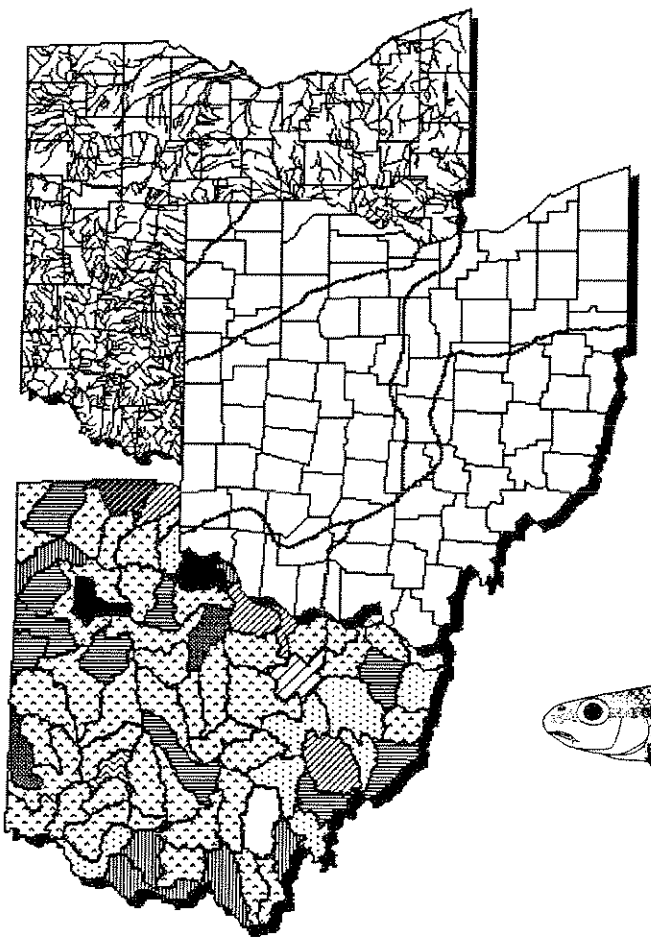
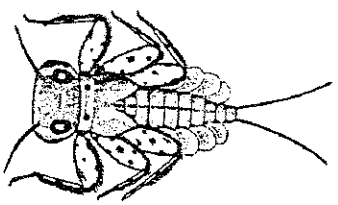
State of Ohio
Environmental Protection Agency

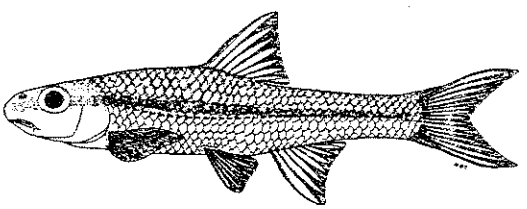
Ecological Assessment Section
Division of Water Quality
Planning & Assessment

Biological and Water Quality Study of the Rocky River and Selected Tributaries

Summit, Lorain, Medina, and Cuyahoga Counties (Ohio)







August 16, 1993

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

Biological and Water Quality Study of the Rocky River and Selected Tributaries

Summit, Lorain, Medina, and Cuyahoga Counties, Ohio

August 16, 1993

OEPA Technical Report EAS/1993-8-3

prepared by

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NOTICE TO USERS

Ohio EPA adopted 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, and the Invertebrate Community Index (ICI), which is based on macroinvertebrates. Criteria for each index are specified for each of Ohio's five ecoregions, and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the chemical and whole effluent toxicity evaluation methods, figure prominently in the assessment of Ohio's surface water resources.

Several documents support the adoption of the biological criteria by outlining the rationale for using biological information, the specific methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results. These documents are:

Ohio Environmental Protection Agency. 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 & Assessment, 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. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989a. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 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 & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1990c. 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.

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

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

Ohio EPA - WQP&A
Ecological Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228
(614) 777-6264

Acknowledgements

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Biological and Water Quality Survey of the Rocky River and Selected Tributaries

(Summit, Medina, and Cuyahoga Counties, Ohio)
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Introduction

The Rocky River study area included the Rocky River mainstem, the East and West Branches, Abram Creek and Baldwin Creek. Several smaller tributaries were also sampled; these included: the North Royalton "A" tributary to the East Branch, and the North Branch Rocky River, Plum Creek, Baker Creek, Blodgett Creek and Mallet Creek, which flow into the West Branch.
Specific objectives of this evaluation were to:

1) monitor and assess chemical/physical water quality and biological communities in the Rocky River study area to determine the degree to which the streams are affected by point and nonpoint sources of pollution and by habitat alterations,

2) evaluate impacts from combined sewer and stormwater overflows (CSOs) and municipal WWTPs on their respective receiving streams,

3) determine the attainment status of current aquatic life use and non-aquatic use designations and recommend changes in use where appropriate, and

4) conduct a water resource trend assessment where historical data exists.

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

Summary

A total of 84.1 miles of the Rocky River mainstem, its branches and selected tributaries were assessed as part of the 1992 sampling effort. Of the total miles assessed, 46.9 miles were in FULL attainment of a WWH aquatic life use (55% of the study area); 15.8 miles demonstrated PARTIAL attainment (18% of the study area) and 21.4 miles were in NON attainment of the WWH use (25% of the study area). Aquatic life use attainment status and biocriteria scores for all sampling locations are presented in Table 1.

