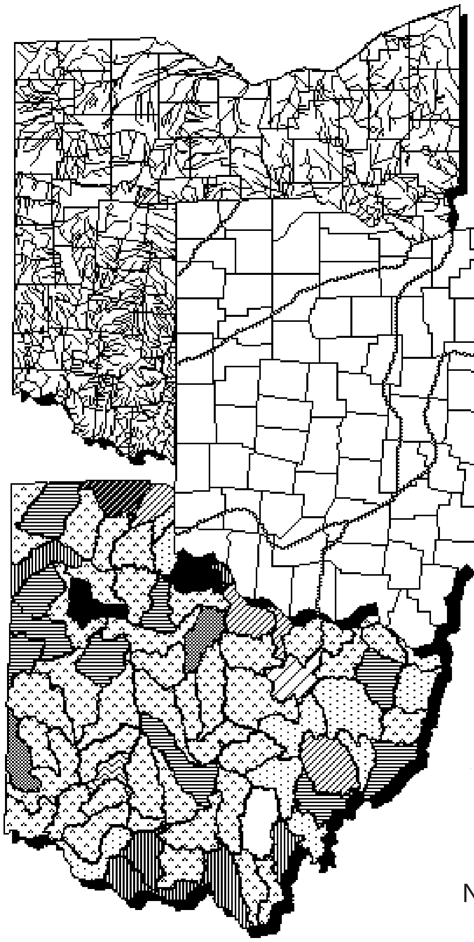
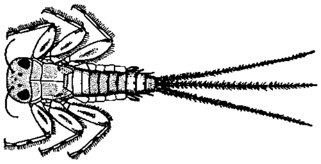
State of Ohio
Environmental Protection Agency

Ecological Assessment
Division of Surface Water

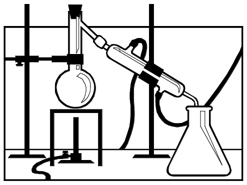
# Biological and Water Quality Study of Blacklick Creek and Selected Tributaries

## Frankin and Fairfield Counties, Ohio

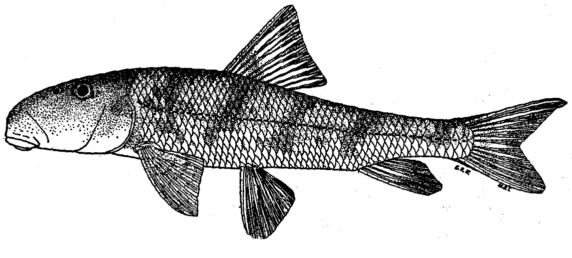




Mayfly *(Stenonema)*



Chemical Analysis



Northern Hogsucker *(Hypentelium nigricans)*

March 31, 1998

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

# Biological and Water Quality Study of Blacklick Creek

Franklin and Fairfield Counties, Ohio

March 31, 1998

Ohio EPA Technical Report MAS/1997-12-7

Prepared by
State of Ohio Environmental Protection Agency
Division of Surface Water
Monitoring and Assessment Section
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Central District Office
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Columbus, Ohio 43207-3417

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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., Ecol. Assess. Sect., 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 Qual. 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

# 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 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, Water Quality Support Documents [WQPSDs], 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)

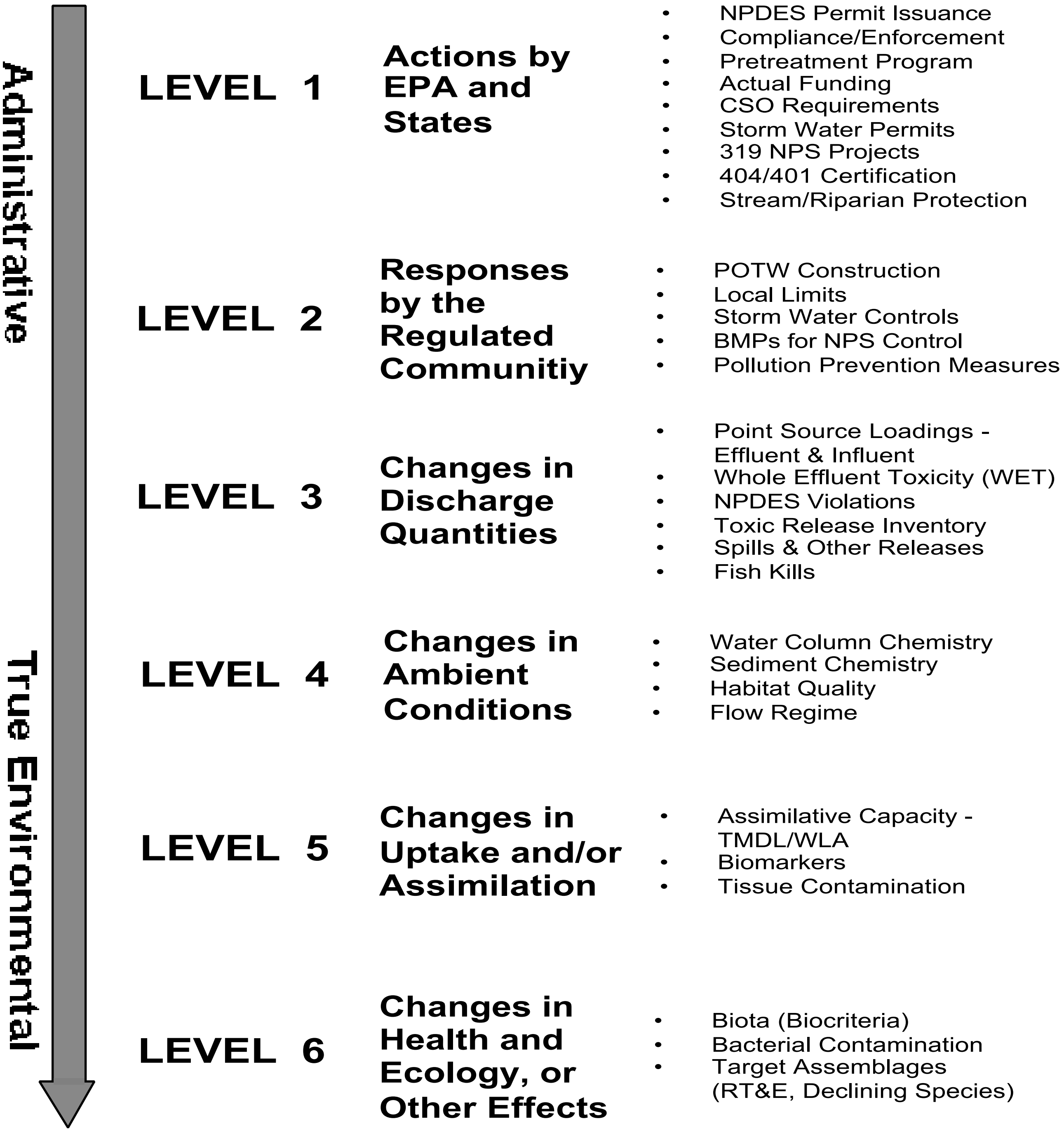

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

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 NPS Assessment, and 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 narrative 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 rivers and streams, the aquatic life use criteria frequently control the resulting protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS with the general intent of each with respect to the role of biological criteria 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.* Biological criteria are stratified across five ecoregions for the WWH use designation.

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.* Biological criteria for EWH apply uniformly across the state.

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. No specific biological criteria have been developed for the CWH use although the WWH biocriteria are viewed as attainable for CWH designated streams.

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. Biological criteria for MWH were derived from a separate set of habitat modified reference sites and are stratified across five ecoregions and three major modification types: channelization, run-of-river impoundments, and extensive sedimentation due to non-acidic mine drainage.

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. No formal biological criteria have been established for the LRW use designation.

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 coliform bacteria, *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 are detailed in other documents.

# ACKNOWLEDGEMENTS

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

Study Area Description - Rich McClay, John Owen, and Charles Boucher
Pollutant Loadings - John Owen and Paul Vandermeer
Ambient Chemical Water Quality - Paul Vandermeer
Sediment Chemistry - Paul VanDermeer
Biological Assessment:
    Physical Habitat for Aquatic Life - Charles Boucher and Brian Alsdorf
    Macroinvertebrate Community - Marty Knapp
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Reviewers - Chris Yoder, Marc Smith, Jeff DeShon, Jeff Bohne, and Dave Altfater.

The field work in support of this project would have not been possible without the capable assistance of the following 1996 seasonal field staff: Tom Holmes, Eric Corbin, Kevin Kish, . Additionally, the Ohio EPA would like to formally acknowledge all of the private landowners that generously provided access to throughout the study area.

# Biological and Water Quality Study of Blacklick Creek

(Franklin and Fairfield Counties, Ohio)

State of Ohio Environmental Protection Agency
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## INTRODUCTION

As part of the five-year basin approach for the NPDES (National Pollution Discharge Elimination System) permitting process, ambient biological, water column chemical and physical, and sediment samples were collected by Ohio EPA from Blacklick Creek during the summer and fall of 1996. The study area extended from the headwaters (RM 23.0) to near the mouth (RM 1.4). Eight undesignated Blacklick Creek tributaries were evaluated during the summer of 1997. This effort was limited to the collection of fish community samples only. Although the tributary sampling was not a formal component of the Blacklick Creek survey, the results were summarized and incorporated in this final report.

Specific objectives of this study were to:

1) Monitor and assess the overall chemical, physical, and biological integrity of Blacklick Creek,
2) Determine attainment status of selected beneficial use designations and recommend changes where appropriate,
3) Evaluate the influence of the Blacklick Estates, Fairfield County (Tussing Rd.), Jefferson Twp. (Wengert Rd.) WWTPs, and several minor permitted facilities within the Blacklick Creek basin, and
4) Summarize previous studies by Ohio EPA to evaluate changes in environmental conditions of Blacklick Creek and to expand Ohio EPA databases for statewide trend analysis (e.g., 305[b]).

The findings of this 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]), Water Quality Support Documents (WQPSDs), and eventually will be incorporated into the State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Water Resource Inventory (305[b]) report.

## SUMMARY

Twenty-three miles of Blacklick Creek were sampled and assessed as part of the 1996 survey. The effort included an aggregate total of 29 biological, chemical/physical, and sediment stations, encompassing the mainstem from the headwaters (RM 23.0) to the near the mouth (RM 1.4). Previous biosurveys of Blacklick Creek were conducted by Ohio EPA in 1991, 1989, 1987, and 1986. Each of these efforts evaluated a portion, not all, of the mainstem.

Two aquatic life use designations are currently in effect on Blacklick Creek. The stream reach between RM 20.4 (Havens Rd.) and RM 16.5 (SR 16) is designated EWH. The remaining segments (upper and lower) are designated WWH. Aquatic life use attainment status for existing and recommended use designations is presented in Table 1. A graphical evaluation of ambient biological performance in Blacklick Creek is presented in Figure 2

The results from the 1996 biosurvey found 14.7 miles (64.8%) of Blacklick Creek in full attainment of existing aquatic life uses. Partial attainment was indicated for 3.6 miles (15.9%), while non-attainment was observed for the remaining 4.4 miles (19.3%). Impairment (partial and non-attainment) was limited to two river segments. The first extended from the WWH designated headwaters (RM 22.7), through the EWH reach, to Hill Rd. (RM 15.5). The second included the lower 1.8 miles.

Within the headwaters (RM 22.4/22.7) both the fish and benthic macroinvertebrate communities performed at a fair level. As documented in a previous investigation (Ohio EPA 1992), intermittent stream flow was again observed within the upper reaches of Blacklick Creek in 1996. This coupled with failed on-site septic systems and a significant manure release further upstream were the principal associated sources of aquatic life use impairment within this area. Apparently livestock wastes were improperly applied to adjacent agricultural fields within the extreme headwaters of Blacklick Creek (Ohio DNR 1996). Following an extended period of rainfall in mid-August, manure laden runoff was delivered to Blacklick Creek near RM 27.0. Despite the lack of perennial flow and the stressors identified above, ambient water quality within the upper limits of the formal study area (RM 23.0) was generally good. At this station D.O., nutrients, ammonia-N, solids, and fecal bacteria were all found at acceptable levels. Only biochemical oxygen demand (BOD) was elevated. However, in response to citizen complaints regarding the manure release additional water chemistry samples were collected further upstream near RM 27.0. Results from this extralimital effort indicated low D.O., elevated nutrients, and fecal bacteria contamination in the immediate area of the spill.

Progressing downstream, into the EWH designated reach, community performance was markedly improved as stream discharge became continuous. However, all four sampling stations contained within this segment failed to support exceptional biological assemblages. Despite this, most

Table 1. Aquatic life attainment status for the existing and recommended use designations of the Blacklick Creek study area based on data collected by Ohio EPA, 1986 - 1997.

| RIVER MILE Fish/Macro. | IBI | Mod. Iwb | ICI$^{c}$ | QHEI | Use Attainment Status$^{a,b}$ | Comments |
|---|---|---|---|---|---|---|
| ***Blacklick Creek (1996)*** | | | | | | |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | |
| 22.4$^{(H)}$/22.7 | 35* | N/A | F* | 65.5 | **NON** | Kitzmiller/Morse Rd. |
| *Eastern Corn Belt Plains - EWH/WWH Use Designation (Existing/Recommended)* | | | | | | |
| 20.4$^{(H)}$/20.4 | 49$^{ns}$/49 | N/A | G*/G | 63.0 | PARTIAL/FULL | Havens Rd. |
| 18.2$^{(W)}$/18.7 | 41*/41 | 7.8*/7.8$^{ns}$ | 40*/40 | 79.5 | **NON**/FULL | Ust. Jefferson WWTP |
| 18.0$^{(W)}$/17.9 | 44*/44 | 7.7*/7.7* | G*/G | 75.0 | **NON**/PARTIAL | Dst. Jefferson WWTP |
| 16.6$^{(W)}$/16.6 | 48$^{ns}$/48 | 8.4*/8.4 | 40*/40 | 70.5 | PARTIAL/FULL | Broad St. |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | |
| 15.5$^{(W)}$/15.2 | 43 | 8.5 | 34$^{ns}$ | 68.0 | FULL | Adj. Rose Hill Rd. |
| 11.3$^{(W)}$/11.3 | 38$^{ns}$ | 7.8$^{ns}$ | G | 74.5 | FULL | Tussing Rd. |
| 11.0$^{(W)}$/11.1 | 39$^{ns}$ | 8.6 | G | 63.5 | FULL | Dst. Tussing Rd. WWTP |
| 8.8$^{(W)}$/8.9 | 41 | 8.3 | 46 | 62.0 | FULL | Refugee Rd. |
| 5.0$^{(W)}$/5.6 | 43 | 8.7 | 50 | 78.0 | FULL | Ust. Blacklick Est. WWTP |
| *4.83$^{(W)}$/4.83$^{MZ}$* | *36* | *7.6* | *P/F* | -- | *N/A* | *Blacklick Est. WWTP Mixing Zone* |
| 4.6$^{(W)}$/4.5 | 45 | 8.2$^{ns}$ | 52 | 64.5 | FULL | Dst. Blacklick Est. WWTP |
| 1.8$^{(W)}$/1.4 | 38$^{ns}$ | 7.6* | 46 | 77.0 | PARTIAL | SR 317 |
| ***Blacklick Creek (1991)*** | | | | | | |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | |
| 27.1$^{(H)}$/26.0 | 26* | N/A | 2* | 40.0 | **NON** | Intermittent conditions |
| 22.4$^{(H)}$/23.0 | 28* | N/A | 12* | 61.0 | **NON** | Intermittent conditions |
| *Eastern Corn Belt Plains - EWH/WWH Use Designation (Existing/Recommended)* | | | | | | |
| 20.4$^{(H)}$/20.3 | 47$^{ns}$/47 | N/A | 40*/40 | 53.5 | PARTIAL/FULL | Havens Rd. |
| 16.6$^{(H)}$/16.6 | 46$^{ns}$/46 | 9.1$^{ns}$/9.1 | 48/40 | 66.5 | FULL/FULL | Broad St. |
| ***Blacklick Creek (1989)*** | | | | | | |
| *Eastern Corn Belt Plains - EWH/WWH Use Designation (Existing/Recommended)* | | | | | | |
| - /20.3 | -- | -- | 44$^{ns}$/44 | -- | (FULL/FULL) | Havens Rd. |
| - /18.6 | -- | -- | G*/G | -- | (**NON**/FULL) | Ust. Jefferson WWTP |
| - /16.5 | -- | -- | 34*/34$^{ns}$ | -- | (**NON**/FULL) | Broad St. |

Table 1. continued.

| RIVER MILE<br>Fish/Macro. | IBI | Mod.<br>Iwb | ICI[c] | QHEI | Use Attain-<br>ment Status[a,b] | Comments |
|---|---|---|---|---|---|---|
| ***Blacklick Creek (1987)*** | | | | | | |
| | *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | |
| 11.3(W)/11.3 | 38ns | 7.2* | MGns | 70 | PARTIAL | Tussing Rd. |
| 11.0(W)/11.0 | 36ns | 6.5* | MGns | 70 | PARTIAL | Dst. Tussing Rd. WWTP |
| ***Blacklick Creek (1986)*** | | | | | | |
| | *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | |
| 11.3(W)/ - | 38ns | 8.5 | -- | -- | (FULL) | Tussing Rd. |
| 9.7(W)/ - | 33* | 9.0 | -- | -- | (PARTIAL) | |
| 5.6(W)/4.9 | 45 | 9.3 | G | -- | FULL | Ust. Blacklick Est. WWTP |
| 4.7(W)/4.6 | 33* | 8.8 | F* | -- | PARTIAL | Dst. Blacklick Est. WWTP |
| 3.3(W)/3.6 | 27* | 6.3* | 18* | -- | **NON** | Impacted |
| 2.1(W)/2.1 | 32* | 8.0ns | 26* | -- | PARTIAL | Impacted |
| ***Blacklick Creek Tributaries (1997)*** | | | | | | |
| *Eastern Corn Belt Plains - Undesignated/WWH Use Designation (Existing/Recommended)* | | | | | | |
| ***Unnamed Trib.*** ***(Joins Blacklick Cr.at RM 6.5)*** | | | | | | |
| 0.5(H)/ - | 36ns | N/A | -- | 56.0 | (FULL) | Development Pressures |
| ***Unnamed Trib.*** ***(Joins Blacklick Cr.at RM 10.4)*** | | | | | | |
| 0.3(H)/ - | 44 | N/A | -- | 75.5 | (FULL) | SR 256 |
| ***Unnamed Trib.*** ***(Joins Blacklick Cr.at RM 11.3)*** | | | | | | |
| 0.3(H)/ - | 40 | N/A | -- | 73.5 | (FULL) | SR 256 |
| ***Unnamed Trib.*** ***(Joins Blacklick Cr.at RM 12.9)*** | | | | | | |
| 0.3(H)/ - | 46 | N/A | -- | 74.0 | (FULL) | Graham Rd. |
| ***Swisher Creek*** | | | | | | |
| 1.3(H)/ - | 40 | N/A | -- | 47.0 | (FULL) | Clark St. Rd. |
| ***Unnamed Trib. to Dysar Run*** | | | | | | |
| 0.1(H)/ - | 46 | N/A | -- | 70.5 | (FULL) | |
| ***French Run*** | | | | | | |
| 0.7(H)/ - | 38ns | N/A | -- | 68.0 | (FULL) | Waggoner Rd. |

Table X. continued.

| RIVER MILE Fish/Macro. | IBI | Mod. Iwb | ICI[c] | QHEI | Use Attainment Status[a,b] | Comments |
|---|---|---|---|---|---|---|
| ***North Br. French Run (1997)*** | | | | | | |
| *Eastern Corn Belt Plains - Undesignated/EWH Use Designation (Existing/Recommended)* | | | | | | |
| 0.2(H)/ - | 54 | N/A | -- | 81.5 | (FULL) | adj. Elementary School |

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

[ns] Nonsignificant departure from biocriterion ($\leq$4 IBI or ICI units; $\leq$0.5 MIwb units).

[a] Use attainment status based on one organism group is parenthetically expressed.

[b] Biocriteria do not apply inside mixing zones.

[c] Narrative evaluation based on qualitative benthic macroinvertebrate sample (G-good, F-fair, and P-poor).

H Headwater site type (drainage area ≤ 20 miles $^2$).

W Wading site type.

**Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)**

(OAC 3745-1-07, Table 7-14)

| INDEX - Site Type | WWH | EWH | MWH[d] |
|---|---|---|---|
| IBI - Headwater/Wading | 40 | 50 | 24 |
| MIwb - Wading | 8.3 | 9.4 | 6.2 |
| ICI | 36 | 46 | 22 |

[d] - Modified Warmwater Habitat for channelized habitats/impounded habitats.

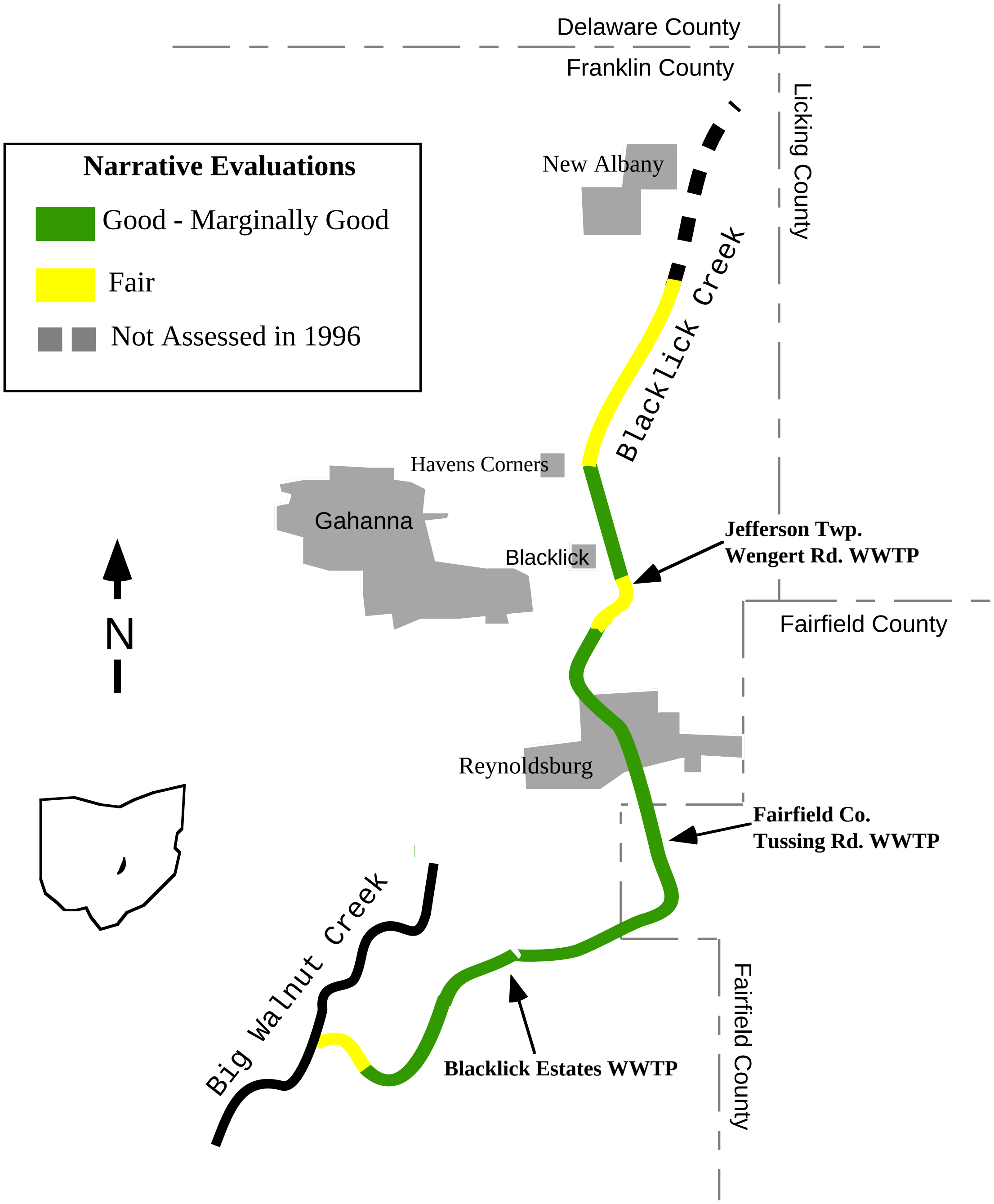


Figure 2. Narrative evaluation of ambient biological performance (fish and macrobenthos) for the Blacklick Creek study area, 1996.

stations did fully support WWH communities. The macrobenthos, in particular, maintained a level of structure and organization indicative of good water quality throughout this segment. Results from water column sampling revealed few exceedences or violations of the water quality criteria supporting various beneficial use designations (e.g., aquatic life and recreational). The typical suite of water quality parameters (nutrients, ammonia-N, solids, demand, and D.O.) occurred at acceptable concentrations throughout this segment. This included a significant reduction in BOD (in comparison with the headwaters) and D.O. concentrations well above both the minimum and average EWH standards.

