Biological and Water Quality Study
Munn Run

Southern Ohio Port Authority

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Scioto County, Ohio

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State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response
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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, the following new publications by the Ohio EPA have become available. These publications should also be consulted as they represent the latest information and analyses used by the 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 may be obtained by writing to:

Ohio EPA, Division of Surface Water
Monitoring and Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8777

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 6-10 different study areas with an aggregate total of 350-400 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 uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health,

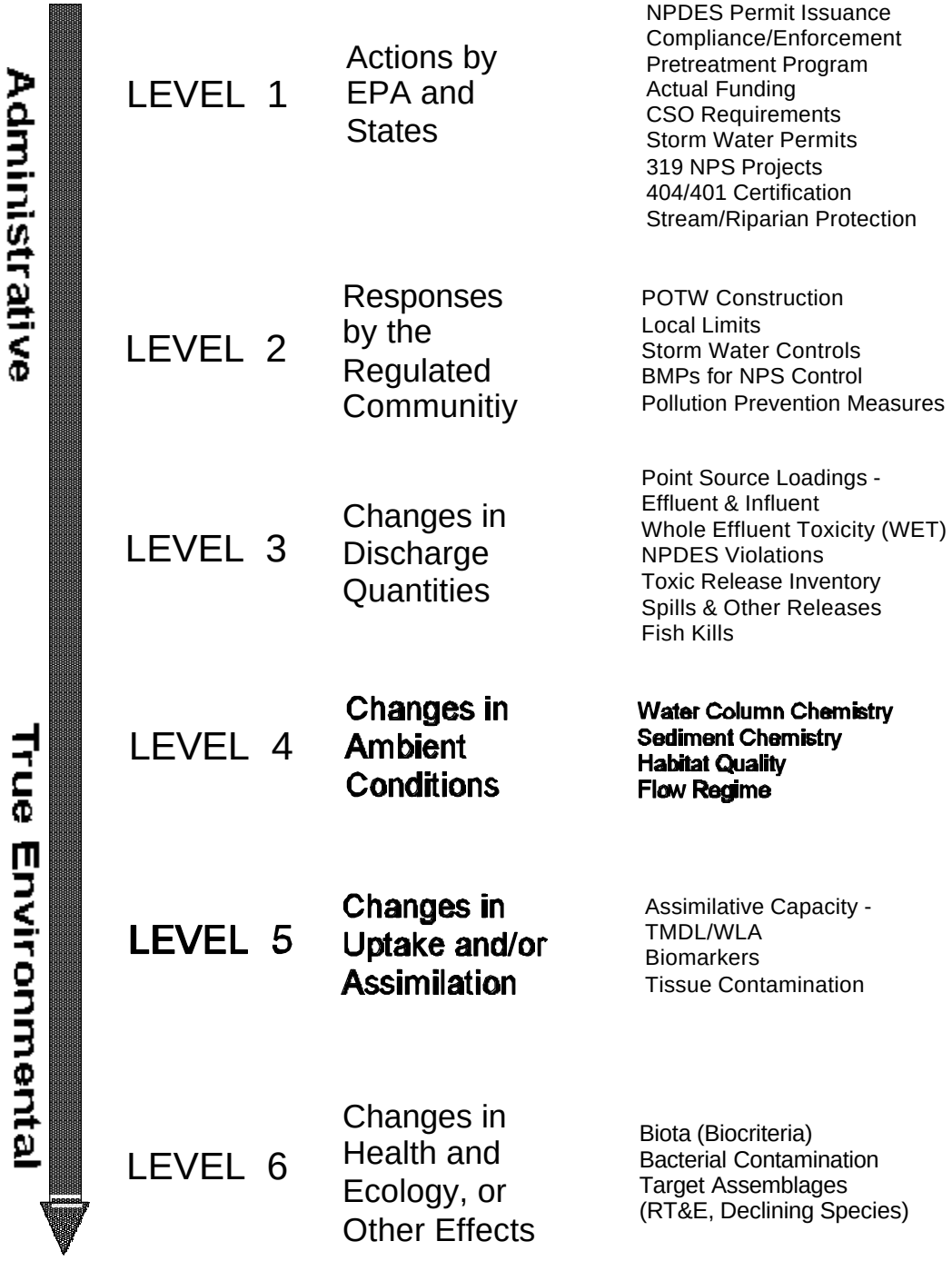

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

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 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.

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

Surface Water - Mike Gray
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    Macroinvertebrate community - Mike Gray
    Fish community - David Altfater.
Data Management - Dennis Mishne
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INTRODUCTION

The former steel mill property is located adjacent to the Ohio River and north and west of the currently operating New Boston Coke plant. Due to the size of the former steel mill property, it has been subdivided into smaller sections called parcels for ease of investigation. Along the eastern edge of parcel three is a small stream named Munn Run. The New Boston Coke plan discharges all of their treated process water and noncontact cooling water into Munn Run. The discharge enters Munn Run within the culverted portion of the stream. The culvert is present in the lower 0.15 miles of the stream (from RM 0.17 to RM 0.02).

Ohio EPA is providing assistance to SOPA through a technical assistance grant provided by U.S. EPA to Ohio EPA. As part of this project, the Division of Surface Water evaluated surface water, sediment, and biological conditions in the lower 0.5 miles of Munn Run to assess the contribution of potential contaminants from parcel three of the former steel mill, currently owned by SOPA. The open hearth building was located on parcel three when the steel mill was operational.

Specific objectives of this evaluation were to:

1) Establish biological conditions in Munn Run in the vicinity of the Southern Ohio Port Authority property (SOPA) by evaluating fish and macroinvertebrate communities,

2) Evaluate surface water and sediment chemical quality in Munn Run, and

3) Determine the aquatic life attainment status of Munn Run with regard to the Warmwater Habitat (WWH) aquatic life use designation codified in the Ohio Water Quality Standards.

SUMMARY

A total of 0.5 miles of Munn Run was assessed by the Ohio EPA in 2001. Based on the performance of the biological communities, the entire 0.5 miles were in non-attainment of the Modified Warmwater Habitat aquatic life use (Table 1). The non-attainment was associated with poor macroinvertebrate communities at each sampling location. A notable decline in biological performance from upstream conditions was observed at RM 0.2, an area adjacent to SOPA parcel three. Sampling during 2001 confirmed the appropriateness of the Modified Warmwater Habitat aquatic life use designation for the lower one mile of Munn Run. Presently, the entire length of Munn Run is listed as Warmwater Habitat in the Ohio Water Quality Standards.

Poor habitat and siltation appeared to be the predominant stressors at the upstream site. At the Munn Run site adjacent to SOPA parcel three, greatly reduced numbers of macroinvertebrates in the quantitative sample and a reduced fish community indicated a potential water quality toxics

problem. Severely elevated levels of lead and zinc were noted in the sediments, along with an exceedance of the lead water quality criterion in Munn Run adjacent to the SOPA property. The biological degradation noted in Munn Run at SOPA parcel three was most evident during low flow conditions, when exposure to contaminants in most severe. At the mouth of Munn Run, elevated temperature associated with the New Boston Coke effluent discharge was the predominant stressor.

Table 1. Attainment status of the proposed Modified Warmwater Habitat aquatic life use for Munn Run (RM 0.98 - 0.0) based on biological sampling conducted during August and October, 2001.

RIVER MILE Fish/Invert.	IBI	MIwb	ICI	QHEI	Attainment Status	Site Location
Munn Run	*Western Allegheny Plateau (WAP) - MWH Use Designation* (Proposed)					
0.4 / 0.4	32	NA	8*	34.0	Non	Upstream SOPA property
0.2 / 0.2	26	NA	10*	35.5	Non	Adjacent SOPA property
- / 0.1	-	-	4*	-	(Non)	Downstream SOPA property

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

INDEX	WWH	EWH	MWH[a]
IBI-Headwater	44	50	24
ICI	36	46	22

[a] Modified Warmwater Habitat for channel modified areas.

C Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

RECOMMENDATIONS

Status of Aquatic Life Uses

Munn Run was designated for aquatic life uses in the 1978 Ohio WQS. This study represents the first use of a standardized approach to the collection of instream biological and habitat data to evaluate and establish the aquatic life use designation for the lower section of Munn Run. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on the existing, unverified use. Beneficial use designations are detailed in Table 2.

The Modified Warmwater Habitat aquatic life use designation is appropriate for the lower 0.98 miles of Munn Run. Past channel modification has occurred in the lower one mile of Munn Run, and is reflected in the low QHEI scores of 34.0 and 35.5 at RMs 0.4 and 0.2, respectively. The lower 0.15 miles of Munn Run is culverted, with approximately 50 feet of open stream before discharging into the Ohio River.

Status of Non-Aquatic Life Uses

Munn Run is recommended for Primary Contact Recreation in the lower 0.98 miles. Water at several locations was of sufficient depth (3 feet deep over a 100 square foot area) to support the Primary Contact Recreation use. In addition, 0.4 miles of the lower one mile flows through a city park.

Table 2. Waterbody use designations for Munn Run. Designations based on the 1978 and 1985 Water Quality Standards appear as asterisks (*). Designations based on Ohio EPA biological field assessments appear as a plus sign (+). Designations based on the 1978 and 1985 standards for which results of a biological field assessment are now available are displayed to the right of existing markers. A delta (Ä) indicates a new recommendation based on the findings of this report.

Stream Segment	Use Designations												
		Aquatic Life Habitat						Water			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Munn Run													
Headwaters to Pleasant Valley		*							*	*		*	
Pleasant Valley (RM0.98) to mouth		*		Ä						*/+		*/+	

Table 3. Sampling locations in Munn Run, 2001. Type of sampling included fish community (F), macroinvertebrate community (M), sediment (S) and surface water (W).

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark
0.40	F,M,S,W	38.7550	82.9273	Ust. SOPA, New Boston park
0.2	F,M	38.7517	82.9279	Adj. SOPA
0.18	S,W	38.7517	82.9279	Adj. SOPA
0.01	M,S,W	38.7496	82.9266	Dst. SOPA & New Boston Coke discharge

METHODS

All physical, chemical, 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, 1995) for aquatic habitat assessment. Sampling locations are listed in Table 3.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-16). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Three attainment status results are possible at each sampling location - Full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (Table 1) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.*, Full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description.

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 habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 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 whereas scores less than 45 generally cannot support a warmwater assemblage

consistent with the WWH biological criteria. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Sediment and Surface Water Assessment

Fine grain sediment samples were collected in the upper 4 inches of bottom material at each location using decontaminated stainless steel scoops. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 1996). Sediment grab samples were homogenized in stainless steel pans (material for VOC analysis was not homogenized), transferred into glass jars with teflon lined lids, placed on ice (to maintain 4ºC) in a cooler, and shipped to an Ohio EPA contract lab. Sediment data is reported on a dry weight basis. Surface water samples were collected directly into appropriate containers, preserved and delivered to an Ohio EPA contract lab. Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature. Sediment evaluations were conducted using guidelines established in Ecotox Thresholds (USEPA 1996), Ontario Ministry of the Environment (Persaud *et al.* 1993), and New York Department of Environmental Conservation (1999).

Macroinvertebrate Community Assessment

Macroinvertebrates were collected from artificial substrates and from the natural habitats at three Munn Run sites. The artificial substrate collection provided quantitative data and consisted of a composite sample of 5 modified Hester-Dendy multiple-plate samplers colonized for six weeks. At the time of the artificial substrate collection, a qualitative multihabitat composite sample was also collected. This sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, margin). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b).

Fish Community Assessment

Fish were sampled twice at each site using pulsed DC electrofishing methods, with sampling distances at each site 150 meters in length. Fish were processed in the field, and included identifying each individual to species and recording any external abnormalities. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b).

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 used to judge aquatic life use attainment and impairment (partial

and non-attainment). The rationale for using the biological criteria, 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, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked together. The ultimate measure of success in water resource management is the 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), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

RESULTS

Surface Water Quality

Chemical analyses were conducted on surface water samples collected during 2001 from three locations in Munn Run (Appendix Table 2). Surface water samples were analyzed for TAL metals, pesticides, PCBs, volatile organic compounds, and semivolatile compounds. Temperature was measured in conjunction with the fish community assessment sampling. Parameters which were in exceedence of Ohio WQS criteria are reported in Table 4.

The Munn Run samples from river mile 0.4 (upstream from the SOPA property) had no exceedences of Ohio WQS criteria. Water samples collected from river mile 0.18 exceeded the Outside Mixing Zone Average (OMZA) criteria for lead, 4,4'-DDT, methoxychlor, and iron. The iron value exceeded a criterion based on agricultural use which may not be appropriate for Munn Run at this location. At river mile 0.01, surface water samples exceeded the OMZA criteria for selenium, 4,4'-DDT, and methoxychlor, and the Outside Mixing Zone Maximum (OMZM) criterion for temperature.

The exceedence of the OMZA temperature criterion at river mile 0.18 was probably the result of weather conditions, an absence of stream cover, and thermal loading from dark substrates. The exceedence of the Outside Mixing Zone Maximum (OMZM) criterion for temperature at the mouth of Munn Run (downstream from the New Boston Coke cooling water discharge) had impacts that extended into the Ohio River.

Sediment Chemistry

Sediment samples were collected at three locations in Munn Run by the Ohio EPA on September 10 and 11, 2001. All sampling locations are indicated by river mile in Figure 2. Samples were analyzed for volatile and semivolatile organic compounds, pesticides, PCBs, total analyte list

Table 4. Exceedences of Ohio Water Quality Standards criteria (OAC 3745-1) for chemical/physical parameters from the Munn Run study area during 2001 (units are ug/l for metals and organics).

River Mile	Parameter (value)
0.40	None
0.18	Lead (41.6)*; 4,4'-DDT (0.11)*; Methoxychlor (0.21)*; Iron (7340)$^{++}$; Temperature (28 ^{o}C)*
0.01	Selenium (15.5*, 9.5*); 4,4'-DDT (0.11)*; Methoxychlor (0.12)*; Temperature (36 ^{o}C)**

* Exceedence of Outside Mixing Zone Average criteria (OMZA).
** Exceedence of Outside Mixing Zone Maximum criteria (OMZM).
$^{++}$ Exceedence of Outside Mixing Zone Average criteria (OMZA)- Agricultural Use.

inorganics, diesel range organics, gasoline range organics, particle size, and total organic carbon. Specific chemical parameters tested and results are listed in Appendix Table 1.

Sediment data was evaluated using guidelines established in Ecotox Thresholds (USEPA 1996), the Ontario Ministry of the Environment (Persaud *et al.* 1993), and criteria prescribed by New York State's Department of Environmental Conservation (1999). The ecotox thresholds are based on comparison to either *Effects Range Low* (ERL) values or USEPA sediment quality criteria. The Ontario 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* (LEL) is a level of sediment contamination that can be tolerated by the majority of benthic organisms, and a *Severe Effect Level* (SEL) indicates a level at which pronounced disturbance of the sediment-dwelling community can be expected. New York State's sediment evaluation process establishes sediment screening criteria for identifying areas of sediment contamination, and providing an initial assessment of potential adverse impacts. Non-polar organic contaminant criteria are derived using the equilibrium partitioning approach, while the metals analyses are for the most part based on Persaud*et al.* (1993). This tiered approach to evaluating sediment is consistent with OAC 3745-300-09.

Sediment collected from the most upstream location in Munn Run (RM 0.40 - upstream from SOPA property; New Boston park) exhibited a number of chemical parameters exceeding LEL and/or ERL guidelines (Table 5). Of the tested parameters, copper, iron, nickel, lead, zinc and five polycyclic aromatic hydrocarbons were considered slightly elevated. Volatile organics, chlorinated organic pesticides, and PCBs were not detected.