Rocky River mainstem and Abram Creek
Based on the performance of the biological communities and the ecoregional biocriteria, 0.3 miles of the free-flowing portion of the Rocky River were in FULL attainment of the designated WWH aquatic life use (3% of the surveyed reach). A total of 3.5 miles (34% of the surveyed reach) were NON attaining, and 6.6 miles (63% of the surveyed reach) demonstrated PARTIAL attainment. Within the 1.2 mile estuary portion of the Rocky River, 0.6 miles were in FULL attainment of the interim biological criteria (fish sampling only) for Lake Erie affected stream segments and 0.6 miles demonstrated PARTIAL attainment. The small percentage of the Rocky River that fully attained appeared to be due to the effluent dominated nature of the system. Under low flow

Table 1. Aquatic life use attainment status for the existing or recommended Warmwater Habitat (WWH) stream segments in the Rocky River and tributaries based on data collected during June - September 1992.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comment
Rocky River						
	Erie Ontario Lake Plain- WWH Use Designation (Existing)					
11.5/11.6	44	7.6[ns]	MG	68.0	FULL	
11.3/11.3	32*	9.0	F*	N/A	N/A	N. Olmsted Mixing Zone
11.1/11.1	30*	7.2*	F*	70.0	**NON**	Dst. N. Olm. WWTP
10.0/9.8	26*	7.7[ns]	F*	67.0	**NON**	
9.5/ -	32*	8.2		69.0	(PARTIAL)	Dst. Abrams Cr.
9.0/9.0	26*	6.9*	30[ns]	70.5	**NON**	
5.8/5.8	34[ns]	7.1*	MG	62.0	PARTIAL	
3.0/2.9	28*	7.4[ns]	MG	80.5	PARTIAL	
- /1.3			MG		(FULL)	
1.0/ -	28[ns]	7.5		58.0	(FULL)	Estuary
0.1/ -	27*	7.2[ns]		34.0	(PARTIAL)	Estuary
Abrams Creek						
	Erie OntarioLake Plain - WWH Use Designation (Existing)					
1.9/2.0	16*	N/A	4*	59.0	**NON**	Dst. WWTPs
0.4/0.3	12*	N/A	8*	73.0	**NON**	Dst. NASA
East Branch Rocky River						
	Erie Ontario Lake Plain - WWH Use Designation (Existing)					
26.7/26.6	45	N/A	48		FULL	
21.9/22.1	48	8.8	54	79.0	FULL	
18.2/18.2	43	8.4	G	N/A	FULL	
17.5/17.5	38	7.3*	VG	70.0	PARTIAL	Dst. Medina 300 WWTP
15.315.2	44	8.0	44	63.5	FULL	
11.6/11.6	38	8.2	G	83.5	FULL	Dst. N. Roy. "A" trib
10.7/10.7	38	8.5	42		FULL	
10.0/10.0	36[ns]	8.6	46	62.0	FULL	
9.3/ -	36[ns]	8.3	-		(FULL)	
6.5/6.4	36[ns]	7.4[ns]	G	63.5	FULL	
4.9/4.9	34[ns]	5.6*	G	70.0	**NON**	Dst. Baldwin Cr.
1.4/1.2	22*	4.4*	G	70.0	**NON**	Dst. Berea WWTP

Table 1. (continued)

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comment
North Royalton A Tributary						
	Erie Ontario Lake Plain - WWH Use Designation (Existing)					
0.6/0.6	35*	N/A	P*	44.5	**NON**	
0.2/0.2	20*	N/A	P*	70.5	**NON**	Dst. N. Royalton "A"WWTP
Baldwin Creek						
	Erie Ontario Lake Plain - WWH Use Designation (Existing)					
7.4/7.5	31*	N/A	MG	54.5	PARTIAL	
- /7.0	-	-	28*	-	**(NON)**	Dst. N. Royalton "B" WWTP
5.8/5.8	17*	N/A	36	82.0	**NON**	
3.0/3.0	27*	N/A	32[ns]	43.5	**NON**	
2.6/2.6	22*	N/A	30[ns]	68.5	**NON**	Dst. Strongsville "C" WWTP
1.4/1.4	18*	N/A	40	58.5	**NON**	
West Branch Rocky River						
	Erie OntarioLake Plain - WWH Use Designation (Existing)					
35.5/35.5	43	N/A	54	66.5	FULL	
33.3/33.3	49	N/A	40	70.0	FULL	Dst. Montville Landfill
27.3/27.3	42	8.3	VG	73.0	FULL	
17.2/17.2	38	8.4	48	61.0	FULL	
13.3/13.3	32*	8.0	48	75.0	PARTIAL	Dst. Medina 500 WWTP
4.8/4.7	42	7.6[ns]	MG	81.0	FULL	
3.6/3.5	33*	6.7*	MG	69.5	**NON**	Dst. Blodgett Cr.
2.1/2.1	32*	6.7*	MG	58.0	**NON**	Dst. Plum Cr.
0.4/0.4	30*	7.6[ns]	G	71.5	PARTIAL	
Plum Creek						
	Erie Ontario Lake Plain- WWH Use Designation (Existing)					
0.3/0.3	18*	N/A	F	43.5	**NON**	

Table 1. (continued)

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comment
Baker Creek						
	Erie Ontario Lake Plain- WWH Use Designation (Existing)					
0.3/0.5	37[ns]	N/A	F*	68.0	PARTIAL	
North Branch Rocky River						
	Erie Ontario Lake Plain- WWH Use Designation (Existing)					
5.5/5.5	47	8.2	50	73.5	FULL	
Blodgett Creek						
	Erie Ontario Lake Plain- WWH Use Designation (Existing)					
0.1/0.1	38[ns]	N/A	P*	63.5	**NON**	
Mallet Creek						
	Erie Ontario Lake Plain- WWH Use Designation (Existing)					
0.7/0.6	47	N/A	MG	68.5.	PARTIAL	

