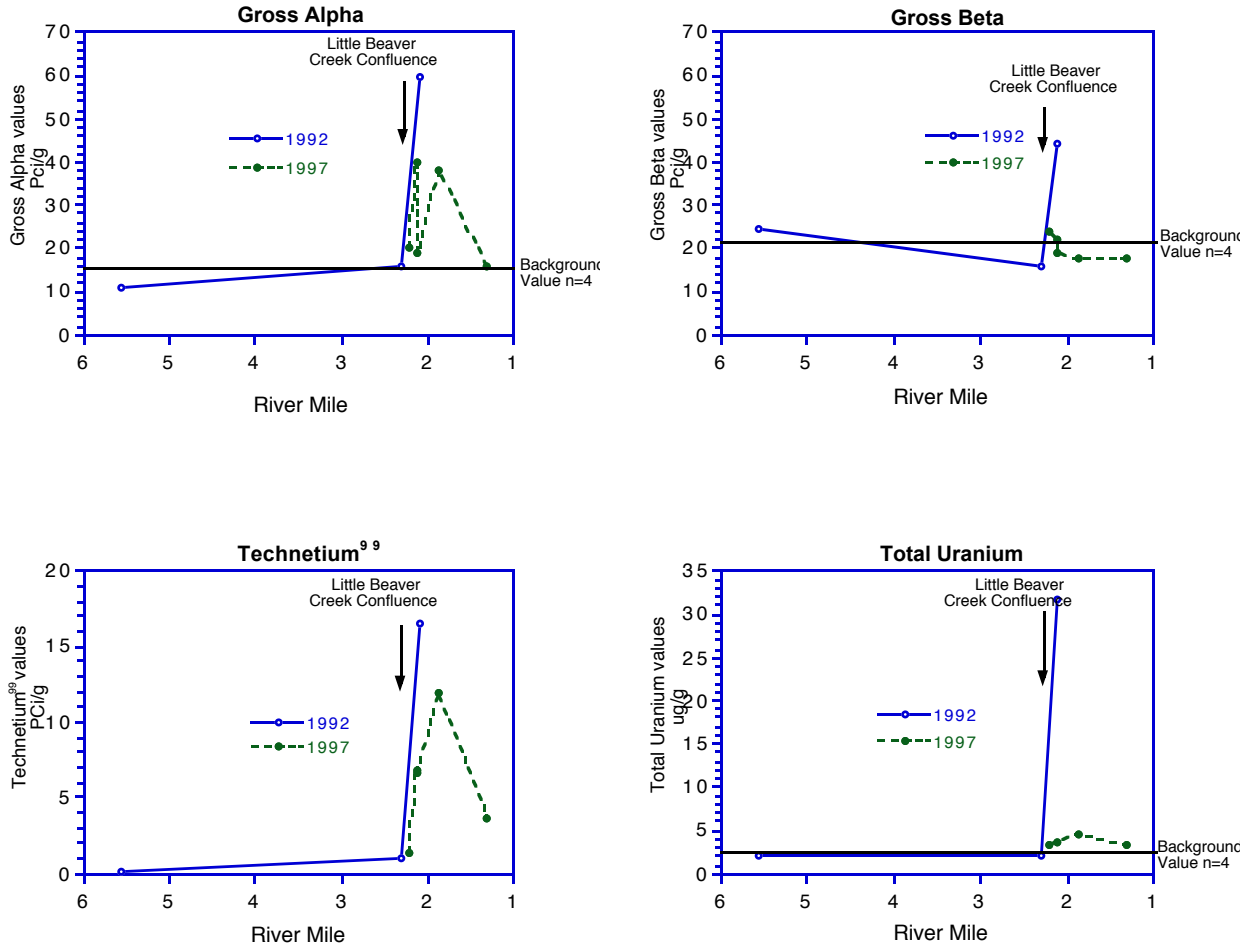

Figure 4. Longitudinal trend of gross beta, gross alpha, technetium^{99}, and total uranium radiologicals in sediment from Big Beaver Creek, 1992 and 1997.

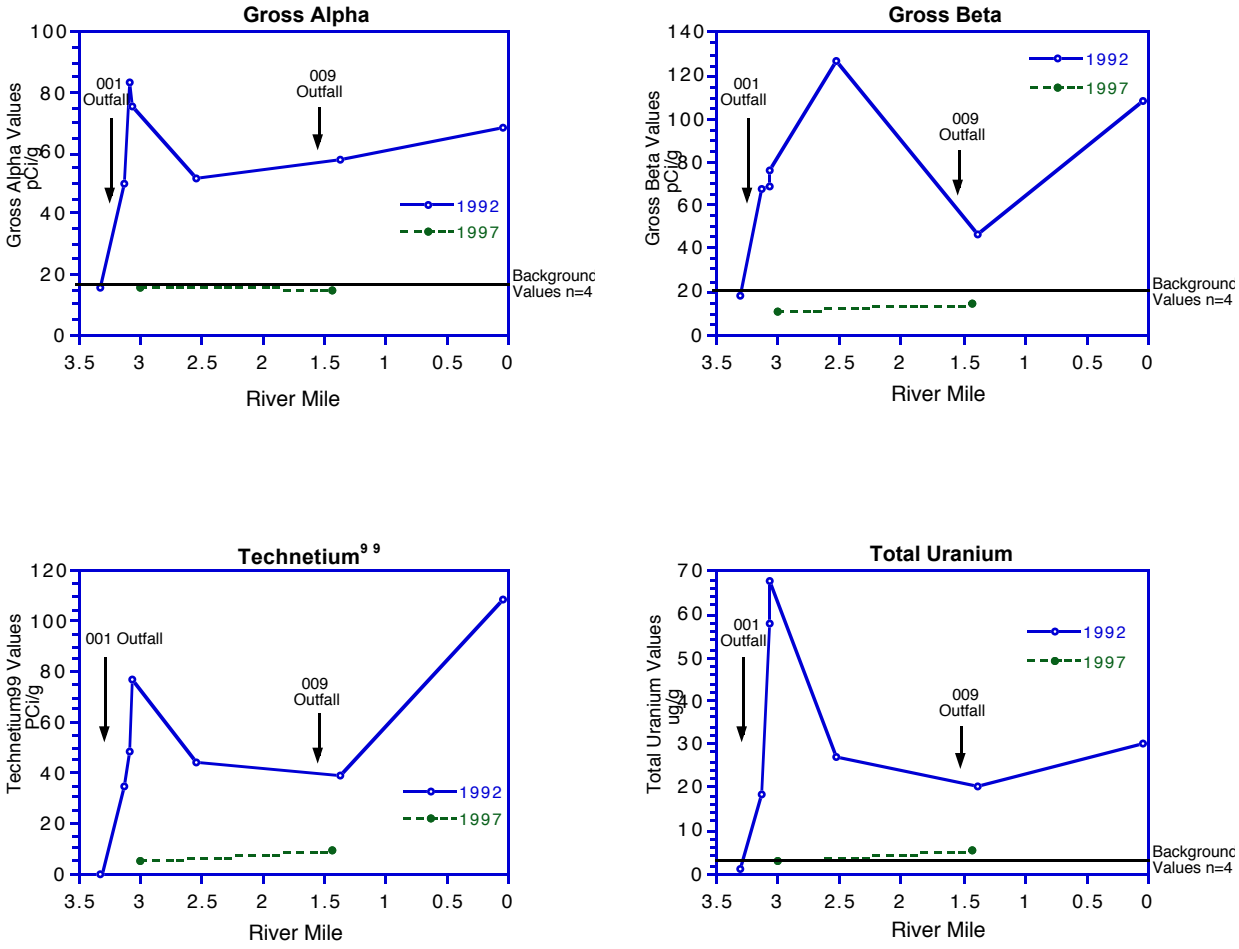

Figure 5. Longitudinal trend of gross beta, gross alpha, technetium99, and total uranium radiologicals in sediment from Little Beaver Creek, 1992 and 1997.

Surface Water Chemistry

Surface water chemical analyses of Little Beaver Creek, North Holding Pond Ditch, and East Drainage Ditch samples collected quarterly by PORTS (RCRA Annual Report, 1997 Groundwater Monitoring, March 1998) during 1997 are reported in Table 5. A total of four samples were collected at each location. The samples were tested for five metals, three inorganics, four physical parameters, four radionuclides, and 36 volatile organic compounds.

Of the non-organic chemical parameters measured which have Ohio Water Quality Criteria (pH, iron), all concentrations were within acceptable levels. Four parameters (calcium, magnesium, potassium, sodium) were compared to screening toxicological benchmarks (Suter and Tsao 1996). All four chemicals had concentrations far below levels that would potentially cause chronic toxicity. All volatile organic compounds tested were reported by the laboratory as non-detected. Uranium was measured in the North Holding Pond Drainage Ditch (RM 1.52, 0.13) and in Little Beaver Creek downstream from the North Holding Pond Ditch (at RM 1.00) at average concentrations of 4.6 ug/l and 2.7 ug/l, respectively, exceeding the chronic toxicity benchmark of 2.6 ug/l (Suter and Tsao 1996).

Pollutant Discharges: 1996 - 1997

Three PORTS outfalls have active discharges to Little Beaver Creek. Specific details of each are highlighted below and summarized from information included in three USDOE reports (1992, 1996a, 1996b).

X-230J7 East Holding Pond and Oil Separation Basin (Outfall 001)

The X-230J7 East Holding Pond is approximately 600 feet long and 100 feet wide and was constructed to control sedimentation resulting from stormwater runoff from storm sewers D and E. The discharge from storm sewers D and E enters a southern branch of the East Drainage Ditch upstream from X-230J7. An oil-skimming boom directs floating debris or oily water (entering through the storm sewers) and surface waters to a secondary oil collection basin located adjacent to this pond. The amount of recoverable waste oil is insignificant under normal discharge conditions.

An average of 1.1 million gallons of water per day enters the X-230J7 from the East Drainage Ditch. The East Drainage Ditch drains the mid-northeastern part of the site via storm sewers D and E. The pond also accepts once-through cooling water that has passed through the plant's air conditioning system. Until November, 1988, the East Drainage Ditch received effluent from the X-701B Holding Pond (NPDES 601). The X-230J7 empties into the lower East Drainage Ditch, which discharges to Little Beaver Creek about 1,200 feet downstream from the Oil Separation Basin.

X-230J6 Northeast Holding Pond (Outfall 011)

The X-230J6 Northeast Holding Pond is approximately 5,300 square feet in area and was constructed to control sedimentation resulting from stormwater runoff from storm sewer L. The discharge from storm sewer L enters the western branch of the Northeast Drainage Ditch (NEDD) upstream from X-230J6. An oil-skimming boom directs floating debris or oily water entering through the storm sewers and surface waters to a secondary oil collection basin located adjacent to

the pond. The amount of recoverable waste oil is insignificant under normal discharge conditions. X-230J6 discharges to the eastern branch of the NEDD which flows into Little Beaver Creek.

