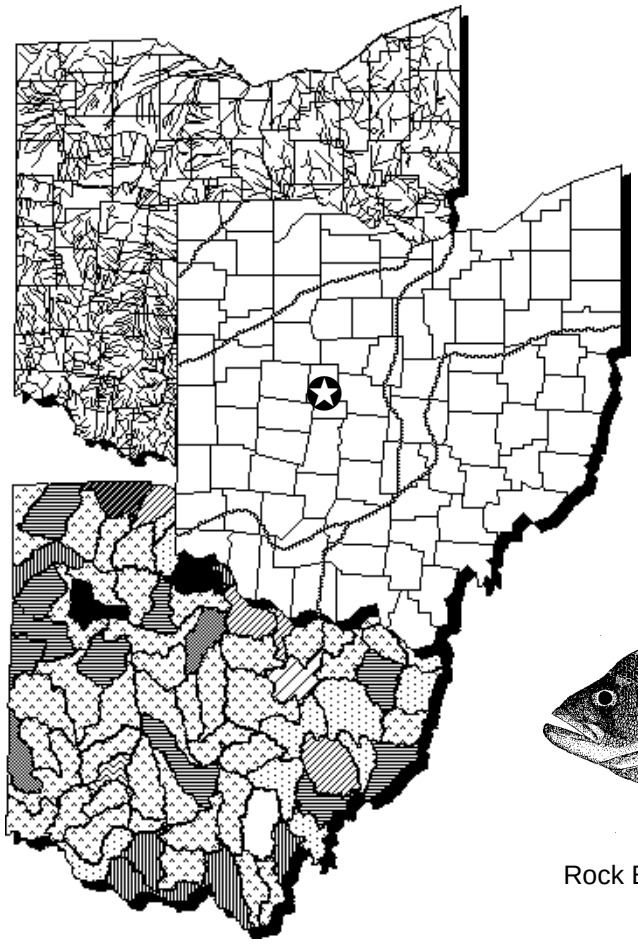
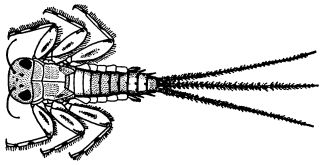
State of Ohio
Environmental Protection Agency

Ecological Assessment
Division of Surface Water

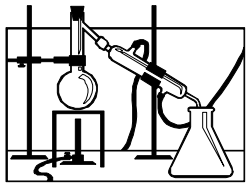
Biological and Water Quality Study of Mill Creek (Scioto River Basin) and Selected Tributaries

Logan, Union, and Delaware Counties, Ohio

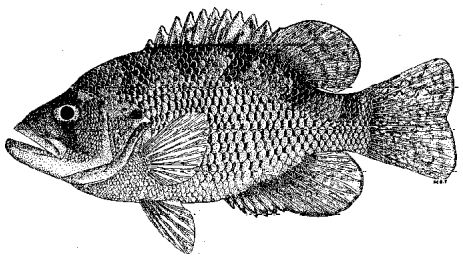




Mayfly *(Stenonema)*



Chemical Analysis



Rock Bass *(Ambloplites rupestris)*

June 30, 1997

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

Biological and Water Quality Study of Mill Creek (Scioto River Basin) and Selected Tributaries

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OEPA Technical Report MAS/1996-12-11

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Water
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NOTICE TO USERS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

These documents and this report can be obtained by writing to:

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

FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 10-15 different study areas with an aggregate total of 250-300 sampling sites.

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

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

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach is outlined in Figure 1 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and,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

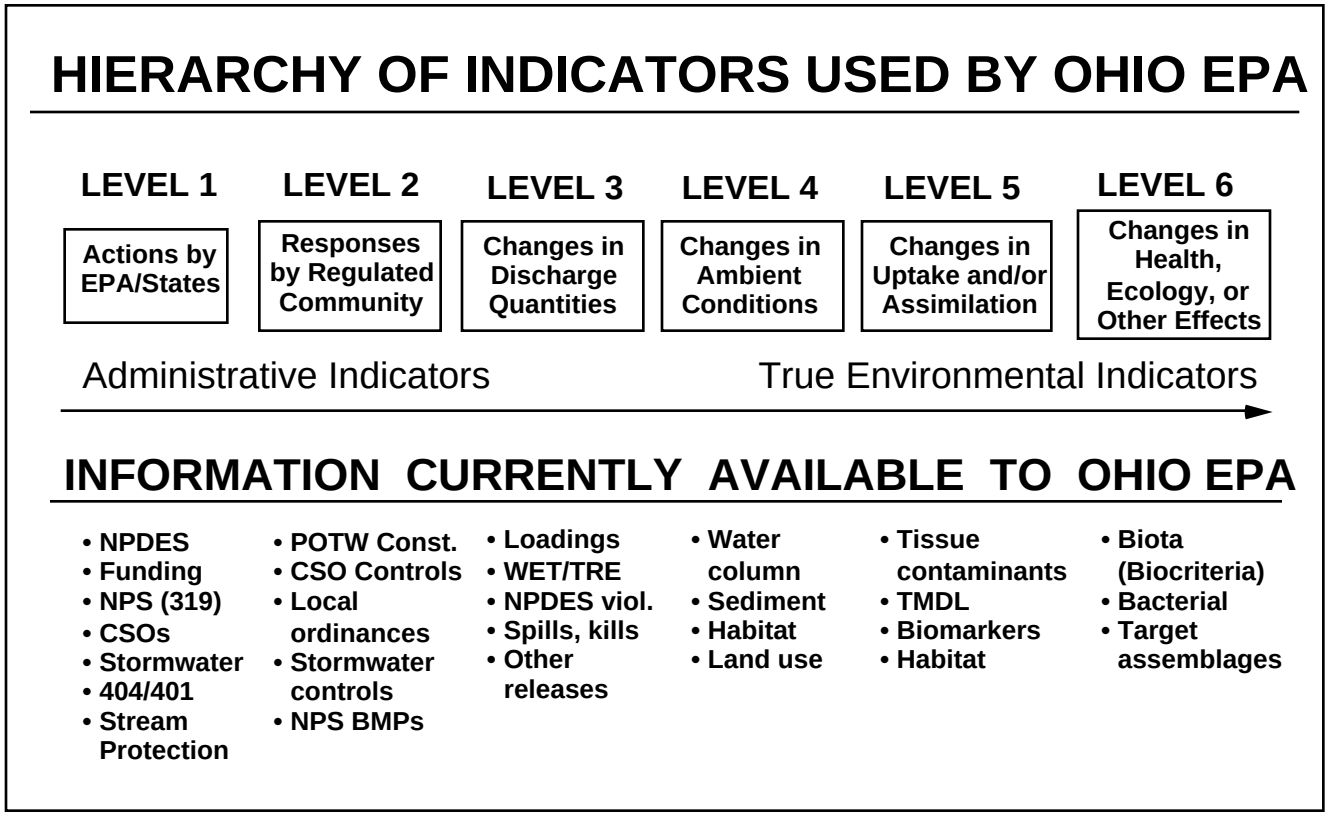

Figure 1. Hierarchy of administrative and environmental indicators used by Ohio EPA for monitoring, assessment, reporting, and evaluating program effectiveness. This is patterned after a model developed by the U.S. EPA, Office of Water.

generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the

biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.*, rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

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

Ohio Water Quality Standards: Designated Aquatic Life Uses

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

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

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

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the

   Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been*

sanctioned and permitted by state or federal law; the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

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

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

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.*, fecal coliforms, *E. coli)* and the criteria for each are specified in the Ohio WQS.Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health are detailed in other documents.

ACKNOWLEDGEMENTS

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

Study Area Description - Vince J. Mazeika, Central District Office (CDO)
Pollutant Loadings - Kathy Karam, CDO
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Sediment:Kathy Karam, CDO
Biological Assessment:
Macroinvertebrate Community - Jack Freda, CO
Fish Community - Brian Alsdorf, CO
Fish Tissue Analysis - Brian Alsdorf, CO
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TSD Coordinator - Jack Freda
Continuous Monitoring - Trinka Mount, CO; Kathy Karam, CDO
Editor - Jack Freda
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Biological and Water Quality Survey of Mill Creek (Scioto River Basin) and Selected Tributaries (Logan, Union, and Delaware Counties, Ohio)

State of Ohio Environmental Protection Agency
Division of Surface Water
1800 WaterMark Drive
P.O. Box 163669
Columbus, Ohio 43216-1049

INTRODUCTION

The Mill Creek study area extended from upstream of Otter Creek near East Liberty (river mile [RM] 39.4) to the Mill Rd. bridge (RM 1.8) near the confluence with the Scioto River. Sampling was also conducted in four small tributaries to Mill Creek: Town Run, the Crosses Run subbasin, Blues Creek and Otter Creek.

Specific objectives of this evaluation were to:

1) monitor and assess the overall chemical, physical, and biological integrity of the water bodies within the 1995 Mill Creek study area,

2) evaluate the influence of the Marysville Waste Water Treatment Plant (WWTP), a four million gallon per day (MGD) plant that discharges to Mill Creek at RM 18.26,

3) evaluate the influence of urban runoff in Marysville,

3) evaluate the influence of contaminated runoff from the Eljer Plumbingware RCRA (Resource Conservation and Recovery Act) site on Town Run and other point and nonpoint pollution sources in the Marysville urban area,

4) evaluate the impact of The Scotts Company and Subsidiaries, a formulater of fertilizers and fertilizers containing pesticides on Crosses Run, as a potential source of toxics and biological degradation,

4) provide biological and chemical data on nonpoint source concerns in the basin, and

5) evaluate any changes in ambient biological and water quality condition since previous intensive surveys of Mill Creek in 1978, 1986, and 1990, and expand the Ohio EPA database for long-term trend analysis (*e.g.*, 305[b] report).

The Mill Creek survey sampling effort included 27 chemical, physical and biological sampling

locations (see Figure 3; Table 3). A summary of the biological sampling results is presented in Table 1.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA such as NPDES permits, Director's Orders, and the Ohio Water Quality Standards (OAC 3745-1). They may eventually be incorporated into the State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Water Resource Inventory (305[b] report).

SUMMARY

Mill Creek

The 1995 survey assessed the lower 39.4 miles of the Mill Creek mainstem. A total of 27 chemical, physical and biological sampling stations were placed in a reach from upstream Otter Creek in Logan County [River Miles (RMs) 39.4 - 39.1] to near the confluence with the Scioto River at Bellepoint in Delaware County (RMs 1.7 - 1.6). Previous similar surveys between Marysville and Bellepoint were conducted by Ohio EPA in 1978, 1986, and 1990. Mill Creek is designated Warmwater Habitat (WWH) for its entire length.

The Marysville WWTP was the most significant source of impact to chemical water quality and biological community performance in the Mill Creek mainstem. The WWTP contributes, by far, the greatest proportion of point source loading to Mill Creek. Biological results showed the aquatic life use attainment was partial both immediately upstream and downstream from the discharge, but declined to nonattainment approximately two miles downstream. Nonattainment coincided with the measurement of consistently low dissolved oxygen (D.O.) concentrations and elevated levels of ammonia-N, total phosphorus, and fecal coliform bacteria downstream from the Marysville WWTP. Mixing zone sampling was primarily indicative of gross organic enrichment. However, the effluent has a recent history of significant chronic toxicity (based on bioassay testing). Additionally, avoidance of the mixing zone was noted during one of two fish sampling passes. Sharp loading increases in 1994-95 for ammonia-N, biochemical oxygen demand (BOD), suspended solids, copper, and zinc have been associated with the delivery of lime sludge from the water treatment plant. The introduction of sludge resulted in solids handling and removal problems at the WWTP. Degraded biological and water quality conditions and sewage solids were observed downstream from the discharge, indications of the reduced treatment efficiency.

Despite these impacts, the 1995 results reflect significant improvements in the overall quality of Mill Creek within the immediate Marysville urban area (upstream from the WWTP) and more rapid recovery downstream from Marysville than in previous years. More consistent performance by the WWTP should resolve much of the remaining partial and nonattainment in Mill Creek. Initial 1996 reports from Ohio EPA district personnel indicate the WWTP has made improvements in treatment since the 1995 survey.

Table 1. Aquatic life use attainment status for stations sampled in the Mill Creek basin based on data collected July-September, 1995. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of fish and macroinvertebrate communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities. All sites were evaluated using the "wading method" IBI metrics unless indicated otherwise.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	WWH Attainment Status[c]	Comments
Mill Creek						
			Eastern Corn Belt Plains WWH Use Designation (Existing)			
39.1/39.4	43	8.1[ns]	28/MG[d]	61.5	FULL	Ust. Otter Creek
36.1/36.0	46	8.2[ns]	40	64.0	FULL	Dst. Otter Creek
28.2/28.2	51	8.8	42	71.0	FULL	Wheeler-Green Rd.
24.8/24.8	49	8.7	40	73.0	FULL	Cotton Slash Rd.
19.3/19.3	41	8.5	40	74.5	FULL	Maple St.
19.1/19.0	45	7.7*	42	70.5	PARTIAL	Main St.
18.4/18.6	44	7.5*	40	77.0	PARTIAL	Dst. Town Run
18.2/18.2	*37*	*6.4*	*16*	*NA*	*NA*	*Marysville WWTP Mixing Zone*
18.1/18.1	39[ns]	6.6*	18*	71.0	PARTIAL	Cherry St.
16.2/16.9	36[ns]	5.2*	20*	63.0	**NON**	Adj. Waldo Rd
14.6/14.6	42	8.5	44	68.0	FULL	U.S. 36
12.0/12.1	37	8.3	42	78.5	FULL	Ust. Crosses Run
11.6/11.7	34*	8.0[ns]	40	74.5	PARTIAL	Dst. Crosses Run
6.9/6.9	38[ns]	8.6	G	74.5	FULL	Bellpoint/Hinton Mill Rd.
4.4/4.4	49	9.7	44	88.5	FULL	Ust. Ostrander WTP
3.7/3.7	54	9.4	44	81.0	FULL	Dst. WWTP & Blues Cr.
1.7/1.6	51	9.6	50	91.0	FULL	Near mouth
Otter Creek						
			Eastern Corn Belt Plains WWH Use Designation (Existing)			
0.7[H]/0.7	45	NA	G	70.5	FULL	Dst. U.S. 33 Construction
Town Run						
			Eastern Corn Belt Plains WWH Use Designation (Recommended)			
0.9[H]/0.8	26*	NA	F*	45.5	**NON**	Ust. Eljer Plumbingware

Table 1. (continued).

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	WWH Attainment Status[c]	Comments
Town Run *(continued)*						
0.7[H]/0.7	30*	NA	F*	53.5	**NON**	Dst. Eljer Plumbingware
0.1[H]/0.1	28*	NA	P*	60.5	**NON**	Dst. Marysville urban
Crosses Run						
Eastern Corn Belt Plains WWH Use Designation (Existing)						
2.8[H]/2.8	12*	NA	P*	28.0	**NON**	@ Dairy Farm
-- /2.4	NA	NA	4*	NA	(**NON**)	Ust. Trib./Water Dam
2.1[H]/2.0	12*	NA	0*	42.5	**NON**	Dst. Scotts Company
0.9[H]/0.6	12*	NA	6*	73.5	**NON**	Dst. N. Fk. Crosses Run
North Branch Crosses Run						
Eastern Corn Belt Plains Undesignated (WWH Use Recommended)						
1.0[H]/1.0	12*	NA	P*	45.0	**NON**	Ust. Scotts Company
0.2[H]/0.1	14*	NA	0*	30.5	**NON**	Dst. Scotts Company
Unnamed Tributary to Crosses Run at RM 2.24						
Eastern Corn Belt Plains Undesignated (No Recommended Use)						
-- /0.1	NA	NA	VP*	NA	(**NON**)	@ mouth
Blues Creek						
Eastern Corn Belt Plains WWH Use Designation (Existing)						
0.7/0.6	42	8.4	G	71.5	FULL	Near mouth

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

ns Nonsignificant departure from ecoregion biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).

a A narrative evaluation based on the qualitative sample (G-*good*, MG-*marginally good*, F-*fair*, P-*poor*) is used in lieu of the ICI when artificial substrate data are not available.

b All Qualitative Habitat Evaluation Index (QHEI) values are based on the most recent version (Rankin 1989).

c Use attainment status based on one organism group is parenthetically expressed.

d The quantitative (artificial substrate) sample was affected by nondetectable current speed; a *marginally good* narrative evaluation was substituted after further analysis of the data.

W Wading site type

Table 1. (continued).

H Headwater site type

Biocriteria: Eastern Corn Belt Plains (ECBP)
(OAC Chapter 3745-1-07, Table 7-17)

INDEX -	Site Type	WWH	EWH	MWH[e]
IBI -	Headwater/Wading	40	50	24
Mod. Iwb -	Wading	8.3	9.4	5.8
ICI		36	46	22

e - Modified Warmwater Habitat for channelized habitats

The remaining Mill Creek sites were in full attainment of the WWH aquatic life use except for a slight decline, resulting in partial attainment, at RM 11.6/11.7. This site was immediately downstream from Crosses Run which receives discharges from The Scotts Company. The drop into partial attainment resulted from the wide variation in fish community scores between sampling passes. The July 31 pass yielded scores in the *fair* range with an IBI of 28 and MIwb of 7.1. In contrast, the September 1 sampling yielded scores in the *good* to *very good* range with an IBI of 40 and MIwb of 8.9. IBI scores at two additional downstream sites between Crosses Run and Blues Creek (RMs 6.9 and 4.4) showed similar between pass variability (8-10 units), but the scores declined between the July and August sampling dates. Biological community performance improved at the remaining downstream sites (RMs 3.7 and 1.7) and was consistently in the *very good* or *exceptional* range on each sampling date. The large differences in passes between Crosses Run and Blues Creek was atypical of other Mill Creek sites and suggested periodic impacts and additional stresses from discharges or polluted runoff in Crosses Run. Chemical and biological sampling in Crosses Run revealed many water quality criteria exceedences and severely degraded biological communities adjacent to and downstream from Scotts. Over the past decade Crosses Run has yielded consistently *poor* quality biological communities while The Scotts Company has been associated with an extensive fish kill (1987), numerous NPDES permit violations, slug type discharges of ammonia, and contamination from pesticides and organic compounds.

While chemical and biological sampling continued to show significant impacts near the Marysville WWTP, conditions have improved both upstream and downstream from the WWTP when compared to previous surveys. Nonattainment in 1995 was limited to one sampling site (RM 16.2/16.9) compared to the four sites documented in 1990 between RMs 18.8 and 11.7. In the segment from Cotton Slash Rd. (RM 24.8) to the mouth, 18.3 river miles were in full attainment in 1995 compared to only 3.4 in 1990, 7.5 in 1986 and 1.7 in 1978. Conversely, miles of nonattainment (*not* including partial attainment) decreased from 10.9 in 1978, 6.0 in 1986 and 8.5

in 1990 to only 1.3 in 1995.

Exceptional biological community performance was achieved in the lower 5 miles of Mill Creek in 1995, well above the *marginally good* performance of 1990 and 1986. This improvement is portrayed in Figure 2 as the percentage of deviation by IBI scores from ecoregional expectations. In 1995 strong deviations were generally restricted to metrics that measure fish community pollution tolerance. Although tolerant fish predominated Mill Creek in 1995, metrics that measure structural and functional community aspects displayed significant improvement. Primary reasons for the changes include improved treatment and reduced loadings from point source discharges, elimination of problem discharges (*e.g.*, Ray Lewis metal plating, capping of CSOs in Marysville) and a lessening of toxic impacts downstream from Marysville. These changes were particularly manifested well downstream, in the lower reaches of Mill Creek.

Crosses Run

Biological and water quality conditions in Crosses Run have remained severely impacted during the past decade (1986-1995). Excessive concentrations of ammonia were also documented at the mouth of Crosses Run in 1978, nearly a decade earlier. The *very poor* condition of the fish and macroinvertebrates coincided with water quality standards exceedences for ammonia, pesticides, fecal coliform bacteria, and dissolved oxygen, and sediment contamination from pesticides and organic compounds.

The Scotts Company is a major source of biological and chemical impacts to Crosses Run that may extend downstream into Mill Creek. Plant operations and inadequate environmental controls contribute to the degraded conditions. For example, spraying of recycle pond water on test fields during a rainfall event (observed on June 30, 1995) resulted in direct runoff and extremely high ammonia levels in the North Branch of Crosses Run. Despite tertiary treatment, the five small package plants have had chronic treatment problems with a total of 189 NPDES permit violations from 1990 through 1995. Ammonia concentrations as high as 170 mg/l (limit 10 mg/l) were discharged from the 002 for six days in January 1992; as recently as February 1996, ammonia concentrations of 43 mg/l and 86 mg/l (limit 10 mg/l) were discharged from the same outfall. DERR sampling in 1994 identified pesticide and organic chemical contamination in soils and sediments associated with landfilling of product and field broadcast of off-specification pesticide products. Sampling in 1995 revealed water quality standard (WQS) exceedences of aquatic life and human health criteria for pesticides downstream from the facility. Fish tissue concentrations of the pesticide chlordane exceeded FDA action limits immediately downstream from Crosses Run with Scotts a suspected source. Chemical and/or biological impacts associated with Scotts have been described in water quality surveys since 1978 (Ohio EPA 1978, 1986, 1991). Also, in 1986, a fish kill that extended over fourteen miles downstream into the Scioto River resulted from a break in the wastewater recycling system at Scotts. It is clear the facility needs to improve treatment and increase efforts to segregate pollutants from their waste streams and the surrounding environment.

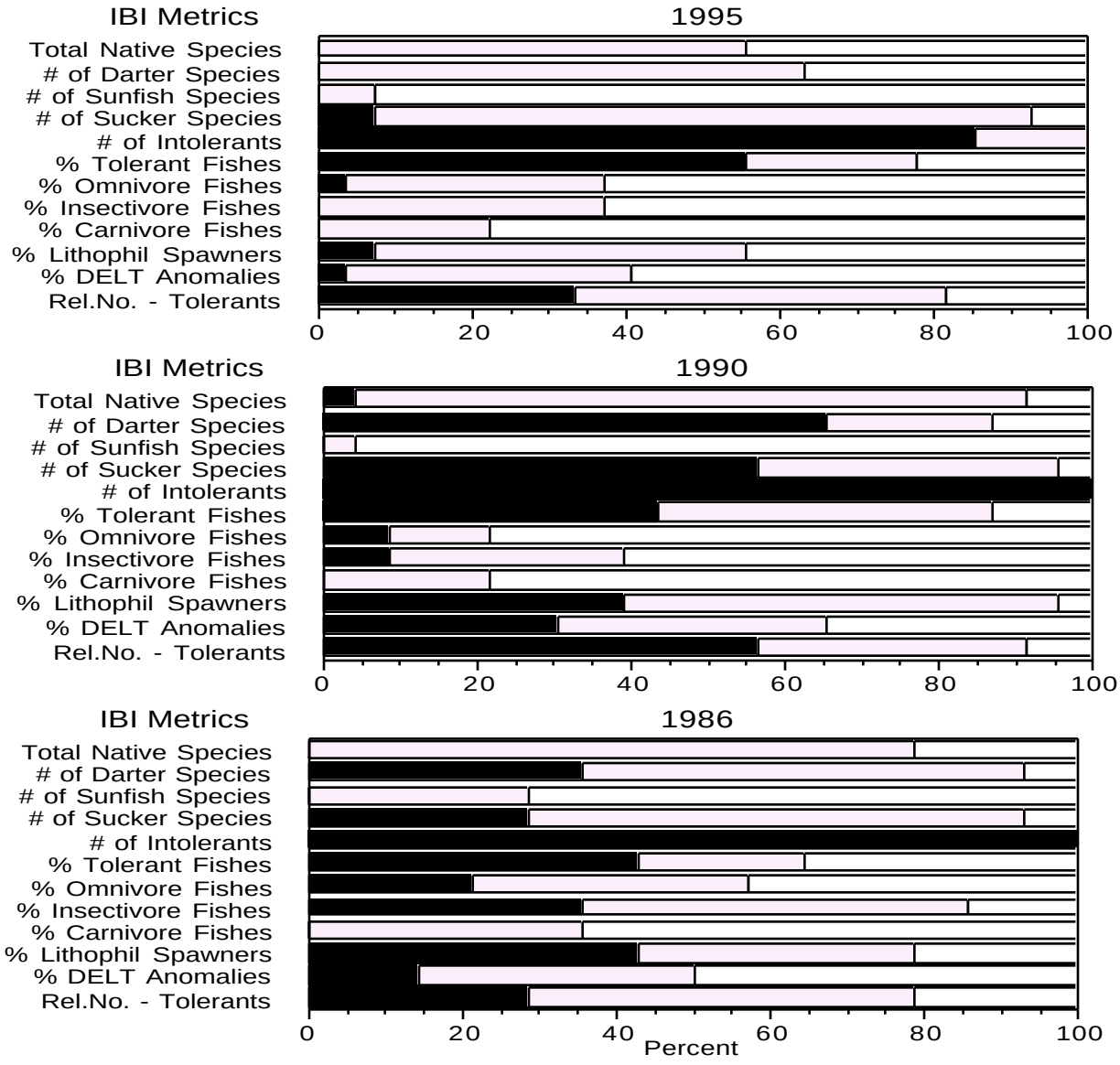

Figure 2. Composite of IBI metric scores from sites between RMs 25.1 and 1.7 (excluding mixing zones) sampled in Mill Creek, 1986-1995. The occurrence of individual metric scores (1,3,5) is expressed as a percentage. Black indicates strong deviation from ecoregional expectations. Grey indicates moderate deviation. White is within expectations.

Town Run

Despite improvements in Mill Creek in downtown Marysville, conditions at the mouth of Town Run have remained *poor* with no significant change since the 1986 survey. Degraded biological communities reflected stresses beyond the impacts in the upper reaches of the tributary from Eljer Plumbingware, urban runoff, septic tank drainage and habitat modification. Additional investigation, particularly of the culverted area in downtown Marysville, is needed to find more specific causes and sources of impact.

Other Tributaries

Sampling in the lower reaches of Otter Creek and Blues Creek revealed good quality fish and macroinvertebrate communities. The Otter Creek station was approximately 2-3 miles downstream from major road construction and expansion activities on U.S. 33 near East Liberty but no significant impacts were observed. Blues Creek no longer receives discharges from the unsewered village of Ostrander; a new WWTP was constructed after the 1990 survey and discharges directly to Mill Creek. However, there were no noticeable changes in biological communities at the site compared to the 1990 study.

NPDES Permit Violations

A review of NPDES permitted dischargers in the Mill Creek basin revealed over 850 violations among 10 minor dischargers (< 1 MGD) and one major discharger (the Marysville WWTP) between 1990 and 1995. While the total is quite large, many violations were associated with small discharges to small tributaries or ditches; their influence was considered localized and did not appreciably affect the mainstem. Other dischargers have ceased operating, been eliminated, corrected the problem discharge, or tied-in to the local municipal sewer system.

Two of the eleven dischargers (BMY Corporation, Union County Home), accounted for 40.2% of the total permit violations. An additional 22.1% were associated with The Scotts Company discharges in the Crosses Run subbasin. BMY discharged to an LRW designated petitioned ditch more than three miles upstream from the mainstem. After incurring numerous violations during peak production related to the Gulf War, the company closed in 1993 and is no longer a significant violator. The Union County Home, located nearly two miles upstream on Infirmary Ditch (an undesignated Mill Creek tributary), will tie-in to a new Marysville interceptor sewer being placed along State Route 4. Neither entity was considered a significant influence on the mainstem in 1995. Discharge characteristics from The Scotts Company were considered different with acutely toxic conditions and severe impairment of a WWH designated stream (Crosses Run) related to an active industrial facility. However, it is anticipated the company will tie-in to the local sewer system when an extension of service becomes available. The new line would also service Goodyear Corp. (1.8% of total violations) and BMY Corp. should that plant reopen. These facilities accounted for nearly two-thirds of the violations included in this report. The above cited actions should significantly reduce the number of permit violations in the future.

Based on instream biological and chemical results, the most significant consequences of NPDES violations occurred below the Marysville WWTP in Mill Creek and The Scotts Company in Crosses Run. A lengthy history of permit violations and associated impairments downstream from Scotts has been documented. Marysville recorded less than 9% of the total permit violations but was the largest source of point source loadings and associated use impairment on Mill Creek. In contrast, the small and recently constructed Ostrander WWTP accumulated nearly as many permit violations as Marysville (mostly for pH) but an exceptional biota was observed immediately downstream from the discharge. An evaluation of these sources using an array of source performance and ambient chemical/physical and biological indicators through the water quality survey process not only assessed the relative significance of any impacts on the receiving streams, but differentiated the most environmentally meaningful violators from the less important.

Initial reports from the Marysville WWTP in 1996 indicated the plant was operating within permit limits and many of the problems experienced in 1995 had been corrected. If this trend continues the end result should be further long-term improvements in biological and chemical performance instream.

CONCLUSIONS

Mill Creek

Water Chemistry

- The Marysville WWTP effluent continued to show variable quality despite past plant upgrades and implementation of a pretreatment program. Loadings of most conventional pollutants and metals had showed a declining trend in the late 1980s and early 1990s. However, since the 1990 survey, effluent performance has been increasingly variable and was especially poor during 1994-95. The solids problems associated with the acceptance of lime slurry from the water treatment plant were a major reason for the recent increases. Since 1995, treatment has improved at the plant according to district personnel. Bioassay monitoring conducted by Ohio EPA and the Marysville WWTP continued to suggest variable instream and effluent toxicity.

- Ammonia, nitrate and phosphorus concentrations rose dramatically downstream from the WWTP. Ammonia exceedences were detected for about 1.5 miles downstream from the WWTP while nitrate and phosphorus remained elevated between Marysville and the mouth (approximately 18 miles). Despite significant levels of ammonia in Crosses Run, only slight increases were noted in Mill Creek downstream from the confluence (RM 11.7).

- Fecal coliform bacteria levels, a good indicator of sewage inputs, most frequently exceeded

Ohio Water Quality Standards during 1995. Most exceedences were associated with point source discharges (e.g., the Marysville WWTP), septic ditches, agricultural runoff and other nonpoint sources of pollution.

- Continuous monitors detected a well-defined D.O. sag over an approximate eight-mile stretch between the Marysville WWTP and Crosses Run (RMs 18.14-11.7). Lowest concentrations were recorded at RM 16.8 (adjacent Waldo Road) where all measurements were below the minimum warmwater habitat (WWH) criterion (4 mg/l).

- Surface water samples were collected for analysis of volatile and semi-volatile organic compounds throughout Mill Creek. Chloroform was detected in the Marysville WWTP effluent and at RMs 18.3 and 18.1; its presence is a fairly common phenomenon associated with chlorinated sewage effluents. Pesticide analysis was limited to the two sites bracketing the confluence with Crosses Run but detectable amounts of mirex, heptachlor epoxide and hexachlorobenzene were detected in the water column at each site. Detection of these compounds *upstream* from the confluence raises concerns about potential sources in the Marysville area.

Fish

- In 1995, fish community performance in Mill Creek was *marginally good* to *good* with some *exceptional* assemblages noted upstream and downstream from a reach beginning in Marysville and continuing downstream from Crosses Run.

- The middle reach from Marysville to downstream from Crosses Run (RMs 19.4 to 11.6) was principally affected by urban polluted runoff and the Marysville WWTP. The Mill Creek Estates WWTP and sources originating in Crosses Run were also suspected of contributing to the degradation documented in this reach.

- Except for the middle reach of Mill Creek, *significant* improvement in fish community performance was recorded in 1995 compared to previous surveys in 1986 and 1990. Greatest improvements were recorded in the lower reaches of Mill Creek (approximately five river miles); conditions near the confluence with the Scioto River shifted from *marginally good* to *exceptional* during the past ten years. In contrast, fish community health continued to reach *poor* levels downstream from Marysville and the Marysville WWTP. Organic waste loadings and associated low D.O. levels were considered the primary sources of impact.

- Given the typically good quality macrohabitat conditions of Mill Creek, efforts to reduce the impacts documented in 1995 should result in better overall fish community performance.

Macroinvertebrates

- ICI scores were in the *good* to *exceptional* ranges at all sites upstream from the Marysville

WWTP. Significant improvement in ICIs (*e.g.*, from *fair* to *very good*) was noted in the Marysville urban area when compared to previous surveys in 1978, 1986 and 1990.

- The Marysville WWTP continued to be a significant source of impact to the macroinvertebrates. Mixing zone communities (RM 18.25) were *poor* and reflected significant organic enrichment. Downstream from the WWTP, ICI scores were in the lower *fair* range for approximately three miles before recovering to the *good* range at RM 14.6. While the magnitude of impact immediately downstream from the WWTP remained similar, 1995 results reflected less toxicity associated with the effluent and a more rapid recovery downstream than in the past.

- In contrast to previous surveys, Mill Creek communities downstream from Crosses Run exhibited little change from upstream and no significant impacts. Previously, recovery trends downstream from Marysville were interrupted in 1986 and 1990 downstream from Crosses Run.

- Communities in the lower reaches of Mill Creek have shown significant improvement over the past decade. ICIs scores at RM 1.6 reached the *marginally good* to *good* ranges between 1978 and 1990 but were clearly *exceptional* in 1995.

Fish Tissue

- Concentrations of the banned pesticide chlordane exceeded USFDA action levels in a fish tissue sample from Mill Creek immediately downstream from Crosses Run. These results implicate The Scotts Company facility on Crosses Run. High concentrations of chlordane were documented in soil and sediment at the facility in December 1994 (DERR 1994; file data).

Sediment

- Excluding iron, elevated levels of arsenic, chromium, lead, and zinc were encountered sporadically throughout Mill Creek. However, only arsenic and chromium were rated as highly or extremely elevated based on Illinois sediment ranking criteria (Kelly and Hite 1984). No concentrations reached Severe Effect Levels based on "ecotoxic effect" rankings described by Persaud *et. al.* (1994). The arsenic and chromium levels were not associated with any obvious discharges or pollution sources. Silver was detected upstream and downstream from the Marysville WWTP but the source remained unknown.

- Mirex and hexachlorobenzene were detected in the water column at the two Mill Creek sites bracketing Crosses Run (the only mainstem sites where water column pesticides were analyzed) but not in sediment samples.

- A series of nine polyaromatic hydrocarbon (PAH) compounds were found in sediments from the Marysville area (PAHs are semivolatile organics often associated with petroleum

production). The compounds were most consistently detected between Cotton Slash Road (upstream Marysville) and the Marysville WWTP (RMs 24.7-18.3). Polychlorinated biphenols (PCBs) and volatile organic compounds (VOCs) were not detected in any of the sediment samples collected. No organics were detected in sediments from the lower 12.2 miles of Mill Creek despite significant contamination in Crosses Run.

- Sediment contamination appeared less severe in the Mill Creek mainstem than in Town Run and Crosses Run, the two degraded tributaries sampled during the survey. Chlordane was not analyzed in 1995 sediment and water column samples so the status of this pesticide in Mill Creek was unknown.

Crosses Run

- Fish and macroinvertebrate communities continued to reflect acutely toxic impacts downstream from The Scotts Company. The biological indices were routinely in the *poor* or *very poor* ranges. On three of four sampling occasions, no fish were found at the mouth of the North Branch Crosses Run (RM 0.1) or from Crosses Run immediately upstream from the confluence (RM 2.1). Similar conditions influenced the macroinvertebrates where nearly identical, tolerant communities received "0" ICI scores (0-60 scoring range) at each station. The similarities in impact response between the separate waterbodies suggests similar water quality stressors in both the North Branch and Crosses Run.

- *Poor* biological conditions at sites upstream from The Scotts Company were primarily related to the very small stream size, flow desiccation, and unrestricted cattle access near Crosses Run RM 2.8. Despite these severe conditions, additional impacts of a toxic nature were found downstream from Scotts despite improved habitat and perennial flow.

- Scotts' five package type wastewater treatment plants experienced numerous permit violations from 1990 through 1995, primarily for ammonia and residual chlorine. Outfalls 001 and 002 were found acutely toxic during bioassay testing conducted by Ohio EPA in February 1996. Compliance sampling from these outfalls in November 1995 and February 1996 also revealed several pesticides including atrazine, cyanazine, pendimethalin, and diazanon. A small but detectable amount of trans-chlordane was also found in the Crosses Run water column immediately downstream from the North Branch.

- Ammonia concentrations were highly elevated at several locations within Crosses Run. Inconsistent treatment at Scotts package WWTPs and contaminated storm water runoff from the plant property were considered the primary sources of ammonia. Fecal coliform bacteria exceedences were also prevalent throughout Crosses Run.

- A continuous monitor near the mouth of Crosses Run recorded D.O. concentrations below the minimum WWH criterion (4 mg/l) during a 40-hour sample collection period. The minimum

value was 1.86 mg/l with a maximum value of 3.67 mg/l.

- Many water quality standards exceedences were detected for pesticides in the Crosses Run subbasin downstream from The Scotts Company property and discharges. Pesticides included aldrin, dieldrin, endrin, endosulfan I and II, heptachlor, DDT metabolites, and a lindane isomer. Numerous semivolatile contaminants were also detected in water samples near the facility.

- Analysis of sediment metals indicated elevated to extremely elevated concentrations of arsenic, copper, chromium, iron, lead and zinc in the Crosses Run subbasin. However, exceedences of the severe effect level (SEL) criteria described by *Persaud et al.* (1994) were limited to the most upstream site on Crosses Run (RM 2.8).

- Crosses Run sediments also contained highly elevated concentrations of the pesticides dieldrin and heptachlor epoxide (Kelly and Hite criteria), and numerous semivolatile compounds (mostly PAHs) which exceeded SEL criteria. Sampling by DERR in 1994 revealed extremely elevated concentrations and SEL exceedences for chlordane, DDT metabolites, and dieldrin. These compounds were also found adjacent to Crosses Run in soil samples from The Scotts Company property. The pesticide chlordane was not analyzed during the 1995 survey.

Town Run

- Impaired biological communities in Town Run were associated with habitat modification, urbanization, the Eljer Plumbingware RCRA site, and septic tank drainage (Town Run is sewered but a few homes have remained unconnected; septic tank drainage at the most upstream sampling site was considered a source of biological and water quality impacts). However, the most severe impacts were observed at the mouth, downstream from the Marysville urban area and a culverted section of the stream. Oil sheens and foul odors observed at the mouth suggested contributions from additional unknown sources in the downtown area.

- Copper, lead, and zinc levels increased sharply downstream from Eljer Plumbingware at RM 0.6. Copper exceeded the final acute (FAV) criterion in three samples from RMs 0.6 and 0.1 and zinc exceedences were found only at RM 0.6. While copper and lead exceedences were detected at all three sample locations, highest concentrations were found downstream from Eljer Plumbingware.

- Many fecal coliform bacteria exceedences were encountered throughout Town Run. Septic tank drainage at the most upstream site (RM 0.8) was an obvious source, but polluted nonpoint urban runoff or other unknown sources may also contribute to the contamination.

- Surface water samples revealed no detectable volatile, semivolatile or pesticide/PCBs in the water column of Town Run.

- Sediment sampling was limited to a single site at the mouth of Town Run. Lead and zinc were detected at extremely elevated concentrations and a sediment organic scan revealed numerous semivolatile compounds along with dieldrin, DDE, BHC, and mirex. Earlier sediment metals sampling by DERR (Ohio EPA 1996) found extremely elevated copper, lead and zinc levels in Town Run immediately downstream from Eljer Plumbingware and highly to extremely elevated concentrations downstream to the mouth.

RECOMMENDATIONS

Status of Aquatic Life Uses

Some streams evaluated in this study were originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. Since this study represents the first time biological data were used to evaluate and establish aquatic life use designations in these streams, some 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.). However, these changes should not be so construed because this represents the first use of an objective and robust use evaluation system and database. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside the WWH use before 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. Table 2 is a current listing of use designations for water bodies in the Mill Creek basin; recommended changes or additions to stream designations based on the 1995 survey results are also noted in Table 2.

Mill Creek

Habitat conditions throughout the mainstem are more than adequate to support warmwater and, as demonstrated in some areas, *exceptional* warmwater communities. Demonstrated attainment of the WWH use designation upstream and well downstream from Marysville clearly supports the current WWH designation. The WWH aquatic life use is recommended although, *exceptional* biological performance in the lower reaches of Mill Creek in 1995 may reflect the ultimate potential in this stretch.

Crosses Run

An extensive use designation analysis for Crosses Run was conducted during a 1990 Mill Creek study (Ohio EPA 1991). Warmwater habitat was the recommended use based primarily on the relatively natural habitat qualities present downstream from The Scotts Company and the lack of ongoing channel maintenance by local authorities. Crosses Run near The Scotts Company appeared to have undergone some historic modifications and the grass banks are maintained. The 1991 report concluded that habitat improvement measures in these areas could result in increased

Table 2. Waterbody use designations for the Mill Creek basin. Recommended changes in use or new use designations appear in bold italics and are designated with a ▲. Designations originally based on 1978 water quality standards are denoted with a *. A + is used to indicate the designated use is based on results of a biological field assessment performed by Ohio EPA.

Stream Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recre-ation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Mill Creek		+						+	+			+		
Blues Creek - headwaters to St. Rte. 4 (RM 11.5)				+				+	+			+		ECBP Ecoregion -Channel Mod.
- State Route 4 to the mouth		+						+	+			+		
Ronolds Run		*						*	*			*		
Dry Run		*						*	*			*		
Grassy Run		*						*	*			*		
Dun Run		*						*	*			*		
Town Run		▲											▲	
BMY Tributary (Mill Cr. RM 9.3)							+	+	+				+	Small Drainage Maintenance
Phelps Run		*						*	*			*		
Crosses Run		+						+	+			+		
North Branch Crosses Run		▲											▲	
Otter Run		*						*	*			*		
Otter Creek		*/+						+	+			+		

stream potential in the absence of existing water quality impacts. Based on the 1995 survey, aquatic life performance was well below WWH, Modified Warmwater Habitat (MWH), and even Limited Resource Water criteria (*fair/poor* limit). The *very poor* condition of the biological communities was considered strongly associated with water quality and sediment contamination from The Scotts Company. As in 1990, no improvements in biological communities are anticipated, regardless of habitat quality, until the chemical quality improves.

North Branch of Crosses Run

Previously unnamed, the North Branch of Crosses Run is a small, headwater drainage that originates in fallow pastures and agricultural fields west of The Scotts Company. The stream then traverses the property and enters Crosses Run at RM 1.95. Physical habitat conditions (mean QHEI=38.0), drainage area (1.5 square miles), and biological community health conditions (poor/very poor) were nearly identical to the WWH designated section of Crosses Run upstream from the North Branch (mean QHEI=35 and 1.2 square miles, respectively). Like upper Crosses Run, the North Branch appeared to have undergone some historic modification on Scotts property and the grass banks are maintained. However, there is no ongoing channel maintenance by local authorities covered under sections 401, 404, or Chapter 6131 of the Clean Water Act. Also, the stream is not under regular channel maintenance for "small drainageway maintenance" as described under the definition of a Limited Resource Water (LRW) (OAC 3745-1-07). Like upper Crosses Run, habitat improvement measures in the modified areas could result in increased stream potential in the absence of existing water quality impacts (Ohio EPA 1991). These factors essentially preclude the MWH or LRW designations. Warmwater Habitat is considered the most applicable aquatic life use designation.

Town Run

Town Run is a small, previously undesignated, urban stream in Marysville. Habitat conditions were generally fair (average QHEI value of 53.2) and examples of anthropogenic influence in the stream were many (*e.g.*, snagging, canopy removal, small channel modifications, etc.). Biological communities were in the *fair* and *poor* ranges but most impacts could be at least partially attributed to obvious pollution sources such as septic tank discharges (a few remain in the drainage) and the Eljer Plumbingware landfill. Oil sheens and foul odors observed downstream from the culverted section in downtown Marysville suggested additional, unknown pollution sources. Until it is determined that biological performance will not improve in the absence of these impacts, the WWH use designation is considered appropriate.

Otter Creek

Otter Creek was originally designated WWH using the 1978 water quality standards. Based on the 1995 biological and physical habitat assessment, the existing WWH designation is considered appropriate. Both fish and macroinvertebrates fully attained the WWH use at RM 0.7 and physical habitat conditions (QHEI=70.5) were adequate to support WWH communities.

The status of physical habitats and the condition of biological communities upstream near the recent U.S. 33 construction was not extensively evaluated in 1995. Based on field observations by Ohio EPA nonpoint source staff, at least short term impacts to stream habitats have occurred (see page 23). However, stream gradients in this reach are quite high (a benefit to recovery) and attempts were made following construction to enhance riffle-pool development. Future surveys in the Otter Creek subbasin should evaluate this reach to monitor long-term recovery trends.

Blues Creek
For Blues Creek, no changes in the current WWH designations or MWH designation in upper watershed are recommended.

Status of Non-Aquatic Life Uses
Excepting Town Run and the North Branch of Crosses Run, no changes in existing non-aquatic life use designations are recommended.

- Town Run was previously undesignated. Habitats in this small, urban stream included some shallow pools (> 40 centimeter depth) but none exceeded the one meter or greater depth generally associated with the Primary Contact Recreation designation. For this reason the Secondary Contact Recreation (SCR) designation is considered appropriate.

- The North Branch of Crosses Run is small and lacks deep pools except when the North water dam (a spill control impoundment) is closed. The impoundment and most of the streams length is located on The Scotts Company Property and access by non-employees is restricted. Therefore, the potential for full body contact is minimal. The Secondary Contact Recreation (SCR) designation is recommended.

Other Recommendations
- The Marysville WWTP outfall is directly opposite a city park. During the 1995 survey, field crews often observed children wading in and near the effluent discharge. Considering the many fecal coliform exceedences associated with the discharge, the city should consider posting signs to identify the outfall and warn citizens to avoid contact with the effluent.

- Water stops installed on The Scotts Company property were intended for spill control following a large fish kill in 1987. However, despite being utilized often when high levels of ammonia were detected in monitoring samples, no spill incidents were reported from the company during 1990-95 (Ohio EPA DERR file data). If an unregulated or unpermitted release of pollutants occurs at the facility, it should be considered a spill and reported to Ohio EPA in the future.

- Numerous WQS exceedences were detected in Town Run downstream a from septic tank discharge at RM 0.8. The Union County Health Department should be notified of problem

discharges from failing on-site septic systems. Additional impacts observed downstream from the culverted section of Town Run in Marysville should also be investigated for illegal tie-ins or unknown discharges.

Future Monitoring Needs

- A potential source of pollutants in the immediate area of The Scotts Company that was not evaluated in 1995 was air emission and fallout of particulate matter and gaseous ammonia. Over 80 permitted air sources at the Scotts facility emitted a reported 47.42 tons of particulate matter during 1996. In addition, it is estimated by CDO Division of Air Pollution Control (DAPC) that Scotts emits as high as 500 tons of gaseous ammonia per year. The Ohio EPA DAPC does not regulate ammonia except as a toxic substance, thus no ammonia limits exist in Scotts' air permits. The Scotts Company also houses a Research and Development section at Marysville that experiments with raw materials of unknown quality and quantity.

  Prevailing winds from the southwest carry much of this material toward Mill Creek. The Central District Office Division of Air Pollution Control has received numerous complaints from citizens and neighboring industrial entities regarding airborne particulate matter accumulating on cars and parking lots. Some of these events have been so significant that the OEPA officials have collected large quantities of the particulate material off cars and parking lots. Dispersion of this material could affect a large area surrounding the facility.

  The combined effect of permitted gaseous emissions (primarily ammonia) and fugitive particulate emissions on surface waters is unknown, although the potential for impacts exists. It is recommended that future studies consider this potential impact. Air source dispersion models could provide a predictive mechanism to estimate concentrations of various by-products leaving Scotts facility that may indirectly affect surface waters. This information may help to explain results from the 1995 study or future water quality surveys in the Marysville area.

- Excessive copper and cyanide levels were occasionally detected in Mill Creek immediately upstream from the Marysville WWTP at RM 18.33 and were not entirely explained by known sources (*e.g.*, the Eljer Plumbing landfill on Town Run). Cyanide was not detected in Mill Creek upstream from Town Run or in Town Run, but was regularly detected upstream from the Marysville WWTP and at several sites downstream. Additional investigation is needed to locate the source(s) of cyanide and copper. These may include the Ray Lewis and Marysville landfills, non-contact cooling water discharges from Ray Lewis at RM 18.41 (process wastes are directed to the WWTP), and storm sewers that may discharge between Town Run and the Marysville WWTP.

- The detection of mirex and hexachlorobenzene in a water column samples from Mill Creek upstream from Crosses Run should prompt additional investigation into potential sources.

Beyond the Marysville area, a thorough investigation should also include: (1) Beech Ditch, a small tributary that enters Mill Creek at RM 13.84. A fish kill and spill of anhydrous ammonia from a farm chemical supplier (Terra International) were recorded in May 1991. (2) Mill Creek Estates WWTP at RM 12.57. (3) An unnamed tributary that enters Mill Creek near Mill Creek Estates (upstream from Crosses Run) and drains portions of Scotts test fields.

- Any future monitoring of pesticides from water or sediment samples in the basin should include analysis for chlordane.

- Throughout the Marysville area along Mill Creek and Town Run, many small discharges, drainage pipes and storm sewers were observed. A thorough investigation locating, identifying and characterizing these discharge points could aid in evaluating and correcting problems instream. A similar "stream walk" inventory by the Northwest District Office along the Olentangy River in Galion, Ohio documented almost 60 discharge points in four miles of river (Ohio EPA 1996a).

- The section of Otter Creek adjacent to the U.S. 33 road construction and expansion in Logan County should be monitored to learn aquatic life use status and long-term recovery trends.

- Analysis of chemical results for longitudinal and historical trends was occasionally hampered by incomplete parameter coverage, both within the 1995 study area, and for comparisons with previous surveys. Mill Creek has been selected as a target subbasin by the Central District Office to demonstrate a holistic, watershed based approach to water quality management and restoration of identified chemical, physical and biological impairments. With this goal in mind, efforts should be made to normalize analysis for all samples collected in the basin. Standard analysis should include not only stream surveys, but other sampling regiments employed at Ohio EPA (e.g., DERR, CSIs, bioassay, modeling, fixed stations, complaints). The ultimate result of this approach would be a robust database with much greater utility in the long term.

STUDY AREA DESCRIPTION

Physical Geography

The Mill Creek basin drains 178 square miles in Logan, Union and Delaware counties. The headwaters of Mill Creek rise in the Eastern Corn Belt Plains of West Central Ohio approximately two miles east by south east of Rushylvania in Logan county. Just east of Walnut Grove the creek crosses the old Greenville Treaty Line (County Road 26) and moves southeast. Passing within a mile of North Greenfield it continues into Union county. Skirting Lunda, Raymond, and Peoria, Mill Creek flows through Marysville then continues east passing New Dover and Watkins. Less than a mile south of Ostrander in Delaware county, it receives Blues Creek, persists eastward then enters the Scioto River at Bellepoint, in view of the US 42 bridge.

Near the headwaters at County Road 26 and the village of Walnut Creek the bench mark elevation is 1147 feet. The first sample site on Mill Creek (Logan County Road 131) is at 1090 feet. Approximately 20 miles downstream in Marysville, elevation has dropped 120 feet and falls an additional 130 feet upon reaching the mouth at Bellepoint.

Mill Creek and its tributaries lie within the Central Lowlands physiographic region. The topography of this drainage area strongly reflects glacial deposition. Advancement of the Wisconsin glacier over the sedimentary bedrock was the predominant geologic influence. Ground moraines left nearly level or gently sloping terrain while end moraines show their presence by steeper slopes or a hilly, hummocky aspect. Glacial lake beds provided flats and the meltwater incised the present stream patterns down through the till and drift.

The source of the Mill Creek headwaters is a series of terminal moraines that arc around a “bedrock high” near Bellfontaine in southeastern Logan County. Dolomite and other limestones form the underlying bedrock in the basin. Glacial movement over this base produced calcareous tills and left igneous rocks now found in the substrates of the Mill Creek system.

A glacial lake bed (drained by Otter Creek) lies north east of the village of East Liberty. Poor drainage and channelization (ditching) characterize these flats north of SR 347.

North of Raymond, Mill Creek flows at the base of the Broadway Moraine that extends south east to Wheeler - Green Road. Many intermittent tributaries drain this glacial deposition feature. Sites subject to severe erosion on Morley and Blount soils extend from 1/2 to 1 mile west of SR 739 and south of Hoover-Bault Road. Union County Natural Resource Conservation Service (NRCS) staff state that a comparatively large number of acres on this moraine participate in the Conservation Reserve Program. However, recent legislative changes may result in many acres returning to active cultivation.

Blues Creek flows along the base of a recessional moraine extending east from SR 4 to Mill Creek south of Ostrander.

This watershed experiences the cold winters and moist, warm, summers of a humid continental climate. Large daily changes in temperature are common. Precipitation may vary widely from year to year but is normally abundant and widespread. Thunder storms occur about 40 times a year in Union county, usually between April and August (Union County NRCS)).

In the study area, cultivation and planting take place between mid April and mid June. This coincides with the period of historic highest average monthly precipitation. The overlap of these human and natural phenomena holds the potential for soil loss and runoff into surface waters. October has the lowest monthly average precipitation and lesser potential for surface runoff. During this period groundwater contributes a larger portion of the flow in Mill Creek system than at other times of the year (pers. comm., Richard Swisshelm, U.S.G.S. - Water Resources Division, Columbus, Ohio).

The headwater area of Mill Creek shows the densest tree cover in the watershed. As one proceeds downstream, a greater concentration of forest cover is found in riparian corridors as cultivation dominates the landscape. In 1996 forest covered approximately 7% of Union county. Many reaches show some forested riparian corridors, though they may be narrow. In recent years there has been considerable timber buying activity. This has resulted in the removal of higher value hardwoods such as oaks, leaving lower value species to reseed (pers. comm., Kathy Smith, ODNR Division of Forestry).

The dominant species found along tributaries of the watershed include: cottonwood, silver maple, red maple, sycamore, box elder, buckeye, hackberry, willow, green ash and American elm.

Soils found in the Mill Creek drainage basin are formed of high lime glacial drift, till and lake sediments. The texture and slope of the parent glacial materials strongly influence drainage, permeability and erosion potential that can vary greatly from site to site. There are soils with high erosion potential (frequently on the slopes of end moraines) and soils of very slow permeability (often in glacial lake beds) within the study area (United States Department of Agriculture, 1975). These characteristics present limitations for cultivation, construction, septic treatment and other uses, which if exceeded may impact surface water.

In the upper reaches of the watershed, flooding between Walnut Grove and the intersection of SR 292 and County Road 2 is viewed by many land owners as a serious problem (pers. comm., Logan County NRCS).

Cultural Geography

The US census count for Union county in 1990 was 31,969. The National Population Assessment (NPA) data services projection for year 2000, (found in the most recent county plan), is 37,400. Local government and chamber of commerce officials believe this figure was reached or slightly exceeded in 1996 for an increase of 17% (pers. comm., Union County Engineers Office). Most population increases since 1980 have occured within Marysville and adjoining townships to the north. Nearly all of this area is within the study watershed.

Within the watershed, the period 1991-1996 saw little change in total acreage farmed, but the trend toward fewer and larger operations continued. In Logan County, the head waters and upper reaches of the watershed drain end moraines and fine textured soils. Between Walnut Grove and SR 47 (approximately RMs 46-20) there is considerable acreage in the Conservation Reserve Program (CRP). However a decline of 12% to 30% is expected as more acres return to cultivation in response to the 1996 Farm Bill. The percentage of CRP acres drops south of SR 47, due in part to the gentler topography and lessened threat of soil erosion. The number of "No Till" acres have remained essentially steady here (pers. comm., Logan County NRCS).

Between North Greenfield and Walnut Grove there are several 100 head dairy herds. Beef operations of 10 to 25 head are estimated to number between 8 and 12. Poultry and swine operations are small and few in number. In Union County's share of the watershed, concentrated swine operations are increasing in number but the small number of dairy farms has changed little.

Estimates (1996) for field cover in the Union County portion of the watershed are: corn 30%, soybeans 60% and wheat 10%. "No till" practice continues to expand, although it is largely confined to wheat and soybean fields. Recent (1996) changes in federal agricultural policy are resulting in decreased Conservation Reserve Program acres. Local officials believe this trend will disproportionately affect the Broadway moraine that presently has a concentration of CRP acreage, thus putting more acres under cultivation (pers. comm., Union County NRCS).

The building of the Honda Manufacturing plant (in the Big Darby watershed) has been a dominant stimulus for land use change within the study watershed during the last fifteen years. In Union county, single family home building permit applications more than doubled between 1991 and 1996 (197 to 403). Yet most development in the watershed has occurred in Marysville proper. Local officials expect the Marysville sewage treatment facility to expand in the next three years (pers. comm., Union County Engineer's Office).

The rail and highway corridor between Marysville and the Columbus perimeter is expected to draw the major part of development in the future (only the portion north of County Road 37-Beecher Gamble road lies within the watershed). Yet the potential for land use change is increasing north and west of Marysville as well. Extended water and sewer line service facilitates land use change as development follows the utilities.

Raymond and Peoria are expected to be sewered in the next 3 to 5 years. Should this occur, impacts on Mill Creek's unnamed tributary south of Raymond may lessen. A sanitary sewer trunkline is proposed along SR 4 toward County Road 132. Besides stimulating development, the action would enable the County Home and existing subdivisions to quit the problematic package sewage treatment plants used in 1996 (pers. comm., Union County Engineer's Office).

Although at a slow pace, single lot residential development is occurring and expected to continue in the upper reaches of the watershed south of Walnut Grove (along SR 292 between SR 47 and SR 540). Sewage lines do not yet serve this area. The new Ben Logan School complex, which opened in 1996, is expected to draw new residents here (pers. comm., Logan County Planning Office). West Mansfield, though not in the study water shed, is upgrading sewage treatment facilities. The expected stimulus to development may extend over the watershed boundary south toward Mill Creek.

Otter Creek / US 33 Construction

Construction work on US 33 West of East Liberty has visibly impacted Otter Creek. From County Road 145 and the intersection of SR 347 and "old" 33, the stream is constricted between the old and newly constructed road berms. In some sections the road berms are adjoining with the stream banks on both sides.

Upstream of East Liberty several nonpoint source (NPS) preventive measures were installed during the construction period: silt fence, bank seeding, shrubs, rip rap and installation of small cobble-boulder dams for sediment retention. In late 1996 these measures showed varying degrees of effectiveness. The steeper berm sections, though well seeded, show developing gullies. Some shrubs appeared to be washing out, even those planted well above the stream's high water level. The most prominent observation was the migration of fines from the road berm slope into the stream.

The small dams have allowed the settling of these fines in downstream pools. These pools and associated runs show the deposition of fines in thick, agglutinated layers. At a distance, these sections take on the appearance of sheet like, limestone strata. A jab with a stick proved otherwise. South of East Liberty at the SR 347 bridge, no similar deposition and agglutination of fines into layers was observed. The dams and pools in the former construction area may be effective in preventing heavy migration of fines but much of the substrate at these deposition sites has been sealed over with hardpan like layers.

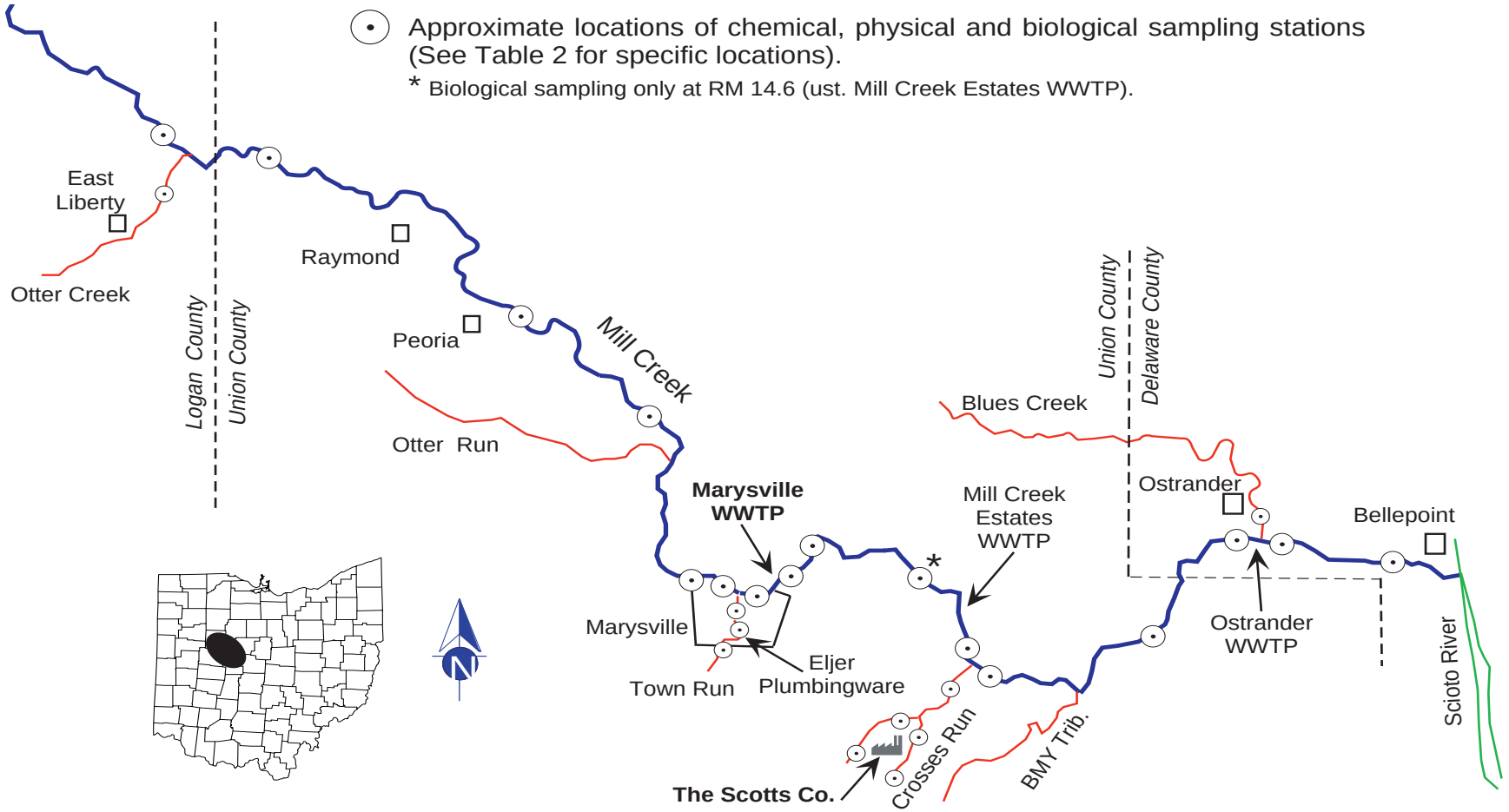

Figure 3. The Mill Creek Study area showing principal streams and tributaries, population centers, pollution sources, and environmental monitoring stations.

METHODS AND MATERIALS

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. Chemical, physical and biological sampling locations are listed in Table 3.

Determining Use Attainment Status

The attainment status of aquatic life uses (*i.e.*, FULL, PARTIAL, and **NON**) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-17). The biological community performance measures which are used include the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The ICI was developed by Ohio EPA (1987b) and further described by DeShon (1995). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being 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 *et al.* 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 is at least *fair*, and **NON**-attainment if all indices fail to attain or any index indicates *poor* or *very poor* performance. Partial and non-attainment indicate that the receiving water is impaired and does not meet the designated use criteria specified by the Ohio WQS.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI

score which generally ranges from 20 to 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 frequently typify habitat conditions which have the ability to support *exceptional* warmwater faunas.

Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates. During the present study, macroinvertebrates collected from the natural substrates were also assessed using a new index currently in the testing and refinement phase. This method relies on tolerance values derived for each taxon, based upon the abundance data for that taxon from artificial substrate (quantitative) samples collected throughout Ohio. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon has been collected are weighted by its abundance on the artificial substrates. The mean of the weighted ICI scores for the taxon results in a value which represents its relative level of tolerance on the ICI's 0 to 60 scale. For the qualitative collections in the Mill Creek study area, the median tolerance value of all organisms from a site resulted in a score termed the Qualitative Community Tolerance Value (QCTV). The QCTV shows potential as a method to supplement existing assessment methods using the natural substrate collections. QCTV scores for sampling locations in the study area were used in conjunction with other aspects of the community data to make evaluations and were not unilaterally used to interpret quality of the sites or aquatic life use attainment status.

Fish Community Assessment

At most stations, fish were sampled twice using wading method pulsed DC electrofishing gear. Exceptions were Town Run and the two most upstream sites in the Crosses Run subbasin which were sampled once. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling Laboratory Methods for Assessing Fish and Macro-invertebrate Communities (Ohio EPA 1989b).

Area of Degradation Value (ADV)

An Area Of Degradation Value (ADV; Rankin and Yoder 1991; Yoder and Rankin 1995) was calculated for the study area based on the longitudinal performance of the biological community indices. The ADV portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, or ICI) departs from the applicable biocriterion or the upstream level of performance (Figure 4). The "magnitude" of impact refers to

the vertical departure of each index below the biocriterion or the upstream level of performance. The total ADV is represented by the area beneath the biocriterion (or upstream level) when the results for each index are plotted against river mile. The results are also expressed as ADV/mile to normalize comparisons between segments and other streams and rivers.