This portion of Blacklick Creek receives effluent from the Jefferson Twp.-Wengert Rd. WWTP (RM 18.1) and Columbus Steel Drum Co. (RM 17.8 via an unnamed tributary). Both facilities are minor dischargers and combined, contribute less than 6% of the aggregate wastewater flow discharged from WWTPs to Blacklick Creek. Pollutant loads from the Jefferson Twp. WWTP have steadily increased since 1990; however, its relative contribution to the aggregate load has remained small. Pollutant loads from the Columbus Steel Drum Co. were minimal and appeared to have little effect on the water quality of Blacklick Creek. Given the stability of the water chemistry, bracketing the plants, and ambient biological performance consistent with the WWH biocriteria through most of this segment, biological departures from the EWH standard in 1996 were not strongly correlated with wastewater discharged by these facilities. Rather, these data suggest that Blacklick Creek is naturally incapable of *consistently* supporting exceptional aquatic communities throughout the EWH segment.

It is also important to consider that the EWH designation is imposed on the stream reach straddling the drainage area break (20 miles$^2$) between the headwater and wading site types. In recognition of natural physical, chemical, and biological characteristics exhibited by streams or rivers as they progressively increase in size, Ohio EPA has developed sampling methodologies, community measures, and performance standards to account for this longitudinal succession (Ohio EPA 1987). In practice, this assessment scheme has typically functioned well since its inclusion in the Ohio WQS (Yoder and Rankin 1995). However, in this instance, the EWH segment is fragmented, containing both headwater and wading stations. Moreover, the drainage area of most of this segment is barely in excess of the headwater threshold. This necessitates the use of different biological measures (calibrated for either headwater and wading conditions) to evaluate fish community data collected over a short, relatively homogeneous, section of stream. Analysis of the fish community data strongly suggested that the "diminished" scores are, in large part, artifacts of this unique situation--the abrupt change in stream class and the accompanying index change--rather than an indication of environmental degradation.

Collectively, these observations bring into question the appropriateness of the EWH use designation and attainability of the corresponding biocriteria for this segment of Blacklick Creek. Compared against the WWH biological performance benchmarks, nearly all of these stations were brought into full attainment (Table 1). Departure from this criteria was limited to one station (RM 18.0, immediately downstream from the Jefferson Twp. WWTP). However, impairment at this location was minimal, as two of the three biological indices met or surpassed the respective WWH criterion. Only the MIwb (a fish community index) deviated from the minimum WWH standard. This departure was not excessive, constituting only 0.1 units. Moreover, it is doubtful that the subpar performance of the MIwb at RM 18.0 was directly linked to effluents discharged by the Jefferson Twp. WWTP, as all other ambient indicators (chemical and biological) performed at expected levels. Ultimately, a redesignation of this reach to the more appropriate WWH aquatic life use is warranted to account for both the transitional nature and true biological potential of this segment. The ramifications of this recommended use on aquatic life attainment are further detailed in the Recommendations Section of this report.

Within the remaining downstream portion of Blacklick Creek (from RM 15.5 to the mouth), departures from the WWH biological criteria were limited to the lower 1.8 miles (RM 1.8, SR 317). All other stations were found to fully support the WWH use (full attainment). At RM 1.8, both the IBI and the ICI were consistent with the respective WWH criteria. Impairment was driven solely by the MIwb which deviated from the minimum WWH standard by only 0.2 units.

The lower segment of Blacklick Creek receives effluent directly or indirectly (via tributaries) from the Fairfield Co. Tussing Rd. WWTP (RM 18.1), the Blacklick Estates WWTP (RM 4.85), and several other minor facilities. Both Fairfield Co. and Blacklick Estates are major dischargers and, combined, contribute over 90% of the aggregate wastewater flow to Blacklick Creek--split about evenly between the two plants. Based on entity generated Monthly Operating Reports (MOR) data, these facilities are by far the most significant source of ammonia-N, BOD, and Total Suspended Solids (TSS) loads within the subbasin. Pollutant loads from the other permitted entities are small by comparison and appeared to have little effect on the water quality of Blacklick Creek.

Ambient water quality within this segment was generally good, as concentrations of most chemical indicators remained within acceptable ranges. However, selected Fairfield Co. WWTP effluent and mixing zone samples were notable exceptions. Collections made in mid-July revealed a marked increase of several analytes. The concentrations of TSS, BOD, and total phosphorus were orders of magnitude greater than the other effluent and mixing zone samples collected at this facility. These data suggest a plant upset or other operational irregularities, possibly linked to a period of extended rainfall in mid-July. It is possible that the WWTP experienced heavy inflow and infiltration, or other problems, within the collection system during this wet weather period, resulting in the disruption of normal treatment. Treatment irregularities were also inferred from variable bioassay results.

Fecal coliform counts greater than the average and maximum Primary Contact Recreation (PCR) standards were the only regularly observed exceedences. Most exceedences occurred on the same date in mid-July, coinciding with elevated stream flows following a period of extended rainfall. The frequency and magnitude of bacteriological contamination were low, and did not appear to pose a significant threat to the PCR use designation. The only other exceedences recorded were for metals. One of six samples collected downstream from the Blacklick Estates WWTP (RM 4.6) detected nickel and copper concentrations in excess of the acute and chronic criteria, respectively.

Ultimately, pollutant loads from the Fairfield Co. WWTP (including the plant upset), Blacklick Estates WWTP, and other minor facilities did not appear to have a significant adverse effect on chemical water quality of Blacklick Creek. Inputs of nutrients, solids, and oxygen demanding wastes were safely assimilated as D.O. concentrations downstream from the facility were consistently well above the minimum and average WWH criteria. It is difficult to attribute, with confidence, the modest biological impairment documented at RM 1.8 (near the mouth) to wastes discharged by the Blacklick Estates WWTP, considering generally good performance of the other ambient biological and chemical indicators downstream from this facility. As stated earlier, departures from WWH biological criteria were driven solely by the MIwb, as the other community indices were fully consistent with their respective performance standards.

### *Selected Tributaries:1997*

Eight undesignated Blacklick Creek tributaries were evaluated in 1997: French Run, North Branch French Run, Swisher Creek, Dysar Run tributary, and four unnamed tributaries. The sampling effort was limited to the collection of fish community data only. Each stream was sampled at one station, typically located less than a mile upstream from the mouth. Primary objectives of the 1997 effort were to evaluate ambient conditions, recommend appropriate beneficial uses for these undesignated streams, and to establish baseline stations to monitor biological performance, through time, within this rapidly developing area.

Community performance, as measured by the IBI, ranged between exceptional (IBI=54) and marginally good (IBI=36). At a minimum, all stations supported fish assemblages consistent with the headwater WWH biological criterion (Table 1). A fully exceptional community was indicated in the North Branch French Creek.

### *Trends Assessment: 1986-1996*

The environmental conditions of Blacklick Creek have been evaluated at assorted locations since 1974. Efforts through the 1970s, however, were very limited in scope and included only water chemistry sampling. Ambient biological data, often integrated with the sampling of other media, were collected from Blacklick Creek at various locations in 1986, 1987, 1989, 1991, and 1996. A fully integrated survey of the stream reach between RM 11.3 and RM 2.1 was conducted in

1986--assessing both the Fairfield County-Tussing Rd. and the Blacklick Estates WWTPs. The 1987 sampling effort targeted the Tussing Rd. facility only (RM 11.3 - 11.0), and included two fish community and chemistry sampling sites. The Jefferson Twp.-Wengert Rd. WWTP was again assessed in 1989. This effort included one water chemistry and three macroinvertebrate stations (RM 20.3 - 16.5). The 1991 survey was fully integrated, but was limited to the upper limits of the study area (RM 27.1 - 16.6), and again targeted the Jefferson Twp.-Wengert Rd. WWTP. The 1996 study was also fully integrated, evaluating the entire length of Blacklick Creek between RM 23.0 (Morse Rd.) and RM 1.4 (SR 317). Given the very limited scope of the 1974-75, 1987, and 1989 sampling efforts, the trend assessment focused on the more robust and fully integrated 1986, 1991, and 1996 data sets.

The results from the 1986 survey clearly delineated distinct and significant impacts downstream from both the Blacklick Estates and the Fairfield County-Tussing Rd. WWTPs. The performance of ambient indicators within the reach influenced by the Blacklick Estates WWTP exemplified a *classic* water quality profile downstream from an input of poorly treated sewage. A distinct D.O. sag was evident with many violations of the minimum WWH D.O. criterion. Nutrients, BOD, and other wastewater constituents were highly elevated within the lower four miles of Blacklick Creek, including total phosphorus well in excess of the 1.0 mg/l WWH guideline and toxic concentrations of ammonia-N. Ambient biological performance was reflective of these degraded conditions, as only 2.5 miles (22.1%) of the 11.3 mile segment evaluated in 1986 were found to contain fish and macroinvertebrate communities fully consistent with the WWH biocriteria (full attainment). Areas of full use attainment were limited to two brief stream segments situated immediately upstream from the Blacklick Estates and the Tussing Rd. WWTPs, respectively. The remaining nine miles (77.9%) of the study area supported degraded assemblages (partial and non-attainment). The response of the communities (fish and macroinvertebrate) to effluents discharged by these facilities included: reduced species/taxa richness and structural evenness, an increase in the proportion of environmentally tolerant species/taxa, and an increased incidence of DELT anomalies within the fish community. The severity and magnitude of aquatic life use impairment were by far the greatest downstream from the Blacklick Estates WWTP.

By 1996, the impacts associated with these facilities appeared fully abated, as nearly every station contained communities consistent with the WWH use. Presently, 9.5 miles (84.1%) of the middle and lower portions of the study fully support the WWH aquatic life use. Departure from the WWH standard in 1996 was not severe, as in 1986, and was limited to the lower 1.8 miles. Water quality within this segment of Blacklick Creek was generally good in 1996. With few exceptions, the various chemical water quality indicators were found within acceptable ranges, including D.O. concentrations greater than the criteria for the protection of aquatic life. These positive changes in the environmental conditions of Blacklick Creek represent the full effect of wastewater treatment system upgrades implemented at both the Fairfield Co.-Tussing

Rd. and Blacklick Estates WWTPs.

Evaluated in 1991 and 1996, ambient biological performance within the upper portion of Blacklick Creek appeared stable. Except for the extreme headwaters, which were severely affected by the 1991 drought (exacerbating the effects of other stressors), stations common to both survey years supported very similar communities. The results from both sampling efforts (1991 and 1996) found Blacklick Creek relatively unaffected by the Jefferson Twp. WWTP. Diminished community performance from stations sampled in 1996 (closely bracketing the WWTP) were attributed to the transitional nature of the upper portion of Blacklick Creek (headwaters to wading), and the respective criteria prescribed for each stream size class. Chemical water quality within the upper portion of Blacklick Creek was generally good and appeared stable through time.

## CONCLUSIONS

### ***Blacklick Creek (mainstem)***

- Water quality throughout Blacklick Creek was generally good in 1996. Most parameters were found within acceptable ranges, including D.O. concentrations greater than the various criteria for the protection of aquatic life (WWH and EWH, average and minimum). Fecal coliform counts in excess of the PCR criteria (average and maximum) were the most frequently WQ observed exceedence. However, these were indicated in only seven of 69 water quality samples (10%), and most coincided with wet weather and the corresponding increase in stream flow. As such, the level of bacteriological contamination in Blacklick Creek was considered modest and did not constitute a significant threat to the PCR use.

- Impairment of the existing or recommended aquatic life uses was not directly attributed to any of the permitted discharges evaluated as part of the Blacklick Creek intensive survey (Jefferson Twp., Fairfield Co., Blacklick Estates, and other minor entities). Aquatic life use impairment within the existing WWH designated headwaters was a result of intermittent stream flow coupled with failed on-site septic systems and a release of animal wastes within the upper limits of the study area in late August. Within the existing EWH designated reach, fish and macroinvertebrate communities failed to consistently perform at an exceptional level. This segment has never demonstrated full attainment of the EWH aquatic life use (Table 1), and apparently is not capable of *consistently* supporting exceptional aquatic communities--spatially or temporally. Thus, a use change to the more appropriate WWH designation is warranted. This would bring nearly all of this reach into full attainment status. Within the remaining downstream portion of Blacklick Creek impairment of the existing WWH aquatic life use was limited to the lower 1.8 miles--beginning approximately three miles downstream from the Blacklick Estates WWTP. Departure from the WWH criteria was not severe, as only one of the three biological indices performed below its respective criterion. Given the stability and generally good performance of nearly all other ambient indicators (chemical, physical, and biological) downstream from this facility, it is difficult to attribute the very modest impairment to wastewater discharged by the Blacklick Estates WWTP.

- Effluent and mixing zone samples collected from the Fairfield Co.-Tussing Rd. WWTP in late July revealed highly elevated concentrations of oxygen demanding wastes, solids, oil and grease, and nutrients in comparison with other samples taken throughout the summer. This isolated occurrence coupled with intermittent effluent toxicity (bioassay tests) suggested episodic plant upsets or operational irregularities. These events may have possibly been related to inflow or infiltration, or other problems, within the collection system. Although impairment, or other significant water quality impacts, were not associated with the upset, further investigation into the cause(s) of these events is warranted.

- As a result of treatment process upgrades to the Fairfield Co. Tussing Rd. WWTP and the Blacklick Estates WWTP, significant improvements in the overall environmental conditions of Blacklick Creek (chemical and biological) have been realized. The 1996 intensive survey indicated near complete biological recovery from the degraded conditions (non and partial attainment) documented in previous investigations. These positive changes were directly linked to reduced pollutant loads from the major permitted discharges to Blacklick Creek.

### *Selected Tributaries*

- At a minimum, all eight of the undesignated Blacklick Creek tributaries evaluated in 1997 supported fish communities consistent with the WWH headwater biocriterion. A fully exceptional community was indicated in North Branch French Run.

## RECOMMENDATIONS

### Status of Aquatic Life Uses

Many streams and rivers in the state were originally designated for aquatic life uses in the 1978 and 1985 Ohio Water Quality Standards. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. This study represents the appropriate use of this type of biological data to evaluate and establish aquatic life use designations. While some of the changes may appear to constitute "downgrades" (*i.e.*, EWH to WWH, WWH to MWH, etc.) or "upgrades" (*i.e.*, LWH to WWH, WWH to EWH etc.), any changes should not be construed as such because this constitutes an objective and robust use evaluation system. 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 designations. Thus some of the following aquatic life use recommendations constitute a fulfillment of that obligation. The beneficial use designation matrix for the Blacklick Creek area is presented in Table 2.

The following segments of Blacklick Creek evaluated in 1996 are recommended to retain their existing WWH aquatic life use designation. The recommended aquatic life use for seven of the eight undesignated Blacklick Creek tributaries evaluated in 1997 is WWH. The remaining undesignated tributary, North Branch French Run, clearly possessed exceptional headwater community attributes. As such, the EWH aquatic life designation is recommended. All recommended use designations apply to the entire stream length unless otherwise noted.

**Blacklick Creek (mainstem)**

- Headwaters to Havens Rd., RM 20.4 (WWH-existing)

- SR 16, RM 16.5, to the mouth (WWH-existing)

**Selected Tributaries**

- French Run (undesignated/WWH - recommended)
- Swisher Creek (undesignated/WWH - recommended)
- Dysar Run Tributary (undesignated/WWH - recommended)
- Unnamed Tributary RM 6.5 (undesignated/WWH - recommended)
- Unnamed Tributary RM 10.4 (undesignated/WWH - recommended)
- Unnamed Tributary RM 11.3 (undesignated/WWH - recommended)
- Unnamed Tributary RM 12.9 (undesignated/WWH - recommended)
- North Br. French Run (undesignated/EWH - recommended)

The intervening stream segment is currently designated EWH. Based on the findings of the 1996 biosurvey, the existing aquatic life use did not appear to accurately reflect the true biological potential of this segment, as standard aquatic community measures (IBI, ICI, and MIwb) failed to meet the EWH performance standards on a consistent basis (temporally and spatially). Departures from the EWH criteria were not directly correlated with any obvious or apparent stressor. As a result, the existing aquatic life use is recommended to be replaced with the more appropriate WWH use. Aquatic life use attainment status for Blacklick Creek based on the recommended WWH use designation is 17.2 miles (75.8%) full, 3.2 miles (14.1%) partial, and 2.3 miles (10.1%) non.

- Havens Rd., RM 20.4, to SR 16, RM 16.5 (EWH-existing/WWH-recommended)

**Status of Non-Aquatic Life Uses**

All non-aquatic life uses (Recreational and Water Supply) should remain as presently designated in the Ohio Water Quality Standards (OAC 3745-1-07). For previously undesignated streams, both the agricultural and industrial water supply use designations, and the primary contact recreational use designation are recommended.

Table 2. Existing and recommended beneficial use designations for the Blacklick Creek study area. Recommendations are based on the results from the 1996-97 Blacklick Creek sampling effort.

| **River/Stream**<br>Affected Segment | **Benificial Use Designations** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Aquatic Life Habitat** | | | | | | **Water Supply** | | | **Recreation** | | |
| | **SRW** | **WWH** | **EWH** | **MWH** | **SSH** | **CWH** | **LRW** | **PWS** | **AWS** | **IWS** | **BW** | **PCR** | **SCR** |
| **Blacklick Creek** | | | | | | | | | | | | | |
| Headwaters to Havens Rd. (RM 20.4) | | + | | | | | | | + | + | | + | |
| Havens Rd.(RM 20.4) to SR 16 (RM 16.5) | | ▲ | * | | | | | | + | + | | + | |
| SR 16 (RM 16.5) to mouth | | + | | | | | | | + | + | | + | |
| **Unnamed Trib. (Joins Blacklick Creek at RM 6.5)**[a] | | | | | | | | | | | | | |
| Entire Length | | ▲ | | | | | | | ▲ | ▲ | | ▲ | |
| **Unnamed Trib. (Joins Blacklick Creek at RM 10.4)**[a] | | | | | | | | | | | | | |
| Entire Length | | ▲ | | | | | | | ▲ | ▲ | | ▲ | |
| **Unnamed Trib. (Joins Blacklick Creek at RM 11.3)**[a] | | | | | | | | | | | | | |
| Entire Length | | ▲ | | | | | | | ▲ | ▲ | | ▲ | |
| **Unnamed Trib. (Joins Blacklick Creek at RM 12.9)**[a] | | | | | | | | | | | | | |
| Entire Length | | ▲ | | | | | | | ▲ | ▲ | | ▲ | |
| **French Run**[a] | | | | | | | | | | | | | |
| Entire Length | | ▲ | | | | | | | ▲ | ▲ | | ▲ | |
| **North Branch French Run**[a] | | | | | | | | | | | | | |
| Entire Length | | | ▲ | | | | | | ▲ | ▲ | | ▲ | |

| **River/Stream** Affected Segment | **Benificial Use Designations** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Aquatic Life Habitat** | | | | | | **Water Supply** | | | **Recreation** | | |
| | **SRW** | **WWH** | **EWH** | **MWH** | **SSH** | **CWH** | **LRW** | **PWS** | **AWS** | **IWS** | **BW** | **PCR** | **SCR** |
| **Unnamed Trib. to Dysar Run**[a] | | | | | | | | | | | | | |
| Entire Length | | ▲ | | | | | | | ▲ | ▲ | | ▲ | |
| **Swisher Creek**[a] | | | | | | | | | | | | | |
| Entire Length | | ▲ | | | | | | | ▲ | ▲ | | ▲ | |

a - Previously undesignated stream.
\+ - Designated use based on the results of an integrated ambient biological assessment performed by Ohio EPA (verified).
* - Existing aquatic life use based on the 1985 Ohio WQS.
▲- Recommended aquatic life use designation based on the results from the 1996-97 Blacklick Creek subbasin sampling effort.

## Future Monitoring Needs

A re-evaluation of the areas investigated in 1996 and 1997 should be conducted in 2001 or 2006 as provided in the Five-Year Basin Monitoring Approach. This should proceed in accordance with the rate of suburban development pressures in the watershed.

## Other Recommendations

Despite surplus treatment capacity at the WWTPs, Blacklick Creek is likely near the assimilative capacity needed to maintain the WWH use. Biological indicators (fish and macroinvertebrates) were frequently at, or just below, the minimum WWH thresholds (IBI, MIwb, and ICI). These results suggest that additional stress would likely expand, significantly, the areas of modest impairment (partial and non-attainment) documented in 1996.

An additional threat to the integrity of Blacklick Creek would include suburban development pressures. As measured by the frequency of General Stormwater Permits (GSP), development has increased substantially over the last four years. These activities are most pronounced in the portion of the watershed contained in Franklin County. Within this area the issuance of GSPs have risen from an average of 2.5/year, prior to 1994, to 12.5/year. The deleterious effects of this intensive land use include: construction site runoff (primarily sediment), modification of the flow regime (increased runoff rates), riparian encroachment or removal, and, at times, direct channel modification. Collectively, these factors have been found to negatively impact the quality of surface water resources through the degradation of physical habitat (e.g., sedimentation, riparian removal, "flashy" hydroperiod) and lowering of chemical/physical quality of the water column itself (e.g., urban runoff, nutrients, lower summer flows, and higher instream temperatures).