Ecoregion Biocriteria:

Erie Ontario Lake Plains (EOLP)

INDEX - Site Type	WWH	EWH	MWH[d]
IBI - Headwaters/Wading	40	50	20
IBI - Wading	38	50	22
IBI - Boat	40	48	20
IBI - Estuary[e]	32	48	24
Mod. Iwb - Wading	7.9	9.4	5.6
Mod. Iwb - Boat	8.7	9.6	5.7
Mod. Iwb - Estuary[e]	7.5	9.6	5.8
ICI	36	46	22

[d] - Modified Warmwater Habitat for channel modified areas.
[e] - Interim Estuary WWH Criteria

* - significant departure from biocriteria; poor and very poor results are underlined.
ns - nonsignificant departure from biocriteria for WWH or EWH (4 IBI or ICI units; 0.5 Iwb units).
[a] - Narrative evaluation used in lieu of ICI where quantitative sampling was not done or where artificial substrates were influenced by slow (< 0.3 ft/sec) current velocity (E=Exceptional; G=good; MG=Marginally good; F=Fair; P=Poor; VP=Very Poor).
[b] - Qualitative Habitat Evaluation Index (QHEI) values based on the new version (Rankin 1989).
[c] - Attainment status based on one organism group is parenthetically expressed.

conditions ($Q_{7,10}$), wastewater discharges accounted for approximately 95% of the flow volume downstream from the East and West Branches. Additionally, the North Olmsted WWTP had a definable enrichment impact that extended approximately 2.5 miles downstream from the discharge. The lower two mile segment of Abram Creek was in **NON** attainment of the WWH use. Both fish and macroinvertebrate communities were in poor or very poor condition within this reach. Inadequately treated effluent from the Brookpark and Middleburg Heights WWTPs was apparently causing the severely degraded conditions in Abram Creek.

West Branch Rocky River

The West Branch Rocky River study area can be divided into two distinct segments: an upper reach that extended from RM 33.5 to RM 13.3 and a lower reach from RM 4.8 to 0.4. An impounded segment separated these two reaches. From RM 35.5 to RM 17.2 the West Branch supported relatively diverse and balanced fish and macroinvertebrate communities and fully attained the designated WWH aquatic life use. No significant impact was attributed to the Montville landfill which represented a substantial improvement compared to conditions encountered in 1981. PARTIAL attainment was indicated at RM 13.3 due to nutrient enrichment downstream from the Medina 500 WWTP that primarily affected the fish community. In the lower stream segment, more pollution tolerant macroinvertebrate assemblages were collected from the natural substrates beginning at RM 4.7. Based on a narrative evaluation, the benthos was representative of a marginally good condition at RMs 4.7, 3.5, and 2.1 and improved to good at RM 0.4. In this area, the fish community was degraded beginning at RM 3.6 and extending to RM 0.4. The impact on the fish did not appear to be a typical response to nutrient enrichment, rather, possible chronic or episodic toxicity was suggested. Beginning downstream from Blodgett Creek (RM 3.6), a reduction in species richness and a loss of intolerant taxa were documented with no significant increase of omnivorous and tolerant species. Blodgett Creek and Plum Creek, which were impacted by WWTP discharges, and an unnamed tributary receiving flow from the Columbia Hills Trailer Park are all potential sources of impact within this stream segment. A total of 24.4 miles (73% of the study area) of the West Branch was in FULL attainment of the WWH biocriteria; 6.3 miles (18% of the study area) achieved PARTIAL attainment; 2.9 miles (8% of the study area) were in **NON** attainment of the WWH use. Sampling results from the North Branch Rocky River, Mallet Creek, Baker Creek, Blodgett Creek, and Plum Creek are presented in the Results and Discussion section of this document.

East Branch Rocky River and Baldwin Creek

Except for a 1.3 mile segment of PARTIAL attainment downstream from the Medina 300 WWTP, the upper 13.8 surveyed miles of the East Branch study area (RM 26.7 to RM 12.9) supported relatively good biological communities. The fish assemblage in the partially attaining segment was apparently moderately impacted by nutrient enrichment. The macroinvertebrate community was considered to be in excellent to good condition throughout surveyed area. Beginning downstream from the North Royalton "A" tributary (RM 11.6), fish assemblages in the East Branch were increasingly threatened or impacted by the additive affects of point sources and urban polluted runoff. The majority of this segment was fully attaining; however, declines in the performance of the fish community were documented downstream from the North Royalton "A" WWTP, the Strongsville "B" WWTP, Baldwin Creek, and the Berea WWTP. The East Branch failed to attain (**NON**) the designated WWH aquatic life use because one or both fish indices scored in the poor or very poor range downstream from Baldwin Creek (RM 4.9) to the mouth. A total of 21.4 miles were considered to be in FULL attainment of the WWH aquatic life use (80% of the study area). The area of **NON** attainment downstream from Baldwin Creek represented 18% of the East Branch study area.

Baldwin Creek was considered to be in PARTIAL attainment of the designated WWH aquatic life use upstream from the North Royalton "B" WWTP but likely becomes intermittent during summers with average or below average rainfall. Beginning downstream from the North Royalton "B" WWTP, the stream was in NON attainment of the WWH use due in large part to the overwhelmingly effluent dominated nature of the stream. The fish community was affected by the resulting nutrient enrichment to a greater extent than the macroinvertebrates and yielded IBI scores that were in the poor or very poor range from RM 5.8 to the most downstream site at RM 1.4.