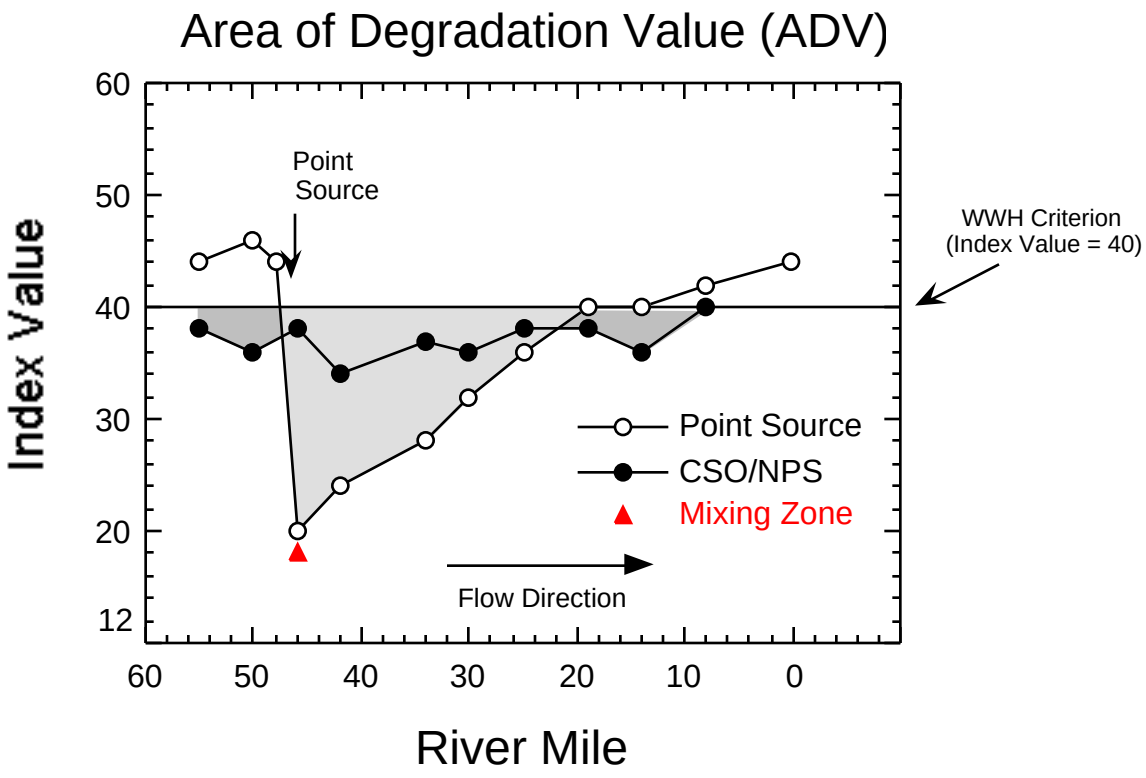

Figure 4. Graphic illustration of the Area of Degradation Value (ADV) based on the ecoregion biocriterion (WWH in this example). The white circle trend line and grainy shading (area of departure) represents a typical response to a point source impact (mixing zone appears as a solid triangle). The black circle trend line and dashed shading (area of departure) represents a typical response to a nonpoint source or combined sewer overflow (CSO) impact. The shaded area common to both trend lines represents the overlapping impact of the point and nonpoint sources.

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are the principal arbiter of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiter within a weight of evidence framework has been extensively discussed

elsewhere (Karr *et al*. 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and the biological response signatures (Yoder and Rankin 1995a) 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.

Table 3. Sampling locations in the Mill Creek study area, 1995. (E - effluent sample, C - water chemistry, S^M - sediment metals, S^O - sediment organics, C^O - water column organics, B - benthic macroinvertebrates, F - fish, FT - fish tissue, D- datasonde/ continuous monitoring).

Stream/ River Mile	Sampling Type	USGS 7.5 min. Latitude/Longitude	Landmark	Quad. Map
Mill Creek				
39.4	B	40°14'44"/83°26'11"	Ust. Logan C.R. 131	Peoria
39.2	C	40˚23'00"/83˚37'46"	Logan CR 131	W. Mansfield
39.1	F	40˚21'51"/83˚32'54"	Logan CR 131	W. Mansfield
36.1	C,F	40˚21'20"/83˚30'45"	Bennington-Newland Rd.	East Liberty
36.0	B	40°14'44"/83°26'11"	Lunda Rd.	Peoria
28.2	B,F,FT	40°14'44"/83°26'11"	Wheeler Green Rd.	Peoria
28.13	D	40°18'43"/83°26'08"	Wheeler Green Rd.	Peoria
28.1	C,S^M,S^O,C^O	40°18'43"/83°26'08"	Wheeler Green Rd.	Peoria
24.8	B,F	40°17'25"/83°24'08"	Cotton Slash Rd.	Peoria
24.7	C,S,D,C^O	40°17'21"/83°24'03"	Cotton Slash Rd.	Peoria
19.4	C,C^O	40˚14'31"/83˚21'49"	Maple Street	Marysville
19.3	B,F	40˚14'29"/83˚22'08"	Maple St.	Marysville
19.1	F	40°14'23"/83°21'59"	Main St.	Marysville
19.0	B,C,S^M,S^O,D,C^O	40°14'25"/83°22'02"	Main St.	Marysville
18.9	C,D	40°14'19"/83°21'51"	Dst. Town Run	Marysville
18.8	F	40°14'22"/83°21'40"	Dst. Town Run	Marysville
18.6	B	40°14'23"/83°21'35"	Ust. Marysville WWTP	Marysville
18.33	C,S^M,S^O,C^O	40˚14'28"/83˚21'10"	Ust. Marysville WWTP	Marysville
18.3	D	40˚14'28"/83˚21'10"	Ust. Marysville WWTP	Marysville
18.26	E,C^O	40˚14'30"/83˚21'09"	Marysville WWTP 001	Marysville
18.25	C,B,F,C^O	40°14'33"/83°21'23"	Marysville WWTP Mix Zone	Marysville
18.1	B,F,C,S^M,S^O,D,C^O	40°14'40"/83°21'16"	Dst. Cherry St.	Marysville
18.0	F	40°14'42"/83°22'30"	Dst. Cherry St.	Marysville
17.4	D	40˚15'00"/83˚20'44"	Dst. Marysville	Mag. Springs
16.9	B	40°15'18"/83°20'44"	Adj. Waldo Rd.	Magnetic Springs
16.8	C,S^M,S^O,D,C^O	40°15'21"/83°20'43"	Adj. Waldo Rd.	Magnetic Springs
16.2	F	40°15'03"/83°20'12"	Adj. Waldo Rd.	Magnetic Springs
15.75	D	40˚14'53"/83˚19'52"	Dst. Marysville	Mag. Springs
14.6	B,F,D	40˚14'52"/83˚18'55"	U.S. 36	Marysville
14.55	D	40˚14'52"/83˚18'55"	U.S. 36	Marysville
12.2	C,S^M,S^O,C^O,D,FT	40°13'39"/83°17'53"	Hinton Mill Rd.	Marysville
12.1	B	40°13'37"/83°17'56"	Dst. Hinton Mill Rd.	Marysville
12.0	F	40˚13'32"/83˚17'57"	Dst. Hinton Mill Rd.	Marysville
11.7	B,C, FT,D ,S^M,S^O,C^O	40°13'21"/83°17'44"	Dst. Crosses Run	Marysville
11.6	F	40˚13'19"/83˚17'40"	Dst. Crosses Run	Marysville
6.9	B,F,FT,D	40°13'53"/83°14'22"	Ust. Hinton Mill Rd.	Shawnee Hills
6.89	C,,S^M,S^O,C^O	40°13'53"/83°14'22"	Ust. Hinton Mill Rd.	Shawnee Hills
4.4	B	40˚15'21"/83˚13'02"	Ust. Blues Creek	Shawnee Hills
4.2	C,F,S^M,S^O,D,C^O	40˚15'20"/83˚12'39"	Adj. Bellpoint Rd.	Ostrander

Table 3. continued.

Stream/ River Mile	Sampling Type	USGS 7.5 min. Latitude/Longitude	Landmark	Quad. Map
Mill Creek (continued)				
3.9	C,C[O]	40˚15'20"/83˚11'56"	Ostrander Rd.	Ostrander
3.7	B,F	40˚15'15"/83˚12'21"	Dst. Blues Creek	Shawnee Hills
1.7	F	40°14'56"/83°10'31"	Ust. Mills Rd.	Shawnee Hills
1.6	C,S[M],S[O],D,C[O],B	40°14'53"/83°10'25"	USGS Gage - Mills Rd.	Shawnee Hills
Otter Creek				
1.7	C	40˚20'30"/83˚33'20"	S.R. 347	East Liberty
0 .7	B,F	40˚21'12"/83˚35'02"	Dst. East Liberty	East Liberty
Town Run				
0.9	F	40˚13'45"/83˚21'30"	Ust. Eljer Plumbingware	Marysville
0.8	C,B	40˚13'45"/83˚21'30"	Ust. Eljer Plumbingware	Marysville
0.7	B,F	40˚13'56"/83˚21'46"	Dst. Eljer Plumbingware	Marysville
0.6	C	40˚13'56"/83˚21'46"	Dst. Eljer Plumbingware	Marysville
0.1	C,B,F S[M],S[O],C[O]	40˚14'08"/83˚21'37"	@ mouth; dst. Marysville	Marysville
McCarthy Park Tributary				
0.1	C,S	40˚14'30"/83˚21'08"	@ mouth	Marysville
Crosses Run				
2.8	C,F,B,S[M],S[O],C[O]	40°11'52"/83°19'07"	Ust. PCRR, Dst. Dairy	Marysville
2.4	B	40°12'05"/83°18'55"	Ust. South Water Stop	Marysville
2.1	F	40˚12'19"/83˚18'46"	Ust. Industrial Parkway	Marysville
2.0	B,C S[M],S[O],C[O]	40°12'54"/83°18'46"	Ust. Industrial Parkway	Marysville
0.9	F	40°11'52"/83°19'07"	Ust. Watkins Rd.	Marysville
0.8	S[M],S[O],C[O],D,FT	40°12'56"/83°17'59"	Ust. Watkins Rd.	Marysville
0.6	B	40°12'54"/83°18'08"	Dst. Watkins Rd.	Marysville
North Branch Crosses Run				
1.0	B,F	40˚12'21"/83˚19'21"	Upstream Scotts Company	Marysville
0.9	C,S[M],S[O],C[O]	40˚12'21"/83˚19'21"	Upstream Scotts Company	Marysville
0.2	F	40˚12'26"/83˚18'56"	Ust. Scottslawn Rd	Marysville
0.1	C,B,F,S[M],S[O],C[O]	40˚13'05"/83˚17'51"	Scottslawn Rd @ mouth	Marysville
Unnamed Tributary to Crosses Run at RM 2.24				
0.1	B	40˚12'14"/83˚18'52"	Scotts Co. drainage/002, 006	Marysville
Blues Creek				
0.7	F,C	40°15'42"/83°12'27"	Ust. Ostrander Rd.	Ostrander
0.6	B	40°15'39"/83°12'28"	Ostrander Rd.	Ostrander

RESULTS AND DISCUSSION

Pollutant Loadings: 1976-1995

Monthly effluent loadings are reported to Ohio EPA by all National Pollutant Discharge Elimination System (NPDES) permitted discharging entities. Third quarter (July-September) Monthly Operating Report (MOR) data provided the quantity and character of pollutant loadings from 1976 through 1995 for the ten minor dischargers (*i.e.*, < one MGD) and the one major discharger (the Marysville WWTP) evaluated within the 1995 Mill Creek study area. Three of the eleven (Marysville, Mill Creek Estates, and Ostrander) discharge directly to Mill Creek.

Pollutant loading trends analysis included the 95th and 50th percentiles of five parameters where available: Ammonia-nitrogen (NH_3-N), Nitrate-Nitrogen (NO_3-N), Five-day Biochemical Oxygen Demand (BOD_5)/ Five-day Carbonaceous Biochemical Oxygen Demand ($cBOD_5$), Total Suspended Solids (TSS), and Annual discharge (MGD). Note that BOD_5 and $cBOD_5$ are combined on the same graph and reflect permit parameter changes emphasizing only carbonaceous BOD not total BOD.

A file review was also conducted of NPDES permit violations at all permitted discharges within the Mill Creek basin. Permit violations for the third quarter of 1995 are listed in Table 4 and a summary of NPDES permit violations between 1990 and 1995 can be found in Table 5. For all dischargers, permit violations totaled 855 from 1990 to 1995. Three dischargers, Union County Home, The Scotts Company, and BMY accounted for 532 of the violations or 62.2% of the total. Most BMY violations occurred when production increased sharply during the Gulf War. The company is currently closed and no longer a significant violator. The Marysville WWTP contributes the large majority of point source loadings to Mill Creek but accounted for only 8.5% of total violations.

Entities are listed from upstream to downstream as each discharge reaches Mill Creek.

Nestle R & D Center, Inc. (Mill Creek RM 18.9 via storm sewer)

Nestle R & D Center, Inc. (formerly Westreco, Inc.) at 721 Collins Avenue in Marysville is a food products research and development center that contains pilot plants for a variety of coffee, tea, chocolate, and ice cream food products. This facility currently holds an NPDES permit for discharges of non-contact cooling water and storm water with an average flow of 288,000 gpd (gallons per day). The permittee was issued a compliance schedule in the effective NPDES permit requiring connection of the two non-contact cooling water and storm water outfalls to the existing monitoring station, outfall 001. The work was completed in October 1992. Presently, all storm water and cooling water not directed to the municipal sewer system discharge to a storm sewer. The sewer enters Mill Creek downstream from the Maple Street bridge at RM 18.90 (Lat. 40˚ 13’ 48” N Long. 83˚ 22’ 21” W).

Table 4. Number of NPDES permit violations documented in the third quarter of 1995 (July 1-September 30). Data evaluated was contained in monthly operating reports submitted to the Ohio EPA by those entities. TNTC = too numerous to count.

Outfall	Date	Parameter	Violation Units	(Reported/Permit Limit)
Nestle R&D				
001	8/3/95	Water Temperature	°C	30.0/29.0
Marysville WWTP				
001	7/15-7/21/95	Ammonia	kg/d	66/34
	7/15-7/21/95	Ammonia	mg/l	5.4/2.3
	July 1995	Ammonia	kg/d	33/23
	July 1995	Ammonia	mg/l	1.9/1.5
	8/8-8/14/95	Fecal coliform	#/100 ml	TNTC/2000
	8/8-8/14/95	$cBOD_5$	kg/d	257/227
	8/22-8/28/95	Ammonia	mg/l	2.9/2.3
	8/8-8/14/95	Ammonia	kg/d	48/34
	8/8-8/14/95	Ammonia	mg/l	2.7/2.3
	August 1995	Ammonia	kg/d	37/23
	August 1995	Ammonia	mg/l	2.8/1.5
Union County Home				
001	July 1995	Fecal coliform	#/100 ml	TNTC/1000
	August 1995	$cBOD_5$	kg/d	1.2/0.9
	August 1995	$cBOD_5$	mg/l	13/10
	8/01-8/07/95	Suspended Solids	kg/d	1.7/1.6
	8/01-8/07/95	Suspended Solids	mg/l	19/18
	August 1995	Suspended Solids	kg/d	1.6/1.1
	August 1995	Suspended Solids	mg/l	18/12
	September 1995	Fecal coliform	#/100 ml	2800/1000
	9/22-9/28/95	Suspended Solids	kg/d	2.2/2.2
	9/22-9/28/95	Suspended Solids	mg/l	24/18
	9/15-9/21/95	Suspended Solids	kg/d	2.5/1.6
	9/15-9/21/95	Suspended Solids	mg/l	28/18
	September 1995	Suspended Solids	kg/d	2.4/1.1
	September 1995	Suspended Solids	mg/l	26/12
Mill Creek Estates WWTP				
001	July 1995	Fecal coliform	#/100 ml	TNTC/1000
	7/22-7/28/95	Fecal coliform	#/100 ml	TNTC/2000
	7/15-7/21/95	Fecal coliform	#/100 ml	TNTC/2000
	7/08/7/14/95	Fecal coliform	#/100 ml	TNTC/2000

Table 4. continued.

Outfall	Date	Parameter	Violation Units	(Reported/Permit Limit)
Mill Creek Estates WWTP (continued)				
001	7/01-7/07/95	Fecal coliform	#/100 ml	TNTC/2000
	September 1995	Fecal coliform	#/100 ml	9200/1000
The Scotts Company				
001	July 1995	Ammonia	kg/d	0.257/0.125
	July 1995	Ammonia	mg/l	4.0/2.0
	7/26/95	Ammonia	kg/d	0.515/0.187
	7/26/95	Ammonia	mg/l	8.0/3.0
002	8/08/95	Chlorine Residual	mg/l	1.5/0.5
005 (pool)	7/17/95	Chlorine Residual	kg/d	0.005/0.002
	7/17/95	Chlorine Residual	mg/l	1.6/0.5
	8/04/95	Chlorine Residual	mg/l	0.9/0.5
008	8/15/95	pH	S.U.	9.6/9.0
	8/30/95	pH	S.U.	9.6/9.0
Goodyear Tire and Rubber				
001	September 1995	Suspended Solids	mg/l	38/30
Ostrander WWTP				
001	July 1995	Fecal coliform	#/100 ml	5000/1000
	7/22-7/28/95	Fecal coliform	#/100 ml	5000/2000
	9/29/95	pH	S.U.	6.3/6.5
	9/27/95	pH	S.U.	6.4/6.5
	9/26/95	pH	S.U.	6.3/6.5
	9/25/95	pH	S.U.	6.4/6.5
	9/21/95	pH	S.U.	6.4/6.5
	9/20/95	pH	S.U.	6.2/6.5
	9/13/95	pH	S.U.	6.4/6.5
	9/11/95	pH	S.U.	6.4/6.5
	9/01/95	pH	S.U.	6.4/6.5
Northwood Stone and Asphalt				
001	July 1995	Suspended Solids	mg/l	140/30
	7/19/95	Suspended Solids	mg/l	147/45
	7/15/95	Suspended Solids	mg/l	133/45

Table 5. Number of NPDES permit violations documented at Mill Creek basin dischargers from 1990-1995. Data evaluated was contained in monthly operating reports submitted to the Ohio EPA by those entities.

Facility	Outfall	Parameter	Number of Violations	Total Violations (%)
Nestle R & D Center	001	pH	2	
		Water Temperature	6	8 (0.9%)
Marysville WTP	001	Suspended Solids	3	
		pH	1	4 (0.5%)
Marysville WWTP	001	Suspended Solids	5	
		BOD_5/$cBOD_5$	13	
		Ammonia	25	
		Lead	7	
		Mercury	12	
		Hex. Chromium	1	
		Fecal coliform	4	
		Antimony	2	
		Cadmium	4	73 (8.5%)
Union County Home	001	Suspended Solids	85	
		BOD_5/$cBOD_5$	31	
		Dissolved Oxygen	72	
		Ammonia	4	192 (22.5%)
General Industries	001	Oil & Grease	16	
	002	Fecal coliform	5	
		BOD_5/$cBOD_5$	9	
		Suspended Solids	6	
		Ammonia	11	47 (5.5%)
Mill Creek Estates	001	Suspended Solids	19	
		BOD_5/$cBOD_5$	8	
		Fecal coliform	43	
		Dissolved Oxygen	4	
		Residual Chlorine	23	97 (11.3%)
The Scotts Company	001	Suspended Solids	15	
		Residual Chlorine	4	
		pH	3	
		Ammonia	54	
		Dissolved Oxygen	2	
		Fecal coliform	7	
		BOD_5/$cBOD_5$	4	

Table 5. continued.

Facility	Outfall	Parameter	Number of Violations	Total Violations (%)
The Scotts Company (continued)	002	$BOD_5/cBOD_5$	2	
		Suspended Solids	1	
		Ammonia	21	
		Residual Chlorine	1	
	003	Suspended Solids	2	
		Residual Chlorine	1	
		Ammonia	19	
	004	Fecal coliform	2	
		Ammonia	2	
		Residual Chlorine	5	
	005	Suspended Solids	18	
		Fecal coliform	2	
		Residual Chlorine	4	
		Ammonia	8	
		$BOD_5/cBOD_5$	2	
	006	Water Temperature	6	
	008	pH	4	189 (22.1%)
Goodyear	001	Suspended Solids	6	
		Dissolved Oxygen	4	
		Fecal coliform	5	15 (1.8%)
BMY Corporation	001	$BOD_5/cBOD_5$	19	
		Suspended Solids	55	
		Ammonia	72	
		pH	4	
		Dissolved Oxygen	1	151 (17.7%)
ODOT (U.S. 33 Rest Area)	001	Suspended Solids	6	
		pH	1	
		$BOD_5/cBOD_5$	2	
		Dissolved Oxygen	2	
		Ammonia	1	12 (1.4%)
Ostrander WWTP	001	pH	36	
		Suspended Solids	15	
		Dissolved Oxygen	6	
		Fecal coliform	5	62 (7.3%)
Northwood Stone	001	Suspended Solids	5	5 (0.6%)
Total Violations (all dischargers)				855

In July 1995, the facility directed a substantial amount of the non-contact cooling water flow to the Marysville wastewater treatment plant (WWTP) due to the occurrence of pH violations at outfall 001 (Table 4). The pH violations were attributed to a high pH in the water supplied by the Marysville WTP. Further pH violations have been largely resolved by connection to the municipal sanitary sewer system and the future use of a closed loop cooling water system (currently under construction). A third quarter 1995 temperature violation at the facility was due to a reporting error (Table 4). Also, the company was responsible for a pollutant spill of milk on September 19, 1995 that entered Mill Creek via the Maple Street storm sewer (see Table 9, Pollutant Spills Section). Sanitary wastewater, boiler blowdowns, and industrial process wastewater flows are tied-in to the city sanitary sewer system.

*Marysville Water Treatment Plant (**Mill Creek** RM 19.05)*
The Marysville Water Treatment Plant (WTP) produces approximately 1.5 MGD of potable water for Marysville, several small unincorporated communities, and various industries located in central Union County. Water treatment processes at the plant include rapid mixing, flocculation, primary settling, recarbonation, secondary settling, sand filtration and chlorination. The permitted discharge at outfall 001 (RM 19.05) consists of supernatant from the lime sludge lagoon. Discharges are controlled by a gate valve installed on the discharge pipe at the outfall. The facility is currently eliminating all discharges from the lime sludge lagoon. Presently all sludge generated at the water treatment plant is sent to the Marysville WWTP via a recently constructed pump station and force main. Old sludge in the lagoon is also being pumped to the WWTP. Well water is used to create a slurry in the lagoon and a 4-inch trash pump is used to convey the slurry to the pump station. Average daily flows to the WWTP approximate 50,000 gpd. Filter backwash is discharged to the WWTP daily and the lime sludge is discharged seasonally when weather permits lagoon clean out.

On March 7, 1995 the lime sludge lagoon overflowed spilling at least 1,000 gallons of lime sludge directly into Mill Creek. The overflow situation occurred because of ice formation on the lagoon followed by heavy rains and discharges to the lagoon. To correct the overflow, the dike was plugged and the overflow weir at the outfall was reinforced. Several permit violations for suspended solids and pH were noted in the last several years (Table 5). There were no permit violations during the third quarter of 1995.

Ray Lewis & Sons, Inc. (Mill Creek RM 18.41, via storm sewer)
Ray Lewis & Sons is a metal plating operation that manufactures various types of plumbing fixtures from aluminum, chromium, copper, magnesium, nickel and zinc. Process operations include melting, remelting, alloying, casting, machining, buffing and electroplating. The permitted cooling tower discharge is approximately 7000-9000 gpd to Mill Creek at RM 18.41 via a storm sewer and drainage ditch. Process pretreatment and sanitary wastewater have been directed to the Marysville WWTP since 1989. Process wastewater is treated by a system that employs electrolytic recovery, chemical precipitation, and reverse osmosis. Some waste streams such as

copper, cyanide and nickel rinses are segregated, recovered and reused in product operations. Sludge generated by the treatment system is hauled off-site for disposal. During third quarter, 1995, this facility contributed less than 0.2% (0.0069 MGD) of the point source flow to Mill Creek.

Marysville WWTP (Mill Creek RM 18.26)

The Marysville WWTP at 620 North Main Street in Marysville is designed for flows of 4.0 MGD (Million Gallons per Day). Basic treatment processes include primary settling, aeration, intermediate and final settling, tertiary filters and disinfection with post aeration before discharge to Mill Creek at RM 18.26 (Lat. 40˚ 14' 03" N, Long. 83˚ 21' 26" W). The original treatment plant was constructed in 1954 and was expanded to its present size in 1989. More recently, the facility has completed construction of two belt filter presses to assist in the de-watering of sewage sludge and lime sludge generated at the Marysville WTP. The sludge de-watering facility was brought on-line in April 1995 and has greatly increased the total amount of sludge to be processed at the WWTP. Construction of a storage pad for the de-watered lime sludge is planned to accommodate the increased volume from the water treatment plant.

Recent ammonia violations at the plant were attributed to high ammonia levels in the filtrate from the belt filter presses (Tables 4-5). The current WWTP permit includes a compliance schedule requiring evaluation of local (*i.e.*, pretreatment) permit limits, compliance with final permit limits for total residual chlorine, and a study to find and eliminate sources of mercury and silver in the sanitary sewer system. The facility met the schedule of compliance by May 1994.

Hydraulic overloads are experienced during heavy rains. The plant is equipped with a 1.25 MGD flow equalization basin that provides the capacity to hold and treat the overloads. Ongoing efforts by plant personnel to identify and eliminate sources of infiltration/inflow continue.

A study of the Mill Creek area, around the Marysville WWTP, was completed by Ohio EPA, Division of Emergency and Remedial Response in April 1995 (Ohio EPA 1995). Results from this study showed sediment and surface water contamination from many possible sources including: the Marysville WWTP, the abandoned Marysville landfill (located on the WWTP property), the Ray Lewis Landfill (adjacent to and immediately south of the WWTP), Town Run (Eljer Plumbingware) and storm sewer discharges located in McCarthy Park, opposite the Marysville WWTP outfall (nonpoint sources). Metals, PAHs, volatile organics and pesticides were found in sediment and surface water in Mill Creek and Town Run. Elevated levels of barium, cadmium, chromium, copper, lead, mercury, sodium and zinc were found in sediment samples. The pesticide 2,4-D was detected near the WWTP outfall. Copper, nickel, lead and zinc were commonly found in surface water samples along with VOCs and pesticides (aldrin, 4,4-DDE and 4, 4-DDD).

The Marysville WWTP effluent quality continued to exhibit the effects of variable treatment

efficiency despite recent plant upgrades and implementation of a pretreatment program. Annual median flows have steadily increased since the early 1980s but have normally remained below design capacity through periodic plant upgrades (Figure 5). Since the last water quality survey in 1990, loadings for ammonia (NH_3-N), biochemical oxygen demand (BOD), and total suspended solids (TSS) have increased (Figure 5). Ammonia loadings had exhibited a noticeable decreases after 1984 but increased after 1990 and were particularly high in 1995. Suspended solids BOD_5 loadings also displayed marked decreases after plant upgrades in 1982 but again increased in the late 1980s and 1990s. The more recent increases coincided with increased flows, the introduction of lime slurry from the water treatment plant and associated solids handling problems.

Third quarter loadings for cadmium, copper, lead, nickel and zinc have also increased since the 1990 survey. (Figure 6). Several industries have tied into the Marysville WWTP that may account for the increased loadings. The Honda Marysville Plant first tied into the treatment facility in 1982 with the East Liberty Plant connecting in April 1990. Ray Lewis and Son tied into the WWTP on August 1, 1989.

During the third quarter of 1995, loadings from the Marysville WWTP contributed 95.0% (93.06 kg) of the $cBOD_5$, 96% (95.6 kg) of the TSS, 99.2% (35.8 kg) of the NH_3-N and comprised 95.6% of the discharge flow (3.202 MGD) to Mill Creek compared with other permitted direct dischargers.

The Marysville WWTP was required to perform bimonthly chronic toxicity tests with Allowable Effluent Toxicity (AET) values of 0.3 TU_a (acute toxic units) or 30% mortality in 100% effluent and 1.1 TU_c (chronic toxic units). The Ohio EPA conducted seven acute bioassay tests between 1986 and 1995 (Table 6). Two test dates resulted in acute toxicity from the effluent to the *Ceriodaphnia* and fathead minnow test species. Three acute tests showed instream toxicity to the fathead minnow. Biomonitoring data collected by the entity from 1991 through 1995 showed AET exceedences in 13 of 24 tests conducted (Table 6), an indication of variable instream and effluent toxicity.

Union County Home (*Infirmary Ditch RM 17.92; 1.93****)***
Union County Home is located on County Home Road in Paris Township. The WWTP also services the Union County Juvenile Detention Center and the Dog Pound with a design flow of 24,000 gpd. Upgraded in 1978, the facility currently includes a trash trap, extended aeration, clarifiers and chlorination. Treated wastewater is discharged to Infirmary Ditch at RM 1.93 (Lat. 40˚ 15’ 46 N, Long. 83˚ 23’ 20” W); Infirmary Ditch enters Mill Creek at RM 17.92 .

This facility has a long history of NPDES permit violations, primarily for dissolved oxygen, suspended solids and $cBOD_5$ (Tables 4-5). These violations have been due, in part, to hydraulic and organic overloads and difficulties in treating cleaning compounds and food wastes generated at the nursing home. The county is presently experimenting with additives to improve treatment

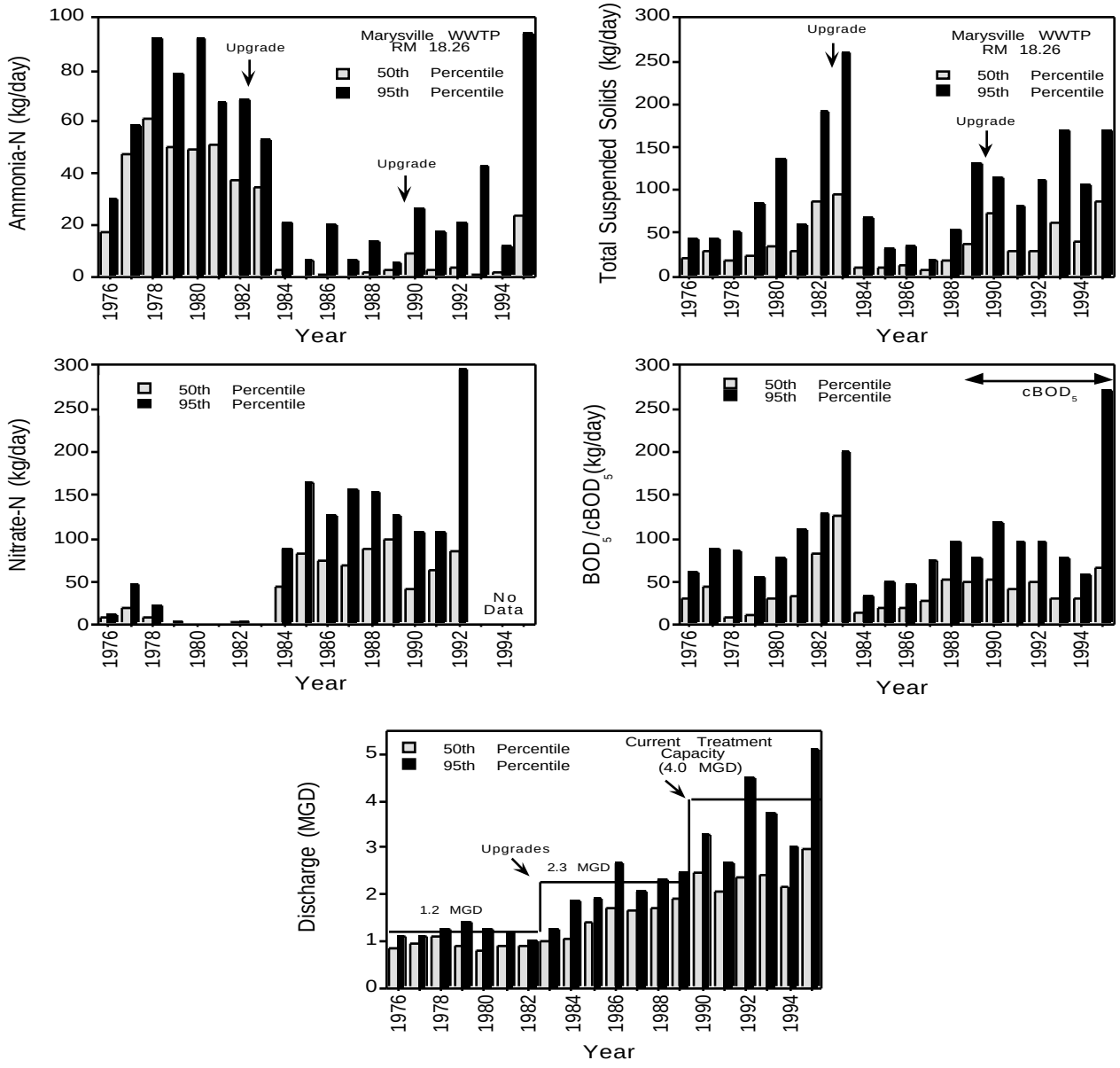

Figure 5. Annual third quarter loadings (50th and 95th percentiles in kg/day) of ammonia-N, nitrate-N, TSS and BOD_5, and discharge (50th and 95th percentiles in MGD) from the Marysville WWTP, 1976-1995.

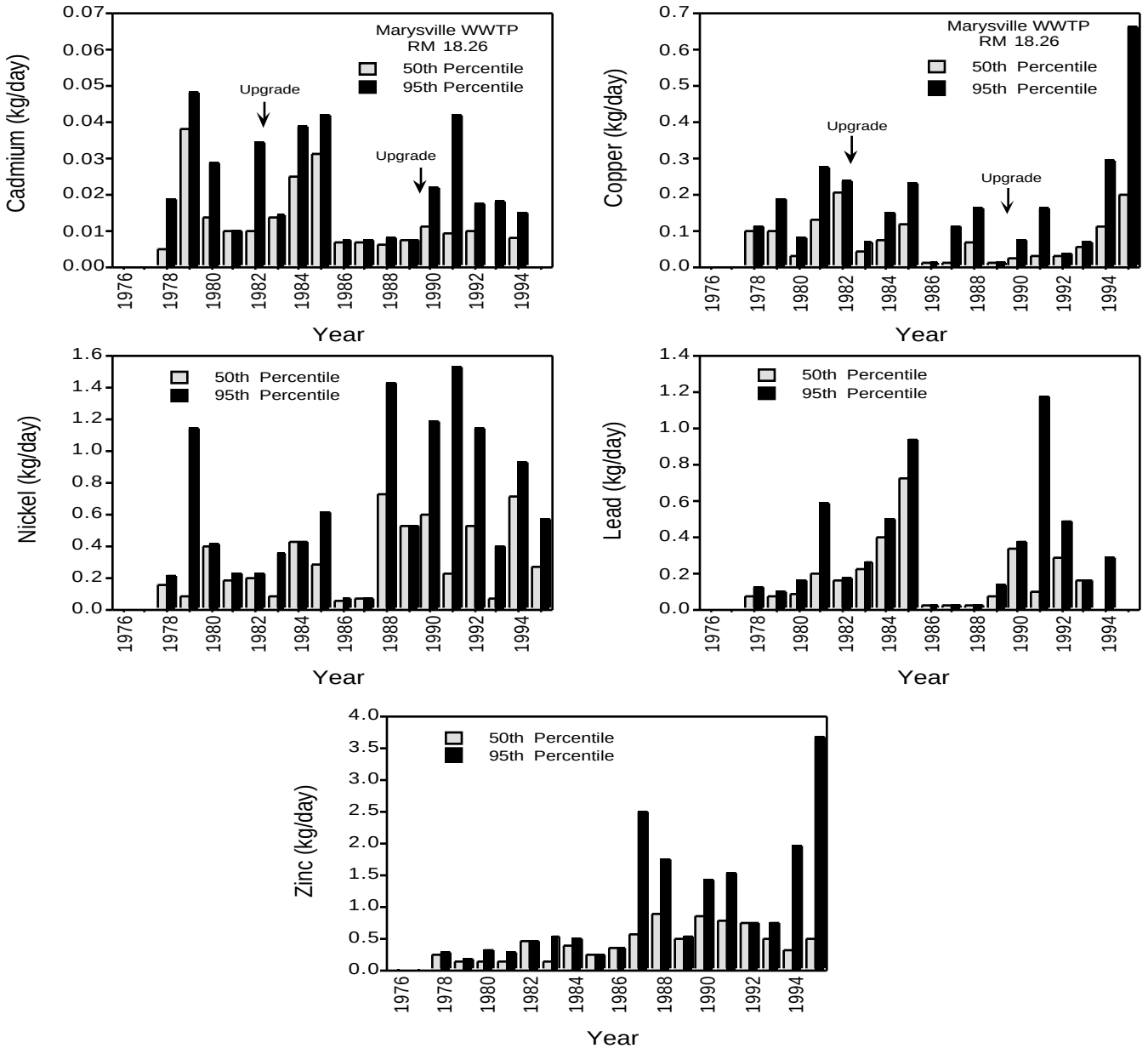

Figure 6. Annual third quarter loadings (50th and 95th percentiles in kg/day) of cadmium, copper, nickel, lead and zinc from Marysville WWTP, 1976-1995.

Table 6. Acute (TU_a) and chronic (TU_c) toxicity bioassay data collected from Marysville WWTP, June 1986 to September 1995. Data that were not available were denoted with (NA). Ohio EPA collected acute bioassay data while chronic data were generated by the facility.

Ohio EPA Testing Date	*Ceriodaphnia* Percent Affected Upst.	Near Field	TU_a Effluent	*Fathead Minnow* Percent Affected Upst.	Near Field	TU_a Effluent
July 95	0	0	<1.0	0	0	<1.0
Feb 95	0	0	<1.0	0	40	1.2
May 93	NA	0	1.4	NA	10	<1.0
Sept 91	0	100	<1.0	0	100	<1.0
April 91	0	0	<1.0	0	0	<1.0
Sept 90	0	0	<1.0	0	0	<1.0
Sept 86	0	0	<1.0	0	0	<1.0
June 86	60	0	<1.0	0	0	<1.0

Entity Testing Date	*Ceriodaphnia* Percent Affected Upst.	Far Field	TU_c Effluent	*Fathead Minnow* Percent Affected Upst.	Far Field	TU_c Effluent
Sept 95	100	60	1.1	2	0	<1.0
July 95	0	100	1.8	32	8	<1.0
May 95	0	0	<1.0	20	100	<1.0
April 95	0	100	3.5	54	17	1.8
March 95	30	0	1.8	0	5	3.5
Sept 94	0	100	1.1	8	7	<1.0
July 94	78	100	3.5	15	18	<1.0
May 94	40	100	10	32	25	3.5
March 94	20	100	7.1	8	13	<1.0
Feb 94	NA	0	1.1	NA	NA	NA
Jan 94	0	10	1.8	22	31	1.1
Nov 93	NA	NA	NA	45	23	<1.0
Sept 93	NA	80	7.1	NA	NA	NA
July 93	10	10	>5.0	17	40	2.0
March 93	10	0	1.4	8	10	<1.0
March 93	20	100	7.1	8	13	<1.0

Table 6. continued.

Entity Testing (cont.) Date	*Ceriodaphnia* Percent Affected Upst.	Far Field	TU_c Effluent	*Fathead Minnow* Percent Affected Upst.	Far Field	TU_c Effluent
Feb 93	0	0	>1.0	5	8	>1.0
Nov 92	0	0	1.1	38	9	1.1
Sept 92	30	0	2.0	15	10	3.5
July 92	NA	10	<1.0	6	7	<1.0
May 92	0	30	<1.0	6	7	<1.0
April 92	0	10	>1.0	NA	NA	NA
Jan 92	0	0	1.4	10	10	1.4
Nov 91	0	0	>1.0	3	10	>1.0
Sept 91	0	30	<1.0	17	10	<1.0

at the facility. In addition, laundry and food service may soon be eliminated at the nursing home. This should improve treatment at the plant.

The Union County Home WWTP was issued a compliance schedule in the current NPDES permit (March 31, 1999 expiration date) to meet final limits for suspended solids and $cBOD_5$ by July 1, 1995. In addition, a flow measuring device must be installed by July 1, 1994. To date, the county has not met the schedule to install tertiary treatment at the Union County Home lant and continues to violate the compliance schedule and the NPDES permit. A proposed sanitary sewer trunkline along SR 4 would enable the County Home to tie into the Marysville WWTP and alleviate the chronic permit violations (pers. comm., Union County Engineer's Office).

General Industries Company (*Mill Creek RM 13.84 via unnamed tributaries****)***
General Industries at 648 Clymer Road manufactures molded plastics. The average annual flow is 648,000 gpd with a design flow of 450,000 gpd. In December 1993 the sanitary discharge was directed to the Marysville WWTP. Direct discharges were limited to cooling water until December 1996 when a cooling tower was installed and the discharge ceased. During the 1995 survey, the treated cooling water was discharged to an Unnamed tributary to Beech Ditch, 3.65 miles upstream from the confluence with Mill Creek at RM 13.84 (Lat. 40˚ 13' 42"N, Long. 83˚ 20' 53").

General Industries attributes most oil and grease violations at outfall 001 to a long history of drainage problems at the outfall (Table 5). No violations were noted during third quarter, 1995.

The sampling location for outfall 001 was a catch basin that, during heavy rains, backed up allowing oil and grease residues to accumulate in a stagnant pool of water. Marysville replaced a drainage tile to eliminate the problem. Waste streams at the facility include used hydraulic oil and solvents (which are collected in drums and shipped off-site for disposal) and waste plastic that is shredded and recycled. Non-contact cooling water is supplied to three process lines. Two lines use once-through cooling water from well water and the third line is serviced by a total recycle unit using city supplied water.

Mill Creek Estates (Mill Creek RM** 12.57**)

The Mill Creek Estates WWTP is at the south end of Valley View Drive in Dover Township. Built in 1971 with a design flow of 105,000 gpd, the final effluent discharges to Mill Creek at RM 12.57 (Lat. 40˚ 13' 54" N, Long. 83˚ 18' 00" W). The treatment process involves aeration, clarifier, upflow fixed media clarifier, slow surface sand filters and UV disinfection. The plant was upgraded in 1978 and the 1980s. Ultraviolet disinfection and rehabilitation of the fixed media clarifier and dosing tank were scheduled for Spring 1996.

The plant has experienced many NPDES permit violations, primarily for fecal coliform and total residual chlorine (Tables 4-5). A compliance schedule required the facility to meet final limits for fecal coliform and total residual chlorine by July 1995. A study of inflow/infiltration was also to be conducted since the plant experiences hydraulic overloads. During the last inspection, numerous deficiencies were noted including: excessive debris on the influent bar screen, a high sludge blanket, weed growth on the tertiary sand filters, and solids in the chlorine contact tank. The automated chlorine dosing system has been inoperable since October 1991. Since then, the plant is using a bucket filled with chlorine tablets for disinfection resulting in the permit violations for chlorine and fecal coliform. The problem should be corrected following installation of UV disinfection (Spring 1996).

During the third quarter of 1995, loadings from Mill Creek Estates contributed 1.8% (1.76 kg) of $cBOD_5$, 3.2% (3.18 kg) of TSS, 0.11%, (0.039 kg) of NH_3-N and comprised 3.13% (0.105 MGD) of flow relative to other permitted direct dischargers to Mill Creek.

The Scotts Company and Subsidiaries (Crosses Run subbasin RMs 11.83; 1.8-2.24)

The Scotts Company is located at 14310 Scottslawn Road in Union County, approximately four miles southeast of Marysville. The company formulates lawn and garden fertilizers and fertilizers containing herbicides and pesticides. The facilities consist of the main formulation plant along with waste treatment and storage areas, research laboratories, administration offices, product test fields and unused land. Three cooling water outfalls and five package type treatment plants are permitted to discharge treated sanitary wastewater (there is also an outfall on the property from a swimming pool located in an adjacent park [009]). Outfall locations in the Crosses Run subbasin are listed in Table 7.

Design flows for the five sanitary outfalls range from 1,200 gpd to 16,500 gpd. Tertiary

treatment was added to the package plants in 1978. According to the Permit to Install (PTI) issued for the 1978 plant upgrades, The Scotts Company will be expected to tie into the sanitary sewer service from Marysville and Union County when it becomes available.

Table 7. Locations of The Scotts Company NPDES permitted discharges in the Crosses Run subbasin.

Outfall	Receiving Stream	Confluence / RM Mill Cr. / Crosses Run / Tributary	Effluent Characteristics
002	Crosses Run (via Unnamed Trib)	11.83, 2.24, 0.29	Sanitary
006	Crosses Run (via Unnamed Trib)	11.83, 2.24, 0.22	Cooling Water
003	Crosses Run (via Unnamed Trib)	11.83, 2.24, 0.01	Sanitary
007	North Branch Crosses Run	11.83, 1.95, 0.70	Cooling Water
001	North Branch Crosses Run	11.83, 1.95, 0.54	Sanitary
008	North Branch Crosses Run	11.83, 1.95, 0.30	Cooling Water
009	Crosses Run	11.83, 1.90	Swimming Pool
005	Crosses Run	11.83, 1.90	Sanitary (Pool WWTP)
004	Crosses Run	11.83, 1.80	Sanitary

Process wastewaters are discharged to one of several process recycle ponds or to an internal closed loop treatment and recycling system. However, discharges of process wastewater from this facility are not authorized in the current NPDES permit. Periodic land application of the recycled wastestreams occurs when flows in the recycle systems exceed those necessary to supply make-up water for the formulation process. One such application was observed by Ohio EPA personnel on June 29, 1995 during a period of heavy rains. Runoff from the application entered the North Branch of Crosses Run, resulting in measurements of 51.7 mg/l ammonia instream. The event was reported as a pollutant spill (see Table 9). Also, in 1993, land application of recycle water resulted in a large fish kill on Sugar Creek in the Big Darby Creek basin. The source of recycle water was later traced to Scotts.

Permit violations from the facility package plants were numerous (Tables 4-5). From 1990 through 1995, 189 violations were recorded at the outfalls with ammonia accounting for 55% of the violations. Beyond frequency, the magnitude of ammonia exceedences (based on concentration) was often significant (Figure 7). Permit violation concentrations under summer limits (2-3 mg/l) averaged 11.83 mg/l while under less stringent winter limits (6.8-10.0 mg/l)

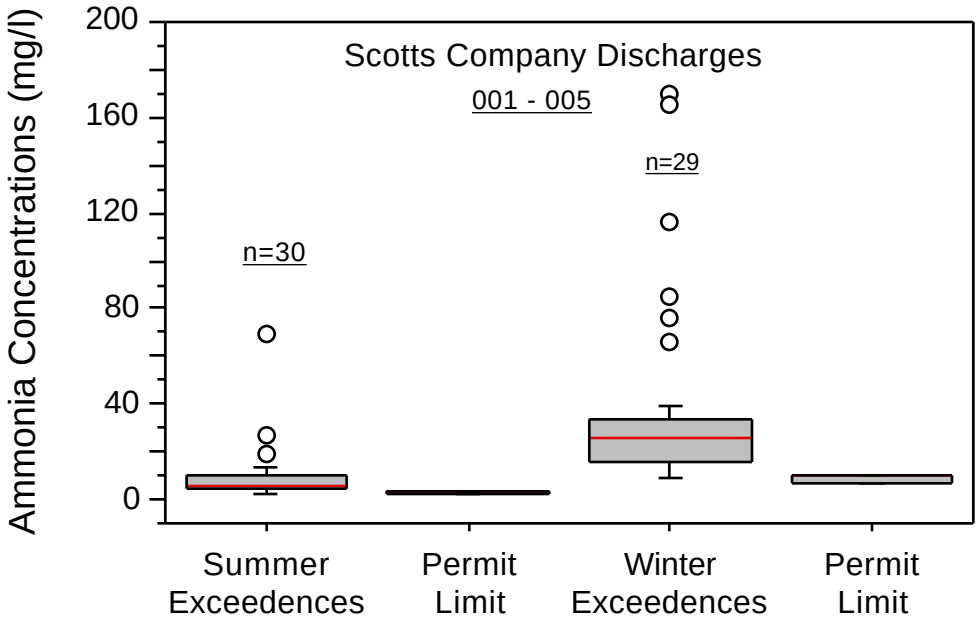

Figure 7. Box and whisker plots of ammonia concentrations associated with NPDES permit violations at the five Scotts Company sanitary WWTP discharges, 1990-95.

concentrations averaged 40.7 mg/l. Most other violations were for suspended solids, fecal coliform and residual chlorine. The majority of ammonia violations (and total violations) were from outfall 001 that treats sanitary wastewater from the Trionize Plant. Violations during the third quarter of 1995 were primarily for ammonia at outfall 001 (4) and residual chlorine at outfall 005 (4); the 005 plant treats the swimming pool effluent (Tables 4-5).

Besides the package plant discharges, Scotts operates two water stops or impoundments on the North Branch of Crosses Run (North Dam RM 0.5) and at the mouth of the unnamed tributary to Crosses Run at RM 2.24 (South Dam). Installed for spill containment following a large fish kill in 1986, the water stops are used to temporarily contain contaminated runoff (*i.e.*, containing ammonia) from the facility. According to Scotts, the water is later discharged to the receiving streams when concentrations reach safe levels. Ohio EPA personnel observed an uncontrolled release overflowing the face of the South Dam on August 16, 1995.

Several unauthorized releases to surface water originated at this facility and two releases resulted in major fish kills. In 1986 a fish kill in the Scioto River, was traced back to a break in the wastewater recycling system. In July 1993, 1,884 fish were killed in Sugar Creek (Big Darby

Creek basin) following land application and runoff of wastewater from the Scotts Company. Field testing by Ohio EPA indicated ammonia concentrations in excess of 10 mg/l in pools of standing water on the affected field. Again in June, 1995 Ohio EPA Division of Emergency and Remedial Response (DERR) personnel investigated a surface water release from the facility associated with land application on Scotts property; concentrations of 51.7 mg/l ammonia were recorded in the receiving stream (North Branch Crosses Run).

During a preliminary site assessment in December 1994, Ohio EPA DERR personnel discovered VOCs (2-butanone, toluene), pesticides (heptachlor, endrin, endosulfan II) and herbicides (2,4-D) in the water column. Sediment samples collected during this investigation revealed elevated levels of semivolatile compounds and pesticides (4,4-DDD and chlordane) downstream from the facility. Soil sampling on the Scotts property also detected numerous organics and pesticides, including nearly all compounds identified in Crosses Run.

Two CSIs (Compliance Sampling Inspections) were conducted at the facility during November 1995 and February 1996. Samples were collected at outfalls 001, 002, 003 and 004 and February sampling included screening bioassay testing for acute toxicity and water quality sampling at a "far field" mixing zone site, immediately downstream from the North Branch. Several pesticides (non banned) were detected in the effluents including atrazine, cyanazine, pendimethalin and diazinon. Pendimethalin and diazinon were also detected in Crosses Run at the "far field" site. Bioassay results indicated that outfall 001 was acutely toxic to both the fathead minnow and *Ceriodaphnia* within less than 24 hours (Table 8). Outfall 002 was acutely toxic to *Ceriodaphnia* and fish experienced 30 percent mortality within 24 hours. The 003 and 004 outfalls were not considered acutely toxic to the fathead minnow or *Ceriodaphnia.*

Table 8. Acute toxicity bioassay data collected by the Ohio EPA from The Scotts Company WWTPs, February 1996.

Outfall	*Ceriodaphnia* Percent Mortality		*Fathead Minnow* Percent Mortality	
	24 Hours	48 Hours	24 Hours	48 Hours
001	100*	100	100*	100
002	100*	100	30	30 ◊
003	0	0	15	15
004	0	0	5	15
Control	0	0	5	5

* Results after 19 hours.

◊ One additional fish was "adversely affected, but not dead" at 48 hours.

Goodyear Tire and Rubber Company (Crosses Run RM 11.83; 2.05)

Goodyear Tire and Rubber Company, built in 1967 is located just south of Marysville. The company is a manufacturer of rubberized conveyor belts and assorted industrial sheet rubber products. Presently, discharges from the facility are limited to non contact cooling water, storm water and sanitary wastewater through outfall 001. Boiler blowdown water was disconnected from the sanitary wastewater treatment system in 1994 and is directed to a field adjacent to the facility. Biocides and a rust inhibitor are added to the non contact cooling water and boiler feedwater.

The design capacity of the wastewater treatment plant is 21,000 gpd. The average annual flow is approximately 16,000 gpd to Crosses Run at RM 2.05 before discharge to Mill Creek at RM 11.83. Wastewater treatment includes an extended aeration package plant with tertiary polishing pond and disinfection. Marysville and Union County are extending sanitary sewer service along Industrial Parkway. A sanitary sewer is expected to be on line by the summer of 1997 and this facility is expected to tie into this extension.

Fecal coliform violations have been a problem at this facility (Table 5). A study traced the problem to bird droppings around the plant cooling tower. Goodyear is currently chlorinating the storm sewer drain at the base of the cooling tower to prevent further violations. The suspended solids violation in September 1995, was attributed to high levels of algae in the polishing pond (Tables 4-5). The facility is now using a combination of biocides to control the algae. During the last inspection several deficiencies were observed including significant amounts of solids in the clarifier and chlorine contact tank, and high accumulation of sludge in the polishing pond. In addition, a sheen of oil and grease was observed in the receiving stream immediately downstream from outfall 001.

BMY Wheeled Vehicle Division (BMY Tributary RM 9.3;3.2)

This facility, at 13311 Industrial Parkway, closed during the summer of 1995. When the facility was operating, they were responsible for the assembly of five ton military trucks for the United States Army and most recently, school buses. Design flow of the treatment facility was 30,000 gpd with an average flow of 17,000 gpd. The treatment process involved an extended aeration package plant with tertiary sand filters and disinfection. Final effluent was discharged to an unnamed tributary of Mill Creek (BMY Tributary) at RM 3.20 (Lat. 40˚ 11’ 52” N, Long. 83˚ 24’ 35” W). The BMY tributary enters Mill Creek at RM 9.30.

The current NPDES permit changed outfall 002 from an industrial process discharge to a sanitary discharge from the new sewage treatment plant. Effluent violations at the facility were attributable to both hydraulic overloads during peak manufacturing (Gulf War) and during low flow conditions associated with the closure process (Table 5). Should this facility reopen, they could tie into a sanitary sewer being provided by Union County and the city of Marysville. The new sewer service was expected by the summer of 1997.

Ohio Department of Transportation (ODOT) (BMY Tributary RM 9.3; 2.3)

The Ohio Department of Transportation operates a road side rest area on US 33 North west bound approximately 4 miles east of SR 36 and 1.5 miles south of Scottslawn Road. This is an extended aeration plant with sludge holding, tertiary sand filters and disinfection and a design flow of 10,000 gpd. Actual flow varies seasonally between 15,000 and 30,000 gpd. In 1992, the two smaller package plants from both rest areas (northbound and southbound) were combined into the current facility. Wastewater from this facility is discharged to an unnamed tributary (*i.e.*, BMY Tributary) at approximately RM 2.3 (Lat. 40 11' 40" N, Long. 83 17' 15" W). The tributary enters Mill Creek at RM 9.30.

High ammonia loadings have historically been a problem for this facility (Table 5). Several approaches have been used to control ammonia levels, but none have been entirely successful. Pre-aeration and the use of sodium bicarbonate are currently being used to address the problem. No permit violations were noted during the third quarter of 1995.

Ostrander WWTP (Mill Creek RM 4.05)

The Village of Ostrander WWTP, built in 1991, uses a conventional activated sludge treatment system with a design flow of 90,000 gpd. Located south of Ostrander Road and west of Blues Creek, the treatment process involves primary and secondary treatment along with solids handling and disinfection facilities. The final effluent is discharged to Mill Creek immediately upstream from Blues Creek at RM 4.05 (Lat. 40˚ 15' 20" N, Long. 83˚ 12' 40" W). The plant has experienced operational problems with low pH (Tables 4-5). An evaluation of the problem identified the village water supply as the primary factor affecting the pH. Hydraulic *under-loading* at the WWTP was also considered a potential contributing factor due to excessive nitrification (that consumes alkalinity) at low flows. Since the 1995 survey, adjustments have been made that effectively raised the pH both in the drinking water and in the WWTP effluent. There were also two violations for fecal coliform during July 1995.

During the third quarter of 1995, loadings from the Ostrander WWTP accounted for 0.2% (0.021 kg) of $cBOD_5$, 0.7% (0.66 kg) of TSS, 0.04% (0.0147 kg) of NH_3-N and 1.18% (0.0394 MGD) of flow relative to other permitted direct dischargers to Mill Creek.

Northwood Stone and Asphalt (Unnamed Trib. to Mill Creek RM 3.35; 2.62)

The Northwood Stone and Asphalt facility is a sand and gravel quarry at 8328 Watkins Road, Ostrander, Ohio. The facility manufactures limestone products (500,000 tons per year) and asphalt (120,000 tons/year). Permitted discharges from outfall 001 consist of stormwater from the settling pond in the bottom of the quarry with a reported average flow of 288,000 gpd. The quarry discharges to an unnamed tributary at RM 3.35 (Lat. 40˚ 12' 53" N, Long. 83˚ 12' 00" W); the tributary enters Mill Creek at RM 2.62.

The quarry will expand its operations and it is anticipated that flows from the outfall 001 will increase. Recent permit violations for suspended solids resulted from above average rainfall

during June and July 1995 (Tables 4-5). In July 1995, the pit was deepened to increase the detention time and reduce the potential for flooding of the asphalt plant and sediment pond.

Pollutant Spills and Wild Animal Kills

Mill Creek Basin

Beyond NPDES permit violations and water quality criteria exceedences, a review of Ohio EPA Division of Emergency and Remedial Response spill records documented unpermitted releases of toxic and/or oxygen-demanding substances in the Mill Creek study area. Accidental spills and unauthorized discharges of pollutants represent a potential impact on aquatic life that may or may not be traceable to a specific source. Spills occur at random and may significantly impact aquatic and terrestrial organisms without leaving obvious signs. It is likely that the reported spills represent a fraction of the actual spill occurrences within the Mill Creek study area.

Sewage and sludge spills accounted for four of the eight spills reported during 1995 (Table 9). Two spills of fertilizer were reported in the Mill Creek tributaries, Crosses Run and Blues Creek. Most of the spills exceeded 1000 gallons and could have the potential to cause serious harm to the aquatic community. Only one spill involved petroleum constituents.

Table 9. Summary of Pollutants spilled into Mill Creek and its tributaries reported to the Ohio EPA Division of Emergency and Remedial Response from January 1995 - December 1995.

Date	Entity	Material	Amount	Waterway
02-26-95	Marysville WWTP	Sludge	1000 gallons	Mill Creek
03-06-95	Marysville WTP	Lime sludge	1000 gallons	Mill Creek
03-09-95	Conrail	Diesel Fuel	2000 gallons	Unnamed creek
03-09-95	Raymond & Peoria	Sewage	unknown	Mill Creek
05-23-95	Leeper Farms	Fertilizer	1000 gallons	Blues Creek
06-29-95	The Scotts Co.	Fertilizer	unknown	Crosses Run and Mill Cr.
09-19-95	Nestle R&D	Milk	unknown	Mill Creek

Chemical Water Quality

Mill Creek

Between June and October 1995, six water grab samples were collected from each Mill Creek site (four samples were collected from RM 19.4). Using sampling protocols specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 1989), samples were collected, preserved, and analyzed for a variety of pollutants including metal, nutrients and demand parameters. Analytical results for the conventional and metals parameters are presented in Appendix Table A-1.

Sampling stations were selected to provide information concerning ambient and effluent water quality, and to assess impacts, if any, from major industrial and municipal discharges in the Mill Creek study area. Ambient results were evaluated to determine instantaneous exceedences of criteria in the Ohio Water Quality Standards (OAC Chapter 3745-1). Exceedences were based on Warmwater Habitat aquatic life (WWH), Primary Contact Recreation (PCR), and Agricultural and Industrial Water Supply use designations (AWS and IWS) and are summarized in Table 10.

Flow conditions recorded from the U.S. Geological Survey Flow Gage at Bellepoint (RM 1.6) were above normal for most of the late spring and early summer (Figure 8). Discharge approached summer low flow conditions in late August and September but still remained above the $Q_{7\text{-}10}$ (0.9 cubic feet per second [cfs]) and 80% duration flow (3.9 cfs) during the sampling period. Most chemical sampling in the mainstem was conducted under moderately elevated flows (40-50% duration; Table 11). Samples from the first sampling pass on June 28-30 and the last pass on October 5 were collected following significant rainfall events; mainstem flows were highly elevated and at <10% flow duration (Table 11). During the first pass, a single mainstem sample was collected on June 30 from RM 4.2. Mean flows on the 30th were 1250 cubic feet per second (cfs). All other first pass samples were collected on June 28 at 501 cfs. Sharp differences in the concentrations of some runoff related parameters between RM 4.2 and the other mainstem sites (and between June samples and subsequent sampling passes) are likely related to the differences in flow conditions and associated nonpoint source runoff.

Fecal coliform counts above PCR criteria were the most frequent violations observed in the Mill Creek mainstem (Table 10, Figure 9). Only the McCarthy Park tributary did not have an exceedence of the criterion during the sampling season. Most of the fecal coliform exceedences were associated with point sources such as Marysville WWTP, septic ditches, agricultural inputs and other diffuse sources. All of the sampling stations on Mill Creek had values exceeding the maximum primary contact criterion (2000 /100 ml) on at least one occasion.

Dissolved oxygen levels below the minimum WWH criterion (4.0 mg/l) were found between Marysville and Crosses Run (RMs 16.8-12.2) and at RM 39.2, the extreme upstream limit of the survey area (Table 10). Mean D.O. levels fell below the 5 mg/l (24 hour average) criterion at the

Table 10. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical/ physical parameters in the Mill Creek study area, 1995. (units are #/100 ml for fecal coliform, ug/l for metals, cyanide and pesticides, and mg/l for all other parameters).

Stream	River Mile	Exceedence: Parameter (value)
Mill Creek	39.2	Fecal coliform (1060)◊, (2700)◊◊; Dissolved Oxygen (4.5)‡, (3.3, 3.6)‡‡
	36.1	Fecal coliform (1070)◊, (5800)◊◊◊
	28.1	Fecal coliform (7090)◊◊◊
	24.7	Fecal coliform (2300)◊◊
	19.0	Fecal coliform (2300)◊◊
Town Run >>>		
	18.33	Dissolved Oxygen (4.5)‡; Fecal coliform (1360)◊, (6000)◊◊◊; Mercury (0.2)*; Copper (44, 42, 85)** # Cyanide (30, 14)*, (54)**
Marysville WWTP >>>		
	18.25 (mix zone. Note: WWH criteria do not apply to mix zones)	Total Phosphorus (4.40, 5.58, 6.55, 2.18)†; Fecal coliform (3300, 3850, 4600, 2000)◊◊; Mercury (0.3)* # Cyanide (14, 15)*
	18.14	Ammonia (3.92, 4.62)*; Dissolved Oxygen (1.8)‡‡; Fecal coliform (2100, 31000)◊◊ (6820)◊◊◊; Total Phosphorus (2.03, 3.29, 6.67, 1.98)† # Cyanide (11, 12, 13)*
	16.8	Ammonia (2.97, 3.16)*; Dissolved Oxygen (4.7, 4.2)‡; (3.6)‡‡; Fecal coliform (2900, 2050)◊◊ (8730, 26000)◊◊◊; Total Phosphorus (1.80, 4.18, 5.10)† # Cyanide (18)*

Table 10. continued.

Stream	River Mile	Exceedence: Parameter (value)
Mill Creek (continued)		
	12.17	Fecal coliform (1030)◊; (3800)◊◊; (9910)◊◊◊ Dissolved Oxygen (4.6, 4.9, 4.1, 4.5)‡, (3.9)‡‡; Total Phosphorus (1.90, 2.38, 3.12)† Mirex (0.011)*
Crosses Run >>>		
	11.7	Fecal coliform (3100, 2700, 2000, 2900)◊◊; Dissolved Oxygen (4.2, 4.7, 4.4)‡; Total Phosphorus (1.74, 2.13, 2.98)† Mirex (0.013)*
	6.89	Fecal coliform (5200)◊◊◊ Total Phosphorus (1.42, 2.08, 2.44)†
	4.2	Fecal coliform (4300, 3300, 3000)◊◊; Total Phosphorus (1.08, 1.99)† Copper (18)**; Lead (10)*
Ostrander WWTP / Blues Creek >>>		
	3.9	Fecal coliform (1200)◊, (2000, 3100)◊◊; Total Phosphorus (1.70)†
Crosses Run	2.8	Fecal coliform (2400)◊, (84000, >60000, >60000)◊◊◊; Dissolved Oxygen (4.5)‡; Ammonia (10.8, 2.64)*; Total Dissolved Solids (1500)*
	2.0	Fecal coliform (2100, 2100, 4200)◊◊; (58500)◊◊◊; Dissolved Oxygen (4.8)‡ (4.0)‡‡; Total Phosphorus (1.58)†; Ammonia (5.18, 9.48, 3.71)*, (5.2, 39.7)**; Zinc (187)** Dieldrin (0.16 ug/l)*§, d-BHC (0.128)*§, Endosulfan II (0.005)*, Endosulfan sulfate (0.046)*
North Br. Crosses Run >>>		

Table 10. continued.