Ultimately, the maintenance of the WWH use, and the recovery of impaired segments, is directly threatened by an anticipated increase of wastewater flows and land use changes, that will follow suburban development within the basin. To date, the WWTP upgrades have substantially advanced aquatic life use attainment in Blacklick Creek in comparison with pre-upgrade surveys. However, the ability of Blackilick Creek to safely continue to assimilate additional wastes without accruing environmental damage, or returning to its once degraded state, may be nearing capacity. Although a direct, clear and compelling link between the modest impairment documented in 1996 and effluents discharged by the WWTPs within the basin was not established, the conditions for granting future increases in effluent volumes should be conservative. Careful consideration must be given to the potential instream effects of additional pollutant loads if the improvements in Blacklick Creek are to be maintained into the future.

Regarding land use impacts, every effort should be made to prevent and abate associated problems. Successful stream protection may be achieved through the implementation of construction site and stormwater BMPs, the maintenance, or reestablishment, of permanent wooded riparian corridors on the mainstem and all Blacklick Creek tributaries, and the avoidance of any direct channel modification to the mainstem or any Blacklick Creek tributary.

# STUDY AREA DESCRIPTION

The Blacklick Creek study area included 23.0 miles of mainstem, from Havens Corners (RM 23.0) to near the mouth (RM 1.4). Blacklick Creek flows from its headwaters in western Licking and northeast Franklin Counties in a southerly direction, past the village of Blacklick and through the city of Reynoldsburg before turning southwest and joining Big Walnut Creek at the Alum Creek confluence in southeast Franklin County. Blacklick Creek is 25.5 miles long and drains an area of 61.3 miles$^2$. A map of the 1996 study area is presented in Figure 3.

Blacklick Creek is located in the Eastern Corn Belt Plains (ECBP) ecoregion of Ohio. The gently rolling glacial till plain comprising the ECBP ecoregion is broken by moraines, kames, and outwash plains. Local relief is generally less than 50 feet. Soils derived from glacial till materials contain substantial amounts of clay and soil drainage is often poor. Many of the smaller streams in the ECBP ecoregion have been channelized to assist soil drainage.

A mixture of rural residential lots (1-5 acres) and suburban housing development is the predominant and increasing land use in the study area. Agricultural land uses are present in the headwaters, but represent a relatively small portion of the total land use in the watershed. The main population centers in the study area are Blacklick, Gahanna, New Albany, and Reynoldsburg. Construction site erosion and streambank modification are the predominant types of nonpoint source (NPS) pollution in the study area. Other types of NPS pollution known or suspected in the study area include agriculture, on-site wastewater treatment, and urban runoff (Ohio EPA, 1990). General characteristics and identified point and nonpoint pollution sources in the study area and detailed location of all sampling stations are presented in Table 3 and 4.

Table 3. Stream characteristics and identified pollution sources in the Blacklick Creek study area, 1991.

| **Stream Name** | **Length (Miles)** | **Average Fall (Feet/Mile)** | **Drainage Area (Square Miles)** | **Nonpoint Source Pollution Categories** | **Identified Point Sources** |
|---|---|---|---|---|---|
| ***Blacklick Creek*** | | | | | |
| | 25.5 | 15.5 | 61.3 | San. & storm sewers<br>Construction sites<br>On-site septic systems<br>Channelization<br>Streambank modification<br>Agriculture | Jefferson Twp. WWTP<br>Fairfield Co. WWTP<br>Blacklick Est. WWTP<br>Columbus Steel Drum<br>ODA WWTP<br>Lenox Inn WWTP |

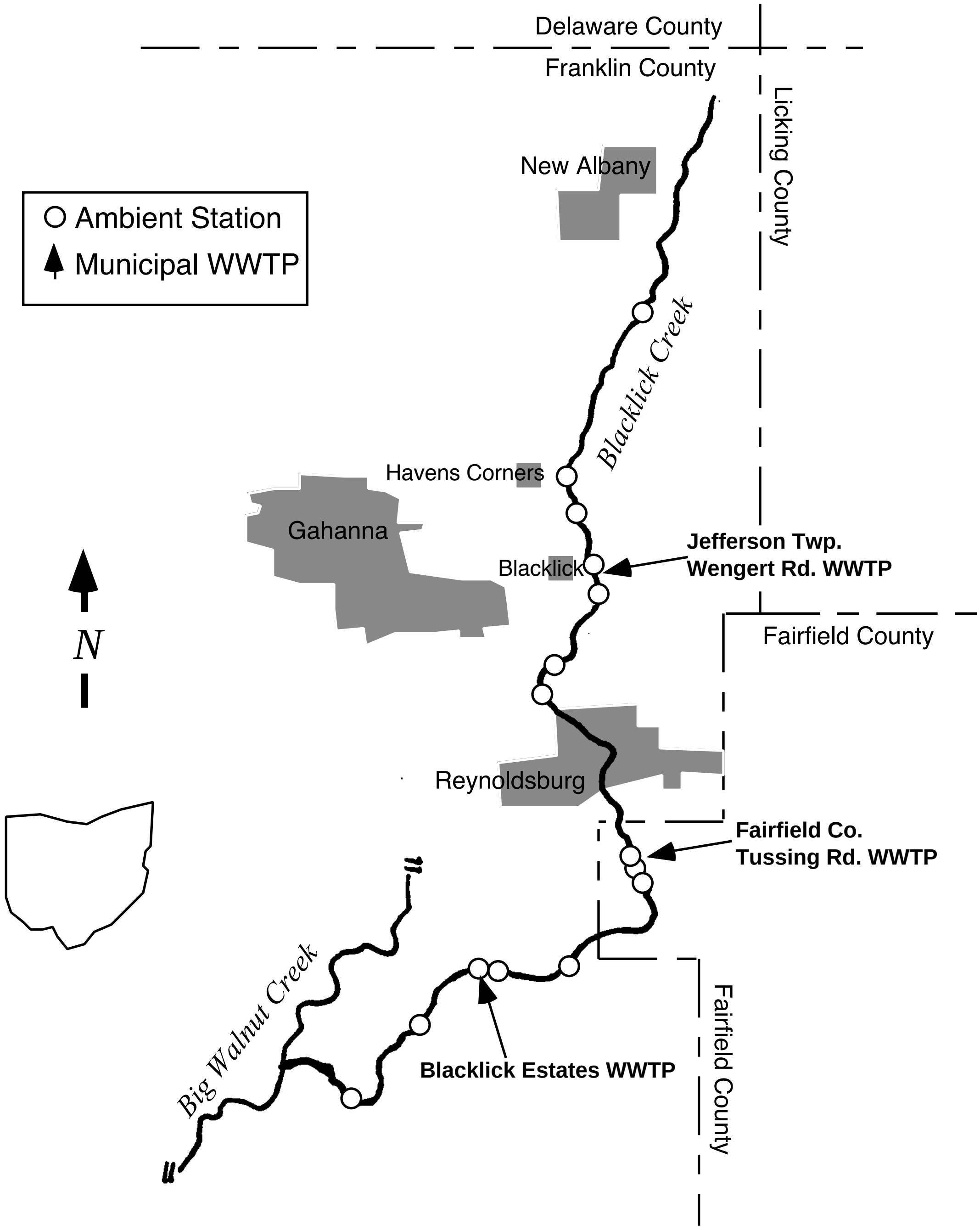


Figure 3. The Blacklick Creek study area showing population centers, pollution sources, and approximate locations of 1996 mainstem sampling stations.

Table 4. Sampling locations (effluent sample - E, water chemistry - C, sediment chemistry - S, macrobenthos - B, and fish - F) in the Blacklick Creek study area, 1996-97.

| **Stream River Mile** | **Type of Sampling** | **Latitude/Longitude** | **Landmark** | **USGS 7.5 minute Quadrangle Map** |
|---|---|---|---|---|
| ***Blacklick Creek*** | | | | |
| 23.0 | (C) | 40° 03'42"/82° 47'48" | Morse Rd. | New Albany |
| 22.7 | (B) | 40° 03'24"/82° 47'55" | Kitzmiller Rd. | New Albany |
| 22.4 | (F) | 40° 03'09"/82° 48'11" | Morse Rd. | New Albany |
| 20.4 | (B,F) | 40° 01'48"/82° 48'26" | Havens Rd. | New Albany |
| 20.35 | (C) | 40° 01'47"/82° 48'47" | Havens Rd. | New Albany |
| 19.48 | (C) | 40° 01'09"/82° 48'47" | at Havens Corners | New Albany |
| 18.7 | (B) | 40° 00'36"/82° 48'31" | ust. Jefferson Twp. WWTP | New Albany |
| 18.2 | (F) | 40° 00'07"/82° 48'26" | ust. Jefferson Twp. WWTP | New Albany |
| 18.0 | (C,F) | 40° 59'59"/82° 48'24" | dst. Jefferson Twp. WWTP | Reynoldsburg |
| 17.9 | (B) | 39° 59'55"/82° 48'23" | dst. Jefferson Twp. WWTP | Reynoldsburg |
| 16.6 | (B,F) | 39° 53'03"/82° 48'43" | Broad St. | Reynoldsburg |
| 16.5 | (C) | 39° 58'58"/82° 48'45" | Broad St. | Reynoldsburg |
| 15.5 | (C,F,S) | 39° 58'25"/82° 48'43" | adj. Rose Hill Rd. | Reynoldsburg |
| 15.2 | (B) | 39° 58'12"/82° 49'16" | adj. Rose Hill Rd. | Reynoldsburg |
| 11.3 | (B,F) | 39° 55'45"/82° 47'37" | Tussing Rd. | Reynoldsburg |
| 11.25 | (C) | 39° 55'44"/82° 47'33" | Tussing Rd. | Reynoldsburg |
| 11.15 | (E) | 39° 55'41"/82° 47'28" | Fairfield Co.WWTP-001 | Reynoldsburg |
| 11.12 | (C) | 39° 55'40"/82° 47'29" | **Mixing Zone** | Reynoldsburg |
| 11.1 | (B) | 39° 55'39"/82° 47'29" | dst Fairfield Co. WWTP | Reynoldsburg |
| 11.0 | (F) | 39° 55'35"/82° 47'44" | dst Fairfield Co. WWTP | Reynoldsburg |
| 8.9 | (B) | 39° 54'43"/82° 48'31" | Refugee Rd. | Reynoldsburg |
| 8.8 | (C,F) | 39° 54'14"/82° 48'32" | Refugee Rd. | Reynoldsburg |
| 5.6 | (C,B,F) | 39° 53'46"/82°51'30" | ust. Blacklick Est. WWTP | Reynoldsburg |
| 4.85 | (E) | 39° 53'43"/82° 51'32" | Blacklick Est.WWTP-001 | Reynoldsburg |
| 4.8 | (C,B,F) | 39° 53'42"/82° 51'33" | **Mixing Zone** | Reynoldsburg |
| 4.6 | (C,F) | 39° 53'35"/82° 51'40" | Winchester Pike | Reynoldsburg |
| 4.5 | (B) | 39° 53'30"/82° 51'42" | Winchester Pike | Reynoldsburg |
| 1.8 | (C,F) | 39° 52'26"/82° 53'00" | SR 317-Hamilton Rd. | South East Columbus |
| 1.4 | (B) | 39° 52'45"/82° 53'27" | Near Mouth | South East Columbus |
| ***Unnamed Tributary (Joins Blacklick Creek at RM 6.5)*** | | | | |
| 0.5 | (F) | 39° 45'37"/82° 50'06" | Near Mouth | Reynoldsburg |
| ***Unnamed Tributary (Joins Blacklick Creek at RM 10.4)*** | | | | |
| 0.3 | (F) | 39° 55'19"/82° 46'58" | SR 256 | Reynoldsburg |
| ***Unnamed Tributary (Joins Blacklick Creek at RM 11.3)*** | | | | |
| 0.3 | (F) | 39° 55'50"/82° 47'17" | SR 256 | Reynoldsburg |
| ***Unnamed Tributary (Joins Blacklick Creek at RM 12.9)*** | | | | |
| 0.3 | (F) | 39° 56'48"/82° 47'43" | Graham Rd. | Reynoldsburg |
| ***French Run*** | | | | |
| 0.7 | (F) | 39° 57'22"/82° 47'37" | Waggoner Rd. | Reynoldsburg |
| ***North Br. French Run*** | | | | |
| 0.2 | (F) | 39° 57'32"/82° 47'52" | adj. Elementary School | Reynoldsburg |
| ***Unnamed Tributary to Dysar Run*** | | | | |
| 0.1 | (F) | 39° 59'38"/82° 47'10" | Near Mouth | Reynoldsburg |
| ***Swisher Creek*** | | | | |
| 1.3 | (F) | 40° 02'34"/82° 47'15" | Clark State Rd. | New Albany |

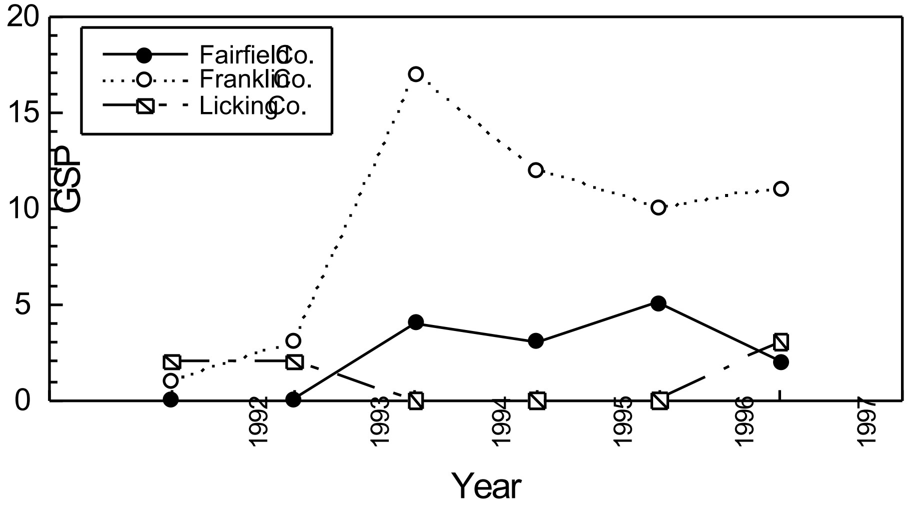


Figure 4. The frequency of General Stormwater Permits (GSP), by county, within the Blacklick Creek watershed, 1992-97.

Since precise land use statistics were not available for the study area, the rate of development was estimated by examining the number of GSPs issued by Ohio EPA, for each county within the Blacklick Creek watershed. A GSP and a storm water management plan is required for construction activity greater than five acres. As measured by the frequency of GSPs, development has increased substantially over the last four years (Figure 4). These activities are most pronounced in the portion of the watershed contained in Franklin County. Within this area the issuance of GSPs have risen from an average of 2.5/year, prior to 1994, to 12.5/year.

Suburban development pressure is one of the most significant, and potentially permanent, threats to the biological integrity of Blacklick Creek. Unlike impacts associated with many traditionally identified pollutants (e.g., poorly treated sewage), where instream recovery proceeds at a fairly rapid pace following successful abatement efforts; the conversion of a watershed to intense suburban/urban land use fundamentally alters, often irretrievably, the hydrologic budget of the catchment. The effect of these modifications cascade throughout the basin, influencing runoff patterns and stream discharge characteristics (Gordon et al. 1992; Novotony and Chesters 1981). The well-drained and impervious nature of an urbanized watershed leads to increased total runoff (and attendant nonpoint source pollution), higher peak discharge, and shorter duration of peak flows. As the ability of the landscape to attenuate and gradually release stormwater is diminished, the critical summer low flows are reduced and the frequency of bankfull flows are disrupted. Both of these discharge characteristics are vital to the physical and biological integrity of surface waters. As stream flows are typically at their lowest between mid-summer and late fall, water of sufficient volume is needed for aquatic life uses and wasteload dilution (from both point and nonpoint sources). The fluvial processes responsible maintenance and formation of a natural and stable low flow channel are mediated by bankfull discharges (typically a 1.5 year event). Increased frequency of these flows may create unstable conditions (e.g., rapid bank erosion and accelerated substrate aggradation and degradation) as the channel configuration is brought into a new equilibrium with the modified "flashy" runoff patterns. These results are not only detrimental to aquatic life (i.e., unstable habitat) but may also be problematic for adjacent human land uses (e.g., severe bank erosion or increased flooding).

The construction work itself can also create significant water quality problems. Uncontrolled runoff from large construction sites can deliver tons of clayey silts to local streams, significantly impairing their ability to support and maintain healthy and diverse communities of aquatic organisms. Additionally, these activities often proceed without regard for the critical function of wooded riparian corridors. Typically, stream side vegetation is either encroached upon or completely removed, affecting bank stability, instream habitat quality, sunlight attenuation, and the natural buffering mechanisms against various adjacent land uses. In addressing local drainage concerns many smaller tributaries are often channelized or enclosed entirely within culverts, converting once viable streams into drainage ways.

Significant relationships have been found between land use intensity and instream biological integrity (Yoder and Rankin 1996; Steedman 1988). Ultimately, the cumulative effects of *traditionally* conceived and implemented land development schemes on the quality of surface water resources are significant and long-term, often leaving the creeks, rivers, and streams of an intensively developed catchment impaired for the foreseeable future.

# 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.

## 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 commnity 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 (1994). 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 1988). 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 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, 1994). 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 in-stream 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 using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates.

### Fish Community Assessment

Fish were sampled using wading or boat method pulsed DC electrofishing gear. The wading method was used at a frequency of one or two samples at each site. The boat method was used at a frequency of two samples at each site.

### 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 1991a; Yoder 1994). 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 1994) 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

### Pollutant Loadings: 1979-1996

Monthly effluent loadings are reported to the Ohio EPA by all NPDES (National Pollutant Discharge Elimination System) permitted entities. Third-quarter (July-September) Monthly Operating Report (MOR) data describe the quantity and character of pollutant loadings through the period of record for each discharger evaluated.

#### *Jefferson Twp.-Wengert Rd. WWTP (Unnamed tributary to Blacklick Creek RM 18.10)*

The Jefferson Water and Sewer District owns and operates the Wengert Rd. WWTP. The facility is located on the south side of Wengert Rd., Jefferson Township, Franklin County Ohio. The facility discharges to an unnamed tributary that joins Blacklick Creek at RM 18.10. The WWTP services various developments within the unincorporated areas of Jefferson Township.

Ohio EPA issued a Permit To Install (PTI) in December 1988 for a 0.180 MGD extended aeration WWTP. The approved plant consisted of a bar screen, comminutor, flow equalization tank, two (2) parallel extended aeration plants, each with an exclusive circular clarifier, rapid sand filter, ultraviolet disinfection system, flow meter, and a cascade (stair-step) aerated discharge. The following year, Ohio EPA issued a water quality based, NPDES discharge permit (4PQ00000/OH0101702) for the WWTP.

Since the 1988, Ohio EPA has been in litigation regarding the issuance of the original PTI. In 1993, Ohio EPA issued an new PTI for the Wengert Rd. facility, based revised discharge criteria. The revised criteria requires a new pollutant source to meet Best Available Demonstrated Control Technology (BADCT) standards. All new municipal WWTPs with direct discharges must incorporate nitrification treatment (ammonia removal) to meet ammonia limitations of 1.0 mg/1 average-summer and 3.0 mg/l average winter. In June of 1995 a renewal NPDES discharge permit was issued which incorporated the BADCT standards for ammonia. As of March 1998, the revised PTI for the Wengert plant is still in litigation.

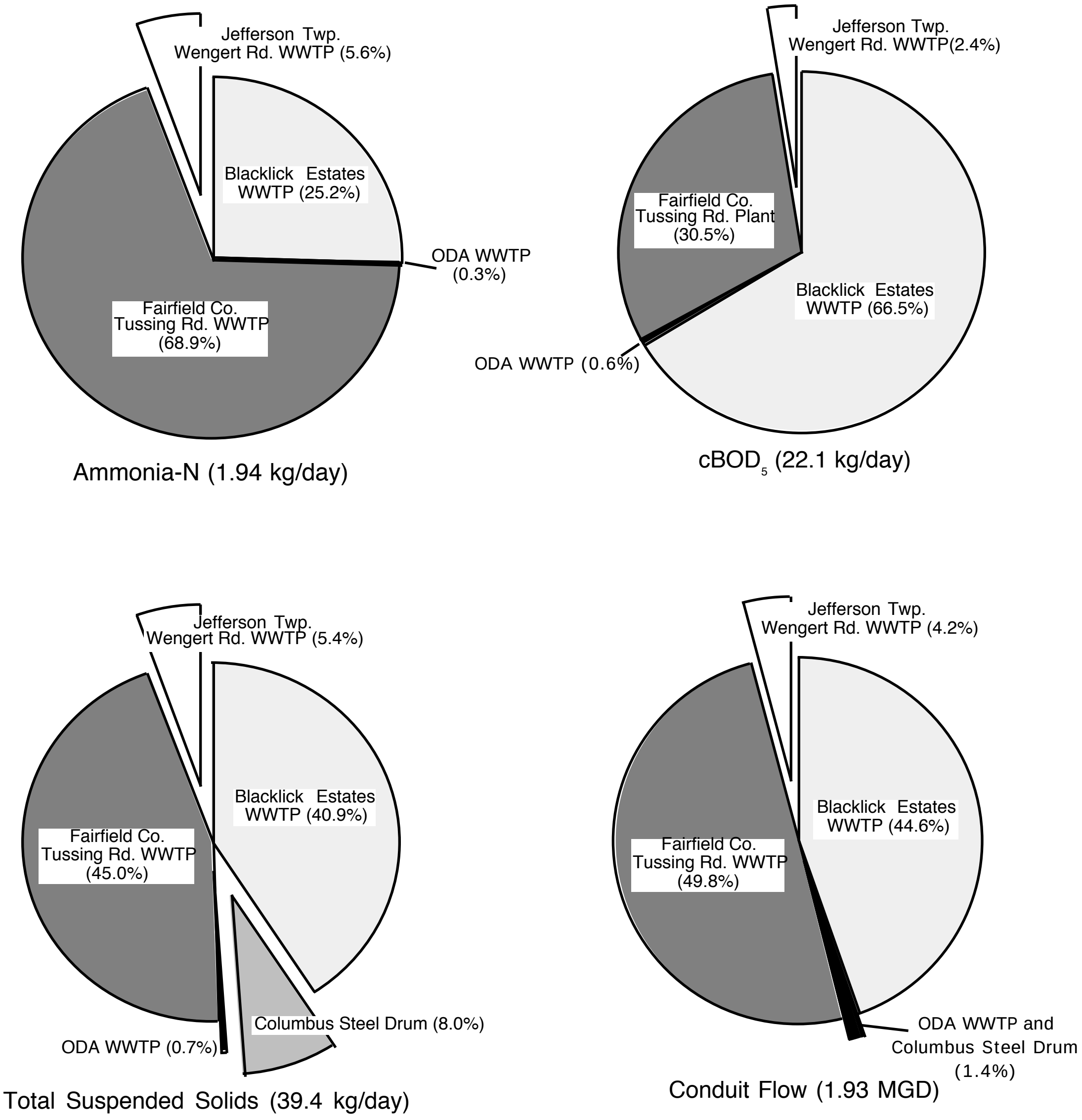
This facility contributes less than 5% of the wastewater flow and loadings of $cBOD_5$, ammonia-N, and TSS to Blacklick Creek (Figure 5). Generally, flow and loadings of $cBOD_5$, ammonia-N, and TSS have been increasing at the plant since 1990. The facility contributes less than 6% to the aggregate BOD, TSS, and ammonia-N load within the Blacklick Creek basin. Pollutant loads and conduit flow through the period of record are presented in Figure 6.