1981-1992 Trend Assessment

Compared to 1981 survey results, concentrations of ammonia-N declined in the mainstem of the Rocky River in reponse to treatment plant improvements and subsequent reduction of ammonia loadings from WWTPs throughout the basin (i.e., Brookpark, Medina 500 and North Olmsted WWTPs). The macroinvertebrate community in the Rocky River demonstrated improvement in 1992 compared to 1981, but still was not fully achieving the WWH aquatic life use. Though an impact was apparent, the most improved macroinvertebrate results were recorded upstream from the North Olmsted to RM 9.0. Conversely, the results of the 1992 fish sampling effort indicated reduced community performance within the upper portion of the Rocky River mainstem.

Despite increased flows from the two WWTPs that discharge to Abram Creek, water quality improved slightly since 1981 for all parameters sampled, however, fish and benthic communities in Abram Creek were severely degraded by the Brookpark and Middleburg Heights WWTPs in 1981 and1992.

Fish community sampling of the East Branch Rocky River downstream from the Medina 300 WWTP (RM 17.5) reflected a significant decline in fish community performance as measured by the IBI. In 1981, this station received a narrative evaluation of very good (IBI=47). However, in 1992, the fish assemblage was characterized as marginally good (IBI=38). The most notable changes within the fish community over the eleven year period were a reduction in species richness, an increase in the abundance of tolerant and omnivorous species, and an increase in the incidence of DELT anomalies. No impact was attributed to the Medina 300 WWTP in the macroinvertebrate community. Improvement of ammonia-N and phosphorus concentrations since 1981in the East Branch Rocky River were correlated with the reduction of loadings of phosphorus and ammonia-N from the North Royalton "A" and Strongsville "B" WWTPs. Improvements to the North Royalton "A" and Strongsville "B" WWTPs after 1981 also resulted in improved fish and macroinvertebrate community preformance in 1992.

Improved chemcal water quality sampling results from Baldwin Creek in 1992 compared to 1981 were attributed to improvements and subsequent reductions in pollutant loadings from the North Royalton "B" and Strongsville "C" WWTPs. Macroinvertebrate sampling in Baldwin Creek documented impacts from the North Royalton "B" and the Strongsville "C" WWTPs in both 1981 and 1992. However, there appeared to be a lesser impact in 1992. In comparison with the 1981 survey results, the 1992 sampling effort documented continued impacts on the fish assemblage of Baldwin Creek. Achievement of the WWH fish community biological criteria was not observed at any station during either sampling effort. The condition of the fish community downstream from the Strongsville "C" WWTP appeared to have declined in 1992 compared to 1981 based on the IBI scores.

There was a large decline in COD concentrations in the West Branch Rocky River downstream from the Montville Landfill tributary and a general decline of COD in the basin in 1992 compared with 1981 sampling results. Interim remedial measures at the Montville Landfill including leachate collection were likely responsible for the improved water quality in the upper West Branch. Severe toxic impacts to the macronivertebrate and fish communities in the West Branch Rocky River were attibuted to the Montville Landfill (RM 33.4) in 1981 Fish and macroinvertebrate assemblages were not significantly affected by the Montville Landfill in 1992. The 1992 sampling effort demonstrated a large improvement in D.O., phosphorus and ammonia-N levels downstream from the Medina 500 WWTP in response to a significant reduction of pollutant loadings from the WWTP. However, the fish and maroinvertebrate communities were apparently unaffected by the improvements to the WWTP. The fish sampling results indicated a continued enrichment impact in 1992 and the macroinvertebrate community was not significantly affected in either 1981 or 1992. In 1981, severe toxic impacts to the macronivertebrate and fish communities were documented in the West Branch Rocky River and Blodgett Creek due to the discharge of poorly treated wastewater from the Versailles WWTP and the Strongsville "A" WWTP. The macroinvertebrate community continued to be severely impacted but the Blodgett Creek fish community demonstrated significant improvement in 1992. There was a decline in the macroinvertebrate community of the West Branch downstream from the confluence of Bloggett Creek (RM 3.5) in 1992 but the benthos still marginally met biological expectations. The fish assemblage at RM 3.6 was characterized as fair (IBI=33) and, though full achievement of the WWH biological criteria was not observed, it appeared that substantial recovery had occurred since 1981. Fish community performance at locations downstream from Plum Creek achieved WWH biological criteria in 1981, however, 1992 survey results indicated diminished performance within this reach

Evaluated Point Sources

North Olmsted WWTP (Rocky River: RM 11.4)

No acute or chronic toxicity was apparent within the North Olmsted WWTP mixing zone; however, a significant enrichment impact was attributed to the effluent discharge. A depression in the macroinvertebrate community was most severe at RM 11.1 and remained evident at RM 9.8. The fish community was similarly affected. Reduced species richness and increased percentages of tolerant and omnivorous species were most evident at RM 11.1 and became less pronounced at RMs 10.0 and 9.5. An increase in COD was noted in the North Olmsted mixing zone but was assimilated within 2 miles downstream from the discharge. The biological communities in the free-flowing portion of the Rocky River never fully attained the WWH aquatic life use downstream from the North Olmsted WWTP. Apparently the addition of pollutants from the surrounding urban area and Abram Creek was limiting further recovery.

Middleburg Heights WWTP and Brookpark WWTP (Abram Creek: RM 4.0 and RM 3.7)

Abram Creek was severely impacted downstream from the Brookpark and Middleburg Heights WWTPs, both chemically and biologically. Elevated ammonia-N and fecal coliform bacteria levels and depressed D.O. were documented. Fish and macroinvertebrate assemblages reflected poor or very poor conditions. Acute toxicity was indicated at RM 1.9 and conditions appeared only marginally improved at RM 0.4.