X-230L North Holding Pond (Outfall 009)

The X-230L North Holding Pond collects storm runoff from the following units: the X-533 Switchyard; the west side of the X-333 Process Building; the northern end of Pike Avenue; the X-342 and X-344 buildings; Scioto Avenue; X-630-2A and a portion of the X-630B cooling towers; X-745-B, E and F; the western side of the X-747H Surplus and Scrap Yard; storm sewers C, K and M; and the North Drainage Ditch. The North Drainage Ditch consists of six small drainage ditches including the western drainage (two ditches), the central drainage (three ditches), and the eastern drainage (one ditch). The primary purpose of the X-230L is to retain accidental spills until the materials can be removed and disposed of properly.

A summary of the PORTS WWTP discharges of wastewater/stormwater to Little Beaver Creek is detailed in Table 6.

The largest discharger to Little Beaver Creek is outfall 001, contributing on average one million gallons per day of flow to the stream. Monitored chemical/physical constituents in the effluent of outfall 001 were generally low, with 5 of the 7 parameters during 1997 reporting 50th percentile values at less than the lab method detection limit. Outfall 001 parameters with permit limits were all below either the 30-day or daily maximum limit. Substantial reductions of zinc and trichloroethylene discharged from outfall 001 were observed between 1991 (Ohio EPA 1993) and 1997 .

PORTS outfalls 009 and 011 combined, contribute one-third of the volume of effluent flow to Little Beaver Creek compared to outfall 001. These two outfalls contributed generally low amounts of chemical compounds to Little Beaver Creek, with all parameters within established permit limits during 1997.

Chemical Spills/ Wild Animal Kills

Chemical spills and wild animal kills are additional indications of impacts due to excessive pollutant loadings. Reviews were conducted of Ohio EPA spills data and Ohio DNR wildlife kills reports. No wildlife kills were reported by the ODNR for the study area streams between 1985 and 1997. Although a large number of spills have been reported to Little Beaver Creek between 1992 and 1997 associated with the PORTS facility, nearly all the spills were of unknown amount and type of material (Table 7).

Table 5. Mean concentrations of chemical compounds measured in surface water samples collected by PORTS from Little Beaver Creek, 1997. Values in parentheses are number of samples reported as 'less than lab detection'.

SURFACE WATER

Parameter	East Drainage Ditch RM 3.14, 0.02 n=4	N. Holding Pond RM 1.52, 0.13 n=4	Little Beaver Creek RM 3.08 n=4	RM 2.67 n=4	RM 2.02 n=4	RM 1.00 n=4
Specific Conductance (us/cm)	332	381	303	317	334	372
Field pH (SU)	7.66	7.30	7.36	7.27	7.18	7.31
Temperature (°C)	15.7	12.7	16.3	13.5	12.1	10.5
Alkalinity as $CaCO_3$ (mg/l)	57 (1)	80	46	46	47	60
Chloride (mg/l)	25.5	29.0	22.0	20.9	22.2	22.3
Sulfate (mg/l)	52.5	54.6	55.8	58.0	68.4	69.2
Calcium -Dissolved (mg/l)	20.6	28.9	17.1	17.3	19.5	24.5
Iron-Dissolved (ug/l)	73	139.6	103.4	144.8	148.7	131.7
Magnesium-Dissolved (mg/l)	16.6	15.9	15.8	15.9	17.1	17.8
Potassium-Dissolved (ug/l)	2970	2840	2835	3035	3172	3082
Sodium-Dissolved (mg/l)	18.5	21.4	15.8	15.8	16.3	18.0
Gross Alpha (pCi/l)	7 (2)	7 (2)	4 (3)	4 (2)	7 (2)	10 (2)
Gross Beta (pCi/l)	17.8 (2)	12 (3)	8 (3)	11 (3)	11 (2)	16 (1)
Technetium (pCi/l)	30.2 (3)	<27 (4)	<27 (4)	<27 (4)	<27 (4)	<27 (4)
Uranium, ICF/MS (ug/l)	1.6 (3)	4.6	<1.0 (4)	1.1 (2)	1.3 (1)	2.7
1,1,1-Trichloroethane (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,1,2,2-Tetrachloroethane (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,1,2-Trichloroethane (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,1-Dichloroethane (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,1-Dichloroethene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,2-Dichlorobenzene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,2-Dichloroethane (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,3-Dichlorobenzene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
1,4-Dichlorobenzene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
2-Butanone (ug/l)	<100 (4)	<100 (4)	<100 (4)	<100 (4)	<100 (4)	<100 (4)
4-Methyl-2-pentanone (ug/l)	<100 (4)	<100 (4)	<100 (4)	<100 (4)	<100 (4)	<100 (4)
Acetone (ug/l)	<100 (4)	<100 (4)	<100 (4)	<100 (4)	<100 (4)	<100 (4)
Benzene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Bromodichloromethane (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Bromoform (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Bromomethane (ug/l)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)
Carbone Disulfide (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Carbon Tetrachloride (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Chlorobenzene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Chloroethane (ug/l)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)
Chloroform (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Chloromethane (ug/l)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)

Table 5. Continued.

	SURFACE WATER					
	East Drainage Ditch	N. Holding Pond	Little Beaver Creek			
Parameter	RM 3.14, 0.02 n=4	RM 1.52, 0.13 n=4	RM 3.08 n=4	RM 2.67 n=4	RM 2.02 n=4	RM 1.00 n=4
Dibromochloromethane (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Ethylbenzene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Freon 113 (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Freon 114 (ug/l)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)
Methylene chloride (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Tetrachloroethene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Toluene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Trichloroethene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
Trichlorofluoromethane (ug/l)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)	<4 (4)
Vinyl Chloride (ug/l)	<1 (4)	<1 (4)	<1 (4)	<1 (4)	<1 (4)	<1 (4)
cis-1,2-Dichloroethene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
m,p-Xylene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
o-Xylene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)
trans-1,2-Dichloroethene (ug/l)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)	<2 (4)

Table 6. Concentrations of monitored chemicals in effluent discharged from the PORTS facility to Little Beaver Creek, 1996 and 1997.

	Effluent Concentration					
	Outfall 001 RM 3.14		**Outfall 009 RM 1.52**		**Outfall 011 RM 2.53**	
Parameter	1996	1997	1996	1997	1996	1997
Zinc -Total (ug/l)						
50th percentile	42	43	40	22	51	46
95th percentile	133	84	99	51	145	147
Maximum	133	108	448	71	198	150
Permit 30-day		-		-		-
Limit: Daily Max.		-		-		-
Chromium - Total (ug/l)						
50th percentile	MDL	MDL	MDL	MDL	5	7
95th percentile	4	5	6	6	10	21
Maximum	4	30	6	27	11	52
Permit 30-day		-		-		*102*
Limit: Daily Max.		-		-		*4724*
Chromium - Hex. (ug/l)						
50th percentile	MDL	MDL	MDL	MDL	MDL	MDL
95th percentile	MDL	MDL	MDL	MDL	MDL	MDL
Maximum	MDL	MDL	MDL	MDL	MDL	MDL
Permit 30-day		-		-		*11*
Limit: Daily Max.		-		-		*15*
Phosphorus - Total (mg/l)						
50th percentile	0.13	0.16	0.05	0.05	0.1	0.09
95th percentile	0.31	0.20	0.08	0.08	0.16	0.17
Maximum	0.31	0.22	0.11	0.32	0.22	0.23
Permit 30-day		-		-		-
Limit: Daily Max.		-		-		-
TSS (mg/l)						
50th percentile	3	MDL	8	7	2	4
95th percentile	11	10	24	26	10	11
Maximum	13	18	45	32	11	21
Permit 30-day		*20*		*30*		*30*
Limit: Daily Max.		*45*		*45*		*45*

Table 6. Continued.

	Effluent Concentration					
	Outfall 001 RM 3.14		Outfall 009 RM 1.52		Outfall 011 RM 2.53	
Parameter	1996	1997	1996	1997	1996	1997
Trichloroethylene (ug/l)						
50th percentile	MDL	MDL	NA	NA	NA	NA
95th percentile	MDL	MDL	NA	NA	NA	NA
Maximum	1	MDL	NA	NA	NA	NA
Permit 30-day	*75*		-		-	
Limit: Daily Max.	*1709*		-		-	
Nickel -Total (ug/l)						
50th percentile	MDL	MDL	NA	NA	NA	NA
95th percentile	MDL	132	NA	NA	NA	NA
Maximum	MDL	424	NA	NA	NA	NA
Permit 30-day	-		-		-	
Limit: Daily Max.	-		-		-	
Conduit Flow (MGD)						
50th percentile	1.05	0.99	0.372	0.259	0.084	0.077
95th percentile	2.375	2.09	0.864	0.85	0.267	0.187
Maximum	3.51	3.05	0.864	1.313	0.392	0.291
Permit 30-day	-		-		-	
Limit: Daily Max.	-		-		-	

NA - not analyzed.
MDL - less than the method detection limit.

Table 7. Summary of pollutant discharges to Little Beaver Creek and Big Beaver Creek reported to the Ohio EPA Division of Emergency and Remedial Response from 1992 - 1997.

Date	Stream	Entity	Material	Amount	Units
3/31/92	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
4/30/92	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
5/01/92	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
6/29/92	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
7/06/92	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
7/07/92	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
8/27/92	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
3/24/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
4/21/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
4/23/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
5/10/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
5/12/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
5/28/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
6/23/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
7/21/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
7/30/93	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
2/01/94	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
3/07/95	Holding Pond	DOE-PORTS	Diesel Fuel	100	Gal.
4/12/95	Little Beaver Cr.	DOE-PORTS	Wastewater	0.0	Gal.
7/10/95	Little Beaver Cr.	DOE-PORTS	Wastewater	0.0	Gal.
10/04/95	Little Beaver Cr.	DOE-PORTS	Wastewater	0.0	Gal.
1/09/96	Little Beaver Cr.	DOE-PORTS	Wastewater	0.0	Gal.
1/30/96	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
7/23/96	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
8/28/96	Little Beaver Cr.	DOE-PORTS	Unknown	Unk.	-
3/17/97	Little Beaver Cr.	DOE-PORTS	Wastewater w/PCB	0.0	Gal.
3/20/97	Little Beaver Cr.	DOE-PORTS	Wastewater	0.0	Gal.

Physical Habitat for Aquatic Life

Physical habitat was evaluated in Little Beaver Creek and Big Beaver Creek at each 1997 biological sampling location. Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 8.