### *Fairfield Co.-Tussing Rd. WWTP (Blacklick Creek RM 11.15)*

The Tussing Rd. WWTP is owned and operated by the Fairfield County Commissioners. The facility is located at 10955 Tussing Rd, Pickerington, Fairfield County, Ohio. The facility discharges directly to Blacklick Creek at RM 11.15.

From 1975 to 1987, the Public Service Corporation (PSC) owned and operated the WWTP. PSC was a private utility company providing service to homes, businesses, a school, and a nursing home in the northwest corner of Fairfield County. During PSC's ownership, the WWTP went through various expansions. In 1974, Ohio EPA issued a plan approval for a phased construction of a 0.55 MGD wastewater treatment plant. The initial NPDES permit was issued to PSC in June, 1979 (permit 4PU00004/OH0054305). By 1987, the construction of the initial 0.110 MGD WWTP and two plant expansions (increases to 0.220 MGD and final to 0.460 MGD) were approved by Ohio EPA. These expansions included additional aeration tanks, final clarifiers, increased sludge management facilities (tanks and drying beds), and disinfection facilities.

In September of 1987, the Fairfield County Commissioners purchased the WWTP from PSC and renamed it the Tussing Rd. Water Reclamation Facility. From that point, the Commissioners began a program of improvements at the WWTP to meet permit limitations and conditions and to keep pace with the growth in the area. Starting in 1988, Ohio EPA issued various PTIs for plant upgrades and expansions. The design flow of the WWTP went from 0.460 MGD to 2.0 MGD under three separate expansions. In 1988, the Ohio EPA approved an expansion to 1.0 MGD. In November of 1990, the Commissioners were issued an approval to expand plant capacity to 1.4 MGD. In 1994, Ohio EPA approval was given for a 2.0 MGD plant expansion. This would allow for the eventual abandonment of the other smaller WWTPs operated by Fairfield County. These facilities include Easton Village, New England Acres and Chevington Woods. Since the expansion, only the Chevington Woods WWTP has been abandoned.



Ammonia-N (1.94 kg/day)

$cBOD_5$ (22.1 kg/day)

Total Suspended Solids (39.4 kg/day)

Conduit Flow (1.93 MGD)

Figure 5. Relative contribution to average third-quarter loadings (kg/day) and conduit flow (MGD), by entity, to Blacklick Creek, 1996.

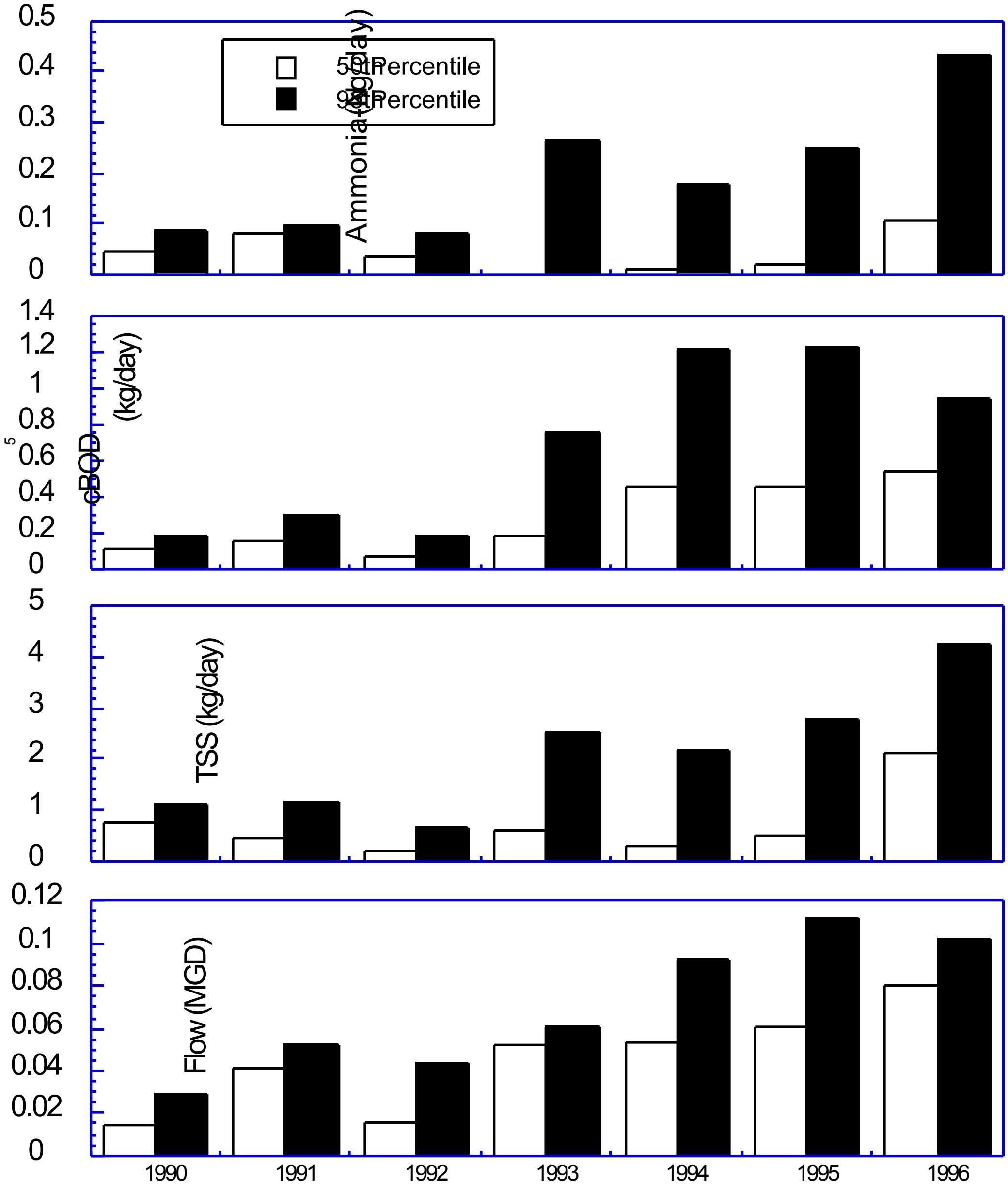


Figure 6. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Ammonia-Nitrogen ($NH_3$-N), five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$), and Total Suspended Solids (TSS) from the Jefferson Twp.-Wengert Rd. WWTP, 1990 through 1996.

The plant modifications from 1988 to 1994 included improving preliminary treatment systems, air handling systems, secondary clarification, and the sludge management system, and a change in the disinfection systems. Currently, the WWTP consists of an influent lift station, mechanical bar screen, aeration tanks, secondary clarification, and ultraviolet disinfection. Sludge is managed by aerobic digestion, dewatering by belt press, and a storage pad. Ultimate disposal is by land application.

In 1987, Ohio EPA issued a renewal discharge permit which required seasonal effluent limitations for ammonia-nitrogen (2.0 mg/l average-summer and 6.0 mg/l average-winter) , and minimum D.O. concentration for the final effluent. In a 1994 permit modification for the expansion to 2.0 MGD, effluent limitations for ammonia-nitrogen were reduced to 1.3 mg/l average-summer and 4.8 mg/l average-winter, with a minimum D.O. level of 7.0 mg/l for the summer and 5.0 mg/l for the winter.

In 1996, the Tussing Rd. WWTP accounted for nearly half of the point source flow to Blacklick Creek, including approximately 69% of the ammonia-N, 31% of the $cBOD_5$, and 45% of the TSS loadings (Figure 5). Based upon the MOR pollutant loadings information, flow has steadily increased since 1979. Median and 95th percentile discharge typically remained below various design flows. Erratic 95th percentiles values were indicated in 1992 and 1995 only. Annual third-quarter loads of $BOD_5/cBOD_5$ and TSS were erratic and displayed no discernable pattern through the period of record. Peak BOD loads were observed in 1985, 1986, and 1991. Peak TSS loads occurred in 1987 and 1995. Median ammonia-N loads were markedly reduced after 1988, despite variable and often elevated 95th percentiles. After 1988, peak ammonia-N loads were recorded in 1990, 1995, and 1996. Third-quarter loading of nitrate+nitrite-N appeared inversely related to ammonia-N loads. As nitrates are the end product of nitrification, this relationship is typically observed at WWTPs employing advanced treatment, and thus expected. Third-quarter pollutant loads and conduit flow through the period of record are presented in Figure 7.

Compliance history of the Tussing Rd. WWTP between 1992 and 1996 revealed few permit violations for most years. However, 1995 was anomalous as 34 permit violations were indicated. The most frequently exceeded parameters in 1995 were ammonia-N (22 violations) and TSS (8 violations). Many of these violations were associated with construction activities in support of improvements at the WWTP during this time. These permit exceedences corresponded well with peak loadings of ammonia-N and TSS during the third-quarter of 1995.

Ambient and effluent samples collected on July 22, 1996 indicated a plant upset. Concentrations of demand parameters (BOD, COD), TSS, oil and grease, and nutrients (phosphorus, TKN) were all well above permitted effluent values. Additionally, fecal coliform bacteria counts were depressed, in comparison with other samples, suggesting possible toxicity in the effluent.

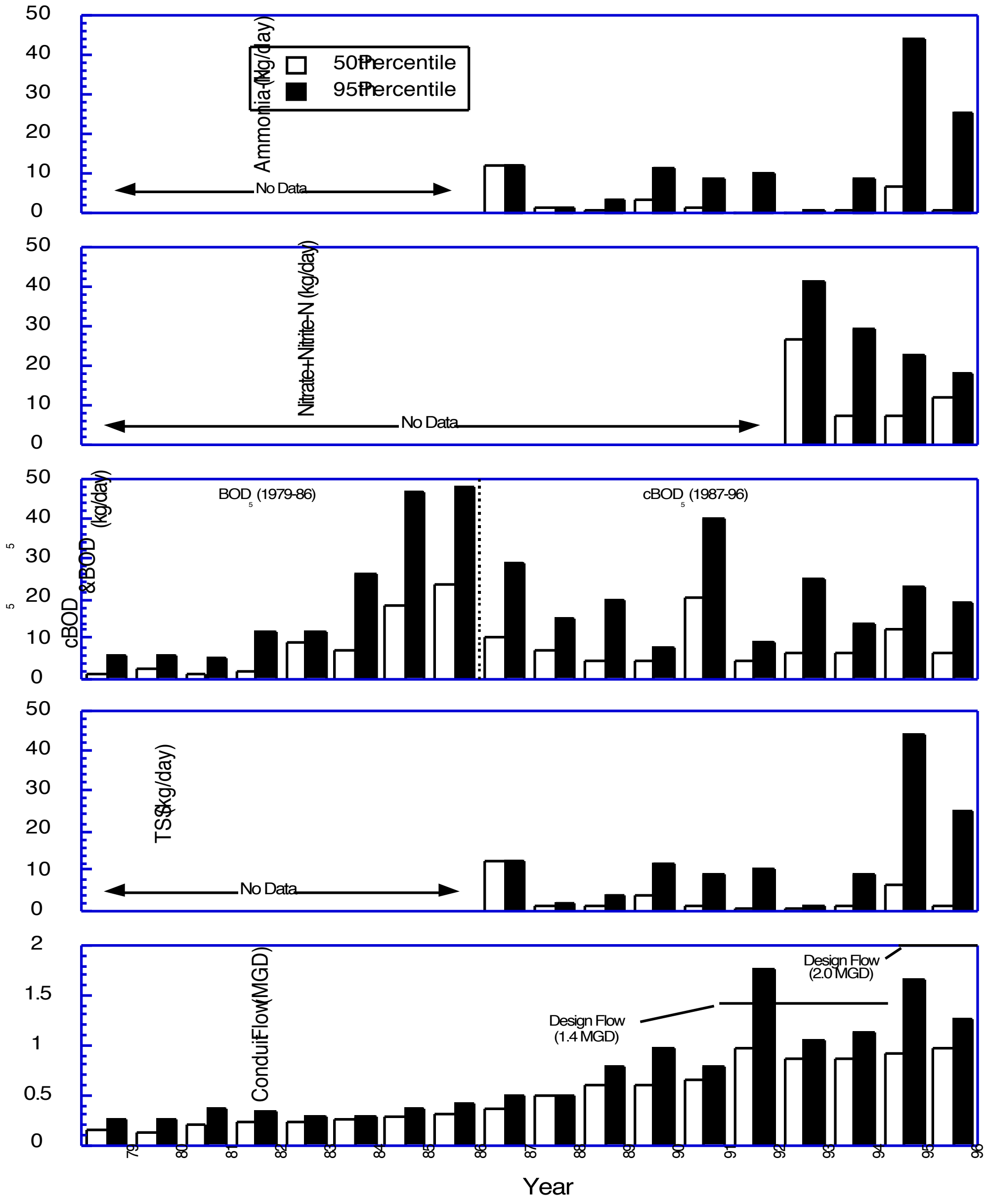


Figure 7. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Ammonia-Nitrogen ($NH_3$-N), Nitrate+Nitrite-Nitrogen ($NO_3$+$NO_2$-N), Biochemical Oxygen Demand ($BOD_5$ and $cBOD_5$), and Total Suspended Solids (TSS) from the Fairfield Co. Tussing Rd. WWTP, 1979 through 1996.

Samples taken downstream from the outfall, indicated impacts to the chemical water quality of Blacklick Creek, including elevated BOD, TSS, and total phosphorus. All other effluent and downstream samples taken at different times during the summer showed expected concentrations of these analytes. The apparent plant upset seemed to be an isolated event with an unknown cause and frequency. An investigation into the cause(s) of this problem is warranted.

Effluent bioassays generated by the Tussing Rd. WWTP showed some toxicity in 1996 (Table 5). Both chronic and acute toxicity effects were observed in *Ceriodaphnia* tests, and chronic effects in the fathead minnow (*Pimephales promelas*) tests. Historical bioassays also indicated chronic and acute effluent toxicity in *Ceriodaphnia* tests and limited acute toxicity to fathead minnows. Bioassay data generated by Ohio EPA in 1996 did not show an acute effect on either organism (Table 6). The data generated by the facility would suggest intermittent toxicity that may correlate with the treatment irregularity recorded on July 22, 1996.

Table 5. Acute ($TU_a$) and chronic ($TU_c$) bioassay results from the Tussing Rd. WWTP 1994-1996 (all data generated by the facility).

| ***Tussing Rd.WWTP, Entity Bioassay Test Results*** | | | |
|---|---|---|---|
| **Entity Test Date** | **Organism (chronic effect)** | **$TU_a$ Effluent** | **$TU_c$ Effluent** |
| 4/18/94 | Ceriodaphnia (reproduction) | NA | 4.20 |
| 4/18/94 | Ceriodaphnia (survival) | NA | 1.50 |
| 5/16/94 | Fathead minnow | 1.41 | NA |
| 7/12/94 | Ceriodaphnia | 1.36 | NA |
| 6/28/96 | Fathead minnow (reproduction) | NA | 1.0 |
| 6/28/96 | Fathead minnow (reproduction) | NA | 1.0 |
| 8/11/96 | Ceriodaphnia | 3.80 | NA |
| 8/11/96 | Ceriodaphnia (both*) | NA | 3.50 |
| 8/11/97 | Ceriodaphnia (both*) | NA | 3.50 |

NA = Not applicable, * = Both survival and reproduction
$TU_a$ = Acute toxic units, $TU_c$ = Chronic toxic units

Table 6. Acute bioassay results from the Tussing Rd. WWTP 1996 (all data generated by Ohio EPA).

| ***Tussing Rd. WWTP, Ohio EPA Bioassay Testing Results*** | | | | |
|---|---|---|---|---|
| **Ohio EPA Testing Date** | **Ceriodaphnia Percent Affected** | | **Fathead Minnow Percent Affected** | |
| | **Upstream** | **Near Field** | **Upstream** | **Near Field** |
| 7/8/96 | 0 | 0 | 0 | 0 |
| 9/16/96 | 0 | 0 | 0 | 0 |

### *Blacklick Estates WWTP (Blacklick Creek RM 4.85)*

The Blacklick Estates WWTP is currently owned and operated by the Citizens Utilities Company of Ohio. The facility is located at 4010 Signal Road, Madison Township, Franklin County, Ohio. Final effluent is discharged directly to Blacklick Creek at RM 4.85. The original facility was constructed around 1960 and consisted of a comminutor, lift station, extended aeration tanks, secondary clarifiers, chlorination tank and sludge holding facilities. Despite a design flow of 1.2 MGD, the WWTP experienced numerous permit violations due in part to significant inflow and infiltration problems in the collection system.

In 1986, Director's Final Findings and Orders (DFFOs) and a short-term NPDES renewal permit were issued to the Ohio Utilities Company (owners at the time) for the facility. The WWTP was out of compliance with its previous NPDES permit, and the DFFOs were issued to require improvements be made at the facility.

In May of 1988, a renewal NPDES permit and DFFOs were issued. As a result, a General Plan for wastewater treatment plant improvements was submitted and subsequently approved in December of 1989. To settle litigation regarding the NPDES permit, effluent limitations were adjusted in April of 1990.

In September of 1990, US EPA issued Findings of Violations and Orders for Compliance regarding the Blacklick Estates WWTP. By January of 1991, Ohio EPA issued a PTI for the construction of two additional secondary clarifiers and a chlorination, dechlorination and post aeration tank system. The submittal of the PTI application was a result of requirements listed in DFFOs, issued along with the renewal NPDES permit in 1988, to meet new effluent limitations.

In July 1993, a renewal NPDES permit was issued. Also, in March 1993, Ohio Utilities Company and US EPA entered into a Consent Order due to past NPDES permit violations. The consent order required additional improvements be made to the WWTP.

In September 1994, Ohio EPA issued a PTI for major improvements to the Blacklick Estates WWTP. These improvements included the installation of new influent pumps, fine screens and aerated grit removal, modifications to the aeration system, the addition of two (2) secondary clarifiers, modifications to return sludge pumps, and chlorine control for *Nocardia sp.* and filamentous bacteria. The modifications to the aeration system included changes to the treatment configuration from plug flow to step feed, upgrades of the air diffuser system and the installation of ringlace media to enhance treatment capabilities. Construction of these improvements was completed in late 1995.

Blacklick Estates WWTP contributes approximately 45% of the wastewater flow reaching Blacklick Creek. The plant contributes approximately 25% of the ammonia-N, 67% of the total $cBOD_5$, and 41% of the TSS loads to Blacklick Creek (Figure 5). Since 1982, treatment has improved considerably at the Blacklick Estates WWTP. While flow has remained relatively consistent, loadings of ammonia-N have decreased considerably since the 1984 peak. The load of oxygen demanding wastes (BOD/cBOD), while erratic, has shown a decreasing trend. Total suspended solids loads have also decreased. Loadings of nitrate+nitrite-N (from improved nitrification) and total phosphorus have increased. Third-quarter pollutant loads and conduit flow through the period of record are presented in Figures 8 and 9.

The decrease in some pollutant loadings may also be reflected in bioassay results. Historical (1993) bioassay results from the entity show considerable acute and chronic toxicity to *Ceriodaphnia* for both survival and reproduction. Ohio EPA bioassay test results generated from 1996 data indicated that effluent from the Blacklick Estates WWTP was not acutely toxic to the fathead minnow, *Pimephales promelas* and only slightly toxic to *Ceriodaphnia dubia* (Table 7 and 8).

Table 7. Acute ($TU_a$) and chronic ($TU_c$) bioassay results from the Blacklick Estates WWTP 1993 (all data generated by the facility).

| ***Blacklick Estates WWTP, Entity Bioassay Test Results*** | | | |
|---|---|---|---|
| **Entity Test Date** | **Organism** | **$TU_a$ Effluent** | **$TU_c$ Effluent** |
| 8/4/93 | Ceriodaphnia (survival) | 3.51 | 2.80 |
| 8/4/93 | Ceriodaphnia (reproduction) | NA | 5.70 |
| NA = Not applicable | | | |

Table 8. Acute bioassay results from the Blacklick Estates WWTP 1996 (all data generated by Ohio EPA).

| ***Blacklick Estates WWTP, Ohio EPA Bioassay Testing Results*** | | | | |
|---|---|---|---|---|
| | **Ceriodaphnia** | | **Fathead Minnow** | |
| | **Percent Affected** | | **Percent Affected** | |
| **Ohio EPA Testing Date** | **Upstream** | **Near Field** | **Upstream** | **Near Field** |
| 6/3/96 | 0 | 0 | 0 | 0 |
| 8/12/96 | 0 | 5 | 0 | 0 |

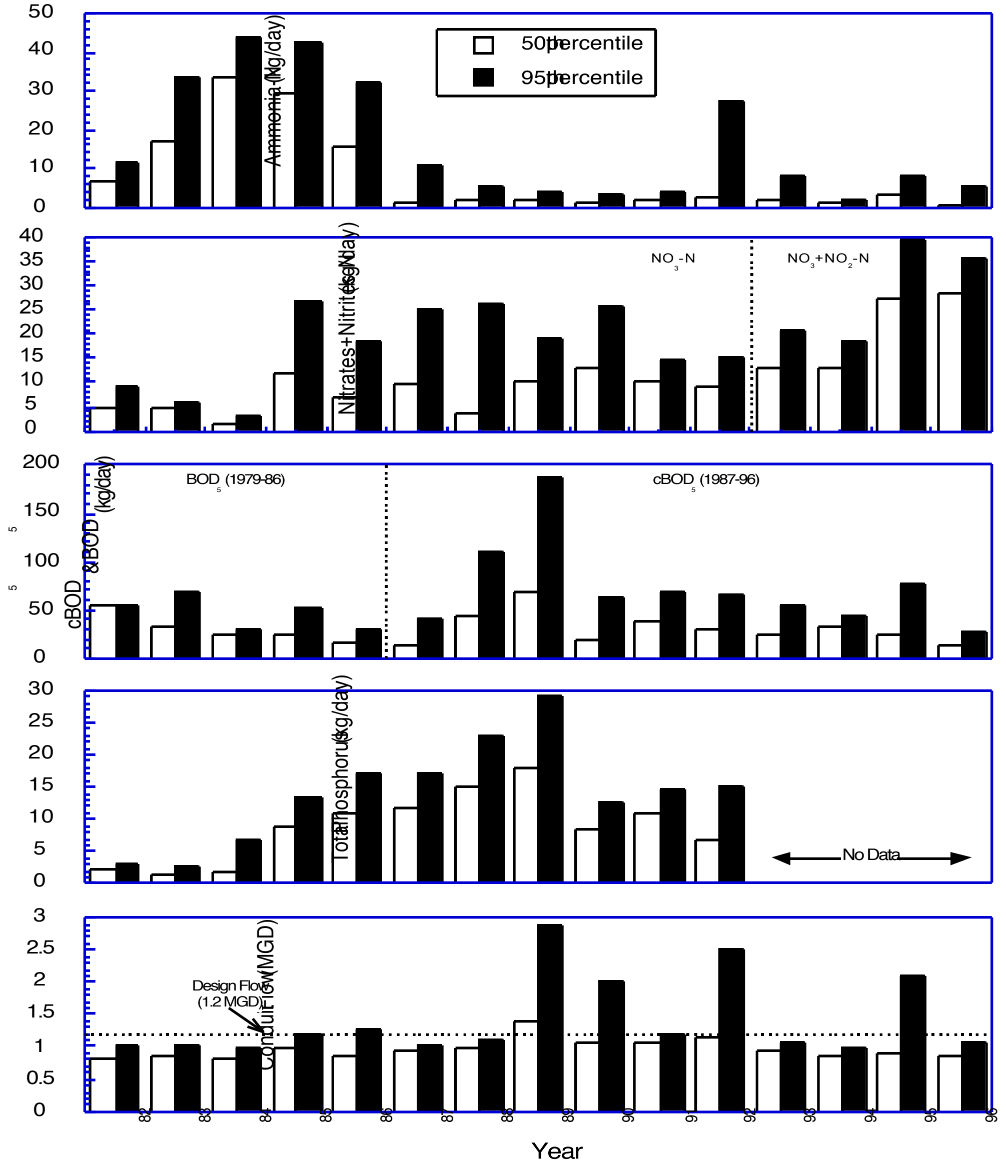


Figure 8. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Ammonia-Nitrogen ($NH_3$-N), Nitrate+Nitrite-Nitrogen ($NO_3$+$NO_2$-N), Biochemical Oxygen Demand ($BOD_5$ and $cBOD_5$), and Total Phosphorus from the Blacklick Estates WWTP, 1982 through 1996.

