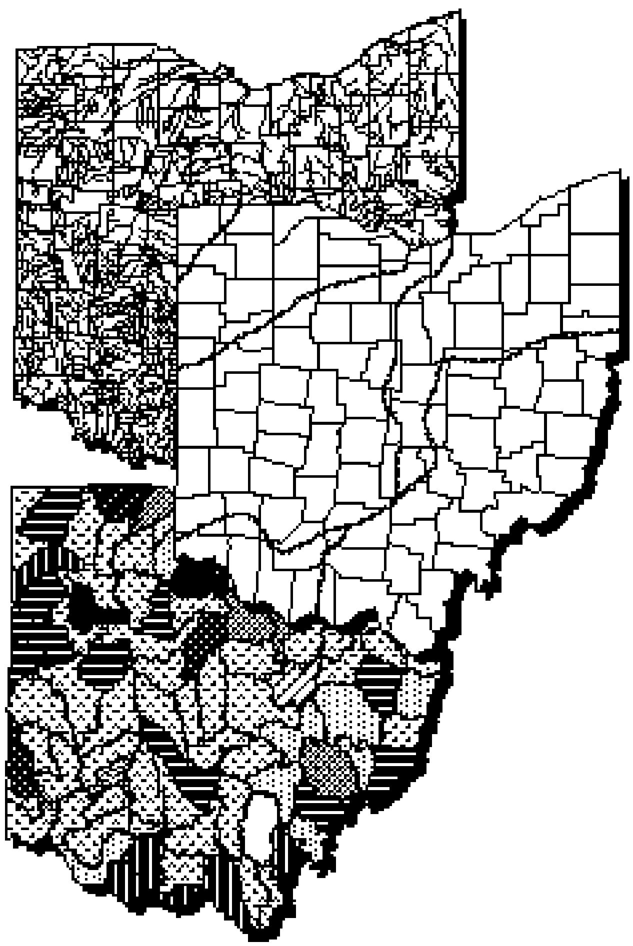
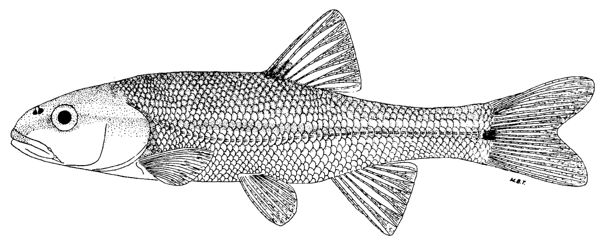
State of Ohio
Environmental Protection Agency

Ecological Assessment Unit
Division of Surface Water

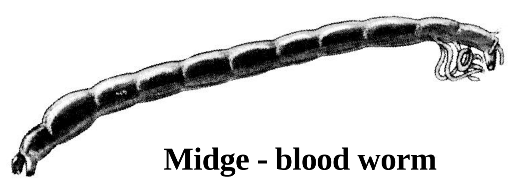
Biological and Water Quality Study of Raccoon Creek

Sandusky County





Creek Chub (*Semotilis atromaculatus*)



Midge - blood worm
(*Chironomus decorus*)

February 14, 1997

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43216-1049

Biological and Water Quality Study of Raccoon Creek

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OEPA Technical Report

MAS/1996-12-14

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Waters
Ecological Assessment Unit
1685 Westbelt Drive
Columbus, Ohio 43228
and
Surface Water Section
Northwest District Office
347 North Dunbridge Road
Bowling Green, Ohio 43402

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NOTICE TO USERS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

These documents and this report 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

Acknowledgments

Katie McKibben - Study Area Description and Map
Janet Thomas - Pollutant Loadings, Surface Water Chemistry and Sediment Chemistry
Mike Gray - Macroinvertebrate Community Assessment
Robert Miltner - Fish Community Assessment, TSD Coordinator
Jeff DeShon, Marc Smith and Chris Yoder - Reviewers

Water chemistry analysis and bioassay data were provided by the Ohio EPA Division of Environmental Services. Mike Krock, Tom Stratton, Amy Meyer and Dan Lavoie assisted in collection of field samples. Property owners granting access for sampling are also thanked.

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, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition. Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.*, rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each. Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Ohio Water Resource Inventory (305[b] report), the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Uses

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and

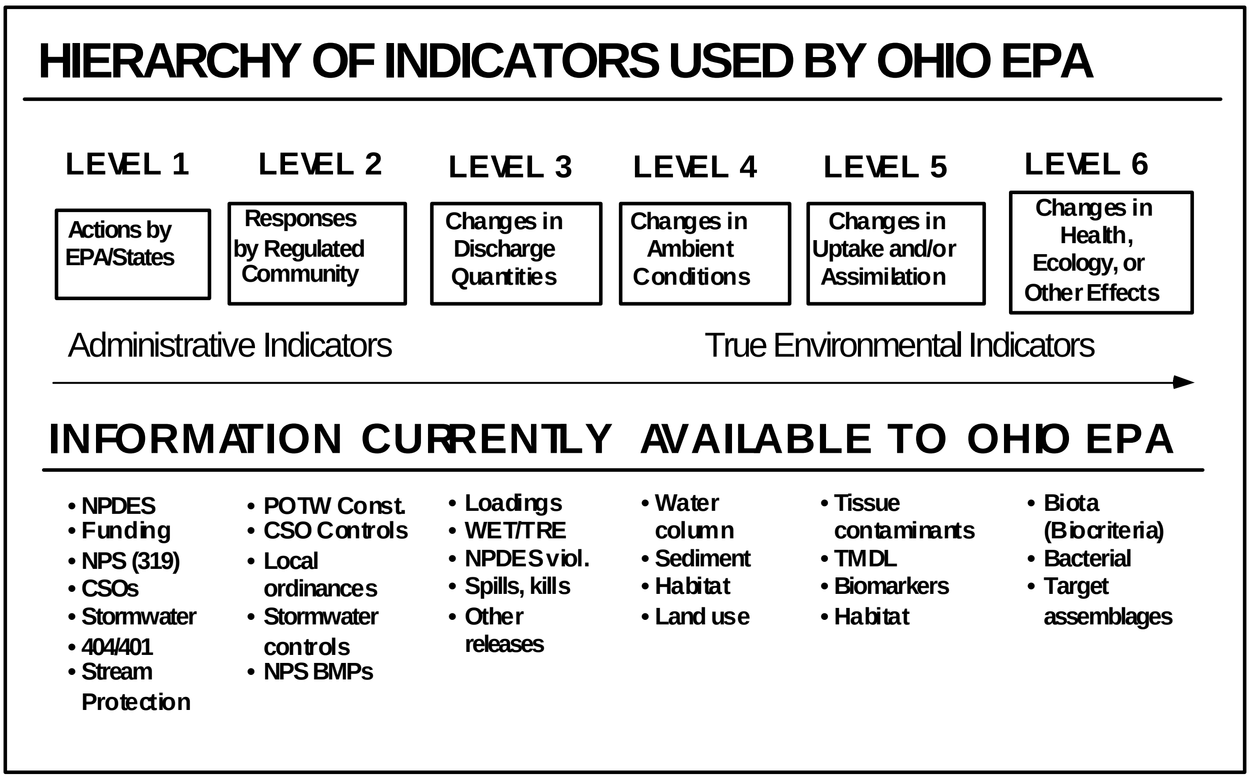


Figure 1. Hierarchy of administrative and environmental indicators used by Ohio EPA for monitoring, assessment, reporting, and evaluating program effectiveness. This is patterned after a model developed by the U.S. EPA, Office of Water.

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

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

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

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.*, fecal coliforms, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health and detailed in other documents.

INTRODUCTION

Raccoon Creek from Limerick Road (River Mile [RM] 13.2) to US 6 (RM 3.0) was the object of this survey.

Specific objectives of this study were to:

1) Evaluate the physical habitat, surface water and sediment quality, and the biological integrity of Raccoon Creek,

2) Assess impacts from the Clyde municipal wastewater treatment plant, combined sewer overflows, nonpoint sources of pollution, and habitat alterations,

3) Determine attainment status of the Warmwater Habitat (WWH) aquatic life use and other non-aquatic use designations, and recommend changes where appropriate, and

4) Compare results of this survey with previous surveys to assess changes in water quality and biological integrity.

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

SUMMARY

A biological and water quality survey of Raccoon Creek was conducted 15 June - 10 October 1995. Biological communities in Raccoon Creek were significantly impaired by pollutant loadings from the Clyde WWTP, unsewered discharges and habitat alterations.

Raccoon Creek
Raccoon Creek met WWH criteria only at the upstream reference location (RM 13.0), giving 1.6 miles (extrapolating to RM 14.0) in FULL attainment (Table 1). Suburban runoff, combined sewer overflows (CSOs) and habitat alterations negatively affected benthic communities within the reach flowing through Clyde, resulting in 1.0 mile of PARTIAL attainment. Discharges of poorly treated or raw sewage from the Clyde WWTP and landfill leachate grossly polluted the creek and sediments immediately downstream from the plant, completely or partially disrupting the benthic macroinvertebrate community for 8.2 miles. Habitat alterations, agricultural impacts, and unsewered discharges contributed to aquatic life use impairment in the remaining downstream reach. Consequently, WWH criteria were not met at any location downstream from the Clyde WWTP resulting in 11.4 miles in NON attainment.

Table 1. Aquatic life use attainment status for stations sampled in Raccoo n Creek based on data collected July-October, 1995. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Inde x (QHEI) is a measure of the ability of the physical habitat to support a biotic community. Attainment status from 1986 and 1983 surveys are included.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI	QHEI	Attainment Status	Comment
Raccoon Creek (1995)			*WWH existing*			
13.6/13.0	26^{ns}	NA	32^{ns}	45.0	FULL	Background/reference
11.7	30	NA	22^{*}	37.5	PARTIAL	ust conditions
11.3	29	NA	12^{*}	34.5	**NON**	dst Whirlpool Corp
11.0	28	NA	0^{*}	45.5	**NON**	Clyde WWTP mixing
-- /10.98			10^{*}		(**NON**)	dst WWTP
-- /10.75			4^{*}		(**NON**)	WWTP/landfill leachate
10.2	31	NA	12^{*}	48.8	**NON**	WWTP impact
8.1/8.7	25^{ns}	NA	12^{*}	41.5	**NON**	impact/recovery
5.5/6.5	23^{*}	4.1^{*}	20^{*}	42.5	**NON**	impact/recovery
3.6	21^{*}	4.2^{*}	22^{*}	39.5	**NON**	impact/recovery
Raccoon Creek (1986)						
13.2/13.0	29	NA	16^{*}	74.0	PARTIAL	Background/reference
11.6/11.7	31	NA	22^{*}	60.5	PARTIAL	ust conditions
11.2/11.3	14^{*}	NA	2^{*}	46.0	**NON**	dst Whirlpool Corp
10.2	18^{*}	NA	4^{*}		**NON**	WWTP impact
8.6/8.7	19^{*}	NA	12^{*}	41.5	**NON**	impact/recovery
6.5	19^{*}	NA	20^{*}	52.0	**NON**	impact/recovery
3.7/3.1	21^{*}	5.8^{*}	24^{*}	51.0	**NON**	impact/recovery
Raccoon Creek (1983)						
13.2/13.0	22^{*}	NA	18^{*}		**NON**	Background/reference
11.6/11.7	22^{*}	NA	24^{*}		**NON**	ust conditions
11.3	12^{*}	NA	0^{*}		**NON**	dst Whirlpool Corp
11.1	12^{*}	NA			(**NON**)	dst WWTP
10.2	16^{*}	NA	4^{*}		**NON**	WWTP impact
10.1	20^{*}	NA			(**NON**)	WWTP impact
8.5/8.7	16^{*}	NA	0^{*}		**NON**	impact/recovery
6.5	22^{*}	NA	8^{*}		**NON**	impact/recovery
3.1	20^{*}	6.1	8^{*}		**NON**	impact/recovery
Little Raccoon Creek (1995)						
4.3	14^{*}	NA	22^{*}	38.5	**NON**	Channelized,NPS

Table 1. Continued.

River Mile Fish/Invertebrate	IBI	MIwb[a]	ICI	QHEI	Attainment Status	Comment
Little Raccoon Creek (1983)						
4.3	25[ns]	NA		55.0	(FULL)	Channelized
Caswell Ditch						
0.8	30	NA	48	18.0	FULL	Channelized,NPS
Gries Ditch						
1.0	20*	NA	40	55.5	**NON**	Channelized,NPS, enriched

Ecoregion Biocriteria: Huron-Erie Lake Plain (HELP)

INDEX	WWH	EWH[b]	MWH[c]
IBI -headwaters	28	50	20
IBI - wading	32	50	22
MIwb - wading	7.3	9.4	5.6
ICI - all streams/rivers	34	46	22

a - MIwb not applicable to Headwater streams (drainage area < 20 km^2).
b - Exceptional Warmwater Habitat.
c - Modified Warmwater Habitat for channel modified areas.
ns - **NON**significant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Poor and Very Poor scores are underlined.

Little Raccoon Creek, Caswell Ditch and Gries Ditch

Little Raccoon Creek, and the aptly named, Caswell Ditch and Gries Ditch, are channelized ditches with grossly modified physical habitats. Little Raccoon and Gries Ditch did not attain WWH criteria due to the severity of nonpoint pollution. Community performance in Little Raccoon Creek declined significantly compared to 1983 due to an accumulation of silt and large amounts of decomposing matter in its stream bed, illustrating long term damage from channelization paired with lack of flushing due to low gradient and small drainage area. Water quality in Gries Ditch was degraded by organic and nutrient enrichment from livestock wastes and unsewered discharges. Caswell Ditch, while having the worst habitat of the three, was least impacted by nonpoint pollution, as it appeared to receive a relatively high input of ground water, the flow from which tends to mitigate negative effects of poor habitat.

RECOMMENDATIONS

Raccoon Creek

Status of Aquatic Life Uses

Raccoon Creek is currently designated WWH. The performance of the fish community, in meeting the WWH criteria at most locations sampled, and the macroinvertebrate community meeting at the reference location, demonstrate that the use designation is appropriate.

Status of Non-Aquatic Life Uses
All non-aquatic life uses should remain as presently designated in the Ohio Water Quality Standards.

Other Recommendations
Improvement in the performance and further upgrades to the Clyde WWTP are needed before water quality in Raccoon Creek will be sufficient to meet the aquatic life or beneficial use designation. Additionally, wider riparian buffers along the entire stream length are strongly recommended to help minimize nonpoint source impacts. Poorly maintained septic beds servicing houses adjacent to the creek need to be properly maintained.

Future Monitoring Concerns
Compliance inspection and assistance for the Clyde WWTP is apparently needed to help increase the plant's operating efficiency. The amount and chemical composition of leachate from the landfill adjacent to the WWTP should be quantified to more accurately assess impacts to Raccoon Creek.

Little Raccoon Creek, Caswell Ditch and Gries Ditch
Status of Aquatic Life Uses
All three streams are undesignated in the Water Quality Standards. Performance of biological indicators in Caswell Ditch, where the habitat was most severly impacted by recent channelization, indicates that a WWH designation is appropriate for this stream. Although the habitat impacts in Caswell Ditch were partially offset by groundwater flow, the recommended WWH use designation for Gries Ditch is appropriate because it was additionally impacted by nonpoint organic and nutrient enrichment that masked the true potential of the biological communities. Additionally, Gries Ditch, though formerly channelized, is not under an active ditch maintenance program. Similarly, a Warmwater Habitat use designation is appropriate for Little Raccoon Creek.

Status of Non-aquatic Life Uses
All three streams should be designated Agricultural Water Supply and Secondary Contact Recreation.

Other Recommendations
Because organic and nutrient enrichment from livestock wastes is a leading cause of impairment in Gries Ditch, curtailing livestock access to the stream is recommended. A wider riparian buffer is needed on Little Raccoon Creek to minimize siltation.

Future Monitoring Concerns
Because all three sites are regional reference sites, they should be resampled as per the 5 year basin approach.

Table x. Waterbody use designations for the Raccoon Creek Basin. Changes to existing use designations appear in ***bold italics***, or designations based on the 1978 water quality standards for which results of biological field assessments are now available apear as triangles to the right of existing markers.

Stream Segment	**Use Designations**												
		Aquatic Life Habitat						**Water Supply**			**Recreation**		
	SRW	**WWH**	**EWH**	**MWH**	**SSH**	**CWH**	**LRW**	**PWS**	**AWS**	**IWS**	**BW**	**PCR**	**SCR**
Raccoon Creek - headwaters to U.S. Route 6 (RM 3.1)		+							+	+			+
- at RM 13.1		+						+	+	+			+
- Clyde Community Park Pond		+						+	+			+	
- RM 3.1 to mouth		+						+	+			+	
Little Raccoon Creek		▲							▲	▲		▲	
Gries Ditch		▲							▲	▲		▲	
Mills Creek		*							*	*		*	
Snyders Ditch				+					+	+			+
Caswell Ditch		▲							▲	▲		▲	

STUDY AREA

The Raccoon Creek watershed located in eastern Sandusky County flows north from the Sandusky-Seneca County line through the City of Clyde before entering Sandusky Bay. Raccoon Creek is 14.9 miles long draining approximately 34.0 square miles (ODNR, 1967) of predominantly agricultural land. The other tributary in the study area was Little Raccoon Creek, a channelized agricultural ditch. A map of the study area is shown in Figure 2.

The Raccoon Creek watershed lies entirely in the Huron/Erie Lake Plain ecoregion. Like most of northwest and north central Ohio, the land is gently rolling to nearly flat due to glacial activity. Originally the watershed comprised many fens, marshes and swamps, but it has been drained and altered by tiles and manmade ditches that discharge directly to the stream. The soils in the study area are dark colored, heavy clay soils that formed in moderately fine textured lacustrine sediment or glacial till. The major soils include Hoytville-Nappanee, Lenawee-Del Rey, Toledo-Fulton and Toledo associations.

The City of Clyde is the only major urban area in the Raccoon Creek watershed. The watershed is largely rural with land use primarily dedicated to agricultural activities. Approximately 80 percent is used for producing grain crops, specialty crops, and orchards, 1-2 percent is pasture, 7 percent is woodland, and the remaining 11 percent is urban, residential and other uses (Ohio EPA 1994).

There is an extensive area of coastal wetlands along the southern shore of Lake Erie. Approximately 400 acres of wetlands are located in the estuarine portion of Raccoon Creek (RM 3.1 to the mouth). The majority of these wetlands are diked and managed by the State and other conservation clubs. This segment of the stream has an aquatic life use designation of warmwater habitat and is designated primary contact recreation.

Raccoon Creek is impaired by a combination of point and nonpoint pollution sources, including effluent and combined sewer overflow (CSO) discharges from the City of Clyde, and general agricultural runoff from crop production and livestock operations. Inadequate or failed on-site wastewater treatment systems and in place pollutants are also impairing the stream. Agriculture and on-site wastewater treatment systems are the significant pollution sources to Little Raccoon Creek (Ohio EPA 1994). Table 2 shows characteristics of the streams that were sampled during the 1995 survey and the identified pollution sources in the study area.

Conservation tillage practices in farming have increased over the last ten years as indicated by the 1994 Sandusky County Tillage Transect Survey. Almost half of the grain crop acreage was planted using no till or ridge till (50% corn, 46% soybeans). The soybean conservation tillage acres have more than doubled since 1992 (Sandusky SWCD 1994). These two tillage/planting methods maintain crop residue and reduce soil erosion which is the main source of agricultural nonpoint pollution.

The Clyde Dump site is located in the northwest part of the City of Clyde, directly north of the wastewater treatment plant and fire station. It is bordered on the west by Raccoon Creek. The dump is owned by the City and was operated from 1930 to 1969. It was used for disposal of a wide variety of municipal, commercial and industrial wastes. The site was never properly covered or officially closed, and open dumping on the surface of the fill area has continued over the years. As late as June, 1995 the City was placing yard waste on the site.

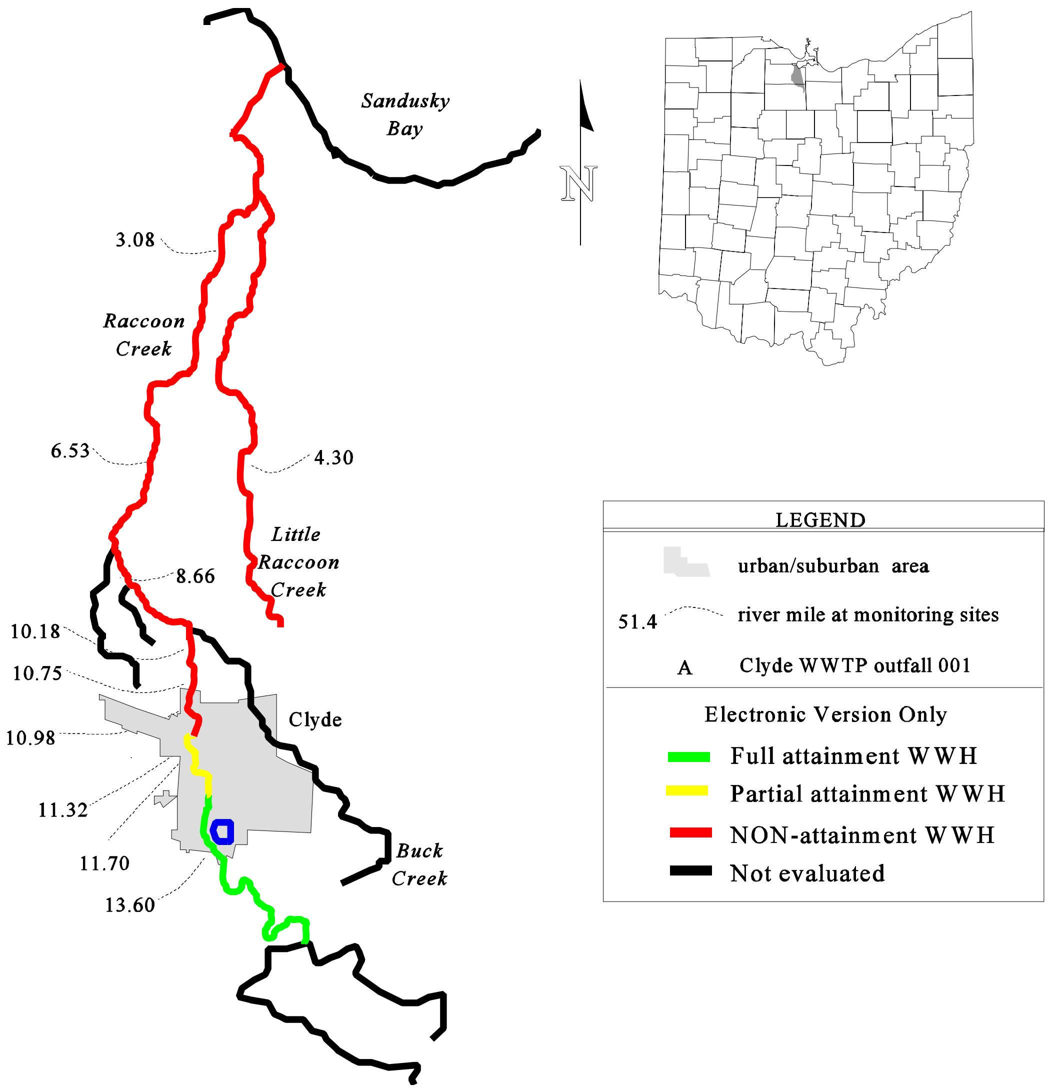


Figure 2. Map of the Raccoon Creek drainage basin showing approximate sampling locations in relation to the City of Clyde and the Clyde WWTP. For a detailed description of sampling locations see Table x. Aquatic life use attainment status, based on results of this study are represented by color coded lines (see Legend).

Ohio EPA files in DSIWM and DERR indicate numerous environmental problems. Leachate discharges from the Clyde Dump site to Raccoon Creek have been observed during several agency inspections since 1987. Chemical analysis of soil, sediment and surface water in 1990 indicated that organic and inorganic compounds are migrating from the site via surface runoff and leachate discharges (Ohio EPA-DERR 1994). Surface water and sediment samples from Raccoon Creek, and one leachate sample from a perimeter ditch surrounding the dump site were collected during the 1995 survey.

In addition to the warmwater habitat aquatic life use designation, Raccoon Creek is designated for use as agricultural and industrial water supply. At RM 13.1, Raccoon Creek is also designated as a public water supply. The recreational use designation is secondary contact from the headwaters to RM 3.1 and primary contact from RM 3.1 to the mouth and in the Clyde Community Park Pond.

Table 2. Stream Characteristics and Significant Identified Pollution Sources in the Raccoon Creek study area. (from ODNR 1967, Ohio EPA 1994)

River/Stream	Length (mi.)	Gradient (ft./mi.)	Drain. Area (sq. mi.)	nonpoint Sources	Point Sources
Raccoon Creek	14.9	12.9	34.0	Agriculture Crop Production Livestock Harvesting Reforestation Residue Mgmt On-site Systems In Place Pollutants	Clyde WWTP
Little Raccoon Creek	-	-	-	Agriculture On-site Systems	
Buck Creek	-	-	-	Agriculture Specialty Crops On-site Systems	

Table 3. Sampling locations in the Raccoon Creek study area, 1995 (C - conventional water chemistry, C_o - conventional plus organics; C_{sm} - sediment metals; C_{so} - sediment organics; D - Datasonde®; F - fish; M- macroinvertebrates).