Little Beaver Creek is a small, high gradient, unmodified stream which is effluent dominated by the X-230-J7 (outfall 001) holding pond discharge. Substrates consisted of predominantly slab boulders and bedrock at the upper reach to gravel and sand near the mouth. During the 1997 survey, Little Beaver Creek upstream from the X-230-J7 holding pond was composed of isolated pools with no observable stream flow. These intermittent flow conditions were also recorded during the 1992 and 1993 biological surveys. Qualitative Habitat Evaluation Index (QHEI) scores for Little Beaver Creek within the study area ranged between 56.5 and 83.0, with a mean value of 75.3. These scores are indicative of good to excellent stream and riparian habitat and reflect conditions which are capable of supporting WWH stream fish communities.

Big Beaver Creek within the study area (lower six miles) was predominated by substrates of sand and gravel. At RM 5.6, hardpan was prevalent within a previously channel modified section under the Shyville Road bridge and bedrock predominated in the 75 meters of the reach upstream from the bridge. During the 1997 sampling, and similar to 1992, Big Beaver Creek was intermittent upstream from Little Beaver Creek (confluence at RM 2.2) to at least RM 4.0. However, stream flow was observed at RM 5.6 and further upstream. The intermittent flow conditions in this section of Big Beaver Creek just upstream from Little Beaver Creek results from the stream channel entering the glacial outwash deposits of the abandoned Newark River Valley. The stream flow in this section of Big Beaver Creek becomes interstitial during low stream flow periods. QHEI scores for Big Beaver Creek at RMs 5.6 and 1.3 (73.5 and 77.5) are adequate for supporting a warmwater biological community despite low flow and intermittent conditions. A significant observation during the second fish sampling pass at RM 1.3 was the occurrence of a 1-3 inch layer of a very fine silt/clay material on the stream bottom. The sampling station at RM 1.3 was located downstream from a major highway construction project on State Route 32, as well as, a sand and gravel mining operation.

Table 8. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for Big Beaver Creek and Little Beaver Creek, 1992-1997.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: 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	MWH High Influence: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	Total HL MWH Attributes	MWH Moderate Influence: 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 ML MWH Attributes	MWH HL/WWH Ratio	MWH ML/WWH Ratio
(02-022) Big Beaver Creek																																	
Year: 97																																	
5.6	**77.5**	5.24	■	■		■	■	■			■	■	8						0	▲						▲					2	0.11	0.33
1.3	**73.5**	6.06	■	■		■	■	■	■			■	7						0	▲	▲							▲	▲		4	0.13	0.63
Year: 92																																	
5.6	**76.5**	5.24	■	■		■	■	■	■	■	■	■	9						0	▲											1	0.10	0.20
1.3	**78.0**	6.06	■	■		■	■	■	■	■	■	■	9						0	▲											1	0.10	0.20
(02-023) Little Beaver Creek																																	
Year: 97																																	
3.3	**56.5**	27.78	■	■			■			■	■		5	●	●				2			▲	▲			▲		▲			4	0.50	1.17
3.1	**83.0**	27.78	■	■		■	■	■	■	■	■	■	9						0		▲										1	0.10	0.20
2.5	**77.0**	48.78	■			■	■	■	■	■	■	■	8	●					1				▲								1	0.22	0.33
1.4	**78.0**	45.45	■	■		■	■	■	■	■	■	■	9	●					1		▲		▲								2	0.20	0.40
0.1	**82.0**	16.00	■	■		■	■	■	■	■	■	■	9						0		▲										1	0.10	0.20
Year: 93																																	
3.3	**60.0**	27.78	■	■	■	■	■	■		■	■		8		●				1			▲				▲		▲			3	0.22	0.56
3.1	**84.5**	27.78	■	■		■	■	■	■			■	7						0									▲	▲		2	0.13	0.38
2.1	**83.0**	30.77	■	■	■	■	■	■	■			■	9	●					1				▲	▲				▲				3	0.20	0.50
1.6	**83.5**	45.45	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
1.4	**79.0**	45.45	■	■	■	■	■	■	■	■	■	■	10						0									▲				1	0.09	0.18
Year: 92																																	
3.3	**69.0**	27.78	■	■		■	■	■			■	■	8						0									▲				1	0.11	0.22
2.5	**81.5**	48.78	■	■		■	■	■	■	■	■		9						0													0	0.10	0.10
0.1	**73.5**	16.00	■	■			■	■	■			■	6						0	▲		▲						▲	▲		4	0.14	0.71

Macroinvertebrate Community

Macroinvertebrate communities were sampled using artificial substrates in 1997 at five locations on Little Beaver Creek from RM 3.3 to RM 0.2 and two locations on Big Beaver Creek at RMs 5.6 and 1.3 (Table 1). Summarized results from the macroinvertebrate sampling are compiled in Table 9 and Figure 6. ICI metrics and scores and raw data tables by river mile are attached as Appendix Tables 1 and 2. Included in Table 9 are historic macroinvertebrate community results collected in 1992 by the Ohio EPA. Evaluations were based on the warmwater habitat ICI biocriterion established for the WAP ecoregion. A detailed discussion of the 1992 data is provided in Ohio EPA (1993).

Little Beaver Creek

Little Beaver Creek is naturally a moderately high to very high gradient intermittent stream -a stream that goes completely dry or is restricted to isolated pools during part or most of a year. Immediately upstream from the X-230-J7 holding pond discharge (the East Drainage Ditch - EDD), the stream consisted of small, isolated pools of less than 1 foot depth. The macroinvertebrate community diversity was low (8 taxa) with only one EPT taxa collected. These results may indicate a pollution problem upstream or that natural aquatic conditions necessary for macroinvertebrate community viability were severely limited.

The location downstream from the EDD (RM 3.1) had sufficient flow and met the minimum conditions for the sampling methods used. The macroinvertebrate community was in the poor range with an ICI score of four. However, the flow (with no upstream base flow) was 100% effluent made up of the non-contact cooling water from outfall 001. After reviewing the NPDES sampling data submitted for outfall 001 (OI000003001) and instream water samples (collected as part of the RCRA groundwater monitoring program), there was no indication that the effluent discharge or the groundwater plume were chemically impacting the stream community in 1997. The 001 outfall is discharged into a holding pond which overflows into the EDD before flowing into Little Beaver Creek. The predominant organisms in the sample collected at RM 3.1 were Nemertea (proboscis worms) and *Craspedacusta sowerbyi* (colonial hydroids of freshwater jellyfish). Both taxa are more commonly found in ponds than in running streams and were likely carried into the stream in the discharged water. The food base of headwater streams is coarse particulate organic matter (CPOM) originating from leaf litter and woody debris falling into the stream from riparian vegetation. This litter is colonized and digested by microorganisms. The litter and attached microbes are consumed by macroinvertebrates which convert the CPOM into fine particulate organic matter (FPOM). The FPOM is carried downstream by the current and is the food base for communities further downstream in higher order streams (Merritt and Cummins 1996; Vannote et al. 1980). The artificial nature of the effluent does not provide the CPOM to sustain a balanced, viable macroinvertebrate community in this stream reach.

At Fog Road (RM 2.5), community performance was in the fair range with an ICI score of 26. The habitat between RMs 3.1 and 2.5 is lined with heavy vegetation with many riffles, log jams, and deep pools providing good sources of CPOM.

The macroinvertebrate community performance at stations in the lower 1.5 miles (RMs 1.4 and 0.2) of Little Beaver Creek were in the exceptional range with ICI scores of 52 and 58, respectively; both easily achieved the WWH biocriterion of 36. Taxa diversity was high and pollution sensitive mayflies, caddisflies, and Tanytarsini midges predominated the samples. After the water discharged into Little Beaver Creek from outfall 001 has reached this point in the stream, it has traveled a sufficient distance to pick up enough CPOM to support diverse, high quality macroinvertebrate communities.

Big Beaver Creek

Sampling in Big Beaver Creek indicated macroinvertebrate communities performing in the very good (RM 1.3) to exceptional (RM 5.6) range; again both easily achieved the WWH biocriterion. The ICI score was 46 at RM 5.6 and 44 at RM 1.3. Taxa diversity was high and pollution sensitive Tanytarsini midges predominated the samples. The lower site was influenced by heavy silt loads in all habitats especially in the pools which were filled with a light silty-clay substance.

Table 9. Summary of macroinvertebrate data collected from artificial (quantitative) and natural (qualitative) substrates in Little Beaver Creek and Big Beaver Creek, 1997 and 1992. Little Beaver Creek and Big Beaver Creek have 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
Little Beaver Creek (1997)							
3.3				8	1		Poor[b]
3.1	49	24	17	9	1	4	Poor
2.5	74	38	34	10	3	26	Fair
1.4	241	63	56	21	9	52	Exceptional
0.2	131	56	47	20	12	58	Exceptional
Little Beaver Creek (1992)							
3.3	60	43	23	29	4	20*	Fair[b]
3.1	100	36	20	21	5	22*	Fair
2.5	83	30	23	14	1	16*	Fair
0.1	388	62	36	44	11	42	Very Good
Big Beaver Creek (1997)							
5.6	1031	61	46	42	10	46	Exceptional
1.3	670	59	45	25	8	44	Very Good
Big Beaver Creek (1992)							
5.6	1044	45	32	27	10	42	Very Good
1.3	128	53	47	19	5	40	Good

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

INDEX	**WWH**	**EWH**	**MWH**[c]
ICI	36	46	22

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

b - Based on comparison of macroinvertebrate community performance with ecoregion reference sites with intermittent or near intermittent conditions in similar size drainage areas.

c - 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 ICI units).