Significant contamination of bottom sediments occurred in Munn Run at RM 0.18 (SOPA property). Severe Effect Levels were documented for iron, manganese, lead, and zinc (Table 5). Comparable levels of PAH compounds were noted on-property compared to the upstream location at RM 0.40. Volatile organics, chlorinated organic pesticides, and PCBs were not detected. The sediment sample had an organic/ petroleum odor. Disturbance of the sediments at RM 0.18 released small amounts of oil to the surface of the water.

Sampling near the mouth of Munn Run (RM 0.01 - downstream from SOPA property and the New Boston Coke cooling water discharge) revealed relatively low levels for most of the chemicals detected. As at the two upstream sites, volatile organics, chlorinated organic pesticides, and PCBs were not detected. Four metals were measured above LEL and ERL guidelines, and one (manganese) exceeded the SEL. Only one PAH compound was detected. Sediment conditions indicated minor chemical contamination at the mouth of Munn Run.

Physical Habitat For Aquatic Life

Physical habitat was evaluated in Munn Run at each fish sampling location. Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 6. Muck predominated the bottom substrates in the study area, with small amounts of gravel, sand and artificial riprap. Prior channel modifications were evident at each location assessed. Instream channel development was fair to poor, with riffles absent except at the mouth, the presence of which varies depending on the Ohio River water level. Maximum pool depths at the two fish sites varied between 90 and 105 centimeters**,** with deeper pool areas (greater than 70 cm) important for supporting more diverse fish communities. Heavy silt conditions and extensive embeddedness of the substrates were evident at all biological sampling locations. QHEI scores for Munn Run were 34.0 and 35.5. These scores are indicative of poor stream habitat. Aside from the mouth of Munn Run (lower 50 feet), the lower 0.15 mile of Munn Run is enclosed in a large culvert.

Fish Community Assessment

Fish communities were assessed at two Munn Run sites on August 28 and October 15, 2001 (Figure 2). One site was located upstream from SOPA (RM 0.4) at a New Boston park and the second site was located on SOPA property at parcel three. A fish site on Munn Run downstream from SOPA was not possible because only 50 feet of open stream exists before its confluence with the Ohio River.

A fair fish community was noted at the location sampled in Munn Run at RM 0.4 upstream from the SOPA property (Table 7). The IBI score of 32 was in the fair range, and achieved the ecoregional biocriterion established for Modified Warmwater Habitat (MWH) streams and rivers in Ohio (Table 1). A decline in the fish community of Munn Run was observed at parcel three of the SOPA property (RM 0.2), with the IBI decreasing to 26. However, the IBI score from RM 0.2 met the MWH ecoregional biocriterion. The fish community at RM 0.2 was reflective of poor conditions. There was a notable decline in species richness and total number of fish collected from RM 0.4 to RM 0.2, which was particularly evident during the intermittent flow conditions on August 28. Sample results at RM 0.2 on August 28 revealed an IBI score of 20 - a level not attaining the MWH biocriterion. Sampling during October, when flow was re-established in Munn Run, provided better results at RM 0.2, and

was directly related to downstream movement of fish from upstream. At RM 0.2, agitated sediments released oil to the surface of the water.

Macroinvertebrate Community Assessment

The macroinvertebrate communities in Munn Run were sampled at three locations during 2001 using qualitative (multi-habitat composite) and quantitative (artificial substrates) sampling protocols. Results are summarized in Table 8. Raw data and ICI metrics and scores are attached as Appendix Tables 5 and 6.

The upstream sample collected at river mile 0.4 was predominated by pollution tolerant organisms. Qualitative EPT taxa richness consisted of only one mayfly taxon. The stream had been channelized in this reach and the poor habitat, absence of riffle habitat and upstream silt load contributed to the poor macroinvertebrate community. The site had an ICI score of 8 and was evaluated as poor. The macroinvertebrate community did not meet the designated Warmwater Habitat criterion nor the criterion for the proposed Modified Warmwater Habitat use which was based on the modified stream channel.

The macroinvertebrate sample collected from Munn Run adjacent to SOPA parcel three at river mile 0.2 had an ICI score of 10 and was evaluated as poor. Although the ICI score and the evaluation for this site was similar to the upstream site, they differ in some important aspects. The density of organisms in the quantitative sample was much lower than the upstream site (245 organisms/ft^2 at river mile 0.4 and 19 organisms/ft^2 at river mile 0.2, a 92% reduction in macroinvertebrate abundance). The reduction in macroinvertebrate abundance in the sample from Munn Run adjacent to SOPA parcel three indicates a potential toxic impact. The response of the biological community can be diagnostic for stressor identification (Yoder and Rankin 1995). Organisms tolerant of organic enrichment, nutrients and low dissolved oxygen comprised 94.4 % of the upstream sample and 70% of the sample from SOPA parcel three. Toxics tolerant organisms comprised 0% of the upstream sample and 1% of SOPA parcel three sample. The qualitative EPT taxa richness consisted of two mayfly taxa from the river mile 0.2 site.

The macroinvertebrate community at the mouth of Munn Run (RM 0.01) had an ICI score of 4 and an evaluation of poor. Organisms tolerant of organic enrichment, nutrients and low D.O. comprised 97% of the sample at this site. There were no qualitative EPT taxa. The community was dominated by aquatic worms and physid snails. Although this site had gravel and cobble substrates with adequate current velocities, the high instream temperatures prevented the establishment of a diverse macroinvertebrate community. A temperature of 36^{o} C measured on August 28, 2001 exceeded the Outside Mixing Zone Maximum criterion.

Poor habitat and siltation appeared to be the predominant stressors at the upstream site. At the Munn Run site adjacent to the SOPA property, greatly reduced numbers of macroinvertebrates in the quantitative sample indicated a potential water quality problem. At the mouth of Munn Run, elevated temperature was the predominant stressor.