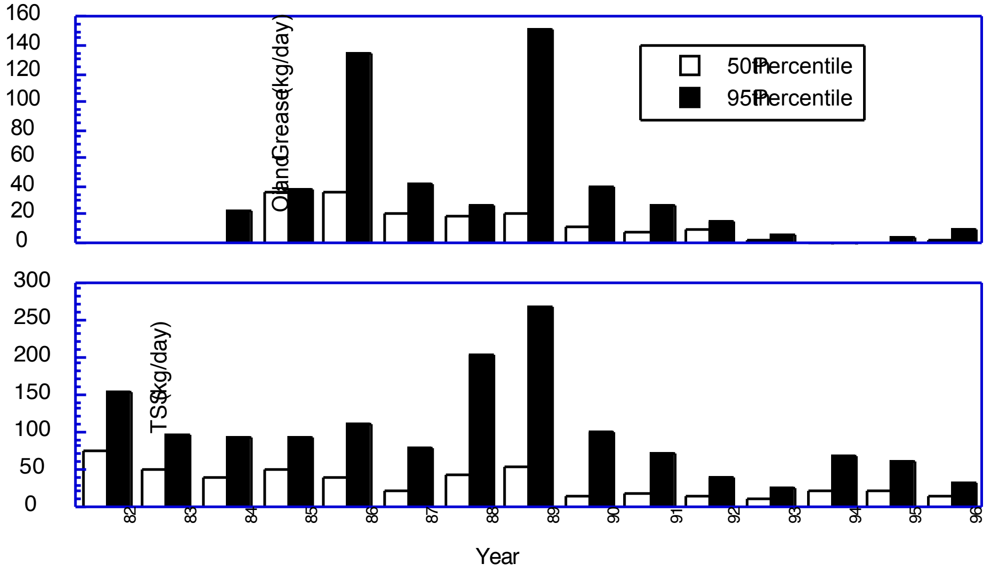


Figure 9. Third-quarter median and 95th percentile and pollutant loads (kg/day) of Oil and Grease and Total Suspended Solids (TSS) from the Blacklick Estates WWTP, 1982 through 1996.

### *Columbus Steel Drum Company (Unnamed tributary to Blacklick Creek RM 17.8)*

Columbus Steel Drum, located in Blacklick Ohio, reconditions and recycles 55-gallon steel drums. The facility process includes heat oxidation, stripping, caustic washing, shot blasting, and painting. The facility's effluent is primarily stormwater runoff and thus rainfall dependent. The receiving stream is an unnamed tributary of Blacklick Creek, that joins the mainstem at RM 17.8. Third-quarter pollutant loads and conduit flow through the period of record are presented in Figures 10 and 11.

### *Ohio Department of Agriculture (Unnamed tributary network to Blacklick Creek RM 11.3)*

This facility was constructed in 1976 in Reynoldsburg, Ohio. The treatment process includes extended aeration, clarification, sand filtration, sludge holding, and chlorination with a design flow of 0.088 MGD. Final effluent is discharged to an unnamed tributary of Blacklick Creek that joins the mainstem at RM 11.3. Third-quarter pollutant loads and conduit flow through the period of record are presented in Figure 12. As of April 3, 1997 this facility was connected to the Reynoldsburg sanitary sewers system, eliminating its direct discharge.

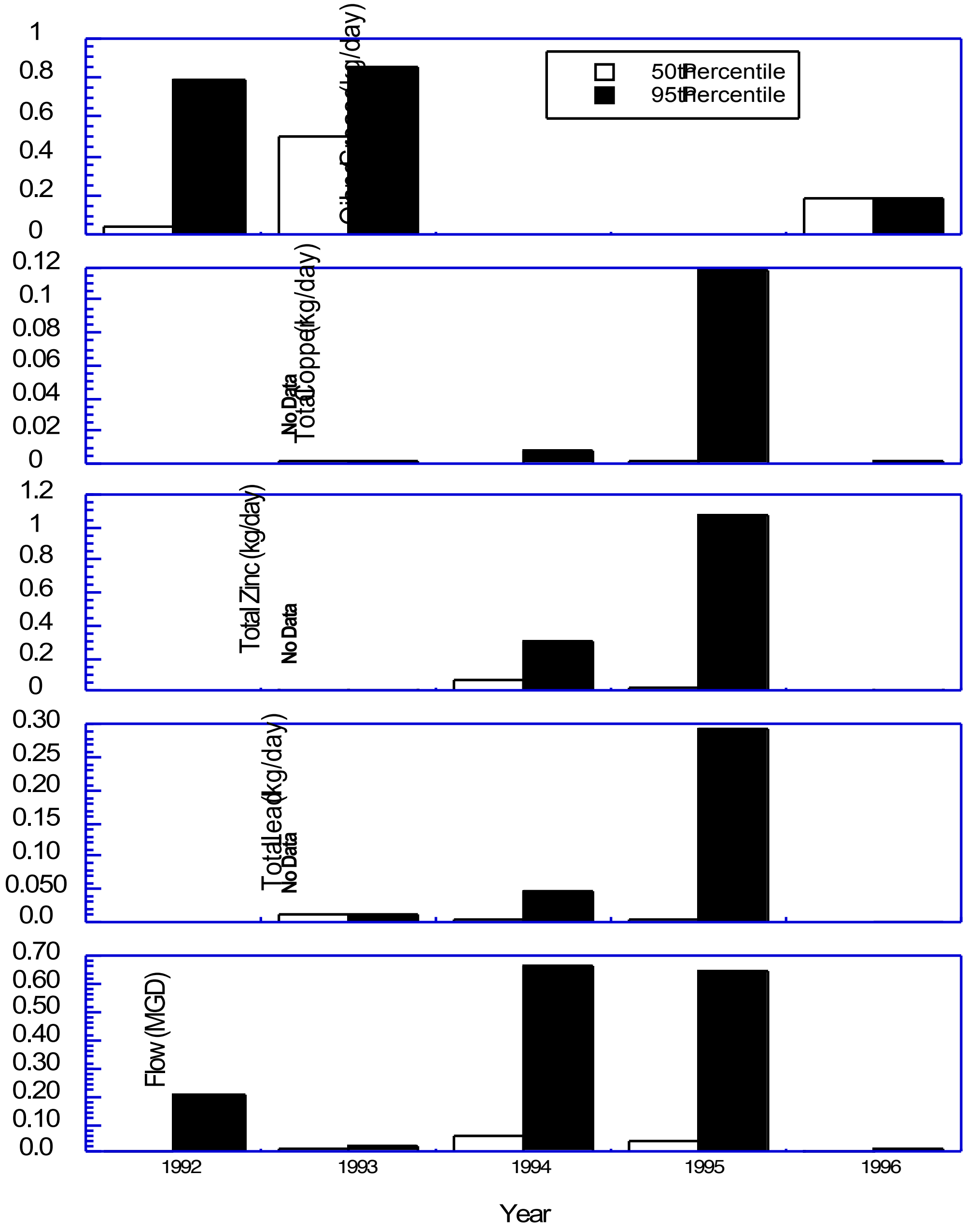


Figure 10. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Oil and Grease, Total Copper, Total Lead, and Total Zinc from Columbus Steel Drum, 1992 through 1996.

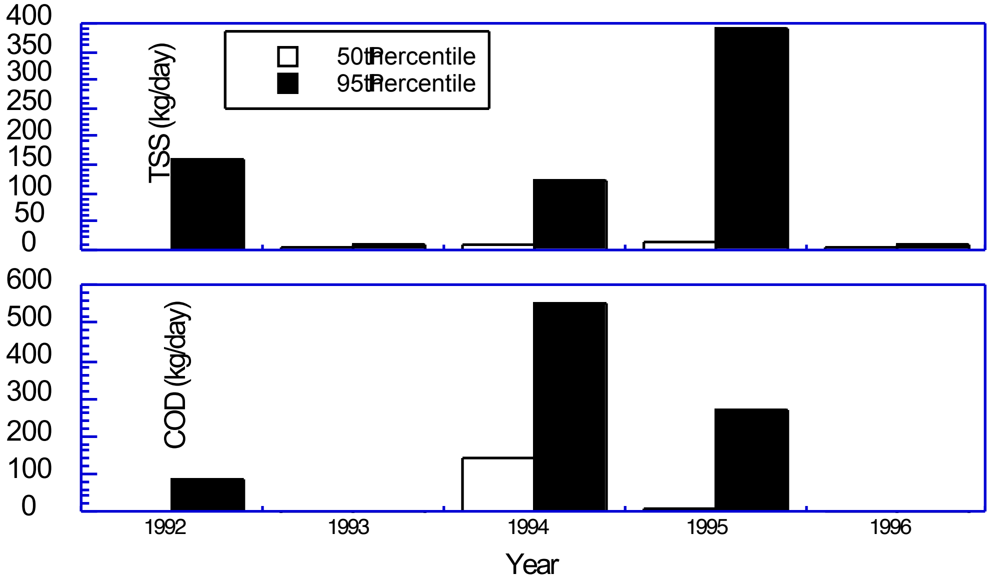


Figure 11. Third-quarter median and 95th percentile pollutant loads (kg/day) of Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) from Columbus Steel Drum, 1992 through 1996.

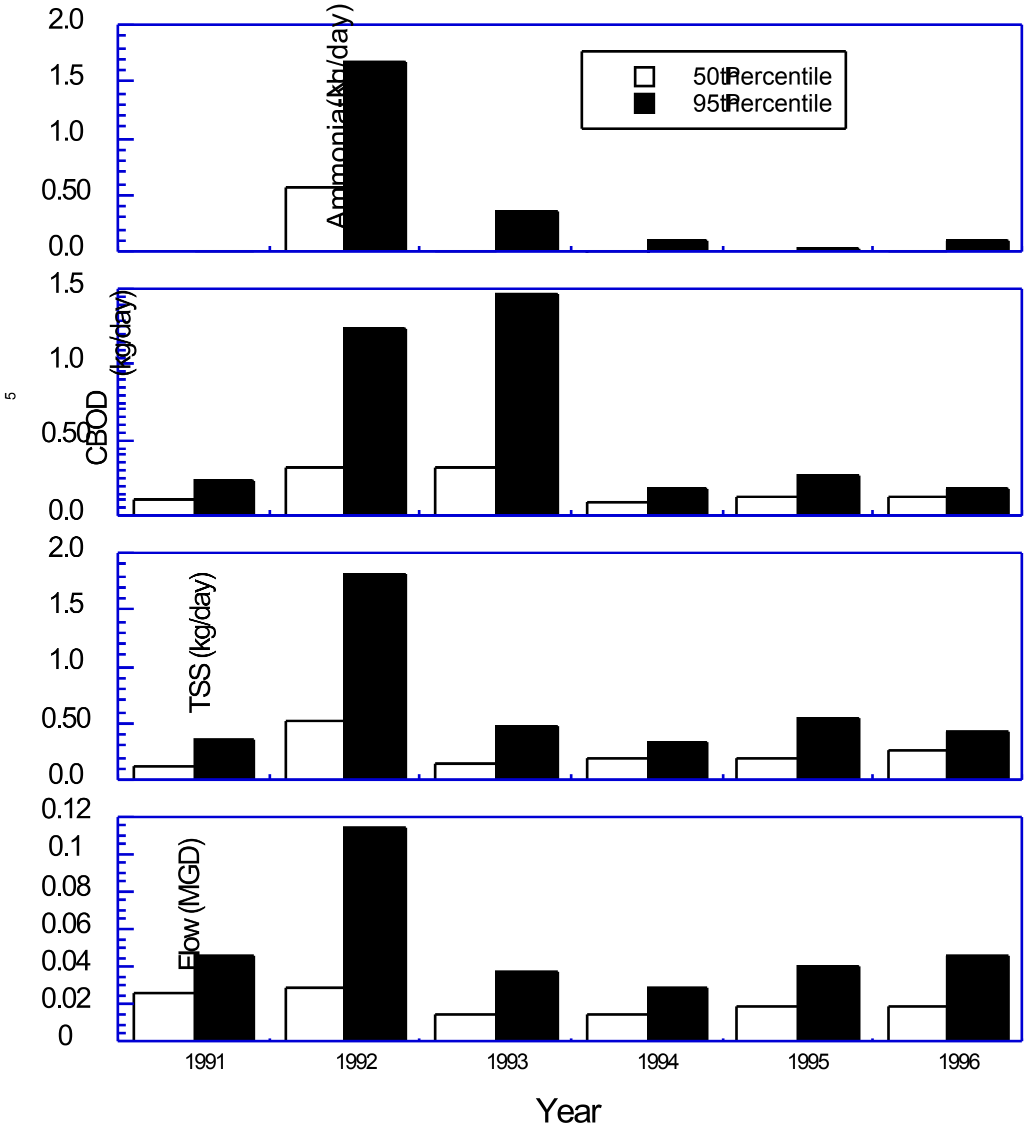


Figure 12. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Ammonia-N ($NH_3$-N), five-day Biochemical Oxygen Demand ($cBOD_5$) and Total Suspended Solids (TSS) from the Ohio Department of Agriculture WWTP, 1991 through 1996.

### ***Lenox Inn (Unnamed tributary RM 0.35 to Blacklick Creek RM 11.84)***

Located in Reynoldsburg, the Lenox Inn operates a package sewage treatment plant. The process includes activated sludge, sand filtration and chlorination; the design flow is 0.05 MGD. Final effluent is discharged to an unnamed tributary of Blacklick Creek that joins the mainstem at RM 11.84. This plant will soon be abandoned, as the area is scheduled to be sewered.

### *Pollutant Spills and Wild Animal Kills*

Only one spill event was noted on Blacklick Creek during the 1996 survey. Within the headwaters near RM 27.7, animal wastes were land applied to adjacent agricultural fields. Following heavy rains in mid-August, manure laden runoff drained to Blacklick Creek via the field tiles. Three to four miles of Blacklick Creek were affected over a four-day period. However, no fish or wildlife kill was reported (Ohio DNR 1996). The landowner was informed of the problem and instructed on proper techniques for the land application of animal wastes to avoid this problem in the future.

## Chemical Water Quality

Between July and September 1996, four to five water grab samples were taken at 15 Blacklick Creek monitoring sites. This effort included 11 ambient, two mixing zone, and two effluent stations. Samples were collected, preserved, and analyzed for a variety of pollutants following the protocols specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 1989). Analytical results for the field and laboratory parameters are presented in Appendix Table A. Longitudinal concentrations of these data are presented in Figures 13 and 14.

Sampling stations were selected to provide information concerning ambient and effluent water quality, and to assess impacts, if any, from major municipal, minor municipal, and industrial dischargers to Blacklick Creek. Ambient results were evaluated to determine instantaneous exceedences of criteria in the Ohio Water Quality Standards (OAC 3745-1). Exceedences were based on Warmwater Habitat (WWH) and Exceptional Warmwater Habitat (EWH) aquatic life, Primary Contact Recreation (PCR), and Agricultural and Industrial Water Supply (AWS and IWS) beneficial use designations where applicable.

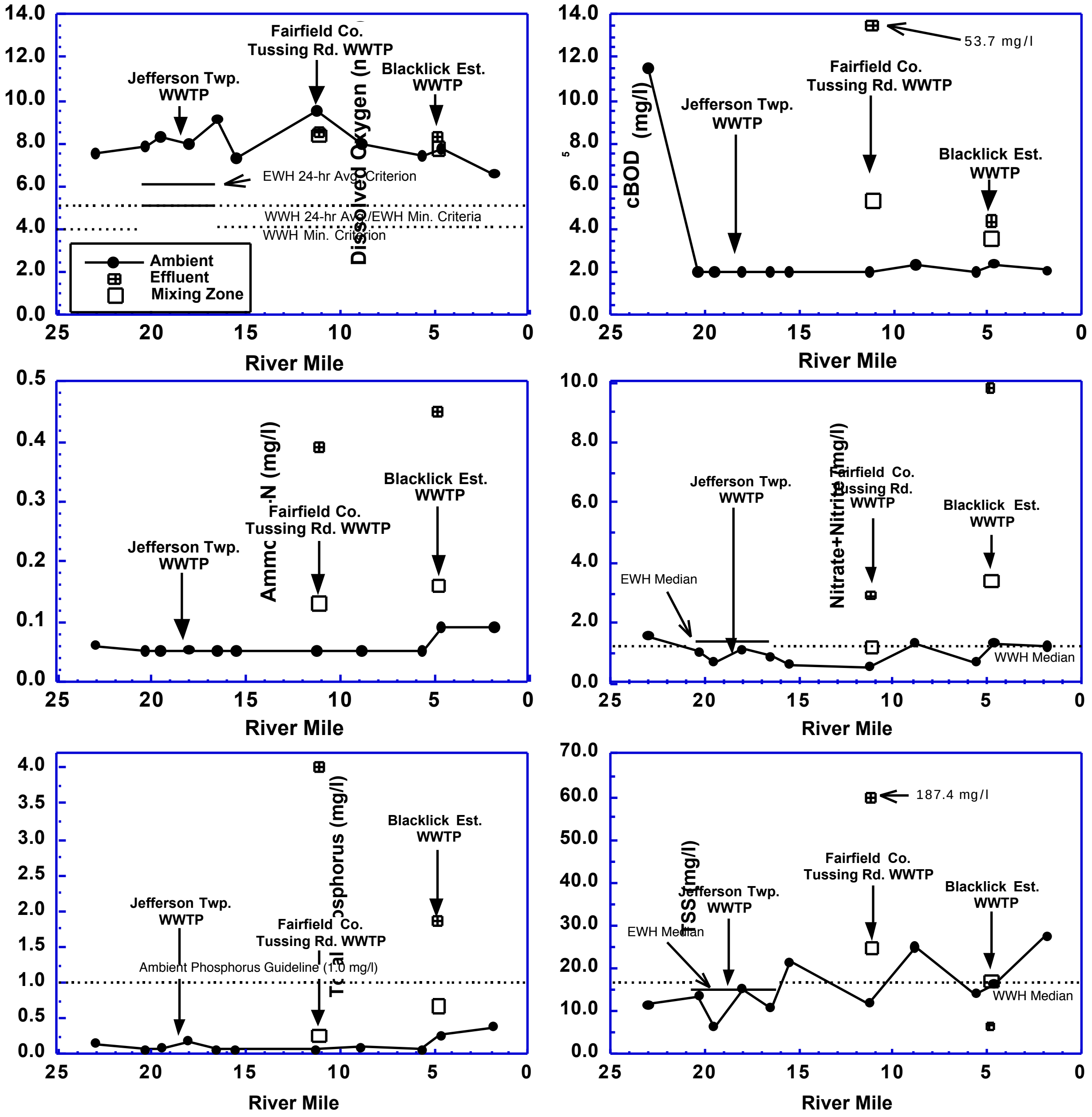


Figure 13.Mean longitudinal concentrations of Dissolved Oxygen, Ammonia-Nitrogen, Nitrate+ Nitrite-Nitrogen, five-day carbonaceous Biochemical Oxygen Demand (cBOD$_5$), Total Phosphorus, and Total Suspended Solids (TSS) from Blacklick Creek, 1996.

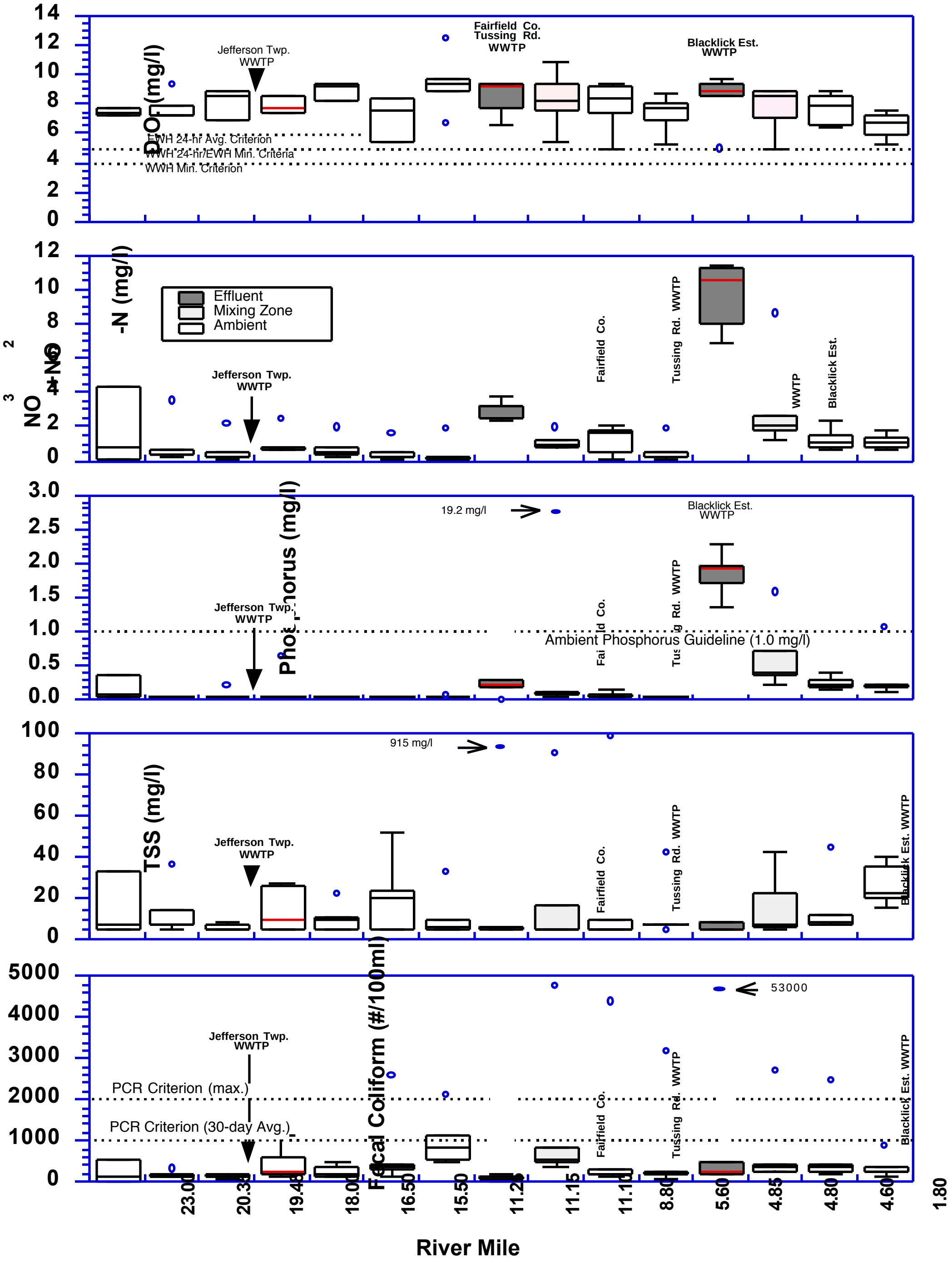


Figure 14. Box plots of Dissolved Oxygen (D.O), Nitrate+Nitrite-Nitrogen, Total Phosphorus, Total Suspended Solids (TSS), and Fecal Coliform from all day-time chemical sampling stations in the Blacklick Creek study area, 1996.