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 Minute Quadrangle Map
Raccoon Creek				
13.6	$C_{o,sm,so}$	41 16 43 / 82 58 34	ust Limerick Rd	Clyde
13.3	F	41 17 14 / 82 58 54	ust Limerick Rd	Clyde
13.0	M,D	41 17 30 / 82 58 53	dst Limerick Rd	Clyde
11.7	$C_{sm,}$F,M	41 18 27 / 82 59 11	dst Spring St. CSO	Clyde
11.32	$C_{sm,so}$	41 18 45 / 82 59 08	ust Clyde WWTP	Clyde
11.3	F,M	41 18 52 / 82 59 09	ust Clyde WWTP	Clyde
11.02	C_o	41 19 01 / 82 59 08	Clyde WWTP effluent	Clyde
11.01	C,M	41 19 01 / 82 59 08	WWTP mix zone	Clyde
10.98	$C_{o,sm,so}$ F,M	41 19 01 / 82 59 10	dst Clyde WWTP	Clyde
10.75	$C_{o,sm,so,}$M	41 19 11 / 82 59 11	dst landfill	Clyde
10.2	F,M	41 19 43 / 82 59 16	ust TR-223 (Bookmeyer Rd)	Clyde
10.18	C_{sm}	41 19 42 / 82 59 15	ust TR-223 (Bookmeyer Rd)	Clyde
8.7	M	41 19 30 / 83 00 19	TR - 229 (Beeler Rd)	Freemont East
8.66	$C_{sm,so}$	41 20 33 / 83 00 18	TR - 229 (Beeler Rd)	Freemont East
8.1	F	41 20 32 / 83 00 19	ust Stokes Road	Freemont East
6.5	M	41 21 56 / 83 59 52	SR 412	Clyde
6.53	C	41 22 00 / 82 59 22	SR 412	Clyde
5.5	F	41 22 44 / 82 59 37	ust Karbler Road	Clyde
3.6	F	41 24 05 / 82 58 58	Minier Road	Vickery
3.1	M	41 24 28 / 82 58 55	US 6	Vickery
3.08	C_{sm}	41 24 27 / 82 58 55	US 6	Vickery
Landfill perimeter ditch - confluence with Raccoon Cr. at RM 10.76				
0.2	C_o	41 19 06 / 82 59 08	Landfill	Clyde
Little Raccoon Creek				
4.3	C,F,M	41 23 55 / 82 58 25	SR 510	Clyde
Caswell Ditch				
0.8	C,F,M	41 23 52 / 82 44 51	Bogart Rd.	Sandusky
Gries Ditch				
1.0	F,M	41 21 48 / 83 15 26	Staff Rd.	Helena
0.24	C	41 22 13 / 83 14 57	Shade Rd.	Helena

METHODS

All chemical, physical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c); aquatic habitat assessments are based on proceedures outlined in the Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995). Chemical, physical and biological sampling locations are listed in Table 3.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-17). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Numerical endpoints are stratified by ecoregion, use designation, and stream or river size. Three attainment status results are possible at each sampling location - full, partial, or **NON**-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. **NON**-attainment means that **NON**e of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (see Table 1) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices (IBI, MIwb, ICI), the use attainment status (*i.e.*, full, partial, or **NON**), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location.

The attainment status of aquatic life uses (*i.e.*, full, partial, and **NON**-attainment) 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 used include the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The ICI was developed by Ohio EPA (1987b) and further described by DeShon (1995). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information from the Wabash River (Gammon 1976; Gammon *et al.* 1981).

Performance expectations for the principal aquatic life uses in the Ohio WQS (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of the aquatic life use is full if all three indices (or those available) meet the applicable biocriteria, partial if at least one of the indices does not attain and performance is 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 habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates.

Fish Community Assessment

Fish were sampled using wading method pulsed DC electrofishing gear. The wading method was used at a frequency of two samples at each site on Raccoon Creek, and one sample at each site on Little Raccoon Creek, Caswell Ditch and Gries Ditch.

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 3). 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 expressed as ADV/mile to normalize comparisons between segments, sampling years, and other streams and rivers.

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are used to judge aquatic life use attainment and impairment (partial and **NON**-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, and have been experimentally or statistically linked togather. The ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including aquatic community structure and function, often collectively referred to as ecosystem health. While there have been criticisms of misapplying the metaphor of ecosystem “health” compared to human patient “health” (Suter 1993), we are here referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

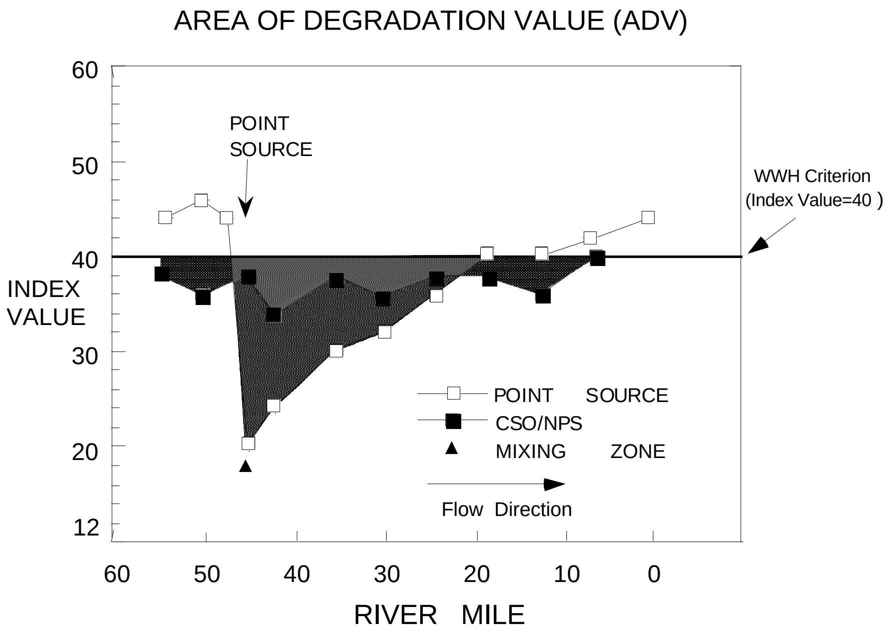


Figure 3. Graphic illustration of the Area of Degradation Value (ADV) based on the WWH ecoregion biocriterion. The index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears as a solid triangle); the filled boxes and dashed shading (area of departure) represent a typical response to a nonpoint source or combined sewer overflow impact. The blended shading represents the overlapping impact of the point and nonpoint sources.

Pollutant Loadings: 1976-1995

The Clyde WWTP is the only NPDES permitted facility discharging to Raccoon Creek since Whirlpool Corporation began sending sanitary and process wastewater to the Clyde WWTP in 1990. The following discussion of pollutant loadings is based on historical data from Monthly Operating Reports (MORs) submitted by the Clyde WWTP as part of the self-monitoring program. The loadings figures are based only on the treated effluent (Outfall 001) and do not include loadings from Combined Sewer Overflows (CSOs) or plant bypasses; both are additional sources of pollutants.

City of Clyde WWTP (2PD00004) - Originally constructed in 1954, then upgraded in 1987, the Clyde WWTP is an advanced treatment facility consisting of influent pumps, bar screens, grit chambers, oxidation ditches with integral clarifiers (ODIC), chlorinators, and tertiary polishing lagoons with continuous flow. Final effluent is discharged to Raccoon Creek at river mile (RM)11.02. The plant has a design flow of 1.9 MGD and an hydraulic capacity of 4.8 MGD. The Clyde WWTP serves a population of 5300 and also receives about 23% of its influent from the Whirlpool Corporation. Combined sewers serve 85% of the city, separate sewers serve 10%, and 5% of the city remains unsewered. The current permit lists only four (4) CSOs: Outfall 003 - the McPherson Highway regulator, Outfall 005-Spring St., Outfall 006-Vine St., and Outfall 008-the Buckeye gate valve. Although the city claims to have eliminated three (3) other CSOs (Outfall 002-weir overflow northwest of the lift station next to a fire station, Outfall 007-Vine and Mulberry overflow, and Outfall 009-South St.) that were not included in the last permit, there is evidence that discharges from at least two of these overflows may still be occurring. The Clyde WWTP is under Director's Findings and Orders to conduct a Toxicity Reduction Evaluation (TRE) and to bring the WWTP into compliance with permit limitations by April 1996.

The annual discharge flow (MGD) from Clyde WWTP Outfall 001 increased beginning in 1990 as a result of additional flow from the Whirlpool Corporation (Figure 4). The average annual flow through the plant from 1976-1989 was 1.12 MGD, increasing to 1.50 MGD for the period 1990-1995. Average flows are still below design flow; however, since 1990 the 95th percentile flows have always exceeded the design flow for the plant.

Average annual loadings of ammonia-nitrogen (NH_3-N) decreased greatly since the plant upgrade in 1987, but with a corresponding increase in nitrate-nitrogen (NO_3-N) (Figure 5). Although the treated wastewater is in a more advanced stage of nitrification at the point of discharge, there appears to have been little reduction in the overall loading of nitrogen to Raccoon Creek. The average NH_3-N load for 1976-1986 was 61.95 kg/day and the average NO_3-N load was 14.87 kg/day. For the period 1987-1994 the average NH_3-N load decreased to 3.72 kg/day, while the NO_3-N load increased to 53.46 kg/day during 1987-1989 (The average NO_3/NO_2-N load for 1989-1994 was 64.54). The total nitrogen load to Raccoon Creek, including NH_3-N, NO_3-N, and NO_2-N, was approximately 78 kg/day during 1976-1986 and only dropped

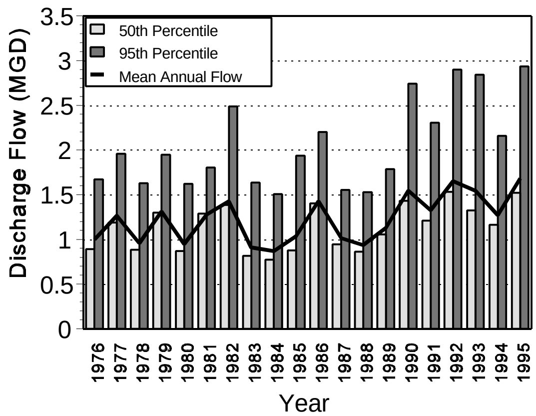


Figure 4. Median and 95th percentile annual discharge (Millions of Gallons per Day - MGD) by the Clyde WWTP to Raccoon Creek, 1976 - 1995.

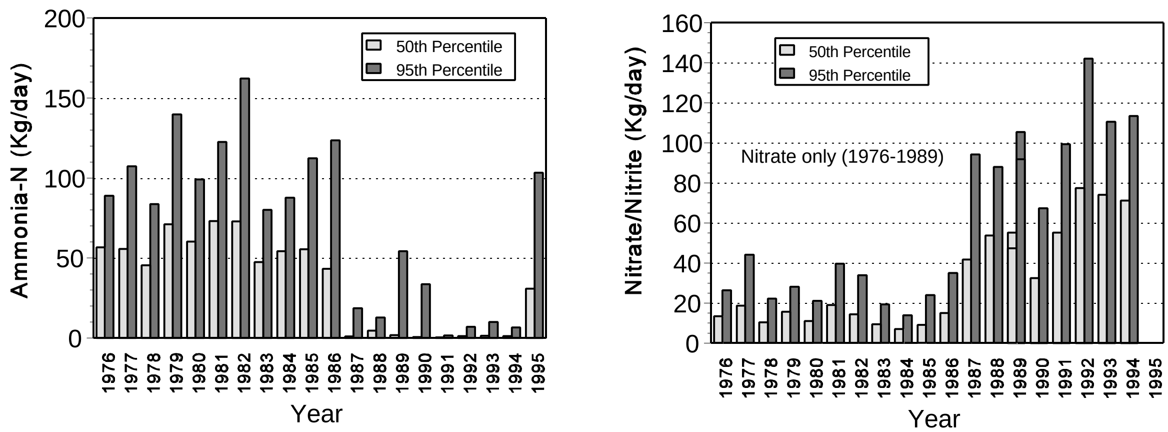
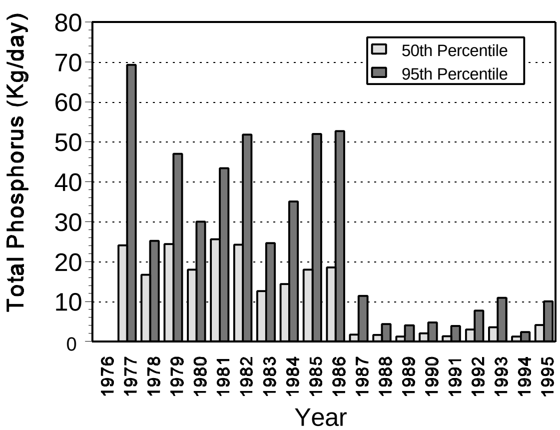


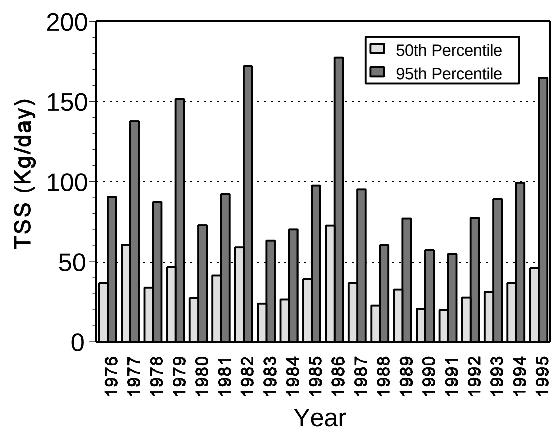
Figure 5. Median and 95th percentile annual loadings of ammonia-nitrogen (left) and nitrite/nitrate-nitrogen (right) by the Clyde WWTP to Raccoon Creek, 1976 - 1995.

to about 63 kg/day during 1987-1994. It should also be noted that the loading of ammonia- N from the Clyde WWTP was unusually high in 1995, similar to loadings typical of the pre-1987 years. There was no nitrate-N data reported in 1995, so no conclusions can be drawn about the total pollutant loading of nitrogen to Raccoon Creek during this time.

Plant data showed a dramatic decrease in total phosphorus and $cBOD_5$ loadings to Raccoon Creek since the 1987 plant upgrade (Figure 6). The average load of total phosphorus was 22.18 kg/day during 1977-1986 and dropped to 2.77 kg/day for the 1987-1995 period. The average $cBOD_5$ load for 1984-1986 was 95.00 kg/day compared to 13.12 kg/day during 1987-1994. However, high loadings of $cBOD_5$ in 1995 were, as with ammonia-N above, similar to pre-1987 $cBOD_5$ loadings. The average $cBOD_5$ load in 1995 was 78.58 kg/day.

The 1987 plant upgrade resulted in only slight reductions in loadings of total suspended solids (TSS) to Raccoon Creek for a few years, but loadings of TSS have been increasing steadily since 1991 (Figure 6), and 1995 loadings were among the highest reported during the 1976-1995 period. The average TSS load for 1976-1986 was 49.52 kg/day compared to 37.60 kg/day during 1987-1995. The average TSS load in 1995 was 58.23 kg/day.





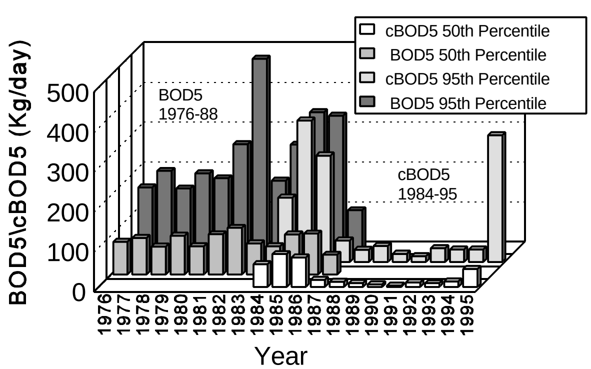


Figure 6. Median and 95th percentile annual loadings of phosphorus (upper left), Total Suspended Solids (upper right), and BOD_5 $cBOD_5$ (lower left) by the Clyde WWTP to Raccoon Creek, 1976 to 1995).

Surface Water Quality

Water Chemistry samples were collected at 10 sites in Raccoon Creek during the 1995 survey. Samples of the Clyde WWTP effluent were also collected. Raw data from these analyses are presented in Appendix Table A-1.

The most upstream site was Raccoon Creek at Limerick Road (RM 13.60), upstream from Clyde. The Water Quality Standards designate RM 13.1 as Public Water Supply, where water was once withdrawn from Raccoon Creek to fill the City's adjacent upground reservoir. However, Raccoon Creek is no longer used as a source of water for either of Clyde's two Reserviors. Sample sites within the City of Clyde were chosen so as to be located downstream from the two remaining combined sewer overflows (CSOs) that discharge to Raccoon Creek upstream from the Clyde WWTP: Outfall 005 at Spring St., and Outfall 003 - the McPherson Hwy. (US 20) regulator. However, there was physical evidence that Outfall 002, the weir overflow at RM 11.31 (downstream of Outfall 003) located adjacent to the fire station, had been discharging despite claims by the City of Clyde that this overflow was eliminated. Consequently, the site downstream from the 003 outfall was relocated after 2 sample passes to RM 11.29 downstream of Outfall 002. Samples were collected from the Clyde WWTP effluent (RM 11.02) and the effluent mix zone (RM 11.01). Sites upstream (RM 10.98) and downstream (RM 10.80) of the old Clyde landfill, which is located directly north of the WWTP, were sampled to identify leachate from the landfill entering Raccoon Creek and potential impacts. The remaining sites at RM 10.18, RM 8.66, RM 6.53 (SR 412), and RM 3.08 (US 6) were chosen to assess impact and recovery of water quality.

Although Limerick Rd. was selected as a control site for the City of Clyde, sample results show elevated levels of nutrients and demand parameters. The dissolved oxygen (D.O.) was low, exceeding water quality standards on 3 of the 6 sample passes (Table 4, Figure 7). Other nutrient levels, especially ammonia-nitrogen, did not exceed water quality standards but were elevated (Figure 8), indicating a pollutant source(s) exists upstream. Fecal coliform levels did not exceed the secondary contact recreation criteria, but did exceed the primary contact recreation criteria which are applicable in the Clyde Community Park Pond located downstream from Limerick Rd. Nonpoint source runoff, on-lot septic systems and a golf course are potential sources of nutrient contamination upstream.

Three water quality standard exceedences at Limerick Rd. on August 9, 1995 (fecal coliform, iron, and copper - Table 4) appear to have been directly related to a heavy rainstorm event which occurred preceding sample collection. Higher levels of fecal coliform and iron are not unusual when associated with runoff or high water following rainstorm events, and exceedences of these parameters also occurred at the other sample sites on this date. Copper exceedences occurred at some of the other sites on this date, but those appear to be directly related to an extremely high level of copper in the WWTP effluent. The source of the copper at the Limerick Rd. site is unknown.

Table 4. Exceedences of Ohio EPA water quality criteria (OAC 3745-1; Ohio EPA 1994) for water quality parameters measured in grab samples taken from the Raccoon Creek study area, 1995. Units are μg/l for metals and organics, number of colonies/100ml for fecal coliform, and mg/l for all other parameters. Mixing zone samples appear in italics.

Stream	River Mile	Parameter (value)
Raccoon Creek	13.60	D.O. (3.3‡‡, 2.8‡‡, 4.0‡) Fecal Coliform (>10000◊◊◊) Cu (41*) Fe (12300*) TDS (510#, 590#, 546#, 700#, 620#)
	11.70	D.O. (4.4‡, 4.3‡, 4.2‡) Fecal Coliform (>10000◊◊◊) Fe (8440*) TDS (512#, 542#, 634#, 550#)
	11.31	TDS (546#, 516#)
	11.29	Fecal Coliform (>10000◊◊◊) Fe (8500*) TDS (546#, 672#)
	11.02 **(Clyde WWTP Effluent sample)**[b]	D.O. (6.0∂∂, 3.5‡‡∂∂, 3.0‡‡∂∂, 3.3‡‡∂∂, 5.7∂∂, 6.9∂∂) Chlorine-T. Resid. (0.25**∂, 0.20**∂, 0.05**∂, 0.15**∂, 0.40**∂, 0.25**∂) Fecal Coliform (>10000◊◊◊∇∇) NH_3-N (10.2*∇∇, 11.3*∇∇, 15.4**∇∇, 6.50*∇∇, 2.64*∇∇, 2.12*∇∇) NO_3/NO_2-N (12.1#) Total P (1.03†∇, 1.36†∇) Cu (411***∇∇) TDS (614#, 616#, 510#, 574#, 692#, 662#) TSS (37∇∇) $cBOD_5$ (11∇)

Table 4. Continued

Stream	River Mile	Parameter (value)
Raccoon Creek	*11.01* *(mixing zone sample)*[a]	*D.O. (3.9‡‡)* *Chlorine-T. Resid. (0.25**, 0.20**, 0.05**, 0.30**, 0.40**, 0.25**)* *Fecal Coliform (>10000◊◊◊)* *NO_3/NO_2-N (11.1#)* *NH_3-N (8.88*, 10.5*, 3.42*, 5.59*, 2.35*)* *Cu (129***)* *Fe (5520*)* *TDS (614#, 554#, 560#, 704#, 650#)*
	10.98	Chlorine-T. Resid. (0.20**, 0.18**, 0.09**, 0.25**, 0.20**, 0.35**) Fecal Coliform (>10000◊◊◊) NH_3-N (7.94*, 10.1*, 3.74*, 5.60*, 2.30*) Cu (100***) Fe (5810*) TDS (618#, 566#, 558#, 738#, 588#)
	10.80	D.O. (4.8‡, 3.6‡‡, 3.5‡‡) Fecal Coliform (>10000◊◊◊) NH_3-N (7.78*, 9.73*, 3.70*, 5.38*, 2.18*) Cu (93***) Fe (5580*) TDS (620#, 652#, 563#, 684#, 648#)
	10.18	D.O. (3.4‡‡, 3.0‡‡, 2.5‡‡) Fecal Coliform (>10000◊◊◊) NH_3-N (7.17*, 9.67*, 3.30*, 4.79*) Cu (90***, 226***) Fe (5700*) TDS (608#, 548#, 552#, 694#, 644#)
	8.66	D.O. (4.5‡, 4.5‡, 4.4‡) Fecal Coliform (>10000◊◊◊) NH_3-N (4.36*, 6.18*, 2.76*) Cu (46**)

Table 4. Continued.

Stream	River Mile	Parameter (value)
Raccoon Creek	8.66- *continued*	Fe (6980*)
		TDS (646#, 598#, 756##, 716#)
	6.53	D.O. (4.9‡, 4.6‡)
		Fecal Coliform (>10000◊◊◊)
		NH_3-N (3.30*)
		Cu (30*)
		Fe (11900*)
		TDS (1210##, 992##, 1400##, 1460##)
	3.08	Fecal Coliform (2000◊, >10000◊◊, 1500◊)
		TDS (1190##, 966##, 1530*##, 1530*##)
		Cu (26*)
		Fe (1020*, 13900*, 1230*, 1080*)
Clyde Landfill		
Perimeter Ditch Leachate	TDS (3950*##)	
(one sample only)		Total P (2.06†)
		Cu (82**)
		Fe (12900*)
		Hg (0.51*)
Little Raccoon Creek	4.30	Fecal Coliform (>10000◊◊◊)
		TDS (1310##, 966##, 2260*##)
		Fe (1690*, 9920*)

a outside mixing zone criteria are applied to mixing zone samples to gauge potential for localized impacts to receiving waters.
b water quality standards do not apply to effluent samples, but are shown to gauge the relative quality of the effluent in comparison to the standards.
† all phosphorus values listed exceed the WQS guideline of 1.0 mg/l.
* exceedence of numerical criterion for prevention of chronic toxicity (CAC).
** exceedence of numerical criterion for prevention of acute toxicity (AAC).
*** exceedence of numerical criterion for prevention of lethality (FAV).
# exceeds numerical criterion for human health 30 day average for Public Water Supplies.
exceeds numerical criterion for human health maximum for Public Water Supplies.
◊ exceedence of average primary contact recreation criterion (fecal coliform 1000/100ml).
◊◊ exceedence of maximum primary contact recreation criterion (fecal coliform 2000/100ml).
◊◊◊ exceedence of maximum secondary contact recreation criterion (fecal coliform 5000/100ml).

Table 4. Continued.

‡	exceedence of average warmwater habitat dissolved oxygen concentration (5.0 mg/l).
‡‡	exceedence of minimum warmwater habitat dissolved oxygen concentration (4.0 mg/l).
‡‡‡	exceedence of the nuisance prevention minimum criterion (2.0 mg/l).
∂	violation of NPDES permit daily maximum concentration limit.
∂∂	violation of NPDES permit daily minimum concentration limit.
∇	exceedence of NPDES 30 day average concentration limit.
∇∇	exceedence of NPDES 7 day average concentration limit.

D.O. concentrations fell below water quality standards at the site downstream from the Spring St. CSO on 3 out of 6 sample passes; however, levels were not as low as they were at Limerick Rd. Exceedences of the water quality standards for fecal coliform and iron occurred at both sites that were downstream of CSOs (RM 11.70 and RM 11.29) on August 9, 1995, after the rainstorm (as noted above), but generally the CSOs did not appear to have caused significant impacts to water quality in Raccoon Creek on most of the sampling dates. Any impacts that may have occurred further downstream as a result of discharges from the CSOs would be obscured since Raccoon Creek is being so severely impacted by the WWTP discharge. It should be noted that Outfall 002 (the weir overflow northwest of the lift station next to the fire station) has been discharging and is the reason for relocation of the sampling site at RM 11.31 to RM 11.29. The City of Clyde claims that this overflow was eliminated; therefore, Outfall 002 was not listed as a permitted outfall in the WWTP's most recent NPDES Permit. However, *it was observed discharging on August 9, 1995 following the rainstorm* and, on other sample dates, solids (including what appeared to be pieces of toilet paper) from recent discharges were observed covering the rip rap and weeds around the old discharge pipe.

Inadequately treated sewage being discharged from the Clyde WWTP (RM 11.02) on a regular basis, is having a severe impact on the water quality in Raccoon Creek. Effluent samples collected during this survey indicated numerous NPDES Permit violations, and the Clyde WWTP effluent also exceeded the water quality standards (WQS) applicable in Raccoon Creek for several parameters. Several pollutants in the effluent were extremely elevated (see Table 4), resulting in water quality standard violations in Raccoon Creek to RM 3.08 at US 6 (the most downstream site in the survey). On high flow days, such as August 9, 1995 following the heavy rainfall, the WWTP effluent is receiving comparatively less treatment, resulting in additional and more severe violations of the NPDES Permit limitations and WQS, and adding substantially to toxic conditions in Raccoon Creek.