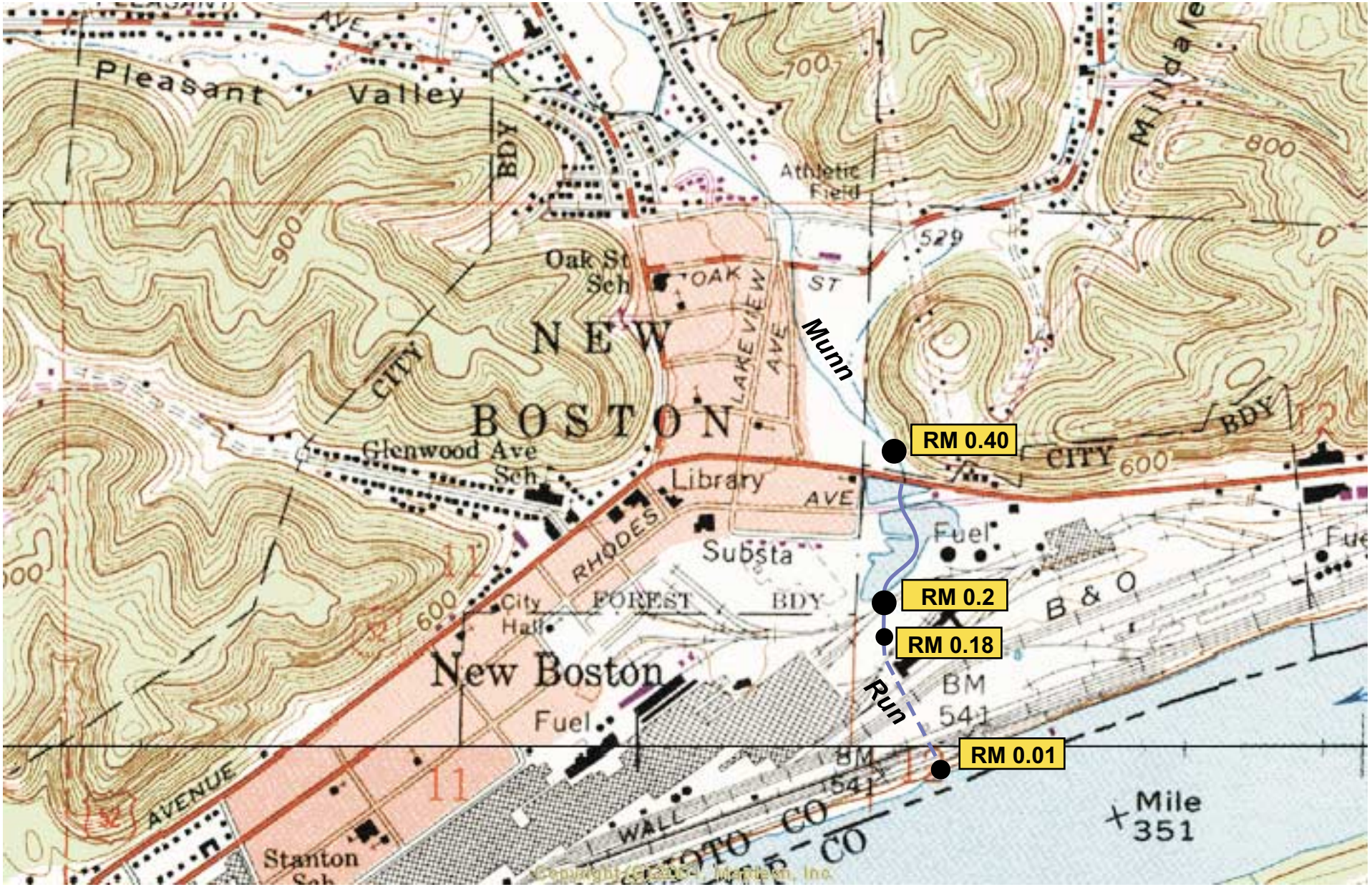

Figure 2. Map of Munn Run showing sampling locations, 2001.

Table 5. Select detected chemical parameters measured in sediment samples collected by Ohio EPA from Munn Run, September, 2001. Contamination levels were determined for a number of parameters using either Ecotox Thresholds (USEPA 1996), Persaud et al.(1993) or New York States' contaminated sediments screening guidance (1999). Parameters in italics do not have sediment evaluation guidelines established.

	Munn Run			
	RM 0.01	**RM 0.18**	**RM 0.18Duplicate**	**RM 0.40**
Volatile Organics (ug/kg)	None detected at or above the reporting limit			
Pesticides/PCBs (ug/kg)	None detected at or above the reporting limit			
Extractable Petroleum Hydrocarbons - Diesel Range Organics	None detected at or above the reporting limit			
Semivolatile Organics (ug/kg)				
Benzo(a)anthracene	nd	nd	nd	847[LEL]
Benzo(a)pyrene	nd	nd	892[ERL,LEL]	927[ERl,LEL]
Benzo(b)fluoranthene	1090	1740	2180	2030
Naphthalene	nd	nd	951[ERL]	nd
Chrysene	nd	nd	1030[LEL]	971[LEL]
Fluoranthene	nd	1750[ERL,LEL]	2210[ERL,LEL]	2000[ERL,LEL]
Phenanthene	nd	957[ERL,LEL]	1180[ERL,LEL]	nd
Pyrene	nd	1410[ERL,LEL]	1850[ERL,LEL]	1560[ERL,LEL]
Bis(2-ethylhexyl)phthalate	nd	1100	972	nd
Total PAHs	1090	5857[ERL,LEL]	10,293[ERL,LEL]	8335[ERL,LEL]
Gasoline Range Organics (mg/kg)	0.5	0.7	0.6	0.4
Inorganics (mg/kg)				
Arsenic	3.63	15.9[ERL,LEL]	13[ERl,LEL]	5.09
Barium	181	337	389	69.4
Cadmium	nd	4.59[ERL,LEL]	4.31[ERL,LEL]	nd
Chromium	21.8	64[LEL]	50.9[LEL]	24.5
Copper	36.5[ERl,LEL]	85.5[ERL,LEL]	70.7[ERL,LEL]	23.6[LEL]
Iron	32,100[LEL]	55,900[LEL,SEL]	38,100[LEL]	22,300[LEL]
Mercury	nd	nd	0.242[ERL,LEL]	nd
Manganese	1660[LEL,SEL]	2880[LEL,SEL]	3560[LEL,SEL]	346
Nickel	38.1[ERL,LEL]	45.7[ERL,LEL]	35.3[ERL,LEL]	16.8[LEL]
Lead	28.1	489[LEL,SEL,ERL]	451[LEL,SEL,ERL]	60.3[ERL,LEL]
Zinc	146[LEL]	1130[LEL,SEL,ERL]	843[LEL,SEL,ERL]	156[ERL,LEL]

[LEL] Value exceeds the Lowest Effect Level in Persuad et al. 1993.
[SEL] Value exceeds the Severe Effect Level in Persuad et al. 1993.
[ERL] Value exceeds the Effects Range-Low in Ecotox Thresholds (USEPA 1996).

Table 6 Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for sites sampled in Munn Run, 2001.

			WWH Attributes										MWH Attributes																				
													High Influence					*Moderate Influence*																
Key QHEI Components			No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	**Total HL MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total ML MWH Attributes**	**(MWH HL+1)/(WWH+1) Ratio**	**(MWH ML+1)/(WWH+1) Ratio**
River Mile	QHEI	Gradient (ft/mile)																															
(09-001) Munn Run																																	
Year: 2001																																	
0.4	**34.0**	15.50									■		1	◆	◆	◆	◆		4	■		■	■			■	■		■			6	2.50	5.50
0.2	**35.5**	15.50									■		1	◆	◆	◆	◆		4	■		■	■			■	■		■			6	2.50	5.50

Table 7. Fish community summaries based on pulsed DC electrofishing sampling conducted by Ohio EPA in Munn Run from August and October, 2001. Relative numbers are per 0.3 km. Individual sample passes for RM 0.2 are shown below the mean results.

Stream/ River Mile	Mean Number of Species	Total Number Species	Mean Relative Number	QHEI	Mean Index of Biotic Integrity	Narrative Evaluation
Munn Run (2001)						
0.4	7.5	9	3,227	34.0	32	Fair
0.2	4.0	6	384	35.5	26	Poor
0.2 (8/28/2001)	-	2	76	35.5	20*	Poor
0.2 (10/15/2001)	-	6	692	35.5	32	Fair

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

INDEX	**WWH**	**EWH**	**MWH**
IBI-Headwater	44	50	24

* Significant departure from ecoregional biocriterion (>4 IBI units); poor and very poor results are underlined.

Table 8. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in Munn Run during 2001.

River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualititative Taxa	Qualititative EPT[a]	ICI	Evaluation
	MWH Use Designation (Proposed)						
0.4	245	27	20	12	1	8 *	Poor
0.2	19	24	14	15	2	10 *	Poor
0.01	1055	17	14	8	0	4*	Poor

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)
(Ohio Administrative Code 3745-1-07, Table 7-16

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

[a] EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa richness, a measure of pollution sensitive organisms.
[b] Modified Warmwater Habitat for channel modified areas.
C Significant departure from ecoregional biocriterion; poor and very poor results are underlined.

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APPENDICES

Appendix Table 1. Results of sediment samples collected by Ohio EPA from Munn Run, September 10-11, 2001.