Stream	River Mile	Exceedence: Parameter (value)
Crosses Run	0.8	Fecal coliform (4400, 3000, 2000)◊◊; Dissolved Oxygen (4.1, 4.2)ǂ; Ammonia (2.49, 4.09, 3.74, 8.24)* Endrin (0.011)*
North Branch Crosses Run		
	0.9	Fecal coliform (2400)◊◊; (12300)◊◊◊; Ammonia (51.7)**; Dissolved Oxygen (4.7)ǂ; Total Phosphorus (2.04)† Aldrin (0.023)*§; Heptachlor (0.003)*§, Endosulfan I (0.009)*, Endosulfan II (0.004)*, Dieldrin (0.003)§
	0.1	Fecal coliform (34000, 4100, 3600)◊◊; (66000)◊◊◊ Ammonia (2.64, 0.84 ,3.63)*, (8.75)**; Total Phosphorus (1.16, 1.11, 1.45, 2.09, 2.01)†; Copper (24)*; Dieldrin (0.13 ug/l)*§; Endrin (0.027 ug/l)*, Endosulfan II (0.017)*
Town Run	0.8	Fecal coliform (2900, 3700, 3200, 4100, 8730)◊◊; (7540, 8730)◊◊◊ Dissolved Oxygen (4.5)ǂ; Ammonia (1.01)*; Copper (21)*, (26)**; Lead (11)*
Eljer Plumbingware >>>		
	0.6	Fecal coliform (2100, 3400)◊◊; (>60000, 5900)◊◊◊ Dissolved Oxygen (4.8)ǂ; Copper (32)* (54)** (151, 385)***; Lead (34, 65)*; Zinc (246, 540)**
	0.1	Fecal coliform (2600, 3600, 2200)◊◊; (6000, 21000)◊◊◊ Copper (83)***; Lead (22)*
McCarthy Park Trib.		
	0.1	Dissolved Oxygen (4.2)ǂ; (2.4)ǂǂ

Table 10. continued.

Stream	River Mile	Exceedence: Parameter (value)
Otter Creek	1.7	Fecal coliform (1680)◊, (2200 3150)◊◊; Total Phosphorus (1.00)†; Copper (42)*
Blues Creek	0.7	Fecal coliform (3700)◊◊; Copper (20)*

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

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

*** exceedence of numerical criteria for prevention of acute toxicity inside the mixing zone [i.e., Final Acute Value (FAV)].

‡ exceedence of the average warmwater habitat dissolved oxygen criterion (5.0 mg/l).

‡‡ exceedence of the minimum warmwater habitat dissolved oxygen criterion (4.0 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 maximum Secondary Contact Recreation criterion (fecal coliform 5000/100 ml)

† exccedence of the WWH phosphorus guideline (1 mg/l).

§ exccedence Human Health 30 day Average (single route) Criteria.

Note: Although reported as **total** Cyanide, values are referenced to exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) which are for **free** Cyanide. Values are presented to demonstrate longitudinal trends in water quality but may not represent true exceedences for **free** cyanide.

most upstream site (RM 39.2) and at RM 12.2, immediately upstream from Crosses Run (Figure 9). Less severe departures were found immediately upstream from the WWTP (RM 18.33) and immediately downstream from Crosses Run (RM 11.7). Continuous monitor sampling also recorded severe D.O. depletion and a well-defined D.O. sag between the Marysville WWTP and Crosses Run (see page 62). Organic waste loadings from the Marysville WWTP were the primary source of oxygen depletion downstream from Marysville. Specific reasons for D.O. violations in the upper mainstem are unknown but may be related to small stream size, low stream gradient and nonpoint pollution sources.

Ammonia and nitrate levels rose sharply downstream from the Marysville WWTP (Figure 10). Ammonia exceedences detected at RM 18.14 and 16.8 (Waldo Road) can be attributed to the correspondingly high effluent concentrations found in the August 30 and September 12 samples

(Appendix Table 1). The WWTP was violating the ammonia permit limit during much of August and September (Table 4). Ammonia concentrations in Mill Creek declined with increased distance downstream and experienced only a slight increase downstream from Crosses Run. Nitrate levels also rose sharply downstream from Marysville WWTP and remained elevated throughout the remainder of the mainstem. Like ammonia, a slight increase in nitrate levels was observed downstream from Crosses Run.

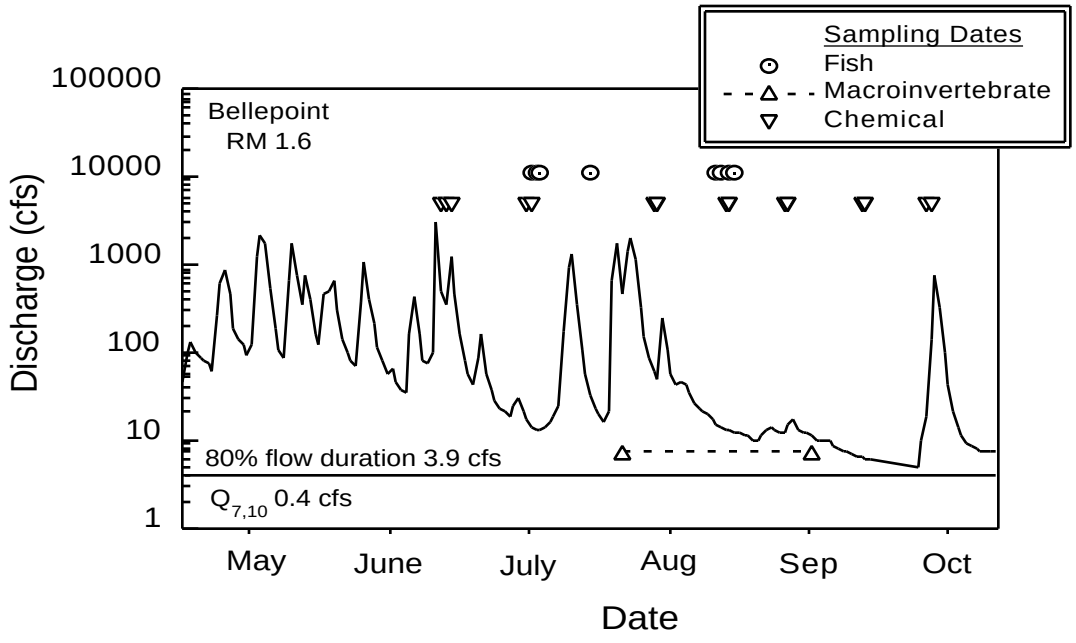

Figure 8. Flow hydrograph for Mill Creek at Bellepoint, Ohio (RM 1.6) from May through September, 1995. Sampling dates and May through November low-flow conditions [Q7-10 to 80% duration flow for the period of record 1942 to 1981] are indicated on the hydrograph.

Phosphorus levels upstream from the Marysville WWTP (RMs 39.2 to 18.33) were well below the Ohio EPA recommended phosphorus guideline of one mg/l for warmwater streams (Figure 10). Downstream from the WWTP, concentrations rose sharply and remained elevated to the mouth. Total phosphorus exceeded the one mg/l guideline in 24 of 109 samples (22 %) and mean concentrations remained above 1 mg/l from Marysville to Blues Creek, approximately 14 river miles downstream. The agency guideline of one mg/l is for prevention of "nuisance algae growth" and is not directly related to protection of aquatic life. In contrast, median and 75th percentile phosphorus concentrations at wadeable reference sites in the Eastern Corn Belt Plain ecoregion range from 0.07 to 0.13 mg/l (Ohio EPA 1996b). The 90th percentile concentration (0.22 mg/l) is

still well below the guideline (Figure 10). In Mill Creek, only sites upstream from the Marysville WWTP had phosphorus levels that did not deviate strongly from ecoregional norms.

Table 11. Stream flow from provisional records for the U.S. Geological Survey gage site on Mill Creek near Bellepoint (RM 1.6) for each chemical sampling field date (mainstem collections). Monthly precipitation information for the central Ohio region during the summer of 1995 is listed in the far right column.

Sampling Pass #	Month	Day	Flow (cfs)	Duration (%)[a]	Monthly Precipitation (in.) [% Above Normal][b]
1	June	28	501	<10%	6.24 [154%]
1	June	29	347	<10%	
1 (RM 4.2)	June	30	1250	<10%	
2	July	17	17	40%	4.39 [111%]
2	July	18	14	30-40%	
3	August	14	63	40-50%	5.68 [160%]
3	August	15	48	40-50%	
4	August	30	13	40-50%	5.68 [160%]
4	August	31	13	40-50%	
5	September	12	12	40-50%	1.15 [40%]
5	September	13	15	40-50%	
6	October	4	18	40-50%	4.22 [190%]
6	October	5	136	<10%	

[a] Flow exceeded by the given percentage listed during the period May-November based on information contained in Johnson and Metzger (1981).

[b] from *Monthly Water Inventory Report for Ohio, Central Region*; ODNR; Division of Water, Water Inventory Unit; June to October 1995.

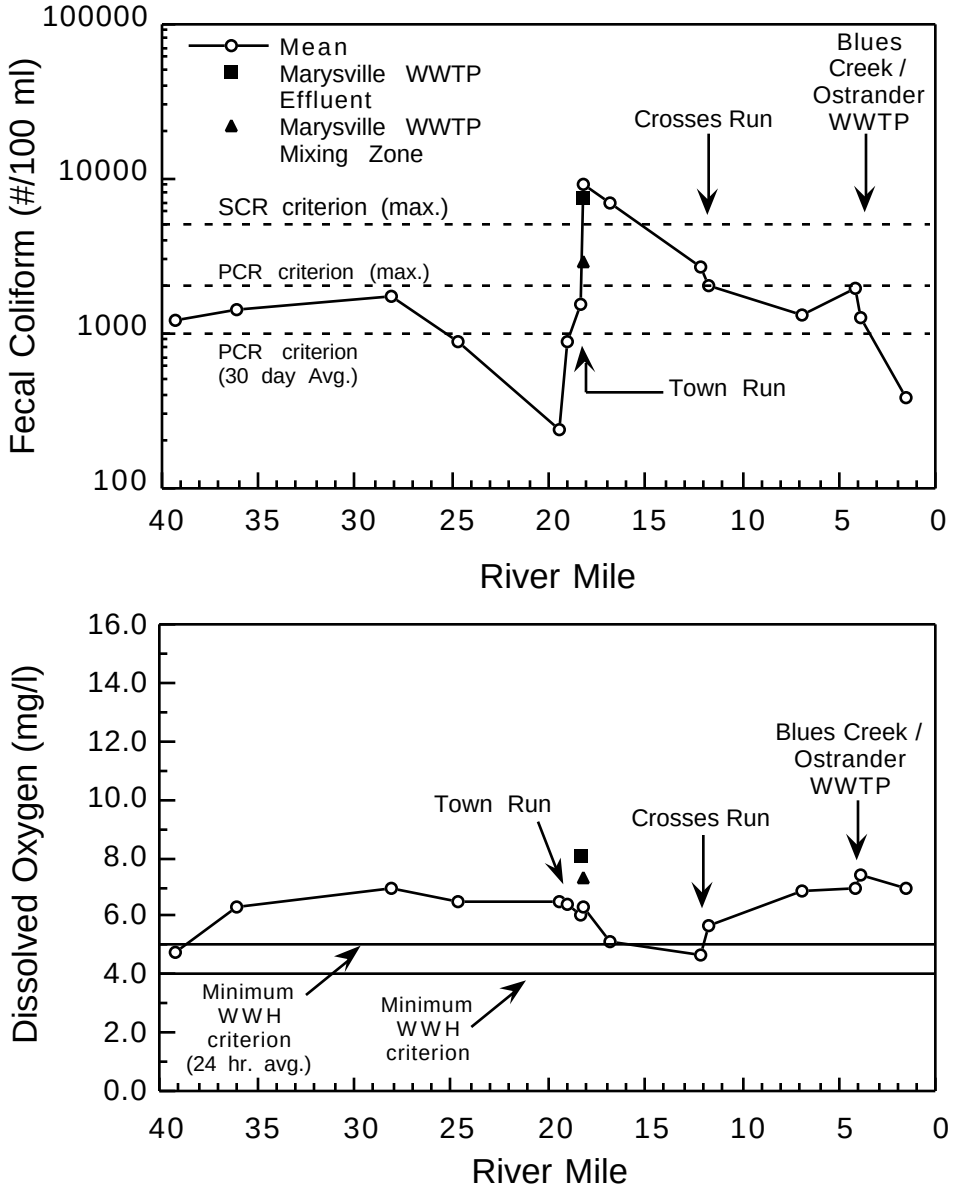

Figure 9. Longitudinal mean concentrations of fecal coliform bacteria (top plot) and dissolved oxygen (bottom plot) in the Mill Creek mainstem, 1995.

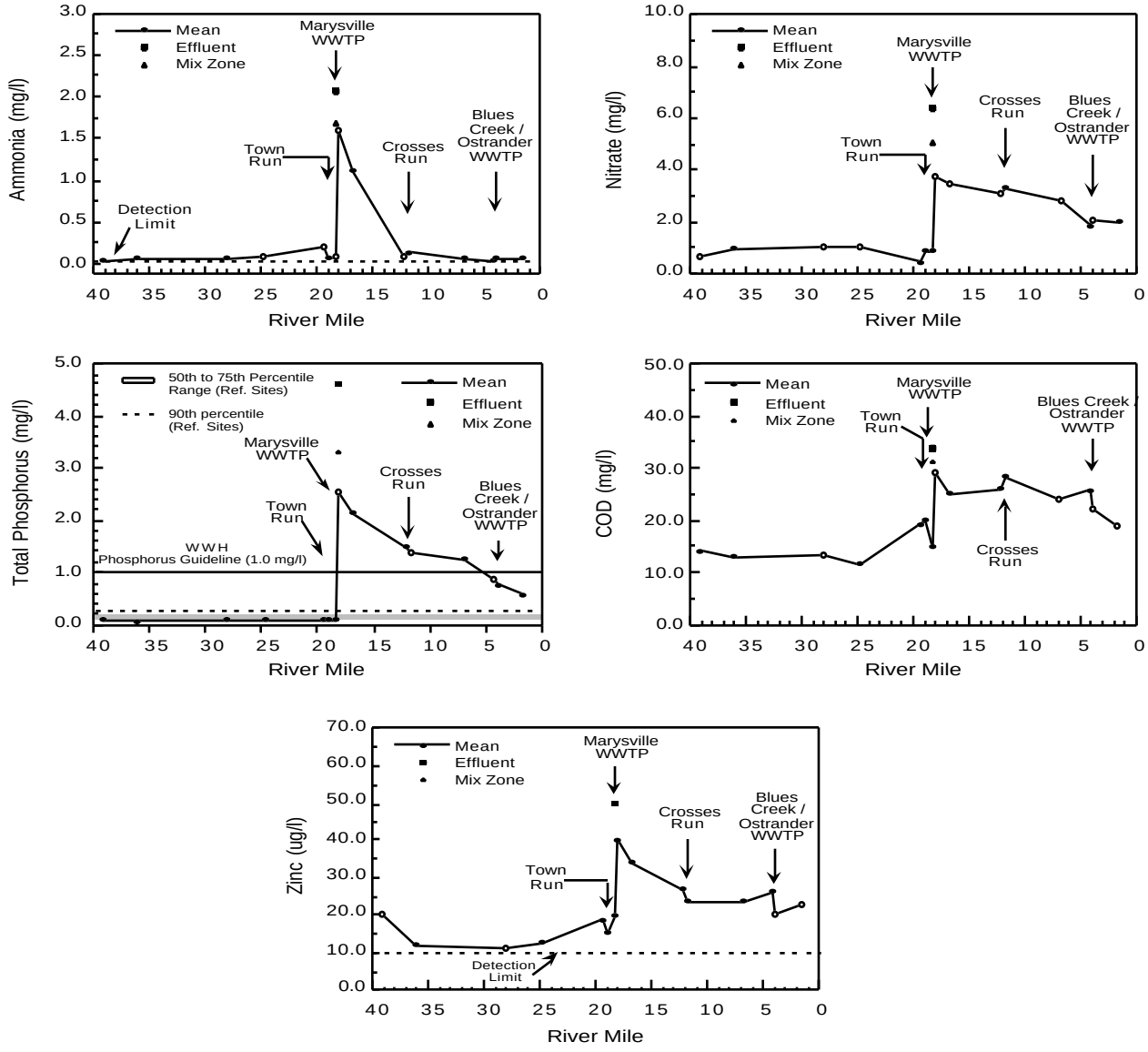

Figure 10. Longitudinal mean concentrations of ammonia-N, nitrate-N, total phosphorus, chemical oxygen demand, and zinc in the Mill Creek mainstem, 1995. Note: Due to inconsistent analysis for COD between stations during the first sampling pass, COD concentrations from June 28-29 were excluded.

Mean suspended solids levels showed an increasing trend from upstream to downstream with highest levels immediately upstream from Blues Creek at RM 4.2. However, analysis of the results by sampling pass suggests a strong correlation between high solids levels and high stream flows on June 28-30 (Figure 11, Appendix Table 1). The highest solids levels (345 mg/l) were found at RM 4.2, immediately upstream from Blues Creek. This was the only mainstem sample collected on June 30 and the average daily flow (1250 cfs) was the highest of any sampling dates during the summer. Elevated but comparatively lower concentrations were found at the remaining sites (June 28-29 samples) when flows ranged from 347-501 cfs. If the first pass data is excluded, a general increasing trend downstream from Marysville still holds with peak concentrations near Crosses Run (mean 26.4 mg/l at RMs 12.2-11.7) and Blues Creek (mean 21.3 mg/l at RMs 4.2-3.8).

Concentrations of most heavy metals increased downstream from Marysville but WQS exceedences were limited to copper at RM 18.33 (immediately upstream from the Marysville WWTP) and lead and copper at RM 4.2, immediately upstream from Blues Creek. Lead concentrations tended to increase downstream from Marysville but were strongly correlated with total suspended solids levels and rainfall event sampling on June 28 and 30 (Figure 11). The trend suggests nonpoint source runoff as the primary source of lead. Copper exhibited a sharp increase immediately upstream from the Marysville WWTP while elevated levels of zinc (no exceedences) were found in effluent sampling and the remainder of Mill Creek downstream from Marysville (Figure 10). Both metals tended to be found in lower concentrations during rain event sampling in June, suggesting an association with consistent or point source discharges.

The highest concentrations of copper in Mill Creek were found at RM 18.33, downstream from Town Run (a small urban tributary) and immediately upstream from the Marysville WWTP (Figure 12). The Eljer Plumbingware landfill on Town Run is an obvious potential source of copper. However, with one exception, copper concentrations were higher at Mill Creek RM 18.33 than at the mouth of Town Run, one-half mile upstream. This does not fit the theory that highest concentrations should be found in the closest proximity to the source. Besides copper, cyanide was detected in 50% of the samples from RM 18.33 but was not found at any site in the basin upstream from that point (Figure 12, Appendix Table 1). The reported “total” cyanide concentrations exceeded the water quality standard for “free” cyanide in nine samples from RMs 18.33 to 16.8 (Table 10). The relationship between free and total cyanide was not known and the concentrations may not have been true exceedences of standards. However, the data are included to display the presence of significant amounts of cyanide (in some form) in the Marysville area. The results raise concerns for a potential unknown source of cyanide (and probably copper), between Town Run and the Marysville WWTP. Additional investigation, including revisiting the Ray Lewis non contact cooling water discharge at RM 18.41, is needed to resolve this issue. Before Ray Lewis directed process wastes to the Marysville WWTP in 1988, copper and cyanide were included in their NPDES permit for direct discharge to Mill Creek.

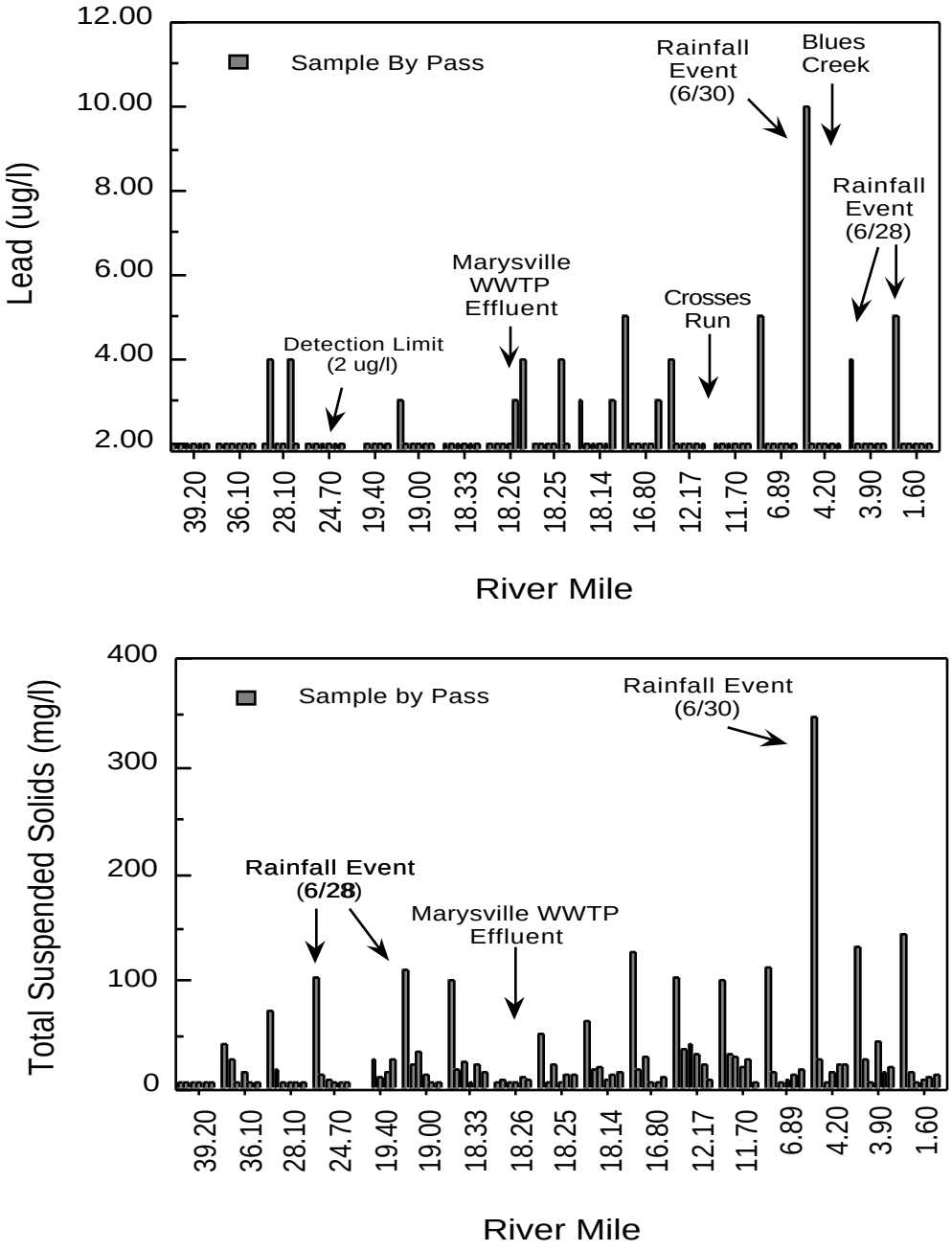

Figure 11. Longitudinal trend in concentrations of lead and suspended solids by sampling pass, June to October 1995.

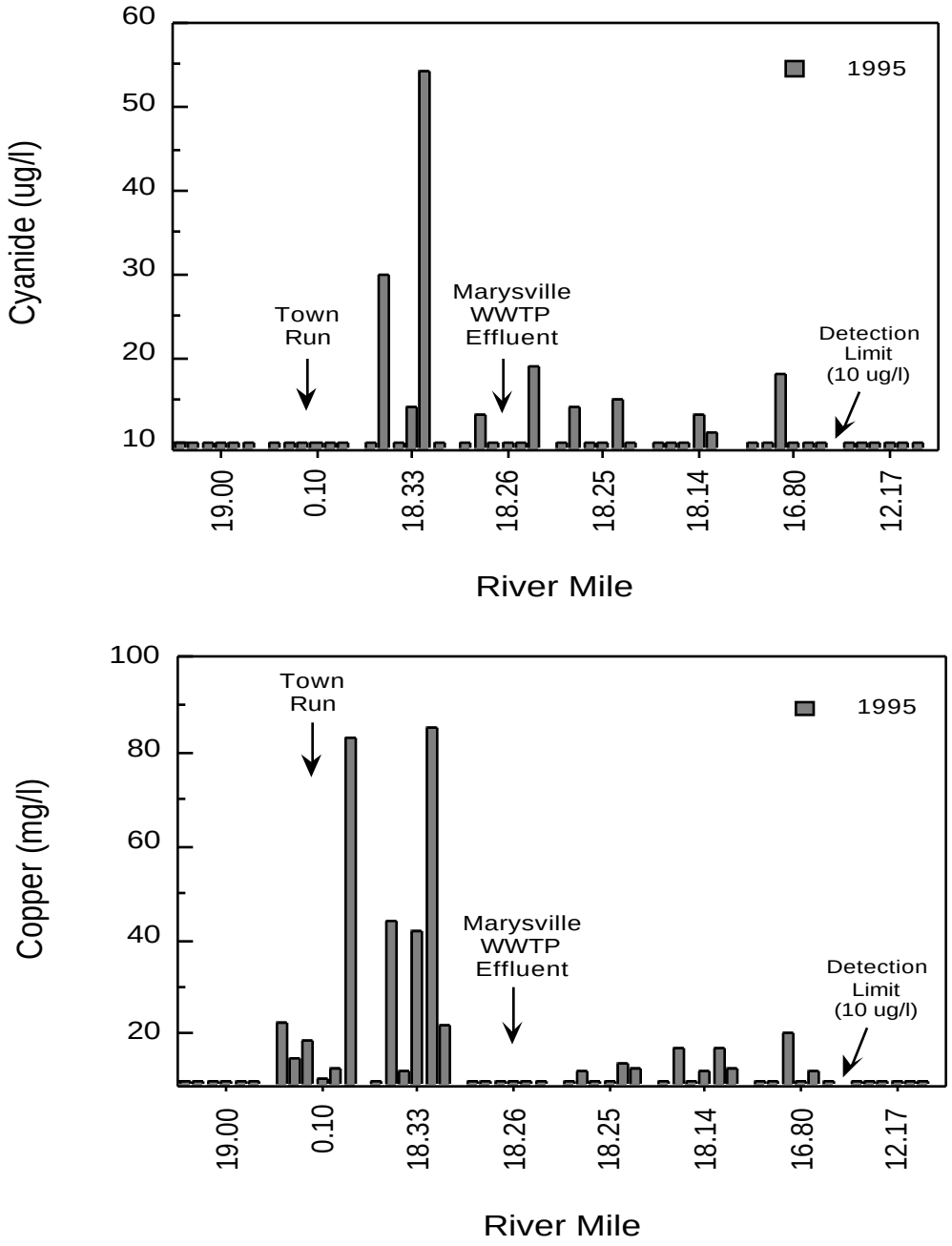

Figure 12. Concentrations of copper and total cyanide by sampling pass from Marysville to Crosses Run (RM 19.00-12.17) June to October, 1995.

Stream and effluent samples collected between RMs 18.33 and 18.14 were analyzed for mercury, silver and antimony due to inclusion of these metals in the most recent Marysville WWTP NPDES permit. Mercury violations were noted upstream from the WWTP at RM 18.33 and the WWTP mixing zone (RM 18.25) but no mercury was detected in the effluent. Detectable amounts of silver were found in one of six effluent samples and one of six samples upstream from the discharge. Antimony was detected upstream and downstream from the WWTP. Detectable amounts were noted once in the effluent on August 14 and the mixing zone on August 30.

Diurnal Dissolved Oxygen Study-Mill Creek and Crosses Run

Diurnal dissolved oxygen, temperature, pH and conductivity data were collected with Datasonde continuous sampling units during August 1995. Datasondes were placed at thirteen stations on Mill Creek between RMs 28.2 and 1.6, and in Crosses Run (RM 0.8) downstream from the Scotts Company. Two sample stations (RMs 17.4 and 12.2) did not record oxygen concentration but recorded oxygen saturation. These data were then converted to mg/l using 1985 Standard Methods values. The datasonde unit at a third station (RM 14.55) experienced difficulties with the battery and did not collect data after eleven hours. Data from RM 24.7 was dropped due to the pooled habitat and lack of adequate current velocity over the probe; these conditions were considered responsible for the abnormally low dissolved oxygen readings.

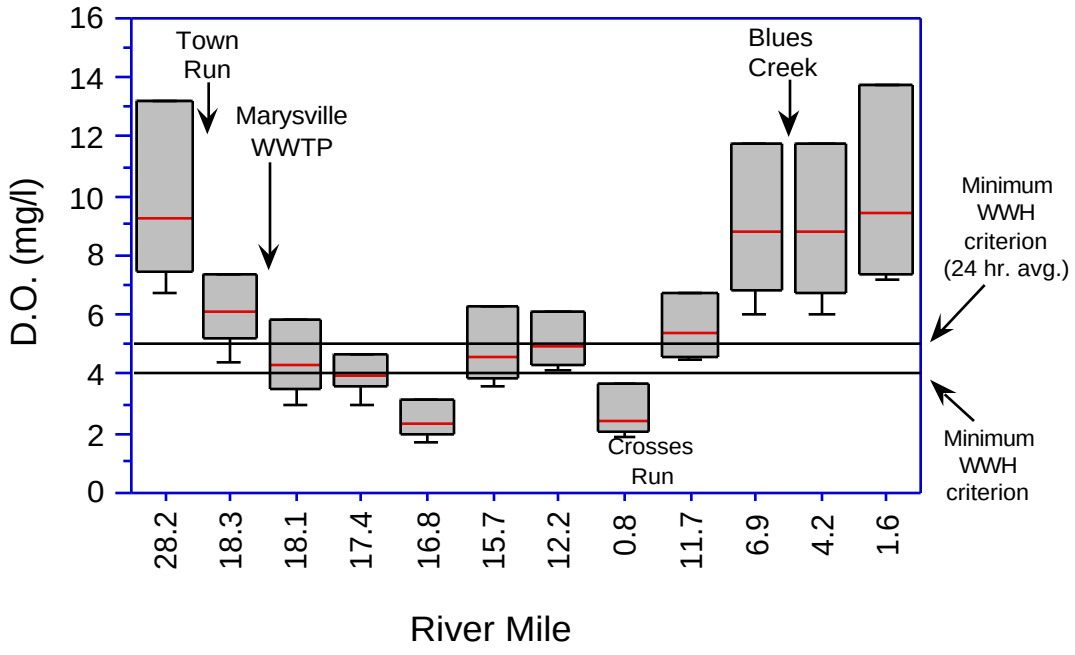

Figure 13. Box and whisker plot of dissolved oxygen continuous monitor data from Mill Creek and Crosses Run, August 29-31, 1995.

Dissolved oxygen levels were well above WWH criteria upstream from Marysville (RM 24.8) and well downstream from Marysville and Crosses Run between RMs 6.9 and RM 1.6 (Figure 13, Appendix Table 2). The D.O. profiles displayed the typical fluctuations associated with diurnal photosynthetic and respiration rates. In contrast, a significant D.O. sag was observed between the Marysville WWTP and Crosses Run (RMs 18.1 to 12.2). Median dissolved oxygen levels at each site were below the average WWH criterion (5 mg/l) and 75th percentile concentrations were below the criterion from RM 18.1 to 16.8. The most severe DO depletion was measured at RM 16.8 where all measurements were under 4 mg/l (minimum WWH criterion) and the 25th percentile level (1.98 mg/l) fell below the nuisance prevention criterion (2 mg/l). Dissolved oxygen levels in Crosses Run were very similar to RM 16.8 with all measurements at RM 0.8 below 4 mg/l. A Mill Creek station immediately downstream from Crosses Run at RM 11.7 reflected only slight changes in the already depressed oxygen levels. Recovery of the D.O. profile was noted in the lower seven miles of the mainstem.

Crosses Run

Ammonia-N exceedences were routinely encountered throughout the Crosses Run basin but became more numerous downstream from The Scotts Company (Table 10, Figure 14). The highest single concentration (51.7 mg/l) was found on June 29, upstream from Scotts point sources at RM 0.9 on the North Branch of Crosses Run. This concentration coincided with field runoff reaching the site following land application of waters pumped from a Scotts Company recycle pond. The runoff incident was reported as a pollutant spill by Ohio EPA field personnel and investigated by the Division of Emergency and Remedial Response (Table 9). The next highest concentration (39.7 mg/l) was observed on September 13 at RM 2.0, immediately upstream from the North Branch. High concentrations likely resulted from inconsistent treatment within the on-site package WWTPs or slugs of contaminated runoff. Compliance sampling investigations (CSIs) conducted in February 1996 at Scott's four WWTP discharges detected permit violations for ammonia in the 001 and 002 outfalls and in the far field mixing zone in Crosses Run. A total of 104 permit violations for ammonia were reported from outfalls 001-005 in 1990-95 (Table 5).

Exceedences of fecal coliform criteria for both primary (1000-2000/100 ml) and secondary (5000/100 ml) contact were common throughout the basin and second to ammonia in number (Table 10, Figure 14). Highest mean concentrations were found at RM 2.8, immediately downstream from a dairy farm with unrestricted cattle access. In addition, Scotts WWTPs have experienced problems with excessive coliform levels (Table 5), although no permit violations were reported during third quarter, 1995. The large populations of wild geese on the property were also a potential source of bacteria.

Excepting the mouth of the North Branch, dissolved oxygen levels below the average WWH criterion (5.0 mg/l) were found on one or two occasions at each site. Continuous monitor sampling in August recorded more severe oxygen depletion downstream from the Scott property

at RM 0.8 (Figure 13, Appendix Table 2); all measurements were below the minimum 4 mg/l WWH criterion.

Exceedences of the 1 mg/l phosphorus guideline were observed in 7 of the 25 samples (28%) but five of the exceedences were limited to the mouth of the North Branch (Table 10, Figure 14). Zinc exceeded the acute aquatic criterion in an October 3 sample from RM 2.0 (Industrial Parkway) and a similar concentration (not an exceedence) was found at RM 2.8 on the same date. Detectable quantities of arsenic, copper and lead were also found at RM 2.8 and very high levels of zinc and other metals were also encountered in sediment samples. The elevated concentrations at RM 2.8 may have been associated with soil disturbance from unrestricted cattle access immediately upstream.

Town Run

Chemical samples were collected from three stations at RM 0.8 (upstream from Eljer Plumbingware and the Marysville urban area), 0.6 (downstream from Eljer Plumbingware) and 0.1 (downstream Marysville). The Eljer Plumbingware facility has been identified as a major source of metals in Town Run and a lesser contributor to Mill Creek (Ohio EPA 1996). Most of the streams length has been channelized and a section in downtown Marysville has been culverted.

Exceedences of maximum fecal coliform criteria for both primary (2000/100 ml) and secondary (5000/100 ml) contact were common throughout Town Run (Table 10). A single ammonia violation was observed at RM 0.8 and dissolved oxygen violations were noted at RMs 0.8 and 0.6. While Town Run is sewered within Marysville, a few on-site septic systems remain. A poor quality septic discharge and growths of "sewage fungus" were observed immediately upstream from RM 0.8 by Ohio EPA field personnel.

Lead and copper exceedences were noted at all sites but increased in number and severity downstream from Eljer Plumbingware (Table 10). The highest concentrations of lead and copper were found at RM 0.7 and copper concentrations exceeded inside mixing zone maxima (*i.e.*, final acute values) at both RMs 0.7 and 0.1. Zinc concentrations also increased at RM 0.7 and included two exceedences of acute criteria (*i.e.*, outside mixing zone maxima).

Otter Creek

Water samples were collected from one sample location on Otter Creek at SR 347 (RM 1.7). Exceedences of the primary contact fecal coliform criteria were recorded in 3 of six samples. All the exceedences occurred during the first three sample passes on June 29, July 20, and August 14 with the highest value recorded in August. Total phosphorus exceeded the WWH phosphorus guideline on September 12. Several metals were detected but only copper exceeded standards (August 14). Cadmium, copper, and lead were detected once on August 14 and arsenic was found once on July 20. Zinc was commonly found above detection limits (4 of 6 samples) but no values exceeded standards. Highest concentrations of suspended solids and nitrates were found

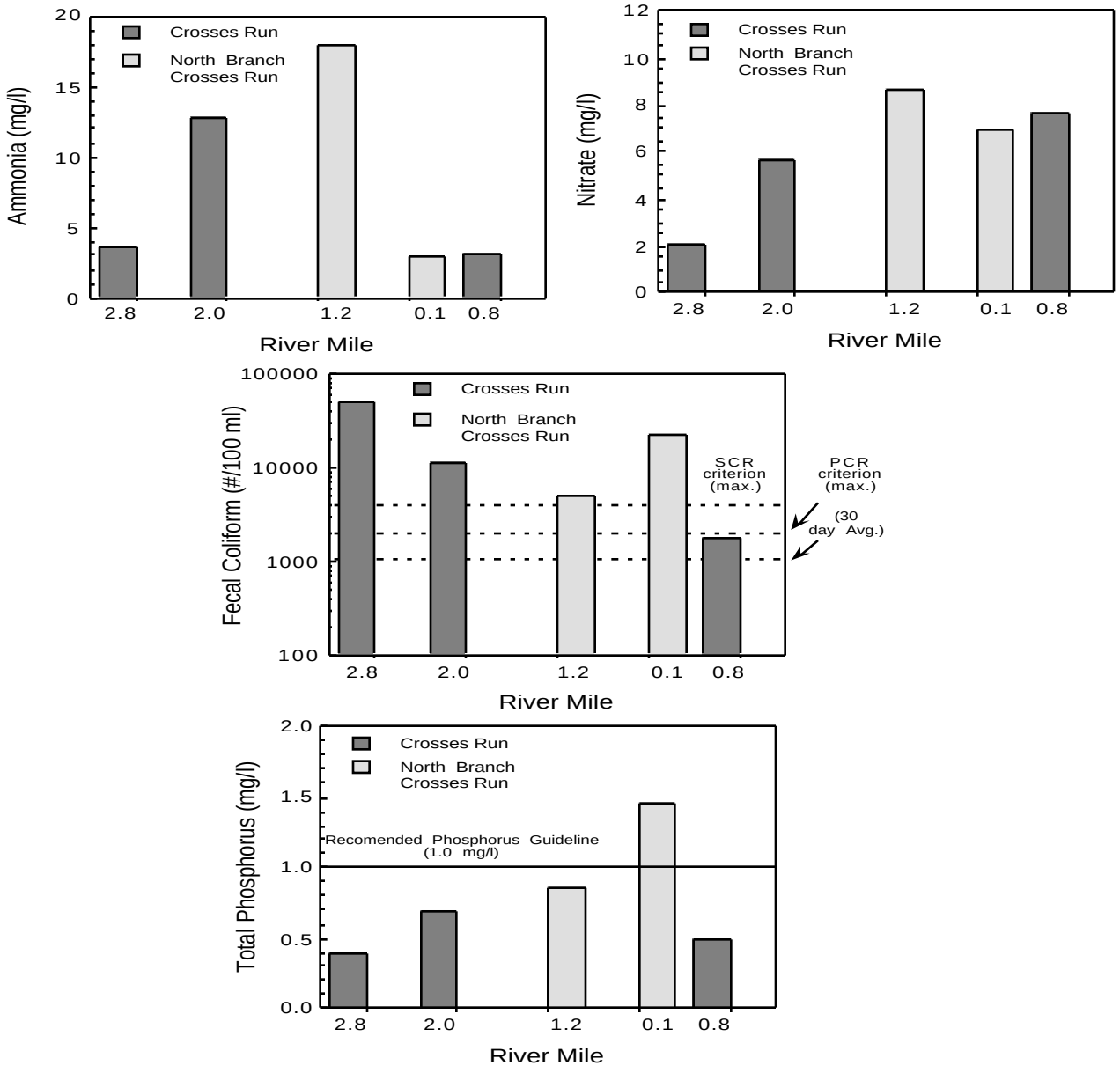

Figure 14. Mean concentrations of ammonia, nitrate, total phosphorus (mg/l) and fecal coliform counts (# colonies/100 ml) at five sampling locations in the Crosses Run watershed, 1995.

on June 29 and resulted from heavy rains and runoff immediately preceding the sampling.

Otter Creek

Water samples were collected at Ostrander Road (RM 0.6) immediately downstream from the Village of Ostrander. Exceedences for copper and fecal coliform, along with elevated nitrates, phosphorus, suspended solids and nickel were recorded on June 30 during a period of high flows and heavy rains. The exceedences were attributed to diffuse nonpoint sources and runoff event sampling.

Water Column Organics

Surface water samples collected at twenty one locations throughout the Mill Creek study area were analyzed for volatile and semivolatile organic compounds. Seven sites in Crosses Run and in Mill Creek upstream and downstream from Crosses Run were also analyzed for pesticides and PCBs. Compounds found in detectable quantities at the sites are summarized in Tables 12-13.

Mill Creek

No volatile or semivolatile compounds were detected between RMs 28.1 (Wheeler Green Road) and 18.33 (upstream Marysville WWTP). Bromodichloromethane and chloroform were detected in the Marysville WWTP effluent (RM 18.26), in the mixing zone (RM 18.25) and at Cherry Street (RM 18.1). Chloroform is often a byproduct of chlorination and the Marysville WWTP disinfection process is considered the likely source of this contaminant.

Pesticide/PCB sampling in Mill Creek was conducted upstream from Crosses Run at RM 12.2 (Marysville-Hinton Mill Road) and immediately downstream from Crosses Run at RM 11.7. While no PCBs were found, several pesticide compounds were detected. Mirex and hexachlorobenzene were found at each site while heptachlor epoxide and 4,4-DDD (a DDT metabolite) were found at RM 12.2 and RM 11.7, respectively.

Although found in Mill Creek, mirex and hexachlorobenzene were not detected in water column samples from Crosses Run in 1995 and have rarely been detected in Mill Creek in other media samples. In 1995, mirex was found in one Town Run sediment sample and hexachlorobenzene was found in one sediment sample from the North Branch of Crosses Run. Extensive sampling of the Town Run/Marysville area and Crosses Run was conducted by the Ohio EPA DERR (Ohio EPA, 1994, 1996). However, no mirex was detected and hexachlorobenzene detection was limited to 2 of 12 soil samples on Scotts property (Crosses Run drainage). Since these data do not explain the occurrence of hexachlorobenzene upstream from Crosses Run, additional investigation is needed to identify potential sources.

Table 12. Summary of concentrations of detected volatile, semivolatile, and pesticide organics from *water column* samples in ug/l (ppb) for the Mill Creek study area, 1995. Exceedences of numerical criteria for prevention of chronic toxicity [Chronic Aquatic Conc. (CAC)] are listed in **Bold**.

	Mill Creek (River Mile)												
Compound	28.1	24.7	19.0	18.3	18.26 Effluent	18.2 Mix Zone	18.1	16.8	12.2	11.7	6.9	4.2	1.6
VOCs													
Bromodichloro-methane	--	--	--	--	1.3	0.9	0.7	--	--	--	--	--	--
Chloroform	--	--	--	--	1.5	1.1	1.0	--	--	--	--	--	--
Semivolatiles													
All compounds	--	--	--	--	--	--	--	--	--	--	--	--	--
Pesticides													
4,4-DDD	NA	NA	NA	NA	NA	NA	NA	NA	--	0.007	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	0.006	--	NA	NA	NA
Mirex	NA	NA	NA	NA	NA	NA	NA	NA	**0.011**	**0.013**	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	0.027	0.053	NA	NA	NA
PCBs													
All compounds	NA	NA	NA	NA	NA	NA	NA	NA	--	--	NA	NA	NA

-- Not Detected or less than laboratory detection limit

NA - Not Analyzed

Crosses Run subbasin

The only volatile compound detected in Crosses Run was chloroform at Industrial Parkway (RM 2.0; Table 13). Numerous semivolatile compounds were detected downstream from Scotts in Crosses Run at RM 2.0 and the North Branch of Crosses Run (RM 0.1) at Scottslawn Road. Pesticide/PCB samples were also collected at each station in the Crosses Run subbasin on October 3-5, 1995. Eighteen WQS exceedences for aquatic life and human health were detected for aldrin, dieldrin, endrin, endosulfan I, endosulfan II, endosulfan sulfate, d-BHC (a lindane isomer) at four of the five sites in Crosses Run and the North Branch. All exceedences were found adjacent to, or downstream from, The Scotts Company. In contrast, low concentrations of three pesticides compounds were detected at RM 2.8, the extreme upstream limit of Scotts property on Crosses Run. (Table 13).

The North Branch site at RM 0.9 was upstream from all known Scotts point source discharges but sampling in October 1995 detected five pesticides in excess of water quality standards. Ohio EPA personnel observed runoff to the sampling site following land application of waters from a settling/recycle pond on June 29, 1995. While pesticides were not sampled on June 29, analysis of conventional parameters found ammonia concentrations over 50 mg/l, an indication of direct influence from the runoff on the receiving stream. A DERR sample from the settling/ recycle pond in 1994 detected the pesticide aldrin in excess of WQS (Tables 10 and 14).

The 1995 results were consistent with previous sampling performed in 1994 by DERR (Table 14). Water samples collected from surface waters on site detected VOCs (2-butanone, toluene), pesticides (heptachlor, endrin, endosulfan II) and herbicides (2, 4-D) in the water column. Water quality and Human Health criteria were exceeded for each pesticide excepting heptachlor epoxide (no current standard). Crosses Run sediments contained elevated levels of semivolatile compounds and extremely elevated pesticide concentrations (DDT metabolites and chlordane) downstream from Scotts in 1994. Nearly all compounds detected in 1994 and 1995 water and sediment samples were also found in DERR soil samples from The Scotts Company property (Tables 14 and 18; Ohio EPA 1994).

A CSI (Compliance Sampling Inspection) conducted at the facility in February 1996 included pesticide (non-banned) sampling from outfalls 001, 002, 003 and 004 and a “far field” mixing zone immediately downstream from the North Branch. A number of pesticides were detected in the effluents including atrazine, cyanazine, pendimethalin and diazinon. Pendimethalin and diazinon were also detected in Crosses Run at the “far field” site.

Town Run

Surface water samples were collected at the mouth of Town Run (RM 0.1). No volatile, semivolatile or pesticide/PCBs were detected in this sample.

Table 13. Summary of concentrations of detected volatile, semivolatile, and pesticide organics in ug/l (ppb) from *water column* samples in Crosses Run, the North Branch of Crosses Run, and Town Run, 1995. Exceedences of aquatic life Water Quality Standards are listed in **Bold**.

	Stream (River Mile)					
	Crosses Run			N. Branch Crosses Run		Town Run
Compound	2.8	2.0	0.8	0.9	0.1	0.1
VOCs						
Chloroform	--	2.3	--	--	--	--
Semivolatiles						
Benzo[k] fluoranthene	--	5.9	--	--	7.0	--
Benzo[g,h,i]perylene	--	2.1	--	--	2.1	--
Chrysene	--	2.6	--	--	3.9	--
Fluoranthene	--	4.1	--	--	5.9	--
Indeno(1,2,3-cd) pyrene	--	3.1	--	--	3.1	--
Phenanthrene	--	4.3	--	--	3.4	--
Pyrene	--	2.9	--	--	4.0	--
Pesticides						
Aldrin	--	--	0.034 #	**0.023***	--	--
a-BHC	0.010	--	--	0.015	--	--
d-BHC	0.002	**0.128***	--	--	--	--
4,4-DDD	--	0.014	--	--	--	--
4,4-DDE	--	--	--	--	0.067	--
Dieldrin	--	**0.160***	--	0.003*	**0.103***	--
Endosulfan I	--	--	--	**0.009**	--	--
Endosulfan II	--	**0.005**	--	**0.004**	**0.017**	--
Endosulfan sulfate	--	**0.046**	--	--	--	--
Endrin	--	--	**0.011**	--	**0.027**	--
Heptachlor	--	--	--	**0.003***	--	--
Heptachlor epoxide	0.004	--	0.005	--	--	--
PCBs						
All compounds	--	--	--	--	--	--

-- Not Detected

NA Not Analyzed

Data not valid per Quality Assurance

* Exceeds Human Health 30 day Average (single route) Criteria.

Table 14. Summary of concentrations of detected volatile, semivolatile, and pesticide organics in ug/l (ppb) from *water column* samples in the Crosses Run subbasin, December 1994. Samples were collected by the Ohio EPA Division of Emergency and Remedial Response (DERR). Exceedences of the aquatic life Water Quality Standards are listed in **Bold**. NOTE: Excepting benzoic acid, all compounds listed were also found in associated soil and/or sediment samples.

Compound	Crosses Run @ Ind. Parkway ~RM 2.0[1]	Adj. N. Branch Crosses Run (Pond #3) Adj. RM 0.8	N. Branch Crosses Run (Dst. Ponds) ~RM 0.8	Crosses Run Dst. US 33 ~RM 1.0
VOCs				
Acetone	14.0	12.0	8.5 J	14.0
Chloroform	0.7 J	--#	--	--
Ethyl benzene	--	--	--	0.6 J
Methylene chloride	2.2 J	1.7 J	2.2 J	1.8 J
2-butanone	4.8 J	3.9 J	3.5 J	13.0
Toluene	1.4 J	--	3.1 J	6.1
Xylene	--	--	--	2.3 J
Semivolatiles				
Benzoic acid	--	3.6 J	1.7 J	2.0 J
Bis (2-ethylhexly) phthalate	8.0 J	16.0 J	1.3 J	--
4-chloro-3-methylphenol	--	--	--	3.0 J
Pesticides				
Aldrin	--	**0.07***	--	--
Heptachlor	--	--	**0.05***	--
Heptachlor expoxide	--	--	0.05	0.07
Endrin	--	--	--	**0.10***
Endosulfan II	--	--	0.06 J	**0.26***
2,4-D	4.6	--	15.0	**62***

1 River Miles for DERR sampling sites are estimated based on study area map.

--# concentration <Estimated Quantitation Limit (EQL)

J Estimated concentration; compound was present but less than EQL.

* Exceeds Human Health 30 day Average (single route) Criteria.

Sediment Chemistry

To evaluate the extent of possible sediment contamination within the Mill Creek study area, sediment samples were collected at 18 locations throughout the watershed. Selected parameters were ranked based on a sediment classification system described by Kelly and Hite (1984). Further evaluation of the sediment quality was conducted using the *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* (Persaud et. al., 1994)

The Kelly and Hite classification system ranks pollutant concentrations (metals and some common banned pesticides) from non-elevated to extremely elevated. However, the classification system was based on background conditions in Illinois streams and does not address toxicity.

The Persaud *et. al.* guidelines were developed for management of aquatic sediment in Ontario, Canada and, unlike the Kelly and Hite criteria, are based on potential toxicity to aquatic benthic organisms. Their classification system is divided into No Effect Level (NEL), Lowest Effect Level (LEL) and Severe Effect Level. (SEL)

The three levels of effect are described as follows:

--**No Effect Level (NEL):** This level suggests that the sediment will have no adverse effect on aquatic life or water quality. At this level no transfer of chemicals through the food chain and no effect on water quality is expected.

--**Lowest Effect Level (LEL):** This suggests a level of contamination that may have an adverse effect on some benthic biological resources. The sediment is clean to marginally polluted.

--**Severe Effect Level (SEL):** At this level, the sediment is considered heavily polluted and will likely have a significant effect on benthic biological resources.

Mill Creek

Based on the Kelly and Hite criteria for metals, elevated concentrations of arsenic, chromium, or iron were detected at 4 of 11 mainstem stations (Table 15). Three of the stations (RMs 28.1, 24.7, and 1.6) were upstream or well downstream from pollution sources in the Marysville area. Mercury, silver and antimony were analyzed in the immediate vicinity of Marysville WWTP and just upstream from the Ostrander WWTP. These tests did not reveal mercury or antimony concentrations above detection. Silver was detected at RMs 18.33 (Ust. Marysville WWTP), 18.1 (Cherry Street, dst. Marysville WWTP) and 16.8 (Waldo Road). The source of silver is not known and there were no known criteria available to rank the concentrations.

Further evaluation of the sediment metals was conducted using the guidelines from Persaud et.al. All detected metals in Mill Creek exceeded the Lowest Effect Level but no concentrations exceeded the Severe Effect Level (Table 16). Nickel, arsenic copper, and chromium were most commonly found in excess of the LEL; the contamination was generally pervasive throughout the mainstem with little association between concentration levels and known pollution sources. Overall, the mainstem sediments were considered slightly to moderately polluted by heavy metals.

Sediment scans for priority pollutants did not detect volatile organics compounds (VOCs) or PCBs at any Mill Creek sampling locations.

Semivolatile compounds in Mill Creek were found between RMs 24.7 (Cotton Slash Road) and 16.8 (Waldo Road) but none were detected between RM 12.6 (upstream Crosses Run) and the mouth (Table 17). Each compound was initially detected at RM 24.7, well upstream from potential pollution sources in the Marysville area. The most commonly found contaminants were benzo[b,k] fluoranthene, fluoranthene and pyrene. Also found between RMs 24.7 and 18.33 (Ust. Marysville WWTP) were benzo[a] pyrene, benzo[g,h,i] perylene, benzo[a] anthracene, chrysene, indeno [1,2,3-cd) pyrene and phenanthrene. Like sediment metals, none of the concentrations exceeded the SEL but all exceeded the NEL. The Kelly and Hite study did not examine volatile or semivolatile compounds and no conclusions were drawn concerning their classification.

Pesticide detection in Mill Creek sediments was limited to methoxychlor at two sites bracketing Town Run in Marysville (RMs 19.0 and 18.33) and immediately downstream from the Marysville WWTP at RM 18.14 (Table 17). Methoxychlor is generally used as an insecticide for the home and garden (e.g., shrubs, vegetables, deciduous fruit trees), as a treatment for Dutch Elm disease, and in agricultural for treatment of soya beans, alfalfa, livestock and poultry (Howard 1991). The compound was not ranked by sediment classification criteria.

Crosses Run Subbasin

Analysis of sediment metals data based on Kelly and Hite criteria indicated elevated to extremely elevated concentrations of arsenic, copper, chromium, lead, iron and zinc in the Crosses Run basin (Table 15). However, the most severe contamination was found at Crosses Run RM 2.8, located downstream from a dairy farm and at the extreme upstream extent of The Scotts Company property. Elevated levels of arsenic were found at four of the five sites in Crosses Run and the North Branch. The source of arsenic is unknown, though arsenic is a component of pesticides and is a constituent in wood treating processes. Excessive levels of chromium and zinc were also found in sediments at the mouth of the North Branch. Further analysis of sediment metals using criteria described by Persaud *et al.* (Table 16) found exceedences of the severe effect level (SEL) were limited to the most upstream site on Crosses Run (RM 2.8). Except for cadmium, most metals exceeded the LEL at remaining stations downstream.

Detection of semivolatile compounds in Crosses Run sediments was limited to the two sites in closest proximity to The Scotts Company. Out of a total of 15 detected compounds, thirteen were detected at both Crosses Run RM 2.0 (upstream from the North Branch) and in the North Branch at the mouth (RM 0.1). No semivolatiles were detected at the most upstream site on Crosses Run (RM 2.8), the most upstream site on the North Branch (RM 0.9), or the most downstream Crosses Run site at RM 0.8. (It should be noted that the North Branch site was dry when the sample was collected and this may have affected the results.) For compounds evaluated by Persaud *et al.*, seven exceedences of the SEL were found in the North Branch while one for Indeno (1,2,3-cd) was noted in Crosses Run (Table 17). Benzo[b,k] fluoranthene, fluoranthene and pyrene were found in the greatest concentrations. Of the 13 compounds found at each station, 11 were common to both. The strong similarity between samples from different drainages points to similar sources of contamination. The few compounds not found at both sites included hexachlorobenzene and bis (2-ethylhexyl) phthalate (North Branch) and acenaphthene and fluorene in Crosses Run.

Longitudinal trends in sediment pesticides were similar to semivolatiles. Compounds were detected only downstream from or adjacent to The Scotts Company. A total of six compounds were detected, with four each found in Crosses Run at RMs 2.0 and 0.8 and at the mouth of the North Branch. Based on Kelly and Hite criteria, concentrations of dieldrin and heptachlor epoxide were extremely elevated (Table 17). All compounds evaluated by the Persaud *et al.* criteria exceeded the LEL but none exceeded the SEL (Table 17). Pesticide compounds common to both Crosses Run and the North Branch included dieldrin, methoxychlor, and the DDT metabolite, 4,4-DDT and 4,4-DDD.

The 1995 results were generally consistent with previous sampling in Crosses Run conducted in 1994 by DERR (Table 18). Numerous semivolatile compounds were detected downstream from Scotts during each survey, although concentrations were consistently lower in DERR's 1994 samples. Both surveys also found extremely elevated pesticide concentrations based on Kelly and Hite ranking criteria. Concentrations of DDT metabolites and chlordane also exceeded Severe Effect Level criteria (Persaud *et al.*) in DERR sediment samples (chlordane was not analyzed during the 1995 Mill Creek survey). Almost all compounds detected in 1994 and 1995 water and sediment samples were also found in DERR soil samples from The Scotts Company property (Ohio EPA 1994).

Town Run

Sediment metals samples from the mouth of Town Run revealed extremely elevated levels of lead and zinc based on Kelly and Hite criteria (Table 15). Lead and zinc levels may be associated with the Eljer Plumbingware RCRA site located upstream; significant heavy metals contamination has been documented at the site, particularly from lead, zinc, nickel and copper. Surprisingly, all other sediment metals at RM 0.1 (including copper and nickel) were in the non to slightly

elevated ranges or were not elevated compared to other sediment sites in the basin. Using the Persaud *et al.* criteria, all metals except cadmium and chromium exceeded the LEL but none exceeded the SEL (Table 16).

Semivolatile contamination in Town Run sediment was similar to collections from Crosses Run (Table 17). Eleven compounds were detected with each exceeding Lowest Effect criteria and two compounds (Benzo [g,h,i] perylene and Indeno (1,2,3-cd) pyrene) exceeding the Severe Effect Level.

Three of the four pesticide compounds detected (d-BHC, mirex and DDE) were not found in any other 1995 sediment samples. Using Kelly and Hite criteria, dieldrin was extremely elevated (Table 17); using Persaud *et al.* criteria, all concentrations exceeded the LEL but none exceeded the SEL (Table 17).

Summary

Based solely on the guidelines developed by Persaud *et al.* (1993), a potential for adverse effects on some benthic populations in the Mill Creek basin is possible. These contaminants tend to persist in the sediments for long periods, allowing for the possibility to transfer up the food chain and accumulate in greater concentrations in other organisms. Sediments located in Crosses Run showed the highest contaminated levels of metals, semivolatiles and pesticides. Based on 1995 results, it did not appear that significant contamination had migrated downstream to Mill Creek. However, detection of sediment contamination can be highly dependent on other factors such as particle size, percent Total Organic Carbon (TOC), the ability to find suitable deposits of fine material for analysis, stream gradient, etc. Coupled with the lack of complete parameter analysis (e.g. chlordane analysis), these factors make sweeping characterizations of mainstem contamination levels difficult.

Table 15. Summary of concentrations of heavy metals (mg/kg dry weight or ppm) in sediments from the Mill Creek basin, 1995. All parameter concentrations, excluding nickel, silver and antimony, were ranked based on a stream sediment classifications described by Kelly and Hite (1984).

River Mile	Sediment Concentration (mg/kg dry weight)										
	As	Cu	Cd	Cr	Fe	Pb	Ni	Zn	Hg	Ag	Sb
Mill Creek											
28.1	9.13[b]	18.1[a]	0.326[a]	**54.3[d]**	21600[b]	--	32.6	81.9[b]	NA	NA	NA
24.7	**21.7[d]**	41.2[b]	0.489[a]	**58.5[d]**	31400[c]	--	43.1	12.8[a]	NA	NA	NA
19.0	8.73[b]	14.2[a]	0.228[a]	19.0[b]	16400[a]	38.4[c]	--	70.2[a]	--	--	--
18.33	9.08[b]	25.1[a]	0.261[a]	--	13500[a]	28.2[b]	--	135[c]	--	0.219	--
18.14	8.78[b]	43.6[b]	0.309[a]	35.7[c]	20400[b]	28.5[b]	25.4	126[c]	--	0.654	--
16.8	6.66[a]	12.0[a]	-- (.092)	14.8[a]	12400[a]	--	--	51.3[a]	--	0.194	--
12.2	**20.0[d]**	37.2[a]	0.645[b]	**58.7[d]**	**34500[d]**	--	43.0	138[c]	NA	NA	NA
11.7	13.1[c]	11.6[a]	0.165[a]	16.5[b]	18000[b]	--	--	59.0[a]	NA	NA	NA
6.9	7.32[a]	8.28[a]	0.114[a]	--	11500[a]	--	--	40.0[a]	NA	NA	NA
4.2	4.25[a]	6.53[a]	0.094[a]	13.5[a]	9040[a]	--	--	28.6[a]	--	--	--
1.6	**32.8[e]**	16.4[a]	0.483[a]	33.7[c]	**40500[d]**	--	--	103[c]	NA	NA	NA
Crosses Run											
2.8	**21.3[d]**	**936[e]**	0.435[a]	**530[e]**	10000[a]	**488[e]**	500	**1000[e]**	NA	NA	NA
2.0	9.91[b]	25.0[a]	0.305[a]	22.2[b]	17400[a]	--	--	121[c]	NA	NA	NA
0.8	**28.1[e]**	28.1[a]	0.303[a]	29.2[c]	**34900[d]**	18.4[a]	43.2	109[c]	NA	NA	NA
North Branch Crosses Run											
0.9	**22.7[d]**	17.2[a]	0.328[a]	22.9[b]	31300[c]	15.8[a]	27.8	57.6[a]	NA	NA	NA
0.1	**17.4[d]**	48.0[b]	1.03[c]	**90.3[e]**	31800[c]	--	49.2	**317[e]**	NA	NA	NA
McCarthy Park Tributary											
0.1	11.0[b]	17.5[a]	0.284[a]	24.1[c]	18800[b]	--	--	101[c]	NA	NA	NA
Town Run											
0.1	8.42[b]	30.5[a]	0.375[a]	18.0[b]	16500[a]	**154[e]**	--	**420[e]**	NA	NA	NA

[a]Non-elevated: [b] Slightly elevated; [c] Elevated; **[d] Highly elevated; [e] Extremely elevated**

-- Not Detected

NA Not Analyzed

Note: The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity.

Table 16. Summary of concentrations of heavy metals (mg/kg dry weight or ppm) in sediments from the Mill Creek basin, 1995. All parameter concentrations were ranked according to the ecotoxic effects guideline described by Persaud and Jaagumagi (1993).

	Sediment Concentration (mg/kg dry weight)								
River Mile	As	Cu	Cd	Cr	Fe	Pb	Ni	Zn	Hg
Mill Creek									
28.1	9.13[b]	18.1[b]	0.326[a]	54.3[b]	21600	--	32.6[b]	81.9[a]	NA
24.7	21.7[b]	41.2[b]	0.489[a]	58.5[b]	31400	--	43.1[b]	12.8[a]	NA
19.0	8.73[b]	14.2[a]	0.228[a]	19.0[a]	16400	38.4[b]	--	70.2[a]	--
18.33	9.08[b]	25.1[b]	0.261[a]	--	13500	28.2[a]	--	135[b]	--
18.14	8.78[b]	43.6[b]	0.309[a]	35.7[b]	20400	28.5[a]	25.4[b]	126[b]	--
16.8	6.66[b]	12.0[a]	--	14.8[a]	12400	--	--	51.3[a]	--
12.2	20.0[b]	37.2[b]	0.645[b]	58.7[b]	34500	--	43.0[b]	138[b]	NA
11.7	13.1[b]	11.6[a]	0.165[a]	16.5[a]	18000	--	--	59.0[a]	NA
6.9	7.32[b]	8.28[a]	0.114[a]	--	11500	--	--	40.0[a]	NA
4.2	4.25[a]	6.53[a]	0.094[a]	13.5[a]	9040	--	--	28.6[a]	--
1.6	32.8[b]	16.4[b]	0.483[a]	33.7[b]	40500	--	--	103[a]	NA
Crosses Run									
2.8	21.3[b]	936[c]	0.435[a]	530[c]	10000	488[c]	500[c]	1000[c]	NA
2.0	9.91[b]	25.0[b]	0.305[a]	22.2[a]	17400	--	--	121[b]	NA
0.8	28.1[b]	28.1[b]	0.303[a]	29.2[b]	34900	18.4[a]	43.2[b]	109[a]	NA
North Branch Crosses Run									
0.9	22.7[b]	17.2	0.328[a]	22.9[a]	31300	15.8[a]	27.8[b]	57.6[a]	NA
0.1	17.4[b]	48.0[b]	1.03[b]	90.3[b]	31800	--	49.2[b]	317[b]	NA
McCarthy Park Tributary									
0.1	11.0[b]	17.5[b]	0.284[a]	24.1[a]	18800	--	--	101[a]	NA
Town Run									
0.1	8.42[b]	30.5[b]	0.375[a]	18.0[a]	16500	154[b]	--	420[b]	NA

a > No Effect Level and < Lowest Effect Level (NEL)

b ≥ Lowest Effect Level (LEL)

c ≥Severe Effect Level (SEL)

-- Not Detected

NA Not Analyzed

Table 17. Summary of concentrations of volatile and semivolatile organic compounds (mg/kg dry weight or ppm) and pesticdes/PCBs (ug/kg dry weight or ppb) in sediments from the Mill Creek basin, 1995. Underlined results exceeded Severe Effect Levels described by Persaud and Jaagumagi (1993); **Bold** results exceeded "**extremely elevated**" criteria (pesticides only) described by Kelly and Hite (1984).