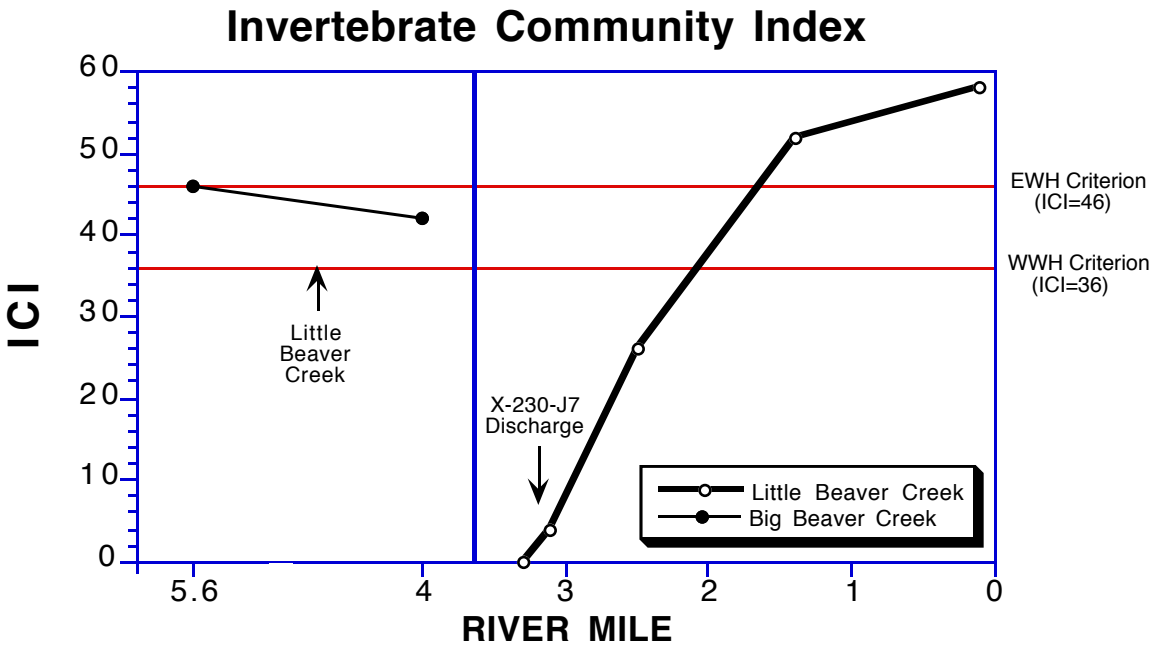

Figure 6. Longitudinal performance of the Invertebrate Community Index (ICI) in Little Beaver Creek and Big Beaver Creek, 1997.

Fish Community

A total of 7,381 fish representing 49 species and four hybrids were collected from Little Beaver Creek and Big Beaver Creek between August and October, 1997. Relative numbers and species collected per location are presented in Appendix Table 3 and IBI metrics are presented in Appendix Table 4. Sampling locations were evaluated using Warmwater Habitat biocriteria.

Little Beaver Creek

Upstream from the X-230-J7 holding pond discharge (001 outfall) to Little Beaver Creek, the 1997 fish community at RM 3.3 was in the upper fair range with an IBI of 37 (Table 10, Figure 7). As occurred during surveys conducted in 1991, 1992 (Ohio EPA 1992) and 1993, low precipitation during the summer and fall resulted in small isolated pools in Little Beaver Creek upstream from the X-230-J7 discharge. The low flow condition in Little Beaver Creek upstream from the X-230-J7 discharge was the principal factor in the failure to achieve the WWH biocriterion.

The fish communities from the four sampling locations (RMs 3.1-0.1) located downstream from the X-230-J7 discharge exhibited good to exceptional biological condition. The IBI (44 - 55) scores were good to exceptional and the entire stream reach achieved the WWH biocriterion. The discharge of wastewater from the X-230-J7 outfall did not have a negative impact on the fish communities of Little Beaver Creek. The contribution of over 1.0 million gallons per day of water from the X-230-J7 outfall has increased the biological diversity of fish communities in Little Beaver Creek.

Big Beaver Creek

Fish communities in Big Beaver Creek were sampled upstream and downstream from the confluence of Little Beaver Creek. Upstream from Little Beaver Creek at Shyville Road (RM 5.6), the fish community exhibited fair to good conditions, with the IBI significantly departing from the WWH biocriterion and the MIwb score achieving the biocriterion. Although RM 5.6 had good populations of pollution sensitive darters (seven species, 227 individuals), the predominance of pollution tolerant species, in particular bluntnose minnow, contributed to the lower than expected biotic integrity. Downstream from the confluence with Little Beaver Creek, the Big Beaver Creek fish community exhibited marginally good quality, with both the IBI (41) and the MIwb (8.1) in the non-significant departure range of the biocriteria. No apparent negative influences from Little Beaver Creek and the PORTS facility were observed in the Big Beaver Creek fish communities. Big Beaver Creek at RM 1.3 appeared to be influenced by a combination of heavy sedimentation and extensive embeddedness of the stream bottom, and the lack of a well-developed riffle/run area when compared to upstream.

Table 10. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in Little Beaver Creek and Big Beaver Creek during 1992, 1993 and 1997. 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.

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]
Little Beaver Creek (1997)									
3.3	Wading-2	8.5	9	590	NA	56.5	NA	37*	Fair
3.1	Wading-2	14.5	17	1098	NA	83.0	NA	44	Good
2.5	Wading-2	15.0	18	997	NA	77.0	NA	48	Very Good
1.4	Wading-2	20.0	22	1112	NA	78.0	NA	55	Exceptional
0.1	Wading-2	23.0	29	863	NA	82.0	NA	52	Exceptional
Little Beaver Creek (1993)									
3.3	Wading-1	NA	8	104	NA	60.0	NA	30*	Fair
3.1	Wading-1	NA	19	939	NA	84.5	NA	56	Exceptional
2.1	Wading-1	NA	17	1802	NA	83.0	NA	54	Exceptional
1.6	Wading-1	NA	19	3669	NA	83.5	NA	54	Exceptional
1.4	Wading-1	NA	26	1640	NA	79.0	NA	54	Exceptional
Little Beaver Creek (1992)									
3.3	Wading-1	NA	11	716	NA	69.0	NA	36*	Fair
2.5	Wading-2	12.0	13	936	NA	82.0	NA	48	Very Good
0.1	Wading-2	NA	26	1387	NA	74.0	NA	54	Exceptional
Big Beaver Creek (1997)									
5.6	Wading-2	27.0	30	1075	6.88		8.8	36*	Good/Fair
1.3	Wading-2	26.0	34	697	2.76	73.5	8.1[ns]	41[ns]	Marginally Good
Big Beaver Creek (1992)									
5.6	Wading-2	22.5	29	296	8.3	77.0	7.7*	48	Fair/Very Good
1.3	Wading-2	NA	28	312	5.1	78.0	9.1	52	V. Good/Exception.

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.

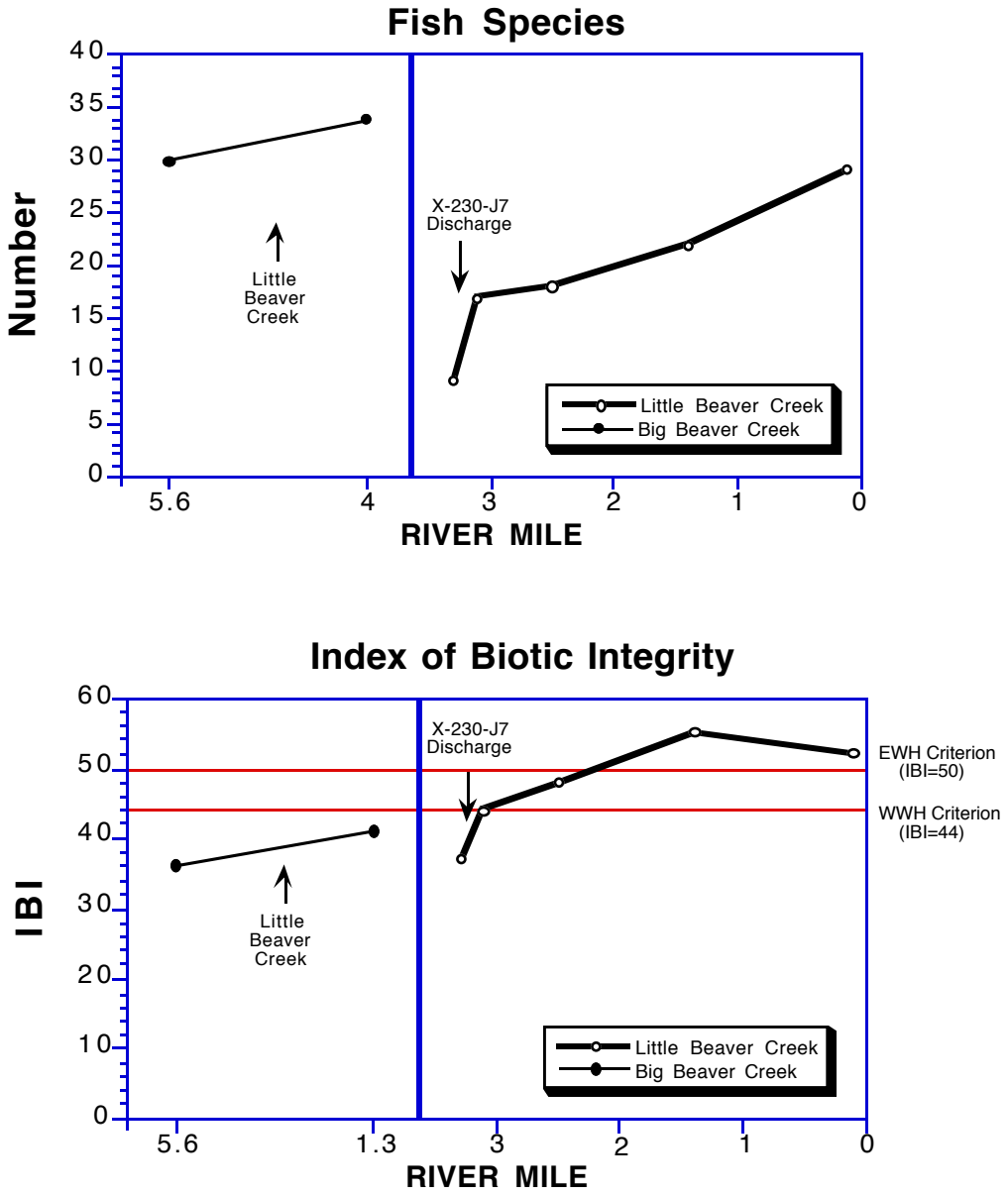

Figure 7. Longitudinal trend of the Index of Biotic Integrity (IBI), and number of fish species from Little Beaver Creek and Big Beaver Creek, 1997.

TREND ASSESSMENT

Changes in Macroinvertebrate Community Performance: 1992, 1997

The upstream site on Little Beaver Creek (RM 3.3) in 1992 had channel flow when the artificial substrates were set and several hard rains occurred during the six week colonization period. The channel had dried to isolated pools by the end of the sampling period. In 1997 the site consisted of isolated pools at the beginning and end of the sampling period with few significant rainfalls during the six week sampling period. The decline in the ICI score from a 20 in 1992 to a zero in 1997 is most likely attributable to the lack of channel flow and the artificial substrates being positioned in an isolated pool (Figure 8). The results at the site downstream from the X-230-J7 holding pond discharge (RM 3.1) showed a nearly identical decline with an ICI score of 22 in 1992 and a four in 1997. This indicates that a lack of natural base flow and the associated CPOM on which headwater stream macroinvertebrate communities are sustained, is the overriding influence in the low ICI scores in this reach. The site at Fog Road (RM 2.5) showed an improvement from an ICI score of 16 in 1992 to 26 in 1997. The improvement in the macroinvertebrate community may be related to the discontinuation of the discharges from the X-611A Lime Sludge Lagoons to Little Beaver Creek at the end of 1996. The sites at the mouth of Little Beaver Creek improved from an ICI score of 42 (RM 0.1) in 1992 to a 58 (RM 0.2) in 1997. The lower score in 1992 may have been a reflection of the high flow conditions during that summer; the substrates in the reach are predominated by small gravel and sand, and are very unstable during high flow events.