Medina 300 WWTP (East Branch: RM 18.2)

Biological sampling of the Medina 300 WWTP mixing zone indicated no acute or chronic toxicity and the WWTP had no significant impact on the macroinvertebrate community downstream. An impact was discernable in the performance of the fish community that

resulted in only a fair MIwb score. The impact was of relatively short duration and the fish assemblage was fully meeting applicable WWH biocriteria at RM 15.3.

North Royalton "A" WWTP (East Branch: RM 12.9, 0.5)

A fair fish community and a poor macroinvertebrate community were present in the North Royalton "A" WWTP tributary upstream from the plant. The lack of attainment in the biological assemblages was apparently due to urban polluted runoff. The fish community demonstrated additional decline downstream from the North Royalton "A" WWTP and was in poor condition. No impact was observed in the East Branch macroinvertebrate community downstream from the confluence of the North Royalton "A" WWTP tributary. A moderate increase in nutrient enrichment was indicated by a higher percentage of omnivorous and herbivorous minnows, however, the fish community indices continued to attain the WWH biocriteria.

Strongsville "B" WWTP (East Branch: RM 11.1, 0.4)

The Strongsville "B" WWTP had no significant impact on the macroinvertebrate community of the East Branch. Negative effects were observable in the fish community downstream from the Strongsville "B" WWTP tributary; nevertheless, achievement of the IBI and MIwb criteria was maintained. It appeared that effluent from this plant was one of several factors that contributed to the gradual decline in fish community performance observed between RM 11.6 and RM 1.4.

Berea WWTP (East Branch: RM 3.2)

Chemical sampling reflected the influence of the Berea WWTP effluent on the East Branch in that mean ammonia-N concentrations increased and 1 of 2 fecal coliform bacteria samples exceeded the secondary contact recreation criterion. No significant change in the macroinvertebrate community was attributed to the discharge; however, the fish community performed at a poor to very poor level. It appeared that the Berea WWTP, in combination with upstream dischargers and polluted runoff, contributed to a decline in the fish community that was first observed at RM 11.6 and worsened downstream. The fish community was improved in the Rocky River mainstem downstream from the confluence of the East and West branches; however, both fish and macroinvertebrate assemblages were somewhat depressed apparently due to an inability of the system to completely assimilate the pollutant load from upstream sources.

North Royalton "B" WWTP (Baldwin Creek: RM 7.3)

The North Royalton "B" WWTP had a significant impact on biological communities in Baldwin Creek. Chronic toxicity was indicated in the benthos 0.3 miles downstream from the WWTP. A significant enrichment impact was also noted at RM 5.8 and RM 3.0. The fish community was in fair condition upstream from the WWTP and in poor condition downstream. A relatively high incidence of DELT anomalies (deformities, eroded fins/barbels, lesions and tumors) and a predominance of pollution tolerant and omnivorous species at RM 5.8 were likely a consequence of the discharge. Minimal recovery was observed in the fish community at RM 3.0, upstream from the Strongsville "C" WWTP.

Strongsville "C" WWTP (Baldwin Creek: RM 2.9)

Nutrient enrichment was indicated by the benthic community downstream from the WWTP (RM 2.6); nevertheless, marginal attainment was documented followed by significant recovery at RM 1.4. The fish community was in poor condition upstream from the plant and

demonstrated an additional decline at RM 2.6. No significant recovery in the fish community was evidenced at RM 1.4.

Montville Landfill (West Branch: RM 33.4)
Slightly higher mean COD and ammonia-N concentrations were recorded at RM 33.3 compared to upstream and a significant sediment load was being contributed to the West branch via the Montville landfill tributary. No impact was evident in the fish community. The macroinvertebrate assemblage also attained the designated WWH use downstream from the landfill. Two minor changes in the macroinvertebrate community were a reduction in the number of cool-water taxa identified at RM 33.3 versus RM 33.5 and fewer riffle beetles and heptageniid mayflies collected from the natural substrates.

Medina 500 WWTP (West Branch: RM 14.8)
The West Branch supported a relatively diverse and sensitive benthic assemblage upstream and downstream from the Medina 500 WWTP, however, an increase in organism density on the artificial substrates did suggest a minor enrichment affect. Changes in the fish community downstream from the WWTP were also indicative of nutrient enrichment (*i.e.*, .increased abundance of omnivorous and tolerant species). Based on the IBI and MIwb criterion, the fish community partially acheived the WWH aquatic life use at RM 13.3 and fully acheived at RM 4.8.

Conclusions

Rocky River and Abram Creek

- The small percentage of the Rocky River mainstem that fully attained a WWH use appeared to be largely related to the effluent dominated nature of the system. Under low flow conditions ($Q_{7,10}$), wastewater discharges account for approximately 95% of the volume of flow downstream from the East and West Branches. Additionally, the North Olmsted WWTP had a definable enrichment impact that extended approximately 2.5 miles downstream from the discharge. Polluted runoff from the surrounding urban area was probably an addtional impediment to full attainment of biotic potential by contributing additional pollutant load.

- With the completion of planned eliminations of at least four discharges and the expansion of two WWTPs within the basin, wastewater flows in the Rocky River are expected to be reduced by approximately 17%. The net effect based on current loadings information is that ammonia-N and CBOD could be reduced by as much as 85% and 65%, respectively, within the next two years, assuming that current treatment efficiencies are mantained.

- Abram Creek was severely degraded at RM 2.0, downstream from the Brookpark and Middleburg Heights WWTPs. These two plants have been eliminated and the flow diverted to the NEORSD Southwest Interceptor Any impacts attributable to the Hopkins International Airport and NASA facility were apparently masked by the WWTP discharges.