	Munn Run			
Sampling Location/River Mile :	RM 0.01	RM 0.18	RM 0.18D	RM 0.40
Date Sampled :	10-Sep-2001	11-Sep-2001	11-Sep-2001	11-Sep-2001
Time Sampled:	02:05 PM	10:25 AM	10:25 AM	11:15 AM
VOLATILE ORGANIC COMPOUNDS (ug/kg)			Duplicate	
Dichlorodifluoromethane	<18.5	<17.4	<16.7	<10.8
Chloromethane	<18.5	<17.4	<16.7	<10.8
Vinyl chloride	<18.5	<17.4	<16.7	<10.8
Bromomethane	<18.5J	<17.4J	<16.7J	<10.8J
Chloroethane	<18.5	<17.4	<16.7	<10.8
Trichlorofluoromethane	<9.3	<8.7	<8.3	<5.4
Acrolein	<185	<174	<167	<108
Acetone	<185J	<174J	<167J	<108J
1,1-Dichloroethene	<9.3	<8.7	<8.3	<5.4
Methylene chloride	<9.3	<8.7	<8.3	<5.4
Carbon disulfide	<185	<174	<167	<108
Acrylonitrile	<185	<174	<167	<108
n-Hexane	<9.3	<8.7	<8.3	<5.4
trans-1,2-Dichloroethene	<9.3	<8.7	<8.3	<5.4
1,1-Dichloroethane	<9.3	<8.7	<8.3	<5.4
Vinyl acetate	<92.6	<87.2	<83.3	<54.0
Methyl ethyl ketone	<185	<174	<167	<108
2,2-Dichloropropane	<9.3	<8.7	<8.3	<5.4
cis-1,2-Dichloroethene	<9.3	<8.7	<8.3	<5.4
Bromochloromethane	<9.3	<8.7	<8.3	<5.4
Chloroform	<9.3	<8.7	<8.3	<5.4
1,1,1-Trichloroethane	<9.3	<8.7	<8.3	<5.4
1,1-Dichloropropene	<9.3	<8.7	<8.3	<5.4
Carbon tetrachloride	<9.3	<8.7	<8.3	<5.4
Benzene	<9.3	<8.7	<8.3	<5.4
1,2-Dichloroethane	<9.3	<8.7	<8.3	<5.4
Trichloroethene	<9.3	<8.7	<8.3	<5.4
1,2-Dichloropropane	<9.3	<8.7	<8.3	<5.4
Bromodichloromethane	<9.3	<8.7	<8.3	<5.4
Dibromomethane	<9.3	<8.7	<8.3	<5.4
2-Chloroethyl vinyl ether	<18.5	<17.4	<16.7	<10.8
4-Methyl-2-pentanone	<92.6	<87.2	<83.3	<54.0
cis-1,3-Dichloropropene	<9.3	<8.7	<8.3	<5.4
Toluene	<9.3	<8.7	<8.3	<5.4
Ethyl methacrylate	<9.3	<8.7	<8.3	<5.4
trans-1,3-Dichloropropene	<9.3	<8.7	<8.3	<5.4
1,1,2-Trichloroethane	<9.3	<8.7	<8.3	<5.4
2-Hexanone	<92.6	<87.2	<83.3	<54.0
1,3-Dichloropropane	<9.3	<8.7	<8.3	<5.4
Tetrachloroethene	<9.3	<8.7	<8.3	<5.4
Chlorodibromomethane	<9.3	<8.7	<8.3	<5.4
Ethylene dibromide	<9.3	<8.7	<8.3	<5.4
Chlorobenzene	<9.3	<8.7	<8.3	<5.4
Ethylbenzene	<9.3	<8.7	<8.3	<5.4
1,1,1,2-Tetrachlorethane	<9.3	<8.7	<8.3	<5.4
p,m-Xylene	<9.3	<8.7	<8.3	<5.4
o-Xylene	<9.3	<8.7	<8.3	<5.4
Styrene	<9.3	<8.7	<8.3	<5.4
Isopropylbenzene	<9.3	<8.7	<8.3	<5.4
Bromoform	<9.3	<8.7	<8.3	<5.4
1,1,2,2-Tetrachloroethane	<9.3	<8.7	<8.3	<5.4

Appendix Table 1. Continued.

	Munn Run			
Sampling Location/River Mile :	RM 0.01	RM 0.18	RM 0.18D	RM 0.40
Date Sampled :	10-Sep-2001	11-Sep-2001	11-Sep-2001	11-Sep-2001
Time Sampled:	02:05 PM	10:25 AM	10:25 AM	11:15 AM
VOLATILE ORGANIC COMPOUNDS (ug/kg)			Duplicate	
1,2,3-Trichloropropane	<9.3	<8.7	<8.3	<5.4
n-Propylbenzene	<18.5	<17.4	<16.7	<10.8
Bromobenzene	<18.5	<17.4	<16.7	<10.8
2-Chlorotoluene	<18.5	<17.4	<16.7	<10.8
1,3,5-Trimethylbenzene	<18.5	<17.4	<16.7	<10.8
4-Chlorotoluene	<18.5	<17.4	<16.7	<10.8
tert-Butylbenzene	<18.5	<17.4	<16.7	<10.8
1,2,4-Trimethylbenzene	<18.5	<17.4	<16.7	<10.8
sec-Butylbenzene	<18.5	<17.4	<16.7	<10.8
p-Isopropyltoluene	<18.5	<17.4	<16.7	<10.8
1,3-Dichlorobenzene	<18.5	<17.4	<16.7	<10.8
1,4-Dichlorobenzene	<18.5	<17.4	<16.7	<10.8
n-Butylbenzene	<18.5	<17.4	<16.7	<10.8
1,2-Dichlorobenzene	<18.5	<17.4	<16.7	<10.8
1,2-Dibromo-3-chloropropane	<18.5	<17.4	<16.7	<10.8
1,2,4-Trichlorobenzene	<18.5	<17.4	<16.7	<10.8
Hexachlorobutadiene	<18.5	<17.4	<16.7	<10.8
Naphthalene	<18.5	<17.4	<16.7	<10.8
1,2,3-Trichlorobenzene	<18.5	<17.4	<16.7	<10.8
SEMIVOLATILE ORGANIC COMPOUNDS (ug/kg)				
Azobenzene	<813	<892	<846	<623
Benzo(b)fluoranthene	1090	1740	2180	2030
Benzo(k)fluoranthene	<813	<892	<846	<623
Bis(2-ethylhexyl)phthalate	<813	1100	972	<623
N-Nitrosodimethylamine	<4190	<4590	<4360	<3210
Bis(2-chloroethly)ether	<813	<892	<846	<623
2-Chlorophenol	<813	<892	<846	<623
Phenol	<813	<892	<846	<623
1,3-Dichlorobenzene	<813	<892	<846	<623
1,4-Dichlorobenzene	<813	<892	<846	<623
1,2-Dichlorobenzene	<813	<892	<846	<623
Bis(2-chloroisopropyl)ether	<813	<892	<846	<623
Hexachloroethane	<813	<892	<846	<623
N-Nitroso-di-n-propylamine	<813	<892	<846	<623
Nitrobenzene	<813	<892	<846	<623
Isophorone	<813	<892	<846	<623
2-Nitrophenol	<813	<892	<846	<623
2,4-Dimethylphenol	<813	<892	<846	<623
Bis(2-chloroethoxy)methane	<813	<892	<846	<623
2,4-Dichlorophenol	<813	<892	<846	<623
1,2,4-Trichlorobenzene	<813	<892	<846	<623
Naphthalene	<813	<892	951	<623
Hexachlorobutadiene	<813	<892	<846	<623
4-Chloro-3-methylphenol	<1630	<1780	<1690	<1250
Hexachlorocyclopentadiene	<1630	<1780	<1690	<1250
2,4,6-Trichlorophenol	<813	<892	<846	<623
2-Chloronaphthalene	<813	<892	<846	<623
Acenaphthylene	<813	<892	<846	<623

Appendix Table 1. Continued.