The two locations on Big Beaver Creek showed a four point improvement in ICI scores between 1992 and 1997. The lower site (RM 1.3) remained in the very good range (1992 ICI=40 and 1997 ICI=44); the upper site (RM 5.6) improved from the very good range to the exceptional range (1992 ICI=42 and 1997 ICI=46).

Changes in Fish Community Performance: 1992, 1993, 1997

The fish communities in Little Beaver Creek between RMs 3.3 and 0.1 were sampled during 1992, 1993 and 1997 (Figure 8). All three years of sampling documented full attainment of the WWH fish biocriterion at sites downstream from the X-230-J7 (outfall 001) discharge. A 12 point decline in the IBI did occur at RM 3.1 between 1993 and 1997; however, WWH biocriteria were still being attained.

Big Beaver Creek was sampled at two locations (RMs 5.6 and 1.3) during 1992 and 1997. Fish community results indicated an overall decline in biological integrity between 1992 and 1997. In particular, IBI values were lower at both Big Beaver Creek sites during 1997, with scores declining from exceptional to marginally good at RM 1.3 and very good to fair at RM 5.6.

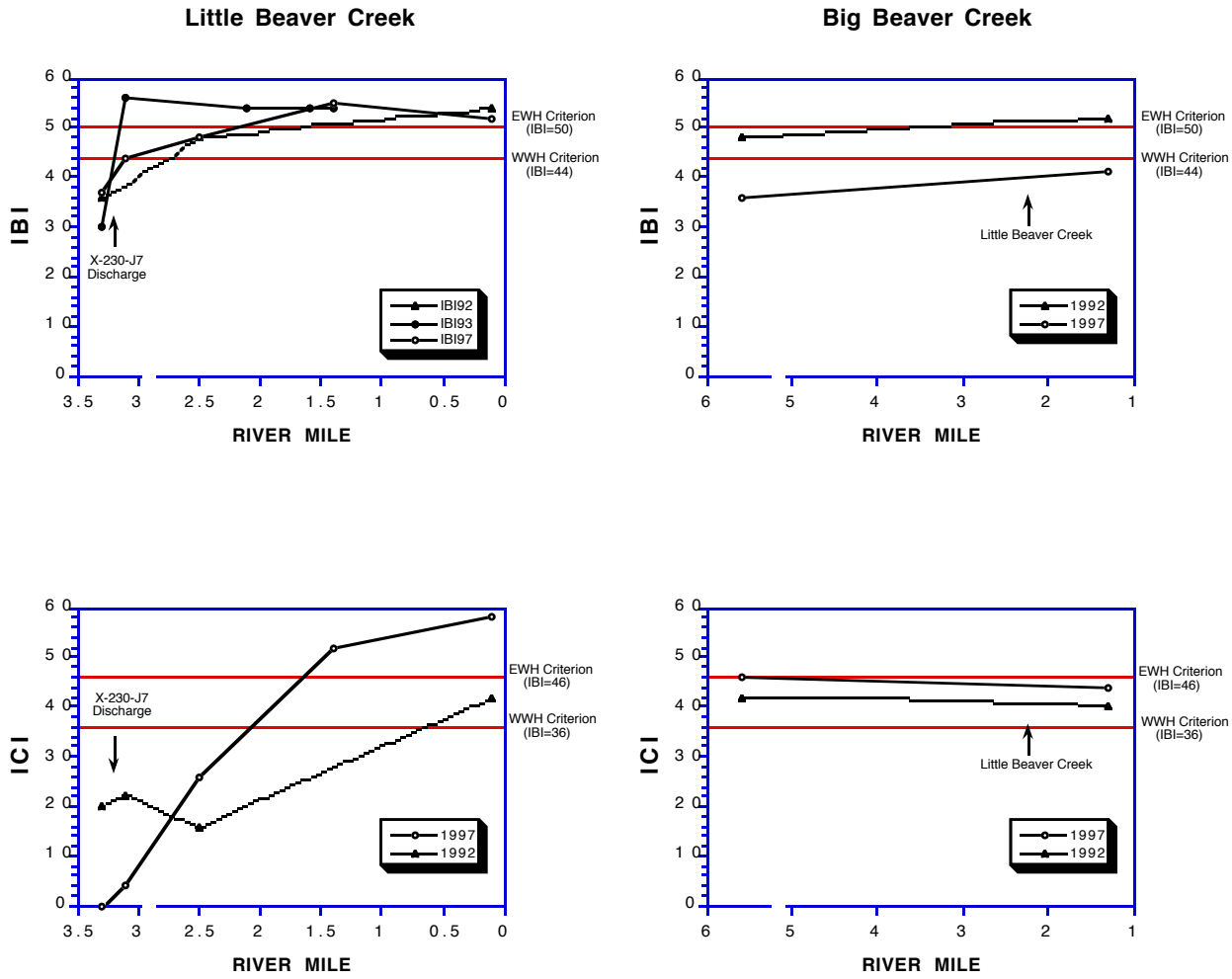

Figure 8. Longitudinal trend of the Index of Biotic Integrity (IBI), and Invertebrate Community Index (ICI) in Little Beaver Creek and Big Beaver Creek during 1992, 1993 and 1997.

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Appendix Table 1. Raw macroinvertebrate data by river mile for sites in the Little Beaver Creek study area, 1997.

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/11/97 River Code: 02-022 River: Big Beaver Creek RM: 5.60

Taxa Code	Taxa	Quant/Qual
00556	*Ephydatia fluviatilis*	+
01801	*Turbellaria*	1
03360	*Plumatella sp*	1
03600	*Oligochaeta*	71 +
06201	*Hyalella azteca*	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	1 +
11130	*Baetis intercalaris*	1 +
12200	*Isonychia sp*	3 +
13400	*Stenacron sp*	2 +
13590	*Stenonema vicarium*	61 +
14950	*Leptophlebia sp or Paraleptophebia sp*	3
17200	*Caenis sp*	11
21200	*Calopteryx sp*	4 +
22001	*Coenagrionidae*	+
22300	*Argia sp*	6 +
23909	*Boyeria vinosa*	1 +
34130	*Acroneuria frisoni*	4 +
47600	*Sialis sp*	1 +
48220	*Chauliodes rastricornis*	1 +
48410	*Corydalus cornutus*	+
50315	*Chimarra obscura*	+
51400	*Nyctiophylax sp*	2
52200	*Cheumatopsyche sp*	68 +
52530	*Hydropsyche depravata group*	+
59110	*Ceraclea ancylus*	+
59140	*Ceraclea maculata*	+
59580	*Oecetis persimilis*	4
60300	*Dineutus sp*	+
68708	*Dubiraphia vittata group*	9 +
68901	*Macronychus glabratus*	+
71100	*Hexatoma sp*	+
74100	*Simulium sp*	+
74501	*Ceratopogonidae*	8
77115	*Ablabesmyia janta*	39
77120	*Ablabesmyia mallochi*	39
77500	*Conchapelopia sp*	118 +
77750	*Hayesomyia senata or Thienemannimyia norena*	79
77800	*Helopelopia sp*	79 +
78401	*Natarsia species A (sensu Roback, 1978)*	+
80370	*Corynoneura lobata*	64
80410	*Cricotopus (C.) sp*	39
80430	*Cricotopus (C.) tremulus group*	39 +
83040	*Dicrotendipes neomodestus*	+
83840	*Microtendipes pedellus group*	39 +
84300	*Phaenopsectra obediens group*	39 +
84450	*Polypedilum (P.) "convictum" (sensu Simpson and Bode, 1980)*	39 +
84460	*Polypedilum (P.) fallax group*	39 +
84470	*Polypedilum (P.) illinoense*	39
84520	*Polypedilum (Tripodura) halterale group*	+
85500	*Paratanytarsus sp*	39
85615	*Rheotanytarsus distinctissimus group*	472 +
85625	*Rheotanytarsus exiguus group*	2557 +
85720	*Stempellinella n.sp nr. flavidula*	39
85800	*Tanytarsus sp*	197
85802	*Tanytarsus curticornis group*	39
85814	*Tanytarsus glabrescens group*	787 +
85840	*Tanytarsus guerlus group*	39
87540	*Hemerodromia sp*	14 +
96900	*Ferrissia sp*	9
97601	*Corbicula fluminea*	4 +
98200	*Pisidium sp*	3 +

No. Quantitative Taxa: 46 Total Taxa: 61

No. Qualitative Taxa: 42 ICI: **46**

Number of Organisms: 5153 Qual EPT: 10

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/11/97 River Code: 02-022 River: Big Beaver Creek RM: 1.30

Taxa Code	Taxa	Quant/Qual
01200	*Cordylophora lacustris*	3
01801	*Turbellaria*	1
03600	*Oligochaeta*	3
08250	*Orconectes (Procericambarus) rusticus*	+
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
11130	*Baetis intercalaris*	132 +
11651	*Procloeon sp (w/o hindwing pads)*	8
12200	*Isonychia sp*	56 +
13400	*Stenacron sp*	4
13561	*Stenonema pulchellum*	31
13590	*Stenonema vicarium*	66 +
16200	*Eurylophella sp*	4
17200	*Caenis sp*	101
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	7 +
23909	*Boyeria vinosa*	+
27500	*Somatochlora sp*	+
34130	*Acroneuria frisoni*	7 +
43300	*Ranatra sp*	+
47600	*Sialis sp*	+
48410	*Corydalus cornutus*	1
48620	*Nigronia serricornis*	1 +
50315	*Chimarra obscura*	2 +
52200	*Cheumatopsyche sp*	57 +
52530	*Hydropsyche depravata group*	+
59001	*Leptoceridae*	+
67800	*Tropisternus sp*	+
68130	*Helichus sp*	1 +
68601	*Ancyronyx variegata*	4
68901	*Macronychus glabratus*	4
69400	*Stenelmis sp*	1
74100	*Simulium sp*	+
77500	*Conchapelopia sp*	24
77750	*Hayesomyia senata or Thienemannimyia norena*	96
77800	*Helopelopia sp*	96
78450	*Nilotanypus fimbriatus*	48
80370	*Corynoneura lobata*	48
80430	*Cricotopus (C.) tremulus group*	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	24
81250	*Nanocladius (N.) minimus*	24
81650	*Parametriocnemus sp*	24
82121	*Thienemanniella n.sp 3*	48
82141	*Thienemanniella xena*	24
84210	*Paratendipes albimanus or P. duplicatus*	24
84450	*Polypedilum (P.) "convictum" (sensu Simpson and Bode, 1980)*	48 +
84460	*Polypedilum (P.) fallax group*	96
84470	*Polypedilum (P.) illinoense*	72
84520	*Polypedilum (Tripodura) halterale group*	48
85500	*Paratanytarsus sp*	72
85615	*Rheotanytarsus distinctissimus group*	24
85625	*Rheotanytarsus exiguus group*	722 +
85720	*Stempellinella n.sp nr. flavidula*	24
85800	*Tanytarsus sp*	168
85814	*Tanytarsus glabrescens group*	1059
85840	*Tanytarsus guerlus group*	24
87540	*Hemerodromia sp*	18
95100	*Physella sp*	+
96900	*Ferrissia sp*	1