Fecal coliform counts greater than the maximum PCR criterion of 2000 colonies/100 ml were the most frequent exceedences observed in 1996. Low to moderate fecal coliform contamination was found along the length of Blacklick Creek between RM 18.00 and RM 4.60. Most occurred on the same date in late July (July 22, 1996), following heavy rains and the attendant elevated stream flows. The fecal coliform contamination likely emanated from diffuse urban and rural nonpoint sources which are typically the most active during wet weather periods.

Mean nutrient concentrations typically remained within normal ranges during the study. In most cases, nitrate+nitrite-N and total phosphorus concentrations were at or below the median value for wadeable WWH streams in the ECBP ecoregion (Ohio EPA 1996). Nitrate+nitrite-N concentrations were above the WWH median at RM 23.00 and downstream from both the Fairfield Co. and Blacklick Estates WWTPs. Ambient phosphorus concentrations were also elevated downstream from these facilities.

Mean TSS concentrations exhibited small fluctuations around the median for wadeable WWH and EWH streams in the ECBP ecoregion (Ohio EPA 1996). Longitudinally, mean $cBOD_5$ peaked at RM 23.0 (headwaters) and downstream from both the Fairfield Co. Tussing Rd. and the Blacklick Estates WWTPs. Elevated oxygen demand in the headwaters was likely related to manure laden runoff.

Water column metal contamination appeared low throughout Blacklick Creek. Arsenic, cadmium, chromium, copper, lead, nickel, and zinc were either not detected or detected at very low concentrations. In only one instance (RM 4.60) did copper and nickel exceed WQS (Table 9); the source was not immediately evident.

Ultimately, pollutant loads from the major and minor WWTPs--including the Tussing Rd. plant upset in late July--did not appear to negatively impact the chemical water quality of Blacklick Creek. Inputs of nutrients, solids, and oxygen demanding wastes appeared safely assimilated as day-time D.O. concentrations remained well above the minimum and average WWH or EWH criteria. Additionally, the level of fecal coliform contamination was by no means severe and did not appear to pose a significant threat to the PCR use designation.

Table 9. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the Blacklick Creek study area, 1996.

| ***Stream*** | **River Mile** | **Exceedence: Parameter (value)** |
|---|---|---|
| ***Blacklick Creek*** | | |
| | **EWH Use Designation-Existing/WWH-Recommended** | |
| *Jefferson Twp.-Wengert Rd. WWTP (RM 18.1)* | | |
| | 18.0 | Fecal Coliform (1130)◊ |
| | **WWH Use Designation-Existing** | |
| | 15.50 | Fecal Coliform (2600)◊◊ |
| | 11.25 | Fecal Coliform (2100)◊◊ (1120)◊ |
| *Fairfield Co.-Tussing Rd. WWTP (RM 11.15)* | | |
| | 8.80 | Fecal Coliform (4800)◊◊ |
| | 5.60 | Fecal Coliform (3200)◊◊ |
| *Blacklick Estates WWTP (RM 4.85)* | | |
| | 4.60 | Fecal Coliform (2500)◊◊<br>Nickel (161)*<br>Copper (66)** |
| | 1.80 | Phosphorus (1.07)† |

* - exceedence of the numerical criteria for the prevention of chronic toxicity [Chronic Aquatic Conc. (CAC)]

** - exceedence of the numerical criteria for the prevention of acute toxicity [Acute Aquatic Conc. (AAC)]

† - exceedence of the WWH phosphorus guideline (1.0 mg/l)

◊ - exceedence of the average Primary Contact Recreation criterion (fecal coliform 1000/100 ml)

◊ ◊ - exceedence of the maximum Primary Contact Recreation criterion (fecal coliform 2000/100 ml)

◊ ◊ ◊ - exceedence of the Secondary Contact Recreation criterion (fecal coliform 5000/100 ml)

## Sediment Chemistry

A single location (RM 15.50) was sampled to determine sediment burdens of organic compounds and heavy metals. Sediments contained PAHs and the plasticizer bis (2-ethylhexyl) phthalate. The PAHs were found at concentrations greater than the Lowest Effect Level (LEL) (Table 10). Metals values included *extremely elevated* cadmium, *highly elevated* arsenic, *elevated* iron and zinc, and *slightly elevated* chromium and nickel (Table 10). The source of these contaminants would include: Columbus Steel Drum (all), airborne deposition (mercury), and historical agricultural pesticide application (arsenic).

Table 10. Concentration of metals and organic contamination in the sediments of Blacklick Creek, 1996. All metals concentrations are ranked according to the guidelines developed by Ohio EPA (1996). Organic contaminants are ranked according to Persaud et al. (1993). Sediment concentrations are reported in mg/kg unless otherwise noted.

| **Blacklick Creek River (RM 15.50)** | | | |
|---|---|---|---|
| **Parameter (Metals)** | **mg/kg** | **Parameter (Organic)** | **mg/kg** |
| Arsenic | **22.3**[d] | Benzo-a-anthracene | *0.7*[#] |
| Cadmium | **1.86**[e] | Benzo-a-pyrene | *0.8*[#] |
| Chromium | *26*[b] | Benzo-b-fluoranthene | *1.0*[#] |
| Copper | 16[a] | Benzo-g-h-i perylene | *0.8*[#] |
| Iron | 29800[c] | Benzo-k-fluoranthene | *0.8*[#] |
| Lead | 37[a] | bis(2-Ethylhexyl)phthalate* | 1.5 |
| Mercury* | 0.045 | Chrysene | *1.2*[#] |
| Nickel | *35*[b] | Fluoranthene | *2.5*[#] |
| Zinc | 209 | Indeno[1,2,3-cd] pyrene | *0.8*[#] |
| | | Phenanthrene | *1.1*[#] |
| | | Pyrene | *1.1*[#] |
| a - not elevated<br>b - *slightly elevated*<br>c - elevated,<br>**d - highly elevated**<br>**e - extremely elevated**<br>* - Mercury not included in sediment guidelines. | | # - Greater than or equal to the Lowest Effect Level (LEL).<br>* - Not evaluated by Persaud et al. 1993 | |

## Physical Habitat for Aquatic Life

As part of the 1996 fish sampling effort, the quality of Blacklick Creek macrohabitats was evaluated at 13 sampling stations. QHEI values ranged between 79.5 (RM 18.2, upstream Jefferson Twp. WWTP) and 63.0 (RM 20.4, Havens Rd.) with a mean reach score of 70.0 (Table 11). Streams or large stream segments with an average value near or greater than 60.0, typically possess (in the aggregate) a compliment of positive habitat features needed to support and maintain a community of aquatic organisms fully consistent with the WWH biological criteria (Rankin 1989 and Rankin 1995).

The channel configuration at most stations was found in a natural or physically recovered state, possessing adequate sinuosity and channel development. Substrates were typically coarse, consisting of gravel, cobble, or bedrock, and appeared unburdened with excessive deposits of fine sediment. Most stations where well-structured with a diversity of instream cover types. The condition of the riparian corridor and adjacent land use practices varied greatly along the length of Blacklick Creek. The best riparian conditions were located within the upper six miles of the study area, where mature woody vegetation extended 10 to 50 m on either side of the stream. With increasing downstream distance, the quality of riparian areas varied, mediated by adjacent land use intensity.

The only significant limiting aspect of the habitat of Blacklick Creek was diminished stream discharge within the headwaters. Near intermittent conditions were observed at the most upstream station (RM 22.4). This observation is supported by the results from a biosurvey conducted during the drought of 1991. At that time, upper Blacklick Creek was reduced to isolated, near stagnant, pools (Ohio EPA 1992). Ephemeral conditions within the headwaters appear to cap biological potential.

Excluding the intermittent headwaters, overall habitat quality of Blacklick Creek was rated as good to very good. The stream appeared to contain the requisite physical attributes typically associated with warm water assemblages of aquatic organisms. Impairment attributable to poor habitat quality did not appear likely.

### *Selected Tributaries*

The condition of near and instream macrohabitats of eight selected Blacklick Creek tributaries were evaluated in 1997. These streams included: French Run, North Branch French Run, Dysar tributary, Swisher Creek, and four unnamed tributaries. As measured by the QHEI, habitat quality at or near the WWH threshold was observed in all but one tributary. Most stations contained a complement of natural headwater features, including coarse substrates, moderate pool development, and a sinuous and unmodified course. Only Swisher Creek was found to have subpar habitat. However, this deficiency was mitigated, to some extent, by significant ground water inputs, augmenting flow and maintaining cool stream temperatures.

Table 11. Qualitative Habitat Evaluation Index (QHEI) matrix showing positive and negative habitat attributes by fish sampling station for Blacklick Creek, 1996.

**Key QHEI Components**

| | | | Positive Habitat Attributes | | | | | | | | | | | Negative Habitat Attributes<br>High Influence | | | | | | Moderate Influence | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| River Mile | QHEI | Gradient (ft./mile) | No Channelization or Recovered | Boulder/Cobble/Gravel Substrates | Silt Free Substrates | Good/Excellent Development | Moderate/High Sinuosity | Extensive/Moderate Cover | Fast Current/Eddies | Low/Normal Embeddedness | Max Depth > 40 cm | Low/No Riffle Embeddedness | **Total WWH Attributes** | Channelized or No Recovery | Silt/Muck Substrates | Low Sinuosity | Sparse/No Cover | Max Depth < 40 cm (WD,HW) | **Total H.I. MWH Attributes** | Recovering Channel | Heavy/Moderate Silt Cover | Sand Substrates | Hardpan Substrate Origin | Fair/Poor Development | Low/No Sinuosity | Only 1-2 Cover Types | Intermittent & Poor Pools | No Fast Current | | | No Riffle | | | |
| **(02-130) Blacklick Creek 1996** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22.4 | 65.5 | 17.5 | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ | | 8 | | | | | | 0 | | ▲ | | | ▲ | | | | ▲ | ▲ | ▲ | | 5 | 0.6 | 0.0 |
| 20.4 | 63.0 | 17.5 | ■ | ■ | | ■ | ■ | | | ■ | ■ | ■ | 7 | | | | | ● | 1 | | ▲ | | | ▲ | | | | ▲ | ▲ | | | 4 | 0.7 | 0.1 |
| 18.2 | 79.5 | 18.5 | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ | | 7 | | | | | | 0 | | | | | | | | | ▲ | ▲ | ▲ | | 3 | 0.4 | 0.0 |
| 18.0 | 75.0 | 18.5 | ■ | ■ | | ■ | ■ | ■ | | | ■ | | 6 | | | | | | 0 | | ▲ | | | ▲ | ▲ | | | ▲ | ▲ | ▲ | | 6 | 1.0 | 0.0 |
| 16.6 | 70.5 | 14.9 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | 0 | | ▲ | | | | ▲ | | | | | | | 2 | 0.2 | 0.0 |
| 15.5 | 68.0 | 4.4 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | | 7 | | | | | | 0 | | ▲ | | | | | | | | ▲ | ▲ | | 3 | 0.4 | 0.0 |
| 11.3 | 74.5 | 10.3 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | 9 | | | | | | 0 | | ▲ | | | | | | | | ▲ | ▲ | | 3 | 0.3 | 0.0 |
| 11.0 | 63.5 | 10.3 | | ■ | | | | ■ | ■ | ■ | ■ | ■ | 6 | | | | | | 0 | ▲ | | | | ▲ | ▲ | | | | | | | 3 | 0.5 | 0.0 |
| 8.8 | 62.0 | 13.2 | ■ | ■ | | | | ■ | | | ■ | | 4 | | | | | | 0 | | ▲ | | | ▲ | ▲ | | | ▲ | ▲ | ▲ | | 6 | 1.5 | 0.0 |
| 5.0 | 78.0 | 9.7 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | 8 | | | | | | 0 | | ▲ | | | | | | | | ▲ | ▲ | | 3 | 0.4 | 0.0 |
| 4.6 | 64.5 | 6.0 | ■ | ■ | | | | ■ | ■ | | ■ | | 5 | | | | | | 0 | | ▲ | | | ▲ | ▲ | | | | ▲ | ▲ | | 5 | 1.0 | 0.0 |
| 1.8 | 77.0 | 6.1 | ■ | ■ | | | ■ | ■ | ■ | | ■ | | 6 | | | | | | 0 | | ▲ | | | ▲ | | | | | ▲ | ▲ | | 4 | 0.7 | 0.0 |
| **(02-286) Unnamed Trib. 1997-RM 6.5** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.5 | 56.0 | 9.7 | ■ | ■ | | | | | | | ■ | | 3 | ● | | | | ● | 2 | | | | ▲ | ▲ | | ▲ | ▲ | ▲ | | | | 5 | 1.6 | 0.7 |
| **(02-287) Unnamed Trib. 1997-RM 10.4** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.3 | 75.5 | 58.8 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | 8 | | | | | | 0 | ▲ | | | | | | | | ▲ | | | | 2 | 0.1 | 0.0 |
| **(02-288) Unnamed Trib. 1997-RM 11.3** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.3 | 73.5 | 40.0 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | 8 | | | | | | 0 | | | | | | | | ▲ | ▲ | | | | 1 | 0.3 | 0.0 |
| **(02-289) Unnamed Trib. 1997-RM 12.9** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.3 | 74.0 | 50.0 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | 0 | | | | ▲ | | | | | | | | | 3 | 0.1 | 0.0 |

Table 11. continued.

**Key QHEI Components**

**Positive Habitat Attributes**

**Negative Habitat Attributes**

*High Influence*

*Moderate Influence*

Silt Free Substrates
Low Sinuosity / No Channelization or Recovered
Moderate/High Sinuosity / Fast Current/Eddies
Good/Excellent Development / Boulder/Cobble/Gravel Substrates
Max Depth>40 cm / Extensive/Moderate Cover
Low/Normal Embeddedness
**Total WWH Attributes**
Silt/Muck Substrates / Sparse Cover
Low/No Riffle Embeddedness
Channelized or No Recovery
Intermittent & Poor Pools
Recovering Channel / Sand Substrates / Max Depth<40cm (WD,HW)
**Total H.I. MWH Attributes**
Heavy/Moderate Silt Cover / Low/No Sinuosity
Hardpan Substrate Origin / Fair/Poor Development
Only 1-2 Cover types / No Fast Current / No Riffle

| River Mile | QHEI | Gradient (ft./mile) | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(02-290) French Run 1997** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.7 | 68.0 | 50.0 | ■ | ■ | | ■ | | ■ | | ■ | ■ | ■ | 7 | ● | | 1 | ▲ | | ▲ | ▲ | | 3 | 0.4 | 0.1 |
| **(02-291) N. Br. French Run 1997** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.2 | 81.5 | 40.8 | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ | ■ | 8 | | | 0 | ▲ | | | ▲ | | 2 | 0.3 | 0.0 |
| **(02-292) Unnamed Trib. to Dysar Run 1997** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.1 | 70.5 | 55.6 | ■ | ■ | | ■ | ■ | ■ | | | ■ | ■ | 7 | | | 0 | | | | ▲ | ▲ | 2 | 0.3 | 0.0 |
| **(02-293) Swisher Creek 1997** | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.3 | 47.0 | 45.5 | ■ | | | | | | | ■ | ■ | ■ | 4 | ● | ● | 2 | | ▲ | ▲ | ▲ | | 3 | 0.75 | 0.5 |

## Biological Assessment: Macroinvertebrate Community

Macroinvertebrate assemblages were sampled and evaluated at 13 sites on Blacklick Creek from adjacent to Kitzmiller Rd. (RM 22.7) to the mouth (RM 1.4). Narrative evaluations of the assemblages, excluding mixing zones, ranged from fair to exceptional quality (Table 12). Invertebrate Community Index (ICI) scores, excluding samplers affected by slow current or suspected disturbance, ranged from 40 (upstream from the Jefferson Twp. WWTP and Broad Street) to 52 (Winchester Pike). Longitudinal performance of the ICI is presented in Figure 15.

The flow condition in Blacklick Creek at RM 22.7 was nearly intermittent with no detectable current on the September 3, 1996 sampling date. Although only two EPT taxa were collected at this site, 23 total taxa were collected from the natural substrates. The QCTV score of 35.5 was below ecoregional expectations (25th percentile score of attaining sites) but above the 75th percentile values of those ecoregional sites which did not attain the biocriteria. Heptagenid mayflies and water pennies were common organisms. This macroinvertebrate was evaluated as fair water quality.

In contrast, the twelve sites sampled downstream from RM 22.7 were located in areas with continuous flow and increased habitat diversity and, consequently, supported vastly improved macroinvertebrate community.

Communities at the six sites, from Havens Rd. (RM 20.4) to downstream from the Tussing Rd. WWTP (RM 11.1), were evaluated as good; the only exception was a marginally good community at the site adjacent to Rose Hill Rd. (RM 15.2). The only two artificial substrates (RM 18.7 and RM 16.6) in this reach which were not vandalized or disturbed had ICI scores of 40. All the sites in this reach had 9 to 12 qualitative EPT taxa and 43 to 48 total qualitative taxa. Four to five caddisfly taxa were collected from the natural substrates at each of these sites, except at RM 15.2 where only one taxa was observed and; as such, the collection at the adjacent Rose Hill Rd. site (RM 15.2) appeared to reflect a slight decrease in macroinvertebrate community performance and was considered marginally good.

Macroinvertebrate assemblages collected from the non-mixing zone samples from Refugee Rd. (RM 8.9) to the near mouth site (RM 1.4) were evaluated as exceptional. The ICI scores ranged from 46 to 52.

The two qualitative samples collected in the Blacklick Estates WWTP mixing zone were evaluated as poor and fair. The number of qualitative EPT taxa in the mixing zone samples (2 to 8 taxa) were lower than the other sites in the lower Blacklick Creek sites and the QCTV scores were the lowest (31.3 and 34.2) observed in the 1996 Blacklick Creek survey sites. Pollution tolerant red midges predominated the natural substrates and indicated a localized nutrient enrichment effect from the WWTP.

Table 12. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and from natural substrates (qualitative sampling) at Blacklick Creek sampling locations, 1996.

| | | | | ***Quantitative Evaluation*** | | | | |
|---|---|---|---|---|---|---|---|---|
| Stream/River Mile | Relative Density | Quant Taxa | Qual Taxa | Qual EPT[a] | Total Taxa | QCTV Score | ICI[b] | Evaluation |
| ***Blacklick Creek (1996)*** | | | | | | | | |
| | | | | *Eastern Corn Belt Plain - WWH Use Designation (Existing)* | | | | |
| 22.7 | - | - | 23 | 2 | - | 35.5 | F* | Fair |
| | | | | *Eastern Corn Belt Plain - EWH Use Designation (Existing)* | | | | |
| 20.4 | 183 | 33 | 63 | 12 | 73 | 35.5 | G* | Good |
| 18.7 | 361 | 38 | 47 | 9 | 62 | 35.6 | 40* | Good |
| 17.9 | - | - | 49 | 9 | - | 38.2 | G* | Good |
| 16.6 | 564 | 33 | 49 | 10 | 62 | 35.5 | 40* | Good |
| | | | | *Eastern Corn Belt Plain - WWH Use Designation (Existing)* | | | | |
| 15.2 | 424 | 30 | 49 | 9 | 61 | 37.2 | $34^{ns}$ | Marg. Good |
| 11.3 | 960 | 32 | 43 | 10 | 55 | 38.5 | G | Good |
| 11.1 | 2285 | 33 | 48 | 10 | 58 | 37.5 | G | Good |
| 8.9 | 1109 | 41 | 61 | 11 | 73 | 37.2 | 46 | Exceptional |
| 5.6 | 1541 | 42 | 51 | 18 | 63 | 39.2 | 50 | Exceptional |
| *4.83* | - | - | *31* | *2* | - | *31.3* | *P* | *Poor* |
| *4.83* | - | - | *44* | *8* | - | *34.2* | *F* | *Fair* |
| 4.5 | 1106 | 40 | 53 | 13 | 69 | 37.5 | 52 | Exceptional |
| 1.4 | 3023 | 36 | 57 | 13 | 69 | 38.2 | 46 | Exceptional |
| ***Blacklick Creek (1991)*** | | | | | | | | |
| | | | | *Eastern Corn Belt Plain - WWH Use Designation (Existing)* | | | | |
| 26.0 | 8 | 14 | 18 | 1 | 24 | 26.0 | 2* | Poor |
| 23.0 | 273 | 18 | 37 | 6 | 47 | 34.8 | 12* | Poor |
| | | | | *Eastern Corn Belt Plain - EWH Use Designation (Existing)* | | | | |
| 20.3 | 548 | 27 | 48 | 11 | 61 | 38.5 | 40* | Good |
| 16.6 | 518 | 42 | 50 | 10 | 71 | 37.2 | 48 | Exceptional |
| ***Blacklick Creek (1989)*** | | | | | | | | |
| | | | | *Eastern Corn Belt Plain - EWH Use Designation (Existing)* | | | | |
| 20.3 | 1212 | 26 | 43 | 11 | 56 | 35.3 | $44^{ns}$ | Very Good |
| 18.6 | 298 | 28 | 33 | 10 | 52 | 40.3 | G* | Good |
| 16.5 | 916 | 27 | 34 | 11 | 51 | 39.7 | 34* | Marg. Good |

Table 12. continued.