East Branch Rocky River and Baldwin Creek

- Beginning downstream from the North Royalton "A" tributary, fish assemblages in the East Branch were increasingly threatened or impacted by the additive affects of point sources and urban polluted runoff. Even though the fish community met ecoregional expectations, declines were documented downstream from the North Royalton "A" WWTP and the Strongsville "B" WWTP. Further impairment was documented downstream from Baldwin Creek and the Berea

WWTP where the fish community was considered to be in poor to very poor condition (RM 4.9 - 1.4). Based on entity generated loadings information, the Berea WWTP pollutant loadings were more than for all other dischargers to the East Branch combined. The planned redirection of wastewater from this plant into the NEORSD Southwest Interceptor in the summer of 1993 should improve conditions in the lower East Branch and the upper Rocky River mainstem.

- Biological integrity in Baldwin Creek was impaired due in large part to the overwhelmingly effluent dominated nature of the stream. The North Royalton "B" WWTP and the Strongsville "C" WWTP both contributed substantial nutrient loads that resulted in a documented instream enrichment impact. A number of failed septic systems were also observed between RM 3.0 and the mouth that likely contributed additional organic load and were responsible for elevated fecal coliform bacteria counts in this stream segment.

West Branch Rocky River

- No significant impact was attributed to the Montville landfill which represented a substantial improvement compared to conditions encountered in 1981.

- Nutrient enrichment was indicated downstream from the Medina 500 WWTP (RM 13.3) which primarily affected the fish community. No impact was directly attributed to the WWTP at RM 4.8, the next downstream site.

- Chemical and biological conditions in the West Branch declined beginning at RM 4.8 and impacts were detectable at all downstream sampling locations. The fish community was most significantly affected. Blodgett Creek and Plum Creek, which were impacted by WWTP discharges, and an unnamed tributary that receives flow from the Columbia Hills Trailer Park are all potential sources of impact within this stream segment.

Recommendations

Status of Aquatic Life Uses

Several of the streams evaluated during this study were originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. Therefore, because this study represents a first use of this type of biological data to evaluate and establish aquatic life use designations, applicable revisions are recommended. While some of the changes may appear to constitute "downgrades" (i.e., EWH to WWH, WWH to MWH, etc.) or "upgrades" (*i.e.* LWH to WWH, WWH to EWH, etc.), any changes should not be construed as such because this constitutes the first use of an objective and robust use evaluation system and database. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on the existing, unverified use designations. Although most of the streams were evaluated in 1981, the numerical biocriteria were not adopted until 1990, thus use attainment status is also a reflection of this change as well.

- The current Warmwater Habitat aquatic life use that applies to the entire Rocky River watershed should be maintained for all stream segments surveyed as a part of this study. Physical habitat conditions were not observed as being a problem, although, significant alteration of the flow regime has occurred on the mainstem, branches and larger tributaries due to the discharge of effluents and urbanization.The WWH aquatic life use should be considered threatened in those

areas that are fully or partially attaining due to development that is expected to continue and potentially will affect the watershed in the future.

- The State Resource Water (SRW) designation currently applied to the Rocky River mainstem, East Branch, and Baldwin Creek should be retained. These streams are state resource waters by definition in that all or portions of the stream and riparian areas are a part of the Cleveland Metropolitan Park system.

Status of Non-Aquatic Life Uses

- The existing Primary Contact Recreation (PCR) designation for the surveyed streams should be retained. The streams have pools with average depths of at least 3 feet covering an area exceeding 100 square feet, the requisite habitat feature to qualify for a primary contact use designation.

Other Recommendations

- The majority of streams that were investigated as part of this study were either impaired or threatened by the cumulative impacts of point and nonpoint pollution sources and increasing urbanization. A watershed based planning approach is needed to minimze future impacts and allow for the restoration and protection of the water resourses in the Rocky River basin.

- Unsewered areas need to be evaluated by the local health departments to correct failed septic systems along the East Branch and Baldwin Creek.

- An investigation is needed to determine the source of elevated fecal coliform bacteria and nutrient concentrations that were detected in the Rocky River near SR 10 (RM 5.8).

Future Monitoring Needs

- Evaluation is needed of the impacts from nonpoint source pollution in previously unmonitored stream segments in the Rocky River Basin.

- A determination of the source and proclivity for reoccurrence of the putrid water encountered downstream from the Lakewood WWTP following a storm event that occurred on September 2, 1992 is needed. The threat that similar events have on recreational users of the Rocky River estuary should also be evaluated. This could be conducted as part of an investigation of CSOs on the mainstem to determine the extent to which they are degrading the stream.

- Sediment and fish tissue sampling on the Rocky River should be conducted for mercury contamination associated with the NASA facility.

- Now that the Brookpark and Middleburg Heights WWTPs have been eliminated, sampling of Abram Creek and the Rocky River is needed to evaluated potential impacts from NASA and Hopkins International Airport. Deicing operations at the airport is an issue that was not addressed by this survey; chemical sampling is particularly needed to delineate what, if any, impact is associated with this activity.

- A similar basin-wide study should be conducted in 1997 in accordance with the five year basin approach monitoring strategy to document changes in the water resource and provide updated information for the reissuance of NPDES permits. The planned elimination of a number of WWTPs along with the proposed expansions of others will necessitate this reevaluation.

Study Area

The Rocky River basin (Figure 1), situated between the Cuyahoga River and the Black River basins, drains 293.8 square miles in northeast Ohio (Ohio Dept. of Natural Resources, 1985). The basin headwaters are in Medina and Summit Counties. The river and its tributaries flow in a northerly direction through glaciated topography to drain into Rocky River Harbor and Lake Erie between the cities of Lakewood and Rocky River on the west side of the Cleveland metropolitan area. Table 2 presents the general characteristics of streams in the study area.