Dissolved oxygen, total residual chlorine (TRC), and ammonia-n (NH_3-N) concentrations violated the Clyde WWTP NPDES Permit limitations on every sample date (Table 4). Dissolved oxygen in the effluent exceeded Water Quality Standards in 3 of 6 samples. A D.O. sag is evident downstream from RM 10.98 with recovery beginning around RM 8.66 (Figure 7). Total residual chlorine was only measured at the effluent and at the two sites downstream of the effluent (RM 11.01, RM 10.98).

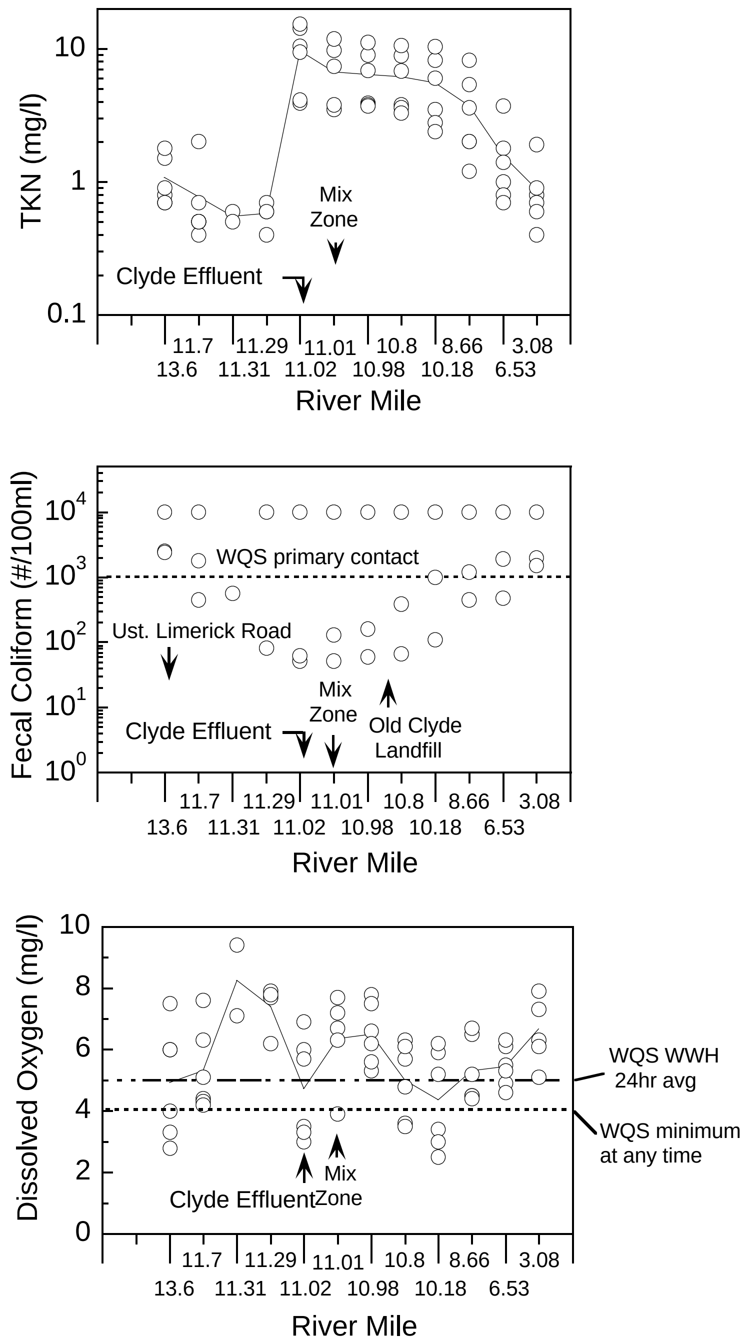


Figure 7. Concentrations of water quality parameters indicative of organic enrichment (TKN - top, and fecal coliform bacteria - center) and dissolved oxygen in relation to the Clyde WWTP, 1995.

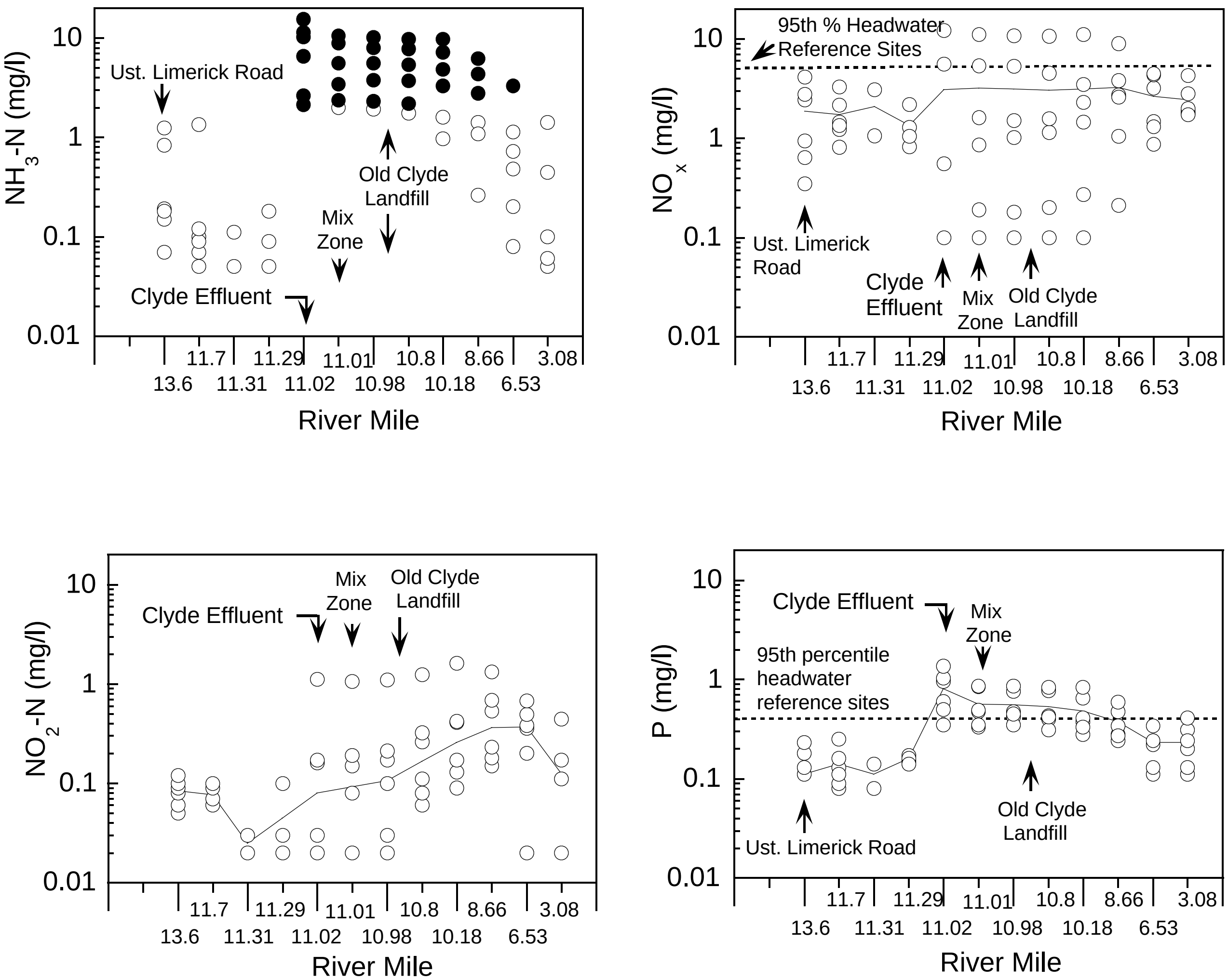


Figure 8. Concentrations of primary nutrients in grab samples collected from Raccoo n Creek, 1995 in relation to the Clyde WWTP. The filled circles in the plot of NH_3-N (top left) represent exceedences of WQS.

At RM 10.98, more than 200 ft. downstream of the effluent, the concentration of TRC still had not declined significantly, and exceeded water quality standards in every sample. Ammonia-n (NH_3-N) also exceeded water quality standards in all 6 effluent samples. Very high concentrations of NH_3-N in the WWTP effluent caused water quality standards exceedences in Raccoon Creek for 4-5 miles downstream from the WWTP (Table 4, Figure 7). Total phosphorus levels were slightly elevated due to the WWTP discharge. Phosphorus concentrations in the effluent exceeded the WQS guideline of 1.0 mg/l in 2 of 6 samples. Additionally, nitrate and nitrite-nitrogen concentrations were highly elevated, exceeding the 95th percentile levels of state wide reference sites.

An extremely high concentration of copper (41 μg/l) was discharged from the WWTP on August 9, 1995, following a heavy rainfall event. This level of copper in the effluent exceeded the NPDES permit limitation and exceeds the WQS final acute value (FAV). The concentration of copper in Raccoon Creek also exceeded the FAV at every site downstream of the WWTP through RM 10.18. Concentrations of copper downstream of RM 10.18 continued to exceed WQS acute (AAC) and chronic (CAC) aquatic criteria at the rest of the sites sampled in this survey.

Samples were collected at sites bracketing the old Clyde landfill (RM 10.98, RM 10.80); however, the water quality in Raccoon Creek has been so degraded by the WWTP effluent, that any adverse impacts which may be occurring from runoff or leachate from the landfill are masked.

Water Column Organics

Priority volatile organic compounds (VOCs) were detected only in and downstream from the Clyde WWTP effluent (Table 5). None of the VOCs detected exceeded established water quality standards. Of the five VOCs detected, three (1,4 dichlorobenzene, chloroform and toluene) are commonly used industrial solvents. Also, a host of non-priority pollutants, apparently related to the manufacture of resins (as solvents and plasticizers), were detected only in and downstream from the Clyde WWTP effluent (see Appendix Table x). The presence of these industrial solvents exclusively in and downstream from the WWTP effluent demonstrates an industrial origin. Specifically, the absence of these compounds in samples collected immediately downstream from the CSO discharge at RM 11.29 and upstream from the WWTP discharge indicates that the source of these compounds is tied in directly to the plant.

Palmitic acid (hexadecanonic acid), a constituent of many naturally occurring fats and oils used in the manufacture of soaps and waxes, was present at all sampling locations. Derivatives of palmitic acid and related compounds (*i.e.*, esters and alcohols) were most numerous at RM 13.6, implicating a possible source upstream from Clyde.

Organochlorine pesticides were present in concentrations below established water quality standards. Total concentration and number of pesticides detected were uniform across samples, excluding the single samples taken downstream from the CSO (RM 11.29) and from the landfill

Table 5. Summary of organic priority and nonpriority pollutants detected in surface wate r samples collected in Raccoon Creek in 1995. All results are reported in ug/l.

	RACCOON CK - RM 13.80 @ Limerick Rd.				RACCOON CK - RM11.29 dst. US 20 and CSO discharge	
PARAMETER*	7/26/95	8/21/95	9/18/95		9/18/95	
Priority Volatile Organic Compounds (VOCs)						
Bromodichloromethane	--	--	--		--	
Chloroform	--	--	--		--	
1,4 Dichlorobenzene	--	--	--		--	
Toluene	--	--	--		--	
1,2,4 Trimethylbenzene	--	--	--		--	
Priority Semi-Volatile Organics (Base Neutral/Acid Extractable)						
NONE DETECTED						
Non-priority Volatile and Semi-Volatile Organics (see Appendix Table __ for list)						
Number Detected**	5	1	20		1	
Pesticides						
Aldrin	--	--	--		--	
a-BHC	--	--	0.006		--	
b-BHC	--	--	--‡		--	
d-BHC	0.007	--	0.004		--	
y-BHC	0.003	--	--		--	
4,4'-DDE		--	--	0.003		0.005
Dieldrin	0.004	0.005	0.007†		--	
Endosulfan II	0.004	0.003	--		--	
Endrin	--	--	--		--	
Endrin Aldehyde	--	--	0.018		--	
Hexachlorobenzene	--	0.010	--		--	
PCBs						
NONE DETECTED						

* Only Pollutants that were detected at least once are listed.

** Only the number of non-priority pollutants tentatively identified is presented here. Tentatively identified compounds are listed on the data sheets for the 20 most prominent compounds. Additional compounds may be present if 20 are listed.

-- Indicates that the pollutant was not detected (i.e. not present or below the method detection limit) at this site.

† Numerical value is an estimated quantity.

‡ Data were unusable. (The compound may or may not be present).

Table 5. Continued. Summary of organic priority and nonpriority pollutants detected in surfac e water samples collected in Raccoon Creek in 1995. All results are reported in ug/l.

	CLYDE WWTP EFFLUENT Outfall 001			RACCOON CK - RM 10.98 ust. Clyde Landfill		
PARAMETER*	7/26/95	8/21/95	9/18/95	7/26/95	8/21/95	9/18/95
Priority Volatile Organic Compounds (VOCs)						
Bromodichloromethane	--	--	0.6	--	--	0.5
Chloroform	6.9	6.1	3.7	5.1	4.3	3.3
1,4 Dichlorobenzene	2.5	1.7	0.5	1.9	1.3	--
Toluene	1.4	7.1	--	0.7	3.5	--
1,2,4 Trimethylbenzene	--	0.5	--	--	--	--
Priority Semi-Volatile Organics (Base Neutral/Acid Extractable)						
NONE DETECTED						
Non-priority Volatile and Semi-Volatile Organics (see Appendix Table __ for list)						
Number Detected**	20(+1VOC)	20	20	20(+2VOC)	20	20
Pesticides						
Aldrin	0.006	--	--	0.004	--	--
a-BHC	--	--	--	--	--	--
b-BHC	0.0008	--	--	--	0.004	--
d-BHC	--	--	--	--	--	--
y-BHC	0.007	--	0.011	--	0.003	0.012
4,4'-DDE	--	--	--	--	--	0.002
Dieldrin	0.003	0.008	0.003	--	0.017	0.004
Endosulfan II	--	0.009	--	--	0.006	--
Endrin	--	0.003	0.004	0.003	0.003	0.006
Endrin Aldehyde	--	--	--	--	--	--
Hexachlorobenzene	--	0.009	--	--	0.007	--
PCBs						
NONE DETECTED						

* Only Pollutants that were detected at least once are listed.

** Only the number of non-priority pollutants tentatively identified is presented here. Tentatively identified compounds are listed on the data sheets for the 20 most prominent compounds. Additional compounds may be present if 20 are listed.

-- Indicates that the pollutant was not detected (i.e. not present or below the method detection limit) at this site.

† Numerical value is an estimated quantity.

‡ Data were unusable. (The compound may or may not be present).

Table 5. Continued. Summary of organic priority and nonpriority pollutants detected in surfac e water samples collected in Raccoon Creek in 1995. All results are reported in ug/l.

PARAMETER*	CLYDE LANDFILL LEACHATE perimeter ditch 7/26/95	RACCOON CK - RM 10.8 dst. Clyde Landfill 7/26/95	8/21/95	9/18/95
Priority Volatile Organic Compounds (VOCs)				
Bromodichloromethane	--	--	--	--
Chloroform	--	3.8	3.4	2.1
1,4 Dichlorobenzene	--	1.5	1.0	--
Toluene	--	--	1.1	--
1,2,4 Trimethylbenzene	--	--	--	--
Priority Semi-Volatile Organics (Base Neutral/Acid Extractable)				
NONE DETECTED				
Non-priority Volatile and Semi-Volatile Organics (see Appendix Table __ for list)				
Number Detected**	1	20	20	20
Pesticides				
Aldrin	--	--	0.002	--
a-BHC	--	--	--	--
b-BHC	--	--	--	--
d-BHC	--	--	--	--
y-BHC	--	0.009	--	0.010
4,4'-DDE	0.005		--	--
--				
Dieldrin	--	0.007	0.009	0.003
Endosulfan II	--	--	0.005	--
Endrin	--	0.003	--	0.005
Endrin Aldehyde	--	--	--	--
Hexachlorobenzene	--	--	0.009	--
PCBs				
NONE DETECTED				

* Only Pollutants that were detected at least once are listed.

** Only the number of non-priority pollutants tentatively identified is presented here. Tentatively identified compounds are listed on the data sheets for the 20 most prominent compounds. Additional compounds may be present if 20 are listed.

-- Indicates that the pollutant was not detected (i.e. not present or below the method detection limit) at this site.

† Numerical value is an estimated quantity.

‡ Data were unusable. (The compound may or may not be present).

perimeter ditch where only the ubiquitous DDT metabolite 4,4'-DDE was present (Table 5). Polychlorinated biphenyls were not detected in any surface water sample.

Sediment Chemistry

Sediment metal concentrations were highest in Raccoon Creek immediately downstream from the Clyde WWTP (Figure 8, Table 6). Total metal concentrations (see Figure 8 for description) at the two sampling locations downstream of the WWTP outfall were highly elevated compared to the upstream reference sample at RM 13.6, and background levels given for Ontario (Persaud et al. 1994) and Illinois (Kelly and Hite 1984). In particular, concentrations of copper, lead and zinc increased dramatically, and were present in levels expected to have moderate to strong impacts on benthic communities. Metal concentrations were also slightly elevated downstream of the Spring Street CSO compared to background levels, reflecting contamination from urban runoff. Chromium concentrations were highly elevated at the upstream reference site (RM 13.6), seemingly unrelated to urban or street runoff. However, new home construction adjacent to the creek at RM 13.6 may have added metals via use of pressure treated wood products.

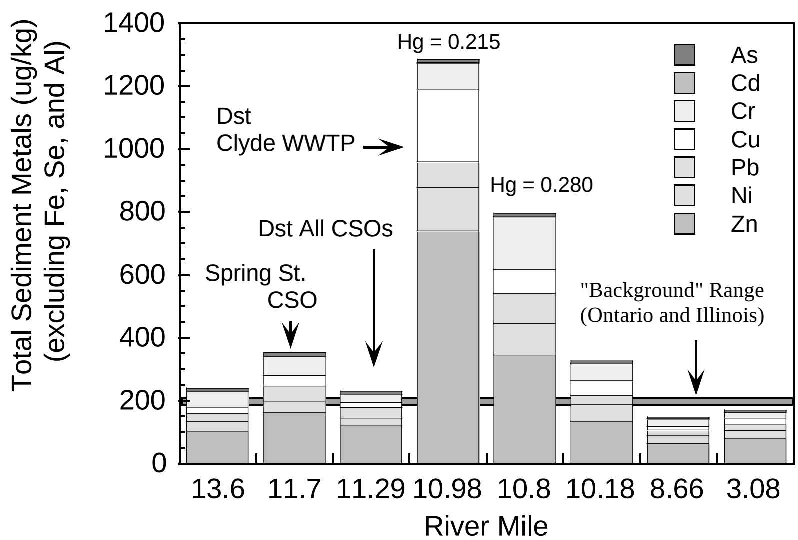


Figure 8. Sediment metal concentration found in Raccoon Creek in relation to CSOs and the Clyde WWTP. The thick stippled line represents the background concentration cited for Ontario (Persaud et al. 1994) and Illinois (Kelly and Hite 1984). Mercury concentrations are less than method detection limits at all location except where noted.

Table 6. Dry weight concentrations (mg/kg or ppm) of metals in sediment samples from Raccoon Creek, 1995. Metal concentrations were compared to published accounts of toxicity thresholds (Long and Morgan 1991, Persaud and Hayton 1994) and background levels (Kelly and Hite 1984) and ranked accordingly (see footnotes).

RM - Site Description	As	Cd	Cr	Cu	Fe	Pb	Ni	Se	Zn	Al	Hg
RM 13.60 - Raccoon Creek @ Limerick Rd.	9.1[†]	0.238	**50.4**[b†]	19.9	21400	26.2	29.7	<1.40	103[a]	24700	--
RM 11.70 - Raccoon Creek dst. Spring St.	12.8[a†]	0.621	**58.7**[c†]	34.9[†]	27200[a]	48.5[a†]	34.0[†]	<1.70	163[a†]	37900	--
RM 11.29 - Raccoon Creek dst. US 20 (dst CSO discharge)	8.48[†]	0.256	27.4[a]	15.7	16100	35.0[†]	21.5	<0.898	121[a†]	13900	--
RM 10.98 - Raccoon Creek ust. Clyde Landfill	11.4[a†]	**2.50**[b†]	**81.4**[c†]	**232**[c‡]	25200[a]	**81.4**[b†]	137[*‡]	<3.07	**740**[c*†]	34000	**0.215**[b†]
RM 10.80 - Raccoon Creek dst. Landfill perimeter ditch	10.5[†]	1.17[a†]	**168**[c*‡]	75.7[a†]	23800[a]	**95.5**[b†]	101[*‡]	<1.41	**344**[c*†]	26200	**0.280**[b†]
RM 10.18 - Raccoon Creek @ TR 223	7.07[†]	0.625	**55.8**[b†]	45.7[†]	14600	29.8	52.4[*†]	<0.962	134[a†]	15800	--
RM 8.66 - Raccoon Creek @ TR 229	5.32[†]	0.228	22.8	12.3	15000	18.1	23.4	<1.17	64.4	15300	--
RM 3.08 - Raccoon Creek @ US 6	6.83[†]	0.271	19.1	17.8	15600	20.3	<24.6	<1.23	79.9	17300	--

[a]Elevated, [b]**Highly Elevated**, [c]**Extremely elevated**; rankings based on Kelly and Hite (1984).
[*]Exceeds ER-M value described by Long and Morgan (1990).
[†]Exceeds Lowest Effect Level described in Persaud and Hayton (1994).
[‡]Exceeds Severe Effect Level described in Persaud and Hayton (1994).

Polycyclic aromatic hydrocarbons (PAHs) downstream from the CSO at RM 11.29 were present in concentrations likely to have a negative impact on benthic biota (Long and Morgan 1991; Persaud et al. 1994). Concentrations declined precipitously, however, at subsequent downstream sites to near background levels. The presence of PAHs is likely related to contamination from urban runoff (*i.e.*, automobile emissions) and not local industries as concentrations decreased below the Clyde WWTP outfall relative to upstream. Polychlorinated biphenyls (PCBs) were not detected in sediment samples collected upstream from the Clyde WWTP, but progressively increased in concentration downstream from it, suggesting contamination from the WWTP and possibly landfill leachate. Metabolic DDT residue (4,4'-DDE) was detected at the upstream reference site, and 4,4'-DDT was present downstream from the WWTP. Because DDT is rapidly degraded to more stable and persistent metabolites (e.g., DDE) DDT detections are more likely the result of atmospheric deposition or possibly deliberate releases of recently discovered material. DDE, however, is persistent in the environment, and is likely the residue, in part, of historical domestic DDT use.

Table 7. Dry weight concentrations of priority organic pollutants detected in sediments collected from Raccoon Creek, 1995. Concentrations preceded by an (*) exceed the Effects Range-Median (ER-M) value for the specific pollutant or the class total (*i.e.*, total PAHs) described by Long and Morgan (1991). Selected parameter concentrations were ranked (see footnotes) based on classifications described by Kelly and Hite (1984).

	RACCOON CREEK				
PARAMETER	RM 13.60	RM 11.29	RM 10.98	RM 10.80	RM 8.66
VOLATILE ORGANIC COMPOUNDS (mg/kg or ppm)					
Toluene	--	--	--	0.4	--
POLYCYCLIC AROMATIC HYDROCARBONS (mg/kg or ppm)					
Acenaphthene	--	0.8	--	--	--
Anthracene	--	1.3	--	--	--
Benzo [B&K] Fluoranthene	--	7.2	2.3	2.1	0.7
Benzo [A] Pyrene	--	3.7	--	0.9	--
Benzo [GHI] Perylene	--	2.7	1.1	0.9	--
Benzo [A] Anthracene	--	4.1	--	0.9	--
Chrysene	--	4.0	--	1.0	--
Dibenz [A,H] Anthracene	--	1.2	--	--	--
Fluoranthene	--	9.8	2.0	1.9	0.6
Fluorene	--	0.8	--	--	--
Indeno [1,2,3-CD] Pyrene	--	3.3	1.4	1.2	--
Phenanthrene	--	6.5	1.0	1.1	--
Pyrene	--	7.4	1.6	1.5	0.6
Total PAH	--	52.8	9.4	11.5	1.9

Table 7. Continued.

PARAMETER	RACCOON CREEK RM 13.60	RM 11.29	RM 10.98	RM 10.80	RM 8.66
PHENOLS (mg/kg or ppm)					
3&4 Methylphenol	--	--	7.6	1.3	--
ORGANOCHLORINE PESTICIDES AND PCBs (μg/kg or ppb)					
4,4'-DDE	6.1	--	--	--	--
4,4'-DDT	--	--	*16	--	--
Total DDT	6.1	--	16[a]	--	--
Dieldrin	*9.5[a]	***13[b]**	--	6.5[a]	--
Methoxychlor	--	12	22	16	5.7
PCB-1254	--	--	67	130	190
Total PCBs	--	--	67[a]	130[a]	190[a]

[a]Elevated; **[b]Highly elevated**; **[c]Extremely elevated**, after Kelly and Hite (1984).
-- indicates parameter was below the method detection limit.

Physical Habitat for Aquatic Life

Raccoon Creek

The quality of the macrohabitat at 8 fish sampling locations in Raccoon Creek was evaluated and scored using the Qualitative Habitat Evaluation Index (QHEI - Rankin 1989). All stream segments evaluated showed evidence of prior channel modifications. Habitat attributes characterizing modified channels were more prevalent than those characteristic of natural streams (Table 8). All segments had either little or no sinuosity, and poor riffle development. Bed loads of fine gravel and sand, especially in the reach downstream of Clyde, embedded substrates and eliminated the functionality of riffles at several locations. Accordingly, the average QHEI score was 41.8 ± 4.5 s.d., showing little variation among sites (Table 8).

Little Raccoon Creek

Little Raccoon Creek at RM 4.3 is a very small, formerly channelized, periodically intermittent, headwater stream (drainage area = 1.9 mi^2). Modified habitat characteristics remain its dominant features (Table 8). Because of the limited drainage area, little recovery (*i.e.*, increased channel development, sinuousness, scouring of fine substrates) is likely to occur.