	Munn Run			
Sampling Location/River Mile :	RM 0.01	RM 0.18	RM 0.18D	RM 0.40
Date Sampled :	10-Sep-2001	11-Sep-2001	11-Sep-2001	11-Sep-2001
Time Sampled:	02:05 PM	10:25 AM	10:25 AM	11:15 AM
SEMIVOLATILE ORGANIC COMPOUNDS (ug/kg)			Duplicate	
Dimethylphthalate	<813	<892	<846	<623
2,6-Dinitrotoluene	<813	<892	<846	<623
Acenaphthene	<813	<892	<846	<623
2,4-Dinitrophenol	<4190	<4590	<4360	<3210
2,4-Dinitrotoluene	<813	<892	<846	<623
4-Nitrophenol	<4190	<4590	<4360	<3210
Fluorene	<813	<892	<846	<623
4-Chlorophenyl phenyl ether	<813	<892	<846	<623
Diethylphthalate	<813	<892	<846	<623
N-Nitrosodiphenylamine	<1630J	<1780J	<1690J	<1250J
4,6-Dinitro-2-methylphenol	<4190	<4590	<4360	<3210
4-Bromophenyl phenyl ether	<813	<892	<846	<623
Hexachlorobenzene	<813	<892	<846	<623
Pentachlorophenol	<4190	<4590	<4360	<3210
Phenanthrene	<813	957	1180	<623
Anthracene	<813	<892	<846	<623
Di-n-butylphthalate	<813	<892	<846	<623
Fluoranthene	<813	1750	2210	2000
Pyrene	<813	1410	1850	1560
Butylbenzylphthalate	<813	<892	<846	<623
Benzo(a)anthracene	<813	<892	<846	847
Chrysene	<813	<892	1030	971
3,3'-Dichlorobenzidine	<1630	<1780	<1690	<1250
Di-n-octylphthalate	<813	<892	<846	<623
Benzo(a)pyrene	<813	<892	892	927
Dibenzo(a,h)anthracene	<813	<892	<846	<623
Indeno(1,2,3-cd)pyrene	<813	<892	<846	<623
Benzo(g,h,i)perylene	<813	<892	<846	<623
PESTICIDES (ug/kg)				
Aldrin	<100	<200	<200	<1000
alpha-BHC	<100	<200	<200	<1000
beta-BHC	<100	<200	<200	<1000
delta-BHC	<100	<200	<200	<1000
gamma-BHC (Lindane)	<100	<200	<200	<1000
Chlordane (tech)	<500	<1000	<1000	<5000
4,4'-DDD	<100	<200	<200	<1000
4,4'-DDE	<150	<300	<300	<1500
4,4'-DDT	<150	<300	<300	<1500
Dieldrin	<100	<200	<200	<1000
Endosulfan I	<150	<300	<300	<1500
Endosulfan II	<150	<300	<300	<1500
Endosulfan sulfate	<150	<300	<300	<1500
Endrin	<250	<500	<500	<2500
Endrin aldehyde	<250	<500	<500	<2500
Heptachlor	<150	<300	<300	<1500
Heptachlor epoxide	<150	<300	<300	<1500
Methoxychlor	<150	<300	<300	<1500
Toxaphene	<500	<1000	<1000	<5000
Endrin ketone	<100	<200	<200	<1000

Appendix Table 1. Continued.

	Munn Run			
Sampling Location/River Mile :	RM 0.01	RM 0.18	RM 0.18D	RM 0.40
Date Sampled :	10-Sep-2001	11-Sep-2001	11-Sep-2001	11-Sep-2001
Time Sampled:	02:05 PM	10:25 AM	10:25 AM	11:15 AM
PCBs (ug/kg)			Duplicate	
PCB-1016	<100	<100	<100	<100
PCB-1221	<100	<100	<100	<100
PCB-1232	<100	<100	<100	<100
PCB-1242	<100	<100	<100	<100
PCB-1248	<100	<100	<100	<100
PCB-1254	<100	<100	<100	<100
PCB-1260	<100	<100	<100	<100
INORGANICS (mg/kg)				
Silver	<6.07	<6.53	<6.22	<4.56
Aluminum	12100	12200	9960	6710
Arsenic	3.63	15.9	13	5.09
Barium	181	337	389	69.4
Beryllium	<6.07	<6.53	<6.22	<4.56
Calcium	3440	66500	109000	6070
Cadmium	<1.20	4.59	4.31	<0.907
Cobalt	23.3	15.3	12.7	10.2
Chromium	21.8	64	50.9	24.5
Copper	36.5	85.5	70.7	23.6
Iron	32100	55900	38100	22300
Mercury	<0.205	<0.208	0.242	<0.155
Potassium	1250	1360	1140	692
Magnesium	3490	9010	7980	3460
Manganese	1660	2880	3560	346
Sodium	<303	408	488	<228
Nickel	38.1	45.7	35.3	16.8
Lead	28.1	489	451	60.3
Antimony	<30.3	<32.6	<31.1	<22.8
Selenium	<1.20	<1.35	<1.28	<0.907
Thallium	<1.20	<1.35	<1.28	<0.907
Vanadium	23.1	43.3	39	27.1
Zinc	146	1130	843	156
Extractable Petroleum Hydrocarbons (mg/kg) DRO				
Diesel	<5.0	<5.0	<5.0	<5.0
TVPH (mg/kg) GRO				
Gasoline	0.5	0.7	0.6	0.4
OTHER				
Total Organic Carbon (mg/kg)	33100	19600	33400	48900
Solids (%)	40	37	39	53
Particle Size:				
Gravel (%)	1.2	0	0	4.3
Sand (%)	3.9	9.9	11.3	24.1
Silt (%)	76.5	75.6	73.7	65.5
Clay (%)	18.4	14.5	15	6.1

Appendix Table 2. Results of surface water samples collected by Ohio EPA from Munn Run, August 28 and October 15, 2001.

	Munn Run					
Sampling Location/River Mile :	RM 0.01	RM 0.01	RM 0.18	RM 0.18	RM 0.40	RM 0.40
Date Sampled :	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001
Time Sampled:	11:15 AM	10:50 AM	01:45 PM	11:50 AM	04:00 PM	02:25 PM
INORGANICS (ug/l)						
Silver	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Aluminum	311	491	4880	669	462	<200
Arsenic	<5.0	<5.0	8.89	<5.0	<5.0	<5.0
Barium	50.9	<50.0	86.7	50	73.4	<50.0
Beryllium	<1.00	<1.00	<1.00	<1.00	<1.0	<1.00
Calcium	33400	34700	35000	39700	42000	39900
Cadmium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cobalt	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Chromium	<15.0	<15.0	<15.0	<15.0	<15.0	<15.0
Copper	<15.0	<15.0	<15.0	<15.0	<15.0	<15.0
Iron	388	975	7340	2040	1750	276
Mercury	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Potassium	2920	3310	10500	4940	4330	4170
Magnesium	10400	11300	5010	12300	11100	13300
Manganese	47.3	84.8	549	226	601	54
Sodium	78100	80900	19600	34400	61900	22800
Nickel	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Lead	<5.0	<5.0	41.6	7.83	<5.0	<5.0
Antimony	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Selenium	15.5	9.5	<5.0	<5.0	<5.0	<5.0
Thallium	<1.50	<1.50	<1.50	<1.50	<1.50	<1.50
Vanadium	<50.0	<50.0	86.5	<50.0	<50.0	<50.0
Zinc	<100	<100	<100	<100	<100	<100
PESTICIDES (ug/l)						
alpha-BHC	<0.020	<0.50	<0.020	<0.50	<0.020	<0.50
gamma-BHC (Lindane)	<0.020	<0.50	<0.020	<0.50	<0.020	<0.50
beta-BHC	<0.020	<0.50	<0.020	<0.50	<0.020	<0.50
Heptachlor	<0.030	<0.50	<0.030	<0.50	<0.030	<0.50
delta-BHC	<0.020	<0.50	<0.020	<0.50	<0.020	<0.50
Aldrin	<0.020	<0.50	<0.020	<0.50	<0.020	<0.50
Heptachlor epoxide	<0.030	<0.50	<0.030	<0.50	<0.030	<0.50
Endosulfan I	<0.030	<0.50	<0.030	<0.50	<0.030	<0.50
4,4'-DDE	<0.030	<0.50	<0.030	<0.50	<0.030	<0.50
Dieldrin	<0.020	<0.50	<0.020	<0.50	<0.020	<0.50
Endrin	<0.050	<0.50	<0.050	<0.50	<0.050	<0.50
4,4'-DDD	<0.020	<0.50	<0.020	<0.50	<0.020	<0.50
Endosulfan II	<0.030	<0.50	<0.030	<0.50	<0.030	<0.50
4,4'-DDT	0.11	<0.50	0.11	<0.50	<0.030	<0.50
Endrin aldehyde	<0.050	<0.50	<0.050	<0.50	<0.050	<0.50
Endosulfan sulfate	<0.030	<0.50	<0.030	<0.50	<0.030	<0.50
Methoxychlor	0.12	<1.25	0.21	<1.25	<0.030	<1.25
Endrin ketone	<0.040	<0.50	<0.040	<0.50	<0.040	<0.50
Chlordane (tech)	<0.100	<1.00	<0.100	<1.00	<0.100	<1.00
Toxaphene	<0.100	<5.00	<0.100	<5.00	<0.100	<5.00