	Sediment Concentration											
River Mile	Mill Creek						Crosses Run			N. Branch Crosses Run		Town Run
Compound	24.7	19.0	18.33	18.14	16.8	12.2-1.6*	2.8	2.0	0.8	1.2	0.1	0.1
*VOCs*** (*mg/kg)*												
All compounds	--	--	--	--	--	--	--	--	--	--	--	--
Semivolatiles ** (*mg/kg)*												
Acenaphthene***	--	--	--	--	--	--	--	0.8	--	--	--	--
Anthracene	--	--	--	--	--	--	--	1.8[b]	--	--	1.0[b]	0.9[b]
Benzo[b,k] fluoranthene	1.5[b]	1.5[b]	1.3[b]	0.6[b]	0.5[b]	--	--	6.6[b]	--	--	17.3[c]	6.5[b]
Benzo[a]pyrene	0.8[b]	0.8[b]	0.8[b]	--	--	--	--	3.2[b]	--	--	7.5[b]	3.5[b]
Benzo[g,h,i] perylene	0.7[b]	0.7[b]	0.5[b]	--	--	--	--	2.3[b]	--	--	7.7[c]	3.3[c]
Benz[a]anthracene	0.8[b]	0.8[b]	0.9[b]	--	--	--	--	3.7[b]	--	--	6.0[b]	2.9[b]
Bis(2-ethylhexyl) phthalate***	--	--	--	--	--	--	--	--	--	--	0.9	--
Chrysene	1.1[b]	1.1[b]	1.0[b]	--	--	--	--	3.6[b]	--	--	8.7[c]	3.4[b]
Dibenz[a,h] anthracene	--	--	--	--	--	--	--	0.9[b]	--	--	2.5[c]	1.1[b]
Fluoranthene	2.6[b]	2.6[b]	1.9[b]	0.9[b]	0.7[b]	--	--	8.4[b]	--	--	17.6[c]	8.0[b]
Fluorene	--	--	--	--	--	--	--	0.8[b]	--	--	--	--
Hexachloro-benzene***	--	--	--	--	--	--	--	--	--	--	13	--
Indeno(1,2,3-cd) pyrene	0.9[b]	0.9[b]	0.7[b]	--	--	--	--	3.3[c]	--	--	8.9[c]	3.9[c]
Phenanthrene	1.5[b]	1.5[b]	1.0[b]	--	0.9[b]	--	--	7.4[b]	--	--	7.3[b]	5.2[b]
Pyrene	1.9[b]	1.9[b]	1.6[b]	0.6[b]	0.5[b]	--	--	6.5[b]	--	--	13.8[c]	6.2[b]
Pesticides (ug/kg)												
Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor**	--	--	--	--	--	--	--	--	5.9[b]	--	--	--

Table 17. continued.

	Sediment Concentration											
River Mile	Mill Creek						Crosses Run			N. Branch Crosses Run		Town Run
Compound	24.7	19.0	18.33	18.14	16.8	12.2-1.6*	2.8	2.0	0.8	1.2	0.1	0.1
Pesticides (ug/kg) continued												
Aldrin	--	--	--	--	--	--	--	--	--	--	--	--
Dieldrin	--	--	--	--	--	--	--	**28**[b]	--	--	**20**[b]	**46**[b]
DDE	--	--	--	--	--	--	--	--	--	--	--	7.2[b]
4,4-DDT	--	--	--	--	--	--	--	16[b]	20[b]	--	14[b]	--
4,4-DDD	--	--	--	--	--	--	--	10[b]	23[b]	--	17[b]	--
Methoxychlor[d]	--	8.2	9.2	7.4	--	--	--	29	--	--	30	--
d-BHC	--	--	--	--	--	--	--	--	--	--	--	17[b]
Mirex	--	--	--	--	--	--	--	--	--	--	--	9.7[b]
Heptachlor-epoxide	--	--	--	--	--	--	--	**16**[b]	**14**[b]	--	--	--
PCBs (ug/kg)												
All compounds	--	--	--	--	--	--	--	--	--	--	--	--

* Inclusive station river miles 12.2, 11.7, 6.9, 4.2, and 1.6

-- Not Detected.

[a] > No Effect Level and < Lowest Effect Level (NEL)

[b] ≥ Lowest Effect Level (LEL)

[c] ≥ Severe Effect Level (SEL)

Bold **Extremely elevated** based on Kelly and Hite (1984)

** Not evaluated by Kelly and Hite.

*** Not evaluated by Persaud and Jaagumagi.

[d] Not evaluated by either sediment classification system.

Table 18. Concentrations of volatiles, semivolatiles and pesticide organics (ug/kg dry weight or ppb) in sediments from the Crosses Run subbasin, December 1994. Samples were collected by the Ohio EPA Division of Emergency and Remedial Response (DERR). Underlined results exceed Severe Effect Levels described by Persaud and Jaagumagi (1993). **Bold** results exceed "**highly elevated**" or "**extremely elevated**" criteria (pesticides only) described by Kelly and Hite (1984). Note: Excepting 3+4 methyl-phenol, all compounds listed were also found in associated soil and/or water column samples.

Compound	Crosses Run @ Ind. Parkway ~RM 2.0[1]	Adj. N. Branch Crosses Run (Pond #3) Adj. RM 0.8	N. Branch Crosses Run (Dst. Ponds) ~RM 0.8	Crosses Run Dst. US 33 ~RM 1.0
VOCs (*ug/kg)*				
Acetone	27	120	--	--
Benzene	--	2.4 J	--	--
2-butanone	3.5 J	34	--	--
Chloroform	--	--	--	2.3 J
Chlorobenzene	--	--	--	0.4 J
Carbon disulfide	0.9 J	11	--	0.7 J
Methylene chloride	9.8	4.8 J	1.7 J	--
4-methyl-2-pentanone	--	1.4 J	--	--
Toluene	0.5 J	9.6	--	--
Xylenes	1.2 J	5.5	--	--
Semivolatiles (*ug/kg)*				
Acenaphthene	49 J	--	--	69 J
Anthracene	140 J	51 J	--	150 J
Benzo[a] anthracene	400	140 J	56 J	380
Benzo[b] fluoranthene	390	74 J	44 J	390
Benzo[k] fluoranthene	330	86 J	44 J	320 J
Benzo[a] pyrene	380	88 J	47 J	390
Benzo[g,h,i] perylene	290 J	80 J	--	200 J
Bis (2-ethylhexel) phthalate	100 J	140 J	--	110 J
Chrysene	510	130 J	80 J	480
Dibenzofuran	--	--	--	57 J
Dibenzo(a,h) anthracene	110 J	47 J	--	82 J

Table 18. continued.

Compound	Crosses Run @ Ind. Parkway ~RM 2.0[1]	Adj. N. Branch Crosses Run (Pond #3) Adj. RM 0.8	N. Branch Crosses Run (Dst. Ponds) ~RM 0.8	Crosses Run Dst. US 33 ~RM 1.0
Semivolatiles (ug/kg) continued				
Di-n-butylphthalate	130 J	--	180 J	47 J
Fluorene	58 J	34 J	--	91 J
Fluoranthene	--	--	120 J	820
Indeno(1,2,3-cd) pyrene	270 J	70 J	--	200
3+4-methylphenol	42 J	--	--	--
4-chloro-3-methylphenol	34 J	--	--	--
Napthalene	--	--	--	36 J
Phenanthrene	620	190 J	120 J	660
Pyrene	680	--	95 J	700
Pesticides (ug/kg)				
Aldrin	--	61	49	--
Dieldrin	19 J	--	**31**[e]	--
Heptachlor	12 J	--	17	42
4,4' DDE	**73**[d]	--	**37**[d]	**120**[d]
4,4' DDD	**170**[e]	17[c]	**110**[e]	**670**[e]
4,4' DDT	--	--	**27**[e]	**330**[e]
[Sum-DDT Metabolites]	**243**[e]	17[c]	**174**[e]	**1120**[e]
Endrin	28 J	--	--	--
Endrin aldehyde	4.8 J	--	4.5	61
Endosulfan sulfate	--	--	1.5	--
Chlordane	**5400**[e]	--	**3900**[e]	**7100**[e]

[1] River Miles for DERR sampling sites are estimated based on study area map.

-- concentration <Estimated Quantitation Limit (EQL)

J Estimated concentration; compound was present but less than EQL. These concentrations were not evaluated using sediment ranking criteria.

[d] **Highly elevated;** Kelly and Hite (1984).

[e] **Extremely elevated;** Kelly and Hite (1984).
Note:The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity.

Fish Tissue Contaminants

Mill Creek

Fish tissue was analyzed from three Mill Creek locations in 1995 and four locations in 1994. Whole body composite samples were evaluated for carp in 1995. All other samples were skin-on scaled fillet composites. All samples were evaluated for selected heavy metal, pesticide and PCB contamination. Detected metal concentrations are summarized in Table 19. Table 20 displays data from the Ohio EPA database and a comparison with data from a national study (Schmitt and Brumbaugh, 1990) completed in 1985. Detected pesticide and PCB concentrations are summarized in Table 21. Information regarding barium, copper, and ß-BHC (aka. hexachloro-cyclohexane, HCH) contamination criteria in fish tissue could not be found in preparation for this report.

Analysis of the fish tissue data resulted in three significant findings:

1) Concentrations of the pesticide total chlordane exceeded the United States Food and Drug Administration (U.S. FDA) recommended action level (RAL) in one carp fillet at RM 11.7, immediately downstream from the confluence with Crosses Run. Extremely elevated levels of chlordane have been detected in Crosses Run sediments and in soil samples from the adjacent Scotts Company property (Ohio EPA 1994).

2) Mercury exceeded U.S. Fish and Wildlife (U.S. FWS) bioaccumulation guidelines for protection of piscivorous birds in approximately two-thirds of the samples from Mill Creek. Elevated levels were found throughout the mainstem and were not associated with any obvious pollution sources in the basin.

3) Analysis of other pesticides and metals in tissue samples revealed no significant contamination for those parameters based on associated criteria.

Information regarding cadmium, while available, is not adequate to define wildlife consumption risks. The US Fish and Wildlife Service has suggested cadmium levels above 2.0 µg/g in fish tissue probably represent cadmium contamination (Eisler 1985). None of the values detected in fish tissue from Mill Creek approached this criterion.

Lead levels have received considerable attention and have resulted in varied recommendations. Eisler (1988) notes that the Canadian permissible concentration limit of 10.0 µg/g in fishery products is probably not protective. He infers a value under 2.0 µg/g and suggests that lower than 1.3 µg/g would be more appropriate. Lead contamination in fish tissue from Mill Creek was not considered significant compared to these benchmarks.

Guidance for mercury assessment in fish tissue in Ohio has recently been derived by the Ohio Department of Health. These values are directed at quantifying human consumption health risks.

Table 19. Summary of the detected metals in fish tissue samples collected from Mill Creek 1994-1995. Bold values exceed the U.S. FDA recommended action level. Note: SOFC=skin on scaled fillet composite, WBC=whole body composite, NT=not tested.

River Mile	***Location***	Detected metals (values in µg/g=ppm)					
Year	Tissue type	Barium	Cadmium	Copper	Lead	Mercury	Selenium
RM 24.8	***At Cotton Slash Rd.***						
	3 carp (WBC)	1.68	0.0778	1.04	0.153	0.0875	0.423
1995	5 rock bass (SOFC)	-	-	0.489	0.0642	0.266	0.266
	2 sm. bass (SOFC)	-	-	0.398	-	0.258	0.504
RM 18.4	***Ust. Marysville WWTP***						
	3 carp (WBC)	1.94	0.0503	2.13	0.204	0.0295	0.441
1995	5 w. crappie (SOFC)	-	-	-	-	0.0854	0.223
	3 lm. bass (SOFC)	-	-	0.337	-	0.134	0.355
RM 18.0	***Dst. Marysville WWTP***						
1994	2 carp (SOFC)	NT	-	NT	0.0527	0.0514	NT
	5 rock bass (SOFC)	NT	0.00507	NT	0.0659	0.112	NT
RM 12.0	***Ust. Crosses Run***						
1995	3 carp (WBC)	1.09	-	1.97	0.227	0.101	0.585
	5 rock bass (SOFC)	-	0.0129	0.402	0.0618	0.0268	0.238
RM 11.7	***Dst. Crosses Run***						
	2 carp (SOFC)	NT	-	NT	-	0.103	NT
1994	4 hogsucker (SOFC)	NT	-	NT	-	0.0633	NT
	5 rock bass (SOFC)	NT	-	NT	0.133	0.296	NT
RM 6.9	***At Hinton Mill Rd.***						
1994	3 carp (SOFC)	NT	-	NT	-	0.0922	NT
	5 rock bass (SOFC)	NT	-	NT	-	0.209	NT
RM 1.6	***At Mills Rd.***						
	3 carp (SOFC)	NT	0.00638	NT	0.0791	0.228	NT
1994	2 rock bass (SOFC)	NT	NT	NT	NT	0.203	NT
	4 hogsucker (SOFC)	NT	-	NT	-	0.102	NT
	2 lm. bass (SOFC)	NT	-	NT	-	0.131	NT

Table 20. Concentrations of selected metals (µg/g≈ppm) in fish tissue samples collected in Ohio through 1995 and as reported by Schmitt and Brumbaugh (1990) from 315 whole fish composite samples collected from 112 sites across the United States[1]. Initial year of Ohio analysis is in parenthesis. Note: NT = not tested.

Metal	Ohio		Geometric Mean		85th Percentile		Maximum	
	Analysis Frequency	Detection Frequency (%)	Ohio	U.S.A.	Ohio	U.S.A.	Ohio	U.S.A.
Barium (1990)	58	57 %	0.723	NT	2.04	NT	3.56	NT
Cadmium (1989)	1414	21 %	0.006	0.03	0.0084	0.05	0.0828	0.22
Copper (1983)	183	74 %	0.727	0.65	1.69	1.0	31.9	23.1
Lead (1983)	1439	41 %	0.070	0.11	0.148	0.22	8.33	4.88
Mercury (1980)	1570	95 %	0.130	0.10	0.226	0.17	1.04	0.37
Selenium (1983)	83	82 %	0.285	0.42	0.470	0.73	1.69	2.3

Based on this framework, six samples from Mill Creek exceeding 0.2 µg/g (0.2 ppm) were moderately elevated. Among the remaining 13 samples, 11 contained mercury values between 0.051and 0.2 µg/g that were slightly elevated. The U.S. Fish and Wildlife Service has found that mercury contamination levels should not exceed 0.1 µg/g to protect piscivorous birds and 1.1 µg/g to protect piscivorous mammals against bioaccumulation (Eisler 1987). Using this guidance 12 of the 19 samples (63%) from Mill Creek would exceed the bioaccumulation guideline for piscivorous birds. These recommendations were further qualified by the U.S. EPA (1992) which indicated the effect on piscivorous wildlife exposed to diet concentrations of one to two ppm Hg was death. Guidance is not readily available for fish tissue although none of the Mill Creek results posed a risk for selenosis (Eisler 1985). Most recommendations regarding protection of aquatic life from selenium poisoning are water column based concentrations. In Ohio, the chronic 30 day average criterion is 5.0 µg/l.

The U.S. FDA recommended action level (RAL) for total PCB contamination is 2000 µg/kg. However values as low as 640 µg/kg have caused reproductive failure in piscivorous mammals (U.S. EPA 1992). The International Joint Commission has established a goal of 100 µg/kg total PCB in fish tissue to protect piscivorous wildlife. PCB (1260) was detected in two Mill Creek fish tissue samples at concentrations below these levels of concern.

DDT (total) was detected in 6 of 19 Mill Creek tissue samples. None of the detected values approached any applicable criterion. The U.S. FDA RAL for total DDT contamination is 5000

µg/kg. The State of New York considers a fish tissue concentration criterion of 200 µg/kg to be protective of piscivorous wildlife (U.S. EPA 1992).

Fish tissue containing elevated amounts of chlordane isomers represented the only Mill Creek samples collected which approached or exceeded a U.S. FDA RAL. The RAL for total chlordane contamination is 300 µg/kg. One carp fillet sample collected downstream from Crosses Run contained 430.55 µg/kg. Other samples of carp collected in this vicinity also had relatively high chlordane contamination. The U.S. FWS says that information necessary for the determination of chlordane criteria is inadequate but notes that the daily intake level used to protect human health is 1.0 µg total chlordane per kg body weight. Furthermore, they indicate food sources should not exceed the RAL (Eisler 1990). High chlordane levels were also documented in soil and sediment samples from the Scotts Company property (Ohio EPA 1994).

Dieldrin was found at levels below those considered to place wildlife at risk in several Mill Creek fish tissue samples. The State of New York has established 120 µg/kg as the dietary limit to protect piscivorous wildlife (U.S. EPA 1992). The U.S. FDA RAL is 300 µg/kg.

The U.S. FDA RAL for heptachlor epoxide is 300 µg/kg. The State of New York recognizes 200 µg/kg in fish tissue as the criteria to protect piscivorous wildlife (U.S. EPA 1992). The detected values in Mill Creek samples were considerably lower.

Table 21. Summary of the detected organic compounds in fish tissue samples collected from Mill Creek 1994-1995. Whole values only are reported. **Bold** values exceed the U.S. FDA recommended action level. Note: SOFC=skin on scaled fillet composite, WBC=whole body composite.

River Mile	***Location***	Detected organic compounds (values in µg/kg=ppb)					
Year	Tissue type	PCB (1260)	DDT (total)	Chlordane (isomers)	ß-BHC	Dieldrin	Heptachlor Epoxide
RM 24.8	***At Cotton Slash Rd.***						
	3 carp (WBC)	-	6	26	-	17	-
1995	5 rock bass (SOFC)	-	-	-	-	-	-
	2 sm. bass (SOFC)	-	-	5	-	9	-
RM 18.4	***Ust. Marysville WWTP***						
	3 carp (WBC)	25	-	17	-	-	-
1995	5 w. crappie (SOFC)	-	-	9	-	4	-
	3 lm. bass (SOFC)	-	-	5	-	-	-
RM 18.0	***Dst. Marysville WWTP***						
1994	2 carp (SOFC)	-	21	69	-	19	-
	5 rock bass (SOFC)	-	-	-	-	-	-
RM 12.0	***Ust. Crosses Run***						
1995	3 carp (WBC)	21	24	238	-	16	4
	5 rock bass (SOFC)	-	-	-	-	-	-
RM 11.7	***Dst. Crosses Run***						
	2 carp (SOFC)	-	24	**430**	10	32	33
1994	4 hogsucker (SOFC)	-	-	12	-	-	-
	5 rock bass (SOFC)	-	-	-	-	-	-
RM 6.9	***At Hinton Mill Rd.***						
1994	3 carp (SOFC)	-	11	226	-	26	12
	5 rock bass (SOFC)	-	-	-	-	-	-
RM 1.6	***At Mills Rd.***						
	3 carp (SOFC)	-	9	117	-	32	-
1994	2 rock bass (SOFC)	-	-	-	-	-	-
	4 hogsucker (SOFC)	-	-	-	-	-	-
	2 lm. bass (SOFC)	-	-	-	-	-	-

Biomarkers

Fish samples were collected for biomarker enzyme induction analysis at five Mill Creek locations between downtown Marysville and the junction of Bellepoint and Hinton Mill Roads (RMs 18.6, 18.1, 12.2, 11.7 and 6.9). The sites bracketed the Marysville WWTP (RM 18.26) and the confluence with Crosses Run (RM 12.0). Common carp and white suckers were collected as test species and analysis included EROD, BUN, Glutathione, and bile for PAH metabolites. However, there was insufficient time to include the draft data in this report. A finalized report should be submitted by USEPA (Cincinnati, Ohio Lab) at a later date.

Physical Habitat for Aquatic Life

Assessment of biological potential and use attainability for a given stream segment requires the analysis of riparian and instream habitat characteristics, disturbance type, potential rate of recovery, and plans for maintenance of modifications (Rankin 1989). Table 22 presents the total QHEI scores for each sampling location in the Mill Creek basin. Generally, QHEI scores above 60 reflect habitat conditions that can support aquatic communities consistent with the WWH use designation. Scores of 75 and above are typical of *very good* to *exceptional* macrohabitat conditions (Rankin 1989). In addition, Table 21 includes a matrix of Warmwater Habitat and Modified Warmwater Habitat characteristics. The Modified Warmwater Habitat characteristics are further broken down into those attributes that have high or moderate influence on altering community performance and display individual habitat characteristics at each site.

Mill Creek

In 1995 the quality of macrohabitats in Mill Creek was evaluated at 16 fish sampling sites extending from a site upstream of the confluence with Otter Creek (RM 39.1) downstream to a site at Mills Rd. (RM 1.7). Qualitative Habitat Evaluation Index (QHEI) scores ranged from 91.1 at Mills Rd. to 61.5 at RM 39.1, upstream from Otter Creek (Table 22). Good quality stream habitats with a predominance of WWH attributes were present at all locations. Including all sites, the mean QHEI was 73.8.

Overall, the macrohabitat quality in Mill Creek tended to improve longitudinally from upstream to downstream. This trend was partially skewed by a relative decrease in QHEI scores at locations immediately downstream from the Marysville WWTP. Substrate attributes downstream from the WWTP (RM 18.1), adjacent to Waldo Road (RM 16.2), and at US 36 (RM 14.6) had the most influence on this deviation. An elevated amount of silt and subsequent embeddedness coupled with mostly gravel size bed materials resulted in reduced interstitial quality at these locations. Easily flocculated fines were also present at these sites that decreased in quantity longitudinally downstream from the WWTP.

Gravel and cobble substrates predominated Mill Creek. Silt in moderate amounts was typical at most sites with some heavy loads present at locations in and downstream from Marysville. The amount of embeddedness varied similarly. Channel morphology also tended to be adequate.

Only the most downstream locations exhibited excellent development, high sinuosity, and high stability.

Upstream from Marysville agriculture was the most prevalent land use adjacent to the stream and the riparian corridor tended to be narrow (*i.e.*, 5-10m). In Marysville, a moderately wide (10-50m) corridor was flanked by a composite of park, residential and light industrial land uses. The lower half of Mill Creek exhibited a wider (*i.e.*, >50m) corridor. Land use on the margins was typically rural/residential areas interspersed by pasture and fewer row crop fields.

Instream cover was almost uniformly moderate from site to site. Most locations had logs, woody debris, rootwads, boulders, deep pools and other functional features. Riffle and run quality was better downstream from Marysville where increased flow resulted in good variation in current velocities.

In summary, macrohabitat conditions in Mill Creek were considered adequate to support the WWH use designation. Furthermore, conditions improved longitudinally with the most downstream locations exhibiting excellent habitat qualities. Efforts to increase the width of the riparian corridor in the upper watershed are recommended as the most effective way to enhance the macrohabitat conditions in this reach.

Otter Creek

Habitat conditions in Otter Creek were evaluated at one fish sampling site (RM 0.7) where a QHEI value of 70.5 was determined. Habitat conditions were similar to those observed in most of Mill Creek. Hardpan substrate was more extensive at this site than at other study area locations. Similar to upper Mill Creek sites, the riparian corridor was narrow and flanked by agricultural land use (*i.e.*, row crop and fallow pasture). Although the QHEI score of 70.5 was reflected good habitat conditions, enhancement of the riparian corridor is recommended as an appropriate mechanism to foster better water resource integrity.

Town Run

QHEI scores of 45.5 (RM 0.9), 53.5 (RM 0.7), and 60.5 (RM 0.1) were recorded at three fish sampling sites in Town Run. These sites, all within the Marysville city limits, were influenced by residential and urban development. The effects of a hardened watershed were commonly evident in the unstable stream channel. Elements of anthropogenic influence (*i.e.*, snagging, canopy removal, small channel modifications, etc.) were numerous. Bricks and broken concrete were frequently encountered components of the substrate. Despite these factors, an average QHEI value of 53.2 indicated generally fair habitat conditions. However, these conditions were considered sufficiently impaired as to exert a moderate influence on the ambient biological potential (Rankin 1989).

Crosses Run

Crosses Run habitats were evaluated at three fish sampling stations. QHEI values increased

downstream from a site in a cattle pasture (RM 2.8, QHEI=28) through a reconstructed channelized reach (RM 2.1, QHEI=42.5) to a lower, essentially natural reach (RM 0.9, QHEI=73.5).

A *poor* mean QHEI score (35.3) for the two upstream sites was indicative of habitat conditions that negatively influence biological performance (Rankin 1989). Within the cattle pasture, the severely degraded stream became intermittent by late summer. The reconstructed reach of the stream displayed slightly better habitat attributes including perennial flow (likely due to effluent augmentation from the Scotts Company) and some marginal riffles. Both reaches lacked any appreciable instream cover and lacked riparian corridors. The high incidence of MWH attrributes, particularly at the most upstream site, reflected the extremely small stream size and negative influences from unrestricted cattle access and historic modification (Table 22).

In contrast, good quality habitats were present upstream from Watkins Rd. (RM 0.9). A moderate amount of instream cover, good channel morphology, and an adequate riparian area created conditions conducive to support of biological communities consistent with WWH ecoregional expectations.

North Branch Crosses Run

In the North Fork of Crosses Run, QHEI scores of 45.0 (RM 1.0) and 30.5 (RM 0.2) were recorded at two fish sampling sites. The upstream site was within a fallow pasture where the stream became intermittent in late summer. The absence of riparian corridor and a sparse instream cover, compounded by the lack of perennial flow, were compelling factors that influenced the generally fair habitat conditions. Macrohabitats were judged not likely to support a WWH aquatic community.

The downstream site was within a large lawn area. No riparian corridor, almost no instream cover, and no functional riffles were present in this channelized reach. The poor QHEI score reflected habitat conditions which could be expected to exert a negative influence on biological community performance (Rankin 1989).

Blues Creek

Good habitat conditions (QHEI=71.5) existed in Blues Creek at the one fish sampling location upstream from Ostrander Rd. (RM 0.7). A variety of substrates existed with silt and embeddedness present in moderate amounts. Moderate to extensive amounts of instream cover, good channel morphology, and good riparian corridor width characterized this site. The prevalent macrohabitat quality was deemed suitable for a WWH biological community.

Table 22. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for stations in the Mill Creek basin study area, 1995.

Table 22. (continued).

Biological Assessment: Macroinvertebrate Community

Macroinvertebrate samples were collected from 28 stations in Mill Creek, Otter Creek, Town Run, Crosses Run and Blues Creek (Table 23). Artificial substrate (quantitative) sampling was the preferred method in Mill Creek and Crosses Run while natural substrate sampling (qualitative) was conducted in the other tributaries. Lists of macroinvertebrate taxa and ICI metric scores from each site in the study area can be found in Appendix B.

Mill Creek

Artificial substrate samples were collected at fifteen stations on the Mill Creek mainstem from RM 39.4, upstream from Otter Creek, to RM 1.6 near the confluence with the Scioto River (Table 23, Figure 15). Excepting RM 39.4, all sites upstream from the Marysville WWTP were consistently in the *good* and *very good* ranges with ICI scores of 40 or 42. The ICI at RM 39.4 was in the *fair* range (28) but the evaluation was upgraded to *marginally good* based on the quality of the natural substrate community. A lack of current over the artificial substrates and subsequent lack of flow-dependent taxa (primarily net-spinning caddisflies) was considered the major reason the ICI fell slightly below ecoregional expectations.

Communities in the Marysville urban area showed minimal impact from point and nonpoint sources prior to the Marysville WWTP discharge. Sites downstream from the Marysville Water Supply dam, the Marysville WTP and Town Run (RMs 19.3-18.6) maintained a predominance of mayflies and low percentages of tolerant organisms. Also, *good* to *exceptional* numbers of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa were collected from the natural substrates. Qualitative Community Tolerance Value (QCTV) scores throughout upper Mill Creek and the Marysville area performed above or very near ecoregional expectations (Figure 15) and reflected minimal impacts through the stretch.

Macroinvertebrate community health declined sharply beginning in the WWTP mixing zone. The effluent had a distinctive coffee colored stain and most substrates were covered with a thick layer of sewage solids. The ICI dropped to 16 (lower *fair* range) and the community was predominated by pollution tolerant oligochaetes and hemoglobin utilizing midges of the *Chironomus riparius* group; tolerant taxa accounted for 89.5% of the over 7,000 organisms collected from the artificial substrates. Collections of *C. riparius* group larvae were restricted to the mixing zone. Similar localized assemblages have been encountered in mixing zones at the Findlay, Columbus Southerly, and Tiffin WWTPs. The source of the larvae appeared to be the sewage treatment plants. At Columbus Southerly, the larvae were found on the walls of the final contact tanks, immediately before discharge to the receiving stream. Each effluent was considered highly enriched but not acutely toxic. Impacts from the Marysville discharge appeared primarily related to excessive organic enrichment.

Community health remained in the *fair* range from the WWTP to a site adjacent to Waldo Road

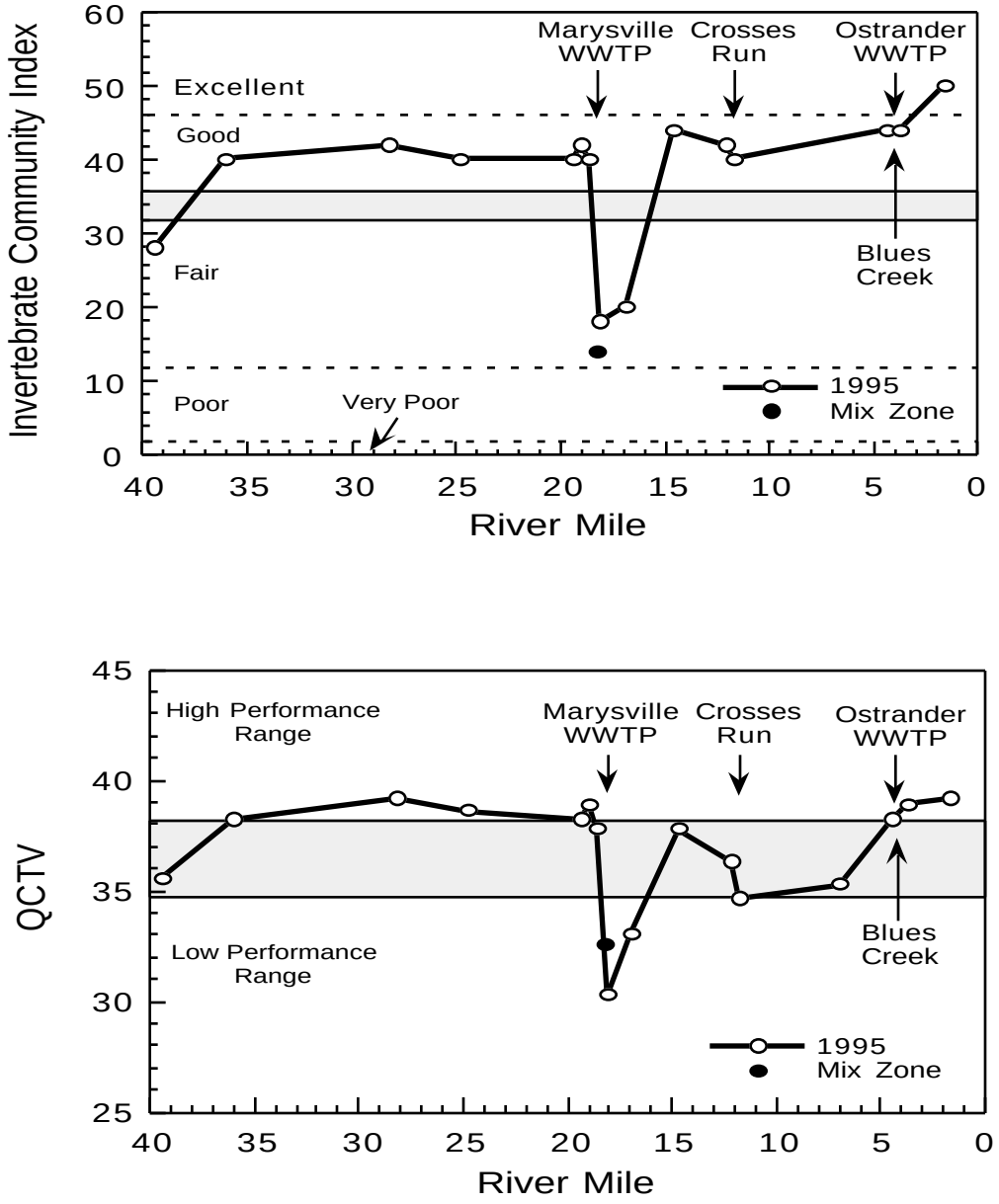

Figure 15. Longitudinal trend of the Invertebrate Community Index (ICI) and the Qualitative Community Tolerance Value (QCTV) in Mill Creek, 1995.

(ICIs = 18 and 20 at RM 18.1 and 16.9, respectively) before improving to the *very good* range (ICI=44) at RM 14.6 (U.S. 36 bridge). The improvement was characterized by sharp declines in the percentages of tolerant organisms and other diptera/noninsects and subsequent increases in taxa richness, percent mayfies, and EPT taxa from the natural substrates.

Remaining stations between RMs 12.2 and 1.6 ranged from *good* to *exceptional*. The ICI experienced only a two-point drop downstream from Crosses Run and reflected no significant impacts to the mainstem. Further downstream, sampling at RMs 4.4 and 3.7 bracketed both the confluence with Blues Creek and the new Ostrander WWTP. Identical ICI scores of 44 (*very good* range) were found at the sites, reflecting no detectable influences from the tributary or the WWTP. Further improvement was noted at RM 1.6, before the confluence with the Scioto River where the ICI of 50 was in the *exceptional* range.

QCTV scores between RM 14.6 and 12.2 (upstream from Crosses Run) did suggest a declining trend in the natural substrate community and a further decline downstream from Crosses Run at RMs 11.7 and 6.9 (Figure 15). However, none of the scores dropped into the range associated with lowered performance (*i.e.*, *fair* or *poor* quality). The natural substrate communities improved with additional distance downstream and reached the higher performance ranges (*good* or *exceptional* quality) at RM 1.6.

Otter Creek

Natural substrate samples were collected from Otter Creek at RM 0.7, approximately two miles downstream from a large area of road construction on US 33. The sample was predominated by riffle beetles, net-spinning caddisflies, water pennies, mayflies and crayfish in moderate to high densities. Large amounts of silt appeared entrained in the sediments and a thin layer of silt covered most substrates. Despite these conditions, total taxa richness was quite high (63) and the number of EPT taxa (12) and QCTV score (36.8) were at or near levels associated with WWH attainment. Community performance was considered *good*.

Crosses Run

Artificial substrates were collected from four of seven stations in the Crosses Run subbasin. Collections from the most upstream sites on Crosses Run (RM 2.8), the North Branch of Crosses Run (RM 1.0) and an Unnamed Tributary to Crosses Run near the mouth were limited to the natural substrates (qualitative sampling). All samples reflected *poor* or *very poor* quality (Table 23).

Crosses Run RM 2.8 was at the extreme upstream extent of the Scotts Company property and immediately downstream from a feedlot with unrestricted cattle access. The stream was pooled and extensively intermittent. The few organisms present were in low densities and mostly comprised of backswimmers, dragonflies, and water beetles. The community health evaluation was rated *poor*.

Crosses Run RM 2.4 was immediately upstream from Scotts South water stop/tributary which receives effluents and stormwater runoff from the Scotts facility. Like RM 2.8, the stream was

intermittent but the grass lined channel had been channelized to a sufficient depth to avoid desiccation. Both the artificial substrate samplers and stream bottom were covered with a thick blanket of filamentous algae. Only 67 organisms distributed among 12 taxa were collected from the artificial substrates; the ICI of 4 was in the lower *poor* range. Qualitative samples were also of *poor* quality and predominated by pollution tolerant lung-breathing snails of the genus *Physella*. The extensive algal mats at the site probably resulted in severe diurnal D.O. swings and periodic anoxia.

ICI scores dropped from 4 to 0 (*very poor*) downstream from The Scotts Company's South water stop and 002, 003 and 006 discharges. Despite improved habitat quality and continuous flow, there were indications of further declines in the macroinvertebrate communities. Both quantitative and qualitative communities were predominated by two tolerant midge taxa, *Cricotopus sylvestris* group and *Polypedilum (P) illinoense*. Both midges are included on the Ohio EPA, Tolerant Taxa List (Ohio EPA 1987b). Based on Ohio EPA data, *C. sylvestris* group is considered one of the more tolerant midge taxa. When found in large numbers, the larvae are often associated with both *poor* and *toxic* water quality conditions. Nearly identical communities were also collected from the mouth of the North Branch of Crosses Run that enters Crosses Run immediately downstream from RM 2.0. The similarities in composition between the two sites suggests similar impact response signatures in both water bodies.

Crosses Run RM 0.6 exhibited slight improvement with an ICI of 6 (lower *poor* range). While most of the very tolerant taxa at sites upstream were absent or reduced in predominance, no EPT taxa were found on the artificial substrates and natural substrate collections were limited to the tolerant mayfly genus *Callibaetis*.

Unnamed Trib. to Crosses Run @ RM 2.24
Runoff from the Scotts facility flows through a small swale and enters Crosses Run at RM 2.24. In addition, the 002 package plant and 006 cooling water outfalls discharge to the tributary. At the mouth, a catch basin or "water stop" is used to temporarily impound the runoff before discharge to Crosses Run (Scotts 003 discharge is located in the very short stretch between the water stop and Crosses Run). When artificial substrates were set in Crosses Run on August 16 1995, the water stop was full and over-flowing a low spot on the dam face into Crosses Run. Six weeks later, a qualitative sample was collected from the small stream flowing along the bottom of the basin after the impoundment had been emptied. The sample was predominated by midge taxa and included several extremely tolerant varieties (e.g., *Psectrotanypus dyari, Cricotopus sylvestris* group, *Glyptotendipes barbipes, Chironomus riparius* group, and *Chironomus (C.) sp. 1*). These taxa are included in the Ohio EPA tolerant taxa list (ICI Metric # 9) and have been associated with both toxic impacts and severe degradation from organic wastes. EPT taxa were limited to the tolerant mayfly genus *Callibaetis*. The sample was evaluated as *very poor*.

North Branch Crosses Run
Station RM 1.0 was located upstream from Scotts recycle/settling ponds and 001 discharge. Like RM 2.8 on Crosses Run, the stream was extensively intermittent and may have dried up during extended dry weather periods. Qualitative sampling yielded 26 taxa comprised mostly of water

beetles, snails, odonates (*i.e.*, dragonflies and damselflies) and water bugs. The mayfly genus *Callibaetis*, tolerant of low dissolved oxygen levels, was the only EPT taxon collected. Community performance was considered *poor* and primarily limited by stream intermittence and possible stream desiccation.

As mentioned previously, artificial substrate and natural substrate collections from the mouth of the North Branch were of *very poor* quality (ICI=0). Community compositions were nearly identical to those found in Crosses Run immediately upstream from the North Branch. The similarities suggest exposure to similar toxic stresses downstream from Scotts property and discharges.

Town Run

Natural substrate samples collected upstream and downstream from Eljer Plumbingware at RMs 0.8 and 0.7 were similar in composition and reflected *fair* macroinvertebrate quality (Table 23). Septic tank drainage was noted at the upstream site and potential impacts from Eljer Plumbingware runoff could not be easily separated from the already impaired stream conditions. Benthic community health declined to the *poor* range near the mouth of Town Run (RM 0.1) after the stream was culverted under the Marysville urban area. The sample was predominated by pollution tolerant midges, leeches and snails; no EPT taxa were found compared to five taxa at each site upstream. An oily sheen was observed on the surface and an "oily and rotten" odor was noted during the collections.

Blues Creek

Qualitative sampling immediately downstream from the Village of Ostrander at RM 0.6 yielded a total of 51 taxa, including ten EPT taxa. Collections were predominated by the net-spinning caddisfly genus *Cheumatopsyche*, riffle beetles and mayflies in moderate to high densities. Filamentous algal growth was also extensive in open canopied sections. The community was considered *good* but reflected enriched conditions.

Table 23. Summary of macroinvertebrate data collected from artificial substrate samplers (quantitative sampling) and natural substrates (qualitative sampling) in the Mill Creek study area, July to September, 1986-1995.

	Quantitative Evaluation							
Stream River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Total Taxa	Qual. EPT[a]	QCTV[b]	ICI	Narrative Evaluation[c]
Mill Creek (1995)								
	Eastern Corn Belt Plains WWH Use Designation (Existing)							
39.4	220	25	31	62	9	35.5	[28][d]	Marg. Good
36.0	205	48	52	82	14	38.2	40	Good
28.2	140	32	52	67	14	39.1	42	Very Good
24.8	320	42	57	72	12	38.6	40	Good
19.3	417	30	36	52	10	38.2	40	Good
19.0	287	29	41	57	14	38.9	42	Very Good
18.6	252	39	40	58	11	37.8	40	Good
18.2 (mix zone)	*1441*	*21*	*28*	*37*	*5*	*32.6*	*16*	*Fair*
18.1	541	26	36	47	6	30.3	18*	Fair
16.9	131	26	32	46	7	33.0	20*	Fair
14.6	314	38	47	63	11	37.8	44	Very Good
12.1	228	30	45	57	12	36.3	42	Very Good
11.7	262	35	40	58	10	34.6	40	Good
6.9	Qual. Only	NA	66	NA	15	35.3	NA	Good
4.4	435	40	53	72	13	38.2	44	Very Good
3.7	497	50	51	74	14	38.9	44	Very Good
1.6	336	33	50	66	17	39.1	50	Exceptional
Mill Creek (1990)								
28.2	554	34	44	60	11	38.9	42	Very Good
19.0	414	34	34	49	5	34.2	22*	Fair
18.6	221	29	31	42	5	34.6	18*	Fair
18.2 (mix zone)	*489*	*24*	*22*	*33*	*4*	*32.6*	*12*	*Poor*
18.1	564	23	20	32	3	31.3	14*	Fair
16.9	372	26	28	44	5	32.6	20*	Fair
12.1	753	26	35	44	8	36.8	34[ns]	Marg. Good
11.7	682	32	29	40	8	33.0	26*	Fair
6.9	1207	24	41	50	9	35.3	36	Good
1.6	663	25	34	40	11	39.7	40	Good

Table 23. (continued).

Stream River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Total Taxa	Qual. EPT[a]	QCTV[b]	ICI	Narrative Evaluation[c]
				Quantitative Evaluation				
Mill Creek (1986)								
24.8	336	45	50	67	10	37.7	38	Good
18.5	87	45	27	44	7	35.3	18*	Fair
18.3	19	10	22	31	5	39.3	6*	Poor
18.1	182	22	25	36	4	34.2	12*	Poor
16.8	75	20	23	34	5	30.1	20*	Fair
12.1	165	39	31	55	9	35.5	36	Good
11.7	77	30	28	50	8	38.9	32[ns]	Marg. Good
6.9	288	33	29	48	8	38.6	38	Good
1.8	456	28	36	49	11	38.9	38	Good
Mill Creek (1984)								
28.2	NA	NA	31	NA	13	39.9	NA	Good
Mill Creek (1978)								
24.8	187	34	18	47	6	40.3	32[ns]	Marg. Good
16.8	350	21	8	26	2	29.6	8*	Poor
12.2	110	20	16	29	4	41.3	14*	Fair
11.6	278	25	19	33	5	32.0	14*	Fair
7.1	47	20	10	28	1	35.3	10*	Poor
1.7	212	28	18	37	5	35.3	32[ns]	Marg. Good
Otter Creek (1995)								
				Eastern Corn Belt Plains WWH Use Designation (Existing)				
0.7	Qual. Only	NA	63	NA	12	36.8	NA	Good
Otter Creek (1988)								
1.7	Qual. Only	NA	56	NA	7	34.2	NA	Marg. Good
Crosses Run (1995)								
				Eastern Corn Belt Plains WWH Use Designation (Existing)				
2.8	Qual. Only	NA	18	NA	0	15.4	NA	Poor
2.4	13	12	24	31	1	17.7	4*	Poor
2.0	306	8	18	19	1	15.6	0*	Very Poor
0.6	185	19	29	37	1	22.8	6*	Poor

Table 23. (continued).

Stream River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Total Taxa	Qual. EPT[a]	QCTV[b]	ICI	Narrative Evaluation[c]
				Quantitative Evaluation				
Crosses Run (1990)								
2.0	159	20	24	33	2	19.6	4*	Poor
0.1	479	31	33	47	4	32.9	22*	Fair
Crosses Run (1988)								
0.8	Qual. Only	NA	17	NA	2	31.3	NA	Poor
Crosses Run (1986)								
0.8	Qual. Only	NA	6	NA	0	NA	NA	Very Poor
North Branch Crosses Run (1995)								
				Eastern Corn Belt Plains WWH Use Designation (Recommended)				
1.0	Qual. Only	NA	26	NA	1	22.8	NA	Poor
0.1	237	12	15	19	0	19.6	0*	Very Poor
Unnamed Trib. to Crosses Run @ RM 2.24 (1995)								
				Eastern Corn Belt Plains Undesignated (No Recommended Use)				
0.1	Qual. Only	NA	19	NA	1	13.0	NA	Very Poor
Town Run (1995)								
				Eastern Corn Belt Plains WWH Use Designation (Recommended)				
0.8	Qual. Only	NA	29	NA	5	32.3	NA	Fair
0.7	Qual. Only	NA	39	NA	5	32.3	NA	Fair
0.1	Qual. Only	NA	23	NA	0	24.8	NA	Poor
Town Run (1990)								
0.1	Qual. Only	NA	16	NA	0	22.8	NA	Poor
Blues Creek (1995)								
				Eastern Corn Belt Plains WWH Use Designation (Existing)				
0.6	Qual. Only	NA	51	NA	10	38.5	NA	Good
Blues Creek (1990)								
0.6	Qual. Only	NA	46	NA	9	35.5	NA	Good

[a] EPT= total Ephemeroptera (mayflies), Plectoptera (stoneflies) and Tricoptera (caddisflies).

[b] Qualitative Community Tolerance Value (QCTV) is calculated as the median tolerance value of all taxa collected during qualitative (*i.e.*, natural substrate) sampling.

Table 23. (continued).

[c] A narrative evaluation based on qualitative sampling results and best professional judgement is used when quantitative data is not available for calculation of the Invertebrate Community Index (ICI).

[d] The quantitative (artificial substrate) sample was affected by nondetectable current speed; a *marginally good* narrative evaluation was substituted based primarily on qualitative sampling results.

* Significant departure from ecoregion biocriteria (>4 ICI units); *poor* and *very poor* results are underlined.

ns Nonsignificant departure from biocriterion (<4 ICI units).

Ecoregion Biocriteria: Eastern Corn Belt Plains (ECBP)
(from OAC 3745-1-07, Table 7-17)

INDEX	WWH	EWH	MWH[e]
ICI	36	46	22

[e] - Modified Warmwater Habitat for channel modified areas.

Biological Assessment: Fish Community

Mill Creek

Forty-five fish species and five hybrids (16,960 individuals) were collected in Mill Creek in 1995. Sampling occurred twice at 16 wading sites from upstream Otter Creek (RM 39.1) in Logan County, downstream to Mills Rd. (RM 1.7) near Bellepoint and the confluence with the Scioto River (Appendix C). Overall, the fish assemblage in Mill Creek was rated as *marginally good* to *good* (Table 24). This characterization was based on fish community indices that ranged from *poor-marginally good* (MIwb=5.2, IBI=36 at RM 16.2) to *exceptional* (MIwb=9.4, IBI=53 at RM 3.7). The mean MIwb for all sites was 8.2 with the mean IBI at 43 (Figure 16).

Ecoregional WWH criteria were not met at five sites. At four of these sites, the fish community failed to meet the MIwb biocriterion (8.3). These sites were within Marysville (RMs 19.2, 18.4, and 18.1) and immediately downstream (RM 16.2). At the fifth site (RM 11.6), the subpar fish community performance was influenced by an IBI score in the lower *fair* range (28) during the first sampling event. The IBI score improved to *good* (40) with the second sample pass, but the average score of 34 remained below the WWH IBI biocriteria (40). Fish community indices generally reflected water quality impacts longitudinally, from within Marysville to downstream from the Crosses Run confluence. At sites upstream from Marysville and downstream from Crosses Run, fish community performance was *good* to *exceptional*.

The MIwb measures relative number, weight, and how evenly relative number and weight is distributed among species. It is sensitive to the total number and biomass of fish excluding tolerant species and to the uneven distribution of individuals and biomass within the community assemblage. The *fair* MIwb scores in Marysville and immediately downstream corresponded with low biomass, a disproportionate proportion of biomass comprised by carp (mean=66.6%, n=8), low numbers of fish, and an abundance of green sunfish (mean=29.5%, n=8). In this stream reach, both highly tolerant species were supported by favorable habitat conditions including numerous pools and silty conditions (Trautman 1981). However, the disproportionate representation by tolerant species and the relative lack of intolerant species was considered more indicative of multiple impacts. An average of only 18.2% (n=8) of the biomass consisted of species not considered tolerant. With adequate macrohabitat (mean QHEI=70.4), the low number of fish (excluding tolerant species) and the associated low amount of biomass reflected a stream subjected to various water quality impairments.

Despite a moderate number of fish species (mean =20.9, n=8) at sites within Marysville and just downstream, many species were only represented by one or two individuals. A few moderately intolerant fish species were present but these were either juveniles (*i.e.*, longear sunfish, northern hogsucker) or habitat specialists such as darters (*i.e.*, greenside darter, rainbow darter) which seemed restricted to the well-aerated riffle habitats. Furthermore, a large percentage (mean=41.9%, n=8) were pioneering species. These characteristics suggest the assemblage

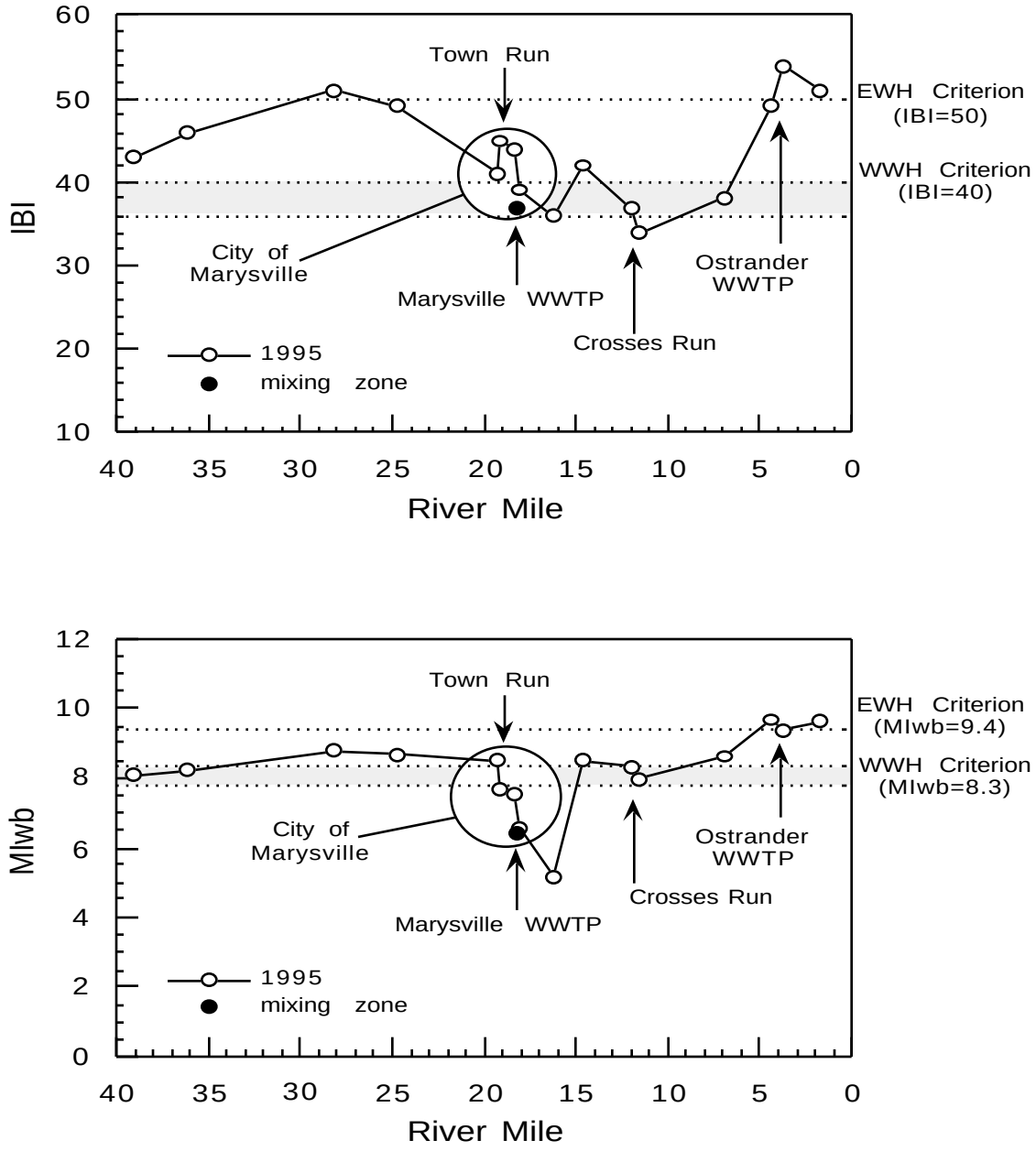

Figure 16. Longitudinal trend of the IBI and MIwb in Mill Creek, 1995

lacked the permanence and stability required to yield the structural and functional organization for an adult predominated community (*i.e.*, adult redhorse suckers, smallmouth bass, rock bass, intolerant species, etc.). The fact that some elements of the fish community were present, resulting in marginally acceptable IBI scores, was interpreted as an ancillary aspect of the observed degradation. It is possible for a fish assemblage to yield a *good* IBI score in spite of adverse environmental conditions. The IBI trend in Mill Creek demonstrates the need to use a combination of indices in the analysis of environmental perturbations.

The trends in MIwb scores near Marysville and downstream indicated water quality problems in this reach were not continuous. As the fish community began to recover, the intermittent repetition of impacts and other influences acted to prevent full recovery. Essentially, juveniles, pioneering species and tolerant species inhabited this reach (RM 19.2-RM 16.2). The symptomatic absence of adult fish not classed as tolerant was taken as evidence of sporadic perturbations. Potential sources of impact began with the Maple Street storm sewer outfall (RM 19.5) where a dry weather septic discharge was observed and a September pollutant spill was reported (Table 8, milk from Nestle R&D). Other possible pollution sources, or combinations of sources, within this reach included: stream dewatering, lime sludge runoff, contaminants from tributaries such as Town Run, abandoned landfill leachate, CSOs, WWTP effluent, and urban runoff.

Upstream from the Maple Street storm sewer, the Marysville water supply intake draws water from the impoundment created by a small low-head dam. The water treatment plant (WTP) and associated lime sludge pits are next to the stream, a short distance downstream from the storm sewer. During the first sampling pass a grey color characteristic of lime sludge was observed in the water column at several sites downstream from the WTP. Town Run, which receives runoff from the Eljer Plumbingware RCRA site and the Marysville urban area, enters this reach at RM 18.9. Two abandoned landfills are located further downstream near the WWTP. During the second sampling pass patches of oily scum were present on the water surface upstream from the WWTP. Conspicuous examples of polluted runoff were frequent within Marysville. Trash in the stream was plentiful and concrete had been poured on the banks in several areas.

There were many possible pollution sources in Marysville besides the WWTP. With cumulative influences suspected, the data documented periodic disruption of the fish community. Efforts to reduce or eliminate the potential sources in this reach should be pursued.

Impacts attributable to the Marysville WWTP were also evident in this reach. At the two sites downstream from the plant, IBI and MIwb scores fell. These mean scores (RM 18.1, IBI=38, MIwb=6.6; RM 16.2; IBI=36, MIwb=5.2) were the lowest recorded in Mill Creek in 1995. Mixing zone samples were also collected twice. During the first sampling pass, the WWTP effluent plume hugged one bank. Flow originating upstream from the WWTP was visibly separated along the opposite bank. The effluent dominated stream half was clear with a tea brown color stain. Opposite the mixing zone, the creek retained the turbid gray cast, character-

istic of lime slurry noted upstream. While sampling, fish avoidance was observed on the effluent side, thus two collections were made to compare the two linear halves of the stream. The mixing zone side of the stream scored lower (IBI=32, MIwb=5.5) than the opposite half (IBI=38, MIwb=7.7). During the second pass, the distinction between stream halves was not evident so sampling was conducted throughout the 50 meter zone (IBI=42, MIwb=7.2). Overall, the mean mixing zone scores (RM 18.2; IBI=37, MIwb=6.4) were consistent with the marked decline in fish community performance downstream from the WWTP.

A decrease in the percentage of simple lithophils (mean=16%) and an increase in the percentage of tolerant fish was noted downstream from the WWTP. Tolerant fish made up 72.5% (n=2) of the population at RM 16.2 (Figure 17). Subsequently, the IBI metric scores for the percentage of tolerant fish and relative number less tolerants were low and the MIwb scored poorly at this site. The predominance of tolerant species and decreases in fish community performance further downstream from the WWTP was characteristic of a pattern of organic enrichment, associated low dissolved oxygen levels (*i.e.*, a D.O. sag), and elevated ammonia-N concentrations.

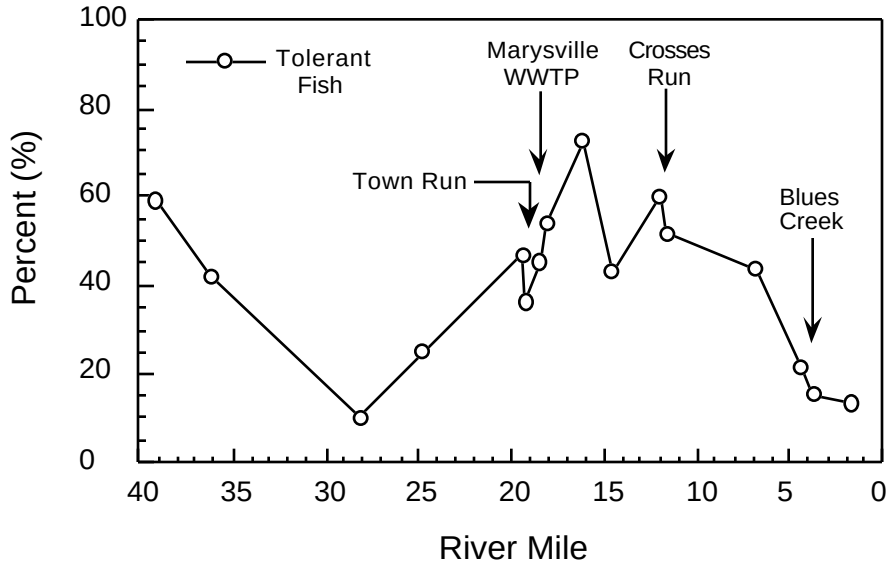

Figure 17. Percentages of tolerant fish collected from Mill Creek stations in 1995

The percentage of tolerant species declined at US 36 (RM 14.6; mean=43%). However, this improvement was interrupted at the next two downstream sampling locations (RMs 12.0 and 11.6). The Mill Creek Estates WWTP discharges to Mill Creek at RM 12.6 while Crosses Run enters at RM 11.8. At the sites downstream from these influences the mean percentage of tolerant species increased to 60.0% and 52.5% respectively (Figure 17).

Between the two sites bracketing the Mill Creek Estates WWTP the mean IBI score declined five points. Individual IBI metric analysis suggested the entity was affecting this reach. Evidence of decline between stations included a longitudinal decrease in the percentage of insectivores and top carnivores, and the low relative number (less tolerant species) downstream from the WWTP.

Downstream from Crosses Run extremely variable results were documented between the two sampling passes. The lowest IBI score (28) in Mill Creek was recorded during the first pass at the site (RM 11.6) immediately downstream from the confluence. During the second pass an IBI score of 40 was recorded. This 12-point improvement between passes was not consistent with the IBI scores from sites further downstream. At RMs 6.9 and 4.2, IBI scores actually fell between the first and second passes by six and ten points, respectively (Figure 18). The margin of difference between passes and erratic pattern of improvement and decline between sites was unusual. The fish community appeared to be periodically subjected to stresses originating from Crosses Run, a severely impacted tributary. The disparity between these results was only reflected over the seven-mile stretch between Crosses Run and Blues Creek as more stable results were observed at RMs 3.7 and 1.7.

In summary, in 1996 Mill Creek supported a generally *good* fish community with *exceptional* assemblages noted upstream and downstream from a reach beginning in Marysville and continuing downstream from Crosses Run. This middle reach (RM 19.4 to 11.6) was affected by polluted urban runoff and the Marysville WWTP. Sources originating in Crosses Run were also associated with the degradation documented in this middle reach. Further, the Mill Creek Estates WWTP was considered culpable for some decline in community performance. Given the typically good quality macrohabitat conditions of Mill Creek, efforts to reduce the impacts of these sources are encouraged and should result in better fish community performance.

Otter Creek

Twenty-five species and fish hybrid (1503 individuals) were collected in two samples in Otter Creek at RM 0.7, adjacent to CR 142 in 1995. The narrative rating of *good* (IBI=45) was within ecoregional expectations for the WWH aquatic life use designation. Creek chub (37% in number, 38% in biomass) and white sucker (10% by number, 28% by biomass) predominated the fish community. Despite a high proportion of tolerant fish (mean=63%), the fairly rich community was comprised of eight sensitive species, eight darter species, and eight minnow species. The percentage of pioneering fish (mean=58%) and the presence of only two headwater species was suggestive of some intermittent tendencies although flow was maintained during the sampling period. Generally, the fish community appeared intact and representative of ambient conditions.

Town Run

Nine fish species (978 individuals) were collected in Town Run in 1995. Sampling occurred once at three sites: RM 0.9, upstream from Eljer Plumbingware, RM 0.7, downstream from Eljer Plumbingware, and RM 0.1, downstream from the Marysville urban area. *Poor* (RM 0.9, IBI=26) and *fair* (RM 0.7, IBI=30 and RM 0.1, IBI=28) narrative ratings were recorded. The IBI

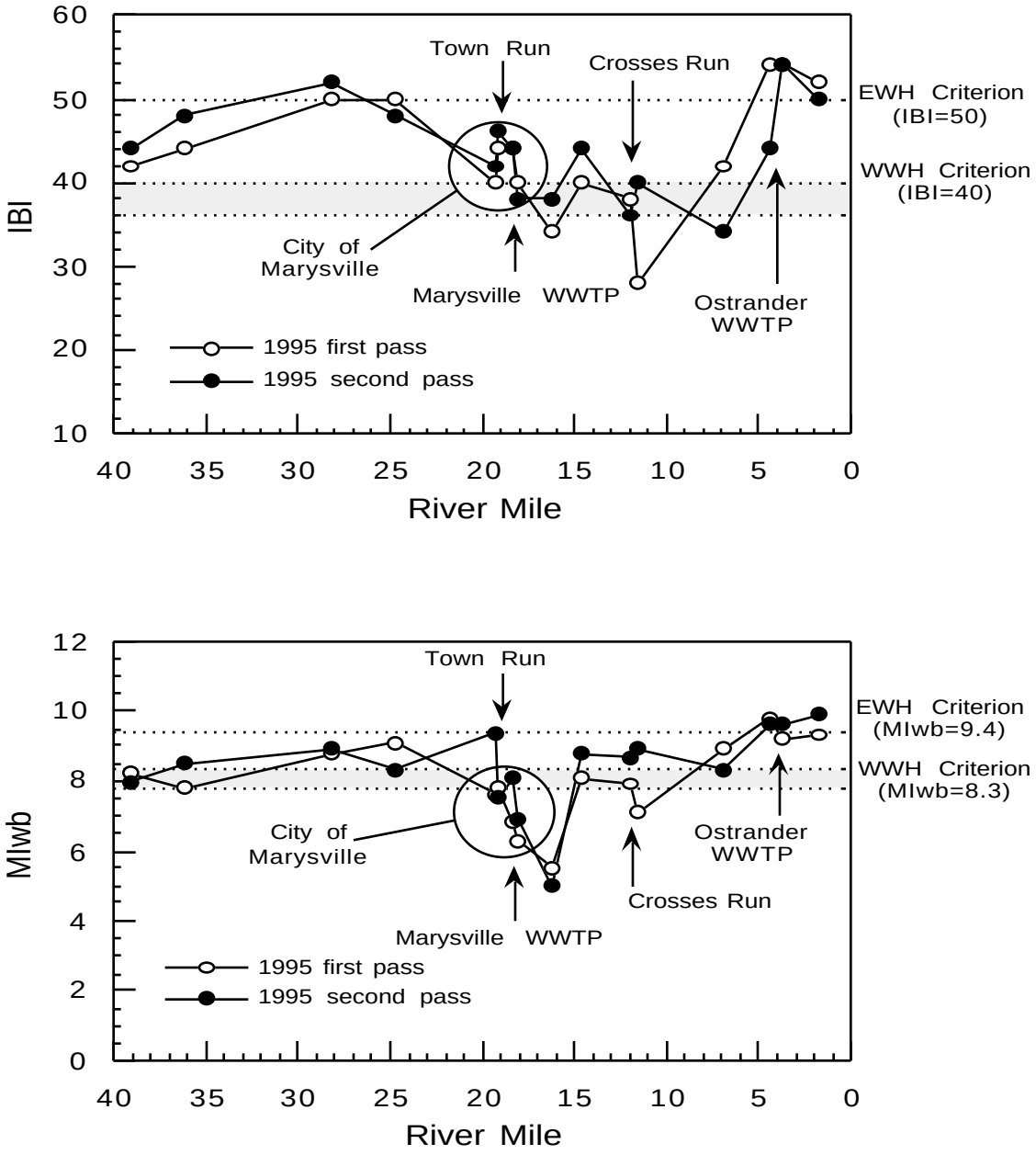

Figure 18. Longitudinal trend of the IBI and MIwb by sampling pass in Mill Creek, 1995.

scores represent a significant departure from the proposed WWH use designation. The tolerant fish community (mean=93%) was comprised primarily of creek chub (66% by number, 79% by biomass) and green sunfish (15% by number, 12% by biomass).