Caswell Ditch

Caswell Ditch, as its name implies, is a regularly maintained channelized ditch. It has relatively homogeneous fine substrates, no riffles, and little channel development. The QHEI was 18.0, reflecting a limited ability to support a normal WWH fauna.

Gries Ditch

Gries Ditch, during the channelization process, was scraped down to bedrock. Consequently, the bottom substrates were primarily limestone bedrock and fragmented cobbles which helped to augment positive habitat attributes. The creek had recovered much of its free flowing character, however scares from channelization remained in the lack of channel development and limited instream cover. The QHEI for Gries Ditch was 55.5, indicating marginal habitat for the support of a normal WWH fauna.

Table 8. QHEI matrix for sites sampled in the Raccoon Creek basin, 1995.

Key: ■ = WWH Attributes; ● = MWH Attributes, High Influence; ▲ = MWH Attributes, Moderate Influence

River Mile	QHEI	Gradient (ft/mile)	No channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max. Depth > 40cm	Low/No Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	**Total H.I. MWH Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total M.I. MWH Attributes**	**MWH H.I./WWH Ratio**	**MWH M.I. WWH Ratio**
(05 -045) Raccoon Creek																																		
13.3	45.0	12.8	■				■				■		3		●	●	●		3	▲	▲			▲	▲			▲	▲	▲		7	1.00	2.75
11.7	37.5	25.0	■			■	■				■		4				●		1		▲			▲		▲		▲	▲	▲		6	0.40	1.60
11.3	34.5	11.1									■		1	●	●	●	●		4	▲	▲			▲	▲	▲		▲	▲	▲		8	2.50	6.50
11.0	45.5	11.1									■		1	●	●	●	●		4	▲	▲			▲	▲			▲	▲	▲		7	2.50	6.00
10.2	48.5	15.6						■			■		2		●	●			2	▲	▲			▲	▲			▲	▲	▲	▲	8	1.00	3.67
8.1	41.5	8.5					■	■			■		3		●	●	●		3	▲	▲		▲	▲	▲			▲	▲	▲	▲	9	1.00	3.25
5.5	42.5	4.1							■		■		2	●	●		●		3	▲	▲		▲	▲	▲				▲	▲		7	1.33	3.67
3.6	39.5	3.5									■		1	●			●		2	▲	▲		▲	▲	▲			▲	▲	▲	▲	9	1.50	6.00
(05-053) Little Raccoon Creek																																		
4.3	38.5	10.4		■									1			●	●	●	3	▲	▲		▲	▲	▲	▲		▲	▲		▲	9	2.00	6.50
(05-058) Caswell Ditch																																		
0.5	18.0	7.3											0	●	●	●	●	●	5		▲		▲	▲	▲	▲		▲	▲		▲	8	6.00	.☹
(05-223) Gries Ditch																																		
1.0	55.5	14.7	■	■		■	■						5			●	●	●	3		▲			▲	▲			▲	▲	▲		6	0.67	1.67

Biological Assessment: Macroinvertebrate Community

Raccoon Creek

Macroinvertebrates were collected at 10 sampling locations in Raccoon Creek from above Clyde near Limerick Rd. (RM 13.0) to Minier Rd. (RM 3.6). Quantitative artificial substrate and qualitative natural substrate data were collected at each site. Results are summarized in Table 9 and graphically depicted in Figure 9. The Invertebrate Community Index (ICI) score at each site was the principal tool used to assess macroinvertebrate community condition. Scores were judged against the ICI biocriterion numeric score of 34 established for the Huron-Erie Lake Plain (HELP) ecoregion of Ohio (OAC 3745-1-07, Table 7-17).

ICI scores ranged from 32 (marginally good) at the most upstream sampling location (RM 13.0) to 0 (very poor) in the Clyde WWTP mixing zone (RM 11.0) (Figure x). Macroinvertebrate community condition declined rapidly in Clyde with ICI scores falling to 22 (fair) downstream from the Spring St. CSO (RM 11.7) and 12 (poor) at US 20 (RM 11.3) upstream from the Clyde WWTP and downstream from the old Whirlpool Corp. discharge. Downstream from the Clyde WWTP, scores remained in the poor range at four sampling locations between RMs 10.98 and 8.1. Fair communities were collected at the two most downstream sampling locations at SR 412 (RM 6.5) and Minier Rd. (RM 3.6).

Macroinvertebrate sampling results at RM 13.0 upstream from Clyde reflected the prevailing background condition of the primarily rural and agricultural Raccoon Creek watershed. The ICI score of 32 was a nonsignificant departure of the HELP biocriterion and indicated that community structure and function was reasonably comparable to the ecoregional reference condition established for the WWH aquatic life use. Overall taxa diversity at the site was high with good numbers of pollution sensitive and intermediate mayflies, caddisflies, and midges. One factor depressing the ICI score, however, was a high percentage of pollution tolerant organisms; these were primarily individuals of the two snail genera *Ferrissia* (limpets) and *Physella* (pond snails).

Significant changes occurred in the macroinvertebrate community within Clyde. ICI scores fell rapidly and reflected negative community responses to ambient conditions. Included were declining overall taxa richness, fewer numbers and kinds of mayflies, and higher proportions of pollution tolerant organisms. Sites upstream from the Clyde WWTP reflected fair and poor community conditions (ICI=22 downstream from Spring St. and ICI=12 downstream from US 20, respectively). These changes were attributed to CSO outfalls located at Spring St. and US 20. Stream-bed siltation, heavy algal growths, and/or septic odors were noted at the two sampling locations.

Sampling in the Clyde WWTP mixing zone revealed extremely degraded conditions. The macroinvertebrate community was severely impaired as evidenced by the ICI score of 0. Taxa diversity was very low and the community was totally predominated by tolerant aquatic worms (98% of the organisms collected). Substrates at the site were heavily covered with sewage bacteria and stream water was sudsy, very turbid, and full of particulate matter. Though the ICI score of 0 suggested a toxic response, the presence of high numbers of organisms indicative of organic enrichment reflected an environment overwhelmed by poorly treated sewage wastes. Similar conditions persisted at the next several sampling locations. ICI scores at four sites between the WWTP (RM 10.98) and T-229 (RM 8.7) ranged between 4 and 12 (poor); macroinvertebrate communities were typified by low taxa diversity and predominance of pollution tolerant organisms. Sewage bacteria covered substrates at all but the T-229 location. There was no evidence of an additional impact associated with leachates discharged from the old Clyde landfill immediately downstream from the WWTP. Such impacts, if present, were masked by the prevailing degraded conditions.

Table 9. Summary of macroinvertebrate data collected from artificial substrates (quantitativ e sample) and natural substrates (qualitative sample) in the Raccoon Creek study area, 1995. Mixing zone samples are denoted by *italics*.

Stream River Mile	Density (#/ft^2)	Quant. Taxa	Qual. Taxa	Total EPT[a]	Total Taxa	ICI	Evaluation
Raccoon Creek (1995)							
13.0	139	38	43	8	57	32[ns]	Marginally Good
11.7	361	24	29	4	43	22[*]	Fair
11.3	510	23	27	4	39	12[*]	Poor
11.0	*3901*	*8*	*12*	*1*	*17*	*0*[*]	*Very Poor*
10.98	715	17	10	1	23	10[*]	Poor
10.75	225	21	9	1	27	4[*]	Poor
10.2	517	19	15	3	29	12[*]	Poor
8.7	213	23	30	4	44	12[*]	Poor
6.5	498	31	29	2	42	20[*]	Fair
3.6	149	28	12	1	35	22[*]	Fair
Raccoon Creek (1986)							
13.0	111	20	40	8	54	16[*]	Fair
11.7	140	33	37	9	57	22[*]	Fair
11.3	1378	9	11	0	16	2[*]	Poor
10.2	1590	15	18	1	26	4[*]	Poor
8.7	661	23	37	3	46	12[*]	Poor
6.5	1256	22	20	3	33	20[*]	Fair
3.1	274	28	30	4	46	24[*]	Fair
Raccoon Creek (1983)							
13.0	57	20	23	7	34	18[*]	Fair
11.7	274	28	21	8	40	24[*]	Fair
11.3	83	4	12	0	15	0[*]	Very Poor
10.2	937	12	22	1	26	4[*]	Poor
8.7	259	10	13	0	16	0[*]	Very Poor
6.5	569	21	17	0	31	8[*]	Poor
3.1	196	18	13	1	25	8[*]	Poor
Little Raccoon Creek (1995)							
4.3	115	25	22	1	38	22[*]	Fair
Caswell Ditch (1995)							
0.5	283	38	30	8	54	48	Exceptional

Table 9. Continued.

Stream River Mile	Density (#/ft^2)	Quant. Taxa	Qual. Taxa	Total EPT[a]	Total Taxa	ICI	Evaluation
Gries Ditch (1995)							
1.0	142	29	40	10	52	40	Good
Gries Ditch (1984)							
1.0	131	33	30	12	46	36	Good

Qualitative Evaluations

Stream/River Mile	Qual Taxa	QCTV[b]	Qual EPT[a]	Relative Density	Predominant Organisms	Narrative Evaluation
Little Raccoon Creek (1983)						
4.3	17	38.3	1	Low-Mod.	Elmid beatles Isopods	F
2.5	22	30.3	1	Moderate	Elmid beatles Isopods	F
Caswell Ditch (1985)						0.8
30	35.0		6	Low	Burrowing mayflies	MG

Ecoregion Biocriteria: Huron-Erie Lake Plain (HELP)

INDEX	WWH	EWH	MWH[b]
ICI	34	46	22

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

[ns] Non-significant departure from ecoregional biocriterion ($\leq$ 4 ICI units).

[*] Significant departure from ecoregional biocriterion; poor and very poor results are underlined.

[b] Modified Warmwater Habitat for channel modified areas.

Modest recovery occurred at the last two sampling locations at SR 412 (RM 6.5) and Minier Rd. (RM 3.6). ICI scores increased to 20 and 22, respectively, which, though indicative of fair macroinvertebrate community condition, did not equal the score achieved upstream from Clyde and continued to not meet WWH ecoregional expectations. Macroinvertebrate communities at these two locations reflected improved taxa diversity and increased number of organisms associated with improving water quality. Imbalances in the communities continued to exist, including the complete absence of mayflies and high percentages of pollution tolerant organisms. The effect of the Clyde WWTP discharge had a persistent negative influence on Raccoon Creek macroinvertebrates from the WWTP to near the lake-influenced lower reach of the stream (a distance of nearly 7.5 miles).

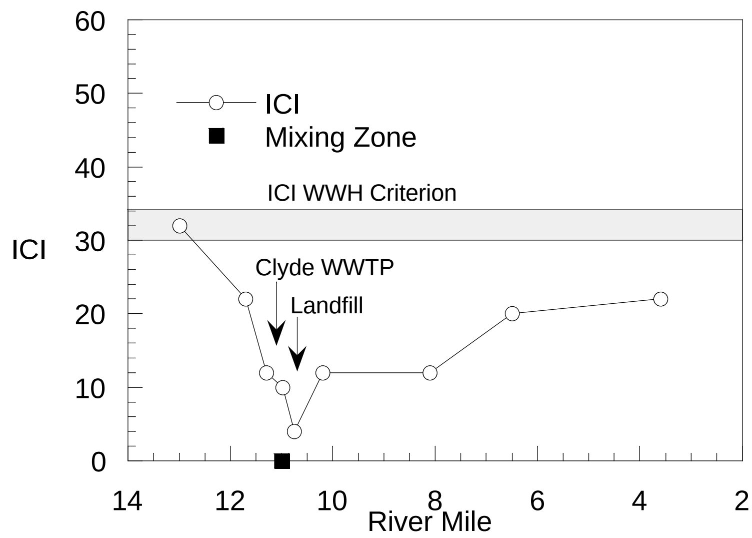


Figure 9. Longitudinal performance of the Invertebrate Community Index (ICI) for Raccoon Creek, 1995 in relation to the Clyde WWTP discharge and an adjacent landfill.

Little Raccoon Creek, Caswell Ditch, Gries Ditch

HELP reference sites sampled in the Raccoon Creek study area included Little Raccoon Creek at SR 510 (RM 4.3), Caswell Ditch at Bogart Rd. (RM 0.5), and Gries Ditch at T-59 (RM 1.0). ICI scores at the three locations were 22 (fair), 48 (exceptional), and 40 (good), respectively. Both Caswell Ditch and Gries Ditch supported diverse macroinvertebrate communities collected from artificial and natural substrates although natural habitat quality was suboptimal at the Caswell Ditch site. Despite evidence of moderate nonpoint influences in the watersheds (heavy algal growths, manure odors, and/or unrestricted livestock grazing), numerous mayfly and caddisfly taxa predominated the communities and accounted for more than 70% of the organisms collected from each stream. Sampling results from Little Raccoon Creek suggested more severe impairment from physical factors than observed in the other two streams. Overall taxa diversity was depressed and no mayflies were collected. Physically, the stream was a ditch with fine bottom sediments and large amounts of oxygen consuming detritus.

Biological Assessment - Fish Communities

Raccoon Creek

Fish communities at 6 of the 8 sites sampled in Raccoon Creek met applicable WWH criteria for the Huron-Erie Lake Plain (HELP) ecoregion (Table 10). Longitudinally, scores tended to decrease downstream from the Clyde WWTP, except for the far field site at RM 10.2 (Figure 10). Habitat at RM 10.2 was the best observed in the creek (Table 10), which likely accounts for the performance of the fish community at that site. Examination of the individual metrics composing the Index of Biotic Integrity (IBI) shows an increasing percentage of pollution tolerant fishes in the catch downstream from RM 10.2 (Figure 11), suggesting degraded water quality is responsible for the poor community performance observed there. Other metrics scored poorly, but did not show a strong longitudinal pattern, reflecting the overall degraded quality of the instream habitat. Avoidance of the Clyde WWTP effluent by fishes was evident in the near field sample collect on 31 August 1995 when stream flows were very low, suggesting toxic conditions. Also noticed were sludge deposits and sewage fungus, indicating that pollution loadings from the Clyde WWTP are responsible, to a large degree, for the degraded water quality in the downstream reach. An unsewered discharge was noticed at RM 3.5, and likely represents an additional contribution to degraded water quality in the lower reach (see Figure 7 - plot of fecal coliform by river mile).

Little Raccoon Creek

Poor habitat quality limited the performance of the fish community in Little Racoon Creek. An abundance of decaying vegetation in the stream margins and silt in the stream bed may have contributed to poor water quality through consumption of dissolved oxygen.

Caswell and Gries Ditches

Performance of the fish communities in Caswell and Gries Ditches serve to illustrate the dichotomy between streams moderately and severely impacted by nonpoint pollution. Caswell Ditch, having been recently channelized, had extremely poor instream habitat, yet the fish assemblage met the WWH criterion. Conversely, Gries Ditch had marginally good habitat but did not support a fish assemblage meeting the WWH criterion. The difference was Gries Ditch was heavily enriched by cattle dung and unsewered discharges. Caswell Ditch demonstrates that fish communities in heavily modified ditches can meet WWH criterion for the Huron-Erie Lake Plain ecoregion.

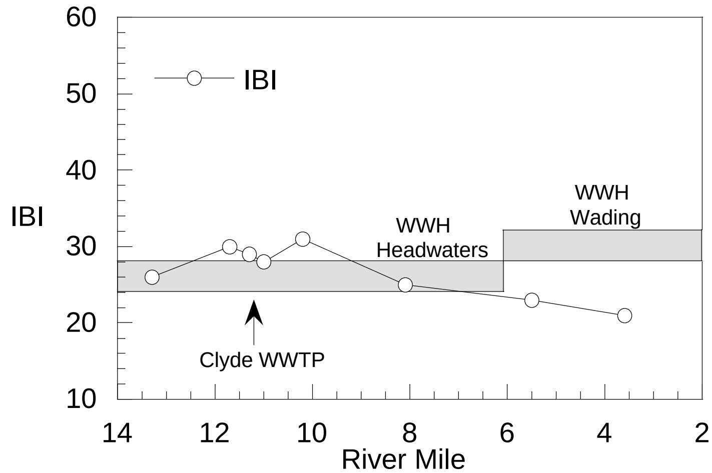


Figure 10. Longitudinal performance of the Index of Biotic Integrity (IBI) by river mile for Raccoon Creek in relation to the Clyde WWTP

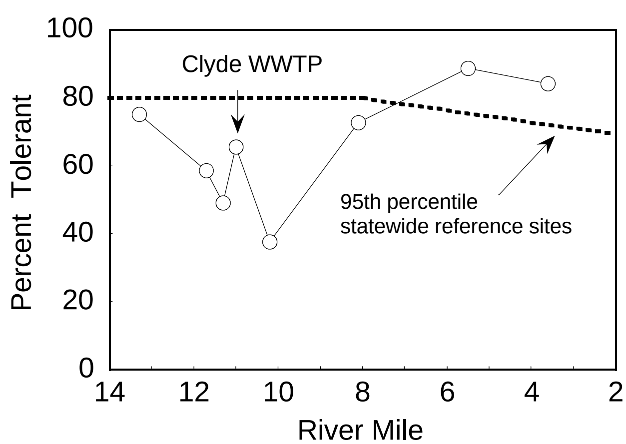


Figure 11. Mean percentage of tolerant fishes by number in electrofishing catches from Raccoon Creek, 1995, in relation to the Clyde WWTP.

Table 10. Fish Community indices from samples collected in the Racoon Creek study area , 1983-1995.

River Mile	Mean Number Species	Cumulative Species	Mean Rel. No (No./0.3 km)	Mean Rel. Wt. (kg/0.3 km)	QHEI	Mean MIwb	Mean IBI	Narrative Evaluation[a]
Raccoon Creek (1995)								
13.3	9.5	12	258	2.2	45	NA	26[ns]	Poor
11.7	9.5	11	644	6.7	38	NA	30	Fair
11.3	9.5	14	692	6.9	35	NA	29	Fair
11.0	7.5	12	460	8.7	46	NA	28	Fair
10.2	8.5	12	682	14.5	49	NA	31	Fair
8.1	10.0	12	578	4.0	42	NA	25[ns]	Poor
5.5	10.0	11	275	2.8	43	4.1[*]	23[*]	V.Poor/Poor
3.6	9.5	12	117	1.8	40	4.2[*]	21[*]	V.Poor/Poor
Raccoon Creek (1986)								
13.2	10.7		715		74	NA	29	Fair
11.7	8.7		713		61	NA	31	Fair
11.2	3.0		20		46	NA	14[*]	Very Poor
10.2	6.3		99			NA	18[*]	Poor
8.6	7.3		117		42	NA	19[*]	Poor
6.5	8.0		153		52	NA	19[*]	Poor
3.7	12.0		223		51	5.8[*]	21[*]	Poor
Raccoon Creek (1983)								
13.2	11.0		1714			NA	22[*]	Poor
11.6	11.0		3446			NA	22[*]	Poor
11.3	1.0		64			NA	12[*]	Very Poor
11.1	1.0		37			NA	12[*]	Very Poor
10.2	5.0		85			NA	16[*]	Very Poor
10.1	6.0		561			NA	20[*]	Poor
8.5	8.0		451			NA	16[*]	Very Poor
6.5	14.0		487			NA	22[*]	Poor
3.1	17.0		527			6.1[*]	20[*]	Fair/Poor
Little Raccoon Creek (1995)								
4.3	4.0	4	40	0.2	40	NA	14[*]	Poor
Little Raccoon Creek (1983)								
4.3	5.0	5	194		55	NA	25[ns]	Poor

Table 10. Continued.

River Mile	Mean Number Species	Cumulative Species	Mean Rel. No (No./0.3 km)	Mean Rel. Wt. (kg/0.3 km)	QHEI	Mean Miwb	Mean IBI	Narrative Evaluation[a]
Caswell Ditch (1995)								
0.5	5.0	5	353	1.34	18	NA	30	Fair
Caswell Ditch (1985)								
0.5	6.0		142		44	NA	26[ns]	M.Good
Gries Ditch (1995)								
1.0	5.0	5	150	0.42	56	NA	20*	Poor
Gries Ditch (1984)								
0.9	8.0	8	292		60	NA	16*	Poor

Ecoregion Biocriteria: Huron-Erie Lake Plain

	IBI		MIwb	
Site Type	WWH	EWH	WWH	EWH
Headwaters	28	50	NA	NA
Wading	32	50	7.3	9.4

NA - MIwb not applicable to Headwater streams (drainage area < 20 km^2).
a - Narrative Evaluations are based on the next highest ecoregional biocriteria (see OEPA 1988 for explanation).
ns - Nonsignificant departure from biocriteria ($\leq$4 IBI units or $\leq$0.5 MIwb units).
* - Indicates significant departure from applicable biocriteria (>4 IBI units or >0.5 MIwb units).

Changes in Chemical Water Quality: 1983 - 1995

Water quality samples have been collected at comparable locations from Raccoon Creek in 1983, 1985, 1986 and 1995. The only appreciable improvements in water quality parameters have been a decrease in phosphorus concentrations both upstream and downstream from the Clyde WWTP, and increased average dissolved oxygen concentrations downstream from the WWTP (Figure 12). Ammonia-nitrogen concentrations measured in 1995 were at levels toxic to aquatic life, and are similar to those recorded in 1983 prior to the most recent plant upgrades. Nitrate concentrations were higher in 1995 both upstream and downstream of the plant. Increased inorganic nitrogen concentrations upstream of the plant are unexplained, but may represent increased discharge of poorly treated wastes from failing on site septic systems. Increased concentrations downstream of the plant are the result of nitrification of ammonia-nitrogen at the WWTP and loadings of nitrite and nitrate-nitrogen to the plant from the Whirlpool Corp. Highly elevated concentrations of nitrite-nitrogen were found in water quality grab samples collected downtream from the Whirlpool Corp. effluent in 1983 and 1986. Whirlpool tied into the Clyde WWTP in 1990, but they have not addressed the nitrite-nitrate issue in their pretreatment program. That the Whirlpool Corp. is passing on the loads to the Clyde WWTP is evidenced by nitrite-nitrate concentrations downtream from the WWTP in 1995 similar to or exceeding those found in 1983 or 1986 (Figure 12).

Improved dissolved oxygen concentrations downstream from the WWTP reflect the decreased $cBOD_5$ loadings coinciding with the plant upgrade (see ***Pollutant Loadings*** sections). However, oxygen concentrations downstream from the plant remain depressed and show similar longitudinal trends between years, demonstrating continued loadings of oxygen demanding pollutants, notably ammonia-nitrogen, to Raccoon Creek by the Clyde WWTP. However, a recently built home adjacent to the creek at RM 13.6 may have accounted for the difference in chromium and zinc via use of pressure treated wood products. Interestingly, zinc is used to purify fats for soaps (Prager 1995), and palmitic acid, a component of palm oil used in the manufacture of soap, and related compounds were present only at RM 13.6 (see *Water Column Organics*), suggesting a possible link.

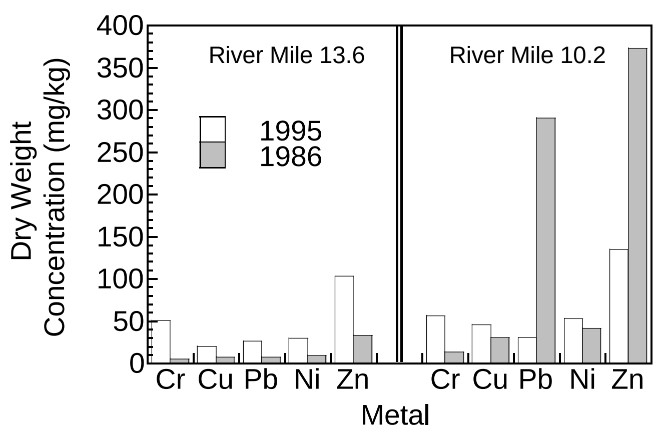
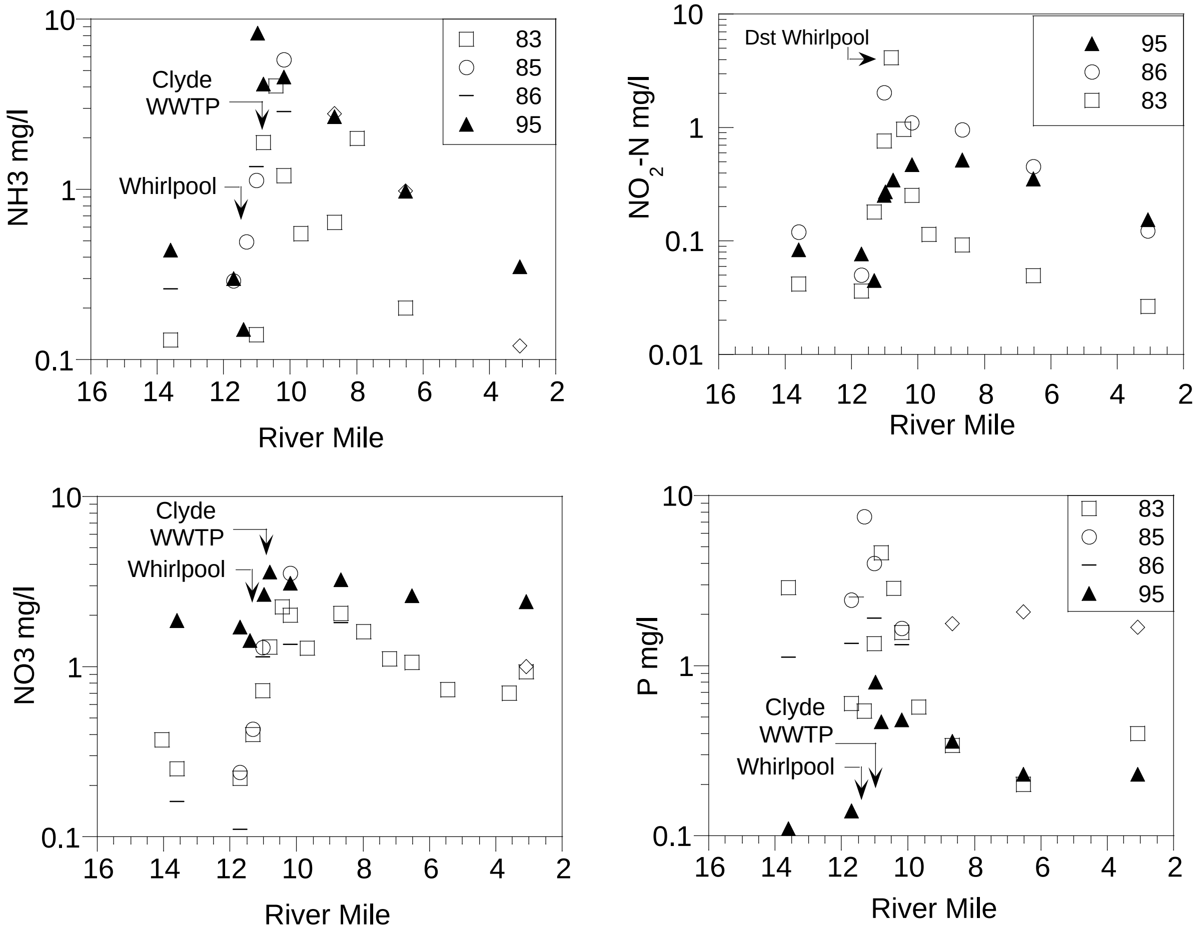


Figure 13. Dry weight concentrations of metals in sediments collected from similar locations in Raccoon Creek, 1995 and 1986.