Major hydrologic features in the Rocky River Basin include: Rocky River Harbor, the Rocky River mainstem, East Branch, and West Branch. Rocky River Harbor consists of the lower 4,200 feet of Rocky River, an artificial lagoon on the east side near the river mouth with a side channel called the West Channel, and an entrance channel from Lake Erie (U.S. Army Corp of Engineers, 1975). The Rocky River is formed by the confluence of the East and West Branches which join together 12 miles upstream from Lake Erie.

Land use in the northern half of the Rocky River watershed is dominated by urban and suburban communities on the west side of the Cleveland metropolitan area, while in the southern half of the watershed land use varies from smaller urban/suburban areas to agricultural production. Rocky River Harbor and its adjacent communities are a highly industrialized area (Ohio EPA, 1983). Premitted watsewater dischargers located in the Rocky River basin are listed in Table 3.

The Rocky River Basin is located in the Erie/Ontario Lake Plain (EOLP) ecoregion. The EOLP is characterized by glacial plains interspersed with higher remnant beach ridges, drumlins, glacial till ridges, till plains, and outwash terraces. Local relief is greater in the Erie/Ontario Lake Plain ecoregion (northeast Ohio) than in the neighboring Huron/Erie Lake Plain (northwest Ohio) and Eastern Corn Belt Plain (central and western Ohio) ecoregions, but less than the relief found in the Western Alleghany Plateau (southeast Ohio) ecoregion (Omernik, 1988).

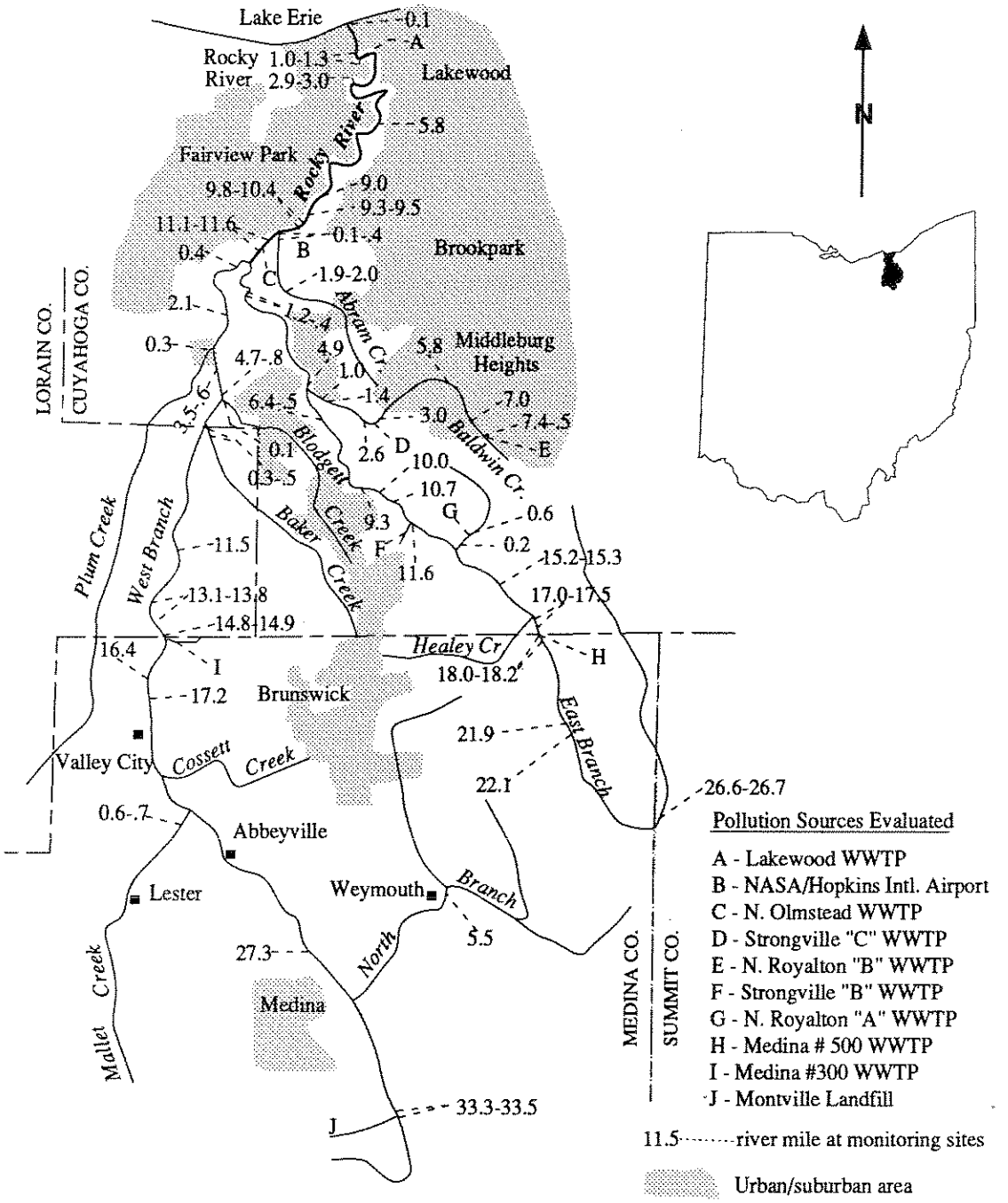

Figure 1. The Rocky River study area showing principal streams and tributaries, population centers, pollution sources, and sampling locations.