The simple, poorly organized fish community reflected the water quality impairment documented in this study (Table 9). Fecal coliform and metals violations were common at all Town Run sampling sites. Although habitats were moderately degraded (mean QHEI=53.2), these conditions were considered secondary to the influence of bacteriological and chemical impacts.

Crosses Run

Acute and chronically toxic conditions prevailed in Crosses Run which drains The Scotts Company property. No fish were present at RM 2.1 upstream from Industrial Parkway during two sampling passes. This symptom of acute toxicity indicates a source of serious contamination exists in the immediate area. A variety of sources and combinations of stressors are known to exist on The Scotts Company property as evidenced by their permit compliance documentation, spills, ambient chemical and sediment chemistry results, and previous investigations (Ohio EPA 1994; CDO bioassay data 1996).

Upstream from the Scotts Company property at RM 2.8, three juvenile largemouth bass and eight green sunfish were collected in one sample. This site is in a cattle pasture and essentially became dry at the time of the second sample pass. Recognizing the basic lack of stream habitat conditions (QHEI=28) the few fish that were present were typical of those expected in such a small, ephemeral stream reach. As such, this was considered evidence that the source(s) of acute toxicity was on The Scotts Company property, and not from an unknown source upstream.

At RM 0.9 three fish species (82 individuals) were collected in each of two samples. The resulting *very poor* IBI score (12) was further symptomatic of the upstream impacts. Apparently, aspects of instream contaminant degradation and dilution enabled some fish to survive at this site. However, the lack of any meaningful community attributes and the gross under representation in both numbers of species and individuals was characteristic of a serious disorder. In all, it is fair to say that pollution originating on The Scotts Company property severely impairs at least two miles of the biological health of Crosses Run.

North Branch Crosses Run

Similar to the mainstem, acute and chronically toxic conditions also existed in the North Branch of Crosses Run. At RM 1.0 upstream from the Scotts Company property, 24 creek chubs were collected in the first sample before the stream became intermittent on the second pass (no sampling was conducted). Downstream at RM 0.2 on the Scotts Company property, four species (22 individuals) were collected during the first pass yielding a *very poor* IBI score (16). Despite perennial flow at this site, no fish were captured during the second sample pass. Conditions at the mouth of the North Branch (*i.e.*, an absence of fish despite perennial flow)

were very similar to Crosses Run RM 2.1 and indicated acutely toxic conditions downstream from The Scotts Company property. It should be noted that the confluence of the North Branch with Crosses Run is downstream from RM 2.1, indicating multiple sources of toxicants on the property.

Blues Creek

Twenty-two fish species (1,955 individuals) were collected in Blues Creek at RM 0.7 upstream from Ostrander Rd. in two samples. The fish community performed within WWH ecoregional expectations (IBI=42, MIwb=8.4). The assemblage was predominated by creek chub (25% by number, 33% by biomass) and white sucker (13% by number, 25% by biomass). Good species richness including six darters, four sunfish, and representation by two intolerant species contributed to the *good* IBI score. Overall, the fish community was typical for the area with adequate structural and functional organization.

Table 24. Fish community indices based on pulsed, D.C. electrofishing samples collected by Ohio EPA within the Mill Creek study area 1978-1995. All sites were evaluated using the "wading method" IBI metrics unless indicated otherwise.

Stream River Mile	Mean Number Species	Cumu-lative Species	Mean Rel.No (No./Km)	Mean Rel. Wt. Kg/Km)	QHEI	Mean MIwb	Mean IBI	Narrative Evaluation[a]
Mill Creek (1995)								
			Eastern Corn Belt Plains WWH Use Designation (Existing)					
39.1	24.5	25	1694	13.2	61.5	8.1[ns]	43	M.Good-Good
36.1	23.0	26	1111	15.6	64.0	8.2[ns]	46	M.Good-V.Good
28.2	22.5	25	1085	6.3	71.0	8.8	51	Good-Except.
24.8	24.0	26	896	19.2	73.0	8.7	49	Good-V.Good
19.3	26.0	34	503	25.8	74.5	8.5	41	Good
19.1	22.0	25	445	18.4	70.5	7.7*	45	Fair-Good
18.4	24.5	30	374	11.4	77.0	7.5*	44	Fair-Good
18.2[mz]	*12.5*	*15*	*1131*	*5.2*	*61.0*	*6.4*	*37*	*Fair-M. Good*
18.1	21.0	25	329	49.1	71.0	6.6*	39[ns]	Fair-M.Good
16.2	16.0	19	241	21.1	63.0	5.2*	36[ns]	Poor-M.Good
14.6	20.5	22	562	12.0	68.0	8.5	42	Good
12.0	22.0	25	693	22.1	78.5	8.3	37	Good-M.Good
11.6	20.5	25	670	26.3	74.5	8.0[ns]	34*	M.Good-Fair
6.9	22.0	24	632	16.2	74.5	8.6	38[ns]	Good-M.Good
4.4	26.5	30	1203	60.3	88.5	9.7	49	Except.-V.Good
3.7	28.0	32	822	35.4	81.0	9.4	54	Exceptional
1.7	24.0	26	1097	29.1	91.0	9.6	51	Exceptional
Mill Creek (1990)								
24.7	24.3	31	289	40.4	58.5	7.6*	45	Fair-Good
19.1	16.5	21	222	22.5	62.5	6.3*	38[ns]	Fair-M.Good
18.8	16.0	19	281	26.3	64.5	6.1*	35*	Fair
18.2[mz]	*14.5*	*19*	*999*	*14.8*	--	*8.4*	*40*	*Good*
18.1	19.5	25	272	16.7	65.0	7.7*	37[ns]	Fair-M.Good
18.0	18.0	22	206	21.4	67.0	5.6*	31*	Poor-Fair
16.8	13.0	16	161	58.9	59.0	5.3*	28*	Poor-Fair
12.2	17.0	20	285	15.0	76.5	7.5*	32*	Fair
11.7	16.5	20	374	21.6	68.0	7.4*	34*	Fair
6.9	16.5	18	813	15.9	77.0	7.3*	32*	Fair
1.8	21.5	26	587	23.1	71.5	8.6	38[ns]	Good-M.Good

Table 24. continued

Stream River Mile	Mean Number Species	Cumu-lative Species	Mean Rel.No (No./Km)	Mean Rel. Wt. Kg/Km)	QHEI	Mean MIwb	Mean IBI	Narrative Evaluation[a]
Mill Creek (1986)								
25.1	21.0	21	554	10.0	--	8.7	46	Good-V.Good
18.6	20.5	24	392	14.6	--	6.9*	34*	Fair
18.0	22.0	26	412	8.2	--	7.3*	37[ns]	Fair-M.Good
16.8	18.5	25	199	8.5	--	5.8*	34*	Poor-Fair
10.9	17.0	21	837	19.0	--	7.0*	27*	Fair-Poor
7.0	17.5	21	695	7.4	--	8.0[ns]	34*	M.Good-Fair
1.8	23.5	26	1920	18.9	--	8.7	41	Good
Mill Creek (1985)								
12.1[G]	22.0	22	375	--	--	5.1*	36[ns]	Poor-M.Good
1.0[G]	25.0	25	596	--	--	5.6*	40	Poor-Good
Mill Creek (1984)								
28.1	21.3	26	511	15.7	69.0	8.9	48	V.Good
Mill Creek (1979)								
0.2[B]	15.3	24	390	39.6	55.0	7.9*	33*	Fair
Mill Creek (1978)								
30.8[G]	19.0	19	343	12.7	--	6.1*	46	Fair-V.Good
24.8[G]	21.0	21	1830	10.3	--	8.8	50	Good-V.-Good
18.3[G]	23.0	23	478	85.0	--	6.5*	42	Fair-Good
18.1[G]	12.0	12	146	2.4	--	5.1*	20	Poor
16.8[G]	15.0	15	312	15.3	--	5.5*	30	Poor-Fair
11.8[G]	15.0	15	878	44.1	--	6.2*	36	Fair-M.Good
6.9[G]	19.0	19	745	31.0	--	7.1*	38[ns]	Fair-M.Good
1.7[G]	23.0	23	668	31.8	--	8.1[ns]	42	M.Good-Good
Otter Creek (1995)								
Eastern Corn Belt Plains WWH Use Designation (Existing)								
0.7[H]	23.0	25	1503	15.4	70.5	NA	45	Good
Town Run (1995)								
Eastern Corn Belt Plains WWH Use Designation (Recommended)								
0.9[H]	6.0	6	886	5.5	45.5	NA	26*	Poor
0.7[H]	7.0	7	625	2.7	53.5	NA	30*	Fair
0.1[H]	8.0	8	528	2.9	60.5	NA	28*	Fair

Table 24. continued.

Stream River Mile	Mean Number Species	Cumu-lative Species	Mean Rel.No (No./Km)	Mean Rel. Wt. Kg/Km)	QHEI	Mean MIwb	Mean IBI	Narrative Evaluation[a]
Crosses Run (1995)								
			Eastern Corn Belt Plains WWH Use Designation (Existing)					
2.8[H]	2.0	2	24	0.4	28.0	NA	12*	Very Poor
2.1[H]	No fish were collected				42.5	NA	12*	Very Poor
0.9[H]	3.0	5	82	0.9	73.5	NA	12*	Very Poor
Crosses Run (1990)								
2.1[H]	3.5	5	54	0.7	34.0	NA	14*	Very Poor
0.8[H]	6.0	8	430	6.8	61.5	NA	22*	Poor
Crosses Run (1986)								
0.8[H]	4.5	6	159	0.4	--	NA	17*	Very Poor
North Branch Crosses Run (1995)								
			Eastern Corn Belt Plains WWH Use Designation (Recommended)					
1.0[H]	1.0	1	48	0.1	45.0	NA	12*	Very Poor
0.2[H]	2.0	4	22	0.2	30.5	NA	14*	Very Poor
Blues Creek (1995)								
			Eastern Corn Belt Plains WWH Use Designation (Existing)					
0.7	21.0	22	1466	16.9	71.5	8.4	42	Good
Blues Creek (1990)								
6.7	13.0	13	538	11.3	49.5	6.2*	30*	Fair
0.7	23.0	23	955	17.3	66.5	8.1[ns]	42	M.Good-Good

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

ns Nonsignificant departure from ecoregion biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).

a All Qualitative Habitat Evaluation Index (QHEI) values are based on the most recent version

mz Mixing zone sample. Biocriteria do not apply.

B Boat site type.

G Backback electrofishing-seine combination sampling technique used in 1978 (discontinued method).

-- Valid MIwb scores could not be calculated using discontinued sampling methodology.

H Headwater site type.

NA MIwb Not Applicable for Headwater site type.

Table 24. continued.

Biocriteria: Eastern Corn Belt Plains (ECBP)

INDEX -	Site Type	WWH	EWH	MWH[e]
IBI -	Headwater/Wading	40	50	24
Mod. Iwb -	Wading	8.3	9.4	5.8

[e] - Modified Warmwater Habitat for channelized habitats

TREND ASSESSMENT

Chemical, Physical Water Quality Changes; 1978-1995

Mill Creek

Historical water column chemistry data from the Mill Creek mainstem were used to evaluate long-term water quality trends. The most comprehensive data sets were collected by Ohio EPA in support of intensive water resource surveys during the summers of 1978, 1986, and 1990. The 1978 survey included the stream reach between RM 30.8 and RM 1.8. However, most sampling was conducted between Maple Street in Marysville and the mouth (RMs 19.0-1.8) and only a few parameters were analyzed. The 1986 and 1990 surveys were more similar to the 1995 study and included the stream reach between RMs 25.1 and 1.8. In addition, the Central District Office has conducted monthly sampling at the Cherry Street bridge (RM 18.1) since 1978. These data were used for long-term trend analysis immediately downstream from the Marysville WWTP.

Ammonia concentrations, while drastically reduced since 1978, were significantly elevated immediately downstream from the Marysville WWTP in 1995 when compared to 1990 (Figure 19). A general trend of recovery between each subsequent survey has been noted near RM 12.2, immediately upstream from Crosses Run. The higher concentrations downstream from the Marysville WWTP were reflected in the historical loadings trends and the long-term ambient monitoring site at Cherry Street (Figure 19). Ammonia loadings increased since 1990 and the 1995 discharges represented a 140 percent increase over 1994. NPDES violations at the plant were linked to high ammonia levels in filtrate from the belt filter presses, the probable source of high concentrations instream.

Nitrate concentrations continued to show a marked increase immediately downstream from Marysville WWTP and remained elevated to the mouth when compared to upstream samples (Figure 20). Nitrate trends at Cherry Street also showed consistently elevated concentrations immediately downstream from Marysville (Figure 20). The increases since the 1970s are typical of improved nitrification and subsequent reductions in ammonia following WWTP upgrades. Beyond the Marysville WWTP, the 1990 survey also associated high nitrate levels with storm event sampling and polluted nonpoint runoff, effluents from the BMY Corporation (now closed), and point and nonpoint sources in the Crosses Run watershed.

Total phosphorus levels showed a similar trend to nitrate and continued to increase sharply downstream from the Marysville WWTP (Figure 20). However, unlike nitrate, excessive phosphorus levels downstream from Marysville were considered primarily point source related (Ohio EPA 1991). Concentrations in 1995 were consistently higher than in previous surveys from RM 18.1-6.9 and did not reach levels similar to earlier surveys until near the mouth.

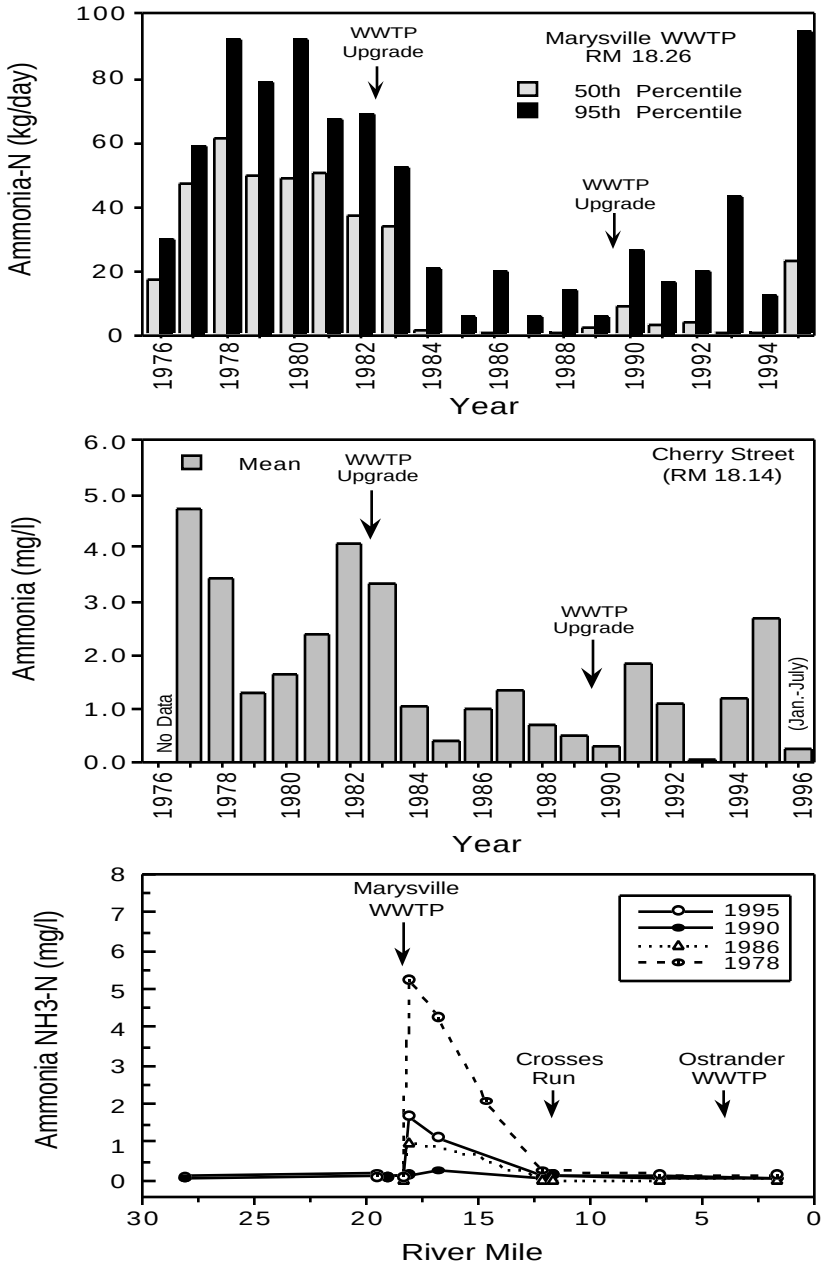

Figure 19. Historical trends in ammonia from Mill Creek displayed in annual loadings (kg/day) discharged from the Marysville WWTP at RM 18.26, 1976-1995 (upper plot), long-term monitoring results from Mill Creek RM 18.1 at Cherry Street (1977-July 1996 [middle plot]), and longitudinal mean concentrations in Mill Creek from Ohio EPA water quality surveys, 1978-1995 (lower plot).

Previously, reductions in phosphorus between 1986 and 1990 were thought to be related to improved treatment efficiency after plant upgrades in 1988-89. The elimination of batch discharges of metal plating wastes in 1989 from Ray Lewis and Son' (RM 18.4) should also have resulted in toxicity reduction downstream from Marysville (Ohio EPA 1990). These factors would presumably reduce point source phosphorus loadings from the WWTP and improve phosphorus uptake in Mill Creek. In addition, another significant source of phosphorus in the lower Mill Creek basin in 1990 (BMY Corporation), was no longer discharging in 1995. Despite these changes, the most recent results suggest no net improvement in phosphorus loadings trends over the last ten years. Treatment efficiency at the Marysville WWTP was a problem in 1995. Phosphorus limits were not included in the plant permit and the WWTP was not specifically designed for phosphorus reduction. However, the highest effluent concentrations during the 1995 survey coincided with a period of poor plant performance and NPDES permit violations for ammonia, fecal coliform bacteria and $cBOD_5$. More consistent operation at the WWTP could have the side-benefit of reductions in phosphorus, besides improved treatment for other permitted parameters. Recent information from plant operating reports and chemical sampling downstream from the WWTP in 1996 suggest that this may already be occurring. The plant has been operating consistently within permit limits and phosphorus levels have declined in Mill Creek immediately downstream. At Cherry Street (RM 18.14) phosphorus averaged 2.3 mg/l in 1995 but had dropped to 0.55 mg/l during the first seven months of 1996.

Fecal coliform exceedences remain problematic downstream from the Marysville WWTP but concentrations upstream in the Marysville urban area were substantially reduced (Figure 20). The final elimination of CSOs in Marysville between 1990 and 1995 was considered a major factor in the reduction of bacteria levels in the Marysville urban area.

Excepting zinc, most metals have shown a significant decrease compared to previous surveys (Figure 21). Reductions have resulted from elimination of direct discharges, improvements in industrial pretreatment and wastewater treatment, and elimination of combined sewer overflows. Remaining potential sources of metals in Marysville included urban and industrial runoff (*e.g.*, the Eljer Plumbingware landfill via Town Run), abandoned landfills near the WWTP property, and unknown sources. The Marysville WWTP has become an increasingly larger source of metals following plant expansions, increases in population growth, service area and industrial inputs.

The severe spikes of zinc in 1978 and 1990 in downtown Marysville was not observed in 1995 but concentrations increased sharply downstream from the Marysville WWTP. The WWTP has become an increasingly larger source of zinc and this was reflected by the loadings trends (see Figure 5) and 1995 instream survey results. Zinc concentrations throughout the remainder of Mill Creek were consistently lower but have remained elevated compared to upstream concentrations (Figure 21).

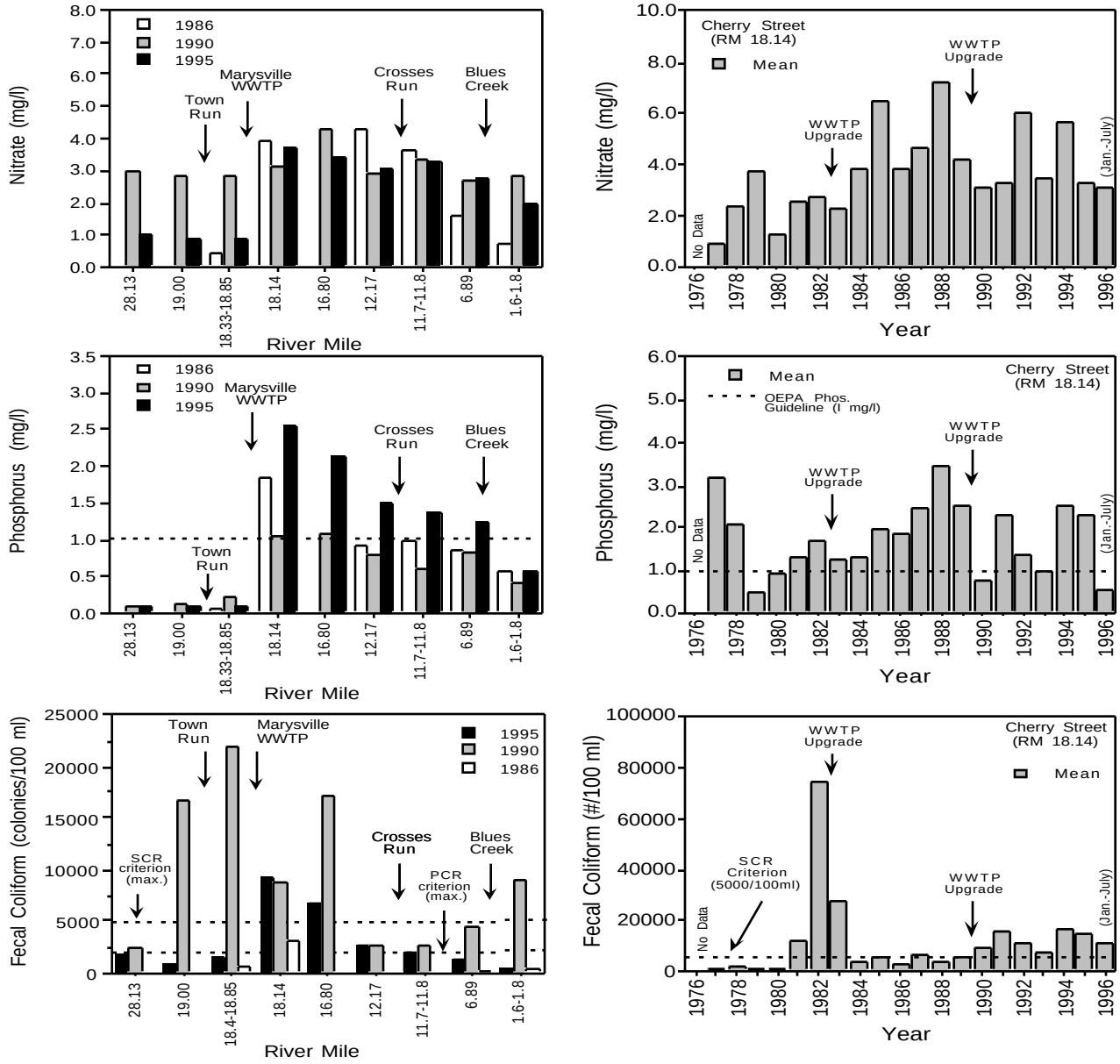

Figure 20. Longitudinal trend of mean nitrate, phosphorus and fecal coliform bacteria levels at selected Mill Creek stations, 1995-86 (left column) and from RM 18.14 at Cherry Street, 1977-July, 1996 (right column).

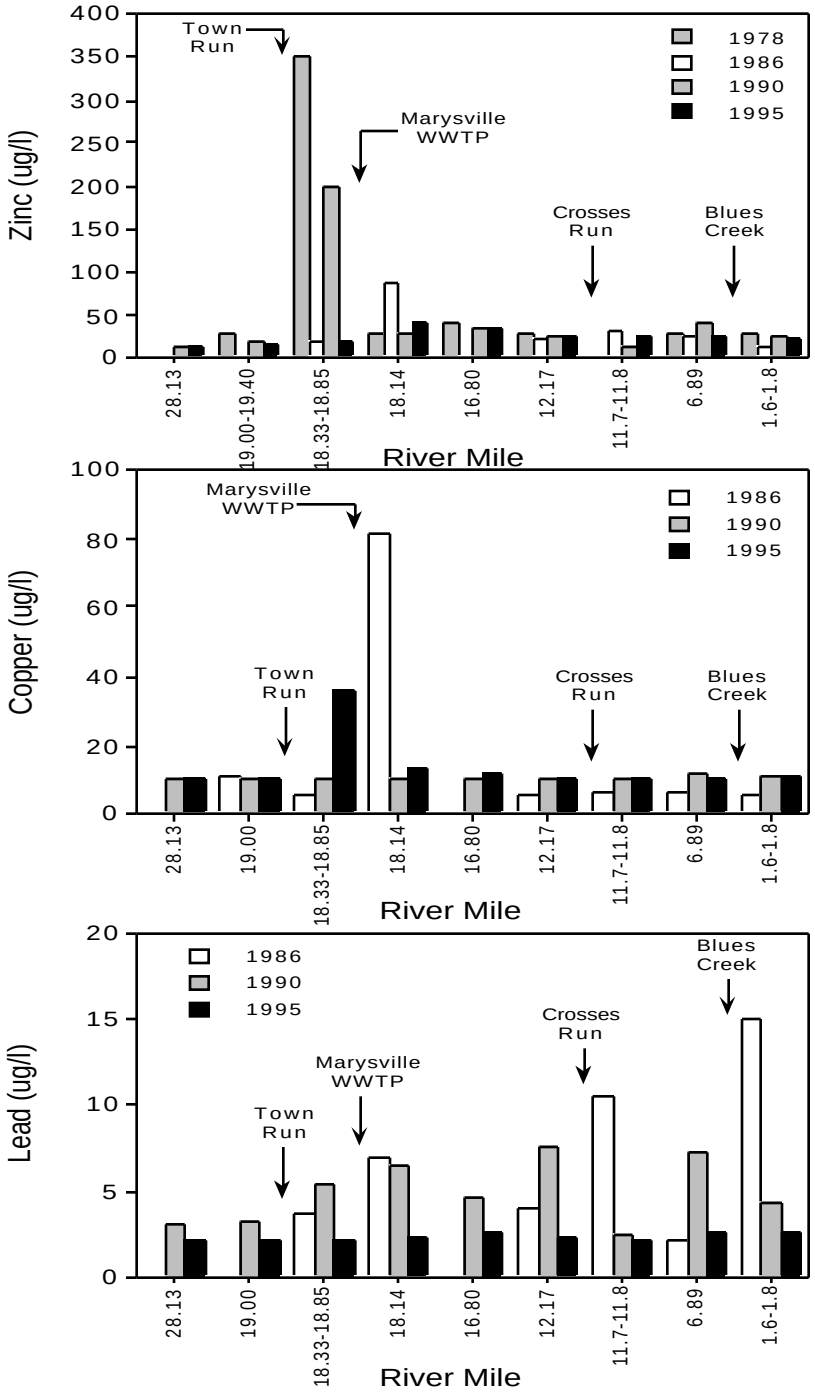

Figure 21. Longitudinal trend of mean zinc, copper, and lead concentrations at selected stations in Mill Creek, 1978 (zinc only) to 1995.

Excepting a spike in concentrations at RM 18.33 (upstream from the Marysville WWTP), copper concentrations were similar to the 1990 survey and were consistent throughout the watershed (Figure 21). The rise in copper levels at RM 18.33 coincided with significant levels of cyanide in the same samples. This combination of contaminants was not strongly correlated with known sources of metals in Town Run. The results raised concerns about additional, unknown sources near the Marysville WWTP.

Lead levels were also consistent throughout the mainstem in 1995 but much lower than in 1986 and 1990 (Figure 21). Slight increases in lead levels during the 1995 survey were encountered well downstream from Marysville and associated with rain event sampling and nonpoint runoff.

Crosses Run

Previous sampling in Crosses Run included a single sample near the mouth in the 1978. In 1986, sampling was conducted downstream from Scotts at RM 0.8 and an additional site was added in 1990 at RM 2.0 (Industrial Parkway), immediately upstream from the North Branch. More sampling locations were added in 1995 to further define water quality conditions in the subbasin. Analysis of trends was mostly limited to RMs 2.0 and 0.8 where site locations and chemical parameter coverage were consistent.

Mean ammonia concentrations in the lower reaches of Crosses Run were significantly reduced compared to the 1978 sample (27 mg/l) but have shown an increase since 1986 (Figure 22). Ammonia concentrations also increased sharply between 1990 and 1995 at Industrial Parkway (RM 2.0). The 1995 results revealed increases in both mean concentrations and frequency of WQS exceedences downstream from The Scotts Company at RM 2.0 (Figure 22; Table 9). The initial elevation in ammonia at RM 2.8 likely resulted from a dairy farm with unrestricted cattle access immediately upstream from Scotts.

Nitrate concentrations have remained elevated at the mouth of Crosses Run since 1986 (Figure 22) but concentrations were lower at RM 2.0 in 1995 than during the previous survey. Total phosphorus concentrations rose slightly from the 1990 survey but mean concentrations have remained lower than the 1 mg/l guideline for prevention of nuisance algal growth since 1986 (Figure 22) .

Town Run

Historical data from Town Run was limited to sampling at the mouth (RM 0.1) during the 1978 and 1990 surveys. Additional sites were added upstream during the 1995 survey to further evaluate the tributary.

With the exception of copper, concentration of most parameters have declined sharply since 1978 and to a lesser degree, since 1990 (Table 25). Mean concentrations of phosphorus in 1990 and 1995 were about the same (0.20-0.19 mg/l) but both were well below the recommended Ohio EPA guideline of 1.0 mg/l. Specific reasons for decreases in other nutrients, metals and coliform

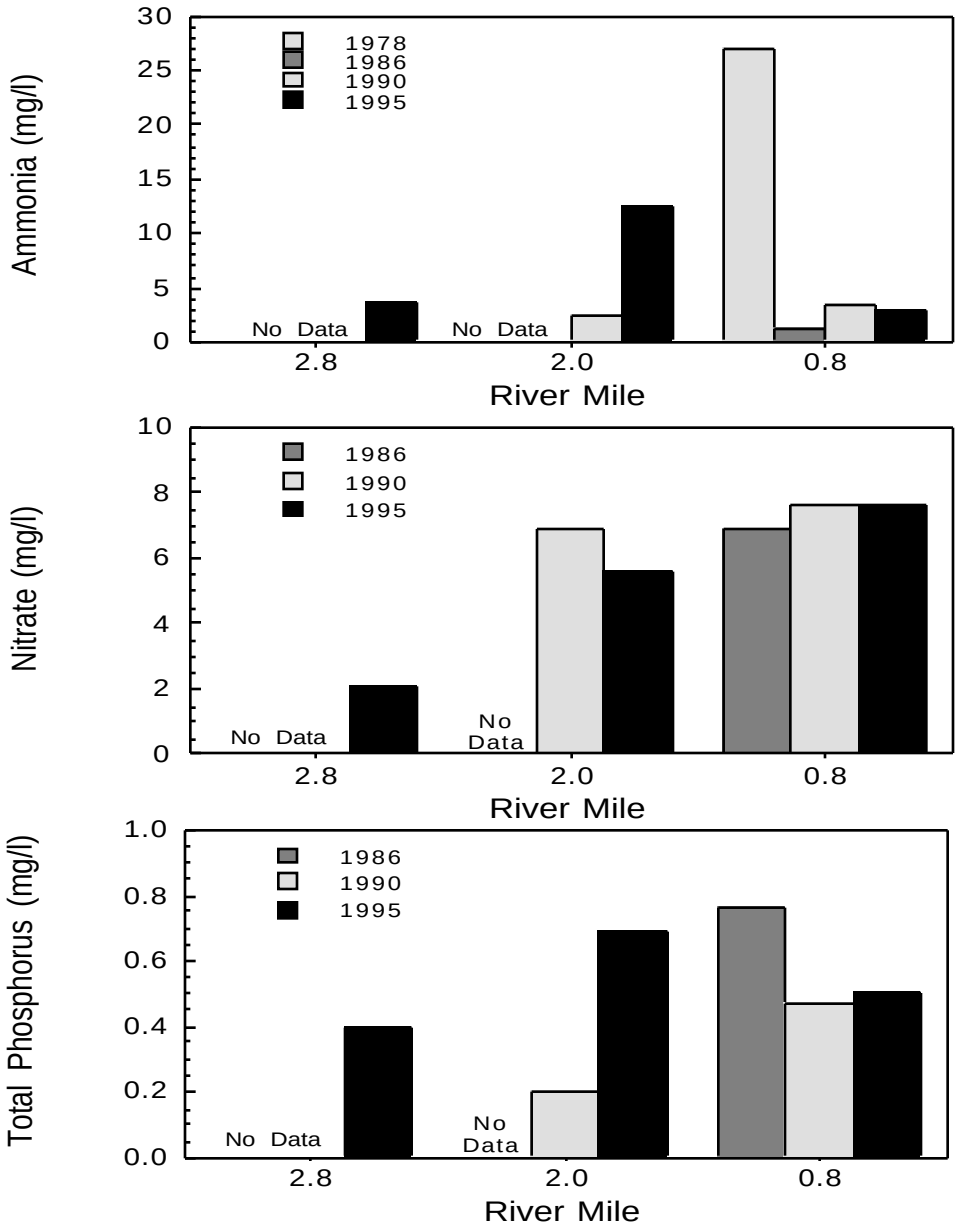

Figure 22. Longitudinal trend of mean lead, ammonia, nitrate and total phosphorus concentrations in Crosses Run, 1978 (ammonia only) to 1995.

bacteria levels since 1978 are not known. Two industries (Nestles Co. and O.M. Scott) discharged to Town Run during the earliest survey and this may explain some of the changes. However, the lack of historical data from further upstream limits the analysis. The most recent sampling in 1995 did indicate significant water quality problems in the upper section of Town Run due to runoff from the Eljer Plumpingware landfill and septic tank drainage (a few on-site systems still remain in the watershed). Observations of oil sheens, foul odors and declines in biological communities at RM 0.1 suggested continuing water quality problems and possible additional sources in the culverted section of the creek under downtown Marysville.

Table 25. Mean concentrations of selected chemical parameters from water column samples at the mouth of Town Run (RM 0.1) in 1978, 1990, and 1995.

Parameter (units)	1978 n=3	1990 n=5	1995 n=6
Ammonia (mg/l)	0.46	0.31	0.08
Nitrate (mg/l)	--	1.84	0.92
Phosphorus (mg/l)	--	0.20	0.19
Total Suspended Solids (mg/l)	--	40	26
COD (mg/l)	46.33	25.75	21.00
Copper (ug/l)	--	20.00	27.33
Nickel (ug/l)	100	--	40*
Lead (ug/l)	76.0	11.00	6.33
Zinc (ug/l)	140	60.67	45.00
Fecal Coliform (# colonies/100 ml)	--	33,275	5,927

* Detection limit
-- Not analyzed

Changes in Biological Community Performance: 1978-1995

Macroinvertebrate Community Trends

Mill Creek

Historical benthic sampling upstream from Marysville at Wheeling Green and Cotton Slash Roads (RMs 28.2 and 24.8) has revealed consistently *good* or *very good* quality over the past decade (Figure 23). In 1978 the ICI was in the *marginally good* range but still reached minimum WWH standards.

Communities in Marysville upstream from the Marysville WWTP showed significant improvement in 1995. ICI scores in 1986 and 1990 from RMs 19.0-18.5/18.6 revealed consistently *fair* quality both upstream and downstream from Town Run while 1995 samples were in the *good* and *very good* ranges (Figure 23). The improving trend was evident in both the artificial and natural substrate samples. Sharp declines in percentages of tolerant organisms (quantitative sampling) and significant increases in QCTV scores (qualitative sampling) were observed as the creek flows through Marysville (Table 23, Appendix B-ICI Metric Table). Improvements to the Marysville sewer system and elimination of CSOs may be reasons for the improvements in community health.

The Marysville WWTP continues to have a major negative influence on the macroinvertebrates (Figure 23). However, since 1990, the characteristics of the impact appear to have shifted from a toxic stress to organic enrichment. The percentage of tolerant taxa has remained virtually constant over the past decade. However, predominant populations from the mixing zone have shifted from toxic tolerant midges of the genus *Cricotopus* in 1990, to more enrichment tolerant oligochaetes and hemoglobin utilizing midges in 1995 (Figure 24).

Communities within two miles of the WWTP continue to reflect levels of impact similar to those observed in 1990 and 1986. However, the 1995 communities recovered rapidly and generally maintained *very good* quality in the lower fifteen miles of the river. In contrast, 1990 and 1986 communities were primarily in the *marginally good* or lower *good* ranges. Historical sampling immediately downstream from Crosses Run have suggested slight but consistent declines, but no significant impacts were observed in 1995 on Mill Creek mainstem communities in the vicinity of Crosses Run. Additional improvement over the historical sampling trends continued downstream to the mouth.

The most recent survey results show an improving trend in Mill Creek, particularly upstream and well downstream from the Marysville WWTP. In addition, the longitudinal extent of impact downstream from the WWTP declined since 1990.

Otter Creek

Good quality communities were observed in 1995 at RM 0.7 while in 1988, *marginally good*

quality communities were found one mile upstream at RM 1.7. Because of the distance between sample sites, significant trends between sampling years could not be determined.

Crosses Run

Benthic communities continued to reflect severe degradation and toxic impacts downstream from The Scotts Company property in 1995. Since 1986, all collections from Crosses Run have reflected *poor* or *very poor* quality with the exception of one 1990 sample at RM 0.1 where the ICI of 22 indicated *fair* conditions (see Figure 27). Additional sampling in 1995 also indicated *very poor* and toxic conditions downstream from Scotts at the mouth of the North Branch. While conditions immediately upstream from the property were also *poor*, the communities did not reflect the toxic influences prevalent at sites downstream.

Blues Creek

Qualitative sampling from both 1995 and 1990 at RM 0.6 reflected *good* but moderately enriched conditions. To date, the elimination of unsewered discharges from Ostrander and construction of the Ostrander WWTP (which now discharges to Mill Creek) has not resulted in significant changes in the benthic community.

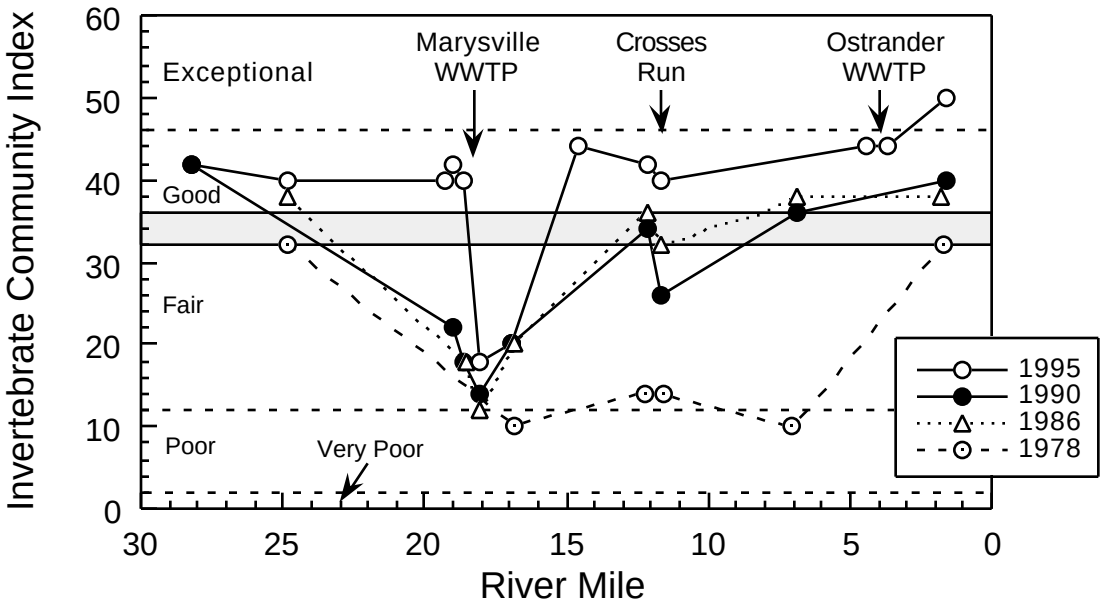

Figure 23. Longitudinal trend of the Invertebrate Community Index (ICI) in Mill Creek, 1978-1995.

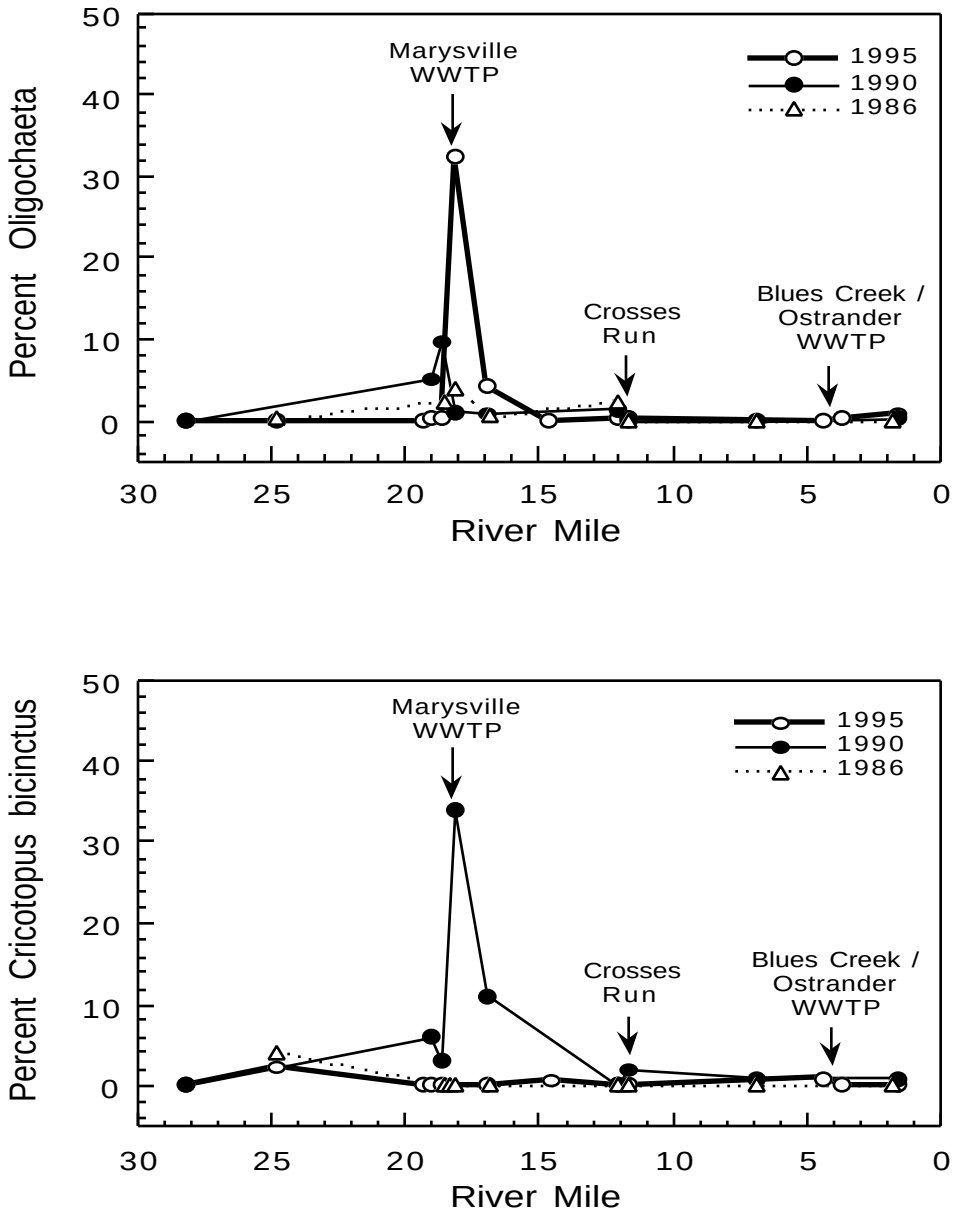

Figure 24. Percentages of Oligochaeta (top plot) and Cricotopus bicinctus (bottom plot) collected from artificial substrate samplers in Mill Creek in 1990 and 1995.

Fish Community Trends 1978-1995

Mill Creek

Fish community data were previously collected from Mill Creek between 1978 and 1990 and are noted in Table 24. Sampling results from the lower 25 miles of Mill Creek in 1986 and 1990 provided the most comparable data with the 1995 survey. Similar stream coverage but different sampling methods were used in the 1978 survey. As a result only the IBI scores from 1978 were used for trend analysis. A pattern of marked improvement was apparent across the entire stream between 1995 and prior surveys (Figure 25). In 1995 fish community performance in Mill Creek was characterized as *good* to *marginally good* (mean IBI=43, mean MIwb=8.2). This was in contrast to the 1990 survey when fish community performance was *fair* (mean IBI=35, mean MIwb=6.9) and the 1986 and 1978 evaluations of *marginally good* to *fair* (1986: mean IBI=36, mean MIwb=7.5; 1979 mean IBI=38).

Despite the overall improvements documented in 1995, biological index scores in the reach within and downstream from Marysville have generally remained *fair* to *poor* over the past ten years. Fish community performance actually declined here between 1986 and 1990 although some improvement was shown in 1995. Some of this marginal improvement was likely due to the elimination of combined sewer overflows (CSOs) in Marysville in 1990. The location of former CSOs coincided with the largest degree of improvement in this reach. In 1995 the Marysville WWTP continued to be the predominant pollution influence in this reach as it has been since 1978 when Ohio EPA first conducted a biological survey of Mill Creek.

The addition of a site at RM 14.6 in 1995 provided resolution on the potential impact of Mill Creek Estates WWTP. A slight longitudinal decline in fish community index scores was attributed to this entity. Lacking a similar data point in past surveys it was previously difficult to discern this condition.

The sporadic results witnessed downstream from Crosses Run in 1995 were also evident in retrospect in the 1990 data. In that survey the IBI score fell from 38 to 26 between two passes at RM 6.9. Similar disparity was evident in 1986 downstream from the Marysville WWTP that likely influenced a 16-point IBI score spread at RM 16.8 and a 10-point spread at RM 10.9. Given the proximity of the confluence of Crosses Run and the Marysville WWTP, it was difficult to determine the relative degree of impact from each source in past data sets. However, it appears both have been previous sources of periodic stressors. A ruptured pipeline at The Scotts Company in 1987 resulted in some 35,000 gallons of recycled wastewater entering Mill Creek via Crosses Run. The spill contained ammonium hydroxide (1200 mg/l) which caused a large fish kill downstream to the mouth of Mill Creek (approximately 14 miles).

Significant improvement at the most downstream locations in 1995 provided testament to statements made in previous reports (Ohio EPA 1991). The decline in fish community indices at these sites between 1986 and 1990 was at odds with a more general trend of improving water

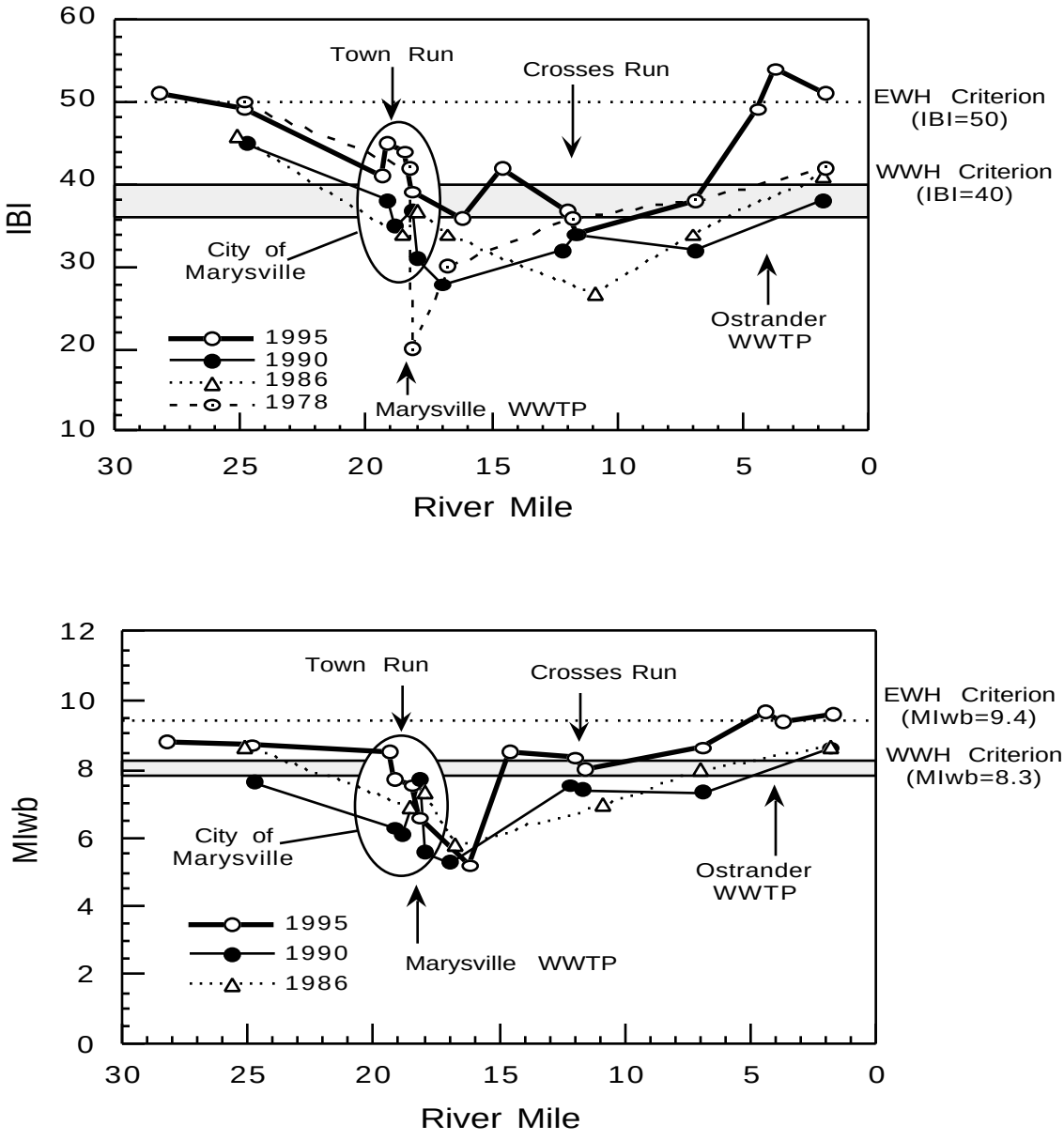

Figure 25. Longitudinal trend of the IBI and MIwb in Mill Creek, 1995-1978. Due to variation in sampling methodologies between 1978 and later surveys, 1978 MIwb values are not included.

resource integrity observed in many Ohio streams. The 1995 performance at *exceptional* levels in this reach was considered indicative of the potential of Mill Creek.

Beyond analysis of the factors which influenced improved IBI scores in 1995 in Mill Creek, a simple comparison of the mean number of species from 1990 and 1986 was revealing (Figure 26). In 1986 an average of 20 species were encountered in each sample. This number decreased to 17.8 in 1990 and increased to 22.9 in 1995. Furthermore, the relative number of fish collected also reflected the 1990 slump. The average relative number of fish at each site was 716 in 1986, 361 in 1990, and 772 in 1995. In particular, during the survey periods the site at RM 16.8 has continuously failed to support a fish fauna that meets ecoregional expectations. Poorly treated effluent from the Marysville WWTP was considered the cause of this departure.

Crosses Run

Since 1986, all IBI scores from the Crosses Run subbasin have fallen in the *poor* or *very poor* ranges (Figure 27). The most downstream Crosses Run site (RM 0.8/0.9) was sampled three times since 1986 and scores ranged from 22 (*poor*) in 1990 to 12 (the lowest IBI score possible) in 1995. Station RM 2.1 was added in 1990 and scored in the *very poor* range during both surveys; no fish were present at the site in 1995. Similar conditions were found at the mouth of the North Branch of Crosses Run (RM 0.2) when sampled for the first time in 1995. Additional sampling upstream from The Scotts Company in 1995 also reflected *very poor* quality. However, impacts were primarily attributed to the very small stream sizes, periodic stream desiccation, unrestricted cattle access (Crosses Run RM 2.8) and resultant habitat impairment. These factors became less significant as distance downstream increased, habitat conditions improved, and stream flows were augmented by the Scotts Company discharges.

Sampling surveys since 1986 were intended to assess the potential influence of The Scotts Company. The consistently low IBI scores downstream form the property over such a long period can clearly be interpreted as representing a persistent toxic situation. Ample evidence exists documenting highly elevated concentrations of various contaminants from the facility that could account for the observed impacts.

Blues Creek

Only slight differences existed between the sampling that occurred in 1990 and 1995 at RM 0.7 in Blues Creek. In both years *good* IBI values of 42 were tabulated. The presence of two intolerant species collected in 1995 but not in 1990 (silver shiner and stonecat madtom) represented the only noteworthy difference between the sampling years. This small variation is an indication of stability that is consistent with year to year results at higher quality reference sites.

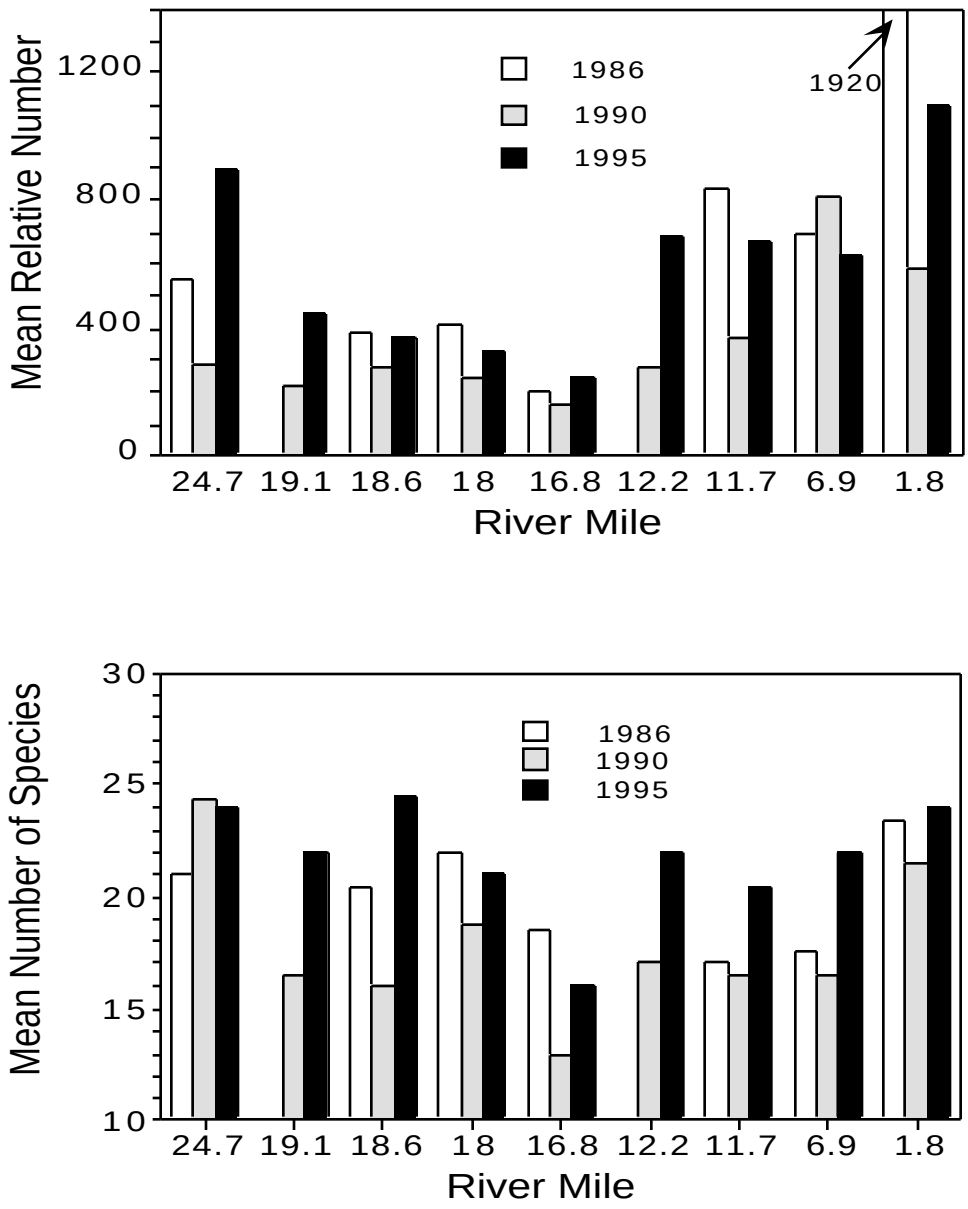

Figure 26. Historical trends in mean relative numbers of fish and mean numbers of fish species at stations in Mill Creek, 1986-95.

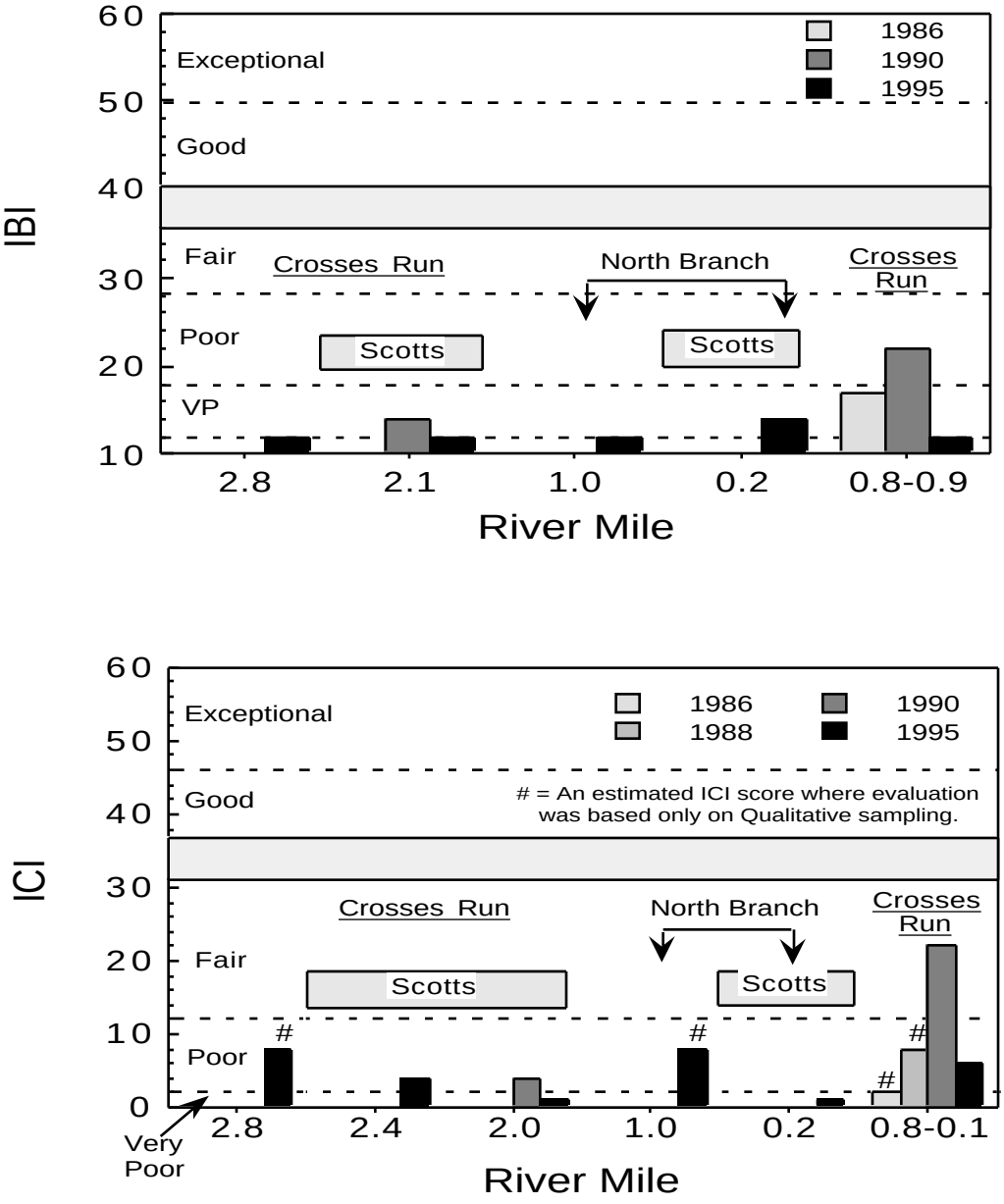

Figure 27. Historical trends in the IBI (fish sampling; upper plot) and the ICI (macroinvertebrate sampling; lower plot) at sampling sites in the Crosses Run subbasin, 1986 to 1995.

Area of Degradation Values (ADV)

The ADV portrays both the length or "extent" and the departure or “magnitude” of degradation to aquatic communities. It reflects the distance that the biological index (IBI, MIwb, or ICI) departs from the applicable biocriterion or the upstream level of performance (see Figure 3; Methods Section). The total ADV is represented by the area beneath the biocriterion (or upstream level) when the results for each index are plotted against river mile (see Figs. 20 and 22). The results are also expressed as ADV/mile to normalize comparisons between segments and other streams and rivers. ADV statistics reported in Table 25 reflect negative influences on the aquatic communities; an ADV of 0 means the fish or macroinvertebrates scored above the minimum performance levels and reflects *good* or *exceptional*, stream quality.

Mill Creek

The 1995 results reflect significant improvements in stream quality. Since the earliest biological survey in 1978, improvements in ADV statistics were most pronounced for the macro-invertebrates (ICI) and the MIwb for fish (Table 25). The ADV per mile dropped from 135.5 to 6.2 for the ICI, and from 55.0 to 11.2 for the MIwb. During the same period, the number of survey miles in full attainment of the WWH aquatic life use increased from 1.7% in 1978 to 17.5% in 1995. Conversely miles in nonattainment dropped from 10.9% to 1.3%.

While these statistics are encouraging, data from the most recent surveys in 1986 and 1990 showed that attainment status trends have only recently shifted in a more positive direction. As recently as 1990, the miles of nonattainment (9.8) in the lower 25 miles of Mill Creek were similar to 1978 and actually increased compared to the 1986 sampling period (4.2 miles). Improvements in point source discharges, elimination of problem discharges (*e.g.*, Ray Lewis metal plating, capping of CSOs in Marysville) and the apparent lessening of toxic impacts downstream from Marysville were considered primarily responsible for the improvements.

Crosses Run

Fish and macroinvertebrate communities near The Scotts Company have remained in a *poor* or *very poor* condition over the past 10 years. ADV statistics from multiple site surveys in 1995 and 1990 reflected the severe impacts and toxic conditions (Table 25). The 1995 statistics suggest further declines over the five-year period. The 1995 results included two sampling passes downstream from The Scotts Company where no fish were collected (RM 2.0 on Crosses Run and RM 0.1 on the North Branch). Macroinvertebrate communities from these same sites were nearly identical in composition and reflected *very poor* quality. The results suggest similar severe sources of impact in both waterbodies.

Table 25. Area of Degradation Values (ADV) statistics for Mill Creek and Crosses Run, 1978-1995. Values obtained for Mill Creek and Crosses Run were calculated using Eastern Corn Belt Plain WWH biocriteria as the baseline for community performance.