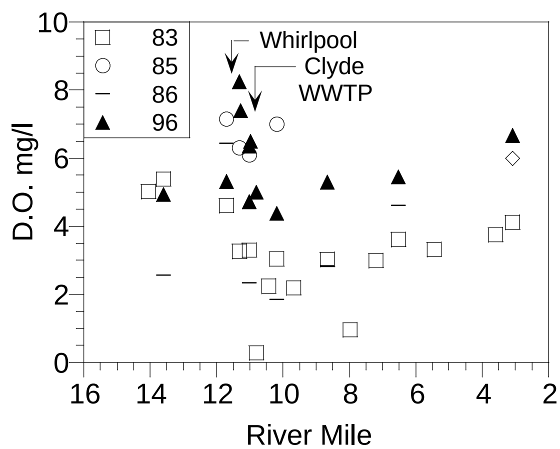


Figure 12. Mean concentrations of nutrients (ammonia-nitrogen,nitrite-nitrogen, nitrate-nitrogen and phosphorus) and dissolved oxygen measured in water quality grab samples, 1983, 1985, 1986 and 1995, in relation to the Clyde WWTP and the defunct Whirlpool discharge.

Changes in Macroinvertebrate Communities: 1983 - 1995

Raccoon Creek

Previous Ohio EPA surveys in Raccoon Creek were conducted in 1983 and 1986 at sampling locations similar or identical to those in 1995. Results indicate that no change in macroinvertebrate community quality has occurred between 1983 and 1995 (Figure 14). The Area of Degradation per stream mile for the ICI was nearly identical between sampling years (Table 9). During all sampling years, fair communities were collected upstream from the WWTP and Whirlpool Corp. in areas affected by CSOs and urban runoff. Severe degradation and very poor quality communities were found beginning below the Whirlpool discharge in 1983 and 1986 and below the Clyde WWTP in 1995. The Whirlpool discharge was diverted to the Clyde WWTP in 1989. Poor communities persisted for at least 3 miles downstream (8 miles in 1983) and in no year did complete recovery occur before Raccoon Creek waters became impounded by Lake Erie.

The only significant difference between survey results in 1983 and 1986 compared to 1995 was the 1995 achievement of the ICI biocriterion at the upstream sampling location near Limerick Rd. However, in both 1983 and 1986, Raccoon Creek was intermittent at the upstream sampling location which had a profound influence on macroinvertebrate community results. This more than any other factor likely explained the difference and apparent improvement at this sampling location.

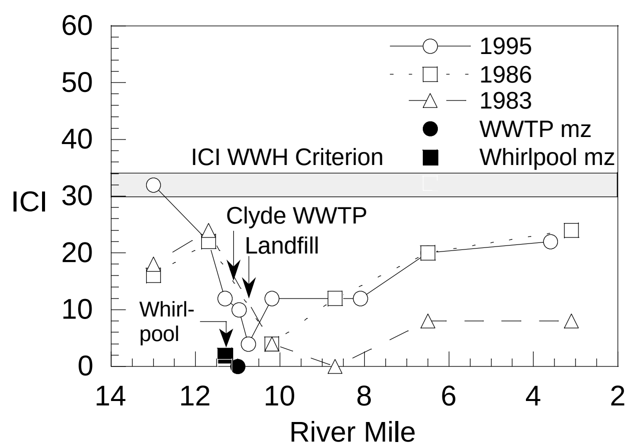


Figure 14. Comparison of ICI scores from biological surveys of Raccoon Creek 1995, 1986 and 1983 in relation to the Clyde WWTP and the former Whirlpool discharge (tied into Clyde WWTP in 1989.

Gries Ditch
Previous macroinvertebrate sampling in Gries Ditch was conducted at the same sampling location (T-59) in 1984. Similar results were achieved with an ICI score of 36 indicating a good quality community.

Changes in Fish Communities: 1983 - 1995

Raccoon Creek
In contrast to the macroinvertebrate community, fish community performance improved significantly immediately downstream from the Clyde WWTP and the former Whirlpool Corporation discharge compared to that measured previously in 1983 and 1986 (Figure 15). The improvement reflects upgrades to the plant implemented in 1988 and the Whirlpool Corporation tie in to the plant in 1989. In the past surveys, fish communities were not achieving WWH criteria downstream of either discharge due to low dissolved oxygen and toxicity, especially in the Whirlpool Corporation effluent. A toxic impact is still associated with the Clyde WWTP effluent, as avoidance of the effluent by fish was noted in the second near field sample collected on August 31, 1995, and ammonium concentrations were highly elevated in water quality grab samples. Accordingly, the miles of stream in partial attainment increased to 1.0 in 1995 from 0.0 in 1986, without significant improvement in the number of stream miles in full attainment (Table 11). A latent dissolved oxygen sag due to loadings of organic wastes and reduced nitrogen was apparent from RM 10.8 to 6.5 (Figure 15) and is a large factor contributing to impairment of aquatic life uses in Raccoon Creek. The disparity between macroinvertebrates and fishes is likely related to the poor plant operation in 1995, as short term perturbations in water quality are likely to be more manifest in the macroinvertebrate community than the fish community given the generally degraded habitat in Raccoon Creek.

Little Raccoon Creek
Little Raccoon Creek was previously survey in 1983. No significant difference in community performance was noted between 1983 and 1995, as the IBI scores only differed by 3 points (Table 10). The consistently poor community performance measured in both surveys demonstrates that MWH is an appropriate use designation for this stream.

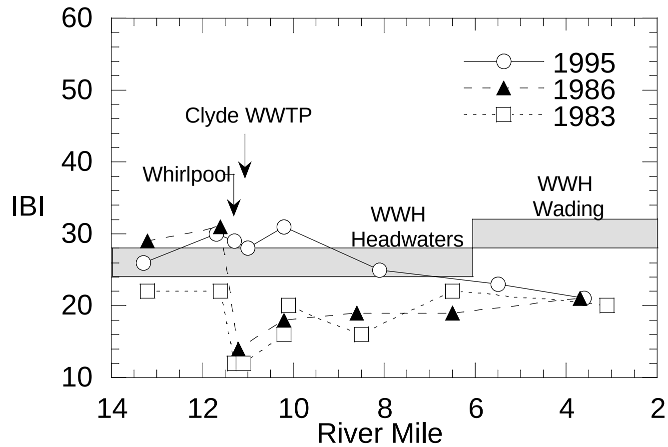


Figure 15. Comparison of IBI scores from biological surveys of Raccoon Creek 1995, 1986 and 1983 in relation to the Clyde WWTP and the former Whirlpool discharge (tied into Clyde WWTP in 1989).

Table 11. Area of Degradation (ADV) statistics for similar segments in Raccoon Creek sampled in 1995, 1986 and 1983.

	Biological Index Scores					Area of Degradation Values			Attainment Status (Miles)			
Year Index	Upper RM	Lower RM	Mini- mum	Maxi- mum	Mean	ADV	ADV/ Mile	Neg. % of Criteria	Full	Partial	NON	POOR/VP
1995												
IBI			21	31	26.6	120	12.4	26.2				
ICI	13.6	3.6	0	22	11.5	1090	141.6	47.2	1.6	1.0	11.4	3.7
1986												
IBI			14	31	21.6	396	41.7	42.7				
ICI	13.2	3.1	2	24	12.4	1207	147.2	49.1	1.9	0.0	8.2	8.2
1983												
IBI			12	22	18.0	471	46.6	38.8				
ICI	13.2	3.1	0.0	12	5.6	1867	227.7	75.9	0.0	0.0	10.1	10.1

REFERENCES

Anonymous. 1992. Wastewater treatment/disposal for small communities, manual, EPA/625/R-92/005

Budavari, S., M. J. O'Neil, A. Smith, and P. E. Heckelman. 1989. The Merck index, an encyclopedia of chemicals, drugs, and biologicals, eleventh edition. Merck and Co., Inc. Rahway, N.J.

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

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

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

Gordon, N.D., T.A. McMahon, B.L. Finlayson. 1992. Stream Hydrology: An introduction for
ecologists. John Wiley & Sons, Ltd. Chichesler, West Susex, England. 526 pp.

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

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

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

Karr, J. R., R. C. Heidinger, and E. H. Helmer. 1985. Effects of chlorine and ammonia from wastewater treatment facilities on biotic integrity. J. Water Polut. Control Fed., 57:912-915.

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

Leonard , P.M. and D.J. Orth. 1986. Application and testing of an Index of Biotic Integrity in small, cool water streams. Trans. Am. Fish. Soc. 115: 401-414.

Long, E.R. and L.G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the national status and trends program. Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration, Seattle, Washington.

Ohio Department of Natural Resources. 1960. Gazetteer of Ohio Streams, Report No. 12, Ohio Water Plan Inventory . Columbus, Ohio.

Ohio Environmental Protection Agency. 1983. Amendments to the Muskingum River Basin Water Quality Management Plan: Rocky Fork Mohican River Basin Comprehensive Water Quality Report.

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

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

___ 1988. Ohio nonpoint source assessment. Division of Water Quality Monitoring and Assessment, Nonpoint Source Management Section Columbus, Ohio.

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

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

___ 1989c. Ohio EPA manual of surveillance methods and quality assurance practices, updated edition. Division of Environmental Services, Columbus, Ohio.

___ 1990a. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

___ 1990b. Compendium of biological results from Ohio rivers, streams and lakes: 1989 edition. Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

___ 1990c. State of Ohio Nonpoint Source Assessment. Volume 5. Lake Erie West Region. Division of Surface Water, Nonpoint Source Program Management Section, Columbus, Ohio.

___ 1993. State of Ohio Water Quality Standards. Chapter 3745-1 of the Ohio Administrative Code.

Omernik, J.M. 1988. Ecoregions of the conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.

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

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

Reash R.J. and T.M. Berra. 1989. Incidence of fin erosion and anomalous fishes in a polluted stream and a nearby clean stream. Water, Air, Soil Pollution. 47: 47-63.

Reash R.J. and T.M. Berra. 1987. Comparison of fish communities in a clean-water stream and an adjacent polluted stream. Am. Midl. Nat. 118: 301-322.

Reash R.J. and T.M. Berra. 1986. Fecundity and trace-metal content of creek chubs from a metal contaminated stream. Trans. Am. Fish. Soc. 115: 346-351.

Steedman, R.J. 1988. Modification of an index of biotic integrity to quantify stream quality in southern Ontario. Canadian Journal of Aquatic Science. 45: 492-501.

Thurston, R. V., R. C. Russo, and K. Emerson. 1979. Aqueous ammonia equilibrium - Tabulation of percent un-ionized ammonia. U.S. EPA Environmental Research Laboratory, Duluth, MN. EPA-600/3-79-091.

U.S. Dept. of Agriculture, 1981. Soil Survey of Ottawa County Ohio.

____ 1963. Soil Survey of Wood County Ohio.

U.S. Environmental Protection Agency. 1976. Quality Criteria for Water. Washington, D.C.

Warren, C. E. 1971. Biology and Water Pollution Control. W. B. Saunders Co., Philadelphia, Pa. 434 pp.

Appendix Tables

Table A-1. Results of water quality grab samples collected from Raccoon Creek, 1995 by river mile and date.

RM	Date	Temp C	pH s.u.	D.O. mg/l	Cl^- mg/l	CaCO3 mg/l	BOD5 mg/l	Sp. Cond. umhos	cBOD5 mg/l	COD mg/l	Oil-Grease mg/l
13.60	July 12, 1995	19.2	7.63	6.0	--	357	<2.0	768	<10	--	--
13.60	July 26, 1995	19.8	7.48	3.3	--	403	<2.0	879	18	--	--
13.60	Aug. 09, 1995	20.7	7.42	7.5	--	256	5.0	583	47	--	--
13.60	Aug. 21, 1995	23.0	7.80	6.0	--	344	<2.0	811	<10	--	--
13.60	Sept. 06, 1995	18.3	7.54	2.8	--	428	4.5	1080	16	--	--
13.60	Sept. 18, 1995	14.5	7.59	4.0	--	378	7.6	884	36	--	--
11.70	July 12, 1995	19.1	7.62	6.3	--	349	<2.0	780	<10	<1.0	--
11.70	July 26, 1995	20.7	7.65	4.4	--	340	<2.0	784	16	<1.0	--
11.70	Aug. 09, 1995	21.1	7.37	7.6	--	201	3.2	455	40	<1.0	--
11.70	Sept. 06, 1995	18.5	7.74	4.3	--	396	<2.0	964	18	<1.0	--
11.70	Sept. 18, 1995	15.5	7.64	4.2	--	324	3.1	806	18	<1.0	--
11.31	July 12, 1995	20.4	8.12	9.4	--	354	<2.0	804	12	1.41	--
11.31	July 26, 1995	22.3	7.94	7.1	--	342	<2.0	816	21	<1.0	--
11.29	Aug. 09, 1995	21.4	7.49	7.7	--	201	3.1	451	31	1.06	--
11.29	Aug. 21, 1995	23.8	7.98	7.9	--	311	<2.0	796	12	<1.0	--
11.29	Sept. 06, 1995	19.8	8.04	6.2	--	394	<2.0	1030	23	<1.0	--
11.29	Sept. 18, 1995	16.1	7.99	7.8	--	285	<2.0	734	19	<1.0	--
11.02	July 12, 1995	23.4	6.97	6.0	0.25	279	7.6	1050	43	1.16	--
11.02	July 26, 1995	25.6	7.00	3.5	0.2	222	24	1014	83	1.09	--
11.02	Aug. 09, 1995	24.4	6.84	3.0	0.05	188	20	943	67	--	--
11.02	Aug. 21, 1995	26.2	7.07	3.3	0.15	256	8.0	983	6.8	38	1.74
11.02	Sept. 06, 1995	24.3	7.00	5.7	0.4	241	3.5	1100	33	<1.0	--
11.02	Sept. 18, 1995	20.6	7.18	6.9	0.25	216	1070	11	36	<1.0	--
11.01	July 12, 1995	23.4	7.18	7.7	0.25	292	9.1	1010	37	--	--
11.01	July 26, 1995	26.0	7.22	3.9	0.2	241	28	978	71	--	--
11.01	Aug. 09, 1995	22.3	7.40	6.7	0.05	197	10	612	40	--	--
11.01	Aug. 21, 1995	25.7	7.30	6.3	0.3	266	8.0	945	35	--	--
11.01	Sept. 06, 1995	24.2	7.16	6.3	0.4	256	4.3	1090	36	--	--
11.01	Sept. 18, 1995	20.4	7.30	7.2	0.25	225	11	1040	36	--	--
10.98	July 12, 1995	23.4	7.14	7.8	0.20	294	8.5	1000	34	1.49	--
10.98	July 26, 1995	26.4	7.22	5.3	0.18	241	27	969	65	<1.0	--
10.98	Aug. 09, 1995	22.3	7.21	6.6	0.09	193	10	574	44	--	--
10.98	Aug. 21, 1995	26.3	7.29	6.2	0.25	266	7.1	935	32	1.05	--
10.98	Sept. 06, 1995	24.2	7.17	5.6	0.2	256	5.9	1090	36	<1.0	--
10.98	Sept. 18, 1995	20.6	7.34	7.5	0.35	227	9.7	1040	39	1.1	--
10.80	July 12, 1995	24.0	7.18	4.8	--	297	10	1000	31	<1.0	--
10.80	July 26, 1995	27.6	7.20	3.6	--	246	28	968	68	1.54	--
10.80	Aug. 09, 1995	22.3	7.32	6.3	--	191	10	574	28	--	--
10.80	Aug. 21, 1995	26.3	7.39	5.7	--	280	6.2	937	29	<1.0	--
10.80	Sept. 06, 1995	23.9	7.21	3.5	--	261	5.8	1090	26	<1.0	--
10.80	Sept. 18, 1995	20.4	7.38	6.1	--	236	9.7	1050	42	<1.0	--
10.18	July 12, 1995	22.7	7.29	3.4	--	302	8.8	986	31	--	--
10.18	July 26, 1995	3.0	253	22	--	974	62	--	--	--	--
10.18	Aug. 09, 1995	22.4	7.47	5.9	--	200	8.8	566	37	--	--
10.18	Aug. 21, 1995	25.3	7.55	5.2	--	282	4.9	926	26	--	--

Table A-1. Continued.

RM	Date	Temp C	pH s.u.	D.O. mg/l	Cl^- mg/l	CaCO3 mg/l	BOD5 mg/l	Sp. Cond. umhos	cBOD5 mg/l	COD mg/l	Oil-Grease mg/l
10.18	Sept. 06, 1995	22.0	7.26	2.5	--	270	5.8	1100	36	--	--
10.18	Sept. 18, 1995	18.2	7.58	6.2	--	246	9.4	1030	33	--	--
8.66	July 12, 1995	21.4	7.65	5.2	--	334	10	983	28	--	--
8.66	July 26, 1995	23.3	7.57	4.5	--	283	12	994	38	--	--
8.66	Aug. 09, 1995	21.4	7.55	6.5	--	177	7.3	482	47	--	--
8.66	Aug. 21, 1995	24.5	7.40	4.5	--	302	6.5	939	15	--	--
8.66	Sept. 06, 1995	20.7	7.28	4.4	--	305	6.3	1140	30	--	--
8.66	Sept. 18, 1995	14.9	7.68	6.7	--	314	3.0	1120	36	--	--
6.53	July 12, 1995	19.3	7.59	5.5	--	768	5.4	1510	18	--	--
6.53	July 26, 1995	21.3	7.44	4.9	--	847	5.4	1570	18	--	--
6.53	Aug. 09, 1995	21.1	7.62	6.1	--	210	9.4	486	24	--	--
6.53	Aug. 21, 1995	22.3	7.27	4.6	--	621	3.5	1370	23	--	--
6.53	Sept. 06, 1995	17.7	7.32	5.3	--	843	<2.0	1760	16	--	--
6.53	Sept. 18, 1995	13.7	7.59	6.3	--	968	<2.0	1820	21	--	--
3.08	July 12, 1995	21.5	7.92	7.9	--	739	<2.0	1470	15	--	--
3.08	July 26, 1995	22.0	7.60	6.3	--	723	5.8	1520	21	--	--
3.08	Aug. 09, 1995	21.2	7.44	6.1	--	195	11	421	28	--	--
3.08	Aug. 21, 1995	23.1	7.59	5.1	--	556	<2.0	1290	21	--	--
3.08	Sept. 06, 1995	19.7	7.81	7.3	--	884	<2.0	1850	20	--	--
3.08	Sept. 18, 1995	14.2	7.88	7.3	--	1010	<2.0	1850	21	--	--
Landfill Perimitter Ditch											
0.00	July 26, 1995	31.0	9.10	12.0	--	404	44	6090	350	1.09	--
Little Raccoon Creek											
4.30	July 12, 1995	19.4	8.09	8.5	--	876	<2.0	1590	15	--	--
4.30	July 26, 1995	21.8	7.98	8.9	--	1140	<2.0	1780	12	--	--
4.30	Aug. 09, 1995	20.8	7.32	6.1	--	202	4.9	451	28	--	--
4.30	Aug. 21, 1995	22.9	7.64	6.3	--	590	<2.0	1240	26	--	--
4.30	Sept. 06, 1995	18.4	7.85	8.2	--	1500	<2.0	2400	13	--	--
4.30	Sept. 18, 1995	13.5	8.12	10.0	--	1570	<2.0	2400	18	--	--
Gries Ditch											
0.24	July 12, 1995	20.7	8.24	11.8	--	316	<2.0	601	18	--	--
0.24	July 26, 1995	22.4	7.94	7.7	--	231	2.5	443	27	--	--
0.24	Aug. 09, 1995	21.0	8.12	8.2	--	358	<2.0	678	19	--	--
0.24	Aug. 21, 1995	24.2	7.90	10.0	--	327	<2.0	648	23	--	--
0.24	Sept. 06, 1995	18.6	7.41	8.5	--	321	<2.0	627	<10	--	--
0.24	Sept. 18, 1995	12.9	7.72	6.6	--	323	<2.0	631	<10	--	--
Caswell Ditch											
0.85	July 12, 1995	21.7	8.24	11.5	--	578	<2.0	1080	<10	--	--
0.85	July 26, 1995	24.0	8.04	10.7	--	438	<2.0	928	15	--	--
0.85	Aug. 09, 1995	21.3	7.83	7.6	--	294	3.0	601	25	--	--
0.85	Aug. 21, 1995	22.8	7.93	8.6	--	396	<2.0	943	<10	--	--
0.85	Sept. 06, 1995	20.9	7.96	9.0	--	637	<2.0	1260	<10	--	--
0.85	Sept. 18, 1995	15.5	8.26	10.2	--	705	<2.0	1190	12	--	--

Table A-1. Continued.

RM	B_DATE	NOx mg/l	NO2 mg/l	NH3 mg/l	TKN mg/l	P mg/l	TDS mg/l	TSS mg/l	Fec. Col. #/100ml
13.60	July 12, 1995	4.12	0.10	0.15	0.7	0.11	510	6	2500
13.60	July 26, 1995	0.94	0.08	0.19	0.8	590	<5	--	
13.60	Aug. 09, 1995	2.75	0.12	0.18	0.9	426	191	>	10000
13.60	Aug. 21, 1995	2.44	0.06	0.07	0.7	0.13	546	10	
13.60	Sept. 06, 1995	0.35	0.05	0.83	1.5	0.18	700	8	2400
13.60	Sept. 18, 1995	0.64	0.09	1.23	1.8	0.23	620	12	
11.70	July 12, 1995	3.27	0.07	<0.05	0.5	0.08	492	12	1800
11.70	July 26, 1995	1.22	0.07	0.07	0.4	0.13	512	<5	
11.70	Aug. 09, 1995	2.16	0.10	0.10	0.5	0.16	306	177	>10000
11.70	Aug. 21, 1995	1.44	0.06	0.09	0.7	0.09	542	<5	
11.70	Sept. 06, 1995	1.34	0.07	0.12	0.5	0.11	634	<5	450
11.70	Sept. 18, 1995	0.81	0.09	1.34	2.0	0.25	550	<5	
11.31	July 12, 1995	3.07	0.03	0.11	0.6	0.08	546	5	570
11.31	July 26, 1995	1.05	0.02	<0.05	0.5	0.14	516	<5	
11.29	Aug. 09, 1995	2.19	0.10	0.09	0.4	0.17	328	151	>10000
11.29	Aug. 21, 1995	1.29	0.03	<0.05	0.6	0.15	546	<5	
11.29	Sept. 06, 1995	0.82	<0.02	<0.05	0.7	0.16	672	<5	82
11.29	Sept. 18, 1995	1.04	0.03	0.18	0.6	0.14	462	<5	
11.02	July 12, 1995	0.55	0.17	10.2	10.5	0.95	614	10	52
11.02	July 26, 1995	0.10	<0.02	11.3	14.3	1.03	616	9	
11.02	Aug. 09, 1995	0.10	0.03	15.4	15.4	1.36	510	37	>10000
11.02	Aug. 21, 1995	0.10	0.02	6.50	9.5	0.60	574	<5	
11.02	Sept. 06, 1995	12.1	1.12	2.64	3.9	0.35	692	6	62
11.02	Sept. 18, 1995	5.55	0.16	2.12	4.1	0.50	662	12	
11.01	July 12, 1995	0.85	0.15	8.88	9.8	0.84	614	11	130
11.01	July 26, 1995	0.10	<0.02	10.5	11.9	0.86	554	6	
11.01	Aug. 09, 1995	1.62	0.08	3.42	3.5	0.33	374	122	>10000
11.01	Aug. 21, 1995	0.19	0.02	5.59	7.4	0.47	560	5	
11.01	Sept. 06, 1995	11.1	1.06	2.35	3.8	0.35	704	6	52
11.01	Sept. 18, 1995	5.32	0.19	1.98	3.8	0.49	650	14	
10.98	July 12, 1995	1.01	0.17	7.94	9.0	0.76	618	5	160
10.98	July 26, 1995	0.10	0.02	10.1	11.2	0.86	566	5	
10.98	Aug. 09, 1995	1.51	0.10	3.74	3.9	0.42	366	128	>10000
10.98	Aug. 21, 1995	0.18	0.03	5.60	6.9	0.47	558	8	
10.98	Sept. 06, 1995	10.7	1.10	2.30	3.8	0.35	738	<5	60
10.98	Sept. 18, 1995	5.28	0.21	1.92	3.7	0.45	588	10	
10.80	July 12, 1995	1.15	0.26	7.78	8.9	0.77	620	22	390
10.80	July 26, 1995	0.10	0.08	9.73	10.6	0.83	652	25	
10.80	Aug. 09, 1995	1.56	0.11	3.70	3.8	0.40	360	109	>10000
10.80	Aug. 21, 1995	0.20	0.06	5.38	6.8	0.43	563	6	
10.80	Sept. 06, 1995	10.6	1.23	2.18	3.6	0.31	684	9	66
10.80	Sept. 18, 1995	4.49	0.32	1.74	3.3	0.42	648	10	
10.18	July 12, 1995	1.44	0.41	7.17	8.2	0.65	608	8	1000
10.18	July 26, 1995	0.10	0.09	9.67	10.4	0.83	548	19	
10.18	Aug. 09, 1995	2.31	0.13	3.30	3.5	0.37	354	113	>10000
10.18	Aug. 21, 1995	0.27	0.17	4.79	6.0	0.41	552	7	

Table A-1. Continued.