No. Quantitative Taxa: 45 Total Taxa: 59

No. Qualitative Taxa: 25 ICI: **44**

Number of Organisms: 3350 Qual EPT: 8

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/10/97 River Code: 02-023 River: Little Beaver Creek RM: 3.30

Taxa Code	Taxa	Quant/Qual	Taxa Code	Taxa	Quant/Qual
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+			
13521	*Stenonema femoratum*	+			
27500	*Somatochlora sp*	+			
43205	*Nepa apiculata*	+			
63300	*Hydroporus sp*	+			
66200	*Cymbiodyta sp*	+			
82730	*Chironomus (C.) decorus group*	2 +			
83300	*Glyptotendipes (G.) sp*	3			
83600	*Kiefferulus (K.) dux*	1			
95100	*Physella sp*	2 +			
96900	*Ferrissia sp*	1			

No. Quantitative Taxa: 5 Total Taxa: 11
No. Qualitative Taxa: 8 ICI: **0**
Number of Organisms: 9 Qual EPT: 1

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/10/97 River Code: 02-023 River: Little Beaver Creek RM: 3.10

Taxa Code	Taxa	Quant/Qual
01418	*Craspedacusta sowerbyi*	35
01900	*Nemertea*	56
03600	*Oligochaeta*	3
08250	*Orconectes (Procericambarus) rusticus*	+
11120	*Baetis flavistriga*	2
21200	*Calopteryx sp*	5
22001	*Coenagrionidae*	1 +
22300	*Argia sp*	6 +
23909	*Boyeria vinosa*	+
26130	*Cordulegaster obliqua*	+
26700	*Macromia sp*	+
28208	*Erythemis simplicicollis*	+
52530	*Hydropsyche depravata group*	+
63300	*Hydroporus sp*	+
69400	*Stenelmis sp*	1
77500	*Conchapelopia sp*	3
77800	*Helopelopia sp*	3
80420	*Cricotopus (C.) bicinctus*	5
80430	*Cricotopus (C.) tremulus group*	32
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	3
81240	*Nanocladius (N.) distinctus*	13
95100	*Physella sp*	21
96120	*Menetus (Micromenetus) dilatatus*	3
96900	*Ferrissia sp*	54

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 17 Total Taxa: 24

No. Qualitative Taxa: 9 ICI: **4**

Number of Organisms: 246 Qual EPT: 1

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/10/97 River Code: 02-023 River: Little Beaver Creek RM: 2.50

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	1
01900	*Nemertea*	28
03360	*Plumatella sp*	1
08200	*Orconectes sp*	+
11120	*Baetis flavistriga*	24 +
13521	*Stenonema femoratum*	25 +
17200	*Caenis sp*	8
21200	*Calopteryx sp*	1 +
22001	*Coenagrionidae*	+
22300	*Argia sp*	6 +
23804	*Basiaeschna janata*	+
26700	*Macromia sp*	+
48220	*Chauliodes rastricornis*	1
48410	*Corydalus cornutus*	3
52200	*Cheumatopsyche sp*	34
52530	*Hydropsyche depravata group*	5 +
74673	*Atrichopogon websteri*	1
77500	*Conchapelopia sp*	10
77750	*Hayesomyia senata or Thienemannimyia norena*	6
77800	*Helopelopia sp*	21
78140	*Labrundinia pilosella*	3
78450	*Nilotanypus fimbriatus*	5
80410	*Cricotopus (C.) sp*	5
81631	*Parakiefferiella n.sp 1*	2
81825	*Rheocricotopus (Psilocricotopus) robacki*	13
82100	*Thienemanniella sp*	2
84300	*Phaenopsectra obediens group*	2 +
84315	*Phaenopsectra flavipes*	2
84460	*Polypedilum (P.) fallax group*	5
84470	*Polypedilum (P.) illinoense*	6
85500	*Paratanytarsus sp*	3
85625	*Rheotanytarsus exiguus group*	3
85800	*Tanytarsus sp*	6
85814	*Tanytarsus glabrescens group*	14
87540	*Hemerodromia sp*	1
95100	*Physella sp*	2
96120	*Menetus (Micromenetus) dilatatus*	3
96900	*Ferrissia sp*	117

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 34 Total Taxa: 38
No. Qualitative Taxa: 10 ICI: **26**
Number of Organisms: 369 Qual EPT: 3

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/10/97 River Code: 02-023 River: Little Beaver Creek RM: 1.40

Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	2
01900	*Nemertea*	9
03600	*Oligochaeta*	5
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
11120	*Baetis flavistriga*	56 +
11130	*Baetis intercalaris*	48 +
12200	*Isonychia sp*	6 +
13521	*Stenonema femoratum*	28 +
13590	*Stenonema vicarium*	28
16200	*Eurylophella sp*	2
17200	*Caenis sp*	46 +
21200	*Calopteryx sp*	8 +
22300	*Argia sp*	19 +
23909	*Boyeria vinosa*	+
34130	*Acroneuria frisoni*	2 +
47600	*Sialis sp*	1
48220	*Chauliodes rastricornis*	2 +
48410	*Corydalus cornutus*	3 +
50301	*Chimarra aterrima*	+
50804	*Lype diversa*	13
51600	*Polycentropus sp*	1
52200	*Cheumatopsyche sp*	1 +
52430	*Ceratopsyche morosa group*	1 +
53800	*Hydroptila sp*	5
59001	*Leptoceridae*	1
60300	*Dineutus sp*	+
68075	*Psephenus herricki*	+
68700	*Dubiraphia sp*	1
68901	*Macronychus glabratus*	1
71910	*Tipula abdominalis*	+
74501	*Ceratopogonidae*	1
74673	*Atrichopogon websteri*	1
77500	*Conchapelopia sp*	20
77750	*Hayesomyia senata or Thienemannimyia norena*	15
77800	*Helopelopia sp*	171
78450	*Nilotanypus fimbriatus*	5
79400	*Zavrelimyia sp*	5
80370	*Corynoneura lobata*	128
80420	*Cricotopus (C.) bicinctus*	5
80430	*Cricotopus (C.) tremulus group*	15
81250	*Nanocladius (N.) minimus*	5
81465	*Orthocladius (O.) carlatus*	10
81650	*Parametriocnemus sp*	5
81825	*Rheocricotopus (Psilocricotopus) robacki*	20
82121	*Thienemanniella n.sp 3*	5
82141	*Thienemanniella xena*	20
83040	*Dicrotendipes neomodestus*	5 +
84210	*Paratendipes albimanus or P. duplicatus*	5
84300	*Phaenopsectra obediens group*	15
84450	*Polypedilum (P.) "convictum" (sensu Simpson and Bode, 1980)*	10
84460	*Polypedilum (P.) fallax group*	55
84470	*Polypedilum (P.) illinoense*	+
84520	*Polypedilum (Tripodura) halterale group*	5
84700	*Stenochironomus sp*	5
85500	*Paratanytarsus sp*	60
85615	*Rheotanytarsus distinctissimus group*	15
85625	*Rheotanytarsus exiguus group*	45 +
85800	*Tanytarsus sp*	25
85814	*Tanytarsus glabrescens group*	151
85840	*Tanytarsus guerlus group*	15
87540	*Hemerodromia sp*	52
95100	*Physella sp*	2
96900	*Ferrissia sp*	19

No. Quantitative Taxa: 56 Total Taxa: 63
No. Qualitative Taxa: 21 ICI: **52**
Number of Organisms: 1204 Qual EPT: 9

Ohio EPA/DSW Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/10/97 River Code: 02-023 River: Little Beaver Creek RM: 0.20

Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	3
11120	*Baetis flavistriga*	+
11130	*Baetis intercalaris*	8 +
11651	*Procloeon sp (w/o hindwing pads)*	1
12200	*Isonychia sp*	14 +
13400	*Stenacron sp*	75 +
13521	*Stenonema femoratum*	44 +
13590	*Stenonema vicarium*	21
17200	*Caenis sp*	49 +
21200	*Calopteryx sp*	1
22300	*Argia sp*	21 +
23909	*Boyeria vinosa*	+
34130	*Acroneuria frisoni*	4 +
48220	*Chauliodes rastricornis*	1
48410	*Corydalus cornutus*	+
50301	*Chimarra aterrima*	2 +
50315	*Chimarra obscura*	+
50804	*Lype diversa*	11
52200	*Cheumatopsyche sp*	+
52430	*Ceratopsyche morosa group*	6 +
52530	*Hydropsyche depravata group*	+
60300	*Dineutus sp*	+
68601	*Ancyronyx variegata*	2
68700	*Dubiraphia sp*	1
68901	*Macronychus glabratus*	1
71100	*Hexatoma sp*	+
74100	*Simulium sp*	1 +
77120	*Ablabesmyia mallochi*	13
77500	*Conchapelopia sp*	16
77800	*Helopelopia sp*	33
78140	*Labrundinia pilosella*	7
78450	*Nilotanypus fimbriatus*	7
80370	*Corynoneura lobata*	98 +
81465	*Orthocladius (O.) carlatus*	3
82101	*Thienemanniella n.sp 1*	3
83840	*Microtendipes pedellus group*	3
84155	*Paralauterborniella nigrohalteralis*	3
84210	*Paratendipes albimanus or P. duplicatus*	13
84300	*Phaenopsectra obediens group*	10
84450	*Polypedilum (P.) "convictum" (sensu Simpson and Bode, 1980)*	7
84460	*Polypedilum (P.) fallax group*	10
84470	*Polypedilum (P.) illinoense*	+
84520	*Polypedilum (Tripodura) halterale group*	3
84700	*Stenochironomus sp*	3
84800	*Tribelos jucundum*	3
85500	*Paratanytarsus sp*	16
85615	*Rheotanytarsus distinctissimus group*	3
85625	*Rheotanytarsus exiguus group*	26
85711	*Stempellinella n.sp 1*	3
85720	*Stempellinella n.sp nr. flavidula*	10
85800	*Tanytarsus sp*	46
85802	*Tanytarsus curticornis group*	3
85814	*Tanytarsus glabrescens group*	42
86501	*Stratiomyidae*	1
96120	*Menetus (Micromenetus) dilatatus*	1
96900	*Ferrissia sp*	4