Stream Index	Upper RM	Lower RM	Biological Index Scores Mini-mum	Maxi-mum	ADV Statistics ADV	**ADV/ Mile**	Attainment Status (miles) FULL	PARTIAL	**NON**	POOR/VP
Mill Creek										
1995										
IBI			34	5	26	**1.0**				
MIwb	25.1	0.0	5.2	9.7	309	**12.3**	18.3	5.1	**1.7**	1.7
ICI			18	50	247	**9.8**				
1990										
IBI			28	45	587	**23.3**				
MIwb	25.1	0.0	5.3	8.6	868	**34.6**	3.4	13.2	**8.5**	2.4
ICI			14	42	759	**30.2**				
1986										
IBI			27	45	574	**22.8**				
MIwb	25.1	0.0	5.8	8.7	703	**28.0**	7.5	11.6	**6**	1.3
ICI			6	38	815	**32.4**				
1978										
IBI			30	44	244	**9.7**				
MIwb	25.1	0.0	5.5	8.2	1407	**56.0**	1.7	12.5	**10.9**	6.3
ICI			10	32	3400	**135.4**				
Crosses Run										
1995										
IBI			12	12	399	**190.0**				
MIwb	2.1	0.6	NA	NA	NA	**NA**	0.0	0.0	**2.1**	2.1
ICI			0	6	594	**282.9**				
1990										
IBI			18	22	334	**159.2**				
MIwb	2.1	0.1	NA	NA	NA	**NA**	0.0	0.0	**2.1**	2.1
ICI			4	22	380	**180.9**				

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APPENDIX TABLES

Appendix A. Results of chemical/physical stream sampling and effluent sampling in the Mill Creek study area, 1995.

Summary of diurnal D.O.(mg/l) data from continuous monitors at twelve locations in the Mill Creek study area, August 29 to August 31, 1995.

Appendix B. Macroinvertebrate sampling data (species lists and Invertebrate Community Index [ICI] metric scores) by station from the Mill Creek study area, 1995.

Appendix C. Fish sampling data (species lists, Index of Biotic Integrity [IBI] and Modified Index of well being [MIwb] metric scores) by station from the Mill Creek study area, 1995.

APPENDIX A

Chemical Data

Appendix Table A-1. Results of chemical/physical sampling conducted in the Mill Creek study area during June-October, 1995. Values proceeded by (*) indicate concentration below method detection limit. NA = not analyzed and/or not reported.

River Mile	Date	Time	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	pH (SU)	Temp. (°C)	COD (mg/l)
Mill Creek							
39.20	6/28	0955	700	6.6	7.93	19.9	10*
	7/17	0945	640	4.5	7.69	21.8	10*
	8/14	0940	750	5.8	7.71	21.5	12
	8/30	1030	750	5.1	7.72	20.5	18
	9/12	0935	710	3.3	7.63	14.2	11
	10/3	1200	NA	3.6	N.A	13.8	20
36.10	6/28	1020	590	6.8	8.01	20.5	40
	7/17	1005	710	5.9	8.18	24.0	10*
	8/14	1000	760	5.8	7.94	24.0	12
	8/30	1015	750	6.1	7.99	22.3	12
	9/12	0950	700	7.6	7.98	16.2	10*
	10/3	1230	610	5.6	7.97	14.3	20
28.10	6/28	1340	470	6.1	7.82	22.5	NA
	7/17	1020	750	6.4	8.12	25.5	10*
	8/14	1015	750	6.4	7.92	25.0	12
	8/30	1100	810	8.8	8.06	23.1	10*
	9/12	1010	710	8.7	7.94	17.5	10*
	10/3	1250	610	5.6	7.73	14.2	25
24.70	6/28	1325	450	6.2	7.77	22.0	NA
	7/17	1035	750	5.7	8.16	25.0	10*
	8/14	1030	750	5.8	8.00	25.0	15
	8/30	1115	810	7.2	8.09	22.5	10*
	9/12	1025	720	7.7	8.03	16.5	11
	10/5	1320	700	6.3	7.83	15.5	12
19.40	8/14	1050	700	6.3	7.91	26.5	24
	8/30	1135	850	7.4	8.22	24.9	29
	9/12	1045	700	5.5	8.16	21.0	11
	10/5	1300	600	6.8	7.87	16.5	12
19.00	6/28	1300	450	7.3	7.88	23.0	NA
	7/17	1055	800	5.4	8.15	26.1	10*
	8/14	1100	700	6.4	7.98	26.5	18
	8/30	NA	850	6.7	8.13	25.2	21
	9/12	1100	750	6.5	7.67	19.1	17
	10/4	1400	700	6.2	7.64	16.0	34

Appendix Table A-1 continued.

River Mile	Date	Time	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	pH (SU)	Temp. (°C)	COD (mg/l)
Mill Creek (continued)							
18.33	6/28	1215	505	6.5	7.83	23.0	NA
	7/17	1130	750	4.5	8.04	26.0	12
	8/14	1130	600	6.5	8.03	26.5	15
	8/30	1210	750	6.2	7.94	23.5	15
	9/12	1135	610	7.1	7.74	18.0	14
	10/4	1300	500	5.2	7.65	16.7	17
18.26	6/28	1135	1000	8.3	7.31	22.0	NA
	7/17	1145	1500	7.8	7.24	24.5	18
	8/14	1145	1400	8.5	7.47	24.5	24
	8/30	1220	1590	7.6	7.20	25.1	51
	9/12	1140	1500	8.5	7.27	23.0	37
	10/4	1310	1500	7.7	7.35	21.5	39
18.25	6/28	1145	650	7.4	7.52	21.5	NA
	7/17	1200	1450	7.4	7.32	25.0	27
	8/14	1150	950	7.4	7.94	26.0	21
	8/30	1225	1400	7.0	7.21	25.0	45
	9/12	1145	1300	7.8	7.30	22.0	34
	10/4	1320	825	6.6	7.49	19.3	28
18.14	6/28	1100	600	7.0	7.71	22.0	NA
	7/18	1320	1015	6.4	7.62	25.0	20
	8/14	1115	900	6.3	7.79	26.0	17
	8/31	1155	1420	5.3	7.48	25.0	33
	9/12	1200	750	6.6	7.38	20.5	40
	10/4	1205	1175	N.A	7.52	18.7	34
16.80	6/28	1115	450	5.7	7.64	22.0	43
	7/18	1340	1010	6.1	7.79	24.2	20
	8/14	1300	800	6.3	7.84	26.0	24
	8/31	1205	1330	3.6	7.55	24.0	27
	9/13	1300	1100	4.7	7.49	20.0	29
	10/4	1145	610	4.2	7.51	17.5	25
12.17	6/28	1035	450	6.0	7.62	21.5	NA
	7/18	1230	1000	4.6	7.88	24.9	26
	8/15	1115	790	4.9	7.88	26.0	21
	8/31	1050	1250	4.1	7.77	23.5	27
	9/13	1030	1350	4.5	7.62	18.5	29
	10/3	0945	1490	3.9	7.48	16.3	28

Appendix Table A-1 continued.

River Mile	Date	Time	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	pH (SU)	Temp. (°C)	COD (mg/l)
Mill Creek (continued)							
11.70	6/28	1150	540	6.0	7.68	22.0	34
	7/18	1210	1010	4.2	7.91	25.0	23
	8/15	1100	800	9.8	7.80	26.9	24
	8/31	1115	1200	5.2	7.82	25.0	21
	9/13	1045	1400	4.7	7.67	18.5	40
	10/3	1005	1490	4.4	7.67	15.9	34
6.89	6/28	1015	370	6.2	7.55	22.0	NA
	7/18	1140	1050	6.9	8.10	24.8	23
	8/15	1035	790	7.3	7.97	25.5	18
	8/31	1040	1210	6.8	8.16	23.8	30
	9/13	1025	1300	7.5	8.05	19.0	20
	10/4	1115	1310	6.7	7.83	15.5	28
4.20	6/30	1230	250	6.5	7.51	22.0	56
	7/18	1045	950	6.5	8.08	24.3	23
	8/15	1005	710	6.3	8.00	25.7	18
	8/31	1010	1120	7.4	8.20	23.5	33
	9/13	1010	1200	7.9	8.03	19.0	29
	10/4	1040	1200	7.1	7.89	15.8	25
3.90	6/28	0955	330	6.7	7.61	22.0	58
	7/18	1020	920	6.7	8.13	24.4	26
	8/15	0940	710	6.5	8.03	25.9	12
	8/30	1330	1050	9.5	8.22	25.0	24
	9/13	0950	1150	7.7	N.A	18.5	20
	10/4	1010	1160	7.5	7.85	15.0	28
1.60	6/28	0940	320	6.6	7.62	22.0	46
	7/18	0955	900	6.4	8.26	24.0	23
	8/15	0925	700	6.9	8.03	25.3	12
	8/31	0945	1000	6.7	8.12	23.5	18
	9/13	0925	1000	8.0	8.07	18.5	20
	10/4	0925	1010	7.1	7.93	15.3	20
Crosses Run							
2.80	6/29	1210	400	6.0	7.80	23.0	28
	8/15	1340	1400	N.A	7.98	N.A	85
	9/13	1130	2200	4.5	7.45	20.5	57
	10/3	1340	760	7.2	7.71	15.8	64
2.00	6/29	1225	1450	4.8	7.73	21.9	52

Appendix Table A-1 continued.

River Mile	Date	Time	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	pH (SU)	Temp. (°C)	COD (mg/l)
Crosses Run (continued)							
2.00	7/20	1225	1850	8.4	8.21	21.5	21
	8/15	1355	1450	8.4	7.88	30.0	73
	8/31	1115	1800	4.0	N.A	24.8	45
	9/13	1145	2100	5.0	8.46	21.0	52
	10/3	1315	460	6.9	7.48	15.9	48
0.80	6/29	1320	510	5.1	7.51	20.1	62
	7/20	1255	1650	8.1	8.42	21.5	18
	8/15	1415	1200	N.A	7.53	N.A	44
	8/31	1135	1600	4.1	7.66	23.0	39
	9/13	1100	1150	4.2	7.68	19.5	37
	10/3	1035	1700	5.9	8.25	14.8	22
0.90	6/29	1145	1500	6.3	7.19	21.5	123
	8/15	1330	600	N.A	8.92	N.A	23
	10/5	1150	800	4.7	7.03	15.0	76
0.10	6/29	1255	200	7.7	7.84	21.1	34
	7/20	1240	1900	13.1	8.88	26.0	18
	8/15	1405	1500	N.A	8.03	N.A	38
	8/31	1035	NA	N.A	N.A	N.A	60
	9/13	1150	1100	10.4	8.47	22.0	32
	10/3	1325	490	7.3	7.66	16.4	53
Otter Creek							
1.70	6/29	1025	650	8.0	8.01	19.9	10*
	7/20	0925	700	6.0	8.21	19.6	10*
	8/14	0910	700	6.4	7.71	22.5	15
	8/31	1320	700	9.6	8.10	24.5	12
	9/12	0910	600	6.9	7.79	15.0	10*
	10/3	1130	610	6.1	8.27	14.0	11
Town Run							
0.80	6/29	1350	150	7.8	7.81	20.2	71
	7/20	1030	700	7.1	8.04	19.0	12
	8/15	1135	620	6.0	7.78	25.5	39
	8/31	1239	1700	4.5	8.13	23.3	33
	9/13	1220	600	6.6	7.98	21.0	34
	10/5	1215	210	8.3	7.80	17.0	51

Appendix Table A-1 continued.

River Mile	Date	Time	Conductivity (µmhos/cm)	Dissolved Oxygen (mg/l)	pH (SU)	Temp. (°C)	COD (mg/l)
Town Run (continued)							
0.60	6/29	1335	200	7.8	7.68	20.1	80
	7/20	1015	650	7.1	8.05	21.4	18
	8/15	1150	600	4.8	7.63	25.9	41
	8/31	1235	1400	N.A	8.57	29.0	36
	9/13	1230	600	9.0	8.14	19.5	40
	10/5	1225	280	8.1	7.74	17.0	33
0.10	6/29	1110	510	6.6	8.04	20.6	15
	7/20	1000	700	6.5	7.72	20.1	10*
	8/15	1200	650	6.9	7.88	24.9	26
	8/31	1220	1050	6.1	7.72	22.5	12
	9/13	1240	600	9.0	7.74	20.0	37
	10/5	1240	290	8.9	7.61	17.0	27
Blues Creek							
0.60	6/30	1200	157	6.6	7.12	21.0	25
	7/18	1120	700	5.5	7.90	23.5	23
	8/15	0945	710	6.3	7.80	24.9	12
	8/30	1345	950	7.0	7.83	24.5	12
	9/13	0945	900	6.2	8.20	18.0	14
	10/4	0950	860	6.4	7.64	15.0	20
McCarthy Park Tributary							
0.10	6/29	1120	600	7.5	7.70	20.0	10*
	7/18	1305	600	8.4	8.07	21.5	10*
	8/14	1135	1100	4.2	7.48	22.0	12
	8/30	1200	990	2.4	7.21	22.5	15

Appendix Table A-1 continued.

River Mile	Date	Time	Nitrate (mg/l)	Ammonia (mg/l)	Total Phosphorus (mg/l)	Cyanide (µg/)
Mill Creek						
39.20	6/28	0955	1.03	0.05	0.05*	10*
	7/17	0945	1.48	0.05*	0.06	10*
	8/14	0940	0.81	0.05*	0.05*	10*
	8/30	1030	0.29	0.05*	0.05*	10*
	9/12	0935	0.15	0.05*	0.10	10*
	10/3	1200	0.10*	0.05*	0.14	10*
36.10	6/28	1020	3.29	0.12	0.11	10*
	7/17	1005	0.87	N.A	0.06	10*
	8/14	1000	1.16	0.05*	0.05	10*
	8/30	1015	0.23	0.05*	0.05*	10*
	9/12	0950	0.10	0.11	0.05*	10*
	10/3	1230	0.10*	0.05*	0.05*	10*
28.10	6/28	1340	3.88	0.16	0.21	10*
	7/17	1020	0.80	0.05*	0.06	10*
	8/14	1015	1.11	0.05*	0.10	10*
	8/30	1100	0.10*	0.05*	0.05*	10*
	9/12	1010	0.10*	0.16	0.05*	10*
	10/3	1250	0.10*	0.05*	0.05*	10*
24.70	6/28	1325	3.53	0.10	0.17	10*
	7/17	1035	0.81	0.05*	0.06	10*
	8/14	1030	1.32	0.05*	0.06	10*
	8/30	1115	0.23	0.05*	0.05*	10*
	9/12	1025	0.10*	0.30	0.05*	10*
	10/5	1320	0.10*	0.05*	0.06	10*
19.40	8/14	1050	1.19	0.05*	0.06	10*
	8/30	1135	0.10*	0.05	0.05*	10*
	9/12	1045	0.13	0.75	0.15	10*
	10/5	1300	0.16	0.05*	0.06	10*
19.00	6/28	1300	2.49	0.09	0.17	10*
	7/17	1055	0.80	0.05*	0.07	10*
	8/14	1100	1.18	0.05*	0.06	10*
	8/30	NA	0.18	0.05*	0.06	10*
	9/12	1100	0.30	0.22	0.09	10*
	10/4	1400	0.30	0.05*	0.08	10*
18.33	6/28	1215	2.18	0.12	0.20	10*
	7/17	1130	0.84	0.05*	0.06	30
	8/14	1130	1.15	0.05*	0.08	10*

Appendix Table A-1 continued.

River Mile	Date	Time	Nitrate (mg/l)	Ammonia (mg/l)	Total Phosphorus (mg/l)	Cyanide (µg/)
Mill Creek (continued)						
18.33	8/30	1210	0.17	0.16	0.05*	14
	9/12	1135	0.10	0.17	0.05	54
	10/4	1300	0.87	0.05*	0.07	10*
18.26	6/28	1135	2.07	0.50	2.80	10*
	7/17	1145	7.75	0.71	4.53	13
	8/14	1145	5.47	0.62	2.40	10*
	8/30	1220	7.20	5.00	6.76	10*
	9/12	1140	10.70	5.46	7.85	10*
	10/4	1310	4.89	0.20	3.38	19
18.25	6/28	1145	2.10	0.21	0.60	10*
	7/17	1200	7.06	0.57	4.40	14
	8/14	1150	2.10	0.12	0.53	10*
	8/30	1225	6.58	4.37	5.58	10*
	9/12	1145	8.96	4.78	6.55	15
	10/4	1320	3.43	0.15	2.18	10*
18.14	6/28	1100	1.96	0.25	0.66	10*
	7/18	1320	3.50	0.51	2.03	10*
	8/14	1115	2.22	0.15	0.58	10*
	8/31	1155	2.91	3.92	3.29	13
	9/12	1200	8.53	4.62	6.67	11
	10/4	1205	3.13	0.14	1.98	12
16.80	6/28	1115	2.29	0.17	0.37	10*
	7/18	1340	3.40	0.14	1.80	10*
	8/14	1300	1.89	0.05*	0.45	18
	8/31	1205	4.02	2.97	4.18	10*
	9/13	1300	6.84	3.16	5.10	10*
	10/4	1145	2.03	0.23	0.92	10*
12.17	6/28	1035	2.65	0.15	0.37	10*
	7/18	1230	1.85	0.05*	0.67	10*
	8/15	1115	1.75	0.05*	0.50	10*
	8/31	1050	4.23	0.16	1.90	10*
	9/13	1030	4.96	0.09	2.38	10*
	10/3	0945	2.86	0.05*	3.12	10*
11.70	6/28	1150	3.34	0.37	0.38	10*
	7/18	1210	1.91	0.05*	0.64	10*
	8/15	1100	1.80	0.05*	0.36	10*
	8/31	1115	3.96	0.22	1.74	10*

Appendix Table A-1 continued.

River Mile	Date	Time	Nitrate (mg/l)	Ammonia (mg/l)	Total Phosphorus (mg/l)	Cyanide (µg/)
Mill Creek (continued)						
11.7	9/13	1045	5.77	0.17	2.13	10*
	10/3	1005	2.87	0.05*	2.98	10*
6.89	6/28	1015	4.18	0.16	0.40	10*
	7/18	1140	1.90	0.05*	0.89	10*
	8/15	1035	1.55	0.05*	0.27	10*
	8/31	1040	2.79	0.07	1.42	10*
	9/13	1025	3.81	0.05*	2.08	10*
	10/4	1115	2.45	0.05*	2.44	10*
4.20	6/30	1230	1.87	0.05*	0.33	10*
	7/18	1045	1.60	0.05*	0.50	10*
	8/15	1005	1.46	0.05*	0.25	10*
	8/31	1010	1.76	0.05	0.97	10*
	9/13	1010	2.38	0.05	1.08	10*
	10/4	1040	1.96	0.05*	1.99	10*
3.90	6/28	0955	4.08	0.14	0.33	10*
	7/18	1020	1.59	0.05*	0.46	10*
	8/15	0940	1.38	0.05*	0.23	10*
	8/30	1330	1.36	0.10	0.82	10*
	9/13	0950	2.12	0.05*	0.92	10*
	10/4	1010	1.85	0.05*	1.70	10*
1.60	6/28	0940	3.86	0.13	0.29	10*
	7/18	0955	1.66	0.05*	0.35	10*
	8/15	0925	1.37	0.05*	0.22	10*
	8/31	0945	0.92	0.05*	0.55	10*
	9/13	0925	1.82	0.10	0.78	10*
	10/4	0925	2.24	0.05*	1.13	10*
Crosses Run						
2.80	6/29	1210	4.01	0.12	0.14	10*
	8/15	1340	0.67	10.80	0.46	NA
	9/13	1130	1.50	1.24	0.34	10*
	10/3	1340	2.22	2.64	0.62	10*
2.00	6/29	1225	9.26	5.18	0.34	10*
	7/20	1225	3.32	3.71	0.30	10*
	8/15	1355	4.70	15.20	0.34	NA
	8/31	1115	3.66	3.40	0.59	10*
	9/13	1145	7.04	39.70	0.96	10*

Appendix Table A-1 continued.

River Mile	Date	Time	Nitrate (mg/l)	Ammonia (mg/l)	Total Phosphorus (mg/l)	Cyanide (µg/)
Crosses Run (continued)						
2.00	10/3	1315	5.78	9.48	1.58	10*
0.80	6/29	1320	7.43	2.49	0.45	10*
	7/20	1255	9.21	0.08	0.37	10*
	8/15	1415	9.09	4.09	0.42	NA
	8/31	1135	8.50	3.74	0.41	10*
	9/13	1100	7.52	8.24	0.86	10*
	10/3	1035	4.24	0.08	0.47	10*
North Branch Crosses Run						
0.90	6/29	1145	21.90	51.70	2.04	10*
	8/15	1330	0.10*	0.05*	0.05	NA
	10/5	1150	3.92	1.73	0.47	10*
0.10	6/29	1255	1.86	2.64	1.16	10*
	7/20	1240	8.87	0.84	0.97	10*
	8/15	1405	12.10	1.07	1.11	NA
	8/31	1035	3.05	0.40	1.45	10*
	9/13	1150	12.70	8.75	2.09	10*
	10/3	1325	2.79	3.63	2.01	10*
Otter Creek						
1.70	6/29	1025	1.80	0.05*	0.05*	10*
	7/20	0925	0.52	0.05*	0.09	10*
	8/14	0910	0.70	0.05*	0.07	10*
	8/31	1320	0.24	0.05	0.05	10*
	9/12	0910	0.20	0.05*	1.00	10*
	10/3	1130	0.13	0.05*	0.06	10*
Town Run						
0.80	6/29	1350	0.57	N.A	0.30	10*
	7/20	1030	2.04	0.12	0.08	10*
	8/15	1135	0.15	0.28	0.54	10*
	8/31	1239	0.10*	1.01	0.22	10*
	9/13	1220	1.21	0.05*	0.16	10*
	10/5	1215	0.59	0.08	0.27	10*
0.60	6/29	1335	0.41	0.20	0.36	10*
	7/20	1015	0.37	0.05*	0.06	10*
	8/15	1150	0.19	0.07	0.44	10*

Appendix Table A-1 continued.

River Mile	Date	Time	Nitrate (mg/l)	Ammonia (mg/l)	Total Phosphorus (mg/l)	Cyanide (µg/)
Town Run (continued)						
0.60	8/31	1235	0.10*	0.05*	0.14	10*
	9/13	1230	1.28	0.05*	0.16	10*
	10/5	1225	0.82	0.08	0.17	10*
0.10	6/29	1110	1.72	0.05	0.12	10*
	7/20	1000	0.60	0.08	0.13	10*
	8/15	1200	0.45	0.05*	0.32	NA
	8/31	1220	0.64	0.15	0.25	10*
	9/13	1240	1.12	0.05*	0.19	10*
	10/5	1240	0.96	0.08	0.16	10*
Blues Creek						
0.60	6/30	1200	1.57	0.05*	0.34	10*
	7/18	1120	1.24	0.05*	0.07	10*
	8/15	0945	0.77	0.05*	0.08	10*
	8/30	1345	0.14	0.06	0.05	10*
	9/13	0945	0.10*	0.05*	0.05*	10*
	10/4	0950	0.35	0.05*	0.08	10*
McCarthy Park Tributary						
0.10	6/29	1120	1.48	0.05*	0.05*	10*
	7/18	1305	0.62	0.05*	0.06	10*
	8/14	1135	0.47	0.05*	0.09	10*
	8/30	1200	0.10*	0.10	0.09	10*

Appendix Table A-1 continued.

River Mile	Date	Time	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Fecal coliform (#/100 ml)	Fecal Strept. (#/100 ml)
Mill Creek						
39.20	6/28	0955	525	5*	1060	2750
	7/17	0945	538	6	2700	32500
	8/14	0940	584	5*	2700	3500
	8/30	1030	514	5	220	2500
	9/12	0935	542	5*	220	1800
	10/3	1200	572	5*	405	2150
36.10	6/28	1020	446	43	5800	5300
	7/17	1005	526	28	654	2300
	8/14	1000	546	8	320	980
	8/30	1015	484	18	365	810
	9/12	0950	490	8	350	690
	10/3	1230	490	8	1070	4800
28.10	6/28	1340	408	73	NA	3100
	7/17	1020	544	20	590	560
	8/14	1015	542	8	510	NA
	8/30	1100	488	5	240	230
	9/12	1010	518	5*	280	350
	10/3	1250	487	6	7090	6000
24.70	6/28	1325	390	104	2300	2800
	7/17	1035	550	14	250	450
	8/14	1030	538	10	760	NA
	8/30	1115	504	5	370	570
	9/12	1025	526	5*	550	2000
	10/5	1320	494	8	990	5400
19.40	8/14	1050	466	26	330	580
	8/30	1135	502	12	380	120
	9/12	1045	470	18	10*	10*
	10/5	1300	436	28	NA	NA
19.00	6/28	1300	396	111	901	2400
	7/17	1055	578	24	470	650
	8/14	1100	382	35	550	NA
	8/30	NA	506	13	590	540
	9/12	1100	512	8	360	490
	10/4	1400	500	8	2300	2400
18.33	6/28	1215	416	103	1360	918
	7/17	1130	541	20	660	740

Appendix Table A-1 continued.

River Mile	Date	Time	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Fecal coliform (#/100 ml)	Fecal Strept. (#/100 ml)
Mill Creek (continued)						
18.33	8/14	1130	392	25	390	420
	8/30	1210	562	8	290	80
	9/12	1135	516	24	310	200
	10/4	1300	426	15	6000	22000
18.26	6/28	1135	720	5*	22000	3000
	7/17	1145	960	10	3300	660
	8/14	1145	866	5	3300	580
	8/30	1220	924	6	4400	2800
	9/12	1140	1020	12	3400	3500
	10/4	1310	1060	9	8000	25000
18.25	6/28	1145	530	52	3300	2400
	7/17	1200	906	7	3850	920
	8/14	1150	486	24	854	480
	8/30	1225	900	5*	4600	3500
	9/12	1145	948	14	2000	4100
	10/4	1320	614	14	NA	NA
18.14	6/28	1100	468	63	2100	3500
	7/18	1320	704	20	580	480
	8/14	1115	500	22	900	620
	8/31	1155	828	10	31000	6500
	9/12	1200	930	14	900	2800
	10/4	1205	780	16	6820	24000
16.80	6/28	1115	418	129	2900	2400
	7/18	1340	686	19	460	520
	8/14	1300	472	30	420	550
	8/31	1205	802	6	26000	5800
	9/13	1300	876	6	2050	5350
	10/4	1145	502	12	8730	29000
12.17	6/28	1035	388	105	3800	4000
	7/18	1230	666	38	490	420
	8/15	1115	516	43	425	780
	8/31	1050	752	32	9910	2700
	9/13	1030	1070	24	1030	980
	10/3	0945	1150	10	360	980
11.70	6/28	1150	402	100	3100	5600
	7/18	1210	638	33	700	580

Appendix Table A-1 continued.

River Mile	Date	Time	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Fecal coliform (#/100 ml)	Fecal Strept. (#/100 ml)
Mill Creek (continued)						
11.7	8/15	1100	515	30	520	680
	8/31	1115	822	22	2700	950
	9/13	1045	1120	26	2000	3500
	10/3	1005	1140	6	2900	6600
6.89	6/28	1015	350	114	NA	6200
	7/18	1140	654	18	180	250
	8/15	1035	500	5*	340	3100
	8/31	1040	778	10	200	260
	9/13	1025	987	14	580	2900
	10/4	1115	1060	20	5200	6100
4.20	6/30	1230	272	345	4300	63000
	7/18	1045	616	28	450	410
	8/15	1005	466	5*	200	760
	8/31	1010	740	18	280	370
	9/13	1010	948	24	3300	2200
	10/4	1040	978	23	3000	3100
3.90	6/28	0955	328	132	1200	5100
	7/18	1020	576	26	580	270
	8/15	0940	464	5*	310	2000
	8/30	1330	700	44	210	360
	9/13	0950	906	18	2000	3600
	10/4	1010	968	22	3100	4300
1.60	6/28	0940	324	143	800	6300
	7/18	0955	466	17	12	180
	8/15	0925	416	5	35	2900
	8/31	0945	662	10	140	380
	9/13	0925	820	12	500	3400
	10/4	0925	828	14	NA	6250
Crosses Run						
2.80	6/29	1210	646	49	2400	4900
	8/15	1340	841	16	84000	2900
	9/13	1130	1500	60	>60000	>100000
	10/3	1340	546	141	>60000	>100000
2.00	6/29	1225	938	35	2100	6300
	7/20	1225	1440	49	2100	2700

Appendix Table A-1 continued.

River Mile	Date	Time	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Fecal coliform (#/100 ml)	Fecal Strept. (#/100 ml)
Crosses Run (continued)						
2.00	8/15	1355	902	21	420	>100000
	8/31	1115	1250	39	390	3100
	9/13	1145	1130	12	58500	39500
	10/3	1315	306	66	4200	32000
0.80	6/29	1320	458	64	4400	9400
	7/20	1255	1280	5*	340	1540
	8/15	1415	794	5*	3000	760
	8/31	1135	1230	5*	190	1580
	9/13	1100	1030	6	2000	26000
	10/3	1035	1480	10	918	3400
North Branch Crosses Run						
0.90	6/29	1145	178	124	2400	350000
	8/15	1330	304	5*	200	390
	10/5	1150	598	19	12300	>100000
0.10	6/29	1255	220	117	NA	98000
	7/20	1240	394	5*	791	1080
	8/15	1405	976	40	34000	35000
	8/31	1035	1120	179	66000	245000
	9/13	1150	970	6	4100	3100
	10/3	1325	354	98	3600	60000
Otter Creek						
1.70	6/29	1025	514	49	2200	3600
	7/20	0925	494	14	1680	3350
	8/14	0910	512	21	3150	2650
	8/31	1320	426	6	800	740
	9/12	0910	458	8	400	1160
	10/3	1130	444	6	170	2600
Town Run						
0.80	6/29	1350	202	138	7540	>100000
	7/20	1030	552	46	2900	4100
	8/15	1135	418	5*	3700	730
	8/31	1239	1130	14	3200	1640
	9/13	1220	468	10	4100	8800

Appendix Table A-1 continued.

River Mile	Date	Time	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Fecal coliform (#/100 ml)	Fecal Strept. (#/100 ml)
Town Run (continued)						
0.80	10/5	1215	176	395	8730	46000
0.60	6/29	1335	164	578	>60000	73000
	7/20	1015	474	10	550	290
	8/15	1150	422	364	2100	2800
	8/31	1235	808	24	190	310
	9/13	1230	420	13	3400	24000
	10/5	1225	226	174	5900	40000
0.10	6/29	1110	422	22	2600	3900
	7/20	1000	506	6	160	480
	8/15	1200	372	5*	3600	2000
	8/31	1220	652	5*	6000	4900
	9/13	1240	418	8	2200	5000
	10/5	1240	252	112	21000	43000
Blues Creek						
0.60	6/30	1200	310	341	3700	61500
	7/18	1120	554	22	360	420
	8/15	0945	498	11	320	2000
	8/30	1345	636	5	80	170
	9/13	0945	760	9	570	4200
	10/4	0950	660	6	580	5100
McCarthy Park Tributary						
0.10	6/29	1120	476	5*	490	2800
	7/18	1305	452	5*	230	480
	8/14	1135	716	5	580	920
	8/30	1200	720	32	100	1000

Appendix Table A-1 continued.

River Mile	Date	Time	Arsenic (µg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Nickel (µg/l)
Mill Creek								
39.20	6/28	0955	2*	0.2*	30*	10*	2*	40*
	7/17	0945	2*	0.2*	30*	10*	2*	40*
	8/14	0940	2	0.2*	30*	10*	2*	40*
	8/30	1030	2*	0.2*	30*	10*	2*	40*
	9/12	0935	2*	0.2*	30*	10*	2*	40*
	10/3	1200	2*	0.2*	30*	10*	2*	40*
36.10	6/28	1020	2	0.2*	30*	10*	2*	40*
	7/17	1005	3	0.2*	30*	10*	2*	40*
	8/14	1000	2*	0.2*	30*	10*	2*	40*
	8/30	1015	2*	0.4	30*	10*	2*	40*
	9/12	0950	2*	0.2*	30*	10*	2*	40*
	10/3	1230	2	0.2*	30*	10*	2*	40*
28.10	6/28	1340	3	0.2*	30*	10*	2*	40*
	7/17	1020	2	0.2*	30*	10*	4	NA
	8/14	1015	2*	0.2*	30*	10*	2*	40*
	8/30	1100	2*	0.2*	30*	10*	2*	40*
	9/12	1010	2*	0.2*	30*	10*	4	40*
	10/3	1250	2*	0.2*	30*	10*	2*	40*
24.70	6/28	1325	3	0.2*	30*	10*	2	40*
	7/17	1035	2*	0.2*	30*	10*	2*	40*
	8/14	1030	2*	0.2*	30*	10*	2*	40*
	8/30	1115	2*	0.2*	30*	10*	2*	40*
	9/12	1025	2*	0.2*	30*	10*	2*	40*
	10/5	1320	2*	0.2*	30*	10*	2*	40*
19.40	8/14	1050	2*	0.2*	30*	10*	2*	40*
	8/30	1135	2*	0.2*	30*	10*	2*	40*
	9/12	1045	2*	0.2*	30*	10*	2*	40*
	10/5	1300	3	0.2*	30*	10*	2	40*
19.00	6/28	1300	3	0.2*	30*	10*	3	40*
	7/17	1055	2	0.2*	30*	10*	2*	40*
	8/14	1100	2*	0.2*	30*	10*	2*	40*
	8/30	NA	2*	0.2*	30*	10*	2*	40*
	9/12	1100	2*	0.2*	30*	10*	2*	40*
	10/4	1400	2*	0.2*	30*	10*	2*	40*
18.33	6/28	1215	2	0.2*	30*	10*	2*	40*
	7/17	1130	4	0.2*	30*	44	2*	40*
	8/14	1130	2	0.2*	30*	12	2*	40*
	8/30	1210	2*	0.2*	30*	42	2*	40*

Appendix Table A-1 continued.

River Mile	Date	Time	Arsenic (µg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Nickel (µg/l)
Mill Creek (continued)								
18.33	9/12	1135	2*	0.2*	30*	85	2*	40*
	10/4	1300	2*	0.2*	30*	22	2*	40*
18.26	6/28	1135	2*	0.2*	30*	10*	2*	40*
	7/17	1145	2*	0.2*	30*	10*	2*	40*
	8/14	1145	2*	0.2*	30*	10*	2*	40*
	8/30	1220	2*	0.2*	30*	10*	2*	40*
	9/12	1140	2*	0.2*	30*	10*	3	40*
	10/4	1310	2*	0.2*	30*	10*	4	40*
18.25	6/28	1145	2	0.2*	30*	10*	2*	40*
	7/17	1200	2*	0.2*	30*	12	2*	40*
	8/14	1150	2*	0.2*	30*	10	2*	40*
	8/30	1225	2*	0.2*	30*	10*	2*	40*
	9/12	1145	2*	0.2*	30*	14	4	40*
	10/4	1320	2*	0.2*	30*	13	2	40*
18.14	6/28	1100	3	0.2*	30*	10*	3	40*
	7/18	1320	7	0.2*	30*	17	2*	40*
	8/14	1115	2*	0.2*	30*	10*	2*	40*
	8/31	1155	2*	0.2*	30*	12	2*	40*
	9/12	1200	2*	0.3	30*	17	2	40*
	10/4	1205	2*	0.2*	30*	13	3	40*
16.80	6/28	1115	2*	0.2*	30*	10*	5	40*
	7/18	1340	2	0.2*	30*	10*	2*	40*
	8/14	1300	2	0.2*	30*	20	2*	40*
	8/31	1205	2*	0.2*	30*	10*	2*	40*
	9/13	1300	2*	0.2*	30*	12	2*	40*
	10/4	1145	2*	0.2*	30*	10	3	40*
12.17	6/28	1035	3	0.2*	30*	10*	4	40*
	7/18	1230	9	0.2*	30*	10*	2*	40*
	8/15	1115	2	0.2*	30*	10*	2*	40*
	8/31	1050	3	0.2*	30*	10*	2*	40*
	9/13	1030	3	0.2*	30*	10*	2*	40*
	10/3	0945	2*	0.2*	30*	10	2	40*
11.70	6/28	1150	2	0.2*	30*	10*	2*	40*
	7/18	1210	8	0.2*	30*	10*	2*	40*
	8/15	1100	2	0.2*	30*	10*	2*	40*
	8/31	1115	3	0.2*	30*	10*	2*	40*
	9/13	1045	3	0.2*	30*	10*	2*	40*
	10/3	1005	2*	0.2*	30*	10*	2*	40*

Appendix Table A-1 continued.

River Mile	Date	Time	Arsenic (µg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Nickel (µg/l)
Mill Creek (continued)								
6.89	6/28	1015	4	0.2*	30*	10*	5	40*
	7/18	1140	10	0.2*	30*	10*	2*	40*
	8/15	1035	2*	0.2*	30*	10*	2*	40*
	8/31	1040	4	0.2*	30*	10*	2*	40*
	9/13	1025	4	0.2*	30*	10*	2*	40*
	10/4	1115	2	0.2*	30*	10*	2*	40*
4.20	6/30	1230	6	0.2*	30*	18	10	40*
	7/18	1045	10	0.2*	30*	10*	2*	40*
	8/15	1005	2*	0.2*	30*	10*	2*	40*
	8/31	1010	4	0.2*	30*	10*	2*	40*
	9/13	1010	4	0.2*	30*	10*	2*	40*
	10/4	1040	2	0.2*	30*	10*	2*	40*
3.90	6/28	0955	4	0.2*	30*	10*	4	40*
	7/18	1020	2	0.2*	30*	10*	2*	40*
	8/15	0940	2	0.2*	30*	10*	2*	40*
	8/30	1330	2*	0.3	30*	10*	2*	40*
	9/13	0950	3	0.2*	30*	10*	2*	40*
	10/4	1010	3	0.2*	30*	10*	2*	40*
1.60	6/28	0940	5	0.2	30*	10*	5	40*
	7/18	0955	2	0.2*	30*	10*	2*	40*
	8/15	0925	2*	0.2*	30*	11	2*	40*
	8/31	0945	3	0.2*	30*	10*	2*	40*
	9/13	0925	3	0.2*	30*	10*	2*	40*
	10/4	0925	3	0.2*	30*	16	2*	40*
Crosses Run								
2.80	6/29	1210	4	0.2*	30*	10*	2*	40*
	8/15	1340	8	0.2*	30*	13	5	40*
	9/13	1130	3	0.2*	30*	10*	2*	40*
	10/3	1340	4	0.2*	30*	15	6	40*
2.00	6/29	1225	5	0.2*	30*	12	2*	40*
	7/20	1225	5	0.2*	30*	10*	2*	40*
	8/15	1355	11	0.2*	30*	10	2*	40*
	8/31	1115	6	0.2*	30*	11	2*	40*
	9/13	1145	5	0.2*	30*	11	2*	40*
	10/3	1315	4	0.2*	30*	19	7	40*
0.80	6/29	1320	8	0.2*	30*	10	2	40*
	7/20	1255	8	0.2*	30*	10*	2*	40*

Appendix Table A-1 continued.

River Mile	Date	Time	Arsenic (µg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Nickel (µg/l)
Crosses Run (continued)								
0.80	8/15	1415	6	0.2*	30*	10*	2*	40*
	8/31	1135	4	0.2*	30*	10*	2*	40*
	9/13	1100	4	0.2*	30*	10*	2*	40*
	10/3	1035	2*	0.2*	30*	10*	2*	40*
North Branch Crosses Run								
0.90	6/29	1145	12	0.3	30*	23	8	40*
	8/15	1330	2*	0.2*	30*	10*	2*	40*
	10/5	1150	7	0.2*	30*	21	2*	40*
0.10	6/29	1255	2*	0.2*	30*	14	2*	40*
	7/20	1240	13	0.2*	30*	10*	2*	40*
	8/15	1405	6	0.2*	30*	10*	2*	40*
	8/31	1035	8	0.3	30*	19	9	40*
	9/13	1150	4	0.2*	30*	10*	2*	40*
	10/3	1325	2*	0.2	30*	24	6	40*
Otter Creek								
1.70	6/29	1025	2*	0.2*	30*	10*	2*	40*
	7/20	0925	2	0.2*	30*	10*	2*	40*
	8/14	0910	2*	1.5	30*	42	3	40*
	8/31	1320	2*	0.2*	30*	10*	2*	40*
	9/12	0910	2*	0.2*	30*	10*	2*	40*
	10/3	1130	2*	0.2*	30*	10*	2*	40*
Town Run								
0.80	6/29	1350	6	0.2	30*	26	11	40*
	7/20	1030	2*	0.2*	30*	10*	2*	40*
	8/15	1135	5	0.2*	30*	10*	2*	40*
	8/31	1239	3	0.2*	30*	10*	2*	40*
	9/13	1220	2*	0.2*	30*	10*	2*	40*
	10/5	1215	2*	0.3	30*	21	11	40*
0.60	6/29	1335	6	0.5	30*	151	34	40*
	7/20	1015	3	0.2*	30*	27	3	40*
	8/15	1150	6	0.2*	35	385	65	50
	8/31	1235	3	0.2*	30*	35	3	40*
	9/13	1230	2	0.2*	30	32	4	40*
	10/5	1225	2	0.2*	30*	54	12	40*

Appendix Table A-1 continued.

River Mile	Date	Time	Arsenic (µg/l)	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Lead (µg/l)	Nickel (µg/l)
Town Run (continued)								
0.10	6/29	1110	2	0.2*	30*	23	3	40*
	7/20	1000	2*	0.2*	30*	15	6	40*
	8/15	1200	4	0.2*	30*	19	3	40*
	8/31	1220	2	0.2*	30*	11	2*	40*
	9/13	1240	2*	0.2*	30*	13	2*	40*
	10/5	1240	2	0.2	30*	83	22	40*
Blues Creek								
0.60	6/30	1200	5	0.2*	30*	20	9	45
	7/18	1120	7	0.2*	30*	10*	2*	40*
	8/15	0945	2	0.2*	30*	10*	2*	40*
	8/30	1345	2*	0.2*	30*	10*	2	40*
	9/13	0945	2*	0.2*	30*	10*	2	40*
	10/4	0950	2	0.2*	30*	10*	2	40*
McCarthy Park Tributary								
0.10	6/29	1120	2*	0.2*	30*	10*	2*	40*
	7/18	1305	2*	0.2*	30*	10*	2*	40*
	8/14	1135	2	0.2*	30*	10*	2*	40*
	8/30	1200	2*	0.2*	30*	10*	2*	40*

Appendix Table A-1 continued.

River Mile	Date	Time	Calcium (mg/l)	Magnesium (mg/l)	Zinc (mg/l)	Mercury (µg/l)	Silver (µg/l)	Antimony (µg/l)
Mill Creek								
39.20	6/28	0955	97	39	64	NA	NA	NA
	7/17	0945	91	38	10*	NA	NA	NA
	8/14	0940	104	38	10	NA	NA	NA
	8/30	1030	95	43	10*	NA	NA	NA
	9/12	0935	98	48	10*	NA	NA	NA
	10/3	1200	101	49	17	NA	NA	NA
36.10	6/28	1020	75	29	21	NA	NA	NA
	7/17	1005	94	40	10*	NA	NA	NA
	8/14	1000	95	34	10*	NA	NA	NA
	8/30	1015	91	40	10*	NA	NA	NA
	9/12	0950	93	44	10*	NA	NA	NA
	10/3	1230	83	40	13	NA	NA	NA
28.10	6/28	1340	63	23	17	NA	NA	NA
	7/17	1020	90	38	10*	NA	NA	NA
	8/14	1015	94	34	10*	NA	NA	NA
	8/30	1100	91	41	10*	NA	NA	NA
	9/12	1010	90	46	10*	NA	NA	NA
	10/3	1250	85	45	10	NA	NA	NA
24.70	6/28	1325	59	22	20	NA	NA	NA
	7/17	1035	95	39	10*	NA	NA	NA
	8/14	1030	91	32	10*	NA	NA	NA
	8/30	1115	91	41	10*	NA	NA	NA
	9/12	1025	91	47	10*	NA	NA	NA
	10/5	1320	79	41	16	NA	NA	NA
19.40	8/14	1050	80	28	10	NA	NA	NA
	8/30	1135	87	37	22	NA	NA	NA
	9/12	1045	62	12	23	NA	NA	NA
	10/5	1300	75	38	20	NA	NA	NA
19.00	6/28	1300	65	24	29	NA	NA	NA
	7/17	1055	88	34	10	NA	NA	NA
	8/14	1100	79	28	10	NA	NA	NA
	8/30	NA	87	38	12	NA	NA	NA
	9/12	1100	56	20	13	NA	NA	NA
	10/4	1400	81	40	15	NA	NA	NA
18.33	6/28	1215	69	24	22	0.20	1.0*	2.0*
	7/17	1130	91	34	20	0.20*	1.0*	2.0*
	8/14	1130	87	30	16	0.20*	0.2*	2.0
	8/30	1210	104	44	15	0.20*	1.0*	N.A

Appendix Table A-1 continued.

River Mile	Date	Time	Calcium (mg/l)	Magnesium (mg/l)	Zinc (mg/l)	Mercury (µg/l)	Silver (µg/l)	Antimony (µg/l)
Mill Creek (continued)								
18.33	9/12	1135	80	29	15	0.20*	0.2*	2.0*
	10/4	1300	67	27	29	0.20*	0.4	2.0*
18.26	6/28	1135	63	25	21	0.20*	1.0*	2.0*
	7/17	1145	51	27	48	0.20*	1.0*	2.0*
	8/14	1145	68	25	32	0.20*	0.2*	1.0
	8/30	1220	45	26	39	0.20*	1.0	N.A
	9/12	1140	55	27	84	0.20*	N.A	N.A
	10/4	1310	55	26	74	0.20*	0.2*	2.0*
18.25	6/28	1145	70	25	22	0.20*	1.0*	2.0*
	7/17	1200	54	27	110	0.20*	1.0*	2.0*
	8/14	1150	84	29	13	0.20*	0.2*	1.0*
	8/30	1225	54	30	39	0.30	N.A	2.0
	9/12	1145	58	27	72	0.20*	0.2*	2.0*
	10/4	1320	61	26	46	0.20*	0.2*	2.0*
18.14	6/28	1100	68	25	23	0.20*	1.0*	2.0*
	7/18	1320	74	33	36	0.20*	1.0*	2.0
	8/14	1115	77	26	14	0.20*	1.0*	1.0*
	8/31	1155	57	29	36	0.20*	0.2*	2.0
	9/12	1200	60	26	69	0.20*	0.2*	2.0*
	10/4	1205	59	25	61	0.20*	0.2*	2.0*
16.80	6/28	1115	72	25	65	N.A	N.A	N.A
	7/18	1340	75	32	25	N.A	N.A	N.A
	8/14	1300	83	28	13	N.A	N.A	N.A
	8/31	1205	63	30	25	N.A	N.A	N.A
	9/13	1300	58	26	41	N.A	N.A	N.A
	0/4	1145	46	16	34	N.A	N.A	N.A
12.17	6/28	1035	61	20	20	N.A	N.A	N.A
	7/18	1230	86	34	41	N.A	N.A	N.A
	8/15	1115	91	32	16	N.A	N.A	N.A
	8/31	1050	88	38	18	N.A	N.A	N.A
	9/13	1030	95	41	23	N.A	N.A	N.A
	10/3	0945	88	40	43	N.A	N.A	N.A
11.70	6/28	1150	59	20	29	N.A	N.A	N.A
	7/18	1210	87	34	24	N.A	N.A	N.A
	8/15	1100	94	33	17	N.A	N.A	N.A
	8/31	1115	94	40	12	N.A	N.A	N.A
	9/13	1045	107	46	26	N.A	N.A	N.A
	10/3	1005	95	42	35	N.A	N.A	N.A

Appendix Table A-1 continued.

River Mile	Date	Time	Calcium (mg/l)	Magnesium (mg/l)	Zinc (mg/l)	Mercury (µg/l)	Silver (µg/l)	Antimony (µg/l)
Mill Creek (continued)								
6.89	6/28	1015	48	16	62	N.A	N.A	N.A
	7/18	1140	89	34	13	N.A	N.A	N.A
	8/15	1035	89	31	11	N.A	N.A	N.A
	8/31	1040	91	36	10*	N.A	N.A	N.A
	9/13	1025	87	38	15	N.A	N.A	N.A
	10/4	1115	99	44	32	N.A	N.A	N.A
4.20	6/30	1230	24	10	89	N.A	N.A	N.A
	7/18	1045	85	33	12	N.A	N.A	N.A
	8/15	1005	82	30	12	N.A	N.A	N.A
	8/31	1010	93	37	10*	N.A	N.A	N.A
	9/13	1010	99	44	10*	N.A	N.A	N.A
	10/4	1040	90	38	26	N.A	N.A	N.A
3.90	6/28	0955	44	15	43	N.A	N.A	N.A
	7/18	1020	85	32	13	N.A	N.A	N.A
	8/15	0940	85	31	10*	N.A	N.A	N.A
	8/30	1330	102	41	12	N.A	N.A	N.A
	9/13	0950	95	42	14	N.A	N.A	N.A
	10/4	1010	100	43	30	N.A	N.A	N.A
1.60	6/28	0940	41	14	41	N.A	N.A	N.A
	7/18	0955	86	33	12	N.A	N.A	N.A
	8/15	0925	24	30	23	N.A	N.A	N.A
	8/31	0945	99	40	10*	N.A	N.A	N.A
	9/13	0925	99	43	10	N.A	N.A	N.A
	10/4	0925	99	42	40	N.A	N.A	N.A
Crosses Run								
2.80	6/29	1210	98	35	15	N.A	N.A	N.A
	8/15	1340	124	50	52	N.A	N.A	N.A
	9/13	1130	137	47	106	N.A	N.A	N.A
	10/3	1340	54	19	195	N.A	N.A	N.A
2.00	6/29	1225	115	37	32	N.A	N.A	N.A
	7/20	1225	175	75	23	N.A	N.A	N.A
	8/15	1355	126	56	24	N.A	N.A	N.A
	8/31	1115	166	73	43	N.A	N.A	N.A
	9/13	1145	125	46	50	N.A	N.A	N.A
	10/3	1315	46	14	187	N.A	N.A	N.A
0.80	6/29	1320	73	23	33	N.A	N.A	N.A
	7/20	1255	152	62	21	N.A	N.A	N.A

Appendix Table A-1 continued.

River Mile	Date	Time	Calcium (mg/l)	Magnesium (mg/l)	Zinc (mg/l)	Mercury (µg/l)	Silver (µg/l)	Antimony (µg/l)
Crosses Run (continued)								
0.8	8/15	1415	102	37	19	N.A	N.A	N.A
	8/31	1135	159	72	31	N.A	N.A	N.A
	9/13	1100	143	58	42	N.A	N.A	N.A
	10/3	1035	178	73	36	N.A	N.A	N.A
North BranchCrosses Run								
0.90	6/29	1145	127	77	66	N.A	N.A	N.A
	8/15	1330	56	26	13	N.A	N.A	N.A
	10/5	1150	90	36	37	N.A	N.A	N.A
0.10	6/29	1255	32	11	108	N.A	N.A	N.A
	7/20	1240	135	53	22	N.A	N.A	N.A
	8/15	1405	108	41	54	N.A	N.A	N.A
	8/31	1035	124	60	96	N.A	N.A	N.A
	9/13	1150	112	43	24	N.A	N.A	N.A
	10/3	1325	52	19	107	N.A	N.A	N.A
Otter Creek								
1.70	6/29	1025	97	37	14	N.A	N.A	N.A
	7/20	0925	87	40	11	N.A	N.A	N.A
	8/14	0910	91	36	104	N.A	N.A	N.A
	8/31	1320	78	35	10*	N.A	N.A	N.A
	9/12	0910	90	42	10*	N.A	N.A	N.A
	10/3	1130	87	40	13	N.A	N.A	N.A
Town Run								
0.80	6/29	1350	34	11	104	N.A	N.A	N.A
	7/20	1030	90	27	10*	N.A	N.A	N.A
	8/15	1135	69	25	12	N.A	N.A	N.A
	8/31	1239	126	81	13	N.A	N.A	N.A
	9/13	1220	68	23	10*	N.A	N.A	N.A
	10/5	1215	40	12	77	N.A	N.A	N.A
0.60	6/29	1335	42	15	246	N.A	N.A	N.A
	7/20	1015	83	26	29	N.A	N.A	N.A
	8/15	1150	75	26	540	N.A	N.A	N.A
	8/31	1235	106	49	25	N.A	N.A	N.A
	9/13	1230	64	22	37	N.A	N.A	N.A
	10/5	1225	42	13	87	N.A	N.A	N.A

Appendix Table A-1 continued.

River Mile	Date	Time	Calcium (mg/l)	Magnesium (mg/l)	Zinc (mg/l)	Mercury (µg/l)	Silver (µg/l)	Antimony (µg/l)
Town Run (continued)								
0.10	6/29	1110	74	23	38	N.A	N.A	N.A
	7/20	1000	67	20	34	N.A	N.A	N.A
	8/15	1200	77	26	32	N.A	N.A	N.A
	8/31	1220	95	36	22	N.A	N.A	N.A
	9/13	1240	59	19	24	N.A	N.A	N.A
	10/5	1240	49	15	117	N.A	N.A	N.A
Blues Creek								
0.60	6/30	1200	35	14	85	N.A	N.A	N.A
	7/18	1120	90	33	10*	N.A	N.A	N.A
	8/15	0945	89	33	10	N.A	N.A	N.A
	8/30	1345	115	50	10*	N.A	N.A	N.A
	9/13	0945	133	60	10*	N.A	N.A	N.A
	10/4	0950	114	52	20	N.A	N.A	N.A
McCarthy Park Tributary								
0.10	6/29	1120	67	20	11	N.A	N.A	N.A
	7/18	1305	53	21	12	N.A	N.A	N.A
	8/14	1135	138	38	15	N.A	N.A	N.A
	8/30	1200	154	36	10*	N.A	N.A	N.A

* Detection limit

Appendix A Table 2. Summary of diurnal D.O.(mg/l) data recorded with Datasonde continuous monitors at 13 locations in Mill Creek and Crosses Run, August 29-31, 1995.

River Mile	Total Hours	Mean (mg/l)	Median (mg/l)	Minimum (mg/l)	Maximum (mg/l)	25th %ile (mg/l)	75th %ile (mg/l)
Mill Creek (August 29-31)							
28.2	47	9.21	8.38	6.75	13.19	7.39	11.00
18.3	40	5.95	6.05	4.33‡	7.30	5.20	6.65
18.1	41	4.14‡	4.22‡	2.94‡‡	5.76	3.49‡‡	4.61‡
17.4	39	3.82‡‡	3.90‡‡	2.90‡‡	4.71‡	3.55‡‡	4.14‡
16.8	41	2.29‡‡	2.32‡‡	1.67‡‡‡	3.16‡‡	1.98‡‡‡	2.50
15.7	40	4.53‡	4.41‡	3.54‡‡	6.31	3.84‡‡	5.08
12.2	42	4.95‡	4.91‡	4.08‡	6.11	4.25‡	5.70
11.7	39	5.40	5.26	4.47‡	6.70	4.60‡	6.10
6.9	35	8.74	8.63	5.96	11.72	6.79	10.45
4.2	40	8.78	8.59	5.99	11.78	6.73	11.08
1.6	40	9.46	8.71	7.15	13.73	7.33	11.59
Crosses Run (August 29-31)							
0.8	40	2.37‡‡	2.17‡‡	1.86‡‡‡	3.67‡‡	2.01‡‡	2.66‡‡

‡ concentration falls below the average dissolved oxygen (D.O.) criterion (5 mg/l).

‡‡ violation of the minimum dissolved oxygen (D.O.) criterion (4 mg/l).

‡‡‡ violation of the nuisance prevention minimum dissolved oxygen (D.O.) criterion (2 mg/l).