***Quantitative Evaluation***

| Stream/River Mile | Relative Density | Quant Taxa | Qual Taxa | Qual EPT[a] | Total Taxa | QCTV Score | ICI | Evaluation |
|---|---|---|---|---|---|---|---|---|
| ***Blacklick Creek (1987)*** | | | | | | | | |
| *Eastern Corn Belt Plain - WWH Use Designation (Existing)* | | | | | | | | |
| 11.3 | - | - | 48 | 9 | - | 35.6 | MG$^{ns}$ | Marg. Good |
| 11.1 | - | - | 56 | 8 | - | 36.3 | MG$^{ns}$ | Marg. Good |
| ***Blacklick Creek (1986)*** | | | | | | | | |
| *Eastern Corn Belt Plain - WWH Use Designation (Existing)* | | | | | | | | |
| 4.9 | - | - | 33 | 11 | - | 39.9 | G | Good |
| 4.6 | - | - | 41 | 9 | - | 32.9 | F* | Fair |
| 3.6 | 2234 | 26 | 39 | 5 | 49 | 30.1 | 18* | Fair |
| 2.1 | 1278 | 35 | 41 | 12 | 59 | 36.3 | 26* | Fair |

***Qualitative Evaluation***

| Stream/River Mile | Qual Taxa | QCTV Score | Qual EPT[a] | Relative Density | Predominant Organisms | Narrative Evaluation |
|---|---|---|---|---|---|---|
| ***Blacklick Creek (1996)*** | | | | | | |
| 22.7 | 23 | 35.5 | 2 | Low | Clams, crayfish, flatworms | Fair |
| 20.4 | 63 | 35.5 | 12 | Moderate | Heptagenid mayflies, red midges, flatworms *Chimarra* caddisfly | Good |
| 11.3 | 43 | 38.5 | 10 | Moderate | Hydropsychid caddisflies, elmid beetles | Good |
| 11.1 | 48 | 37.5 | 10 | High | Hydropsychid caddisflies, midges, oligochaetes | Good |
| 4.8 | 31 | 31.3 | 2 | Low | red midges, oligochaetes | *Poor* |
| 4.8 | 44 | 34.2 | 8 | High | red midges | *Fair* |

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

b - The narrative evaluation using the qualitative sample is based on best professional judgement utilizing sample attributes such as taxa richness, EPT taxa richness, QCTV score, and community composition and is used in lieu of the ICI when artificial substrates are lost or deemed not useable.

c - Mixing Zone samples.

ns-Nonsignificant departure from biocriterion (≤ 4 ICI units); * - significamt depature from biocriteria (> 4 ICI units).

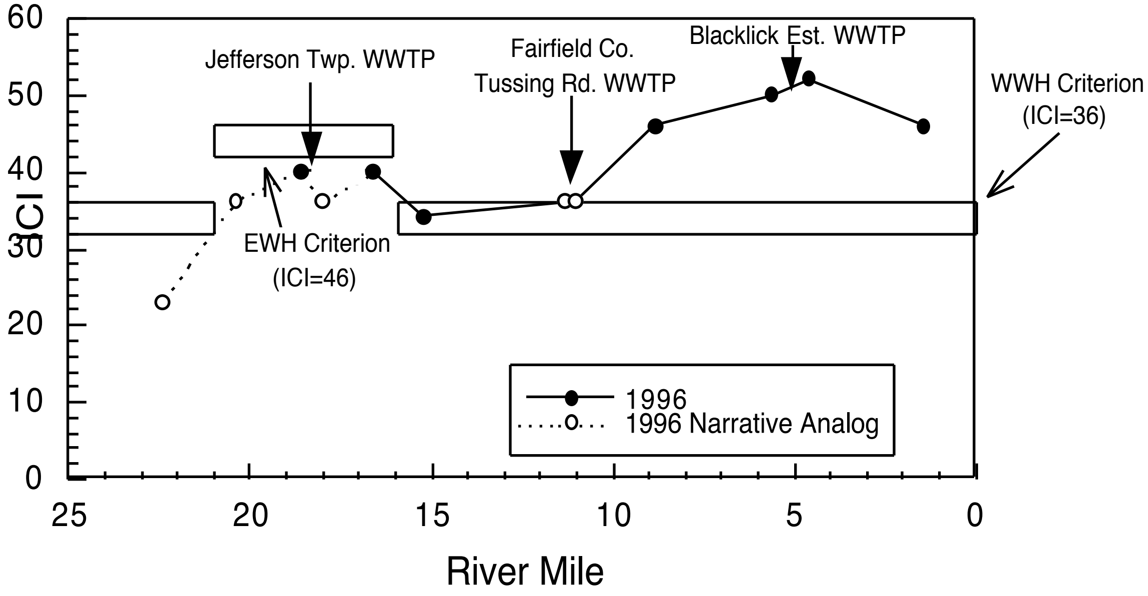

Figure 15. Longitudinal performance of the Invertebrate Community Index (ICI) and narrative equivalent from Blacklick Creek, 1996. The solid lines represent the criteria and area of insignificant departure in support of the existing WWH and EWH aquatic life use designations - Eastern Corn Belt Plain Ecoregion.

**Biological Assessment: Fish Community**

A total of 20, 351 fish comprising 37 species were collected from Blacklick Creek between July and September 1996. The sampling effort included 13 stations, evaluating the mainstem from the headwaters (RM 22.4) to near its confluence with Big Walnut Creek (RM 1.8).

Numerically, the predominant species were: central stoneroller (53.5%), striped shiner (9.5%), rainbow darter (5.4%), northern hogsucker (4.0%), and creek chub (3.6%). In terms of biomass the dominant species were: common carp (36.4%), central stoneroller (20.1%), northern hog sucker (11.4%), white sucker (4.6%), and striped shiner (4.6%). The dominance of the central stoneroller, in terms of abundance and biomass, suggested moderate nutrient enrichment. As one of Ohio's few herbivorous fish, the central stoneroller feeds mainly on attached algal growth. (Becker 1983). This species typically occupies a prominent position within the fish assemblage of enriched, often agriculturally influenced, streams--particularly in areas that lack the beneficial shading effects of mature wooded riparian corridor and possess adequate coarse substrates. The combination of available nutrients, unattenuated sunlight, and abundant attachment sites, is optimal for encrusting algae. Given its ability to directly access this form of primary production, the central stoneroller often thrives in such environments. The suite of remaining dominant species did not appear indicative of a disturbed or stressed fish community. Rather, they are typically well represented in most medium sized central Ohio streams.

Two aquatic life use designations are currently imposed on Blacklick Creek. The EWH use is applied to the reach between RM 20.4 and RM 16.5. The remaining segments (upper and lower) are designated WWH.

Community performance, as measured by the IBI and MIwb, ranged between very good (RM 20.4) and fair (RM 22.4). Overall, the fish assemblage of Blacklick Creek was characterized as good-marginally to good (Table 13). The majority of the sampling stations were found to support an assemblage of fishes fully consistent with the WWH biological criteria, regardless of the designated use. Though modest, departures from the existing criteria (EWH or WWH) were limited to three segments: 1) the extreme headwaters, 2) the majority of the EWH designated segment, and 3) the lower 1.8 miles. Longitudinal performance of the IBI and MIwb is presented in Figure 16.

Beginning with the WWH designated headwaters, community performance at RM 22.4 (Morse Rd.) was evaluated as fair (IBI=35). Diminished performance was attributed to near intermittent stream flow coupled with failed on-site septic systems and possibly a manure release in the headwaters. Moving downstream, within the upper limits of the EWH segment, community performance was markedly advanced at RM 20.4 (IBI=49). Of the four stations sampled within the EWH reach, this site alone was found to fully support an exceptional fish community (Figure 16). The results from the following downstream stations, bracketing the Jefferson Twp. WWTP (RM 18.2 and RM 18.0), strongly deviated from the EWH standard, but were at or near WWH thresholds. The remaining station within the EWH segment (RM 16.6) yielded mixed results. The IBI was improved, and found fully consistent with the EWH criterion (IBI=48). However, as observed upstream, the MIwb failed to perform at an EWH level (MIwb=8.4), remaining instead consistent with the WWH performance standard.

The varied and somewhat contradictory results from the EWH segment were primarily driven by differing scoring criteria based upon Ohio EPA's stream size classification system, not necessarily environmental conditions. In recognition of natural physical, chemical, and biological characteristics exhibited by streams or rivers as they progressively increase in size, community measures have been developed that account for this longitudinal succession. The arbiter of stream size classification in Ohio is drainage area (Ohio EPA 1987). The Blacklick Creek study area includes two broad stream categories: 1) headwaters (stations with drainage area ≤20 miles$^2$); and 2) wadable non-headwaters (stations with a drainage area >20 miles$^2$ to ~300 miles$^2$).

Table 13.Fish community indices and descriptive statistics based on samples collected by Ohio EPA from Blacklick Creek and selected tributaries, 1986-1997.

| ***Stream*** River Mile | Mean Number Species | Cumulative Species | Mean Rel. No. (No./0.3km) | Mean Rel. Wt. (Wt./0.3km) | QHEI | Mean IBI | Mean MIwb | Narrative Evaluation |
|---|---|---|---|---|---|---|---|---|
| ***Blacklick Creek (1996)*** | | | | | | | | |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | | | |
| 22.4$^{(H)}$ | 13.5 | 15 | 453.8 | 2.2 | 65.5 | 35* | N/A | Fair |
| *Eastern Corn Belt Plains - EWH/WWH Use Designation (Existing/Recommended)* | | | | | | | | |
| 20.4$^{(H)}$ | 15.5 | 18 | 2895.0 | 13.0 | 63.0 | 49$^{ns}$ | N/A | Very Good |
| 18.2$^{(W)}$ | 18.0 | 22 | 968.3 | 10.4 | 79.5 | 41* | 7.8* | Good-M. Good |
| 18.0$^{(W)}$ | 19.0 | 24 | 379.4 | 6.4 | 75.0 | 44* | 7.7* | Good-Fair |
| 16.6$^{(W)}$ | 22.0 | 25 | 954.8 | 8.9 | 70.5 | 48$^{ns}$ | 8.4* | Very Good Good |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | | | |
| 15.5$^{(W)}$ | 20.0 | 21 | 1524.8 | 14.1 | 68.0 | 43 | 8.5 | Good |
| 11.3$^{(W)}$ | 20.5 | 23 | 2863.5 | 19.0 | 74.5 | 38$^{ns}$ | 7.8$^{ns}$ | M. Good |
| 11.0$^{(W)}$ | 22.0 | 26 | 3185.0 | 46.5 | 63.5 | 39$^{ns}$ | 8.6 | M. Good-Good |
| 8.8$^{(W)}$ | 18.0 | 20 | 860.3 | 51.3 | 62.0 | 41 | 8.3 | Good |
| 5.0$^{(W)}$ | 23.5 | 25 | 1176.0 | 51.7 | 78.0 | 43 | 8.7 | Good |
| *4.83$^{(W)MZ}$* | *15.0* | *20* | *1080.0* | *5.7* | *44.5* | *36* | *7.6* | *M. Good-Fair* |
| 4.6$^{(W)}$ | 21.3 | 26 | 649.0 | 32.0 | 64.5 | 45 | 8.2$^{ns}$ | Good-M. Good |
| 1.8$^{(W)}$ | 20.5 | 26 | 336.0 | 17.9 | 77.0 | 38$^{ns}$ | 7.6* | M. Good-Fair |
| ***Blacklick Creek (1991)*** | | | | | | | | |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | | | |
| 27.1$^{(H)}$ | 8.7 | 11 | 848.9 | 1.5 | 40.0 | 26* | N/A | Poor |
| 22.4$^{(H)}$ | 12.3 | 15 | 1693.5 | 1.8 | 61.0 | 28* | N/A | Fair |
| *Eastern Corn Belt Plains - EWH Use Designation (Existing)* | | | | | | | | |
| 20.4$^{(H)}$ | 18.0 | 20 | 4838.8 | 12.7 | 53.5 | 47$^{ns}$ | N/A | Very Good |
| 16.6$^{(H)}$ | 23.0 | 26 | 1473.8 | 7.8 | 66.5 | 46$^{ns}$ | 9.1$^{ns}$ | Very Good |
| ***Blacklick Creek (1987)*** | | | | | | | | |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | | | |
| 11.3$^{(W)}$ | 15.0 | 15 | 1112.0 | 4.5 | 70 | 38$^{ns}$ | 7.2* | M. Good-Fair |
| 11.0$^{(W)}$ | 22.0 | 22 | 513.3 | 41.9 | 70 | 36$^{ns}$ | 6.5* | M. Good-Fair |

Table 13. continued.

| Stream **River Mile** | Mean Number Species | Cumulative Species | Mean Rel. No. (No./0.3km) | Mean Rel. Wt. (Wt./0.3km) | QHEI | Mean IBI | Mean MIwb | Narrative Evaluation |
|---|---|---|---|---|---|---|---|---|
| ***Blacklick Creek (1986)*** | | | | | | | | |
| *Eastern Corn Belt Plains - WWH Use Designation (Existing)* | | | | | | | | |
| 11.3(W) | 21.3 | 23 | 1582.8 | 35.1 | -- | 38$^{ns}$ | 8.5 | M. Good-Good |
| 9.7(W) | 17.3 | 20 | 3867.8 | 58.0 | -- | 33* | 9.0 | Fair-Good |
| 5.6(W) | 21.3 | 26 | 1115.0 | 54.9 | -- | 45 | 9.3 | Good |
| 4.7(W) | 15.7 | 19 | 3503.0 | 92.8 | -- | 33* | 8.8 | Fair-Good |
| 3.3(W) | 16.0 | 22 | 727.0 | 42.9 | -- | 27* | 6.3* | Fair |
| 2.1(W) | 19.3 | 23 | 453.3 | 148.5 | -- | 32* | 8.0$^{ns}$ | Fair-Good |
| ***Blacklick Creek Tributaries (1997)*** | | | | | | | | |
| *Eastern Corn Belt Plains - Undesignated/WWH Use Designation (Existing/Recommended)* | | | | | | | | |
| ***Unnamed Trib. (Joins Blacklick Cr.at RM 6.5)*** | | | | | | | | |
| 0.5(H) | 16.0 | 16 | 1393.9 | N/A | 56.0 | 36$^{ns}$ | N/A | M. Good |
| ***Unnamed Trib. (Joins Blacklick Cr.at RM 10.4)*** | | | | | | | | |
| 0.3(H) | 11.0 | 11 | 1060.0 | N/A | 75.5 | 44 | N/A | Good |
| ***Unnamed Trib. (Joins Blacklick Cr.at RM 11.3)*** | | | | | | | | |
| 0.3(H) | 9.0 | 9 | 1232.3 | N/A | 73.5 | 40 | N/A | Good |
| ***Unnamed Trib. (Joins Blacklick Cr.at RM 12.9)*** | | | | | | | | |
| 0.3(H) | 10.0 | 10 | 1157.7 | N/A | 74.0 | 40 | N/A | Good |
| ***Swisher Creek*** | | | | | | | | |
| 1.3(H) | 6.0 | 6 | 396.9 | N/A | 47.0 | 40 | N/A | Good |
| ***Unnamed Trib. to Dysar Run*** | | | | | | | | |
| 0.1(H) | 11.0 | 11 | 666.0 | N/A | 70.5 | 46 | N/A | V. Good |
| ***French Run*** | | | | | | | | |
| 0.7(H) | 9.0 | 9 | 1291.9 | N/A | 68.0 | 38$^{ns}$ | N/A | M. Good |
| ***North Br. French Run*** | | | | | | | | |
| *Eastern Corn Belt Plains - Undesignated/EWH Use Designation (Existing/Recommended)* | | | | | | | | |
| 0.2(H) | 15.0 | 15 | 1153.1 | N/A | 81.5 | 54 | N/A | Exceptional |

* - Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns - Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 Iwb units).
H - Headwater site type (drainage area ≥ 20 miles$^2$).
W - Wading site type
MZ - Mixing Zone sample.

Table X. continued.

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**Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)**

| INDEX - Site Type | WWH | EWH | MWH[a] |
|---|---|---|---|
| IBI - Headwater/Wading | 40 | 50 | 24 |
| MIwb - Wading | 8.3 | 9.4 | 6.2 |
| ICI | 36 | 46 | 22 |

[a] - Modified Warmwater Habitat for channelized habitats/impounded habitats.

A set of IBI metrics has been developed for each stream size class, reflecting differing levels of structure and functional organization of the fish assemblage through the stream continuum (Ohio EPA 1987[b]). Additionally, due to typically low or highly variable biomass and low species richness, the MIwb is not applied to stations classified as headwaters (Ohio EPA 1987[b]). To further complicate the interpretation of these data, the EWH designation is imposed on a reach that straddles the drainage area break (20 miles$^2$) between the headwater and wading segments. This necessitates the use of both the headwater and wading IBI to evaluate community data collected over a very short section of stream.

The upper fraction of the EWH segment has a drainage area ≤20 miles$^2$, and includes only RM 20.4. As stated above, community performance at this station fully met the EWH criteria. These data were evaluated against the EWH headwater IBI criterion only, as the MIwb is not applicable for this stream class. The stations bracketing the Jefferson WWTP (RM 18.2 and RM 18.0) have drainage areas of 21.9 miles$^2$ and 22.2 miles$^2$, respectively--barely in excess of the headwater threshold. Although technically these stations are not classified headwaters, their drainage areas are only slightly greater than the arbitrary headwater limit, and thus the EWH wading IBI and MIwb criteria are prescribed. The precipitous "decline" of the IBI appeared reflective of the change in stream class (headwater to wading) and the accompanying index change.

To test this observation, the results from these stations (RM 18.2 and RM 18.0) were experimentally treated as headwaters. The resulting IBI scores yielded values very similar to the headwater classified station at RM 22.4. These results suggest that the EWH segment is ecologically functioning as "true" headwaters, despite drainage areas greater than the prescribed upper limit. It follows that this observation also explains the subpar performance of the MIwb at these stations. Ultimately, deviations from the biological criteria did not appear attributable to the Jefferson Twp. WWTP or other environmental stressors. Rather, the "diminished" scores represented an artifact of the application of different biological indices, dictated by drainage area,

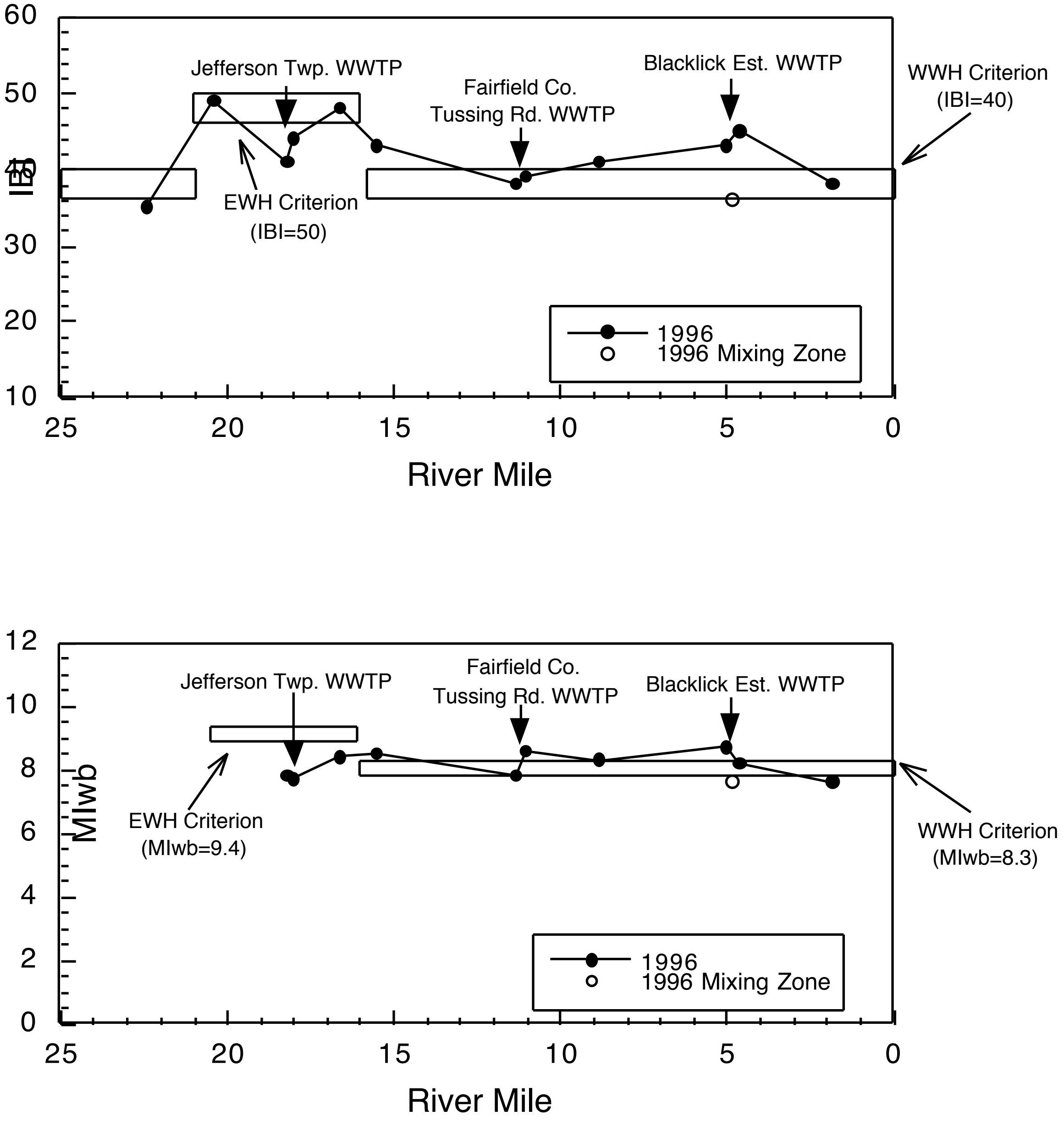

Figure 16. Longitudinal performance of the Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) for Blacklick Creek, 1996. The solid lines represent numerical biological criteria and area of insignificant departure in support of the existing WWH and EWH aquatic life use designations - Eastern Corn Belt Plains Ecoregion.

over a very short stream length. Given the transitional nature of the EWH segment, and community performance near or fully consistent with the WWH biological criteria contained within, a redesignation of this reach to the more appropriate WWH aquatic life use appears warranted.

Within the remaining downstream portion of Blacklick Creek, departure from the WWH biological criteria was limited to one station (RM 1.8, SR 317). All other stations were found to support WWH fish communities. No impact was indicated downstream from either the Fairfield Co.-Tussing Rd. or Blacklick Estates WWTPs. The decline recorded at RM 1.8 was modest, as only the MIwb deviated from the WWH standard by a mere 0.2 points. The IBI indicated structural and functional organization consistent with the WWH criterion throughout this segment.

*Selected Tributaries*

Fish community samples were collected at one station, near the mouth, from each of the Blacklick Creek tributaries evaluated in 1997. The tributary study area included: French Run, North Branch French Run, Swisher Creek, Dysar Run trib., and four additional unnamed tributaries. All of these waters are classified as headwaters (<20.0 miles$^2$ drainage area) and currently undesignated for beneficial uses.

Community performance, as measured by the IBI, ranged between marginally good and exceptional. All community samples yielded IBI score at or in excess of the minimum WWH biocriteria threshold (IBI of 36-nonsignificant departure) (Table 13 and Figure 17). Most sampling stations contained a complement fishes, typical of small headwater, till plains streams. Additionally, nearly all of these small tributaries supported a population, of various sizes, of southern Red-bellied dace--a declining headwater species, as defined by Ohio EPA (1996). A fully exceptional headwater fish fauna was indicated in North Branch French Run at RM 0.2 (IBI=54). Sampling from this station found 15 species present, including several sensitive or declining headwater taxa. As instream biological performance is the ultimate arbiter of aquatic life use recommendations, the EWH designation would appear appropriate for this stream. The WWH aquatic life use is recommended for the seven remaining streams.