RM	B_DATE	NOx mg/l	NO2 mg/l	NH3 mg/l	TKN mg/l	P mg/l	TDS mg/l	TSS mg/l	Fec. Col. #/100ml
10.18	Sept. 06, 1995	11.0	1.62	1.58	2.8	0.28	694	8	110
10.18	Sept. 18, 1995	3.48	0.42	0.96	2.4	0.33	644	13	
8.66	July 12, 1995	2.73	0.68	4.36	5.4	0.47	646	7	1200
8.66	July 26, 1995	0.21	0.23	6.18	8.2	0.59	<5	--	
8.66	Aug. 09, 1995	3.78	0.18	1.42	2.0	0.28	292	142	>10000
8.66	Aug. 21, 1995	1.04	0.53	2.76	3.6	0.34	598	<5	
8.66	Sept. 06, 1995	9.01	1.33	1.08	2.0	0.24	756	7	450
8.66	Sept. 18, 1995	2.58	0.15	0.26	1.2	0.27	716	6	
6.53	July 12, 1995	3.22	0.67	1.13	1.8	0.22	1210	9	1900
6.53	July 26, 1995	0.87	0.36	3.30	3.7	0.34	5	--	
6.53	Aug. 09, 1995	4.32	0.20	0.72	1.4	0.34	348	249	>10000
6.53	Aug. 21, 1995	1.46	0.49	0.48	1.0	0.24	992	6	
6.53	Sept. 06, 1995	4.47	0.38	0.20	0.8	0.11	1400	6	480
6.53	Sept. 18, 1995	1.30	0.02	0.08	0.7	0.13	1460	8	
3.08	July 12, 1995	4.28	0.17	0.10	0.8	0.20	1190	34	2000
3.08	July 26, 1995	1.80	0.44	1.42	1.9	0.31	*QA	30	
3.08	Aug. 09, 1995	2.81	0.17	0.44	0.9	0.41	312	295	>10000
3.08	Aug. 21, 1995	1.87	0.11	0.05	0.7	0.24	966	34	
3.08	Sept. 06, 1995	1.99	0.02	<0.05	0.4	0.11	1530	16	1500
3.08	Sept. 18, 1995	1.71	<0.02	0.06	0.6	0.13	1530	23	
Landfill Perimitter Ditch									
0.00	July 26, 1995	0.10	0.06	0.57	12.3	2.06	3950	396	
Little Raccoon Creek									
4.30	July 12, 1995	3.71	0.03	<0.05	0.6	0.14	1310	17	1400
4.30	July 26, 1995	1.20	0.02	<0.05	0.4	0.19	18	--	
4.30	Aug. 09, 1995	8.76	0.12	0.05	1.1	0.41	352	195	>10000
4.30	Aug. 21, 1995	2.65	0.02	<0.05	0.6	0.14	966	10	
4.30	Sept. 06, 1995	0.16	<0.02	<0.05	0.4	<0.05	2260	11	280
4.30	Sept. 18, 1995	0.86	<0.02	<0.05	0.3	0.07	*QA	5	
Gries Ditch									
0.24	July 12, 1995	3.70	<0.02	<0.05	0.6	<0.05	394	<5	110
0.24	July 26, 1995	2.62	0.02	<0.05	1.0	<0.05	9	--	
0.24	Aug. 09, 1995	1.47	<0.02	<0.05	0.6	<0.05	458	16	730
0.24	Aug. 21, 1995	0.54	<0.02	<0.05	0.4	<0.05	444	<5	
0.24	Sept. 06, 1995	0.10	0.02	0.24	0.7	<0.05	420	6	1600
0.24	Sept. 18, 1995	0.10	0.04	0.43	0.8	<0.05	414	9	
Caswell Ditch									
0.85	July 12, 1995	2.27	0.04	<0.05	0.4	0.05	778	8	5400
0.85	July 26, 1995	2.86	0.02	<0.05	0.3	<0.05	24	--	
0.85	Aug. 09, 1995	3.22	0.03	<0.05	0.4	0.10	402	116	>10000
0.85	Aug. 21, 1995	4.68	0.02	<0.05	0.3	0.05	608	26	
0.85	Sept. 06, 1995	6.59	0.31	0.78	1.0	<0.05	964	20	3000
0.85	Sept. 18, 1995	1.77	<0.02	0.08	<0.2	<0.05	968	14	

Table A-1. Continued.

-- RM	-- B_DATE	As ug/l	Cd ug/l	Ca mg/l	Cr ug/l	Cu ug/l	Fe ug/l	Pb ug/l	Mg mg/l	Hg ug/l	Ni ug/l	An ug/l
13.60	July 12, 1995	2	<0.2	105	<30	<10	306	<2	23	<40	<10	--
13.60	July 26, 1995	2	<0.2	120	<30	<10	266	<2	25	<40	12	--
13.60	Aug. 09, 1995	2	<0.2	76	<30	41	12300	2	16	<40	46	--
13.60	Aug. 21, 1995	<2	<0.2	103	<30	<10	503	<2	21	<40	11	--
13.60	Sept. 06, 1995	<2	<0.2	127	<30	<10	337	<2	27	<40	16	--
13.60	Sept. 18, 1995	3	<0.2	112	<30	<10	776	<2	24	<40	24	--
11.70	July 12, 1995	3	<0.2	102	<30	<10	447	<2	23	<40	<10	--
11.70	July 26, 1995	2	<0.2	100	<30	<10	263	<2	22	<40	<10	--
11.70	Aug. 09, 1995	<2	<0.2	59	<30	<10	8440	4	13	<40	40	--
11.70	Aug. 21, 1995	<2	<0.2	90	<30	<10	292	<2	20	<40	10	--
11.70	Sept. 06, 1995	<2	<0.2	119	<30	<10	161	<2	24	<40	10	--
11.70	Sept. 18, 1995	2	<0.4	95	<30	<10	351	<2	21	<40	21	--
11.31	July 12, 1995	3	<0.2	102	<30	<10	279	<2	24	<40	<10	--
11.31	July 26, 1995	3	<0.2	99	<30	<10	297	<2	23	<40	20	--
11.29	Aug. 09, 1995	<2	<0.2	59	<30	<10	8500	4	13	<40	44	--
11.29	Aug. 21, 1995	3	<0.2	90	<30	<10	259	<2	21	<40	14	--
11.29	Sept. 06, 1995	4	<0.2	115	<30	11	172	<2	26	<40	17	--
11.29	Sept. 18, 1995	3	<0.2	83	<30	<10	360	<2	19	<40	28	--
11.02	July 12, 1995	2	<0.2	74	<30	<10	434	<2	23	52	51	--
11.02	July 26, 1995	<2	<0.2	61	<30	<10	376	<2	17	47	19	--
11.02	Aug. 09, 1995	<2	<0.2	49	<30	411	455	2	16	42	28	--
11.02	Aug. 21, 1995	<2	<0.2	71	<30	<10	151	<2	19	<40	27	--
11.02	Sept. 06, 1995	<2	<0.2	67	<30	<10	204	<2	18	79	35	--
11.02	Sept. 18, 1995	2	<0.2	60	<30	<10	420	<2	16	56	52	--
11.01	July 12, 1995	2	<0.2	79	<30	<10	414	<2	23	45	41	--
11.01	July 26, 1995	<2	<0.2	67	<30	<10	365	<2	18	40	21	--
11.01	Aug. 09, 1995	2	<0.2	56	<30	129	5520	2	14	<40	37	--
11.01	Aug. 21, 1995	<2	<0.2	75	<30	<10	169	<2	19	<40	25	--
11.01	Sept. 06, 1995	<2	<0.2	71	<30	<10	222	<2	19	73	33	--
11.01	Sept. 18, 1995	3	<0.2	62	<30	<10	388	<2	17	52	56	--
10.98	July 12, 1995	2	<0.2	80	<30	<10	429	<2	23	<0.2	44	44
10.98	July 26, 1995	<2	<0.2	67	<30	<10	382	<2	18	<0.2	40	18
10.98	Aug. 09, 1995	2	<0.2	56	<30	100	5810	2	13	<0.2	<40	42
10.98	Aug. 21, 1995	<2	<0.2	75	<30	<10	251	<2	19	<0.2	<40	24
10.98	Sept. 06, 1995	<2	<0.2	71	<30	<10	248	<2	19	<0.2	70	26
10.98	Sept. 18, 1995	2	<0.2	63	<30	<10	325	<2	17	<0.2	51	55
10.80	July 12, 1995	2	<0.2	81	<30	<10	1000	<2	23	<0.2	42	42
10.80	July 26, 1995	2	<0.2	69	<30	<10	752	<2	18	<0.2	<40	21
10.80	Aug. 09, 1995	2	<0.2	55	<30	93	5580	2	13	<0.2	<40	41
10.80	Aug. 21, 1995	<2	<0.2	79	<30	<10	249	<2	20	<0.2	<40	22
10.80	Sept. 06, 1995	<2	<0.2	73	<30	<10	356	<2	19	<0.2	69	31
10.80	Sept. 18, 1995	2	<0.2	65	<30	<10	459	<2	18	<0.2	50	59
10.18	July 12, 1995	3	<0.2	83	<30	<10	486	<2	23	<40	33	--
10.18	July 26, 1995	2	<0.2	70	<30	<10	733	<2	19	<40	36	--
10.18	Aug. 09, 1995	<2	<0.2	57	<30	90	5700	3	14	<40	36	--
10.18	Aug. 21, 1995	<2	<0.2	80	<30	<10	298	<2	20	<40	12	--

Table A-1. Continued.

RM	Date	As ug/l	Cd ug/l	Ca mg/l	Cr ug/l	Cu ug/l	Fe ug/l	Pb ug/l	Mg mg/l	Hg ug/l	Ni ug/l	An ug/l
10.18	Sept. 06, 1995	<2	<0.2	75	<30	<10	396	<2	20	58	28	--
10.18	Sept. 18, 1995	3	<0.2	69	<30	226	855	<2	18	53	53	--
8.66	July 12, 1995	3	<0.2	96	<30	<10	269	<2	23	<40	25	--
8.66	July 26, 1995	3	<0.2	82	<30	<10	389	<2	19	<40	11	--
8.66	Aug. 09, 1995	2	<0.2	51	<30	46	6980	4	12	<40	42	--
8.66	Aug. 21, 1995	2	<0.2	88	<30	<10	296	<2	20	<40	<10	--
8.66	Sept. 06, 1995	<2	<0.2	89	<30	<10	464	<2	20	37	19	--
8.66	Sept. 18, 1995	2	<0.2	91	<30	<10	462	<2	21	45	27	--
6.53	July 12, 1995	2	<0.2	240	<30	<10	310	<2	41	<40	25	--
6.53	July 26, 1995	<2	<0.2	280	<30	<10	426	<2	36	<40	<10	--
6.53	Aug. 09, 1995	<2	<0.2	61	<30	30	11900	6	14	<40	59	--
6.53	Aug. 21, 1995	<2	<0.2	196	<30	<10	336	<2	32	<40	10	--
6.53	Sept. 06, 1995	<2	<0.2	270	<30	<10	296	<2	41	<40	15	--
6.53	Sept. 18, 1995	<2	<0.2	310	<30	<10	455	<4	47	<40	25	--
3.08	July 12, 1995	3	<0.2	230	<30	<10	1020	<2	40	<40	10	--
3.08	July 26, 1995	<2	<0.2	230	<30	<10	473	<2	36	<40	<10	--
3.08	Aug. 09, 1995	2	0.3	55	<30	26	13900	10	14	<40	79	--
3.08	Aug. 21, 1995	2	<0.2	173	<30	<10	1230	<2	30	<40	11	--
3.08	Sept. 06, 1995	2	<0.2	280	<30	<10	778	<2	45	<40	19	--
3.08	Sept. 18, 1995	<2	<0.2	330	<30	<10	1080	<2	46	<40	23	--
Landfill Perimitter Ditch												
0.00	July 26, 1995	33	<0.2	53	<30	82	12900	7	66	0.51	43	96
Little Raccoon Creek												
4.30	July 12, 1995	3	<0.2	280	<30	<10	603	<2	43	<40	<10	--
4.30	July 26, 1995	<2	<0.2	380	<30	<10	1690	<2	46	<40	22	--
4.30	Aug. 09, 1995	<2	<0.2	58	<30	12	9920	4	14	<40	49	--
4.30	Aug. 21, 1995	<2	<0.2	185	<30	<10	607	<2	31	<40	18	--
4.30	Sept. 06, 1995	<2	<0.2	500	<30	<10	606	<2	61	<40	11	--
4.30	Sept. 18, 1995	2	<0.2	520	<30	<10	250	<4	66	<40	11	--
Gries Ditch												
0.24	July 12, 1995	<2	<0.2	69	<30	<10	<50	<2	35	<40	<10	--
0.24	July 26, 1995	<2	<0.2	66	<30	<10	979	<2	16	<40	<10	--
0.24	Aug. 09, 1995	2	<0.2	97	<30	<10	75	<2	28	<40	<10	--
0.24	Aug. 21, 1995	2	<0.2	83	<30	<10	<50	<2	29	<40	<10	--
0.24	Sept. 06, 1995	4	<0.2	74	<30	<10	251	<2	33	<40	<10	--
0.24	Sept. 18, 1995	2	<0.2	75	<30	<10	441	<2	33	<40	11	--
Caswell Ditch												
0.85	July 12, 1995	2	<0.2	144	<30	<10	239	<2	53	<40	<10	--
0.85	July 26, 1995	<2	<0.2	116	<30	<10	1140	<2	36	<40	<10	--
0.85	Aug. 09, 1995	<2	<0.2	83	<30	<10	4630	2	21	<40	24	--
0.85	Aug. 21, 1995	<2	<0.2	114	<30	<10	886	<2	27	<40	12	--
0.85	Sept. 06, 1995	<2	<0.2	156	<30	<10	846	<2	60	<40	<10	--
0.85	Sept. 18, 1995	<2	<0.2	170	<30	<10	765	<2	68	<40	<10	--

Table A-2. NPDES permit violations by the City of Clyde WWTP since 1990.

Date	Value Parameter	Reported	Permit Units	Limitations	Reason
Jan.90	Ammonia - Avg.	3.61	mg/l	3	
Feb.90	Ammonia - Avg.	4.6	mg/l	3	
Feb.90	Ammonia - Avg.	30	kg/day	22	
Feb.90	Ammonia	6.33 & 10.33	mg/l	4.5	
Feb.90	Ammonia	45.8 & 54.1	kg/day	32	
May 90	Chlorine - Residual	Twice	mg/l	Mont Req Daily	Computer Error
July 90	D.O. - 4 Days	5.9 to 6.8	mg/l	7.0 Min.	
Oct. 90	D.O.	None	mg/l	Mont Req Daily	Computer Error
Oct. 90	pH	None	S.U.	Mont Req Daily	Computer Error
Oct.90	Chlorine - Residual	None	mg/l	Mont Req Daily	Computer Error
Oct.90	Temperature	None	C	Mont Req Daily	Computer Error
Oct.90	Flow	None	MGD	Mont Req Daily	Computer Error
June 91	D.O. - 10 Days	5.5 to 6.5	mg/l	7.0 Min.	
July 91	D.O. - 27 Days	3.8 to 6.8	mg/l	7.0 Min.	
July 91	Fecal Coliform	More than 2000	#/100ml	2000	
Aug. 91	D.O. - 26 Days	5.3 to 6.9	mg/l	7.0 Min.	
Aug. 91	Oil & Grease	27	mg/l	10	
Sept. 91	D.O. - 26 Days	5.6 to 6.8	mg/l	7.0 Min.	
Sept. 91	Fecal Coliform	AK	#/100ml	2000	
Sept. 91	Fecal Coliform	AK	#/100ml	2000	
Oct. 91	D.O. - 12 Days	5.8 to 6.9	mg/l	7.0 Min.	
Dec. 91	Mercury - Avg.	0.2	ug/l	0.012	
July 92	D.O.	5.7	mg/l	7.0 Min.	
Aug. 92	D.O. - 2 Days	6.6 & 6.8	mg/l	7.0 Min.	
Aug. 92	Mercury - Avg.	0.2	ug/l	0.012	
Oct. 92	Oil & Grease	14.6	mg/l	10	
Nov. 92	Oil & Grease - 3 Days	14 to 48	mg/l	10 Max.	
Feb. 93	Phosphorous - Avg.	1.3	mg/l	1	
Feb. 93	Phosphorous - Avg.	8.4	kg/day	7.2	
March 93	Oil & Grease	15	mg/l	10	
March 93	Phosphorus - Avg.	1.1	mg/l	1	
March 93	Phosphorus - Avg.	10.7	kg/day	7.2	
March 93	Phosphorus	1.7	mg/l	1.5	
March 93	Phosphorus	17.8 & 12.4	kg/day	11	
March 94	Oil & Grease	11	mg/l	10	
April 94	Oil & Grease	20	mg/l	10	
April 94	Oil & Grease	11	mg/l	10	
April 94	Oil & Grease	19	mg/l	10	
May 94	Oil & Grease	18.9	mg/l	10	
May 94	Oil & Grease	12.1	mg/l	10	
June 94	Oil & Grease	22.7	mg/l	10	
June 94	Oil & Grease	10.8	mg/l	10	
July 94	Oil & Grease	13.4	mg/l	10	
July 94	Oil & Grease	35	mg/l	10	
Aug. 94	Suspended Solids - Avg.	14	mg/l	12	Lab Error
Aug. 94	Oil & Grease - 4 Weeks	12.5 - 25.7	mg/l	10	Testing Procedure

Table A-2. NPDES permit violations by the City of Clyde WWTP since 1990.

Date	Value Parameter	Reported	Permit Units	Limitations	Reason
Aug. 94	Chlorine Residual - 6 Days		0.03 - 0.42	mg/l	0.019
Aug. 94	Silver	None	ug/l	Mont Req 1/Month	Accidental omission
Aug. 94	Cyanide	None	mg/l	Mont Req 1/Month	Accidental Omission
Sept. 94	Oil & Grease	11	mg/l	10	Lab Error
Sept. 94	Chlorine Resid - 6 Days	0.03 - 0.12	mg/l	0.019	Testing Procedure
Sept. 94	Chromium, Hex - Avg.	31	ug/l	15	Speculate Lab Error
Sept. 94	Chromium, Hex	31	ug/l	12	Speculate Lab Error
Jan. 95	Ammonia - Avg.	5.26	mg/l	3	
Jan. 95	Ammonia - Avg.	36.9	kg/day	22	
Jan. 95	Ammonia	8.4	mg/l	4.5	
Jan. 95	Ammonia	5.5	mg/l	4.5	
Jan. 95	Ammonia	73	kg/day	32	
Jan. 95	Ammonia	43.7	kg/day	32	
Feb. 95	Ammonia - Avg.	24.2	mg/l	3.0	
Feb. 95	Ammonia - Avg.	128.9	kg/day	22	
Feb. 95	Ammonia	14.46	mg/l	4.5	
Feb. 95	Ammonia	23.91	mg/l	4.5	
Feb. 95	Ammonia	28.66	mg/l	4.5	
Feb. 95	Ammonia	29.88	mg/l	4.5	
Feb. 95	Ammonia	71.9	kg/day	32	
Feb. 95	Ammonia	94.9	kg/day	32	
Feb. 95	Ammonia	148.3	kg/day	32	
Feb. 95	Ammonia	200.3	kg/day	32	
Feb. 95	CBOD5 - Avg.	28.5	mg/l	25	
Feb. 95	CBOD5	40.1	mg/l	40	
March 95	Ammonia - Avg.	7.0	mg/l	3.0	
March 95	Ammonia - Avg.	53.8	kg/day	22	
March 95	Ammonia	15.6	mg/l	4.5	
March 95	Ammonia	5.6	mg/l	4.5	
March 95	Ammonia	5.0	mg/l	4.5	
March 95	Ammonia	116.5	kg/day	32	
March 95	Ammonia	58.4	kg/day	32	
June, 1995					
001	Days 1 - 30	D.O.	1.3 - 6.0	mg/l	7.0 min.
001	Avg.	Suspended Solids	14.7	mg/l	12
001	Avg.	Suspended Solids	93.7	kg/day	86
001	Week 3	Suspended Solids	20	mg/l	18
001	Week 4	Suspended Solids	19	mg/l	18
001	Week 4	Suspended Solids	157.2	kg/day	130
001	Avg.	Ammonia	9.4	mg/l	1.0
001	Avg.	Ammonia	57.9	kg/day	7.2
001	Weeks 1 - 4	Ammonia	7.9 - 11.2	mg/l	1.5
001	Weeks 1 - 4	Ammonia	42.8 - 87.2	kg/day	11
001	Avg.	Phosphorus	1.6	mg/l	1.0
001	Avg.	Phosphorus	9.3	kg/day	7.2

Table A-2. NPDES permit violations by the City of Clyde WWTP since 1990.

Date	Value Parameter	Reported	Permit Units	Limitations	Reason
001	Weeks 2 - 4	Phosphorus	1.6 - 1.8	mg/l	1.5
001	Week 4	Phosphorus	14.2	kg/day	11
001	Weeks 3 - 4 & Days 6, 9, & 13	Fecal Coliform	AK	#/100ml	2000
001	Day 12	Fecal Coliform	6000	#/100ml	2000
001	Day 1	Chlorine	0.334	mg/l	0.019
001	Avg.	CBOD5	34.6	mg/l	8.0
001	Avg.	CBOD5	203.2	kg/day	58
001	Weeks 2 - 4	CBOD5	12.5 - 69.7	mg/l	12.0
001	Weeks 3 - 4	CBOD5	295.1 - 320.8	kg/day	86
001	Avg.	Mercury	0.20	ug/l	0.150
901	June	Fecal Coliform	None	#/100ml	Mont Req 1/Week
July, 1995					
001	Days 1 - 31	D.O.	1.4 - 6.2	mg/l	7.0 min.
001	Avg.	Suspended Solids	14.4	mg/l	12
001	Avg.	Ammonia	8.43	mg/l	1.0
001	Avg.	Ammonia	39.6	kg/day	7.2
001	Weeks 1 - 4	Ammonia	5.76 - 10.33	mg/l	1.5
001	Weeks 1 - 4	Ammonia	33.3 - 46.1	kg/day	11
001	Avg.	Phosphorus	1.2	mg/l	1.0
001	Avg.	Fecal Coliform	1003	#/100ml	1000
001	Week 3	Fecal Coliform	AK	#/100ml	2000
001	Days 4, 5, 9, 10, & 11	Chlorine	0.038 - 0.175	mg/l	0.019
001	Avg.	CBOD5	20.07	mg/l	8.0
001	Avg.	CBOD5	100.0	kg/day	58
001	Weeks 1, 3, & 4	CBOD5	19.76 - 22.20	mg/l	12.0
001	Weeks 1, 3, &4	CBOD5	103.8 - 121.1	kg/day	86
001	Avg.	Mercury	0.20	ug/l	0.150
901	June	Fecal Coliform	None	#/100ml	Mont Req 1/Week
August, 1995					
001	Days 1 - 30	D.O.	1.2 - 6.3	mg/l001	Avg.
		Suspended Solids	13.3	mg/l	12
001	Avg.	Suspended Solids	87.0	kg/day	86
001	Avg.	Ammonia	7.43	mg/l	1.0
001	Avg.	Ammonia	45.9	kg/day	7.2
001	Weeks 1 - 4	Ammonia	4.30 - 8.96	mg/l	1.5
001	Weeks 1 - 4	Ammonia	33.8 - 75.6	kg/day	11
001	Week 3	Fecal Coliform	6800 - AK	#/100ml	2000
001	Days 30 & 31	Chlorine	0.071 - 0.092	mg/l	0.019
001	Avg.	CBOD5	18.69	mg/l	8.0
001	Avg.	CBOD5	123.0	kg/day	58
001	Weeks 1 - 4	CBOD5	18.94 - 20.3	mg/l	12.0
001	Weeks 1 - 4	CBOD5	89.7 - 166.3	kg/day	86
901	June	Fecal Coliform	None	#/100ml	Mont Req 1/Week

Table A-2. NPDES permit violations by the City of Clyde WWTP since 1990.