APPENDIX B

Macroinvertebrate Data

Invertebrate Community Index (ICI) metrics and scores for stations in the Mill Creek basin (Scioto River drainage) study area, 1995.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Taxa	Qual. EPT	Eco-region	ICI
MILL CREEK — 02-109													
Year: 95													
39.40	22.7	25(4)	3(2)	0(0)	15(4)	3.4(2)	0.0(0)	38.4(6)	57.4(2)	14.9(4)	9(4)	5	**28**
36.00	37.0	48(6)	7(4)	1(2)	30(6)	18.7(4)	3.0(2)	25.0(4)	51.4(2)	9.1(4)	17(6)	5	**40**
28.20	64.0	32(4)	7(4)	2(4)	14(4)	58.9(6)	3.0(2)	2.4(2)	34.3(4)	2.9(6)	14(6)	5	**42**
24.80	72.0	42(6)	8(4)	3(4)	23(6)	29.2(4)	0.6(2)	15.8(2)	53.9(2)	2.9(6)	12(4)	5	**40**
19.30	82.0	33(4)	6(4)	1(2)	19(4)	82.9(6)	0.1(2)	0.6(2)	16.0(6)	1.4(6)	10(4)	5	**40**
19.00	82.0	29(4)	7(4)	1(2)	18(4)	81.8(6)	0.1(2)	2.1(2)	15.9(6)	2.2(6)	14(6)	5	**42**
18.60	84.0	39(6)	7(4)	0(0)	22(6)	80.9(6)	0.0(0)	2.4(2)	15.8(6)	3.0(6)	11(4)	5	**40**
18.20	88.0	21(2)	4(2)	1(2)	7(2)	1.2(2)	0.1(2)	0.7(2)	97.9(0)	89.5(0)	5(2)	5	**16**
18.10	88.0	26(4)	3(2)	1(2)	16(4)	10.6(2)	1.5(2)	0.0(0)	86.7(0)	45.3(0)	6(2)	5	**18**
16.90	89.0	26(4)	4(2)	0(0)	16(4)	22.5(4)	0.0(0)	16.1(2)	58.6(2)	17.6(0)	7(2)	5	**20**
14.60	95.0	38(6)	9(6)	1(2)	21(6)	55.2(6)	5.2(2)	8.7(2)	28.9(6)	5.5(4)	11(4)	5	**44**
12.10	98.0	30(4)	5(2)	2(4)	17(4)	44.0(6)	12.1(4)	14.4(2)	28.0(6)	1.8(6)	12(4)	5	**42**
11.70	103.0	35(4)	7(4)	1(2)	21(6)	49.9(6)	6.3(2)	11.0(2)	31.2(4)	5.0(6)	10(4)	5	**40**
4.40	130.0	40(6)	6(4)	3(4)	24(6)	45.7(6)	0.4(2)	10.1(2)	43.2(4)	4.2(6)	13(4)	5	**44**
3.70	167.0	50(6)	10(6)	1(2)	26(6)	51.3(6)	2.2(2)	13.7(2)	30.9(4)	3.5(6)	14(4)	5	**44**
1.60	178.0	33(4)	10(6)	3(4)	14(4)	41.3(6)	14.2(4)	25.8(4)	17.9(6)	1.1(6)	17(6)	5	**50**
CROSSES RUN — 02-133													
Year: 95													
2.40	1.2	12(0)	1(0)	0(0)	4(0)	3.0(2)	0.0(0)	3.0(2)	88.1(0)	61.2(0)	1(0)	5	**4**
2.00	1.5	8(0)	0(0)	0(0)	4(0)	0.0(0)	0.0(0)	0.0(0)	96.7(0)	96.7(0)	1(0)	5	**0**
0.60	5.1	19(2)	0(0)	0(0)	10(2)	0.0(0)	0.0(0)	3.1(2)	96.6(0)	29.4(0)	1(0)	5	**6**
NORTH BRANCH CROSSES RUN — 02-253													
Year: 95													
0.10	1.4	12(0)	0(0)	0(0)	3(0)	0.0(0)	0.0(0)	0.0(0)	97.8(0)	83.1(0)	0(0)	5	**0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/18/95 River Code: 02-109 River: Mill Creek RM: 39.40

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	8	
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	46	
06201	*Hyalella azteca*	1	+
08250	*Orconectes (Procericambarus) rusticus*		+
11130	*Baetis intercalaris*		+
11200	*Callibaetis sp*		+
11651	*Procloeon sp (w/o hindwing pads)*		+
11670	*Procloeon irrubrum*		+
13400	*Stenacron sp*	3	+
13521	*Stenonema femoratum*		+
14950	*Leptophlebia sp or Paraleptophebia sp*	18	
16700	*Tricorythodes sp*		+
17200	*Caenis sp*	16	+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	10	+
23909	*Boyeria vinosa*		+
24900	*Gomphus sp*		+
45300	*Sigara sp*		+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*		+
63900	*Laccophilus sp*		+
68075	*Psephenus herricki*		+
68708	*Dubiraphia vittata group*		+
69200	*Optioservus sp*		+
69400	*Stenelmis sp*		+
71100	*Hexatoma sp*		+
72700	*Anopheles sp*		+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	211	+
77500	*Conchapelopia sp*	13	+
77800	*Helopelopia sp*		+
78140	*Labrundinia pilosella*	13	
78500	*Paramerina fragilis*		+
78750	*Rheopelopia paramaculipennis*		+
80370	*Corynoneura lobata*	8	
80420	*Cricotopus (C.) bicinctus*		+
81650	*Parametriocnemus sp*		+
82121	*Thienemanniella n.sp 3*	80	
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	105	+
83840	*Microtendipes pedellus group*		+
83900	*Nilothauma sp*	13	
84210	*Paratendipes albimanus or P. duplicatus*	13	+
84300	*Phaenopsectra obediens group*		+
84315	*Phaenopsectra flavipes*		+
84450	*Polypedilum (P.) convictum*		+
84460	*Polypedilum (P.) fallax group*	92	
84470	*Polypedilum (P.) illinoense*	13	+
84750	*Stictochironomus sp*		+
85230	*Cladotanytarsus mancus group*		+
85500	*Paratanytarsus sp*	264	+
85625	*Rheotanytarsus exiguus group*		+
85720	*Stempellinella n.sp nr. flavidula*	13	
85800	*Tanytarsus sp*	26	+
85814	*Tanytarsus glabrescens group*	119	
86100	*Chrysops sp*		+
87540	*Hemerodromia sp*	1	
95100	*Physella sp*	2	+
96900	*Ferrissia sp*	11	+
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	25	Total Taxa:	62
No. Qualitative Taxa:	51	ICI:	**28**
Number of Organisms:	1100	Qual EPT:	**9**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/18/95 River Code: 02-109 River: Mill Creek RM: 36.00

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	8	+
01801	*Turbellaria*		+
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	5	+
06201	*Hyalella azteca*		+
07840	*Cambarus (Cambarus) sciotensis*	1	
08250	*Orconectes (Procericambarus) rusticus*		+
11020	*Acerpenna pygmaeus*	4	
11130	*Baetis intercalaris*	12	+
11200	*Callibaetis sp*		+
11250	*Centroptilum sp (w/o hindwing pads)*		+
11650	*Procloeon sp (w/ hindwing pads)*		+
11651	*Procloeon sp (w/o hindwing pads)*		+
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	1	+
13400	*Stenacron sp*	121	+
13521	*Stenonema femoratum*	3	+
13590	*Stenonema vicarium*	1	+
14950	*Leptophlebia sp or Paraleptophebia sp*		+
17200	*Caenis sp*	50	+
21200	*Calopteryx sp*	5	+
22001	*Coenagrionidae*		+
22300	*Argia sp*	11	+
45300	*Sigara sp*		+
47600	*Sialis sp*	1	+
52200	*Cheumatopsyche sp*	31	+
52430	*Ceratopsyche morosa group*		+
52530	*Hydropsyche depravata group*		+
58505	*Helicopsyche borealis*		+
59700	*Triaenodes sp*		+
63300	*Hydroporus sp*		+
64800	*Uvarus sp*		+
67800	*Tropisternus sp*		+
68075	*Psephenus herricki*		+
68130	*Helichus sp*		+
68708	*Dubiraphia vittata group*		+
68901	*Macronychus glabratus*	2	
69200	*Optioservus sp*		+
69400	*Stenelmis sp*		+
74100	*Simulium sp*		+
74501	*Ceratopogonidae*		+
77120	*Ablabesmyia mallochi*	13	+
77500	*Conchapelopia sp*		+
77750	*Hayesomyia senata or Thienemannimyia norena*	7	
77800	*Helopelopia sp*	144	
78140	*Labrundinia pilosella*	13	
78450	*Nilotanypus fimbriatus*	4	
78650	*Procladius sp*		+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	31	
80370	*Corynoneura lobata*	24	
80410	*Cricotopus (C.) sp*	20	+
80420	*Cricotopus (C.) bicinctus*	26	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	20	
81240	*Nanocladius (N.) distinctus*	7	
81460	*Orthocladius (O.) sp*	7	
82101	*Thienemanniella n.sp 1*	7	
82121	*Thienemanniella n.sp 3*	58	
82141	*Thienemanniella xena*	4	
82820	*Cryptochironomus sp*		+
83000	*Dicrotendipes sp*		+
83840	*Microtendipes pedellus group*	7	
84210	*Paratendipes albimanus or P. duplicatus*	13	
84450	*Polypedilum (P.) convictum*	7	+
84460	*Polypedilum (P.) fallax group*	46	
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*	7	
84790	*Tribelos fuscicorne*	26	
85500	*Paratanytarsus sp*	52	
85501	*Paratanytarsus n.sp 1*	7	
85625	*Rheotanytarsus exiguus group*	20	+
85720	*Stempellinella n.sp nr. flavidula*	7	
85800	*Tanytarsus sp*	26	
85802	*Tanytarsus curticornis group*	7	
85814	*Tanytarsus glabrescens group*	131	
85840	*Tanytarsus guerlus group*	7	+
86100	*Chrysops sp*		+
87400	*Stratiomys sp*		+
87540	*Hemerodromia sp*	4	
93900	*Elimia sp*	8	+

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/18/95 River Code: 02-109 River: Mill Creek RM: 36.00

Taxa Code	Taxa	Quan/Qual
96900	*Ferrissia sp*	10
98600	*Sphaerium sp*	+
99860	*Lampsilis radiata luteola*	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa:	48	Total Taxa:	82
No. Qualitative Taxa:	52	ICI:	**40**
Number of Organisms:	1027	Qual EPT:	**17**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/18/95 River Code: 02-109 River: Mill Creek RM: 28.20

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	3	
01801	*Turbellaria*	3	
03600	*Oligochaeta*		+
06201	*Hyalella azteca*	1	+
07840	*Cambarus (Cambarus) sciotensis*		+
08250	*Orconectes (Procericambarus) rusticus*	1	+
11020	*Acerpenna pygmaeus*	42	+
11130	*Baetis intercalaris*	1	+
11650	*Procloeon sp (w/ hindwing pads)*		+
11651	*Procloeon sp (w/o hindwing pads)*		+
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	50	+
13400	*Stenacron sp*	300	+
13521	*Stenonema femoratum*	7	+
13561	*Stenonema pulchellum*	7	
14950	*Leptophlebia sp or Paraleptophebia sp*	5	
17200	*Caenis sp*		+
18750	*Hexagenia limbata*		+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	8	+
23909	*Boyeria vinosa*	1	+
24900	*Gomphus sp*		+
43300	*Ranatra sp*		+
45300	*Sigara sp*		+
45900	*Notonecta sp*		+
47600	*Sialis sp*		+
50315	*Chimarra obscura*		+
51600	*Polycentropus sp*	2	
52200	*Cheumatopsyche sp*	19	+
52530	*Hydropsyche depravata group*		+
57400	*Neophylax sp*		+
59970	*Petrophila sp*		+
60400	*Gyrinus sp*		+
64050	*Liodessus sp*		+
66500	*Enochrus sp*		+
67000	*Helophorus sp*		+
67700	*Paracymus sp*		+
68075	*Psephenus herricki*		+
68708	*Dubiraphia vittata group*		+
68901	*Macronychus glabratus*	1	
69400	*Stenelmis sp*		+
72700	*Anopheles sp*		+
77120	*Ablabesmyia mallochi*	5	+
77500	*Conchapelopia sp*		+
77800	*Helopelopia sp*	13	+
78140	*Labrundinia pilosella*	12	
80370	*Corynoneura lobata*	109	
82121	*Thienemanniella n.sp 3*	11	
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	5	
83840	*Microtendipes pedellus group*	30	+
84210	*Paratendipes albimanus or P. duplicatus*	5	
84450	*Polypedilum (P.) convictum*	2	+
84460	*Polypedilum (P.) fallax group*	18	
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*	3	
85500	*Paratanytarsus sp*	5	
85625	*Rheotanytarsus exiguus group*	12	+
86100	*Chrysops sp*		+
86200	*Tabanus sp*		+
87400	*Stratiomys sp*		+
87540	*Hemerodromia sp*	3	
93200	*Hydrobiidae*		+
93900	*Elimia sp*	14	+
96900	*Ferrissia sp*	2	+
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	32	Total Taxa:	67
No. Qualitative Taxa:	52	ICI:	**42**
Number of Organisms:	700	Qual EPT:	**14**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/18/95 River Code: 02-109 River: Mill Creek RM: 24.80

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	37	
01801	*Turbellaria*	20	
02600	*Nematomorpha*		+
03360	*Plumatella sp*		+
03600	*Oligochaeta*	1	+
04686	*Placobdella papillifera*		+
06201	*Hyalella azteca*		+
08250	*Orconectes (Procericambarus) rusticus*		+
11020	*Acerpenna pygmaeus*	28	
11120	*Baetis flavistriga*		+
11130	*Baetis intercalaris*	19	+
11651	*Procloeon sp (w/o hindwing pads)*	22	+
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	22	+
13400	*Stenacron sp*	334	+
13521	*Stenonema femoratum*	22	+
14950	*Leptophlebia sp or Paraleptophebia sp*	5	
17200	*Caenis sp*	14	+
21200	*Calopteryx sp*	1	+
22001	*Coenagrionidae*	5	+
22300	*Argia sp*	2	+
47600	*Sialis sp*		+
50315	*Chimarra obscura*		+
52200	*Cheumatopsyche sp*	7	+
53800	*Hydroptila sp*	1	
57400	*Neophylax sp*		+
58505	*Helicopsyche borealis*		+
59400	*Nectopsyche sp*	1	
59970	*Petrophila sp*	1	+
65800	*Berosus sp*		+
67000	*Helophorus sp*		+
67800	*Tropisternus sp*		+
68075	*Psephenus herricki*		+
68201	*Scirtidae*		+
68708	*Dubiraphia vittata group*		+
69400	*Stenelmis sp*		+
71100	*Hexatoma sp*		+
74100	*Simulium sp*		+
74501	*Ceratopogonidae*		+
77120	*Ablabesmyia mallochi*	96	+
77500	*Conchapelopia sp*		+
77800	*Helopelopia sp*	35	
78140	*Labrundinia pilosella*	19	
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	9	
80370	*Corynoneura lobata*	132	
80410	*Cricotopus (C.) sp*	130	+
80420	*Cricotopus (C.) bicinctus*	35	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	8	+
81650	*Parametriocnemus sp*		+
82101	*Thienemanniella n.sp 1*	14	+
82121	*Thienemanniella n.sp 3*	59	+
82141	*Thienemanniella xena*	4	
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	70	+
83840	*Microtendipes pedellus group*	122	+
84210	*Paratendipes albimanus or P. duplicatus*	8	
84450	*Polypedilum (P.) convictum*	8	
84460	*Polypedilum (P.) fallax group*	8	
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*		+
85500	*Paratanytarsus sp*	44	+
85625	*Rheotanytarsus exiguus group*	70	+
85720	*Stempellinella n.sp nr. flavidula*	8	+
85800	*Tanytarsus sp*	35	+
85802	*Tanytarsus curticornis group*		+
85814	*Tanytarsus glabrescens group*	87	+
85840	*Tanytarsus guerlus group*	8	+
87540	*Hemerodromia sp*	44	+
93900	*Elimia sp*		+
96900	*Ferrissia sp*	3	+
98600	*Sphaerium sp*		+
99540	*Elliptio dilatata*		+

No. Quantitative Taxa:	42	Total Taxa:	72
No. Qualitative Taxa:	58	ICI:	**40**
Number of Organisms:	1598	Qual EPT:	**12**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/19/95 River Code: 02-109 River: Mill Creek RM: 19.30

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	3	+
03600	*Oligochaeta*		+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*		+
08250	*Orconectes (Procericambarus) rusticus*	1	+
11020	*Acerpenna pygmaeus*	4	+
11130	*Baetis intercalaris*		+
11651	*Procloeon sp (w/o hindwing pads)*		+
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	46	+
13400	*Stenacron sp*	1452	+
13521	*Stenonema femoratum*	173	+
13561	*Stenonema pulchellum*	38	
17200	*Caenis sp*	15	+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*	1	+
22300	*Argia sp*	5	+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*	1	+
52530	*Hydropsyche depravata group*		+
68708	*Dubiraphia vittata group*		+
68901	*Macronychus glabratus*	1	+
69400	*Stenelmis sp*	3	+
71100	*Hexatoma sp*		+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	33	+
77130	*Ablabesmyia rhamphe group*	27	
77500	*Conchapelopia sp*		+
77800	*Helopelopia sp*	10	
78140	*Labrundinia pilosella*	3	
80370	*Corynoneura lobata*	53	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	73	
81240	*Nanocladius (N.) distinctus*	3	
81270	*Nanocladius (N.) spiniplenus*	3	
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	7	+
83051	*Dicrotendipes simpsoni*	3	
83300	*Glyptotendipes (G.) sp*	50	
83840	*Microtendipes pedellus group*	7	+
84210	*Paratendipes albimanus or P. duplicatus*	10	+
84450	*Polypedilum (P.) convictum*		+
84460	*Polypedilum (P.) fallax group*	20	
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*		+
84790	*Tribelos fuscicorne*	3	
84800	*Tribelos jucundum*	20	
85500	*Paratanytarsus sp*	7	
85720	*Stempellinella n.sp nr. flavidula*		+
85814	*Tanytarsus glabrescens group*	3	
85840	*Tanytarsus guerlus group*	3	+
86100	*Chrysops sp*		+
96900	*Ferrissia sp*	4	

No. Quantitative Taxa:	33	Total Taxa:	52
No. Qualitative Taxa:	36	ICI:	**40**
Number of Organisms:	2085	Qual EPT:	**10**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/19/95 River Code: 02-109 River: Mill Creek RM: 19.00

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	1	+
03360	*Plumatella sp*		+
03600	*Oligochaeta*	5	+
08250	*Orconectes (Procericambarus) rusticus*		+
11020	*Acerpenna pygmaeus*		+
11120	*Baetis flavistriga*		+
11130	*Baetis intercalaris*		+
11245	*Centroptilum sp*	1	
11651	*Procloeon sp (w/o hindwing pads)*	10	+
11670	*Procloeon irrubrum*		+
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	8	+
13400	*Stenacron sp*	1097	+
13521	*Stenonema femoratum*	56	+
14950	*Leptophlebia sp or Paraleptophebia sp*	1	+
17200	*Caenis sp*	1	+
22001	*Coenagrionidae*		+
22300	*Argia sp*	1	+
47600	*Sialis sp*		+
50315	*Chimarra obscura*		+
52200	*Cheumatopsyche sp*	2	+
52530	*Hydropsyche depravata group*		+
65501	*Hydrophilidae*		+
67000	*Helophorus sp*		+
67700	*Paracymus sp*		+
68075	*Psephenus herricki*		+
68708	*Dubiraphia vittata group*		+
69400	*Stenelmis sp*		+
71300	*Limonia sp*		+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	63	
77500	*Conchapelopia sp*	2	
77750	*Hayesomyia senata or Thienemannimyia norena*	6	+
77800	*Helopelopia sp*	4	
78101	*Labrundinia becki*	2	
78140	*Labrundinia pilosella*	4	
78450	*Nilotanypus fimbriatus*	2	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*		+
80370	*Corynoneura lobata*	78	
80410	*Cricotopus (C.) sp*	2	+
81201	*Nanocladius (N.) sp*		+
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	9	
83051	*Dicrotendipes simpsoni*	2	
83300	*Glyptotendipes (G.) sp*	13	
83840	*Microtendipes pedellus group*	9	
84300	*Phaenopsectra obediens group*	2	
84450	*Polypedilum (P.) convictum*		+
84460	*Polypedilum (P.) fallax group*	24	
84470	*Polypedilum (P.) illinoense*		+
84490	*Polypedilum (P.) ontario*		+
84750	*Stictochironomus sp*		+
85500	*Paratanytarsus sp*	4	
85625	*Rheotanytarsus exiguus group*	2	
85720	*Stempellinella n.sp nr. flavidula*		+
85814	*Tanytarsus glabrescens group*	24	
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	29	Total Taxa:	57
No. Qualitative Taxa:	41	ICI:	**42**
Number of Organisms:	1435	Qual EPT:	**14**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/19/95 River Code: 02-109 River: Mill Creek RM: 18.60

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	2	
01801	*Turbellaria*	14	+
03360	*Plumatella sp*		+
03600	*Oligochaeta*	4	+
06201	*Hyalella azteca*	2	+
06700	*Crangonyx sp*	1	+
08250	*Orconectes (Procericambarus) rusticus*	3	+
11020	*Acerpenna pygmaeus*	10	+
11130	*Baetis intercalaris*		+
11650	*Procloeon sp (w/ hindwing pads)*		+
11651	*Procloeon sp (w/o hindwing pads)*	1	+
11670	*Procloeon irrubrum*		+
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	18	+
13400	*Stenacron sp*	866	+
13521	*Stenonema femoratum*	114	
14950	*Leptophlebia sp or Paraleptophebia sp*	1	
17200	*Caenis sp*	9	+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	3	+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*		+
52530	*Hydropsyche depravata group*		+
68075	*Psephenus herricki*		+
68708	*Dubiraphia vittata group*	4	+
69400	*Stenelmis sp*	5	+
74100	*Simulium sp*		+
77115	*Ablabesmyia janta*	2	
77120	*Ablabesmyia mallochi*	34	+
77500	*Conchapelopia sp*	2	
77740	*Hayesomyia senata*	14	+
78140	*Labrundinia pilosella*	6	
78450	*Nilotanypus fimbriatus*	2	
79400	*Zavrelimyia sp*		+
80370	*Corynoneura lobata*	34	+
80410	*Cricotopus (C.) sp*	2	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	12	+
82141	*Thienemanniella xena*		+
82730	*Chironomus (C.) decorus group*	8	
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	12	
83300	*Glyptotendipes (G.) sp*	3	
83840	*Microtendipes pedellus group*	3	
84210	*Paratendipes albimanus or P. duplicatus*	5	+
84315	*Phaenopsectra flavipes*		+
84450	*Polypedilum (P.) convictum*		+
84460	*Polypedilum (P.) fallax group*	15	
84470	*Polypedilum (P.) illinoense*		+
84790	*Tribelos fuscicorne*	2	
84800	*Tribelos jucundum*	6	
85500	*Paratanytarsus sp*	5	+
85625	*Rheotanytarsus exiguus group*	3	+
85720	*Stempellinella n.sp nr. flavidula*	2	
85800	*Tanytarsus sp*		+
85814	*Tanytarsus glabrescens group*	9	
85840	*Tanytarsus guerlus group*	11	
96900	*Ferrissia sp*	11	

No. Quantitative Taxa:	39	Total Taxa:	58
No. Qualitative Taxa:	40	ICI:	**40**
Number of Organisms:	1260	Qual EPT:	**11**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/19/95 River Code: 02-109 River: Mill Creek RM: 18.20

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	81	
01801	*Turbellaria*	67	+
03600	*Oligochaeta*	1777	+
06700	*Crangonyx sp*	10	+
08250	*Orconectes (Procericambarus) rusticus*		+
11130	*Baetis intercalaris*		+
11200	*Callibaetis sp*	1	
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	1	
13400	*Stenacron sp*	80	+
13521	*Stenonema femoratum*	3	
22300	*Argia sp*	7	+
52200	*Cheumatopsyche sp*	3	+
52530	*Hydropsyche depravata group*		+
64800	*Uvarus sp*	1	
69400	*Stenelmis sp*	5	+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*		+
77500	*Conchapelopia sp*	50	+
77750	*Hayesomyia senata or Thienemannimyia norena*	298	+
78702	*Psectrotanypus dyari*		+
80410	*Cricotopus (C.) sp*		+
80420	*Cricotopus (C.) bicinctus*		+
80430	*Cricotopus (C.) tremulus group*		+
80500	*Cricotopus (Isocladius) reversus group*		+
82141	*Thienemanniella xena*		+
82711	*Chironomus (C.) sp 1*		+
82770	*Chironomus (C.) riparius group*	4427	+
83040	*Dicrotendipes neomodestus*	50	
83300	*Glyptotendipes (G.) sp*	50	
84450	*Polypedilum (P.) convictum*		+
84460	*Polypedilum (P.) fallax group*	99	
84470	*Polypedilum (P.) illinoense*		+
85500	*Paratanytarsus sp*	50	
87540	*Hemerodromia sp*		+
95100	*Physella sp*	63	+
96900	*Ferrissia sp*	84	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa:	21	Total Taxa:	37
No. Qualitative Taxa:	28	ICI:	**16**
Number of Organisms:	7207	Qual EPT:	**5**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/19/95 River Code: 02-109 River: Mill Creek RM: 18.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	2	+
03600	*Oligochaeta*	875	+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*		+
08250	*Orconectes (Procericambarus) rusticus*		+
11200	*Callibaetis sp*		+
13000	*Leucrocuta sp*		+
13400	*Stenacron sp*	259	+
13521	*Stenonema femoratum*	8	+
17200	*Caenis sp*	19	+
21200	*Calopteryx sp*	1	+
22001	*Coenagrionidae*		+
22300	*Argia sp*	23	+
23909	*Boyeria vinosa*		+
23950	*Epiaeschna heros*		+
26700	*Macromia sp*		+
43300	*Ranatra sp*		+
45900	*Notonecta sp*		+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*	41	+
65800	*Berosus sp*		+
67000	*Helophorus sp*		+
68075	*Psephenus herricki*		+
68201	*Scirtidae*		+
68700	*Dubiraphia sp*		+
69400	*Stenelmis sp*	9	+
72900	*Culex sp*		+
77115	*Ablabesmyia janta*	50	
77120	*Ablabesmyia mallochi*	38	+
77500	*Conchapelopia sp*	31	
77740	*Hayesomyia senata*	369	
78401	*Natarsia species A (sensu Roback, 1978)*		+
80410	*Cricotopus (C.) sp*	13	
80420	*Cricotopus (C.) bicinctus*	25	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	13	
81240	*Nanocladius (N.) distinctus*	50	
82141	*Thienemanniella xena*	13	
82711	*Chironomus (C.) sp 1*		+
82730	*Chironomus (C.) decorus group*	63	+
83040	*Dicrotendipes neomodestus*	138	+
83300	*Glyptotendipes (G.) sp*	350	+
84020	*Parachironomus carinatus*	38	
84460	*Polypedilum (P.) fallax group*	38	
84470	*Polypedilum (P.) illinoense*	88	+
84540	*Polypedilum (Tripodura) scalaenum group*	63	
85500	*Paratanytarsus sp*		+
96900	*Ferrissia sp*	87	+

No. Quantitative Taxa: 26 Total Taxa: 47

No. Qualitative Taxa: 36 ICI: **18**

Number of Organisms: 2704 Qual EPT: **6**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/19/95 River Code: 02-109 River: Mill Creek RM: 16.90

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	18	
03600	*Oligochaeta*	28	+
05800	*Caecidotea sp*		+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*	2	+
08250	*Orconectes (Procericambarus) rusticus*		+
11130	*Baetis intercalaris*		+
11670	*Procloeon irrubrum*		+
13000	*Leucrocuta sp*		+
13400	*Stenacron sp*	122	+
13521	*Stenonema femoratum*	10	+
14950	*Leptophlebia sp or Paraleptophebia sp*	2	
17200	*Caenis sp*	13	+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	18	+
23909	*Boyeria vinosa*		+
52200	*Cheumatopsyche sp*		+
68708	*Dubiraphia vittata group*		+
69400	*Stenelmis sp*	1	+
74100	*Simulium sp*		+
77115	*Ablabesmyia janta*	26	
77120	*Ablabesmyia mallochi*	4	+
77750	*Hayesomyia senata or Thienemannimyia norena*	37	+
78140	*Labrundinia pilosella*		+
78450	*Nilotanypus fimbriatus*		+
78650	*Procladius sp*		+
80370	*Corynoneura lobata*	16	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	4	
82820	*Cryptochironomus sp*		+
82880	*Cryptotendipes sp*		+
83040	*Dicrotendipes neomodestus*	11	
83051	*Dicrotendipes simpsoni*	34	
83300	*Glyptotendipes (G.) sp*	116	+
84020	*Parachironomus carinatus*	26	
84210	*Paratendipes albimanus or P. duplicatus*	4	
84450	*Polypedilum (P.) convictum*		+
84460	*Polypedilum (P.) fallax group*	30	
84470	*Polypedilum (P.) illinoense*	4	+
84540	*Polypedilum (Tripodura) scalaenum group*		+
84800	*Tribelos jucundum*	4	
85500	*Paratanytarsus sp*	94	
85815	*Tanytarsus glabrescens group Type 1*	7	
85840	*Tanytarsus guerlus group*	4	
96900	*Ferrissia sp*	19	+
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	26	Total Taxa:	46
No. Qualitative Taxa:	32	ICI:	**20**
Number of Organisms:	654	Qual EPT:	**7**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/20/95 River Code: 02-109 River: Mill Creek RM: 14.60

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	2	+
03360	*Plumatella sp*		+
03600	*Oligochaeta*		+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*		+
08250	*Orconectes (Procericambarus) rusticus*		+
11020	*Acerpenna pygmaeus*	163	+
11120	*Baetis flavistriga*	1	
11130	*Baetis intercalaris*	21	+
11200	*Callibaetis sp*		+
11670	*Procloeon irrubrum*		+
12200	*Isonychia sp*	2	+
13000	*Leucrocuta sp*	180	+
13400	*Stenacron sp*	471	+
13521	*Stenonema femoratum*	15	+
14950	*Leptophlebia sp or Paraleptophebia sp*	4	
17200	*Caenis sp*	9	+
21200	*Calopteryx sp*	1	
22001	*Coenagrionidae*		+
22300	*Argia sp*	19	+
23909	*Boyeria vinosa*		+
28500	*Libellula sp*		+
30000	*Plecoptera*	2	
42700	*Belostoma sp*		+
45300	*Sigara sp*		+
45900	*Notonecta sp*		+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*	82	+
52530	*Hydropsyche depravata group*		+
60900	*Peltodytes sp*		+
64050	*Liodessus sp*		+
66500	*Enochrus sp*		+
67000	*Helophorus sp*		+
67700	*Paracymus sp*		+
67800	*Tropisternus sp*		+
68075	*Psephenus herricki*		+
68708	*Dubiraphia vittata group*	1	+
68901	*Macronychus glabratus*		+
69400	*Stenelmis sp*	8	+
74100	*Simulium sp*	2	+
77120	*Ablabesmyia mallochi*	33	+
77740	*Hayesomyia senata*	103	+
77800	*Helopelopia sp*		+
78140	*Labrundinia pilosella*	2	
78450	*Nilotanypus fimbriatus*	4	
80370	*Corynoneura lobata*	152	
80420	*Cricotopus (C.) bicinctus*	9	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	19	+
82141	*Thienemanniella xena*	4	
82820	*Cryptochironomus sp*		+
82880	*Cryptotendipes sp*	5	
83840	*Microtendipes pedellus group*	9	
84210	*Paratendipes albimanus or P. duplicatus*	9	
84315	*Phaenopsectra flavipes*	5	
84450	*Polypedilum (P.) convictum*	5	+
84460	*Polypedilum (P.) fallax group*	52	+
84470	*Polypedilum (P.) illinoense*	5	+
84800	*Tribelos jucundum*	5	
85500	*Paratanytarsus sp*	5	
85625	*Rheotanytarsus exiguus group*	99	+
85814	*Tanytarsus glabrescens group*	33	+
87540	*Hemerodromia sp*	7	+
96900	*Ferrissia sp*	21	

No. Quantitative Taxa:	38	Total Taxa:	63
No. Qualitative Taxa:	47	ICI:	**44**
Number of Organisms:	1569	Qual EPT:	**11**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/20/95 River Code: 02-109 River: Mill Creek RM: 12.10

Taxa Code	Taxa	Quan/Qual	
03600	*Oligochaeta*	2	+
05800	*Caecidotea sp*		+
06700	*Crangonyx sp*	1	+
08250	*Orconectes (Procericambarus) rusticus*		+
11020	*Acerpenna pygmaeus*	134	
11130	*Baetis intercalaris*	35	+
11200	*Callibaetis sp*		+
11650	*Procloeon sp (w/ hindwing pads)*		+
11670	*Procloeon irrubrum*		+
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	123	+
13400	*Stenacron sp*	191	+
13521	*Stenonema femoratum*		+
13570	*Stenonema terminatum*		+
17200	*Caenis sp*	20	+
18750	*Hexagenia limbata*		+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	12	+
45100	*Palmacorixa sp*		+
45300	*Sigara sp*		+
47600	*Sialis sp*		+
48210	*Chauliodes pectinicornis*		+
52200	*Cheumatopsyche sp*	137	+
52530	*Hydropsyche depravata group*	1	
60800	*Haliplus sp*		+
64800	*Uvarus sp*		+
67000	*Helophorus sp*		+
67800	*Tropisternus sp*		+
68075	*Psephenus herricki*		+
68708	*Dubiraphia vittata group*		+
68901	*Macronychus glabratus*	3	+
69400	*Stenelmis sp*	2	+
74100	*Simulium sp*	7	+
77120	*Ablabesmyia mallochi*	9	+
77500	*Conchapelopia sp*	9	+
77750	*Hayesomyia senata or Thienemannimyia norena*	84	
78450	*Nilotanypus fimbriatus*	8	
78650	*Procladius sp*		+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	2	
80370	*Corynoneura lobata*	116	
81825	*Rheocricotopus (Psilocricotopus) robacki*	9	+
82141	*Thienemanniella xena*	22	
82820	*Cryptochironomus sp*		+
83840	*Microtendipes pedellus group*	9	
84450	*Polypedilum (P.) convictum*	9	+
84460	*Polypedilum (P.) fallax group*	9	
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*		+
85500	*Paratanytarsus sp*	18	
85625	*Rheotanytarsus exiguus group*	111	+
85800	*Tanytarsus sp*	4	
85814	*Tanytarsus glabrescens group*	31	
87540	*Hemerodromia sp*	14	+
96900	*Ferrissia sp*	10	+
98200	*Pisidium sp*		+
99100	*Pyganodon grandis*		+

No. Quantitative Taxa:	30	Total Taxa:	57
No. Qualitative Taxa:	45	ICI:	**42**
Number of Organisms:	1142	Qual EPT:	**12**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/20/95 River Code: 02-109 River: Mill Creek RM: 11.70

Taxa Code	Taxa	Quan/Qual	
00401	*Spongillidae*		+
01320	*Hydra sp*	1	
03600	*Oligochaeta*	5	+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*		+
08250	*Orconectes (Procericambarus) rusticus*		+
11020	*Acerpenna pygmaeus*	3	+
11120	*Baetis flavistriga*		+
11130	*Baetis intercalaris*	11	+
11651	*Procloeon sp (w/o hindwing pads)*		+
12200	*Isonychia sp*	1	+
13000	*Leucrocuta sp*	65	+
13400	*Stenacron sp*	539	+
13521	*Stenonema femoratum*	9	
17200	*Caenis sp*	25	+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*	1	+
22300	*Argia sp*	17	+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*	83	+
52430	*Ceratopsyche morosa group*		+
63900	*Laccophilus sp*		+
67000	*Helophorus sp*		+
68130	*Helichus sp*		+
68708	*Dubiraphia vittata group*		+
68901	*Macronychus glabratus*	2	
69400	*Stenelmis sp*		+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	20	+
77500	*Conchapelopia sp*	8	
77750	*Hayesomyia senata or Thienemannimyia norena*	92	+
78140	*Labrundinia pilosella*	4	
78650	*Procladius sp*		+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	8	
80370	*Corynoneura lobata*	106	
80410	*Cricotopus (C.) sp*	4	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	48	
81825	*Rheocricotopus (Psilocricotopus) robacki*	8	
82141	*Thienemanniella xena*	16	
82710	*Chironomus (C.) sp*	4	
82820	*Cryptochironomus sp*		+
82880	*Cryptotendipes sp*	4	
83300	*Glyptotendipes (G.) sp*	4	
83840	*Microtendipes pedellus group*	4	
84450	*Polypedilum (P.) convictum*		+
84460	*Polypedilum (P.) fallax group*	32	
84470	*Polypedilum (P.) illinoense*	4	+
84540	*Polypedilum (Tripodura) scalaenum group*	16	+
84750	*Stictochironomus sp*		+
85500	*Paratanytarsus sp*	32	
85625	*Rheotanytarsus exiguus group*	64	+
85800	*Tanytarsus sp*	8	
85814	*Tanytarsus glabrescens group*	40	
96900	*Ferrissia sp*	20	+
98600	*Sphaerium sp*		+
99100	*Pyganodon grandis*		+
99420	*Amblema plicata plicata*		+
99860	*Lampsilis radiata luteola*		+

No. Quantitative Taxa:	35	Total Taxa:	58
No. Qualitative Taxa:	40	ICI:	**40**
Number of Organisms:	1308	Qual EPT:	**10**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/20/95 River Code: 02-109 River: Mill Creek RM: 6.90

Taxa Code	Taxa	Quan/Qual
00401	*Spongillidae*	+
01200	*Cordylophora lacustris*	+
01801	*Turbellaria*	+
03360	*Plumatella sp*	+
03600	*Oligochaeta*	+
04935	*Erpobdella punctata punctata*	+
05800	*Caecidotea sp*	+
06201	*Hyalella azteca*	+
06700	*Crangonyx sp*	+
08250	*Orconectes (Procericambarus) rusticus*	+
11120	*Baetis flavistriga*	+
11130	*Baetis intercalaris*	+
11200	*Callibaetis sp*	+
11651	*Procloeon sp (w/o hindwing pads)*	+
11670	*Procloeon irrubrum*	+
12200	*Isonychia sp*	+
13000	*Leucrocuta sp*	+
13400	*Stenacron sp*	+
13521	*Stenonema femoratum*	+
17200	*Caenis sp*	+
18750	*Hexagenia limbata*	+
21300	*Hetaerina sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
23950	*Epiaeschna heros*	+
45100	*Palmacorixa sp*	+
45300	*Sigara sp*	+
45400	*Trichocorixa sp*	+
47600	*Sialis sp*	+
51600	*Polycentropus sp*	+
52200	*Cheumatopsyche sp*	+
52430	*Ceratopsyche morosa group*	+
53800	*Hydroptila sp*	+
59970	*Petrophila sp*	+
65800	*Berosus sp*	+
67000	*Helophorus sp*	+
67700	*Paracymus sp*	+
68075	*Psephenus herricki*	+
68708	*Dubiraphia vittata group*	+
68901	*Macronychus glabratus*	+
69400	*Stenelmis sp*	+
74501	*Ceratopogonidae*	+
77120	*Ablabesmyia mallochi*	+
77500	*Conchapelopia sp*	+
78140	*Labrundinia pilosella*	+
78650	*Procladius sp*	+
79020	*Tanypus neopunctipennis*	+
80410	*Cricotopus (C.) sp*	+
82121	*Thienemanniella n.sp 3*	+
82730	*Chironomus (C.) decorus group*	+
82820	*Cryptochironomus sp*	+
83040	*Dicrotendipes neomodestus*	+
84450	*Polypedilum (P.) convictum*	+
84470	*Polypedilum (P.) illinoense*	+
84540	*Polypedilum (Tripodura) scalaenum group*	+
84750	*Stictochironomus sp*	+
85230	*Cladotanytarsus mancus group*	+
85625	*Rheotanytarsus exiguus group*	+
85800	*Tanytarsus sp*	+
85840	*Tanytarsus guerlus group*	+
86100	*Chrysops sp*	+
87400	*Stratiomys sp*	+
93200	*Hydrobiidae*	+
93900	*Elimia sp*	+
96900	*Ferrissia sp*	+
98600	*Sphaerium sp*	+

No. Quantitative Taxa:	0	Total Taxa:	66
No. Qualitative Taxa:	66	ICI:	
Number of Organisms:	0	Qual EPT:	**15**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-109 River: Mill Creek RM: 4.40

Taxa Code	Taxa	Quan/Qual	
00401	*Spongillidae*		+
01320	*Hydra sp*	144	
01801	*Turbellaria*	36	+
03360	*Plumatella sp*		+
03600	*Oligochaeta*		+
04964	*Mooreobdella microstoma*		+
05800	*Caecidotea sp*		+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*	4	+
08250	*Orconectes (Procericambarus) rusticus*		+
11120	*Baetis flavistriga*		+
11130	*Baetis intercalaris*		+
11651	*Procloeon sp (w/o hindwing pads)*	4	+
12200	*Isonychia sp*	1	+
13000	*Leucrocuta sp*	165	+
13400	*Stenacron sp*	742	+
13521	*Stenonema femoratum*	11	+
17200	*Caenis sp*	71	+
18750	*Hexagenia limbata*		+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*	3	+
22300	*Argia sp*		+
23600	*Aeshna sp*		+
47600	*Sialis sp*		+
50315	*Chimarra obscura*		+
52200	*Cheumatopsyche sp*	3	+
52430	*Ceratopsyche morosa group*		+
52530	*Hydropsyche depravata group*		+
59310	*Mystacides sepulchralis*	1	
59500	*Oecetis sp*	4	
59970	*Petrophila sp*		+
63300	*Hydroporus sp*		+
64050	*Liodessus sp*		+
67000	*Helophorus sp*		+
67700	*Paracymus sp*		+
68025	*Ectopria sp*		+
68075	*Psephenus herricki*		+
68708	*Dubiraphia vittata group*	5	+
68901	*Macronychus glabratus*	2	+
69400	*Stenelmis sp*	5	+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	34	+
77500	*Conchapelopia sp*	25	+
77750	*Hayesomyia senata or Thienemannimyia norena*	84	+
78140	*Labrundinia pilosella*	8	
78450	*Nilotanypus fimbriatus*	8	
80351	*Corynoneura n.sp 1*		+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	32	
80370	*Corynoneura lobata*	72	
80410	*Cricotopus (C.) sp*	59	
80420	*Cricotopus (C.) bicinctus*	17	
80430	*Cricotopus (C.) tremulus group*	8	
81229	*Nanocladius (N.) crassicornus*	168	
82141	*Thienemanniella xena*		+
83040	*Dicrotendipes neomodestus*	8	
83300	*Glyptotendipes (G.) sp*	50	
83840	*Microtendipes pedellus group*	84	+
84210	*Paratendipes albimanus or P. duplicatus*	8	
84450	*Polypedilum (P.) convictum*	8	+
84460	*Polypedilum (P.) fallax group*	25	
84470	*Polypedilum (P.) illinoense*	50	+
84540	*Polypedilum (Tripodura) scalaenum group*	8	
84750	*Stictochironomus sp*		+
85500	*Paratanytarsus sp*	34	
85625	*Rheotanytarsus exiguus group*	126	+
85720	*Stempellinella n.sp nr. flavidula*	8	
85800	*Tanytarsus sp*	17	+
85814	*Tanytarsus glabrescens group*	34	
86100	*Chrysops sp*		+
98200	*Pisidium sp*		+
98600	*Sphaerium sp*		+
99860	*Lampsilis radiata luteola*		+

No. Quantitative Taxa:	40	Total Taxa:	72
No. Qualitative Taxa:	53	ICI:	**44**
Number of Organisms:	2176	Qual EPT:	**13**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-109 River: Mill Creek RM: 3.70

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	20	
01801	*Turbellaria*	2	+
03360	*Plumatella sp*		+
03600	*Oligochaeta*	8	+
05800	*Caecidotea sp*		+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*	10	+
08250	*Orconectes (Procericambarus) rusticus*		+
08601	*Hydracarina*	8	
11020	*Acerpenna pygmaeus*	1	
11120	*Baetis flavistriga*	1	
11130	*Baetis intercalaris*		+
11651	*Procloeon sp (w/o hindwing pads)*	2	
11670	*Procloeon irrubrum*		+
12200	*Isonychia sp*	14	+
13000	*Leucrocuta sp*	31	+
13400	*Stenacron sp*	1159	+
13521	*Stenonema femoratum*	17	+
13570	*Stenonema terminatum*	4	+
17200	*Caenis sp*	45	+
18750	*Hexagenia limbata*	1	+
21200	*Calopteryx sp*	2	
21300	*Hetaerina sp*	2	+
22001	*Coenagrionidae*		+
22300	*Argia sp*	17	+
23909	*Boyeria vinosa*		+
47600	*Sialis sp*		+
50315	*Chimarra obscura*		+
52200	*Cheumatopsyche sp*	54	+
52430	*Ceratopsyche morosa group*		+
52530	*Hydropsyche depravata group*		+
57400	*Neophylax sp*		+
59970	*Petrophila sp*		+
67000	*Helophorus sp*		+
68075	*Psephenus herricki*		+
68601	*Ancyronyx variegata*		+
68708	*Dubiraphia vittata group*	8	+
68901	*Macronychus glabratus*	3	+
69400	*Stenelmis sp*	17	+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	49	+
77500	*Conchapelopia sp*	98	
77750	*Hayesomyia senata or Thienemannimyia norena*	37	+
78140	*Labrundinia pilosella*	12	
78450	*Nilotanypus fimbriatus*	12	
78650	*Procladius sp*	12	
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	12	
80370	*Corynoneura lobata*	72	
80410	*Cricotopus (C.) sp*		+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	49	
82141	*Thienemanniella xena*	4	
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	49	
83300	*Glyptotendipes (G.) sp*	61	+
83840	*Microtendipes pedellus group*	37	+
84210	*Paratendipes albimanus or P. duplicatus*	37	+
84315	*Phaenopsectra flavipes*	12	
84450	*Polypedilum (P.) convictum*	37	+
84460	*Polypedilum (P.) fallax group*	73	
84470	*Polypedilum (P.) illinoense*		+
84540	*Polypedilum (Tripodura) scalaenum group*	12	+
84700	*Stenochironomus sp*	12	
84750	*Stictochironomus sp*	12	+
84790	*Tribelos fuscicorne*	12	
85500	*Paratanytarsus sp*	12	+
85625	*Rheotanytarsus exiguus group*	268	+
85720	*Stempellinella n.sp nr. flavidula*	12	+
85800	*Tanytarsus sp*	24	
85814	*Tanytarsus glabrescens group*	24	
93900	*Elimia sp*		+
96120	*Menetus (Micromenetus) dilatatus*	2	
96900	*Ferrissia sp*	6	
99100	*Pyganodon grandis*		+
99860	*Lampsilis radiata luteola*		+

No. Quantitative Taxa:	50	Total Taxa:	74
No. Qualitative Taxa:	51	ICI:	**44**
Number of Organisms:	2485	Qual EPT:	**14**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-109 River: Mill Creek RM: 1.60

Taxa Code	Taxa	Quan/Qual	
00653	*Eunapius fragilis*		+
01801	*Turbellaria*	6	+
03600	*Oligochaeta*	12	+
04935	*Erpobdella punctata punctata*		+
04964	*Mooreobdella microstoma*		+
06201	*Hyalella azteca*		+
06700	*Crangonyx sp*		+
08250	*Orconectes (Procericambarus) rusticus*		+
11020	*Acerpenna pygmaeus*	3	
11120	*Baetis flavistriga*	106	+
11130	*Baetis intercalaris*	141	+
11650	*Procloeon sp (w/ hindwing pads)*		+
11651	*Procloeon sp (w/o hindwing pads)*		+
11670	*Procloeon irrubrum*		+
12200	*Isonychia sp*	48	+
13000	*Leucrocuta sp*	142	+
13400	*Stenacron sp*	233	+
13521	*Stenonema femoratum*	3	+
13561	*Stenonema pulchellum*	11	+
13570	*Stenonema terminatum*	6	
17200	*Caenis sp*	1	+
18750	*Hexagenia limbata*		+
21300	*Hetaerina sp*	1	+
22001	*Coenagrionidae*		+
22300	*Argia sp*	11	+
23909	*Boyeria vinosa*		+
34700	*Agnetina capitata complex*	1	
47600	*Sialis sp*		+
50315	*Chimarra obscura*		+
52200	*Cheumatopsyche sp*	185	+
52430	*Ceratopsyche morosa group*	52	+
52590	*Hydropsyche venularis*	1	
57400	*Neophylax sp*		+
57900	*Pycnopsyche sp*		+
59970	*Petrophila sp*		+
60900	*Peltodytes sp*		+
66500	*Enochrus sp*		+
67000	*Helophorus sp*		+
67700	*Paracymus sp*		+
68700	*Dubiraphia sp*		+
69400	*Stenelmis sp*		+
72700	*Anopheles sp*		+
74100	*Simulium sp*		+
77800	*Helopelopia sp*	7	
78450	*Nilotanypus fimbriatus*	29	
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	24	
80370	*Corynoneura lobata*	28	
80410	*Cricotopus (C.) sp*	7	
80430	*Cricotopus (C.) tremulus group*	7	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	15	
81240	*Nanocladius (N.) distinctus*	7	
81825	*Rheocricotopus (Psilocricotopus) robacki*	7	
82141	*Thienemanniella xena*	52	
82820	*Cryptochironomus sp*		+
83840	*Microtendipes pedellus group*	7	+
84450	*Polypedilum (P.) convictum*	37	+
84460	*Polypedilum (P.) fallax group*		+
84470	*Polypedilum (P.) illinoense*		+
84750	*Stictochironomus sp*		+
85625	*Rheotanytarsus exiguus group*	433	
85720	*Stempellinella n.sp nr. flavidula*		+
87540	*Hemerodromia sp*	54	
93900	*Elimia sp*		+
96900	*Ferrissia sp*		+
97601	*Corbicula fluminea*	1	+
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	33	Total Taxa:	66
No. Qualitative Taxa:	50	ICI:	**50**
Number of Organisms:	1678	Qual EPT:	**17**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/22/95 River Code: 02-133 River: Crosses Run RM: 2.80

Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	+
04935	*Erpobdella punctata punctata*	+
04964	*Mooreobdella microstoma*	+
28955	*Libellula lydia*	+
45300	*Sigara sp*	+
60900	*Peltodytes sp*	+
61400	*Agabus sp*	+
62200	*Copelatus sp*	+
63300	*Hydroporus sp*	+
63900	*Laccophilus sp*	+
67000	*Helophorus sp*	+
67700	*Paracymus sp*	+
67800	*Tropisternus sp*	+
72900	*Culex sp*	+
78702	*Psectrotanypus dyari*	+
84470	*Polypedilum (P.) illinoense*	+
87400	*Stratiomys sp*	+
89001	*Sciomyzidae*	+
95100	*Physella sp*	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 0 Total Taxa: 19

No. Qualitative Taxa: 19 ICI:

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

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/22/95 River Code: 02-133 River: Crosses Run RM: 2.40

Taxa Code	Taxa	Quan/Qual	
03600	*Oligochaeta*		+
04664	*Helobdella stagnalis*	1	
04685	*Placobdella ornata*	2	
04935	*Erpobdella punctata punctata*		+
06201	*Hyalella azteca*	1	+
11200	*Callibaetis sp*	2	+
22001	*Coenagrionidae*	2	+
23704	*Anax junius*		+
23950	*Epiaeschna heros*		+
28955	*Libellula lydia*		+
42700	*Belostoma sp*		+
45300	*Sigara sp*		+
45900	*Notonecta sp*		+
60900	*Peltodytes sp*		+
63900	*Laccophilus sp*		+
64700	*Thermonectus sp*		+
64800	*Uvarus sp*		+
65800	*Berosus sp*	2	+
66500	*Enochrus sp*		+
67000	*Helophorus sp*		+
67700	*Paracymus sp*		+
67800	*Tropisternus sp*		+
72700	*Anopheles sp*		+
78401	*Natarsia species A (sensu Roback, 1978)*		+
82770	*Chironomus (C.) riparius group*	6	
83300	*Glyptotendipes (G.) sp*	12	
84470	*Polypedilum (P.) illinoense*	2	
85814	*Tanytarsus glabrescens group*	2	
94400	*Fossaria sp*		+
95100	*Physella sp*	33	+
95501	*Planorbidae*	2	

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 12 Total Taxa: 31
No. Qualitative Taxa: 24 ICI: **4**
Number of Organisms: 67 Qual EPT: **1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/22/95 River Code: 02-133 River: Crosses Run RM: 2.00

Taxa Code	Taxa	Quan/Qual	
06700	*Crangonyx sp*	1	
11200	*Callibaetis sp*		+
22001	*Coenagrionidae*	20	+
28810	*Pantala flavescens*		+
28955	*Libellula lydia*		+
45300	*Sigara sp*		+
45900	*Notonecta sp*		+
63300	*Hydroporus sp*		+
63900	*Laccophilus sp*		+
65800	*Berosus sp*	30	+
66500	*Enochrus sp*		+
67000	*Helophorus sp*		+
67800	*Tropisternus sp*		+
78401	*Natarsia species A (sensu Roback, 1978)*		+
78702	*Psectrotanypus dyari*	38	+
80510	*Cricotopus (Isocladius) sylvestris group*	576	+
82730	*Chironomus (C.) decorus group*	38	+
84470	*Polypedilum (P.) illinoense*	787	+
95100	*Physella sp*	39	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 8 Total Taxa: 19

No. Qualitative Taxa: 18 ICI: **0**

Number of Organisms: 1529 Qual EPT: **1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/22/95 River Code: 02-133 River: Crosses Run RM: 0.60

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	16	
03451	*Urnatella gracilis*	4	
03600	*Oligochaeta*	39	+
04664	*Helobdella stagnalis*	4	+
04685	*Placobdella ornata*		+
04935	*Erpobdella punctata punctata*		+
04964	*Mooreobdella microstoma*		+
05800	*Caecidotea sp*	9	+
06201	*Hyalella azteca*	22	+
06700	*Crangonyx sp*		+
08250	*Orconectes (Procericambarus) rusticus*		+
11200	*Callibaetis sp*		+
22001	*Coenagrionidae*	1	+
22300	*Argia sp*	1	+
28955	*Libellula lydia*		+
29000	*Sympetrum sp*	1	+
60900	*Peltodytes sp*		+
63300	*Hydroporus sp*		+
63900	*Laccophilus sp*		+
65800	*Berosus sp*		+
67800	*Tropisternus sp*		+
68700	*Dubiraphia sp*		+
69400	*Stenelmis sp*		+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	136	+
77500	*Conchapelopia sp*	22	+
78140	*Labrundinia pilosella*	7	
78650	*Procladius sp*	29	+
80420	*Cricotopus (C.) bicinctus*	7	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	172	
82141	*Thienemanniella xena*		+
83051	*Dicrotendipes simpsoni*	29	
83300	*Glyptotendipes (G.) sp*	201	
84470	*Polypedilum (P.) illinoense*	65	+
85500	*Paratanytarsus sp*	29	
86100	*Chrysops sp*		+
95100	*Physella sp*	132	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa:	20	Total Taxa:	37
No. Qualitative Taxa:	29	ICI:	**6**
Number of Organisms:	926	Qual EPT:	**1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/18/95 River Code: 02-135 River: Otter Creek RM: 0.70

Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	+
04664	*Helobdella stagnalis*	+
04964	*Mooreobdella microstoma*	+
06700	*Crangonyx sp*	+
08250	*Orconectes (Procericambarus) rusticus*	+
11120	*Baetis flavistriga*	+
11130	*Baetis intercalaris*	+
11150	*Labiobaetis propinquus*	+
12200	*Isonychia sp*	+
13000	*Leucrocuta sp*	+
13400	*Stenacron sp*	+
13521	*Stenonema femoratum*	+
13590	*Stenonema vicarium*	+
17200	*Caenis sp*	+
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
23909	*Boyeria vinosa*	+
24900	*Gomphus sp*	+
45300	*Sigara sp*	+
47600	*Sialis sp*	+
52200	*Cheumatopsyche sp*	+
52530	*Hydropsyche depravata group*	+
53800	*Hydroptila sp*	+
60900	*Peltodytes sp*	+
63300	*Hydroporus sp*	+
63900	*Laccophilus sp*	+
64800	*Uvarus sp*	+
66500	*Enochrus sp*	+
67000	*Helophorus sp*	+
67500	*Laccobius sp*	+
67700	*Paracymus sp*	+
68075	*Psephenus herricki*	+
68130	*Helichus sp*	+
68201	*Scirtidae*	+
68708	*Dubiraphia vittata group*	+
68901	*Macronychus glabratus*	+
69225	*Optioservus fastiditus*	+
69400	*Stenelmis sp*	+
71900	*Tipula sp*	+
72700	*Anopheles sp*	+
74100	*Simulium sp*	+
77120	*Ablabesmyia mallochi*	+
77800	*Helopelopia sp*	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	+
82730	*Chironomus (C.) decorus group*	+
82820	*Cryptochironomus sp*	+
83040	*Dicrotendipes neomodestus*	+
84210	*Paratendipes albimanus or P. duplicatus*	+
84440	*Polypedilum (P.) aviceps*	+
84450	*Polypedilum (P.) convictum*	+
84470	*Polypedilum (P.) illinoense*	+
84700	*Stenochironomus sp*	+
84750	*Stictochironomus sp*	+
85500	*Paratanytarsus sp*	+
85625	*Rheotanytarsus exiguus group*	+
86100	*Chrysops sp*	+
86200	*Tabanus sp*	+
87540	*Hemerodromia sp*	+
93900	*Elimia sp*	+
95100	*Physella sp*	+
96900	*Ferrissia sp*	+
98600	*Sphaerium sp*	+

No. Quantitative Taxa:	0	Total Taxa:	63
No. Qualitative Taxa:	63	ICI:	
Number of Organisms:	0	Qual EPT:	**12**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-239 River: Town Run RM: 0.80

Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	+
04664	*Helobdella stagnalis*	+
04666	*Helobdella triserialis*	+
04935	*Erpobdella punctata punctata*	+
05800	*Caecidotea sp*	+
06700	*Crangonyx sp*	+
11250	*Centroptilum sp (w/o hindwing pads)*	+
13400	*Stenacron sp*	+
13521	*Stenonema femoratum*	+
17200	*Caenis sp*	+
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
28955	*Libellula lydia*	+
52200	*Cheumatopsyche sp*	+
52530	*Hydropsyche depravata group*	+
69400	*Stenelmis sp*	+
71900	*Tipula sp*	+
77120	*Ablabesmyia mallochi*	+
77500	*Conchapelopia sp*	+
79400	*Zavrelimyia sp*	+
80420	*Cricotopus (C.) bicinctus*	+
84210	*Paratendipes albimanus or P. duplicatus*	+
84450	*Polypedilum (P.) convictum*	+
85500	*Paratanytarsus sp*	+
85625	*Rheotanytarsus exiguus group*	+
96264	*Planorbella (Pierosoma) pilsbryi*	+
96900	*Ferrissia sp*	+
98200	*Pisidium sp*	+

No. Quantitative Taxa:	0	Total Taxa:	29
No. Qualitative Taxa:	29	ICI:	
Number of Organisms:	0	Qual EPT:	**0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-239 River: Town Run RM: 0.70

Taxa Code	Taxa	Quan/Qual
03360	*Plumatella sp*	+
04664	*Helobdella stagnalis*	+
04935	*Erpobdella punctata punctata*	+
05800	*Caecidotea sp*	+
06700	*Crangonyx sp*	+
11130	*Baetis intercalaris*	+
11200	*Callibaetis sp*	+
13521	*Stenonema femoratum*	+
17200	*Caenis sp*	+
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
23909	*Boyeria vinosa*	+
28500	*Libellula sp*	+
45300	*Sigara sp*	+
52200	*Cheumatopsyche sp*	+
60900	*Peltodytes sp*	+
63900	*Laccophilus sp*	+
64800	*Uvarus sp*	+
65800	*Berosus sp*	+
67000	*Helophorus sp*	+
67500	*Laccobius sp*	+
68707	*Dubiraphia quadrinotata*	+
69400	*Stenelmis sp*	+
72700	*Anopheles sp*	+
77120	*Ablabesmyia mallochi*	+
77500	*Conchapelopia sp*	+
80370	*Corynoneura lobata*	+
80420	*Cricotopus (C.) bicinctus*	+
82820	*Cryptochironomus sp*	+
83040	*Dicrotendipes neomodestus*	+
84210	*Paratendipes albimanus or P. duplicatus*	+
84315	*Phaenopsectra flavipes*	+
84470	*Polypedilum (P.) illinoense*	+
85814	*Tanytarsus glabrescens group*	+
86100	*Chrysops sp*	+
95100	*Physella sp*	+
96264	*Planorbella (Pierosoma) pilsbryi*	+
98200	*Pisidium sp*	+

No. Quantitative Taxa:	0	Total Taxa:	39
No. Qualitative Taxa:	39	ICI:	
Number of Organisms:	0	Qual EPT:	**5**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-239 River: Town Run RM: 0.10

Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	+
04664	*Helobdella stagnalis*	+
04935	*Erpobdella punctata punctata*	+
06700	*Crangonyx sp*	+
08250	*Orconectes (Procericambarus) rusticus*	+
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
23909	*Boyeria vinosa*	+
60900	*Peltodytes sp*	+
69400	*Stenelmis sp*	+
77120	*Ablabesmyia mallochi*	+
77500	*Conchapelopia sp*	+
78650	*Procladius sp*	+
80420	*Cricotopus (C.) bicinctus*	+
82820	*Cryptochironomus sp*	+
84210	*Paratendipes albimanus or P. duplicatus*	+
84315	*Phaenopsectra flavipes*	+
84470	*Polypedilum (P.) illinoense*	+
85500	*Paratanytarsus sp*	+
95100	*Physella sp*	+
96264	*Planorbella (Pierosoma) pilsbryi*	+
98200	*Pisidium sp*	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 0 Total Taxa: 22

No. Qualitative Taxa: 22 ICI:

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

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-253 River: North Branch Crosses Run RM: 1.00

Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	+
04935	*Erpobdella punctata punctata*	+
11200	*Callibaetis sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
27500	*Somatochlora sp*	+
28511	*Libellula luctuosa*	+
28955	*Libellula lydia*	+
45300	*Sigara sp*	+
45900	*Notonecta sp*	+
60400	*Gyrinus sp*	+
60800	*Haliplus sp*	+
60900	*Peltodytes sp*	+
62200	*Copelatus sp*	+
63300	*Hydroporus sp*	+
63900	*Laccophilus sp*	+
66500	*Enochrus sp*	+
67100	*Hydrobius sp*	+
67700	*Paracymus sp*	+
67800	*Tropisternus sp*	+
72700	*Anopheles sp*	+
84900	*Zavreliella marmoata*	+
94400	*Fossaria sp*	+
95100	*Physella sp*	+
95907	*Gyraulus (Torquis) parvus*	+
96280	*Planorbella (Pierosoma) trivolvis*	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 0 Total Taxa: 26

No. Qualitative Taxa: 26 ICI:

Number of Organisms: 0 Qual EPT: **1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-253 River: North Branch Crosses Run RM: 0.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	44	
03600	*Oligochaeta*	36	
04664	*Helobdella stagnalis*		+
04666	*Helobdella triserialis*	102	
04964	*Mooreobdella microstoma*	1	
22001	*Coenagrionidae*	23	+
28810	*Pantala flavescens*	1	+
45300	*Sigara sp*		+
63900	*Laccophilus sp*		+
65800	*Berosus sp*	2	+
67000	*Helophorus sp*		+
67100	*Hydrobius sp*		+
72160	*Psychoda sp*	1	
77500	*Conchapelopia sp*		+
78650	*Procladius sp*		+
80510	*Cricotopus (Isocladius) sylvestris group*	432	+
84470	*Polypedilum (P.) illinoense*	464	+
94400	*Fossaria sp*	26	+
95100	*Physella sp*	52	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 12 Total Taxa: 19
No. Qualitative Taxa: 14 ICI: **0**
Number of Organisms: 1184 Qual EPT: **0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/22/95 River Code: 02-282 River: Trib. to Crosses Run (RM 2.24) RM: 0.10

Taxa Code	Taxa	Quan/Qual
11200	*Callibaetis sp*	+
28955	*Libellula lydia*	+
42700	*Belostoma sp*	+
45300	*Sigara sp*	+
63300	*Hydroporus sp*	+
63900	*Laccophilus sp*	+
64050	*Liodessus sp*	+
64700	*Thermonectus sp*	+
64800	*Uvarus sp*	+
66500	*Enochrus sp*	+
67000	*Helophorus sp*	+
67800	*Tropisternus sp*	+
78702	*Psectrotanypus dyari*	+
80510	*Cricotopus (Isocladius) sylvestris group*	+
82711	*Chironomus (C.) sp 1*	+
82730	*Chironomus (C.) decorus group*	+
82770	*Chironomus (C.) riparius group*	+
83330	*Glyptotendipes (G.) barbipes*	+
84470	*Polypedilum (P.) illinoense*	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 0 Total Taxa: 19

No. Qualitative Taxa: 19 ICI:

Number of Organisms: 0 Qual EPT: **1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/95 River Code: 02-126 River: Blues Creek RM: 0.60

Taxa Code	Taxa	Quan/Qual
02600	*Nematomorpha*	+
03600	*Oligochaeta*	+
05800	*Caecidotea sp*	+
06201	*Hyalella azteca*	+
07840	*Cambarus (Cambarus) sciotensis*	+
08250	*Orconectes (Procericambarus) rusticus*	+
11020	*Acerpenna pygmaeus*	+
11120	*Baetis flavistriga*	+
11130	*Baetis intercalaris*	+
12200	*Isonychia sp*	+
13000	*Leucrocuta sp*	+
13400	*Stenacron sp*	+
13521	*Stenonema femoratum*	+
14950	*Leptophlebia sp or Paraleptophebia sp*	+
17200	*Caenis sp*	+
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
23909	*Boyeria vinosa*	+
45300	*Sigara sp*	+
47600	*Sialis sp*	+
52200	*Cheumatopsyche sp*	+
63900	*Laccophilus sp*	+
66200	*Cymbiodyta sp*	+
67000	*Helophorus sp*	+
67700	*Paracymus sp*	+
68075	*Psephenus herricki*	+
68300	*Cyphon sp*	+
68702	*Dubiraphia bivittata*	+
68708	*Dubiraphia vittata group*	+
69400	*Stenelmis sp*	+
71900	*Tipula sp*	+
72700	*Anopheles sp*	+
74100	*Simulium sp*	+
77120	*Ablabesmyia mallochi*	+
77800	*Helopelopia sp*	+
80360	*Corynoneura "celeripes" (sensu Simpson & Bode, 1980)*	+
82141	*Thienemanniella xena*	+
82820	*Cryptochironomus sp*	+
83840	*Microtendipes pedellus group*	+
84450	*Polypedilum (P.) convictum*	+
84540	*Polypedilum (Tripodura) scalaenum group*	+
84750	*Stictochironomus sp*	+
85625	*Rheotanytarsus exiguus group*	+
85800	*Tanytarsus sp*	+
86100	*Chrysops sp*	+
93900	*Elimia sp*	+
95100	*Physella sp*	+
96900	*Ferrissia sp*	+
99100	*Pyganodon grandis*	+
99180	*Strophitus undulatus undulatus*	+

No. Quantitative Taxa:	0	Total Taxa:	51
No. Qualitative Taxa:	51	ICI:	
Number of Organisms:	0	Qual EPT:	**10**

APPENDIX C

Fish Data

Index of Biotic Integrity (IBI) metrics and scores and Modified Index of well-being (MIwb) scores for stations in the Mill Creek basin (Scioto River drainage) study area, 1995.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)		IBI	Modified Iwb
Mill Creek - (02109)																		
Year: 95																		
39.10	D	07/19/95	23	24(5)	4(5)	2(3)	2(3)	8(5)	32(3)	53(1)	30(3)	2.2(3)	33(3)	0.0(5)	722(3)		42	8.2
39.10	D	08/28/95	23	25(5)	4(5)	3(5)	2(3)	8(5)	20(3)	65(1)	32(3)	1.5(3)	20(1)	0.1(5)	660(3)		42	8.0
36.10	D	07/17/95	37	19(3)	4(5)	2(3)	1(1)	7(5)	53(5)	37(3)	25(3)	1.9(3)	56(5)	0.0(5)	450(3)		44	7.8
36.10	D	08/28/95	37	25(5)	4(5)	3(3)	2(3)	8(5)	39(5)	47(3)	22(3)	2.1(3)	43(3)	0.0(5)	801(5)		48	8.5
28.20	D	07/18/95	64	23(5)	3(3)	2(3)	2(1)	8(5)	65(5)	7(5)	2(5)	4.1(3)	86(5)	0.0(5)	1080(5)		50	8.8
28.20	D	08/29/95	64	22(5)	3(3)	3(3)	2(1)	7(5)	60(5)	13(5)	8(5)	6.0(5)	83(5)	0.2(3)	872(5)		50	8.9
24.80	D	07/18/95	72	23(5)	4(5)	3(3)	2(1)	7(5)	59(5)	16(5)	11(5)	4.3(3)	72(5)	0.0(5)	642(3)		50	9.1
24.80	D	08/29/95	72	24(5)	4(5)	3(3)	3(3)	7(5)	51(5)	35(3)	32(3)	3.4(3)	63(5)	0.1(3)	669(3)		46	8.3
19.30	D	07/18/95	82	20(3)	6(5)	2(3)	0(1)	3(3)	20(3)	43(1)	11(5)	5.9(5)	61(5)	0.6(5)	146(1)		40	7.6
19.30	D	08/29/95	82	28(5)	7(5)	4(5)	1(1)	4(3)	20(3)	51(1)	21(3)	4.0(3)	63(5)	0.2(5)	368(3)		42	9.4
19.10	D	07/31/95	82	20(3)	6(5)	3(3)	0(1)	3(3)	47(5)	40(3)	6(5)	2.1(3)	79(5)	0.0(5)	210(3)		44	7.8
19.10	D	08/31/95	82	22(5)	6(5)	3(3)	0(1)	4(3)	41(5)	32(3)	8(5)	3.6(3)	81(5)	0.3(3)	366(3)		44	7.5
18.40	D	07/19/95	84	20(3)	5(5)	2(3)	1(1)	5(5)	33(3)	40(3)	18(5)	9.2(5)	61(5)	0.0(5)	137(1)		44	6.8
18.40	D	08/29/95	84	27(5)	7(5)	4(5)	1(1)	5(5)	26(3)	51(1)	21(3)	6.4(5)	64(5)	0.9(3)	257(3)		44	8.1
18.22	D	07/31/95	88	14(3)	2(3)	1(1)	0(1)	4(3)	25(3)	24(3)	13(5)	3.5(3)	37(3)	0.0(5)	1056(5)		38	7.9
18.21	D	07/31/95	88	13(3)	2(3)	1(1)	0(1)	3(3)	25(3)	25(3)	13(5)	3.8(3)	33(3)	0.0(5)	942(5)		38	7.7
18.20	D	07/31/95	88	6(1)	0(1)	0(1)	0(1)	3(3)	19(3)	10(5)	10(5)	0.0(1)	76(5)	0.0(5)	114(1)	*	32	5.5
18.20	D	08/29/95	88	11(1)	2(3)	1(1)	0(1)	4(3)	52(5)	12(5)	9(5)	2.1(3)	60(5)	0.0(5)	774(5)		42	7.2
18.10	D	07/19/95	88	16(3)	5(5)	3(3)	0(1)	3(3)	24(3)	53(1)	13(5)	7.3(5)	78(5)	0.5(5)	124(1)		40	6.3
18.10	D	08/29/95	88	23(5)	7(5)	3(3)	1(1)	4(3)	30(3)	55(1)	27(3)	5.5(5)	65(5)	0.6(3)	179(1)		38	6.9
16.20	D	07/19/95	90	14(3)	3(3)	1(1)	0(1)	3(3)	14(1)	79(1)	14(5)	6.8(5)	60(5)	0.0(5)	42(1)	*	34	5.5

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

Index of Biotic Integrity (IBI) metrics and scores and Modified Index of well-being (MIwb) scores for stations in the Mill Creek basin (Scioto River drainage) study area, 1995.