Appendix Table 2. Continued.

	Munn Run					
Sampling Location/River Mile :	RM 0.01	RM 0.01	RM 0.18	RM 0.18	RM 0.40	RM 0.40
Date Sampled :	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001
Time Sampled:	11:15 AM	10:50 AM	01:45 PM	11:50 AM	04:00 PM	02:25 PM
PCBs (ug/l)						
PCB-1016	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0
PCB-1221	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0
PCB-1232	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0
PCB-1242	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0
PCB-1248	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0
PCB-1254	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0
PCB-1260	<1.00	<1.0	<1.00	<1.0	<1.00	<1.0
VOLATILE ORGANIC COMPOUNDS (ug/l)						
Dichlorodifluoromethane	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bromomethane	<1.0J	<1.0	<1.0J	<1.0	<1.0J	<1.0
Chloroethane	<1.0J	<1.0J	<1.0J	<1.0J	<1.0J	<1.0J
Trichlorofluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acrolein	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
Acetone	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
1,1-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methylene chloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon disulfide	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acrylonitrile	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
n-Hexane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
trans-1,2-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl acetate	<1.0	<1.0J	<1.0	<1.0J	<1.0	<1.0J
Methyl ethyl ketone	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
2,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bromochloromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroform	<1.0	<1.0	<1.0	<1.0	1.3	<1.0
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloropropene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	2.6	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bromodichloromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibromomethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Chloroethyl vinyl ether	<10.0	<10.0J	<10.0	<10.0J	<10.0	<10.0J
4-Methyl-2-pentanone	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
cis-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	1.2	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl methacrylate	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
trans-1,3-Dichloropropene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Hexanone	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
1,3-Dichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chlorodibromomethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylene dibromide	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Appendix Table 2. Continued.

	Munn Run					
Sampling Location/River Mile :	RM 0.01	RM 0.01	RM 0.18	RM 0.18	RM 0.40	RM 0.40
Date Sampled :	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001
Time Sampled:	11:15 AM	10:50 AM	01:45 PM	11:50 AM	04:00 PM	02:25 PM
VOLATILE ORGANIC COMPOUNDS (ug/l)						
Chlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachlorethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
p,m-Xylene	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
o-Xylene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Styrene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Isopropylbenzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bromoform	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,2,2-Tetrachloroethane	<1.0	<1.0J	<1.0	<1.0J	<1.0	<1.0J
1,2,3-Trichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
n-Propylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bromobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Chlorotoluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,3,5-Trimethylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Chlorotoluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
tert-Butylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2,4-Trimethylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
sec-Butylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
p-Isopropyltoluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,3-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,4-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
n-Butylbenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2-Dibromo-3-chloropropane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2,4-Trichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Hexachlorobutadiene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Naphthalene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,2,3-Trichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)						
N-Nitrosodiphenylamine	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Bis(2-chloroethly)ether	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2-Chlorophenol	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Phenol	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
1,3-Dichlorobenzene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
1,4-Dichlorobenzene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
1,2-Dichlorobenzene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Bis(2-chloroisopropyl)ether	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Hexachloroethane	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
N-Nitroso-di-n-propylamine	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Nitrobenzene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Isophorone	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2-Nitrophenol	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2,4-Dimethylphenol	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Bis(2-chloroethoxy)methane	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2,4-Dichlorophenol	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
1,2,4-Trichlorobenzene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Naphthalene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Hexachlorobutadiene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0

Appendix Table 2. Continued.

	Munn Run					
Sampling Location/River Mile :	RM 0.01	RM 0.01	RM 0.18	RM 0.18	RM 0.40	RM 0.40
Date Sampled :	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001	28-Aug-2001	15-Oct-2001
Time Sampled:	11:15 AM	10:50 AM	01:45 PM	11:50 AM	04:00 PM	02:25 PM
SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)						
4-Chloro-3-methylphenol	<20.0	<10.0	<20.0	<10.0	<20.0	<10.0
Hexachlorocyclopentadiene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2,4,6-Trichlorophenol	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2-Chloronaphthalene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Acenaphthylene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Dimethylphthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2,6-Dinitrotoluene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Acenaphthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2,4-Dinitrophenol	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
2,4-Dinitrotoluene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
4-Nitrophenol	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Fluorene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
4-Chlorophenyl phenyl ether	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Diethylphthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
N-Nitrosodimethylamine	<10.0J	<10.0J	<10.0J	<10.0J	<10.0J	<10.0J
Azobenzene	<10.0	NA	<10.0	NA	<10.0	NA
4,6-Dinitro-2-methylphenol	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
4-Bromophenyl phenyl ether	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Hexachlorobenzene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Pentachlorophenol	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Phenanthrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Anthracene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Di-n-butylphthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Fluoranthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Pyrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Butylbenzylphthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo(a)anthracene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Chrysene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
3,3'-Dichlorobenzidine	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Bis(2-ethylhexyl)phthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Di-n-octylphthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo(b)fluoranthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo(k)fluoranthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo(a)pyrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Dibenzo(a,h)anthracene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Indeno(1,2,3-cd)pyrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo(g,h,i)perylene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Pyridine	NA	<50.0	NA	<50.0	NA	<50.0
Aniline	NA	<50.0	NA	<50.0	NA	<50.0
Benzyl alcohol	NA	<10.0	NA	<10.0	NA	<10.0
2-Methylphenol	NA	<10.0	NA	<10.0	NA	<10.0
3&4-Methylphenol	NA	<10.0	NA	<10.0	NA	<10.0
2,6-Dichlorophenol	NA	<10.0	NA	<10.0	NA	<10.0
4-Chloroaniline	NA	<50.0	NA	<50.0	NA	<50.0
Benzoic acid	NA	<50.0	NA	<50.0	NA	<50.0
2-Methylnaphthalene	NA	<10.0	NA	<10.0	NA	<10.0
2,4,5-Trichlorophenol	NA	<10.0	NA	<10.0	NA	<10.0
2-Nitroaniline	NA	<50.0	NA	<50.0	NA	<50.0
3-Nitroaniline	NA	<50.0	NA	<50.0	NA	<50.0
Dibenzofuran	NA	<10.0	NA	<10.0	NA	<10.0
4-Nitroaniline	NA	<50.0	NA	<50.0	NA	<50.0
Carbazole	NA	<10.0	NA	<10.0	NA	<10.0