Date	Value Parameter	Reported	Permit Units	Limitations	Reason
Sept., 1995					
001	Days 2 - 10, & 14 - 30	D.O.	3.0 - 6.6	mg/l	7.0 min.
001	Avg.	Ammonia	1.35	mg/l	1.0
001	Week 1	Ammonia	2.53	mg/l	1.5
001	Day 1	Chlorine	0.023	mg/l	0.019
901	June	Fecal Coliform	None	#/100ml	Mont Req 1/Week
October, 1995					
001	Days 1 - 31	D.O.	4.2 - 6.9	mg/l	7.0 min.
001	Days 3 - 5, 10, 11, & 31	Chlorine	0.024 - 0.330	mg/l	0.019
901	June	Fecal Coliform	None	#/100ml	Mont Req 1/Week
Nov., 1995					001
	Avg.	Phosphorus	1.13	mg/l	1.0
001	Week 1	Phosphorus	1.70	mg/l	1.5
Dec., 1995					001
	Avg.	Phosphorus	1.40	mg/l	1.0
001	Week 1 & 2	Phosphorus	2.10 & 2.06	mg/l	1.5
January, 1996					001
	Avg.	Mercury	0.20	ug/l	0.0150

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/15/95 River Code: 05-045 River: Raccoon Creek RM: 13.00

Taxa Code	Taxa	Quan	Qual
00650	*Eunapius sp*	1	+
01320	*Hydra sp*	61	
01801	*Turbellaria*	1	
03360	*Plumatella sp*	1	+
03600	*Oligochaeta*	3	
04664	*Helobdella stagnalis*	3	+
04935	*Erpobdella punctata punctata*		+
05800	*Caecidotea sp*	1	
11130	*Baetis intercalaris*		+
11651	*Procloeon sp (w/o hindwing pads)*	3	
13400	*Stenacron sp*	4	+
13521	*Stenonema femoratum*	63	+
14950	*Leptophlebia sp or Paraleptophebia sp*	1	
17200	*Caenis sp*	7	+
22001	*Coenagrionidae*		+
23600	*Aeshna sp*		+
27500	*Somatochlora sp*		+
45300	*Sigara sp*		+
45400	*Trichocorixa sp*		+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*	13	+
59700	*Triaenodes sp*		+
60900	*Peltodytes sp*		+
63300	*Hydroporus sp*		+
65700	*Anacaena sp*		+
68130	*Helichus sp*		+
68201	*Scirtidae*		+
68708	*Dubiraphia vittata group*	1	+
69400	*Stenelmis sp*	7	+
70501	*Tipulidae*	1	
74100	*Simulium sp*	1	+
74501	*Ceratopogonidae*	1	+
77120	*Ablabesmyia mallochi*	4	+
77500	*Conchapelopia sp*	38	
78401	*Natarsia species A (sensu Roback, 1978)*		+
78650	*Procladius sp*	2	+
80370	*Corynoneura lobata*	32	
81270	*Nanocladius (N.) spiniplenus*	2	
81650	*Parametriocnemus sp*	2	+
81810	*Rheocricotopus sp*		+
83840	*Microtendipes pedellus group*	32	+
84210	*Paratendipes albimanus or P. duplicatus*	26	+
84315	*Phaenopsectra flavipes*	2	+
84450	*Polypedilum (P.) convictum*	4	+
84460	*Polypedilum (P.) fallax group*	7	
84470	*Polypedilum (P.) illinoense*	2	+
84750	*Stictochironomus sp*		+
85400	*Micropsectra sp*	9	
85625	*Rheotanytarsus exiguus group*	24	+
85800	*Tanytarsus sp*	4	+
85814	*Tanytarsus glabrescens group*	13	
87540	*Hemerodromia sp*	11	+
94400	*Fossaria sp*		+
95100	*Physella sp*	151	+
95907	*Gyraulus (Torquis) parvus*	19	+
96900	*Ferrissia sp*	140	
98600	*Sphaerium sp*		+

No. Quantitative Taxa: 38 Total Taxa: 57

No. Qualitative Taxa: 43 ICI: **32**

Number of Organisms: 697 Qual EPT: **6**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/15/95 River Code: 05-045 River: Raccoon Creek RM: 11.70

Taxa Code	Taxa	Quan	Qual
00650	*Eunapius sp*		+
01320	*Hydra sp*	14	
01801	*Turbellaria*	694	+
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	273	+
04935	*Erpobdella punctata punctata*		+
05800	*Caecidotea sp*		+
11120	*Baetis flavistriga*		+
17200	*Caenis sp*	1	+
22001	*Coenagrionidae*	1	+
22300	*Argia sp*		+
23600	*Aeshna sp*		+
27500	*Somatochlora sp*		+
52200	*Cheumatopsyche sp*	5	+
52530	*Hydropsyche depravata group*		+
60900	*Peltodytes sp*		+
68708	*Dubiraphia vittata group*		+
69400	*Stenelmis sp*		+
71900	*Tipula sp*		+
74100	*Simulium sp*		+
74501	*Ceratopogonidae*	2	
77130	*Ablabesmyia rhamphe group*	6	
77500	*Conchapelopia sp*	210	+
78400	*Natarsia sp*		+
80420	*Cricotopus (C.) bicinctus*		+
81632	*Parakiefferiella n.sp 2*	17	
81650	*Parametriocnemus sp*	11	
82820	*Cryptochironomus sp*	6	+
83040	*Dicrotendipes neomodestus*	90	
83051	*Dicrotendipes simpsoni*	68	
84210	*Paratendipes albimanus or P. duplicatus*		+
84315	*Phaenopsectra flavipes*	39	
84450	*Polypedilum (P.) convictum*	6	+
84470	*Polypedilum (P.) illinoense*	23	
84540	*Polypedilum (Tripodura) scalaenum group*		+
84888	*Xenochironomus xenolabis*		+
85400	*Micropsectra sp*	6	
85800	*Tanytarsus sp*	23	
85814	*Tanytarsus glabrescens group*	243	
87540	*Hemerodromia sp*	13	
95100	*Physella sp*	39	+
95907	*Gyraulus (Torquis) parvus*	12	+
98600	*Sphaerium sp*		+

No. Quantitative Taxa: 24 Total Taxa: 43

No. Qualitative Taxa: 29 ICI: **22**

Number of Organisms: 1803 Qual EPT: **4**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/15/95 River Code: 05-045 River: Raccoon Creek RM: 11.30

Taxa Code	Taxa	Quan	Qual
00650	*Eunapius sp*		+
01320	*Hydra sp*	4	
01801	*Turbellaria*	413	+
03360	*Plumatella sp*		+
03600	*Oligochaeta*	1050	+
04664	*Helobdella stagnalis*	1	+
04935	*Erpobdella punctata punctata*	1	+
08220	*Orconectes (Gremicambarus) immunis*		+
08601	*Hydracarina*	8	
11200	*Callibaetis sp*	4	+
17200	*Caenis sp*	4	+
22001	*Coenagrionidae*	17	+
23600	*Aeshna sp*		+
52530	*Hydropsyche depravata group*		+
53800	*Hydroptila sp*	1	
60900	*Peltodytes sp*		+
63900	*Laccophilus sp*		+
67000	*Helophorus sp*		+
67800	*Tropisternus sp*		+
69400	*Stenelmis sp*		+
77500	*Conchapelopia sp*	155	+
79400	*Zavrelimyia sp*	7	
80420	*Cricotopus (C.) bicinctus*	10	+
80430	*Cricotopus (C.) tremulus group*		+
82730	*Chironomus (C.) decorus group*		+
82820	*Cryptochironomus sp*		+
83040	*Dicrotendipes neomodestus*	17	
84315	*Phaenopsectra flavipes*	14	
84450	*Polypedilum (P.) convictum*		+
84470	*Polypedilum (P.) illinoense*	37	+
85500	*Paratanytarsus sp*	3	
85814	*Tanytarsus glabrescens group*	3	
87540	*Hemerodromia sp*	4	
94400	*Fossaria sp*	7	
95100	*Physella sp*	606	+
95907	*Gyraulus (Torquis) parvus*	128	
96900	*Ferrissia sp*	58	
98200	*Pisidium sp*		+
98600	*Sphaerium sp*		+

No. Quantitative Taxa: 23 Total Taxa: 39

No. Qualitative Taxa: 27 ICI: **12**

Number of Organisms: 2552 Qual EPT: **3**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/15/95 River Code: 05-045 River: Raccoon Creek RM: 11.00

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	1	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	19156	+
04664	*Helobdella stagnalis*		+
04935	*Erpobdella punctata punctata*	2	+
04964	*Mooreobdella microstoma*	1	
11200	*Callibaetis sp*		+
22001	*Coenagrionidae*		+
28955	*Libellula lydia*		+
60900	*Peltodytes sp*		+
65800	*Berosus sp*		+
67800	*Tropisternus sp*		+
77500	*Conchapelopia sp*	5	
82730	*Chironomus (C.) decorus group*	334	+
83300	*Glyptotendipes (G.) sp*	5	
95100	*Physella sp*		+
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	8	Total Taxa:	17
No. Qualitative Taxa:	12	ICI:	**0**
Number of Organisms:	19505	Qual EPT:	**1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/15/95 River Code: 05-045 River: Raccoon Creek RM: 10.98

Taxa Code	Taxa	Quan	Qual
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	3040	+
04935	*Erpobdella punctata punctata*		+
04964	*Mooreobdella microstoma*	1	+
06800	*Gammarus sp*	4	
28955	*Libellula lydia*		+
42700	*Belostoma sp*		+
53800	*Hydroptila sp*	1	
77500	*Conchapelopia sp*	71	
80500	*Cricotopus (Isocladius) reversus group*	6	
82730	*Chironomus (C.) decorus group*	334	+
82770	*Chironomus (C.) riparius group*		+
83040	*Dicrotendipes neomodestus*	5	
83051	*Dicrotendipes simpsoni*	5	
83300	*Glyptotendipes (G.) sp*	71	
84040	*Parachironomus frequens*	6	
84050	*Parachironomus "hirtalatus" (sensu Simpson & Bode, 1980)*		+
84460	*Polypedilum (P.) fallax group*	11	
85625	*Rheotanytarsus exiguus group*	11	
87540	*Hemerodromia sp*	8	
95100	*Physella sp*	1	+
95907	*Gyraulus (Torquis) parvus*	1	
98600	*Sphaerium sp*		+

No. Quantitative Taxa: 17 Total Taxa: 23

No. Qualitative Taxa: 10 ICI: **10**

Number of Organisms: 3577 Qual EPT: **0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/16/95 River Code: 05-045 River: Raccoon Creek RM: 10.75

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	1	
01801	*Turbellaria*	1	
03600	*Oligochaeta*	1024	+
04664	*Helobdella stagnalis*	2	
04686	*Placobdella papillifera*	1	
04935	*Erpobdella punctata punctata*		+
04964	*Mooreobdella microstoma*		+
11200	*Callibaetis sp*		+
22001	*Coenagrionidae*		+
45300	*Sigara sp*		+
69400	*Stenelmis sp*	1	
72160	*Psychoda sp*	1	
77500	*Conchapelopia sp*	6	
77800	*Helopelopia sp*	1	
78200	*Larsia sp*	3	
78401	*Natarsia species A (sensu Roback, 1978)*	1	
80420	*Cricotopus (C.) bicinctus*	5	
80430	*Cricotopus (C.) tremulus group*	1	
82730	*Chironomus (C.) decorus group*	40	+
82770	*Chironomus (C.) riparius group*	4	+
83051	*Dicrotendipes simpsoni*	6	
83300	*Glyptotendipes (G.) sp*	19	
84050	*Parachironomus "hirtalatus" (sensu Simpson & Bode, 1980)*	1	
84470	*Polypedilum (P.) illinoense*	3	
94400	*Fossaria sp*	1	
95100	*Physella sp*	1	
98600	*Sphaerium sp*		+

No. Quantitative Taxa: 21 Total Taxa: 27

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

Number of Organisms: 1123 Qual EPT: **1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/16/95 River Code: 05-045 River: Raccoon Creek RM: 10.20

Taxa Code	Taxa	Quan	Qual
01801	*Turbellaria*	6	+
03600	*Oligochaeta*	2136	+
04664	*Helobdella stagnalis*	7	
04687	*Placobdella parasitica*	1	
04935	*Erpobdella punctata punctata*		+
04964	*Mooreobdella microstoma*	4	+
06800	*Gammarus sp*	1	
11200	*Callibaetis sp*		+
22001	*Coenagrionidae*		+
28955	*Libellula lydia*		+
42700	*Belostoma sp*		+
45300	*Sigara sp*		+
52001	*Hydropsychidae*	1	
53800	*Hydroptila sp*	1	
60900	*Peltodytes sp*		+
63900	*Laccophilus sp*		+
70000	*Diptera*	1	
72160	*Psychoda sp*	1	
77500	*Conchapelopia sp*	45	+
82730	*Chironomus (C.) decorus group*	275	+
83040	*Dicrotendipes neomodestus*	11	
83051	*Dicrotendipes simpsoni*	56	
83300	*Glyptotendipes (G.) sp*	22	
84470	*Polypedilum (P.) illinoense*	6	
84750	*Stictochironomus sp*		+
85814	*Tanytarsus glabrescens group*	6	
87400	*Stratiomys sp*		+
95100	*Physella sp*	5	
98600	*Sphaerium sp*	1	

No. Quantitative Taxa: 19 Total Taxa: 29

No. Qualitative Taxa: 15 ICI: **12**

Number of Organisms: 2586 Qual EPT: **1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/16/95 River Code: 05-045 River: Raccoon Creek RM: 8.70

Taxa Code	Taxa	Quan	Qual
01801	*Turbellaria*	15	
02960	*Paragordius sp*		+
03600	*Oligochaeta*	282	+
04664	*Helobdella stagnalis*	1	
04666	*Helobdella triserialis*	1	
08260	*Orconectes (Crokerinus) sanbornii sanbornii*		+
11200	*Callibaetis sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*		+
23600	*Aeshna sp*		+
28955	*Libellula lydia*		+
42700	*Belostoma sp*		+
45300	*Sigara sp*		+
45900	*Notonecta sp*		+
47600	*Sialis sp*	3	
52200	*Cheumatopsyche sp*	1	+
52530	*Hydropsyche depravata group*		+
53800	*Hydroptila sp*		+
60900	*Peltodytes sp*		+
63900	*Laccophilus sp*		+
65800	*Berosus sp*		+
67800	*Tropisternus sp*		+
68708	*Dubiraphia vittata group*	1	
69400	*Stenelmis sp*	1	
74100	*Simulium sp*		+
77500	*Conchapelopia sp*	35	+
77750	*Hayesomyia senata or Thienemannimyia norena*	95	
80420	*Cricotopus (C.) bicinctus*	17	
80430	*Cricotopus (C.) tremulus group*	17	
82730	*Chironomus (C.) decorus group*	17	+
83040	*Dicrotendipes neomodestus*	312	+
83051	*Dicrotendipes simpsoni*	87	
83300	*Glyptotendipes (G.) sp*	17	
84050	*Parachironomus "hirtalatus" (sensu Simpson & Bode, 1980)*		+
84315	*Phaenopsectra flavipes*		+
84450	*Polypedilum (P.) convictum*	17	+
84460	*Polypedilum (P.) fallax group*	17	+
84470	*Polypedilum (P.) illinoense*	44	+
84540	*Polypedilum (Tripodura) scalaenum group*	9	
84750	*Stictochironomus sp*		+
85500	*Paratanytarsus sp*	44	+
95100	*Physella sp*	29	+
98200	*Pisidium sp*	1	

No. Quantitative Taxa: 23 Total Taxa: 43

No. Qualitative Taxa: 30 ICI: **12**

Number of Organisms: 1063 Qual EPT: **4**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/16/95 River Code: 05-045 River: Raccoon Creek RM: 6.50

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	16	
01801	*Turbellaria*	71	+
03600	*Oligochaeta*	132	+
04664	*Helobdella stagnalis*	1	+
04666	*Helobdella triserialis*	3	+
04935	*Erpobdella punctata punctata*	1	+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*		+
45300	*Sigara sp*		+
52200	*Cheumatopsyche sp*	7	
52530	*Hydropsyche depravata group*	1	
63300	*Hydroporus sp*		+
67800	*Tropisternus sp*		+
68708	*Dubiraphia vittata group*		+
69400	*Stenelmis sp*	1	+
74100	*Simulium sp*	6	+
77500	*Conchapelopia sp*	32	+
77750	*Hayesomyia senata or Thienemannimyia norena*	63	
80204	*Brillia flavifrons group*		+
80370	*Corynoneura lobata*	4	
80430	*Cricotopus (C.) tremulus group*		+
81250	*Nanocladius (N.) minimus*	32	
82141	*Thienemanniella xena*	61	
82730	*Chironomus (C.) decorus group*	285	+
83040	*Dicrotendipes neomodestus*	285	+
83840	*Microtendipes pedellus group*	16	
84210	*Paratendipes albimanus or P. duplicatus*	16	
84315	*Phaenopsectra flavipes*	16	+
84450	*Polypedilum (P.) convictum*	111	+
84460	*Polypedilum (P.) fallax group*	111	+
84470	*Polypedilum (P.) illinoense*	222	+
84540	*Polypedilum (Tripodura) scalaenum group*	32	
84750	*Stictochironomus sp*		+
85400	*Micropsectra sp*	301	+
85500	*Paratanytarsus sp*	570	
85625	*Rheotanytarsus exiguus group*	32	
86200	*Tabanus sp*		+
95100	*Physella sp*	26	+
96900	*Ferrissia sp*	16	+
98200	*Pisidium sp*	15	
98600	*Sphaerium sp*	3	+

No. Quantitative Taxa: 31 Total Taxa: 42

No. Qualitative Taxa: 29 ICI: **20**

Number of Organisms: 2488 Qual EPT: **0**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/16/95 River Code: 05-045 River: Raccoon Creek RM: 3.60

Taxa Code	Taxa	Quan	Qual
03600	*Oligochaeta*	49	+
08250	*Orconectes (Procericambarus) rusticus*		+
21200	*Calopteryx sp*		+
52200	*Cheumatopsyche sp*	87	+
60900	*Peltodytes sp*		+
67000	*Helophorus sp*		+
67500	*Laccobius sp*		+
68700	*Dubiraphia sp*		+
69400	*Stenelmis sp*	3	
70000	*Diptera*	1	
77120	*Ablabesmyia mallochi*	3	
77500	*Conchapelopia sp*	34	
77750	*Hayesomyia senata or Thienemannimyia norena*	29	
80204	*Brillia flavifrons group*	10	
80370	*Corynoneura lobata*	14	
80430	*Cricotopus (C.) tremulus group*	5	
81240	*Nanocladius (N.) distinctus*	8	
81825	*Rheocricotopus (Psilocricotopus) robacki*	18	
82141	*Thienemanniella xena*	14	
82730	*Chironomus (C.) decorus group*	42	+
82820	*Cryptochironomus sp*	3	
83040	*Dicrotendipes neomodestus*	18	+
83840	*Microtendipes pedellus group*	13	
84155	*Paralauterborniella nigrohalteralis*	3	
84315	*Phaenopsectra flavipes*	2	
84450	*Polypedilum (P.) convictum*	3	
84460	*Polypedilum (P.) fallax group*	57	
84470	*Polypedilum (P.) illinoense*	13	
84540	*Polypedilum (Tripodura) scalaenum group*	13	
84750	*Stictochironomus sp*		+
85500	*Paratanytarsus sp*	94	
85800	*Tanytarsus sp*	3	
85814	*Tanytarsus glabrescens group*	39	
95100	*Physella sp*	3	
96900	*Ferrissia sp*	166	+

No. Quantitative Taxa: 28 Total Taxa: 35

No. Qualitative Taxa: 12 ICI: **22**

Number of Organisms: 747 Qual EPT: **1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/14/95 River Code: 05-053 River: Little Raccoon Creek RM: 4.30

Taxa Code	Taxa	Quan	Qual
03600	*Oligochaeta*	29	
04935	*Erpobdella punctata punctata*		+
05800	*Caecidotea sp*	34	
05900	*Lirceus sp*	1	
06700	*Crangonyx sp*	1	
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	3	
08310	*Procambarus (Ortmannicus) acutus acutus*		+
21200	*Calopteryx sp*	26	+
22001	*Coenagrionidae*	15	
23600	*Aeshna sp*		+
23909	*Boyeria vinosa*		+
45300	*Sigara sp*	2	+
47600	*Sialis sp*	18	+
52200	*Cheumatopsyche sp*	20	+
60900	*Peltodytes sp*		+
63300	*Hydroporus sp*		+
67800	*Tropisternus sp*		+
68201	*Scirtidae*		+
68707	*Dubiraphia quadrinotata*	54	+
69400	*Stenelmis sp*	5	+
77500	*Conchapelopia sp*	41	+
78650	*Procladius sp*		+
80204	*Brillia flavifrons group*	2	
80370	*Corynoneura lobata*	2	
81650	*Parametriocnemus sp*	2	
82770	*Chironomus (C.) riparius group*		+
83840	*Microtendipes pedellus group*	167	+
84210	*Paratendipes albimanus or P. duplicatus*	2	
84460	*Polypedilum (P.) fallax group*	2	
84520	*Polypedilum (Tripodura) halterale group*		+
84750	*Stictochironomus sp*		+
85400	*Micropsectra sp*	2	
85625	*Rheotanytarsus exiguus group*	4	
87540	*Hemerodromia sp*	3	
95100	*Physella sp*	71	+
96900	*Ferrissia sp*	1	
98200	*Pisidium sp*	70	
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	25	Total Taxa:	38
No. Qualitative Taxa:	22	ICI:	**22**
Number of Organisms:	577	Qual EPT:	**1**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/14/95 River Code: 05-058 River: Caswell Ditch RM: 0.50

Taxa Code	Taxa	Quan	Qual
03600	*Oligochaeta*	12	+
04664	*Helobdella stagnalis*		+
04686	*Placobdella papillifera*	2	
04935	*Erpobdella punctata punctata*		+
06201	*Hyalella azteca*	1	+
08220	*Orconectes (Gremicambarus) immunis*		+
08601	*Hydracarina*	2	
11120	*Baetis flavistriga*	49	+
11125	*Labiobaetis frondalis*		+
11130	*Baetis intercalaris*	599	+
11651	*Procloeon sp (w/o hindwing pads)*	1	
13000	*Leucrocuta sp*	4	
13400	*Stenacron sp*	118	+
13521	*Stenonema femoratum*	38	+
21200	*Calopteryx sp*	2	+
22001	*Coenagrionidae*		+
23600	*Aeshna sp*		+
23909	*Boyeria vinosa*		+
45300	*Sigara sp*		+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*	187	+
60900	*Peltodytes sp*		+
63300	*Hydroporus sp*	1	+
68075	*Psephenus herricki*		+
68130	*Helichus sp*	1	
68201	*Scirtidae*		+
68708	*Dubiraphia vittata group*	28	+
68901	*Macronychus glabratus*		+
69400	*Stenelmis sp*	3	
74501	*Ceratopogonidae*	1	
77120	*Ablabesmyia mallochi*	6	
77355	*Clinotanypus pinguis*		+
77500	*Conchapelopia sp*	27	
77800	*Helopelopia sp*	2	
80370	*Corynoneura lobata*	37	
80420	*Cricotopus (C.) bicinctus*		+
81650	*Parametriocnemus sp*	15	
81825	*Rheocricotopus (Psilocricotopus) robacki*	2	
82141	*Thienemanniella xena*	29	
82820	*Cryptochironomus sp*	6	+
83840	*Microtendipes pedellus group*	4	
84210	*Paratendipes albimanus or P. duplicatus*	33	+
84450	*Polypedilum (P.) convictum*	16	
84460	*Polypedilum (P.) fallax group*	4	
84470	*Polypedilum (P.) illinoense*	2	
85400	*Micropsectra sp*	4	
85500	*Paratanytarsus sp*	6	
85625	*Rheotanytarsus exiguus group*	29	+
85800	*Tanytarsus sp*	25	
85814	*Tanytarsus glabrescens group*	31	
87540	*Hemerodromia sp*	12	
95100	*Physella sp*	75	+
98200	*Pisidium sp*	1	
98600	*Sphaerium sp*		+

No. Quantitative Taxa: 38 Total Taxa: 54

No. Qualitative Taxa: 30 ICI: **48**

Number of Organisms: 1415 Qual EPT: **6**

Ohio EPA Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 08/14/95 River Code: 05-223 River: Gries Ditch RM: 1.00

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	1	
01801	*Turbellaria*	4	
03360	*Plumatella sp*	1	
03600	*Oligochaeta*	2	+
04510	*Hirudinea*		+
05900	*Lirceus sp*	7	+
11020	*Acerpenna pygmaeus*	114	+
11120	*Baetis flavistriga*	10	+
11130	*Baetis intercalaris*	39	
11651	*Procloeon sp (w/o hindwing pads)*	6	
12200	*Isonychia sp*		+
13000	*Leucrocuta sp*	247	+
13400	*Stenacron sp*	86	+
13521	*Stenonema femoratum*	122	+
17200	*Caenis sp*	1	+
22001	*Coenagrionidae*		+
42700	*Belostoma sp*		+
43205	*Nepa apiculata*		+
45300	*Sigara sp*		+
45400	*Trichocorixa sp*		+
47600	*Sialis sp*		+
52200	*Cheumatopsyche sp*	3	+
60900	*Peltodytes sp*		+
63300	*Hydroporus sp*		+
63900	*Laccophilus sp*		+
67500	*Laccobius sp*		+
67800	*Tropisternus sp*		+
68708	*Dubiraphia vittata group*		+
69400	*Stenelmis sp*	1	+
71900	*Tipula sp*		+
74100	*Simulium sp*		+
77120	*Ablabesmyia mallochi*	1	
77500	*Conchapelopia sp*	14	+
77800	*Helopelopia sp*		+
78450	*Nilotanypus fimbriatus*	5	
78650	*Procladius sp*		+
80370	*Corynoneura lobata*	8	
81650	*Parametriocnemus sp*		+
82141	*Thienemanniella xena*	1	
82820	*Cryptochironomus sp*		+
83300	*Glyptotendipes (G.) sp*	1	
83840	*Microtendipes pedellus group*		+
84210	*Paratendipes albimanus or P. duplicatus*	1	+
84460	*Polypedilum (P.) fallax group*	1	
84700	*Stenochironomus sp*		+
84750	*Stictochironomus sp*		+
85625	*Rheotanytarsus exiguus group*	13	
85800	*Tanytarsus sp*		+
85814	*Tanytarsus glabrescens group*	8	+
87540	*Hemerodromia sp*	2	+
94400	*Fossaria sp*	1	
95100	*Physella sp*	10	+
96264	*Planorbella (Pierosoma) pilsbryi*	1	+

No. Quantitative Taxa: 29 Total Taxa: 53

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

Number of Organisms: 711 Qual EPT: **8**

Species List

River Code: 05-045	Stream: **Raccoon Creek**	Sample Date: **1995**
River Mile: **13.30**	Basin: Sandusky River	Date Range: 07/06/95
	Time Fished: 3600 sec Drain Area: 7.9 sq mi	Thru: 08/31/95
	Dist Fished: 0.35 km No of Passes: 2	Sampler Type: D E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CENTRAL MUDMINNOW		I	C	T	4	3.00	1.18	0.04	1.75	13.00
WHITE SUCKER	W	O	S	T	30	23.25	9.13	0.42	19.00	18.43
BLACKNOSE DACE	N	G	S	T	35	33.00	12.95	0.07	3.23	2.34
CREEK CHUB	N	G	N	T	106	97.00	38.08	1.25	56.09	14.40
COMMON SHINER	N	I	S		20	15.00	5.89	0.17	7.73	11.50
FATHEAD MINNOW	N	O	C	T	6	5.50	2.16	0.01	0.31	1.33
BLUNTNOSE MINNOW	N	O	C	T	30	26.25	10.30	0.06	2.53	2.40
CENTRAL STONEROLLER	N	H	N		31	25.25	9.91	0.09	4.17	3.87
BLACK BULLHEAD		I	C	P	3	2.25	0.88	0.04	1.95	19.33
LARGEMOUTH BASS	F	C	C		12	12.00	4.71	0.02	0.85	1.58
GREEN SUNFISH	S	I	C	T	7	6.25	2.45	0.05	2.22	7.57
JOHNNY DARTER	D	I	C		6	6.00	2.36	0.00	0.18	0.67
Mile Total					290	254.75		2.23		
Number of Species					12					
Number of Hybrids					0					