River Mile	Type	Date	Drainage area (sq mi)	Number of					Percent of Individuals						Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
				Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies			
16.20	D	08/31/95	90	16(3)	4(5)	2(3)	0(1)	3(3)	18(1)	66(1)	17(5)	9.5(5)	67(5)	0.0(5)	96(1)	38	5.0
14.60	D	07/19/95	95	19(3)	4(5)	2(3)	1(1)	5(5)	23(3)	40(1)	16(5)	6.6(5)	52(3)	1.0(3)	273(3)	40	8.1
14.60	D	08/31/95	95	20(3)	4(5)	2(3)	0(1)	5(5)	32(3)	46(1)	14(5)	5.6(5)	59(5)	0.2(5)	360(3)	44	8.8
12.00	D	07/20/95	98	20(3)	4(5)	3(3)	0(1)	6(5)	30(3)	59(1)	19(3)	5.5(5)	43(3)	0.0(5)	180(1)	38	7.9
12.00	D	08/31/95	98	22(3)	4(5)	3(3)	1(1)	4(3)	41(5)	61(1)	24(3)	2.7(3)	46(3)	1.0(3)	365(3)	36	8.7
11.60	D	07/31/95	103	17(3)	3(3)	2(1)	1(1)	4(3)	35(3)	53(1)	24(3)	5.5(5)	38(3)	1.6(1)	180(1)	28	7.1
11.60	D	09/01/95	103	23(5)	4(5)	3(3)	1(1)	5(3)	40(5)	50(1)	26(3)	5.8(5)	48(3)	1.1(3)	482(3)	40	8.9
6.90	D	07/31/95	122	22(3)	4(5)	3(3)	1(1)	5(3)	38(5)	35(3)	19(3)	19.1(5)	36(3)	0.3(5)	339(3)	42	8.9
6.90	D	08/31/95	122	20(3)	4(5)	3(3)	2(1)	4(3)	31(3)	52(1)	42(1)	10.3(5)	31(3)	1.0(3)	360(3)	34	8.3
4.40	D	07/20/95	130	23(5)	4(5)	3(3)	3(3)	6(5)	38(5)	20(5)	10(5)	22.7(5)	44(3)	0.0(5)	1028(5)	54	9.8
4.40	D	08/30/95	130	28(5)	6(5)	4(3)	2(1)	5(3)	35(3)	23(3)	12(5)	21.7(5)	48(3)	0.3(3)	867(5)	44	9.6
3.70	D	07/20/95	167	26(5)	5(5)	3(3)	3(3)	7(5)	49(5)	13(5)	5(5)	25.2(5)	61(5)	0.0(5)	588(3)	54	9.2
3.70	D	08/30/95	167	28(5)	5(5)	4(3)	2(1)	6(5)	37(5)	18(5)	9(5)	28.3(5)	55(5)	0.2(3)	794(5)	52	9.6
1.70	D	07/20/95	178	22(3)	4(5)	3(3)	3(3)	5(3)	55(5)	12(5)	6(5)	13.0(5)	57(5)	0.0(5)	882(5)	52	9.3
1.70	D	08/30/95	178	23(5)	4(5)	3(3)	2(1)	4(3)	50(5)	15(5)	9(5)	13.1(5)	54(3)	0.0(5)	1008(5)	50	9.9
Blues Creek - (02126)																	
Year: 95																	
0.70	D	07/21/95	36	20(5)	3(3)	2(3)	1(1)	6(5)	35(3)	47(3)	15(5)	2.9(3)	34(3)	0.0(5)	635(3)	42	8.2
0.70	D	08/30/95	36	22(5)	4(5)	2(3)	2(3)	6(5)	37(5)	58(1)	28(3)	3.0(3)	41(3)	0.2(3)	725(3)	42	8.6

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

Index of Biotic Integrity (IBI) metrics and scores and Modified Index of well-being (MIwb) scores for stations in the Mill Creek basin (Scioto River drainage) study area, 1995.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
Crosses Run - (02-133)																
Year: 95																
2.80	E	08/07/95	0.5	2(1)	0(1)	0(1)	0(1)	0(1)	0(1)	73(1)	0(1)	73(1)	73(1)	0.0(1)	6(1)* *	12
2.10	E	07/31/95	1.5	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1)* *	12
2.10	E	09/14/95	1.5	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1)* *	12
0.90	E	07/24/95	5.0	3(1)	2(1)	0(1)	0(1)	0(1)	1(1)	100(1)	100(1)	97(1)	0(1)	0.0(1)	0(1)*	12
0.90	E	10/10/95	5.0	2(1)	1(1)	0(1)	0(1)	0(1)	0(1)	92(1)	15(1)	77(1)	0(1)	0.0(1)	2(1)* *	12
Otter Creek - (02-135)																
Year: 95																
0.70	D	07/17/95	11.1	23(5)	7(5)	2(3)	6(5)	8(5)	11(5)	58(1)	24(3)	50(3)	34(3)	0.0(5)	670(3)	46
0.70	D	08/28/95	11.1	23(5)	8(5)	2(3)	8(5)	8(5)	12(5)	67(1)	22(3)	66(1)	30(3)	0.0(5)	464(3)	44
Town Run - (02-239)																
Year: 95																
0.90	F	07/25/95	1.2	6(3)	2(3)	0(1)	0(1)	0(1)	1(1)	96(1)	12(3)	84(1)	17(3)	0.0(5)	36(3)	26
0.70	F	07/25/95	1.3	7(5)	2(3)	0(1)	0(1)	1(3)	1(1)	92(1)	24(1)	69(1)	23(5)	0.0(5)	48(3)	30
0.10	F	07/24/95	1.5	7(3)	2(1)	1(1)	0(1)	2(5)	1(1)	91(1)	2(5)	95(1)	9(1)	0.0(5)	46(3)	28
N. Br. Crosses Run - (02-253)																
Year: 95																
1.00	E	08/07/95	1.1	1(1)	1(1)	0(1)	0(1)	0(1)	0(1)	100(1)	0(1)	100(1)	0(1)	0.0(1)	0(1)* *	12
0.20	E	07/31/95	1.5	4(3)	2(1)	0(1)	0(1)	0(1)	0(1)	95(1)	32(1)	96(1)	14(3)	0.0(1)	2(1)* *	16
0.20	E	09/14/95	1.5	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1)* *	12

▲ - IBI is low end adjusted.

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **39.10**	Basin: Scioto River	Date Range: 07/19/95
	Time Fished: 5318 sec Drain Area: 23.3 sq mi	Thru: 08/28/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GOLDEN REDHORSE	R	I	S	M	6	4.50	0.27	0.69	5.25	154.17
NORTHERN HOG SUCKER	R	I	S	M	13	9.75	0.58	0.30	2.24	30.31
WHITE SUCKER	W	O	S	T	188	141.00	8.32	3.51	26.55	24.87
BLACKNOSE DACE	N	G	S	T	3	2.25	0.13	0.01	0.05	2.67
CREEK CHUB	N	G	N	T	620	465.00	27.45	4.67	35.36	10.04
SILVER SHINER	N	I	S	I	45	33.75	1.99	0.10	0.74	2.89
ROSEFIN SHINER	N	I	S	M	10	7.50	0.44	0.02	0.12	2.00
STRIPED SHINER	N	I	S		136	102.00	6.02	0.44	3.35	4.34
SILVERJAW MINNOW	N	I	M		18	13.50	0.80	0.03	0.19	1.83
BLUNTNOSE MINNOW	N	O	C	T	514	385.50	22.75	0.59	4.49	1.54
CENTRAL STONEROLLER	N	H	N		310	232.50	13.72	0.84	6.36	3.61
YELLOW BULLHEAD		I	C	T	5	3.75	0.22	0.52	3.92	138.00
ROCK BASS	S	C	C		36	27.00	1.59	0.85	6.42	31.39
LARGEMOUTH BASS	F	C	C		5	3.75	0.22	0.02	0.16	5.60
GREEN SUNFISH	S	I	C	T	8	6.00	0.35	0.06	0.44	9.63
BLUEGILL SUNFISH	S	I	C	P	35	26.25	1.55	0.14	1.08	5.43
LONGEAR SUNFISH	S	I	C	M	10	7.50	0.44	0.15	1.10	19.30
BLACKSIDE DARTER	D	I	S		9	6.75	0.40	0.02	0.17	3.33
LOGPERCH	D	I	S	M	8	6.00	0.35	0.04	0.31	6.75
JOHNNY DARTER	D	I	C		97	72.75	4.29	0.06	0.45	0.81
GREENSIDE DARTER	D	I	S	M	75	56.25	3.32	0.08	0.60	1.41
BANDED DARTER	D	I	S	I	10	7.50	0.44	0.01	0.08	1.47
RAINBOW DARTER	D	I	S	M	65	48.75	2.88	0.05	0.36	0.97
ORANGETHROAT DARTER	D	I	S		3	2.25	0.13	0.00	0.03	1.67
FANTAIL DARTER	D	I	C		30	22.50	1.33	0.03	0.22	1.30
Mile Total					2,259	1,694.25		13.21		
Number of Species					25					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **36.10**	Basin: Scioto River	Date Range: 07/17/95
	Time Fished: 4679 sec Drain Area: 37.0 sq mi	Thru: 08/28/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	3	2.25	0.20	0.04	0.23	16.00
GOLDEN REDHORSE	R	I	S	M	3	2.25	0.20	0.12	0.80	55.33
NORTHERN HOG SUCKER	R	I	S	M	54	40.50	3.65	1.20	7.70	29.61
WHITE SUCKER	W	O	S	T	65	48.75	4.39	1.10	7.07	22.62
COMMON CARP	G	O	M	T	3	2.25	0.20	7.52	48.25	3,341.67
CREEK CHUB	N	G	N	T	304	228.00	20.53	2.12	13.62	9.31
SILVER SHINER	N	I	S	I	10	7.50	0.68	0.03	0.20	4.20
ROSEFIN SHINER	N	I	S	M	22	16.50	1.49	0.03	0.18	1.68
STRIPED SHINER	N	I	S		166	124.50	11.21	1.25	8.00	10.01
SILVERJAW MINNOW	N	I	M		15	11.25	1.01	0.05	0.31	4.27
BLUNTNOSE MINNOW	N	O	C	T	271	203.25	18.30	0.29	1.88	1.44
CENTRAL STONEROLLER	N	H	N		112	84.00	7.56	0.47	3.02	5.61
ROCK BASS	S	C	C		25	18.75	1.69	0.60	3.87	32.12
SMALLMOUTH BASS	F	C	C	M	1	0.75	0.07	0.03	0.17	36.00
LARGEMOUTH BASS	F	C	C		1	0.75	0.07	0.01	0.04	8.00
GREEN SUNFISH	S	I	C	T	4	3.00	0.27	0.02	0.13	7.00
BLUEGILL SUNFISH	S	I	C	P	26	19.50	1.76	0.13	0.81	6.50
LONGEAR SUNFISH	S	I	C	M	17	12.75	1.15	0.24	1.52	18.59
BLACKSIDE DARTER	D	I	S		2	1.50	0.14	0.01	0.04	4.00
LOGPERCH	D	I	S	M	4	3.00	0.27	0.03	0.19	10.00
JOHNNY DARTER	D	I	C		38	28.50	2.57	0.02	0.14	0.79
GREENSIDE DARTER	D	I	S	M	172	129.00	11.61	0.17	1.12	1.35
BANDED DARTER	D	I	S	I	44	33.00	2.97	0.03	0.18	0.85
RAINBOW DARTER	D	I	S	M	98	73.50	6.62	0.06	0.41	0.87
ORANGETHROAT DARTER	D	I	S		2	1.50	0.14	0.00	0.02	2.00
FANTAIL DARTER	D	I	C		19	14.25	1.28	0.02	0.10	1.05
Mile Total					1,481	1,110.75		15.58		
Number of Species					26					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **28.20**	Basin: Scioto River	Date Range: 07/18/95
	Time Fished: 4761 sec Drain Area: 64.0 sq mi	Thru: 08/29/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	1	0.75	0.07	0.01	0.12	10.00
GOLDEN REDHORSE	R	I	S	M	3	2.25	0.21	0.02	0.37	10.33
NORTHERN HOG SUCKER	R	I	S	M	61	45.75	4.22	1.01	15.97	22.10
WHITE SUCKER	W	O	S	T	14	10.50	0.97	0.18	2.82	17.00
CREEK CHUB	N	G	N	T	46	34.50	3.18	0.50	7.94	14.57
SILVER SHINER	N	I	S	I	20	15.00	1.38	0.05	0.82	3.45
ROSEFIN SHINER	N	I	S	M	60	45.00	4.15	0.05	0.85	1.20
STRIPED SHINER	N	I	S		281	210.75	19.42	1.45	22.91	6.88
SILVERJAW MINNOW	N	I	M		2	1.50	0.14	0.01	0.11	4.50
BLUNTNOSE MINNOW	N	O	C	T	59	44.25	4.08	0.09	1.44	2.05
CENTRAL STONEROLLER	N	H	N		28	21.00	1.94	0.14	2.16	6.50
YELLOW BULLHEAD		I	C	T	2	1.50	0.14	0.01	0.14	6.00
ROCK BASS	S	C	C		60	45.00	4.15	1.78	28.16	39.62
SMALLMOUTH BASS	F	C	C	M	6	4.50	0.41	0.16	2.55	35.83
LARGEMOUTH BASS	F	C	C		5	3.75	0.35	0.01	0.21	3.60
GREEN SUNFISH	S	I	C	T	25	18.75	1.73	0.07	1.04	3.52
LONGEAR SUNFISH	S	I	C	M	6	4.50	0.41	0.04	0.65	9.00
BLACKSIDE DARTER	D	I	S		25	18.75	1.73	0.04	0.63	2.12
LOGPERCH	D	I	S	M	13	9.75	0.90	0.07	1.08	7.03
JOHNNY DARTER	D	I	C		46	34.50	3.18	0.03	0.41	0.75
GREENSIDE DARTER	D	I	S	M	171	128.25	11.82	0.26	4.15	2.05
BANDED DARTER	D	I	S	I	22	16.50	1.52	0.01	0.21	0.82
RAINBOW DARTER	D	I	S	M	236	177.00	16.31	0.17	2.61	0.93
ORANGETHROAT DARTER	D	I	S		2	1.50	0.14	0.00	0.05	2.00
FANTAIL DARTER	D	I	C		253	189.75	17.48	0.17	2.65	0.88
Mile Total					1,447	1,085.25		6.33		
Number of Species					25					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **24.80**	Basin: Scioto River	Date Range: 07/18/95
	Time Fished: 4720 sec Drain Area: 72.0 sq mi	Thru: 08/29/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	10	7.50	0.84	0.13	0.69	17.50
GOLDEN REDHORSE	R	I	S	M	20	15.00	1.67	2.44	12.74	162.80
NORTHERN HOG SUCKER	R	I	S	M	77	57.75	6.44	1.25	6.52	21.63
WHITE SUCKER	W	O	S	T	26	19.50	2.18	0.49	2.55	25.04
COMMON CARP	G	O	M	T	3	2.25	0.25	10.63	55.48	4,725.00
CREEK CHUB	N	G	N	T	20	15.00	1.67	0.28	1.48	18.90
SILVER SHINER	N	I	S	I	50	37.50	4.18	0.10	0.50	2.54
ROSEFIN SHINER	N	I	S	M	6	4.50	0.50	0.01	0.04	1.83
STRIPED SHINER	N	I	S		108	81.00	9.04	0.56	2.94	6.94
SILVERJAW MINNOW	N	I	M		1	0.75	0.08	0.00	0.02	5.00
BLUNTNOSE MINNOW	N	O	C	T	249	186.75	20.84	0.45	2.36	2.42
CENTRAL STONEROLLER	N	H	N		53	39.75	4.44	0.20	1.05	5.06
BRINDLED MADTOM		I	C	I	4	3.00	0.33	0.02	0.08	5.25
ROCK BASS	S	C	C		20	15.00	1.67	0.29	1.53	19.50
SMALLMOUTH BASS	F	C	C	M	14	10.50	1.17	1.11	5.77	105.25
LARGEMOUTH BASS	F	C	C		1	0.75	0.08	0.00	0.02	4.00
GREEN SUNFISH	S	I	C	T	23	17.25	1.92	0.18	0.91	10.13
BLUEGILL SUNFISH	S	I	C	P	11	8.25	0.92	0.03	0.17	3.91
LONGEAR SUNFISH	S	I	C	M	21	15.75	1.76	0.41	2.14	26.05
GREEN SF X LONGEAR					3	2.25	0.25	0.13	0.70	59.33
BLACKSIDE DARTER	D	I	S		14	10.50	1.17	0.03	0.15	2.79
LOGPERCH	D	I	S	M	19	14.25	1.59	0.09	0.48	6.47
JOHNNY DARTER	D	I	C		34	25.50	2.85	0.02	0.12	0.91
GREENSIDE DARTER	D	I	S	M	76	57.00	6.36	0.09	0.49	1.63
BANDED DARTER	D	I	S	I	24	18.00	2.01	0.01	0.07	0.71
RAINBOW DARTER	D	I	S	M	225	168.75	18.83	0.14	0.74	0.84
FANTAIL DARTER	D	I	C		83	62.25	6.95	0.05	0.28	0.87
Mile Total					1,195	896.25		19.16		
Number of Species					26					
Number of Hybrids					1					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **19.30**	Basin: Scioto River	Date Range: 07/18/95
	Time Fished: 5325 sec Drain Area: 82.0 sq mi	Thru: 08/29/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		3	2.25	0.45	0.02	0.09	10.00
GRASS PICKEREL		P	M	P	1	0.75	0.15	0.06	0.22	74.00
GOLDEN REDHORSE	R	I	S	M	6	4.50	0.89	0.87	3.39	194.17
NORTHERN HOG SUCKER	R	I	S	M	22	16.50	3.28	0.97	3.75	58.68
WHITE SUCKER	W	O	S	T	28	21.00	4.17	0.84	3.26	40.10
SPOTTED SUCKER	R	I	S		1	0.75	0.15	0.04	0.15	50.00
COMMON CARP	G	O	M	T	23	17.25	3.43	8.10	31.37	469.35
GOLDFISH	G	O	M	T	7	5.25	1.04	0.11	0.42	20.71
CREEK CHUB	N	G	N	T	81	60.75	12.07	0.95	3.67	15.60
SILVER SHINER	N	I	S	I	1	0.75	0.15	0.01	0.03	10.00
ROSEFIN SHINER	N	I	S	M	1	0.75	0.15	0.00	0.01	2.00
STRIPED SHINER	N	I	S		38	28.50	5.66	0.22	0.84	7.55
SILVERJAW MINNOW	N	I	M		2	1.50	0.30	0.00	0.02	3.00
BLUNTNOSE MINNOW	N	O	C	T	63	47.25	9.39	0.07	0.27	1.48
CENTRAL STONEROLLER	N	H	N		6	4.50	0.89	0.04	0.15	8.83
CHANNEL CATFISH	F		C		1	0.75	0.15	0.45	1.74	600.00
YELLOW BULLHEAD		I	C	T	10	7.50	1.49	0.77	2.96	102.00
BLACK BULLHEAD		I	C	P	2	1.50	0.30	0.05	0.19	32.50
BL'KSTRIPE TOPMINNOW		I	M		2	1.50	0.30	0.00	0.01	1.00
WHITE CRAPPIE	S	I	C		22	16.50	3.28	3.94	15.28	239.00
BLACK CRAPPIE	S	I	C		4	3.00	0.60	0.31	1.22	104.75
ROCK BASS	S	C	C		7	5.25	1.04	0.19	0.75	36.57
SMALLMOUTH BASS	F	C	C	M	5	3.75	0.75	1.64	6.35	437.00
LARGEMOUTH BASS	F	C	C		17	12.75	2.53	2.11	8.18	165.53
GREEN SUNFISH	S	I	C	T	117	87.75	17.44	1.75	6.77	19.90
BLUEGILL SUNFISH	S	I	C	P	107	80.25	15.95	1.40	5.42	17.43
OR'GESPOTTED SUNFISH	S	I	C		30	22.50	4.47	0.19	0.72	8.27
LONGEAR SUNFISH	S	I	C	M	8	6.00	1.19	0.18	0.69	29.50
REDEAR SUNFISH	E	I	C		1	0.75	0.15	0.02	0.06	22.00
GREEN SF X BLUEGILL					5	3.75	0.75	0.17	0.64	44.00
GREEN SF X ORANGESPT					2	1.50	0.30	0.04	0.17	29.00
GREEN SF X LONGEAR					4	3.00	0.60	0.20	0.77	66.50
LOGPERCH	D	I	S	M	5	3.75	0.75	0.04	0.15	10.60
JOHNNY DARTER	D	I	C		5	3.75	0.75	0.01	0.02	1.40
GREENSIDE DARTER	D	I	S	M	32	24.00	4.77	0.07	0.28	2.98
RAINBOW DARTER	D	I	S	M	1	0.75	0.15	0.00	0.01	2.00
FANTAIL DARTER	D	I	C		1	0.75	0.15	0.00	0.01	2.00
Mile Total					671	503.25		25.81		
Number of Species					34					
Number of Hybrids					3					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **19.10**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 4862 sec Drain Area: 82.0 sq mi	Thru: 08/31/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		11	8.25	1.85	0.08	0.42	9.45
GOLDEN REDHORSE	R	I	S	M	3	2.25	0.51	0.53	2.88	235.33
NORTHERN HOG SUCKER	R	I	S	M	7	5.25	1.18	0.26	1.43	50.00
WHITE SUCKER	W	O	S	T	10	7.50	1.69	0.59	3.19	78.40
COMMON CARP	G	O	M	T	8	6.00	1.35	10.18	55.30	1,696.88
GOLDEN SHINER	N	I	M	T	2	1.50	0.34	0.01	0.05	6.50
CREEK CHUB	N	G	N	T	28	21.00	4.72	0.41	2.22	19.46
ROSEFIN SHINER	N	I	S	M	1	0.75	0.17	0.00	0.01	2.00
STRIPED SHINER	N	I	S		38	28.50	6.41	0.38	2.04	13.16
SPOTFIN SHINER	N	I	M		1	0.75	0.17	0.00	0.01	2.00
BLUNTNOSE MINNOW	N	O	C	T	13	9.75	2.19	0.02	0.12	2.31
CENTRAL STONEROLLER	N	H	N		25	18.75	4.22	0.11	0.62	6.05
YELLOW BULLHEAD		I	C	T	10	7.50	1.69	0.68	3.68	90.40
WHITE CRAPPIE	S	I	C		3	2.25	0.51	0.46	2.48	202.67
BLACK CRAPPIE	S	I	C		1	0.75	0.17	0.01	0.03	8.00
ROCK BASS	S	C	C		7	5.25	1.18	0.14	0.76	26.71
LARGEMOUTH BASS	F	C	C		11	8.25	1.85	1.17	6.35	141.73
GREEN SUNFISH	S	I	C	T	138	103.50	23.27	2.01	10.89	19.38
BLUEGILL SUNFISH	S	I	C	P	36	27.00	6.07	0.44	2.37	16.18
OR'GESPOTTED SUNFISH	S	I	C		9	6.75	1.52	0.04	0.22	5.89
LONGEAR SUNFISH	S	I	C	M	14	10.50	2.36	0.26	1.41	24.71
GREEN SF X BLUEGILL					3	2.25	0.51	0.05	0.27	21.67
LOGPERCH	D	I	S	M	4	3.00	0.67	0.03	0.16	10.00
GREENSIDE DARTER	D	I	S	M	175	131.25	29.51	0.52	2.85	3.99
RAINBOW DARTER	D	I	S	M	20	15.00	3.37	0.03	0.17	2.10
FANTAIL DARTER	D	I	C		15	11.25	2.53	0.02	0.08	1.33
Mile Total					593	444.75		18.41		
Number of Species					25					
Number of Hybrids					1					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **18.40**	Basin: Scioto River	Date Range: 07/19/95
	Time Fished: 4307 sec Drain Area: 84.0 sq mi	Thru: 08/29/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		1	0.75	0.20	0.01	0.09	13.00
GRASS PICKEREL		P	M	P	1	0.75	0.20	0.01	0.07	10.00
SILVER REDHORSE	R	I	S	M	1	0.75	0.20	0.76	6.65	1,012.00
GOLDEN REDHORSE	R	I	S	M	1	0.75	0.20	0.22	1.91	290.00
NORTHERN HOG SUCKER	R	I	S	M	9	6.75	1.81	0.36	3.14	53.00
WHITE SUCKER	W	O	S	T	11	8.25	2.21	0.46	4.05	56.00
COMMON CARP	G	O	M	T	4	3.00	0.80	5.66	49.65	1,887.50
GOLDEN SHINER	N	I	M	T	4	3.00	0.80	0.03	0.26	10.00
CREEK CHUB	N	G	N	T	5	3.75	1.00	0.14	1.26	38.40
SILVER SHINER	N	I	S	I	4	3.00	0.80	0.02	0.19	7.25
ROSEFIN SHINER	N	I	S	M	1	0.75	0.20	0.00	0.01	2.00
STRIPED SHINER	N	I	S		21	15.75	4.22	0.29	2.57	18.58
SPOTFIN SHINER	N	I	M		1	0.75	0.20	0.00	0.01	2.00
BLUNTNOSE MINNOW	N	O	C	T	86	64.50	17.27	0.15	1.31	2.31
CENTRAL STONEROLLER	N	H	N		40	30.00	8.03	0.21	1.87	7.12
YELLOW BULLHEAD		I	C	T	3	2.25	0.60	0.32	2.80	142.00
WHITE CRAPPIE	S	I	C		4	3.00	0.80	0.09	0.78	29.75
BLACK CRAPPIE	S	I	C		2	1.50	0.40	0.02	0.20	15.00
ROCK BASS	S	C	C		26	19.50	5.22	0.77	6.76	39.50
SMALLMOUTH BASS	F	C	C	M	2	1.50	0.40	0.07	0.60	46.00
LARGEMOUTH BASS	F	C	C		7	5.25	1.41	0.03	0.26	5.71
GREEN SUNFISH	S	I	C	T	123	92.25	24.70	1.20	10.50	12.98
BLUEGILL SUNFISH	S	I	C	P	22	16.50	4.42	0.18	1.57	10.82
OR'GESPOTTED SUNFISH	S	I	C		5	3.75	1.00	0.04	0.32	9.80
LONGEAR SUNFISH	S	I	C	M	10	7.50	2.01	0.10	0.87	13.20
GREEN SF X ORANGESPT					2	1.50	0.40	0.03	0.29	22.00
LOGPERCH	D	I	S	M	5	3.75	1.00	0.04	0.38	11.60
JOHNNY DARTER	D	I	C		3	2.25	0.60	0.00	0.04	1.67
GREENSIDE DARTER	D	I	S	M	70	52.50	14.06	0.16	1.37	2.97
RAINBOW DARTER	D	I	S	M	16	12.00	3.21	0.02	0.14	1.31
FANTAIL DARTER	D	I	C		8	6.00	1.61	0.01	0.10	1.88
Mile Total					498	373.50		11.41		
Number of Species					30					
Number of Hybrids					1					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **18.22**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 637 sec Drain Area: 88.0 sq mi	
	Dist Fished: 0.05 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	2	12.00	0.87	0.13	1.82	10.50
NORTHERN HOG SUCKER	R	I	S	M	2	12.00	0.87	0.19	2.78	16.00
CREEK CHUB	N	G	N	T	14	84.00	6.06	1.03	14.93	12.29
STRIPED SHINER	N	I	S		5	30.00	2.16	0.14	2.08	4.80
BLUNTNOSE MINNOW	N	O	C	T	30	180.00	12.99	0.57	8.27	3.18
CENTRAL STONEROLLER	N	H	N		94	564.00	40.69	3.38	48.86	5.99
YELLOW BULLHEAD		I	C	T	7	42.00	3.03	0.05	0.69	1.14
ROCK BASS	S	C	C		1	6.00	0.43	0.06	0.87	10.00
LARGEMOUTH BASS	F	C	C		5	30.00	2.16	0.13	1.91	4.40
GREEN SUNFISH	S	I	C	T	4	24.00	1.73	0.11	1.56	4.50
JOHNNY DARTER	D	I	C		15	90.00	6.49	0.16	2.34	1.80
GREENSIDE DARTER	D	I	S	M	41	246.00	17.75	0.84	12.15	3.41
RAINBOW DARTER	D	I	S	M	9	54.00	3.90	0.10	1.48	1.89
FANTAIL DARTER	D	I	C		2	12.00	0.87	0.02	0.26	1.50
Mile Total					231	1,386.00		6.91		
Number of Species					14					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **18.21**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 637 sec Drain Area: 88.0 sq mi	
	Dist Fished: 0.05 km No of Passes: 1	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	2	12.00	0.95	0.13	1.90	10.50
NORTHERN HOG SUCKER	R	I	S	M	2	12.00	0.95	0.19	2.89	16.00
CREEK CHUB	N	G	N	T	14	84.00	6.67	1.03	15.56	12.29
STRIPED SHINER	N	I	S		4	24.00	1.90	0.11	1.63	4.50
BLUNTNOSE MINNOW	N	O	C	T	28	168.00	13.33	0.54	8.19	3.23
CENTRAL STONEROLLER	N	H	N		91	546.00	43.33	3.32	50.11	6.09
YELLOW BULLHEAD		I	C	T	7	42.00	3.33	0.05	0.72	1.14
ROCK BASS	S	C	C		1	6.00	0.48	0.06	0.90	10.00
LARGEMOUTH BASS	F	C	C		5	30.00	2.38	0.13	1.99	4.40
GREEN SUNFISH	S	I	C	T	4	24.00	1.90	0.11	1.63	4.50
JOHNNY DARTER	D	I	C		5	30.00	2.38	0.05	0.81	1.80
GREENSIDE DARTER	D	I	S	M	41	246.00	19.52	0.84	12.66	3.41
RAINBOW DARTER	D	I	S	M	6	36.00	2.86	0.07	1.00	1.83
Mile Total					210	1,260.00		6.63		
Number of Species					13					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **18.20**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 1070 sec Drain Area: 88.0 sq mi	Thru: 08/29/95
	Dist Fished: 0.10 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	2	6.00	1.20	0.08	4.36	14.00
CREEK CHUB	N	G	N	T	3	9.00	1.80	0.11	5.61	12.00
STRIPED SHINER	N	I	S		1	3.00	0.60	0.02	0.93	6.00
BLUNTNOSE MINNOW	N	O	C	T	15	45.00	8.98	0.11	5.74	2.46
CENTRAL STONEROLLER	N	H	N		42	126.00	25.15	0.59	30.69	4.69
LARGEMOUTH BASS	F	C	C		3	9.00	1.80	0.13	6.70	14.33
GREEN SUNFISH	S	I	C	T	1	3.00	0.60	0.03	1.40	9.00
BLUEGILL SUNFISH	S	I	C	P	1	3.00	0.60	0.04	1.87	12.00
JOHNNY DARTER	D	I	C		17	51.00	10.18	0.09	4.52	1.71
GREENSIDE DARTER	D	I	S	M	65	195.00	38.92	0.66	34.12	3.37
RAINBOW DARTER	D	I	S	M	12	36.00	7.19	0.06	2.96	1.58
FANTAIL DARTER	D	I	C		5	15.00	2.99	0.02	1.09	1.40
Mile Total					167	501.00		1.93		
Number of Species					12					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **18.10**	Basin: Scioto River	Date Range: 07/19/95
	Time Fished: 5783 sec Drain Area: 88.0 sq mi	Thru: 08/29/95
	Dist Fished: 0.50 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	15	9.00	2.74	0.11	0.23	12.47
GOLDEN REDHORSE	R	I	S	M	10	6.00	1.82	1.13	2.29	187.70
NORTHERN HOG SUCKER	R	I	S	M	14	8.40	2.55	1.06	2.16	126.14
WHITE SUCKER	W	O	S	T	65	39.00	11.86	2.49	5.08	63.89
COMMON CARP	G	O	M	T	41	24.60	7.48	39.20	79.87	1,593.66
GOLDFISH	G	O	M	T	3	1.80	0.55	0.05	0.10	26.00
GOLDEN SHINER	N	I	M	T	2	1.20	0.36	0.01	0.02	7.50
CREEK CHUB	N	G	N	T	7	4.20	1.28	0.20	0.41	48.00
STRIPED SHINER	N	I	S		2	1.20	0.36	0.04	0.09	36.50
BLUNTNOSE MINNOW	N	O	C	T	9	5.40	1.64	0.02	0.03	3.00
YELLOW BULLHEAD		I	C	T	21	12.60	3.83	1.47	2.98	116.29
BROWN BULLHEAD		I	C	T	1	0.60	0.18	0.02	0.05	40.00
WHITE CRAPPIE	S	I	C		10	6.00	1.82	0.18	0.36	29.40
BLACK CRAPPIE	S	I	C		7	4.20	1.28	0.09	0.18	20.71
ROCK BASS	S	C	C		12	7.20	2.19	0.35	0.72	49.08
SMALLMOUTH BASS	F	C	C	M	1	0.60	0.18	0.30	0.61	500.00
LARGEMOUTH BASS	F	C	C		6	3.60	1.09	0.11	0.22	29.83
GREEN SUNFISH	S	I	C	T	147	88.20	26.82	1.19	2.43	13.54
BLUEGILL SUNFISH	S	I	C	P	39	23.40	7.12	0.24	0.49	10.28
OR'GESPOTTED SUNFISH	S	I	C		10	6.00	1.82	0.03	0.07	5.70
LONGEAR SUNFISH	S	I	C	M	51	30.60	9.31	0.54	1.10	17.63
GREEN SF X BLUEGILL					4	2.40	0.73	0.09	0.18	37.50
LOGPERCH	D	I	S	M	5	3.00	0.91	0.04	0.07	11.60
JOHNNY DARTER	D	I	C		11	6.60	2.01	0.01	0.02	1.45
GREENSIDE DARTER	D	I	S	M	54	32.40	9.85	0.11	0.23	3.50
BANDED DARTER	D	I	S	I	1	0.60	0.18	0.00	0.00	2.00
Mile Total					548	328.80		49.08		
Number of Species					25					
Number of Hybrids					1					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **16.20**	Basin: Scioto River	Date Range: 07/19/95
	Time Fished: 3648 sec Drain Area: 90.0 sq mi	Thru: 08/31/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	3	2.25	0.93	0.03	0.13	11.67
NORTHERN HOG SUCKER	R	I	S	M	3	2.25	0.93	0.07	0.35	32.67
WHITE SUCKER	W	O	S	T	30	22.50	9.35	1.10	5.20	48.67
COMMON CARP	G	O	M	T	12	9.00	3.74	17.12	81.29	1,902.08
CREEK CHUB	N	G	N	T	32	24.00	9.97	0.49	2.34	20.54
STRIPED SHINER	N	I	S		3	2.25	0.93	0.06	0.27	25.33
SPOTFIN SHINER	N	I	M		1	0.75	0.31	0.00	0.02	6.00
BLUNTNOSE MINNOW	N	O	C	T	9	6.75	2.80	0.02	0.08	2.56
CENTRAL STONEROLLER	N	H	N		1	0.75	0.31	0.00	0.01	2.00
YELLOW BULLHEAD		I	C	T	7	5.25	2.18	0.49	2.34	94.00
ROCK BASS	S	C	C		14	10.50	4.36	0.21	1.01	20.29
LARGEMOUTH BASS	F	C	C		10	7.50	3.12	0.15	0.71	19.80
GREEN SUNFISH	S	I	C	T	139	104.25	43.30	0.93	4.41	8.91
BLUEGILL SUNFISH	S	I	C	P	7	5.25	2.18	0.03	0.14	5.57
LONGEAR SUNFISH	S	I	C	M	16	12.00	4.98	0.19	0.90	15.69
GREEN SF X LONGEAR					5	3.75	1.56	0.12	0.57	32.00
LOGPERCH	D	I	S	M	1	0.75	0.31	0.01	0.04	10.00
JOHNNY DARTER	D	I	C		12	9.00	3.74	0.01	0.05	1.08
GREENSIDE DARTER	D	I	S	M	11	8.25	3.43	0.03	0.14	3.64
RAINBOW DARTER	D	I	S	M	5	3.75	1.56	0.00	0.02	1.20
Mile Total					321	240.75		21.06		
Number of Species					19					
Number of Hybrids					1					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **14.60**	Basin: Scioto River	Date Range: 07/19/95
	Time Fished: 4543 sec Drain Area: 95.0 sq mi	Thru: 08/31/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	10	7.50	1.34	0.07	0.59	9.40
NORTHERN HOG SUCKER	R	I	S	M	34	25.50	4.54	1.53	12.75	60.18
WHITE SUCKER	W	O	S	T	29	21.75	3.87	0.77	6.43	35.59
COMMON CARP	G	O	M	T	9	6.75	1.20	2.00	16.59	295.67
CREEK CHUB	N	G	N	T	66	49.50	8.81	1.25	10.37	25.23
STRIPED SHINER	N	I	S		29	21.75	3.87	0.40	3.31	18.31
SPOTFIN SHINER	N	I	M		13	9.75	1.74	0.04	0.34	4.23
BLUNTNOSE MINNOW	N	O	C	T	75	56.25	10.01	0.17	1.45	3.10
CENTRAL STONEROLLER	N	H	N		98	73.50	13.08	0.76	6.29	10.31
YELLOW BULLHEAD		I	C	T	36	27.00	4.81	2.21	18.33	81.67
ROCK BASS	S	C	C		14	10.50	1.87	0.75	6.22	71.21
SMALLMOUTH BASS	F	C	C	M	1	0.75	0.13	0.05	0.42	68.00
LARGEMOUTH BASS	F	C	C		20	15.00	2.67	0.45	3.73	29.85
GREEN SUNFISH	S	I	C	T	112	84.00	14.95	0.70	5.78	8.28
BLUEGILL SUNFISH	S	I	C	P	4	3.00	0.53	0.02	0.20	8.00
LONGEAR SUNFISH	S	I	C	M	43	32.25	5.74	0.46	3.80	14.16
LONGEAR SF X B'GILL					2	1.50	0.27	0.03	0.27	22.00
GREEN SF X LONGEAR					3	2.25	0.40	0.04	0.34	18.00
LOGPERCH	D	I	S	M	3	2.25	0.40	0.03	0.21	11.00
JOHNNY DARTER	D	I	C		30	22.50	4.01	0.03	0.23	1.23
GREENSIDE DARTER	D	I	S	M	85	63.75	11.35	0.25	2.08	3.93
BANDED DARTER	D	I	S	I	1	0.75	0.13	0.00	0.01	2.00
RAINBOW DARTER	D	I	S	M	31	23.25	4.14	0.03	0.27	1.42
FANTAIL DARTER	D	I	C		1	0.75	0.13	0.00	0.01	2.00
	Mile Total				749	561.75		12.03		
	Number of Species				22					
	Number of Hybrids				2					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **12.00**	Basin: Scioto River	Date Range: 07/20/95
	Time Fished: 5823 sec Drain Area: 98.0 sq mi	Thru: 08/31/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
SILVER REDHORSE	R	I	S	M	3	2.25	0.32	0.05	0.22	22.00
NORTHERN HOG SUCKER	R	I	S	M	45	33.75	4.87	3.02	13.69	89.47
WHITE SUCKER	W	O	S	T	156	117.00	16.88	5.21	23.64	44.57
COMMON CARP	G	O	M	T	15	11.25	1.62	2.22	10.08	197.53
GOLDEN SHINER	N	I	M	T	1	0.75	0.11	0.00	0.01	3.00
CREEK CHUB	N	G	N	T	223	167.25	24.13	3.93	17.83	23.51
SILVER SHINER	N	I	S	I	1	0.75	0.11	0.01	0.03	10.00
ROSEFIN SHINER	N	I	S	M	1	0.75	0.11	0.00	0.01	2.00
STRIPED SHINER	N	I	S		29	21.75	3.14	0.32	1.47	14.86
SPOTFIN SHINER	N	I	M		16	12.00	1.73	0.06	0.29	5.31
BLUNTNOSE MINNOW	N	O	C	T	37	27.75	4.00	0.08	0.34	2.70
CENTRAL STONEROLLER	N	H	N		45	33.75	4.87	0.27	1.24	8.11
YELLOW BULLHEAD		I	C	T	18	13.50	1.95	1.55	7.02	114.72
ROCK BASS	S	C	C		24	18.00	2.60	1.01	4.57	56.04
SMALLMOUTH BASS	F	C	C	M	2	1.50	0.22	0.33	1.50	220.00
LARGEMOUTH BASS	F	C	C		7	5.25	0.76	0.03	0.12	4.86
GREEN SUNFISH	S	I	C	T	111	83.25	12.01	0.92	4.16	11.02
BLUEGILL SUNFISH	S	I	C	P	30	22.50	3.25	2.49	11.30	110.77
LONGEAR SUNFISH	S	I	C	M	12	9.00	1.30	0.13	0.61	14.83
BLACKSIDE DARTER	D	I	S		1	0.75	0.11	0.01	0.03	8.00
LOGPERCH	D	I	S	M	14	10.50	1.52	0.12	0.55	11.57
JOHNNY DARTER	D	I	C		36	27.00	3.90	0.04	0.16	1.29
GREENSIDE DARTER	D	I	S	M	89	66.75	9.63	0.24	1.10	3.63
RAINBOW DARTER	D	I	S	M	7	5.25	0.76	0.01	0.03	1.43
FANTAIL DARTER	D	I	C		1	0.75	0.11	0.00	0.01	3.00
Mile Total					924	693.00		22.06		
Number of Species					25					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **11.60**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 4892 sec Drain Area: 103.0 sq mi	Thru: 09/01/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GRASS PICKEREL		P	M	P	1	0.75	0.11	0.01	0.03	11.00
GOLDEN REDHORSE	R	I	S	M	2	1.50	0.22	0.08	0.30	52.50
NORTHERN HOG SUCKER	R	I	S	M	49	36.75	5.49	3.24	12.34	88.25
WHITE SUCKER	W	O	S	T	99	74.25	11.09	6.55	24.92	88.26
COMMON CARP	G	O	M	T	7	5.25	0.78	7.69	29.24	1,464.29
CREEK CHUB	N	G	N	T	107	80.25	11.98	2.02	7.67	25.12
SILVER SHINER	N	I	S	I	2	1.50	0.22	0.01	0.05	9.00
ROSEFIN SHINER	N	I	S	M	2	1.50	0.22	0.00	0.02	2.50
STRIPED SHINER	N	I	S		28	21.00	3.14	0.20	0.77	9.57
SPOTFIN SHINER	N	I	M		20	15.00	2.24	0.04	0.14	2.40
BLUNTNOSE MINNOW	N	O	C	T	124	93.00	13.89	0.23	0.87	2.47
CENTRAL STONEROLLER	N	H	N		99	74.25	11.09	0.63	2.39	8.47
YELLOW BULLHEAD		I	C	T	23	17.25	2.58	1.28	4.87	74.26
BL'KSTRIPE TOPMINNOW		I	M		2	1.50	0.22	0.00	0.01	1.00
WHITE CRAPPIE	S	I	C		1	0.75	0.11	0.00	0.01	3.00
ROCK BASS	S	C	C		33	24.75	3.70	2.47	9.38	99.64
SMALLMOUTH BASS	F	C	C	M	3	2.25	0.34	0.33	1.27	148.33
LARGEMOUTH BASS	F	C	C		14	10.50	1.57	0.25	0.93	23.36
GREEN SUNFISH	S	I	C	T	92	69.00	10.30	0.60	2.30	8.76
BLUEGILL SUNFISH	S	I	C	P	7	5.25	0.78	0.05	0.19	9.71
GREEN SF X LONGEAR					1	0.75	0.11	0.02	0.09	31.00
LOGPERCH	D	I	S	M	17	12.75	1.90	0.16	0.63	12.88
JOHNNY DARTER	D	I	C		18	13.50	2.02	0.02	0.08	1.50
GREENSIDE DARTER	D	I	S	M	134	100.50	15.01	0.39	1.47	3.84
BANDED DARTER	D	I	S	I	1	0.75	0.11	0.00	0.01	4.00
RAINBOW DARTER	D	I	S	M	7	5.25	0.78	0.01	0.05	2.43
Mile Total					893	669.75		26.29		
Number of Species					25					
Number of Hybrids					1					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **6.90**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 3652 sec Drain Area: 122.0 sq mi	Thru: 08/31/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GOLDEN REDHORSE	R	I	S	M	3	2.25	0.36	0.60	3.70	266.67
NORTHERN HOG SUCKER	R	I	S	M	57	42.75	6.77	3.78	23.34	88.42
WHITE SUCKER	W	O	S	T	93	69.75	11.05	3.00	18.51	42.98
COMMON CARP	G	O	M	T	2	1.50	0.24	1.62	9.98	1,077.50
CREEK CHUB	N	G	N	T	71	53.25	8.43	1.08	6.67	20.30
SILVER SHINER	N	I	S	I	8	6.00	0.95	0.03	0.18	4.88
ROSEFIN SHINER	N	I	S	M	3	2.25	0.36	0.01	0.04	2.67
STRIPED SHINER	N	I	S		43	32.25	5.11	0.43	2.68	13.44
SPOTFIN SHINER	N	I	M		8	6.00	0.95	0.02	0.15	3.88
BLUNTNOSE MINNOW	N	O	C	T	179	134.25	21.26	0.35	2.17	2.62
CENTRAL STONEROLLER	N	H	N		101	75.75	12.00	0.60	3.67	7.85
YELLOW BULLHEAD		I	C	T	1	0.75	0.12	0.10	0.63	135.00
STONECAT MADTOM		I	C	I	1	0.75	0.12	0.03	0.21	45.00
ROCK BASS	S	C	C		102	76.50	12.11	3.20	19.73	41.77
SMALLMOUTH BASS	F	C	C	M	3	2.25	0.36	0.65	4.02	289.33
LARGEMOUTH BASS	F	C	C		12	9.00	1.43	0.07	0.43	7.58
GREEN SUNFISH	S	I	C	T	30	22.50	3.56	0.17	1.06	7.60
BLUEGILL SUNFISH	S	I	C	P	3	2.25	0.36	0.01	0.09	6.00
LONGEAR SUNFISH	S	I	C	M	37	27.75	4.39	0.19	1.17	6.81
LOGPERCH	D	I	S	M	21	15.75	2.49	0.16	0.96	9.86
JOHNNY DARTER	D	I	C		5	3.75	0.59	0.01	0.04	1.60
GREENSIDE DARTER	D	I	S	M	52	39.00	6.18	0.09	0.54	2.23
RAINBOW DARTER	D	I	S	M	6	4.50	0.71	0.01	0.06	2.17
FANTAIL DARTER	D	I	C		1	0.75	0.12	0.00	0.02	3.00
Mile Total					842	631.50		16.20		
Number of Species					24					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **4.40**	Basin: Scioto River	Date Range: 07/20/95
	Time Fished: 5644 sec Drain Area: 130.0 sq mi	Thru: 08/30/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		1	0.75	0.06	0.06	0.10	80.00
SILVER REDHORSE	R	I	S	M	2	1.50	0.12	0.03	0.04	18.00
GOLDEN REDHORSE	R	I	S	M	22	16.50	1.37	2.67	4.42	161.55
NORTHERN HOG SUCKER	R	I	S	M	74	55.50	4.61	5.91	9.81	106.55
WHITE SUCKER	W	O	S	T	83	62.25	5.17	4.15	6.88	66.61
COMMON CARP	G	O	M	T	22	16.50	1.37	27.78	46.09	1,683.91
GOLDEN SHINER	N	I	M	T	2	1.50	0.12	0.00	0.00	2.00
CREEK CHUB	N	G	N	T	102	76.50	6.36	3.28	5.45	42.92
SILVER SHINER	N	I	S	I	45	33.75	2.81	0.18	0.30	5.33
REDFIN SHINER	N	I	N		9	6.75	0.56	0.02	0.03	2.44
STRIPED SHINER	N	I	S		111	83.25	6.92	1.21	2.01	14.52
SPOTFIN SHINER	N	I	M		22	16.50	1.37	0.07	0.12	4.23
BLUNTNOSE MINNOW	N	O	C	T	69	51.75	4.30	0.12	0.20	2.28
CENTRAL STONEROLLER	N	H	N		236	177.00	14.71	1.66	2.76	9.40
YELLOW BULLHEAD		I	C	T	4	3.00	0.25	0.30	0.49	98.67
STONECAT MADTOM		I	C	I	9	6.75	0.56	0.14	0.24	21.33
WHITE CRAPPIE	S	I	C		1	0.75	0.06	0.02	0.03	24.00
BLACK CRAPPIE	S	I	C		1	0.75	0.06	0.02	0.03	24.00
ROCK BASS	S	C	C		289	216.75	18.02	8.79	14.57	40.53
SMALLMOUTH BASS	F	C	C	M	50	37.50	3.12	1.43	2.37	38.14
LARGEMOUTH BASS	F	C	C		18	13.50	1.12	0.44	0.72	32.33
GREEN SUNFISH	S	I	C	T	59	44.25	3.68	0.26	0.44	5.97
BLUEGILL SUNFISH	S	I	C	P	56	42.00	3.49	0.34	0.57	8.13
LONGEAR SUNFISH	S	I	C	M	52	39.00	3.24	0.37	0.61	9.49
LOGPERCH	D	I	S	M	79	59.25	4.93	0.45	0.75	7.62
JOHNNY DARTER	D	I	C		11	8.25	0.69	0.01	0.02	1.58
GREENSIDE DARTER	D	I	S	M	131	98.25	8.17	0.50	0.83	5.07
BANDED DARTER	D	I	S	I	1	0.75	0.06	0.00	0.00	2.00
RAINBOW DARTER	D	I	S	M	38	28.50	2.37	0.06	0.09	1.92
FANTAIL DARTER	D	I	C		5	3.75	0.31	0.02	0.02	4.00
Mile Total					1,604	1,203.00		60.28		
Number of Species					30					
Number of Hybrids					0					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **3.70**	Basin: Scioto River	Date Range: 07/20/95
	Time Fished: 5894 sec Drain Area: 167.0 sq mi	Thru: 08/30/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD		O	M		2	1.50	0.18	0.11	0.32	75.00
SILVER REDHORSE	R	I	S	M	1	0.75	0.09	0.02	0.07	31.00
GOLDEN REDHORSE	R	I	S	M	15	11.25	1.37	2.21	6.25	196.53
NORTHERN HOG SUCKER	R	I	S	M	84	63.00	7.66	2.59	7.32	41.07
WHITE SUCKER	W	O	S	T	33	24.75	3.01	1.19	3.38	48.24
COMMON CARP	G	O	M	T	11	8.25	1.00	11.75	33.23	1,423.91
CREEK CHUB	N	G	N	T	38	28.50	3.47	0.61	1.72	21.39
SILVER SHINER	N	I	S	I	58	43.50	5.29	0.16	0.47	3.78
REDFIN SHINER	N	I	N		4	3.00	0.36	0.01	0.02	2.00
STRIPED SHINER	N	I	S		72	54.00	6.57	0.40	1.12	7.36
SPOTFIN SHINER	N	I	M		8	6.00	0.73	0.03	0.07	4.38
BLUNTNOSE MINNOW	N	O	C	T	30	22.50	2.74	0.05	0.14	2.27
CENTRAL STONEROLLER	N	H	N		55	41.25	5.02	0.33	0.93	8.00
COM. CARP X GOLDFISH	G	O		T	1	0.75	0.09	0.50	1.42	670.00
CHANNEL CATFISH	F		C		1	0.75	0.09	0.79	2.23	1,050.00
YELLOW BULLHEAD		I	C	T	23	17.25	2.10	2.46	6.96	142.52
STONECAT MADTOM		I	C	I	8	6.00	0.73	0.22	0.63	37.13
BL'KSTRIPE TOPMINNOW		I	M		2	1.50	0.18	0.00	0.01	1.50
WHITE CRAPPIE	S	I	C		2	1.50	0.18	0.20	0.56	131.00
BLACK CRAPPIE	S	I	C		1	0.75	0.09	0.02	0.06	26.00
ROCK BASS	S	C	C		285	213.75	26.00	9.01	25.49	42.16
SMALLMOUTH BASS	F	C	C	M	3	2.25	0.27	0.09	0.25	39.33
LARGEMOUTH BASS	F	C	C		8	6.00	0.73	0.30	0.85	49.75
GREEN SUNFISH	S	I	C	T	39	29.25	3.56	0.46	1.30	15.69
BLUEGILL SUNFISH	S	I	C	P	38	28.50	3.47	0.31	0.86	10.71
LONGEAR SUNFISH	S	I	C	M	67	50.25	6.11	0.77	2.18	15.31
BLACKSIDE DARTER	D	I	S		5	3.75	0.46	0.02	0.05	4.20
LOGPERCH	D	I	S	M	77	57.75	7.03	0.43	1.20	7.37
JOHNNY DARTER	D	I	C		4	3.00	0.36	0.01	0.02	1.75
GREENSIDE DARTER	D	I	S	M	106	79.50	9.67	0.30	0.84	3.74
BANDED DARTER	D	I	S	I	1	0.75	0.09	0.00	0.00	2.00
RAINBOW DARTER	D	I	S	M	9	6.75	0.82	0.01	0.04	1.89
FANTAIL DARTER	D	I	C		5	3.75	0.46	0.01	0.03	2.40
Mile Total					1,096	822.00		35.35		
Number of Species					32					
Number of Hybrids					1					

River Code: **02-109**	Stream: **Mill Creek**	Sample Date: **1995**
River Mile: **1.70**	Basin: Scioto River	Date Range: 07/20/95
	Time Fished: 5223 sec Drain Area: 178.0 sq mi	Thru: 08/30/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GOLDEN REDHORSE	R	I	S	M	4	3.00	0.27	0.56	1.92	185.50
NORTHERN HOG SUCKER	R	I	S	M	127	95.25	8.69	10.49	36.09	110.09
WHITE SUCKER	W	O	S	T	60	45.00	4.10	2.09	7.19	46.42
COMMON CARP	G	O	M	T	8	6.00	0.55	1.42	4.90	237.13
GOLDFISH	G	O	M	T	1	0.75	0.07	0.05	0.19	72.00
CREEK CHUB	N	G	N	T	64	48.00	4.38	1.56	5.36	32.45
SILVER SHINER	N	I	S	I	64	48.00	4.38	0.26	0.89	5.38
REDFIN SHINER	N	I	N		4	3.00	0.27	0.00	0.02	1.50
STRIPED SHINER	N	I	S		69	51.75	4.72	0.69	2.38	13.39
SPOTFIN SHINER	N	I	M		43	32.25	2.94	0.16	0.55	4.96
BLUNTNOSE MINNOW	N	O	C	T	42	31.50	2.87	0.15	0.50	4.64
CENTRAL STONEROLLER	N	H	N		284	213.00	19.43	2.64	9.08	12.38
YELLOW BULLHEAD		I	C	T	3	2.25	0.21	0.15	0.53	68.33
BROWN BULLHEAD		I	C	T	2	1.50	0.14	0.15	0.53	102.50
STONECAT MADTOM		I	C	I	5	3.75	0.34	0.14	0.47	36.40
ROCK BASS	S	C	C		169	126.75	11.56	3.53	12.14	27.83
SMALLMOUTH BASS	F	C	C	M	16	12.00	1.09	1.61	5.54	134.09
LARGEMOUTH BASS	F	C	C		6	4.50	0.41	0.71	2.44	157.33
GREEN SUNFISH	S	I	C	T	22	16.50	1.50	0.33	1.15	20.23
BLUEGILL SUNFISH	S	I	C	P	20	15.00	1.37	0.15	0.53	10.25
LONGEAR SUNFISH	S	I	C	M	6	4.50	0.41	0.06	0.21	13.33
LOGPERCH	D	I	S	M	83	62.25	5.68	0.71	2.43	11.35
JOHNNY DARTER	D	I	C		2	1.50	0.14	0.00	0.01	2.00
GREENSIDE DARTER	D	I	S	M	344	258.00	23.53	1.42	4.88	5.50
BANDED DARTER	D	I	S	I	1	0.75	0.07	0.00	0.01	2.00
RAINBOW DARTER	D	I	S	M	13	9.75	0.89	0.03	0.10	2.85
Mile Total					1,462	1,096.50		29.06		
Number of Species					26					
Number of Hybrids					0					

River Code: **02-126**	Stream: **Blues Creek**	Sample Date: **1995**
River Mile: **0.70**	Basin: Scioto River	Date Range: 07/21/95
	Time Fished: 4655 sec Drain Area: 36.3 sq mi	Thru: 08/30/95
	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	19	14.25	0.97	0.62	3.66	43.42
WHITE SUCKER	W	O	S	T	249	186.75	12.74	4.26	25.19	22.79
CREEK CHUB	N	G	N	T	493	369.75	25.22	5.55	32.86	15.02
SILVER SHINER	N	I	S	I	3	2.25	0.15	0.02	0.09	6.67
REDFIN SHINER	N	I	N		30	22.50	1.53	0.05	0.28	2.13
STRIPED SHINER	N	I	S		197	147.75	10.08	1.12	6.62	7.57
BLUNTNOSE MINNOW	N	O	C	T	200	150.00	10.23	0.34	2.03	2.29
CENTRAL STONEROLLER	N	H	N		214	160.50	10.95	1.01	5.98	6.29
YELLOW BULLHEAD		I	C	T	15	11.25	0.77	0.60	3.57	53.67
STONECAT MADTOM		I	C	I	2	1.50	0.10	0.00	0.02	2.00
ROCK BASS	S	C	C		50	37.50	2.56	1.35	7.96	35.86
SMALLMOUTH BASS	F	C	C	M	4	3.00	0.20	0.14	0.80	45.25
LARGEMOUTH BASS	F	C	C		3	2.25	0.15	0.15	0.88	65.67
GREEN SUNFISH	S	I	C	T	92	69.00	4.71	0.93	5.48	13.42
BLUEGILL SUNFISH	S	I	C	P	12	9.00	0.61	0.05	0.28	5.25
LONGEAR SUNFISH	S	I	C	M	2	1.50	0.10	0.04	0.22	25.00
BLACKSIDE DARTER	D	I	S		24	18.00	1.23	0.05	0.32	2.96
LOGPERCH	D	I	S	M	38	28.50	1.94	0.22	1.28	7.58
JOHNNY DARTER	D	I	C		38	28.50	1.94	0.03	0.17	1.03
GREENSIDE DARTER	D	I	S	M	143	107.25	7.31	0.26	1.54	2.43
RAINBOW DARTER	D	I	S	M	31	23.25	1.59	0.03	0.17	1.19
FANTAIL DARTER	D	I	C		96	72.00	4.91	0.10	0.61	1.42
Mile Total					1,955	1,466.25		16.90		
Number of Species					22					
Number of Hybrids					0					

River Code: **02-133**	Stream: **Crosses Run**	Sample Date: **1995**
River Mile: **2.80**	Basin: Scioto River	Date Range: 08/07/95
	Time Fished: 923 sec Drain Area: 0.5 sq mi	
	Dist Fished: 0.14 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LARGEMOUTH BASS	F	C	C		3	6.43	27.28	0.02	4.46	2.67
GREEN SUNFISH	S	I	C	T	8	17.14	72.73	0.36	95.54	21.25
Mile Total					11	23.57		0.38		
Number of Species					2					
Number of Hybrids					0					

River Code: **02-133**	Stream: **Crosses Run**	Sample Date: **1995**
River Mile: **2.10**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 1945 sec Drain Area: 1.5 sq mi	Thru: 09/14/95
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: E

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

River Code: **02-133**	Stream: **Crosses Run**	Sample Date: **1995**
River Mile: **0.90**	Basin: Scioto River	Date Range: 07/24/95
	Time Fished: 2491 sec Drain Area: 5.0 sq mi	Thru: 10/10/95
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	2	2.00	2.44	0.01	0.94	4.00
COMMON CARP	G	O	M	T	2	2.00	2.44	0.10	11.45	48.50
CREEK CHUB	N	G	N	T	74	74.00	90.24	0.70	82.76	9.47
FATHEAD MINNOW	N	O	C	T	3	3.00	3.66	0.01	0.71	2.00
LARGEMOUTH BASS	F	C	C		1	1.00	1.22	0.04	4.13	35.00
Mile Total					82	82.00		0.85		
Number of Species					5					
Number of Hybrids					0					

River Code: **02-135**	Stream: **Otter Creek**	Sample Date: **1995**
River Mile: **0.70**	Basin: Scioto River	Date Range: 07/17/95
	Time Fished: 4227 sec Drain Area: 11.1 sq mi	Thru: 08/28/95
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
NORTHERN HOG SUCKER	R	I	S	M	18	18.00	1.20	1.05	6.80	58.33
WHITE SUCKER	W	O	S	T	156	156.00	10.38	4.37	28.28	28.00
BLACKNOSE DACE	N	G	S	T	27	27.00	1.80	0.06	0.39	2.26
CREEK CHUB	N	G	N	T	551	551.00	36.66	5.92	38.35	10.75
SILVER SHINER	N	I	S	I	10	10.00	0.67	0.03	0.18	2.80
ROSEFIN SHINER	N	I	S	M	5	5.00	0.33	0.02	0.10	3.00
STRIPED SHINER	N	I	S		156	156.00	10.38	1.17	7.59	7.51
SILVERJAW MINNOW	N	I	M		16	16.00	1.06	0.06	0.41	3.94
BLUNTNOSE MINNOW	N	O	C	T	190	190.00	12.64	0.49	3.20	2.60
CENTRAL STONEROLLER	N	H	N		68	68.00	4.52	0.57	3.68	8.37
YELLOW BULLHEAD		I	C	T	1	1.00	0.07	0.09	0.60	92.00
BL'KSTRIPE TOPMINNOW		I	M		3	3.00	0.20	0.01	0.07	3.67
ROCK BASS	S	C	C		24	24.00	1.60	0.96	6.24	40.13
LARGEMOUTH BASS	F	C	C		1	1.00	0.07	0.00	0.02	3.00
GREEN SUNFISH	S	I	C	T	11	11.00	0.73	0.06	0.36	5.00
BLUEGILL SUNFISH	S	I	C	P	13	13.00	0.86	0.05	0.29	3.46
LONGEAR SUNFISH	S	I	C	M	10	10.00	0.67	0.11	0.69	10.60
GREEN SF X BLUEGILL					1	1.00	0.07	0.04	0.23	35.00
BLACKSIDE DARTER	D	I	S		4	4.00	0.27	0.01	0.07	2.75
LOGPERCH	D	I	S	M	7	7.00	0.47	0.05	0.31	6.86
JOHNNY DARTER	D	I	C		81	81.00	5.39	0.07	0.43	0.83
GREENSIDE DARTER	D	I	S	M	91	91.00	6.05	0.17	1.11	1.88
BANDED DARTER	D	I	S	I	6	6.00	0.40	0.01	0.08	2.00
RAINBOW DARTER	D	I	S	M	23	23.00	1.53	0.03	0.19	1.26
ORANGETHROAT DARTER	D	I	S		12	12.00	0.80	0.02	0.11	1.39
FANTAIL DARTER	D	I	C		18	18.00	1.20	0.04	0.24	2.06
Mile Total					1,503	1,503.00		15.44		
Number of Species					25					
Number of Hybrids					1					

River Code: **02-239**	Stream: **Town Run**	Sample Date: **1995**
River Mile: **0.90**	Basin: Scioto River	Date Range: 07/25/95
	Time Fished: 2082 sec Drain Area: 1.2 sq mi	
	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: F

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	54	108.00	12.19	0.33	5.90	3.02
CREEK CHUB	N	G	N	T	300	600.00	67.72	4.24	76.68	7.06
CENTRAL STONEROLLER	N	H	N		5	10.00	1.13	0.06	1.01	5.60
LARGEMOUTH BASS	F	C	C		8	16.00	1.81	0.04	0.72	2.50
GREEN SUNFISH	S	I	C	T	71	142.00	16.03	0.84	15.13	5.89
BLUEGILL SUNFISH	S	I	C	P	5	10.00	1.13	0.03	0.54	3.00
Mile Total					443	886.00		5.52		
Number of Species					6					
Number of Hybrids					0					

River Code: **02-239**	Stream: **Town Run**	Sample Date: **1995**
River Mile: **0.70**	Basin: Scioto River	Date Range: 07/25/95
	Time Fished: 3248 sec Drain Area: 1.3 sq mi	
	Dist Fished: 0.13 km No of Passes: 1	Sampler Type: F

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	65	150.00	23.99	0.37	13.75	2.46
CREEK CHUB	N	G	N	T	125	288.46	46.13	1.82	67.95	6.32
CENTRAL STONEROLLER	N	H	N		1	2.31	0.37	0.01	0.19	2.00
LARGEMOUTH BASS	F	C	C		18	41.54	6.64	0.08	3.02	1.94
GREEN SUNFISH	S	I	C	T	60	138.46	22.14	0.39	14.69	2.85
BLUEGILL SUNFISH	S	I	C	P	1	2.31	0.37	0.01	0.26	3.00
JOHNNY DARTER	D	I	C		1	2.31	0.37	0.01	0.19	2.00
Mile Total					271	625.39		2.68		
Number of Species					7					
Number of Hybrids					0					

River Code: **02-239**	Stream: **Town Run**	Sample Date: **1995**
River Mile: **0.10**	Basin: Scioto River	Date Range: 07/24/95
	Time Fished: 2008 sec Drain Area: 1.5 sq mi	
	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: F

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	1	2.00	0.38	0.03	0.89	13.00
COMMON CARP	G	O	M	T	3	6.00	1.14	0.04	1.44	7.00
CREEK CHUB	N	G	N	T	228	456.00	86.36	2.71	93.19	5.94
CENTRAL STONEROLLER	N	H	N		5	10.00	1.89	0.02	0.55	1.60
LARGEMOUTH BASS	F	C	C		3	6.00	1.14	0.01	0.48	2.33
GREEN SUNFISH	S	I	C	T	9	18.00	3.41	0.06	2.06	3.33
JOHNNY DARTER	D	I	C		13	26.00	4.92	0.03	1.10	1.23
FANTAIL DARTER	D	I	C		2	4.00	0.76	0.01	0.28	2.00
Mile Total					264	528.00		2.91		
Number of Species					8					
Number of Hybrids					0					

River Code: **02-253**	Stream: **North Branch Crosses Run**	Sample Date: **1995**
River Mile: **1.00**	Basin: Scioto River	Date Range: 08/07/95
	Time Fished: 1454 sec Drain Area: 1.1 sq mi	
	Dist Fished: 0.15 km No of Passes: 1	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CREEK CHUB	N	G	N	T	24	48.00	100.00	0.06	100.00	1.17
Mile Total					24	48.00		0.06		
Number of Species					1					
Number of Hybrids					0					

River Code: **02-253**	Stream: **North Branch Crosses Run**	Sample Date: **1995**
River Mile: **0.20**	Basin: Scioto River	Date Range: 07/31/95
	Time Fished: 1708 sec Drain Area: 1.5 sq mi	Thru: 09/14/95
	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: E

Species Name / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CREEK CHUB	N	G	N	T	11	11.00	50.00	0.01	16.46	1.18
FATHEAD MINNOW	N	O	C	T	7	7.00	31.82	0.01	11.39	1.29
LARGEMOUTH BASS	F	C	C		1	1.00	4.55	0.01	7.59	6.00
GREEN SUNFISH	S	I	C	T	3	3.00	13.64	0.05	64.56	17.00
NO FISH					0	0.00	0.00			
Mile Total					22	22.00		0.08		
Number of Species					4					
Number of Hybrids					0					