No. Quantitative Taxa: 47 Total Taxa: 56
No. Qualitative Taxa: 20 ICI: **58**
Number of Organisms: 656 Qual EPT: 12

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

Little Beaver Creek Study 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			
(02-022)													
Year: 97													
5.60	59.0	46(6)	6(4)	3(4)	23(6)	1.6(2)	1.4(2)	80.9(6)	15.6(6)	3.1(6)	10(4)	4	46
1.30	69.0	45(6)	8(4)	2(4)	23(6)	12.0(2)	1.8(2)	62.5(6)	23.0(6)	5.1(6)	8(2)	4	44
(02-023)													
Year: 97													
3.30	2.5	5(0)	0(0)	0(0)	3(0)	0.0(0)	0.0(0)	0.0(0)	100(0)	55.6(0)	1(0)	4	0
3.10	3.0	17(2)	1(0)	0(0)	6(0)	0.8(2)	0.0(0)	0.0(0)	93.9(0)	39.0(0)	1(0)	4	4
2.50	3.4	34(4)	3(2)	2(4)	19(4)	15.4(4)	10.6(6)	7.0(2)	64.0(0)	35.2(0)	3(0)	4	26
1.40	4.7	56(6)	7(6)	6(6)	30(6)	17.8(4)	1.8(6)	25.8(6)	51.5(2)	7.1(6)	9(4)	4	52
0.20	6.3	47(6)	7(6)	3(6)	27(6)	32.3(6)	2.9(6)	22.7(6)	37.3(4)	2.1(6)	12(6)	4	58

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

Species List

River Code: **02-022**	Stream: **Big Beaver Creek**	Sample Date: **1997**
River Mile: **5.60**	Basin: Scioto River	Date Range: 09/04/97
	Time Fished: 6617 sec Drain Area: 59.0 sq mi	Thru: 10/01/97
	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
GIZZARD SHAD		O	M		8	6.00	0.56	0.52	7.51	86.13
GRASS PICKEREL		P	M	P	14	10.50	0.98	0.42	6.04	39.57
GOLDEN REDHORSE	R	I	S	M	10	7.50	0.70	0.31	4.49	41.20
NORTHERN HOG SUCKER	R	I	S	M	31	23.25	2.16	0.75	10.87	32.16
SPOTTED SUCKER	R	I	S		4	3.00	0.28	0.04	0.51	11.50
CREEK CHUB	N	G	N	T	12	9.00	0.84	0.03	0.46	3.50
EMERALD SHINER	N	I	S		25	18.75	1.74	0.03	0.50	1.84
REDFIN SHINER	N	I	N		45	33.75	3.14	0.05	0.68	1.38
STRIPED SHINER	N	I	S		6	4.50	0.42	0.03	0.48	7.33
SPOTFIN SHINER	N	I	M		96	72.00	6.69	0.16	2.26	2.16
SILVERJAW MINNOW	N	I	M		1	0.75	0.07	0.00	0.02	2.00
BLUNTNOSE MINNOW	N	O	C	T	583	437.25	40.66	1.11	16.11	2.54
CENTRAL STONEROLLER	N	H	N		133	99.75	9.27	0.41	5.91	4.08
BRINDLED MADTOM		I	C	I	2	1.50	0.14	0.00	0.04	2.00
BL'KSTRIPE TOPMINNOW		I	M		9	6.75	0.63	0.02	0.33	3.37
TROUT-PERCH		I	M		14	10.50	0.98	0.04	0.62	4.07
BROOK SILVERSIDE		I	M	M	26	19.50	1.81	0.02	0.28	1.00
ROCK BASS	S	C	C		4	3.00	0.28	0.16	2.35	54.00
SPOTTED BASS	F	C	C		12	9.00	0.84	0.67	9.75	74.50
LARGEMOUTH BASS	F	C	C		1	0.75	0.07	0.01	0.13	12.00
GREEN SUNFISH	S	I	C	T	42	31.50	2.93	0.65	9.47	20.71
BLUEGILL SUNFISH	S	I	C	P	10	7.50	0.70	0.11	1.54	14.10
LONGEAR SUNFISH	S	I	C	M	111	83.25	7.74	0.94	13.61	11.25
GREEN SF X BLUEGILL					8	6.00	0.56	0.12	1.74	19.88
BLACKSIDE DARTER	D	I	S		18	13.50	1.26	0.03	0.49	2.50
LOGPERCH	D	I	S	M	8	6.00	0.56	0.04	0.54	6.25
JOHNNY DARTER	D	I	C		48	36.00	3.35	0.04	0.64	1.21
GREENSIDE DARTER	D	I	S	M	23	17.25	1.60	0.05	0.70	2.78
BANDED DARTER	D	I	S	I	46	34.50	3.21	0.05	0.77	1.53
ORANGETHROAT DARTER	D	I	S		2	1.50	0.14	0.00	0.02	1.00
FANTAIL DARTER	D	I	C		82	61.50	5.72	0.08	1.18	1.32
	Mile Total				1,434	1,075.50		6.88		
	Number of Species				30					
	Number of Hybrids				1					

River Code: **02-022**	Stream: **Big Beaver Creek**	Sample Date: **1997**
River Mile: **1.30**	Basin: Scioto River	Date Range: 08/05/97
	Time Fished: 5169 sec Drain Area: 69.0 sq mi	Thru: 09/11/97
	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
LONGNOSE GAR		P	M		2	1.69	0.24	0.03	0.91	16.00
GIZZARD SHAD		O	M		49	36.75	5.27	0.72	26.19	19.67
GOLDEN REDHORSE	R	I	S	M	20	15.75	2.26	0.22	8.11	13.25
SHORTHEAD REDHORSE	R	I	S	M	1	0.75	0.11	0.00	0.11	4.00
NORTHERN HOG SUCKER	R	I	S	M	20	18.19	2.61	0.05	1.83	2.90
WHITE SUCKER	W	O	S	T	3	2.81	0.40	0.01	0.27	2.67
COMMON CARP	G	O	M	T	1	0.75	0.11	0.00	0.05	2.00
CREEK CHUB	N	G	N	T	21	19.50	2.80	0.02	0.85	1.19
SUCKERMOUTH MINNOW	N	I	S		1	0.94	0.13	0.00	0.04	1.00
EMERALD SHINER	N	I	S		38	28.50	4.09	0.04	1.32	1.28
STRIPED SHINER	N	I	S		25	20.63	2.96	0.03	1.10	1.48
STEELCOLOR SHINER	N	I	M	P	6	5.06	0.73	0.03	1.20	6.50
SPOTFIN SHINER	N	I	M		208	163.13	23.41	0.23	8.33	1.42
BULLHEAD MINNOW	N	O	C		22	16.50	2.37	0.05	1.85	3.11
BLUNTNOSE MINNOW	N	O	C	T	123	98.25	14.10	0.17	6.28	1.74
CENTRAL STONEROLLER	N	H	N		184	150.38	21.58	0.20	7.17	1.31
CHANNEL CATFISH	F		C		1	0.75	0.11	0.01	0.25	9.00
YELLOW BULLHEAD		I	C	T	1	0.94	0.13	0.00	0.07	2.00
STONECAT MADTOM		I	C	I	2	1.69	0.24	0.02	0.80	14.50
WHITE CRAPPIE	S	I	C		3	2.25	0.32	0.02	0.87	10.67
ROCK BASS	S	C	C		1	0.75	0.11	0.01	0.22	8.00
SPOTTED BASS	F	C	C		21	17.81	2.56	0.50	17.95	25.98
GREEN SUNFISH	S	I	C	T	13	10.69	1.53	0.09	3.26	8.46
BLUEGILL SUNFISH	S	I	C	P	2	1.69	0.24	0.01	0.51	7.50
LONGEAR SUNFISH	S	I	C	M	21	17.63	2.53	0.12	4.22	6.76
GREEN SF X BLUEGILL					1	0.75	0.11	0.02	0.81	30.00
DUSKY DARTER	D	I	S	M	2	1.50	0.22	0.01	0.20	3.50
BLACKSIDE DARTER	D	I	S		1	0.75	0.11	0.00	0.05	2.00
LOGPERCH	D	I	S	M	9	7.50	1.08	0.04	1.54	5.89
JOHNNY DARTER	D	I	C		27	22.69	3.26	0.03	1.10	1.30
GREENSIDE DARTER	D	I	S	M	2	1.50	0.22	0.00	0.11	2.00
BANDED DARTER	D	I	S	I	3	2.25	0.32	0.00	0.05	0.67
RAINBOW DARTER	D	I	S	M	28	22.13	3.17	0.02	0.71	0.89
FANTAIL DARTER	D	I	C		3	2.63	0.38	0.00	0.07	0.67
SAUGER X WALLEYE	E	P			1	0.75	0.11	0.04	1.50	55.00
FRESHWATER DRUM			M	P	1	0.75	0.11	0.01	0.22	8.00
	Mile Total				867	696.94		2.76		
	Number of Species				34					
	Number of Hybrids				2					

River Code: **02-023**	Stream: **Little Beaver Creek**	Sample Date: **1997**
River Mile: **3.30**	Basin: Scioto River	Date Range: 08/04/97
	Time Fished: 2287 sec Drain Area: 2.5 sq mi	Thru: 09/10/97
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D E

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	34	34.00	5.76			
CREEK CHUB	N	G	N	T	272	272.00	46.10			
SOUTH. REDBELLY DACE	N	H	S		14	14.00	2.37			
STRIPED SHINER	N	I	S		4	4.00	0.68			
BLUNTNOSE MINNOW	N	O	C	T	54	54.00	9.15			
CENTRAL STONEROLLER	N	H	N		85	85.00	14.41			
JOHNNY DARTER	D	I	C		33	33.00	5.59			
ORANGETHROAT DARTER	D	I	S		80	80.00	13.56			
FANTAIL DARTER	D	I	C		14	14.00	2.37			
Mile Total					590	590.00				
Number of Species					9					
Number of Hybrids					0					

River Code: **02-023**	Stream: **Little Beaver Creek**	Sample Date: **1997**
River Mile: **3.10**	Basin: Scioto River	Date Range: 08/05/97
	Time Fished: 5479 sec Drain Area: 3.0 sq mi	Thru: 09/10/97
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D E