Species List

River Code: **05-045**	Stream: **Raccoon Creek**	Sample Date: **1995**
River Mile: **11.70**	Basin: Sandusky River	Date Range: 07/06/95
	Time Fished: 4500 sec Drain Area: 9.7 sq mi	Thru: 08/31/95
	Dist Fished: 0.35 km No of Passes: 2	Sampler Type: D E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CENTRAL MUDMINNOW		I	C	T	1	0.75	0.12	0.00	0.07	6.00
WHITE SUCKER	W	O	S	T	65	53.50	8.30	1.14	16.99	21.42
BLACKNOSE DACE	N	G	S	T	47	39.50	6.13	0.15	2.22	3.77
CREEK CHUB	N	G	N	T	249	201.75	31.32	2.58	38.45	12.39
COMMON SHINER	N	I	S		48	39.50	6.13	0.33	4.91	8.33
FATHEAD MINNOW	N	O	C	T	1	1.00	0.16	0.00	0.06	4.00
BLUNTNOSE MINNOW	N	O	C	T	10	9.75	1.51	0.03	0.37	2.60
CENTRAL STONEROLLER	N	H	N		206	189.75	29.45	1.48	22.00	7.63
BLACK BULLHEAD		I	C	P	37	31.00	4.81	0.33	4.93	10.32
LARGEMOUTH BASS	F	C	C		2	2.00	0.31	0.01	0.10	3.50
GREEN SUNFISH	S	I	C	T	91	75.75	11.76	0.66	9.89	8.68
Mile Total					757	644.25		6.72		
Number of Species					11					
Number of Hybrids					0					

Species List

River Code: **05-045**	Stream: **Raccoon Creek**	Sample Date: **1995**
River Mile: **11.30**	Basin: Sandusky River	Date Range: 07/07/95
	Time Fished: 4200 sec Drain Area: 10.1 sq mi	Thru: 08/31/95
	Dist Fished: 0.35 km No of Passes: 2	Sampler Type: D E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
CENTRAL MUDMINNOW		I	C	T	1	0.75	0.11	0.01	0.08	7.00
WHITE SUCKER	W	O	S	T	33	25.00	3.61	0.52	7.44	20.45
COMMON CARP	G	O	M	T	1	1.00	0.14	0.21	2.96	205.00
GOLDFISH	G	O	M	T	29	29.00	4.19	0.92	13.29	31.69
BLACKNOSE DACE	N	G	S	T	11	8.25	1.19	0.02	0.32	2.64
CREEK CHUB	N	G	N	T	139	106.50	15.39	1.08	15.64	10.12
COMMON SHINER	N	I	S		23	18.00	2.60	0.11	1.55	6.17
FATHEAD MINNOW	N	O	C	T	6	4.50	0.65	0.02	0.24	3.67
BLUNTNOSE MINNOW	N	O	C	T	71	53.25	7.70	0.07	1.03	1.33
CENTRAL STONEROLLER	N	H	N		258	208.25	30.09	1.45	20.90	6.89
BLACK BULLHEAD		I	C	P	142	107.75	15.57	1.46	21.06	13.45
LARGEMOUTH BASS	F	C	C		3	3.00	0.43	0.02	0.23	5.33
GREEN SUNFISH	S	I	C	T	151	119.50	17.27	1.00	14.52	8.45
BLUEGILL SUNFISH	S	I	C	P	8	6.25	0.90	0.04	0.54	5.42
GREEN SF X ORANGESPT					1	1.00	0.14	0.01	0.20	14.00
Mile Total					877	692.00		6.92		
Number of Species					14					
Number of Hybrids					1					

River Code: 05-045	Stream: **Raccoon Creek**	Sample Date: **1995**
River Mile: **11.00**	Basin: Sandusky River	Date Range: 07/06/95
	Time Fished: 4800 sec Drain Area: 10.2 sq mi	Thru: 08/31/95
	Dist Fished: 0.35 km No of Passes: 2	Sampler Type: D E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	20	15.00	3.26	0.57	6.61	38.10
COMMON CARP	G	O	M	T	8	6.00	1.31	2.29	26.51	382.13
GOLDFISH	G	O	M	T	37	34.75	7.56	1.40	16.22	41.35
BLACKNOSE DACE	N	G	S	T	36	27.00	5.88	0.10	1.14	3.67
CREEK CHUB	N	G	N	T	87	65.50	14.25	1.28	14.84	19.64
COMMON SHINER	N	I	S		86	64.50	14.04	0.65	7.49	10.05
FATHEAD MINNOW	N	O	C	T	3	2.25	0.49	0.01	0.06	2.33
BLUNTNOSE MINNOW	N	O	C	T	42	32.00	6.96	0.06	0.73	1.98
CENTRAL STONEROLLER	N	H	N		217	163.75	35.64	1.57	18.13	9.57
BLACK BULLHEAD		I	C	P	14	10.50	2.29	0.26	3.01	24.79
GREEN SUNFISH	S	I	C	T	43	36.25	7.89	0.43	5.02	11.53
OR'GESPOTTED SUNFISH	S	I	C		2	2.00	0.44	0.02	0.23	10.00
Mile Total					595	459.50		8.65		
Number of Species					12					
Number of Hybrids					0					

River Code: **05-045**	Stream: **Raccoon Creek**	Sample Date: **1995**
River Mile: **10.20**	Basin: Sandusky River	Date Range: 07/07/95
	Time Fished: 5400 sec Drain Area: 10.7 sq mi	Thru: 09/05/95
	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
WHITE SUCKER	W	O	S	T	10	7.50	1.10	0.19	1.33	25.78
COMMON CARP	G	O	M	T	6	4.50	0.66	8.48	58.45	1,883.33
GOLDFISH	G	O	M	T	7	5.25	0.77	0.19	1.32	36.57
BLACKNOSE DACE	N	G	S	T	36	27.00	3.96	0.09	0.61	3.28
CREEK CHUB	N	G	N	T	149	111.75	16.39	1.60	11.04	14.33
COMMON SHINER	N	I	S		224	168.00	24.64	1.84	12.70	10.97
FATHEAD MINNOW	N	O	C	T	25	18.75	2.75	0.07	0.50	3.84
BLUNTNOSE MINNOW	N	O	C	T	85	63.75	9.35	0.20	1.36	3.08
CENTRAL STONEROLLER	N	H	N		316	237.00	34.76	1.38	9.49	5.81
BLACK BULLHEAD		I	C	P	19	14.25	2.09	0.27	1.86	18.95
GREEN SUNFISH	S	I	C	T	29	21.75	3.19	0.16	1.13	7.55
BLUEGILL SUNFISH	S	I	C	P	3	2.25	0.33	0.03	0.20	13.00
	Mile Total				909	681.75		14.50		
	Number of Species				12					
	Number of Hybrids				0					

River Code: 05-045	Stream: **Raccoon Creek**	Sample Date: **1995**
River Mile: **8.10**	Basin: Sandusky River	Date Range: 07/07/95
	Time Fished: 3060 sec Drain Area: 18.1 sq mi	Thru: 08/31/95
	Dist Fished: 0.37 km No of Passes: 2	Sampler Type: D E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	24	18.91	3.27	0.49	12.36	27.00
BLACKNOSE DACE	N	G	S	T	41	35.27	6.11	0.11	2.79	3.17
CREEK CHUB	N	G	N	T	270	226.73	39.24	1.67	42.05	7.20
SUCKERMOUTH MINNOW	N	I	S		16	15.36	2.66	0.08	1.90	4.88
STRIPED SHINER	N	I	S		22	15.00	2.60	0.12	3.11	8.27
COMMON SHINER	N	I	S		45	45.00	7.79	0.38	9.63	8.52
FATHEAD MINNOW	N	O	C	T	1	0.68	0.12	0.00	0.05	3.00
BLUNTNOSE MINNOW	N	O	C	T	132	113.23	19.60	0.31	7.76	2.80
CENTRAL STONEROLLER	N	H	N		101	83.82	14.51	0.41	10.37	4.75
BLACK BULLHEAD		I	C	P	5	4.68	0.81	0.23	5.68	46.00
GREEN SUNFISH	S	I	C	T	19	18.05	3.12	0.16	4.06	8.84
BLUEGILL SUNFISH	S	I	C	P	1	1.00	0.17	0.01	0.23	9.00
Mile Total					677	577.73		3.98		
Number of Species					12					
Number of Hybrids					0					

Species List

River Code: **05-045**	Stream: **Raccoon Creek**	Sample Date: **1995**
River Mile: **5.50**	Basin: Sandusky River	Date Range: 07/07/95
	Time Fished: 4200 sec Drain Area: 20.9 sq mi	Thru: 09/05/95
	Dist Fished: 0.35 km No of Passes: 2	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	22	18.50	6.73	0.64	23.11	34.91
BLACKNOSE DACE	N	G	S	T	28	24.00	8.74	0.08	2.85	3.29
CREEK CHUB	N	G	N	T	207	176.50	64.24	1.76	63.45	9.94
SUCKERMOUTH MINNOW	N	I	S		4	3.25	1.18	0.02	0.68	6.00
COMMON SHINER	N	I	S		7	6.00	2.18	0.05	1.87	8.71
FATHEAD MINNOW	N	O	C	T	1	1.00	0.36	0.00	0.07	2.00
BLUNTNOSE MINNOW	N	O	C	T	12	11.75	4.28	0.05	1.95	4.58
CENTRAL STONEROLLER	N	H	N		20	19.00	6.92	0.07	2.51	3.60
BLACK BULLHEAD		I	C	P	2	2.00	0.73	0.02	0.65	9.00
GREEN SUNFISH	S	I	C	T	13	11.00	4.00	0.07	2.65	7.00
JOHNNY DARTER	D	I	C		2	1.75	0.64	0.01	0.23	3.50
Mile Total					318	274.75		2.77		
Number of Species					11					
Number of Hybrids					0					

River Code: 05-045	Stream: **Raccoon Creek**		Sample Date: **1995**
River Mile: **3.60**	Basin: Sandusky River		Date Range: 07/10/95
	Time Fished: 3000 sec	Drain Area: 22.2 sq mi	Thru: 09/05/95
	Dist Fished: 0.30 km	No of Passes: 2	Sampler Type: E D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	3	3.00	2.56	0.17	9.79	57.67
BLACKNOSE DACE	N	G	S	T	4	4.00	3.42	0.01	0.79	3.50
CREEK CHUB	N	G	N	T	65	65.00	55.56	1.25	70.59	19.18
SUCKERMOUTH MINNOW	N	I	S		3	3.00	2.56	0.02	1.02	6.00
COMMON SHINER	N	I	S		7	7.00	5.98	0.13	7.13	18.00
FATHEAD MINNOW	N	O	C	T	1	1.00	0.85	0.00	0.23	4.00
BLUNTNOSE MINNOW	N	O	C	T	16	16.00	13.68	0.05	2.77	3.06
CENTRAL STONEROLLER	N	H	N		4	4.00	3.42	0.05	2.58	11.33
BLACK BULLHEAD		I	C	P	1	1.00	0.85	0.00	0.17	3.00
LARGEMOUTH BASS	F	C	C		1	1.00	0.85	0.02	0.85	15.00
GREEN SUNFISH	S	I	C	T	10	10.00	8.55	0.07	3.85	6.80
JOHNNY DARTER	D	I	C		2	2.00	1.71	0.00	0.23	2.00
Mile Total					117	117.00		1.77		
Number of Species					12					
Number of Hybrids					0					

River Code: **05-053**	Stream: **Little Raccoon Creek**	Sample Date: **1995**
River Mile: **4.30**	Basin: Sandusky River	Date Range: 07/10/95
	Time Fished: 1500 sec Drain Area: 1.9 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
WHITE SUCKER	W	O	S	T	4	8.00	20.00	0.04	15.65	4.50
BLACKNOSE DACE	N	G	S	T	6	12.00	30.00	0.05	23.48	4.50
CREEK CHUB	N	G	N	T	4	8.00	20.00	0.10	41.74	12.00
LARGEMOUTH BASS	F	C	C		6	12.00	30.00	0.04	19.13	3.67
Mile Total					20	40.00		0.23		
Number of Species					4					
Number of Hybrids					0					

River Code: **05-058**	Stream: **Caswell Ditch**	Sample Date: **1995**
River Mile: **0.50**	Basin: Sandusky River	Date Range: 07/10/95
	Time Fished: 1800 sec Drain Area: 5.0 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
WHITE SUCKER	W	O	S	T	9	18.00	5.08	0.06	4.32	3.22
CREEK CHUB	N	G	N	T	15	30.00	8.47	0.22	16.37	7.33
BLUNTNOSE MINNOW	N	O	C	T	24	48.00	13.56	0.14	10.57	2.96
CENTRAL STONEROLLER	N	H	N		124	248.00	70.06	0.92	68.15	3.69
JOHNNY DARTER	D	I	C		5	10.00	2.82	0.01	0.60	0.80
Mile Total					177	354.00		1.34		
Number of Species					5					
Number of Hybrids					0					

River Code: **05-223**	Stream: **Gries Ditch**	Sample Date: **1995**
River Mile: **1.00**	Basin: Sandusky River	Date Range: 07/11/95
	Time Fished: 1800 sec Drain Area: 15.0 sq mi	
	Dist Fished: 0.20 km No of Passes: 1	Sampler Type: D

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER	W	O	S	T	69	103.50	69.00	0.17	39.01	1.59
CREEK CHUB	N	G	N	T	4	6.00	4.00	0.08	18.44	13.00
BLUNTNOSE MINNOW	N	O	C	T	5	7.50	5.00	0.03	7.09	4.00
CENTRAL STONEROLLER	N	H	N		16	24.00	16.00	0.11	25.53	4.50
BLACKSIDE DARTER	D	I	S		6	9.00	6.00	0.04	9.93	4.67
Mile Total					100	150.00		0.42		
Number of Species					5					
Number of Hybrids					0					

IBI component metrics for sites sampled in Raccoon Creek, 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
Raccoon Creek - (05-045)																
Year: 95																
13.30	D	07/06/95	7.9	10(3)	6(5)	1(1)	0(1)	0(1)	3(3)	67(1)	31(1)	40(3)	21(3)	0.0(5)	69(1)	28
13.30	E	08/31/95	7.9	9(3)	5(3)	1(1)	1(1)	1(1)	2(1)	83(1)	15(5)	66(1)	7(1)	0.0(5)	52(1)	24
11.70	D	07/06/95	9.7	9(3)	5(3)	1(1)	0(1)	0(1)	3(3)	73(1)	10(5)	56(1)	27(3)	0.0(5)	185(1)	28
11.70	E	08/31/95	9.7	10(3)	6(3)	1(1)	1(1)	0(1)	3(3)	44(3)	10(5)	33(3)	19(1)	0.0(5)	340(3)	32
11.30	D	07/07/95	10.1	11(3)	6(3)	1(1)	0(1)	0(1)	3(3)	51(3)	15(5)	45(3)	39(3)	0.6(3)	545(3)	32
11.30	E	08/31/95	10.1	8(3)	3(1)	0(1)	1(1)	0(1)	2(1)	47(3)	23(3)	25(5)	25(3)	0.7(5)	144(1)	28
11.00	D	07/06/95	10.2	9(3)	6(3)	1(1)	0(1)	0(1)	3(3)	42(3)	15(5)	29(5)	23(3)	0.0(5)	470(3)	36
11.00	E	08/31/95	10.2	5(1)	3(1)	0(1)	0(1)	0(1)	0(1)	89(1)	57(1)	36(3)	34(3)	0.0(5)	12(1)*	20
10.20	D	07/07/95	10.7	10(3)	6(3)	1(1)	0(1)	0(1)	3(1)	43(3)	13(5)	34(3)	29(3)	0.2(3)	462(3)	30
10.20	D	09/05/95	10.7	7(1)	6(3)	1(1)	0(1)	0(1)	2(1)	32(5)	17(3)	29(5)	32(3)	0.0(5)	381(3)	32
8.10	D	07/07/95	18.1	10(3)	7(5)	1(1)	0(1)	0(1)	4(3)	75(1)	24(3)	64(1)	9(1)	0.0(5)	108(1)	26
8.10	E	08/31/95	18.1	10(3)	6(3)	1(1)	0(1)	0(1)	4(3)	70(1)	22(3)	61(1)	22(1)	0.7(3)	222(3)	24
Year: 86																
13.20	D	07/10/86	9.5	11(3)	6(3)	1(1)	0(1)	0(1)	3(3)	45(3)	10(5)	21(5)	53(5)	0.0(5)	366(3)	38
13.20	D	08/12/86	9.5	10(3)	6(3)	1(1)	0(1)	1(1)	3(3)	69(1)	20(3)	42(3)	25(3)	0.0(5)	195(1)	28
13.20	D	09/24/86	9.5	11(3)	6(3)	1(1)	0(1)	1(1)	3(3)	71(1)	34(1)	59(1)	12(1)	0.2(5)	246(3)	24
11.60	E	07/10/86	12.0	9(3)	6(3)	1(1)	0(1)	0(1)	3(1)	33(5)	18(3)	22(5)	23(3)	0.3(3)	349(3)	32
11.60	E	08/12/86	12.0	8(3)	6(3)	1(1)	0(1)	0(1)	3(1)	39(3)	21(3)	20(5)	14(1)	0.0(5)	365(3)	30
11.60	D	09/24/86	12.0	9(3)	5(3)	1(1)	0(1)	1(1)	3(1)	37(3)	17(3)	24(5)	10(1)	0.0(5)	642(3)	30
11.20	E	07/10/86	12.0	3(1)	2(1)	0(1)	0(1)	0(1)	0(1)	89(1)	11(1)	78(1)	67(1)	0.0(1)	2(1)* *	12
11.20	D	08/12/86	12.0	5(1)	4(3)	1(1)	0(1)	0(1)	1(1)	97(1)	44(1)	91(1)	47(5)	0.0(5)	2(1)* *	22

▲- IBI is low end adjusted.

IBI component metrics for sites sampled in Raccoon Creek, 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
11.20	D	09/11/86	12.0	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
10.20	D	07/10/86	13.0	6(1)	3(1)	0(1)	0(1)	0(1)	1(1)	95(1)	26(1)	68(1)	58(1)	0.0(1)	2(1)* *	12
10.20	D	08/12/86	13.0	8(3)	6(3)	1(1)	0(1)	0(1)	3(1)	95(1)	32(1)	53(3)	5(1)	0.7(3)	11(1)	20
10.20	D	09/24/86	13.0	3(1)	2(1)	0(1)	0(1)	0(1)	0(1)	100(1)	5(1)	100(1)	82(1)	40.9(1)	0(1)*	12
8.60	D	07/17/86	15.0	7(1)	5(3)	1(1)	0(1)	0(1)	3(1)	68(1)	26(3)	43(3)	8(1)	1.0(5)	48(1)*	22
8.60	D	08/12/86	15.0	6(1)	4(3)	1(1)	0(1)	0(1)	2(1)	98(1)	19(1)	81(1)	41(1)	0.0(5)	2(1)*	18
8.60	D	09/11/86	15.0	9(3)	6(3)	1(1)	0(1)	0(1)	3(1)	96(1)	55(1)	58(1)	10(1)	0.0(5)	6(1)*	20
6.50	D	07/17/86	18.0	6(1)	4(3)	1(1)	0(1)	0(1)	3(1)	97(1)	57(1)	43(3)	5(1)	3.2(1)	3(1)*	16
6.50	D	08/12/86	18.0	7(1)	5(3)	1(1)	0(1)	0(1)	3(1)	86(1)	50(1)	40(3)	15(1)	0.0(5)	24(1)*	20
6.50	D	09/24/86	18.0	9(3)	6(3)	1(1)	0(1)	0(1)	3(1)	83(1)	48(1)	51(3)	23(1)	0.0(5)	33(1)*	22
Year: 83																
13.20	D	09/08/83	9.5	10(3)	6(3)	1(1)	0(1)	1(1)	3(3)	86(1)	46(1)	76(1)	24(3)	3.3(1)	241(3)	22
11.60	D	09/06/83	12.0	10(3)	6(3)	1(1)	0(1)	0(1)	3(1)	70(1)	37(1)	57(1)	23(3)	2.7(1)	1042(5)	22
11.30	S	09/09/83	12.0	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	100(1)	0(1)	100(1)	100(1)	0.0(1)	0(1)*	12
11.10	S	09/09/83	12.0	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	100(1)	0(1)	100(1)	100(1)	0.0(1)	0(1)* *	12
10.20	D	09/07/83	13.0	4(1)	3(1)	1(1)	0(1)	0(1)	1(1)	100(1)	12(1)	94(1)	6(1)	0.0(5)	0(1)*	16
10.10	D	09/07/83	13.0	6(1)	5(3)	1(1)	0(1)	0(1)	2(1)	98(1)	18(3)	81(1)	3(1)	0.0(5)	12(1)	20
8.50	D	09/07/83	15.0	6(1)	5(3)	1(1)	0(1)	0(1)	1(1)	99(1)	29(3)	80(1)	9(1)	6.0(1)	3(1)	16
6.50	D	09/07/83	18.0	12(3)	8(5)	1(1)	0(1)	0(1)	4(3)	94(1)	28(3)	78(1)	13(1)	5.5(1)	31(1)	22
Little Raccoon Creek - (05-053)																
Year: 95																
4.30	E	07/10/95	1.9	4(1)	2(1)	1(1)	1(1)	0(1)	2(3)	70(1)	20(1)	20(5)	0(1)	0.0(5)	12(1)* *	22
Year: 83																

▲- IBI is low end adjusted.

IBI component metrics for sites sampled in Raccoon Creek, 1995.

				Number of						Percent of Individuals						
River Mile	Type	Date	Drainage area (sq mi)	Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
4.30	G	09/09/83	1.2	5(3)	3(3)	1(1)	0(1)	0(1)	2(3)	100(1)	4(5)	66(1)	3(1)	0.0(5)	0(1)*	26
2.50	G	09/09/83	2.0	4(1)	2(1)	0(1)	0(1)	0(1)	1(1)	100(1)	37(1)	98(1)	20(3)	0.0(3)	0(1)*	16
Trib. to Mills Creek - (05-058)																
Year: 95																
0.50	E	07/10/95	5.0	5(1)	3(3)	0(1)	0(1)	1(1)	1(1)	27(5)	19(3)	25(5)	3(1)	0.0(5)	258(3)	30
Year: 85																
0.50	F	07/22/85	5.0	6(3)	4(3)	1(1)	0(1)	1(1)	2(1)	43(3)	19(3)	63(1)	38(5)	0.0(5)	96(1)*	28
0.50	F	08/14/85	5.0	6(3)	4(3)	1(1)	0(1)	1(1)	2(1)	63(1)	21(3)	67(1)	25(3)	0.0(5)	18(1)* *	24
0.50	F	09/18/85	5.0	6(3)	4(3)	1(1)	0(1)	1(1)	2(1)	53(3)	28(1)	71(1)	37(5)	0.0(5)	100(1)	26
Gries Ditch - (05-223)																
Year: 95																
1.00	D	07/11/95	15.0	5(1)	3(1)	0(1)	0(1)	1(1)	2(1)	78(1)	74(1)	9(5)	6(1)	0.0(5)	33(1)*	20
Year: 84																
0.90	D	08/08/84	15.0	9(3)	5(3)	0(1)	1(1)	1(1)	2(1)	60(1)	43(1)	63(1)	11(1)	0.0(5)	114(1)	20
0.90	D	08/29/84	15.0	12(3)	5(3)	0(1)	1(1)	2(1)	3(1)	70(1)	43(1)	73(1)	12(1)	1.6(1)	154(1)	16
0.90	S	09/26/84	15.0	3(1)	2(1)	0(1)	0(1)	1(1)	0(1)	75(1)	75(1)	83(1)	8(1)	0.0(1)	20(1)*	12

▲- IBI is low end adjusted.

IBI component metrics for sites sampled in Raccoon Creek, 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
Raccoon Creek - (05045)																		
Year: 95																		
5.50	D	09/05/95	20	9(3)	1(1)	1(1)	0(1)	1(1)	21(3)	93(1)	9(5)	0.0(1)	9(1)	0.0(5)	18(1)		24	3.6
5.50	D	07/07/95	20	11(3)	1(1)	1(1)	0(1)	1(1)	17(1)	84(1)	14(5)	0.0(1)	8(1)	0.0(5)	46(1)		22	4.6
3.60	D	09/05/95	22	9(3)	1(1)	1(1)	0(1)	0(1)	17(1)	77(1)	11(5)	1.9(3)	26(3)	0.0(5)	24(1)	*	26	4.9
3.60	E	07/10/95	22	10(3)	1(1)	1(1)	0(1)	1(1)	13(1)	91(1)	22(3)	0.0(1)	14(1)	1.6(5)	12(1)	*	20	3.4
Year: 86																		
3.70	D	08/13/86	21	10(3)	1(1)	1(1)	0(1)	1(1)	31(3)	72(1)	33(3)	0.0(1)	45(3)	0.0(5)	36(1)	*	24	5.8
3.70	D	09/24/86	21	11(3)	1(1)	1(1)	0(1)	1(1)	5(1)	63(1)	69(1)	0.0(1)	26(3)	0.5(3)	119(1)		18	5.8
Year: 83																		
3.10	D	09/08/83	22	15(3)	3(3)	1(1)	1(1)	0(1)	7(1)	64(1)	53(1)	0.0(1)	45(3)	0.7(3)	190(1)		20	6.1

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