River Code: **09-001**	Stream: **Munn Run**	Sample Date: **2001**
River Mile: **0.40**	Location: U.S. Rt. 52	Date Range: 08/28/2001
Time Fished: 3790 sec	Drainage: 8.0 sq mi	Thru: 10/15/2001
Dist Fished: 0.30 km	Basin: Southeast Ohio River Tribs 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
White Sucker	W	O	S	T	1,381	1,381.00	42.80			
Goldfish	G	O	M	T	1	1.00	0.03			
Blacknose Dace	N	G	S	T	133	133.00	4.12			
Creek Chub	N	G	N	T	459	459.00	14.22			
South. Redbelly Dace	N	H	S		663	663.00	20.55			
Fathead Minnow	N	O	C	T	55	55.00	1.70			
Central Stoneroller	N	H	N		529	529.00	16.39			
Yellow Bullhead		I	C	T	5	5.00	0.15			
Black Bullhead		I	C	P	1	1.00	0.03			
Mile Total					3,227	3,227.00				
Number of Species					9					
Number of Hybrids					0					

River Code: **09-001**	Stream: **Munn Run**	Sample Date: **2001**
River Mile: **0.20**	Location: dst. U.S. Rt. 52	Date Range: 08/28/2001
Time Fished: 2789 sec	Drainage: 8.0 sq mi	Thru: 10/15/2001
Dist Fished: 0.30 km	Basin: Southeast Ohio River Tribs 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
White Sucker	W	O	S	T	79	79.00	20.57			
Blacknose Dace	N	G	S	T	34	34.00	8.85			
Creek Chub	N	G	N	T	65	65.00	16.93			
South. Redbelly Dace	N	H	S		12	12.00	3.13			
Fathead Minnow	N	O	C	T	1	1.00	0.26			
Central Stoneroller	N	H	N		193	193.00	50.26			
Mile Total					384	384.00				
Number of Species					6					
Number of Hybrids					0					

Appendix T. 4 Index of Biotic Integrity (IBI) scores and metrics for sites sampled by Ohio EPA in Munn Run, 2001.

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	
Munn Run - (09-001)																	
Year: 2001																	
0.40	E	08/28/2001	8.0	7(3)	5(3)	2(3)	0(1)	0(1)	3(3)	58(1)	38(1)	16(5)	0(1)	0.0(5)	1404(5)	32	
0.40	E	10/15/2001	8.0	8(3)	5(3)	2(3)	0(1)	0(1)	3(3)	68(1)	52(1)	16(5)	0(1)	0.0(5)	982(5)	32	
0.20	E	08/28/2001	8.0	2(1)	2(1)	0(1)	0(1)	0(1)	0(1)	39(3)	0(1)	40(3)	0(1)	0.0(5)	46(1) *	20	▲
0.20	E	10/15/2001	8.0	6(1)	5(3)	2(3)	0(1)	0(1)	3(3)	47(3)	23(3)	15(5)	0(1)	0.0(5)	364(3)	32	

▲ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix T. 5. Invertebrate Community Index (ICI) scores and metrics for sites sampled by Ohio EPA in Munn Run, 2001.

River Mile	Drainage Area (sq mi)	Number of				Percent:							
		Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	Eco-region	ICI
Munn Run (09-001)													
Year: 2001													
0.40	8.0	20(2)	1(0)	0(0)	13(2)	0.2(2)	0.0(0)	3.2(2)	96.2(0)	68.5(0)	1(0)	4	8
0.20	8.0	14(2)	1(0)	0(0)	12(2)	3.1(2)	0.0(0)	2.1(2)	94.8(0)	23.7(2)	2(0)	4	10
0.01	8.0	14(2)	0(0)	0(0)	7(2)	0.0(0)	0.0(0)	0.0(0)	99.9(0)	98.4(0)	0(0)	4	4

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 10/15/2001 River Code: 09-001 RM: 0.40 Site: Munn Run U.S. Rt. 52

Taxa Code	Taxa	Quant/Qual		Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	16	+			
03600	*Oligochaeta*	558				
04686	*Placobdella papillifera*		+			
13521	*Stenonema femoratum*		+			
17200	*Caenis sp*	3				
21200	*Calopteryx sp*		+			
22001	*Coenagrionidae*	1	+			
22300	*Argia sp*	2	+			
28705	*Pachydiplax longipennis*	1				
42700	*Belostoma sp*		+			
45900	*Notonecta sp*		+			
74501	*Ceratopogonidae*	1				
77120	*Ablabesmyia mallochi*	1				
77500	*Conchapelopia sp*	6				
77750	*Hayesomyia senata or Thienemannimyia norena*	1	+			
78450	*Nilotanypus fimbriatus*	1				
78655	*Procladius (Holotanypus) sp*	6				
82730	*Chironomus (C.) decorus group*	274				
83003	*Dicrotendipes fumidus*	6				
83040	*Dicrotendipes neomodestus*	23				
83050	*Dicrotendipes lucifer*	6				
83300	*Glyptotendipes (G.) sp*	273	+			
85500	*Paratanytarsus sp*	28				
85625	*Rheotanytarsus exiguus group*	11				
87701	*Syrphidae*		+			
94400	*Fossaria sp*		+			
95100	*Physella sp*	7				

No. Quantitative Taxa: 20 Total Taxa: 27
No. Qualitative Taxa: 12 ICI: **8**
Number of Organisms: 1225 Qual EPT: 1

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 10/15/2001 River Code: 09-001 RM: 0.20 Site: Munn Run dst. U.S. Rt. 52

Taxa Code	Taxa	Quant/Qual		Taxa Code	Taxa	Quant/Qual
03600	*Oligochaeta*	3	+			
11200	*Callibaetis sp*	3	+			
17200	*Caenis sp*		+			
22001	*Coenagrionidae*		+			
45000	*Hesperocorixa sp*		+			
45400	*Trichocorixa sp*		+			
60900	*Peltodytes sp*		+			
72700	*Anopheles sp*		+			
72900	*Culex sp*		+			
74501	*Ceratopogonidae*	4				
77750	*Hayesomyia senata or Thienemannimyia norena*	1				
78200	*Larsia sp*	1				
79020	*Tanypus neopunctipennis*	5				
80150	*Acricotopus sp*		+			
80420	*Cricotopus (C.) bicinctus*	1				
82730	*Chironomus (C.) decorus group*	19				
83002	*Dicrotendipes modestus*	8				
83040	*Dicrotendipes neomodestus*	2	+			
83158	*Endochironomus nigricans*		+			
83300	*Glyptotendipes (G.) sp*	44	+			
83380	*Goeldichironomus holoprasinus*	4	+			
85500	*Paratanytarsus sp*	1				
85800	*Tanytarsus sp*	1				
94400	*Fossaria sp*		+			

No. Quantitative Taxa: 14 Total Taxa: 24
No. Qualitative Taxa: 15 ICI: **10**
Number of Organisms: 97 Qual EPT: 2

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 10/15/2001 River Code: 09-001 RM: 0.01 Site: Munn Run at mouth

Taxa Code	Taxa	Quant/Qual	
01801	*Turbellaria*	4	+
03600	*Oligochaeta*	3324	+
06810	*Gammarus fasciatus*		+
22001	*Coenagrionidae*	1	
22300	*Argia sp*	3	
60300	*Dineutus sp*		+
71300	*Limonia sp*	19	
79100	*Thienemannimyia group*		+
80410	*Cricotopus (C.) sp*	1	
80420	*Cricotopus (C.) bicinctus*	37	+
80430	*Cricotopus (C.) tremulus group*	1	
81460	*Orthocladius (O.) sp*	1	
82700	*Chironomus sp*	1	
84470	*Polypedilum (P.) illinoense*	16	
94400	*Fossaria sp*	3	+
95100	*Physella sp*	1812	+
96120	*Menetus (Micromenetus) dilatatus*	50	

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 14 Total Taxa: 17
No. Qualitative Taxa: 8 ICI: **4**
Number of Organisms: 5273 Qual EPT: 0