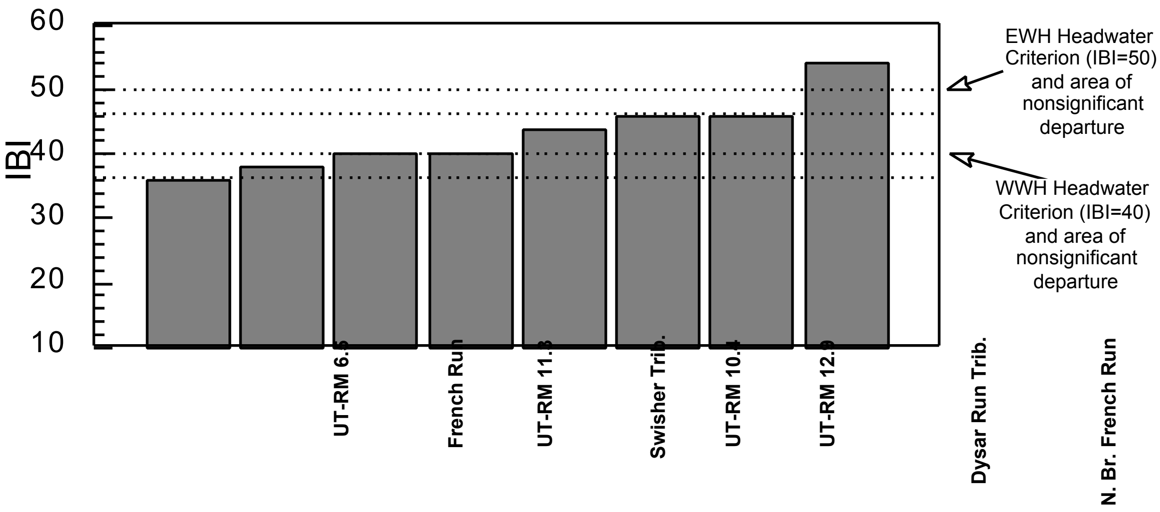

Figure 17. Index of Biotic Integrity (IBI) scores for eight named and unnamed (UT) Blacklick Creek tributaries. Results based on fish community samples collected between July and October, 1997. Dashed lines indicate headwater EWH and WWH biocriteria - Eastern Corn Belt Plains Ecoregion.

## TREND ASSESSMENT

### Chemical/ Physical Water Quality: 1974-1996

Water quality trends analysis is somewhat difficult in this situation due to the sporadic nature of data collection efforts over several years and differing longitudinal sections of Blacklick Creek. Generally, areas downstream from WWTPs were addressed, while other segments were ignored (i.e., midstream segments).

Ammonia-N concentrations showed improvement downstream from the Blacklick Estates WWTP in 1996. Data from the early 1970s and mid-1980s showed significant, increased ammonia-N concentrations downstream from the WWTP (Figure 18). In contrast, the current survey revealed only a minor increase. Trend data for the rest of the stream does not show any impact from ammonia-N, as most values were at or slightly above the median value for wadeable, WWH or EWH streams of the ECBP ecoregion (Ohio EPA, 1996).

Trend data for total phosphorus somewhat mimics that of ammonia-N. Historical trend information is lacking between RM 5.60 and RM 16.50. Upstream from RM 16.50, there is no apparent trend. Phosphorus values were low and appeared stable through time. Downstream from RM 5.60, the trend is toward decreased total phosphorus concentrations. However, the Blacklick Estates WWTP provided a major input of phosphorus that was still apparent, although reduced, in 1996.

Trend information for nitrate+nitrite-N is directly opposite that of ammonia-N and phosphorus, showing increased concentrations instream compared to previous years. Again the Blacklick Estates WWTP provided a major contribution of nitrate+nitrite-N to the stream with increased concentrations from 1986 to 1996. This is typical of better treatment including improved nitrification. A small peak is also evident downstream from the Fairfield Co.-Tussing Rd. WWTP and can be attributed to nitrification within the plant. In comparison with the 1991 results, heightened nitrate+nitrite-N in the upstream portion of Blacklick Creek may be due to agricultural inputs and other nonpoint sources of runoff. Also, the drought conditions in 1991 may have resulted in lower than normal ambient concentrations.

Instream D.O. concentrations increased in comparison with historical data. This trend is especially noteworthy downstream from the Blacklick Estates WWTP, where in 1986 a significant D.O. sag was apparent. Recent data showed a much reduced (but still apparent) oxygen depletion downstream from the plant, but concentrations remained well above the WQS criteria. Again, this is indicative of improved treatment. The EWH portion of the stream also saw a significant increase in D.O. concentrations instream as compared to 1991. Midstream trends cannot be addressed as there is no past data for comparison.

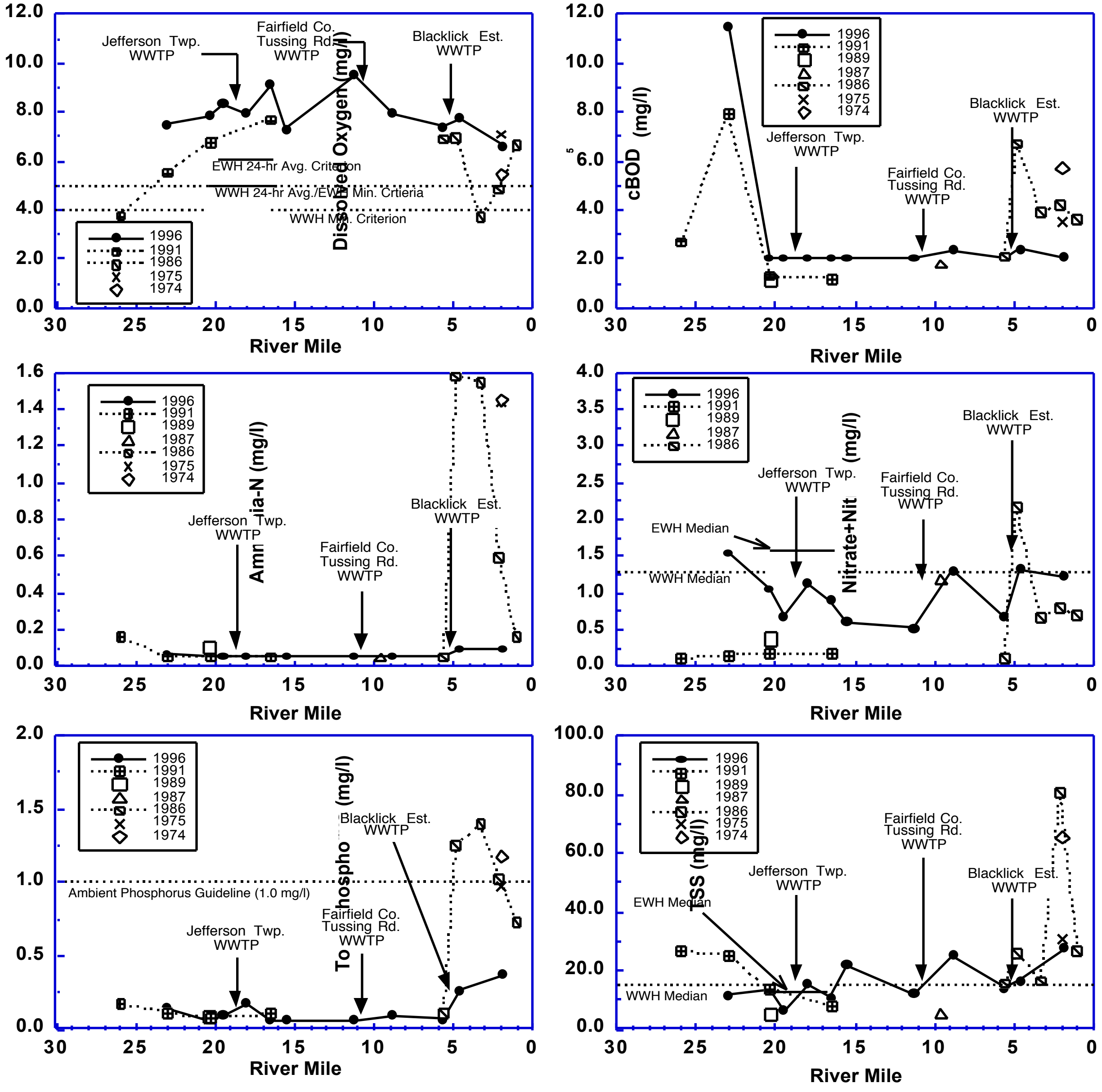

Figure 18. Mean longitudinal concentrations of Dissolved Oxygen, Ammonia-Nitrogen, Nitrate+Nitrite-Nitrogen, five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$), Total Phosphorus, and Total Suspended Solids (TSS) from Blacklick Creek, 1974 through 1996.

## Benthic Macroinvertebrate Community: 1986-1996

The 1996 survey encompassed the entire Blacklick Creek mainstem from the headwaters (RM 22.7) to the near mouth site (RM 1.4). The upper mainstem was sampled in 1989 (RM 26.0 to RM 16.6) and 1991 (RM 20.3 to RM 16.5) and the lower mainstem in 1986 (RM 4.9 to RM 2.1) and 1987 (RM 11.3 and RM 11.1). Longitudinal performance of the IBI, through time is presented in Figure 19.

During the summer of 1991 and 1996, sites located in the headwaters of Blacklick Creek to adjacent to Kitzmiller Rd. (RM 22.7 and RM 23.0), were intermittent with only a few disjunct pools present separated, often widely, by dry or little flow riffle and run areas. Stagnated conditions existed in the pools as evidenced by large amounts of dead and decaying filamentous algae; this was most evident at Central College Rd. (RM 26.0) in 1991. Macroinvertebrates sampled both years suggested serious community imbalances and were evaluated as poor or fair in this reach of Blacklick Creek.

Sites sampled downstream from the above segment of Blacklick Creek were located in areas with continuous stream flow and increased habitat diversity. Macroinvertebrate communities from RM 18.7 to RM 11.1 were evaluated as marginally good to exceptional in 1987 (RMs 11.1 and 11.3), 1988 (RMs 16.5, 18.6, and 20.3), and 1996 (RMs 11.1, 11.3, 15.2, 16.6, 17.9, 18.7, and 20.4).

The lower reach of Blacklick Creek (RM 5.6 to RM 1.4) has shown the largest improvement in macroinvertebrate community performance. In 1986, benthic assemblages indicated good water quality upstream from Blacklick Estates WWTP. Downstream from the WWTP the assemblages were representative of fair conditions only. In 1996, ICI scores were in the exceptional range for the sites from RM 8.9 to the mouth.

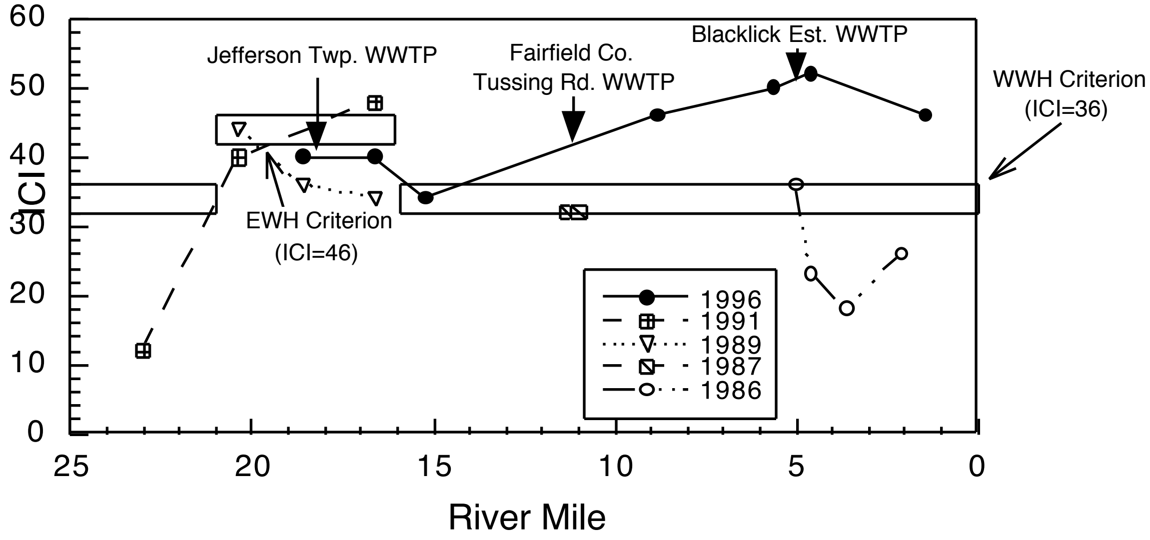

Figure 19. Longitudinal performance of the Invertebrate Community Index (ICI) at Blacklick Creek sampling locations, 1986 through 1996. The solid lines represent the numeric biological criteria in support of the existing WWH and EWH aquatic life use designations - Eastern Corn Belt Plains Ecoregion.

**Fish Community: 1986 - 1996**

Fish community data were collected from Blacklick Creek at various locations in 1986, 1987, 1991, and 1996. In 1986 collections were made at six stations, evaluating the stream reach between RM 11.3 (Tussing Rd.) and RM 2.1 (SR 317) -- assessing both the Fairfield Co.-Tussing Rd. and Blacklick Estates WWTPs. The 1987 sampling effort was modest, consisting of only two stations bracketing the Tussing Rd. facility (RM 11.3 and RM 11.0). The 1991 effort included four stations, extending from RM 27.1 (Walnut St.) to RM 16.6 (Broad St.), evaluating the previously unsampled headwaters and the Jefferson Twp. WWTP. The 1996 survey included 13 stations, evaluating the entire length of Blacklick Creek between RM 22.4 (Morse Rd.) and RM 1.8 (SR 317). Given the very limited scope of the 1987 sampling effort, Blacklick Creek fish community trends assessment will focus on the more robust 1986 and 1991 data.

The results from the 1986 biosurvey clearly delineated distinct and significant impacts from both the Fairfield Co.-Tussing Rd. and Blacklick Estates WWTPs (Figure 20). Only 2.5 miles (22%) of this 11.3 mile segment were found to support fish assemblages fully consistent with the WWH criteria.

Nearly nine miles (78%) of this segment supported degraded fish communities. The response of the assemblage to effluents discharged by these facilities included: reduced species richness, an increase in the proportion of tolerant and omnivorous species, and an increased incidence of Deformities, Eroded fin, Lesions, and Tumors (DELT) anomalies. By 1996, the impacts associated with the WWTPs appeared fully abated, as recovery was indicated through this segment. Presently, 9.5 miles (84%) of the middle and lower study area contained WWH fish communities. Departure from the WWH standard was limited to the lower 1.8 miles (16%) and was not severe. Of the two community indices applicable to this reach (IBI and MIwb), only the MIwb deviated from its criterion in 1996.

Evaluated in 1991 and 1996, ambient biological performance within the upper portion of Blacklick Creek appeared stable. Except for the headwaters, which were severely affected by the 1991 drought (Ohio EPA 1992), stations common to both survey years supported very similar fish communities (Figure 20). The results from both sampling efforts (1991 and 1996) found Blacklick Creek unaffected by the Jefferson Twp. WWTP. Diminished index values from stations sampled in 1996 only (closely bracketing the WWTP), were attributed to the transitional nature of the upper portion of Blacklick Creek (headwater to wading), and the respective criteria prescribed for each stream size class.

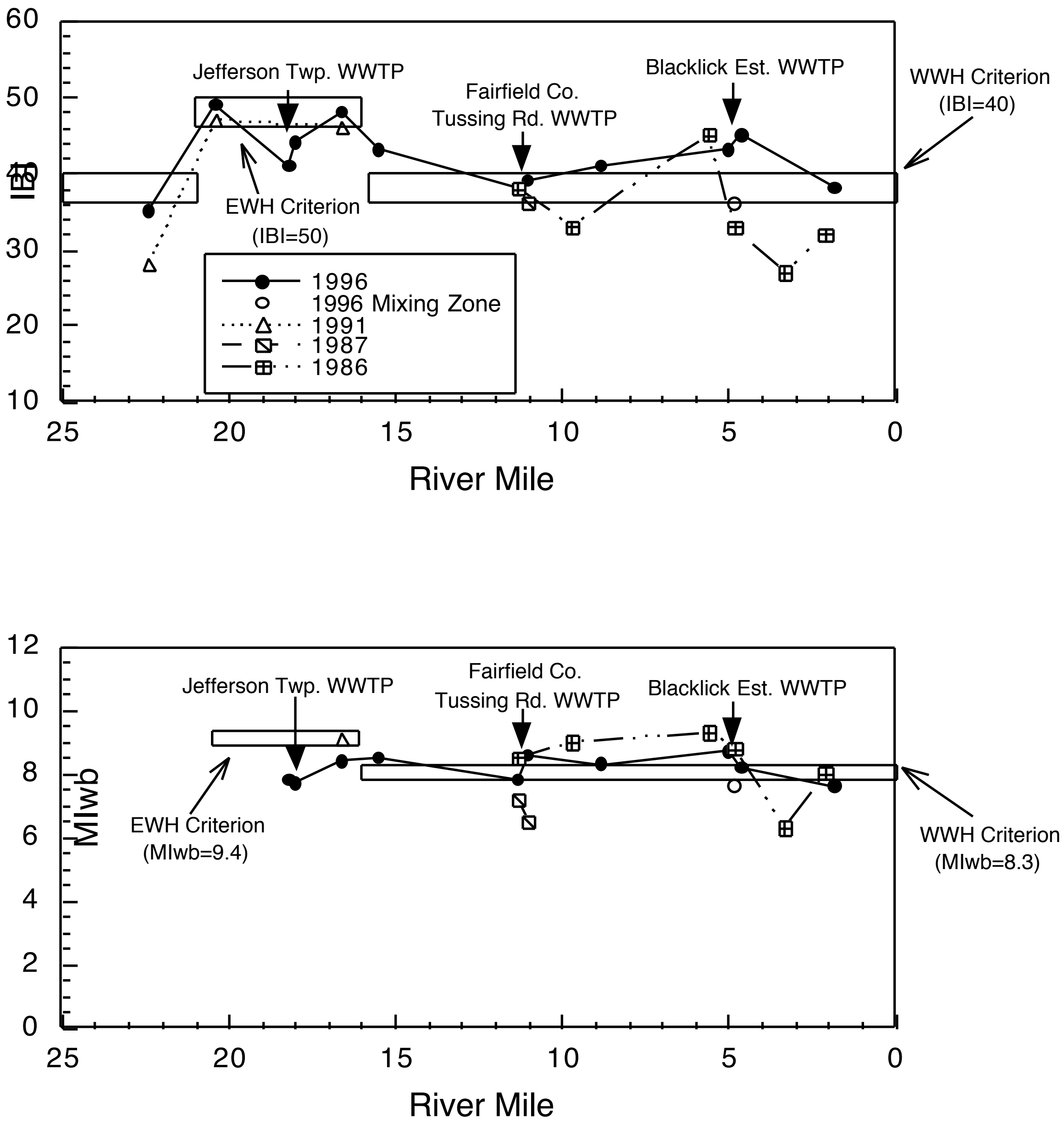

Figure 20. Longitudinal performance of the Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) at Blacklick Creek sampling locations, 1986 through 1996. The solid lines represent numerical biological criteria in support of the existing WWH and EWH aquatic life use designations - Eastern Corn Belt Plains Ecoregion.

## REFERENCES

DeShon, J.D. 1995. Development and application of Ohio EPA's invertebrate community index (ICI), *in* W.S. Davis and T. Simon (eds.). Biological assessment and criteria: tools for risk-based planning and decision making. CRC Press/Lewis Publishers, Ann Arbor.

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

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

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

Gordon, N.D., T.A. McMahon, B.L. Finlayson. 1992. Stream Hydrology: An introduction for ecologists. John Wile and Sons Ltd., 526 pp.

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

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

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

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

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

Kelly, M. H. and R. L. Hite. 1984. Evaluation of Illinois stream sediment data: 1974-1980. Illinois Environmental Protection Agency, Division of Water Pollution Control. Springfield, Illinois.

Miner, R. and D. Borton. 1991. Considerations in the development and implementation of biocriteria, Water Quality Standards for the 21st Century, U.S. EPA, Office of Science and Technology, Washington, D.C., 115 pp.

Novotny, V. and G. Chesters. 1981. Handbook of nonpoint source pollution, sources and management. Van Nostrand Reinhold Environmental Engineering Series. Van Nostrand Reinhold Company, 555 pp.

Ohio Department of Natural Resources. 1960. Gazetteer of Ohio streams. Ohio Dept. Natural Resources, Division of Water, Ohio Water Plan Inventory Report No. 12.

Ohio Environmental Protection Agency 1995. Associations between nutrients, habitat, and aquatic biota in Ohio streams. Division of Surface Water, Columbus, Ohio, 175 pp.

___ 1992. State of Ohio Nonpoint Source Assessment:. Region. Division of Water Quality Planning and Assessment, Nonpoint Source Program Management Section, Columbus, Ohio.

___ 1992. Biological and Water Quality Study of Rocky Fork Walnut Creek and Blacklick Creek. Division of Water Quality Planning and Assessment, Columbus, Ohio.

___ 1990a. The cost of biological field monitoring. Division of Water Quality Planning and Assessment, Columbus, Ohio.

___ 1989a. Addendum to biological criteria for the protection of aquatic life: Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio.

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

___ 1989c. Ohio EPA policy for implementing chemical specific water quality based effluent limits and whole effluent toxicity controls in NPDES permits. Divisions of Water Pollution Control and Water Quality Planning and Assessment, Columbus, Ohio.

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

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

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the upper midwest states. EPA/600/3-88/037. U. S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon. 56 pp.

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

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

Rankin, E.T. 1995. Habitat Indices in Water Resource Quality Assessments, *in* W.S. Davis and T. Simon (eds.). Biological assessment and criteria: tools for risk-based planning and decision making. CRC Press/Lewis Publisher, Ann Arbor.

Rankin, E.T. and C.O. Yoder. 1991. Calculation and use of the area of degradation value (ADV). Division of Water Quality Planning and Assessment, Surface Water Section, Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Division of Water Quality Planning and Assessment, Columbus, Ohio.

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

Steedman, R.J. 1988. Modification and assessment of an index of biotic integrity to quantify stream quality in southern Ontario. Can. J. Fish. Aquat. Sci. Vol. 45.

Trautman, M. B. 1981. The fishes of Ohio with illustrated keys. Ohio State Univ. Press, Columbus. 782 pp

Whittier, T.R., D.P. Larsen, R.M. Hughes, C.M. Rohm, A.L. Gallant, and J.M. Omernik. 1987. The Ohio stream regionalization project: a compendium of results. EPA/600/3-87/025. 66 pp.

Yoder, C.O. 1995. Policy issues and management applications of biological criteria, *in* W.S. Davis and T. Simon (eds.). Biological assessment and criteria: tools for risk-based planning and decision making. CRC Press/Lewis Publisher, Ann Arbor (in press).

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

Yoder, C.O., J. DeShon, R. Thoma, E. Rankin, and R. Beaumier. 1986. Evaluation of effluent toxicity screening of two selected discharges. Division of Water Quality Monitoring and Assessment, Columbus, Ohio.

Yoder, C.O. and E.T. Rankin. 1996. Assessing the condition and status of aquatic life designated uses in urban and suburban watersheds. *in* Effects of Watershed Development and Management on Aquatic Ecosystems, Engineering Foundation Conference Proceedings, August 5-7, 1996, Salt Lake City, UT. (in press)

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multi-metric data, *in* W.S. Davis and T. Simon (eds.). Biological assessment and criteria: tools for risk-based planning and decision making. CRC Press/Lewis Publisher, Ann Arbor.