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	1.00	0.09			
WHITE SUCKER	W	O	S	T	29	29.00	2.64			
CREEK CHUB	N	G	N	T	155	155.00	14.12			
REDFIN SHINER	N	I	N		3	3.00	0.27			
STRIPED SHINER	N	I	S		154	154.00	14.03			
SPOTFIN SHINER	N	I	M		14	14.00	1.28			
BLUNTNOSE MINNOW	N	O	C	T	297	297.00	27.05			
CENTRAL STONEROLLER	N	H	N		352	352.00	32.06			
STRIPED SH X CREEK CHUB		I			1	1.00	0.09			
YELLOW BULLHEAD		I	C	T	1	1.00	0.09			
SPOTTED BASS	F	C	C		30	30.00	2.73			
GREEN SUNFISH	S	I	C	T	14	14.00	1.28			
BLUEGILL SUNFISH	S	I	C	P	2	2.00	0.18			
LONGEAR SUNFISH	S	I	C	M	18	18.00	1.64			
GREEN SF X BLUEGILL					1	1.00	0.09			
JOHNNY DARTER	D	I	C		6	6.00	0.55			
RAINBOW DARTER	D	I	S	M	7	7.00	0.64			
ORANGETHROAT DARTER	D	I	S		11	11.00	1.00			
FANTAIL DARTER	D	I	C		2	2.00	0.18			
Mile Total					1,098	1,098.00				
Number of Species					17					
Number of Hybrids					2					

River Code: **02-023**	Stream: **Little Beaver Creek**	Sample Date: **1997**
River Mile: **2.50**	Basin: Scioto River	Date Range: 08/04/97
	Time Fished: 6294 sec Drain Area: 3.4 sq mi	Thru: 09/10/97
	Dist Fished: 0.34 km No of Passes: 2	Sampler Type: D E

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	4.41	0.44			
WHITE SUCKER	W	O	S	T	34	30.00	3.01			
CREEK CHUB	N	G	N	T	199	175.59	17.61			
SOUTH. REDBELLY DACE	N	H	S		1	0.88	0.09			
STRIPED SHINER	N	I	S		139	122.65	12.30			
SPOTFIN SHINER	N	I	M		4	3.53	0.35			
BLUNTNOSE MINNOW	N	O	C	T	114	100.59	10.09			
CENTRAL STONEROLLER	N	H	N		544	480.00	48.14			
YELLOW BULLHEAD		I	C	T	3	2.65	0.27			
ROCK BASS	S	C	C		1	0.88	0.09			
SPOTTED BASS	F	C	C		4	3.53	0.35			
GREEN SUNFISH	S	I	C	T	13	11.47	1.15			
LONGEAR SUNFISH	S	I	C	M	15	13.24	1.33			
JOHNNY DARTER	D	I	C		3	2.65	0.27			
GREENSIDE DARTER	D	I	S	M	1	0.88	0.09			
RAINBOW DARTER	D	I	S	M	23	20.29	2.04			
ORANGETHROAT DARTER	D	I	S		24	21.18	2.12			
FANTAIL DARTER	D	I	C		3	2.65	0.27			
Mile Total					1,130	997.06				
Number of Species					18					
Number of Hybrids					0					

River Code: **02-023**	Stream: **Little Beaver Creek**	Sample Date: **1997**
River Mile: **1.40**	Basin: Scioto River	Date Range: 08/05/97
	Time Fished: 6566 sec Drain Area: 4.7 sq mi	Thru: 09/10/97
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: E

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	19	19.00	1.71			
WHITE SUCKER	W	O	S	T	14	14.00	1.26			
BLACKNOSE DACE	N	G	S	T	3	3.00	0.27			
CREEK CHUB	N	G	N	T	137	137.00	12.32			
STRIPED SHINER	N	I	S		133	133.00	11.96			
SPOTFIN SHINER	N	I	M		22	22.00	1.98			
SILVERJAW MINNOW	N	I	M		9	9.00	0.81			
BLUNTNOSE MINNOW	N	O	C	T	87	87.00	7.82			
CENTRAL STONEROLLER	N	H	N		376	376.00	33.81			
YELLOW BULLHEAD		I	C	T	5	5.00	0.45			
ROCK BASS	S	C	C		13	13.00	1.17			
SMALLMOUTH BASS	F	C	C	M	1	1.00	0.09			
SPOTTED BASS	F	C	C		3	3.00	0.27			
GREEN SUNFISH	S	I	C	T	9	9.00	0.81			
BLUEGILL SUNFISH	S	I	C	P	12	12.00	1.08			
LONGEAR SUNFISH	S	I	C	M	23	23.00	2.07			
BLACKSIDE DARTER	D	I	S		3	3.00	0.27			
JOHNNY DARTER	D	I	C		10	10.00	0.90			
GREENSIDE DARTER	D	I	S	M	5	5.00	0.45			
RAINBOW DARTER	D	I	S	M	211	211.00	18.97			
ORANGETHROAT DARTER	D	I	S		15	15.00	1.35			
FANTAIL DARTER	D	I	C		2	2.00	0.18			
Mile Total					1,112	1,112.00				
Number of Species					22					
Number of Hybrids					0					

River Code: **02-023**	Stream: **Little Beaver Creek**	Sample Date: **1997**
River Mile: **0.10**	Basin: Scioto River	Date Range: 08/04/97
	Time Fished: 5716 sec Drain Area: 6.3 sq mi	Thru: 09/10/97
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	1	0.75	0.09			
NORTHERN HOG SUCKER	R	I	S	M	30	22.50	2.61			
WHITE SUCKER	W	O	S	T	2	1.50	0.17			
CREEK CHUB	N	G	N	T	112	84.00	9.74			
SUCKERMOUTH MINNOW	N	I	S		5	3.75	0.43			
EMERALD SHINER	N	I	S		16	12.00	1.39			
ROSYFACE SHINER	N	I	S	I	2	1.50	0.17			
REDFIN SHINER	N	I	N		2	1.50	0.17			
STRIPED SHINER	N	I	S		91	68.25	7.91			
STEELCOLOR SHINER	N	I	M	P	9	6.75	0.78			
SPOTFIN SHINER	N	I	M		108	81.00	9.39			
SAND SHINER	N	I	M	M	13	9.75	1.13			
SILVERJAW MINNOW	N	I	M		4	3.00	0.35			
BLUNTNOSE MINNOW	N	O	C	T	154	115.50	13.39			
CENTRAL STONEROLLER	N	H	N		360	270.00	31.30			
STONECAT MADTOM		I	C	I	1	0.75	0.09			
ROCK BASS	S	C	C		3	2.25	0.26			
SPOTTED BASS	F	C	C		11	8.25	0.96			
GREEN SUNFISH	S	I	C	T	28	21.00	2.43			
BLUEGILL SUNFISH	S	I	C	P	9	6.75	0.78			
LONGEAR SUNFISH	S	I	C	M	46	34.50	4.00			
GREEN SF X BLUEGILL					4	3.00	0.35			
GREEN SF X HYBRID					4	3.00	0.35			
BLACKSIDE DARTER	D	I	S		2	1.50	0.17			
LOGPERCH	D	I	S	M	4	3.00	0.35			
JOHNNY DARTER	D	I	C		8	6.00	0.70			
GREENSIDE DARTER	D	I	S	M	4	3.00	0.35			
BANDED DARTER	D	I	S	I	2	1.50	0.17			
RAINBOW DARTER	D	I	S	M	85	63.75	7.39			
ORANGETHROAT DARTER	D	I	S		3	2.25	0.26			
FANTAIL DARTER	D	I	C		27	20.25	2.35			
Mile Total					1,150	862.50				
Number of Species					29					
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 Little Beaver Creek study area, 1997.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
Little Beaver Creek - (02-023)																
Year: 97																
3.30	D	08/04/97	2.5	8(3)	4(3)	2(3)	0(1)	3(5)	3(3)	59(1)	22(1)	75(1)	26(3)	0.0(5)	246(5)	34
3.30	E	09/10/97	2.5	9(3)	5(5)	2(3)	0(1)	3(5)	4(5)	63(1)	8(5)	74(1)	18(3)	0.0(5)	214(3)	40
3.10	D	08/05/97	3.0	14(5)	6(5)	1(1)	2(3)	4(5)	4(5)	46(3)	31(1)	45(3)	22(3)	0.0(5)	702(5)	44
3.10	E	09/10/97	3.0	15(5)	5(5)	0(1)	3(3)	3(5)	5(5)	44(3)	28(1)	43(3)	20(3)	0.2(5)	502(5)	44
2.50	D	08/04/97	3.4	15(5)	5(3)	2(3)	3(3)	4(5)	6(5)	32(5)	12(5)	32(3)	24(3)	0.2(3)	761(5)	48
2.50	E	09/10/97	3.4	15(5)	5(3)	1(1)	4(5)	4(5)	6(5)	32(5)	15(3)	30(3)	16(3)	0.0(5)	593(5)	48
1.40	E	08/05/97	4.7	21(5)	6(5)	2(3)	5(5)	6(5)	8(5)	26(5)	10(5)	27(5)	35(3)	0.0(5)	1094(5)	56
1.40	E	09/10/97	4.7	19(5)	6(5)	0(1)	4(5)	5(5)	7(5)	16(5)	7(5)	17(5)	59(5)	0.5(3)	620(5)	54
0.10	D	08/04/97	6.3	23(5)	9(5)	1(1)	7(5)	7(5)	8(5)	32(5)	17(3)	34(3)	36(3)	0.0(5)	579(3)	48
0.10	E	09/10/97	6.3	23(5)	9(5)	1(1)	7(5)	7(5)	10(5)	20(5)	10(5)	20(5)	51(5)	0.0(5)	702(5)	56

▲ - IBI is low end adjusted.

River Mile	Type	Date	Drainage area (sq mi)	Number of					Percent of Individuals						Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
				Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies			
Big Beaver Creek - (02022)																	
Year: 97																	
5.60	D	09/04/97	59	28(5)	4(5)	3(3)	2(1)	6(5)	15(1)	36(3)	32(3)	3.0(3)	52(3)	0.3(3)	674(3)	38	9.3
5.60	D	10/01/97	59	26(5)	3(3)	3(3)	1(1)	7(5)	9(1)	52(1)	50(1)	1.4(3)	40(3)	0.0(5)	522(3)	34	8.3
1.30	D	08/05/97	69	21(3)	3(3)	3(3)	1(1)	4(3)	18(3)	25(3)	14(5)	4.8(3)	47(3)	0.4(5)	353(3)	38	7.7
1.30	D	09/11/97	69	30(5)	5(5)	3(3)	2(1)	8(5)	17(1)	16(5)	26(3)	2.1(3)	52(3)	0.0(5)	776(5)	44	8.4

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