Table 2. Stream characteristics and significant identified pollution sources in the Rocky River study area.

Stream Name	Length (Miles)	Average Fall (Feet/Mile)	Drainage Area (Square Miles)	Nonpoint Source Pollution Categories	Point Sources Evaluated
Rocky River	12.1	13.7	293.8	Urban runoff Sanitary & storm sewers Airport runoff On-site septic systems	North Olmsted WWTP NASA Hopkins Intl. airport
Abram Creek	7.4	29.4	10.1	Urban runoff Storm sewers Industrial landfills	Middleburg Heights WWTP Brookpark WWTP
West Branch Rocky River	36.3	16.0	188.3	Urban runoff Sanitary landfill Agriculture On-site septic systems	Montville Landfill Medina 500 WWTP
East Branch Rocky River	34.5	16.5	80.4	Urban runoff Sanitary and storm sewers On-site septic systems Agriculture	Medina 300 WWTP Strongsville "B" WWTP Berea WWTP
Baldwin Creek	9.2	53.8	11.9	Urban runoff Storm sewers On-site septic systems	N. Royalton "B" WWTP Strongsville "C" WWTP
North Royalton "A" Tributary	1.4	35.7	2.6	Urban runoff	N. Royalton "A" WWTP
North Branch Rocky River	5.4	22.4	37.6	Agriculture Urban runoff On-site septic systems	
Plum Creek	14.8	16.4	18.9	On-site septic systems	Brentwood WWTP Western Ohio Utility WWTP
Baker Creek	8.2	45.7	5.8	On-site septic systems	
Blodgett Creek	5.1	31.4	2.7	Urban runoff	Strongsville "A" WWTP
Mallet Creek	11.4	27.5	18.8	On-site septic systems Agriculture	

Table 3. 1992 Permitted Wastewater Dischargers in the Rocky River basin.

Public/Semi-public Dischargers	County	Permit#	Stream	RM	Flow
BROOKPARK CITY	CUYAHOGA	3PD00012	ABRAM CREEK	10.38/3.7	
CUY BRENTWOOD	CUYAHOGA	3PH00020	PLUM CREEK		0.16
OLMSTED FALLS TYNDALE SUB.	CUYAHOGA	3PA00022	W BR ROCKY		
MIDDLEBURG HEIGHTS CITY	CUYAHOGA	3PD00045	ABRAM CREEK	10.38/4.03	2.4
NEORSD BEREA	CUYAHOGA	3PD00007	E BR ROCKY	12.07/3.2	2.4
NEORSD STRONGSVILLE A	CUYAHOGA	3PD00021	BLODGETT CREEK	1.6	3.5
NORTH OLMSTED CITY	CUYAHOGA	3PD00016	ROCKY RIVER	11.38	6.3
NORTH ROYALTON B	CUYAHOGA	3PC00018	BALDWIN CREEK	7.95	0.6
NORTH ROYALTON A	CUYAHOGA	3PD00030	E BR ROCKY	0.5	1.7
OLMSTED FALLS VERSAILLES	CUYAHOGA	3PB00065	BLODGETT CREEK		0.08
STRONGSVILLE C	CUYAHOGA	3PB00048	BALDWIN CREEK	2.9	0.8
STRONGSVILLE B	CUYAHOGA	3PB00047	UT TO E BR ROCKY	0.4	0.7
WESTERN OHIO UTILITY	CUYAHOGA	3PU00003	PLUM CREEK	2.6	0.35
LOR COLUMBIA WEST RIVER	LORAIN	3PG00053	W BR ROCKY		0.006
LOR WESTVIEW PARK	LORAIN	3PH00022	W BR ROCKY	.10	
MEDINA 300 SD	MEDINA	3PK00003	E BR ROCKY	17.86	1.8
MEDINA 500 SD	MEDINA	3PK00004	W BR ROCKY	14.8	9.0
MEDINA 11 SD	MEDINA	3PG00043	GRANGER DITCH		0.012
MEDINA 9 SD	MEDINA	3PG00042	E BR ROCKY		0.012
ODOT PARK 3-39	MEDINA	3PP00019	PLUM CREEK		
MT AUGUSTINE TRN CTR	SUMMIT	3PT00035	E BR ROCKY		0.016
OTC TOWPATH PLAZA 6	CUYAHOGA	3PP00037	E BR ROCKY		0.07
HINCKLEY HILLS OASIS	MEDINA	3PR00123	E BR ROCKY		
COLUMBIA MHP	CUYAHOGA	3PV00013	W BR ROCKY	.14	
LAKE ERIE GIRL SCOUT COUN	SUMMIT	3PR00139	UT ROCKY RIVER		0.005
BUCKEYE HIGH SCHOOL	MEDINA	3PT00036	MALLET CREEK		0.01

Industrial Dischargers	County	Permit #	Stream	Type
AIR BP, HOPKINS AIRPRT	CUYAHOGA	3IN00060	ROCKY RIVER	CS
CEILCOTE	CUYAHOGA	3IQ00043	ROCKY RIVER	NC
CHAMPION INTERN. CORP.	CUYAHOGA	3IA0001	ROCKY RIVER	S,NC
CLEVE. BUILDERS SUPPLY	CUYAHOGA	3IJ00038	ROCKY RIVER	
CLEVE. BUILDERS SUPPLY	CUYAHOGA	3IJ00042	ROCKY RIVER	
CLEVE. HOPKINS AIRPORT	CUYAHOGA	9*CHA	ROCKY RIVER	CS S
CUYAHOGA LANDMANR INC.	SUMMIT	3IN00105	ROCKY RIVER	CS
CUYAHOGA LANDMARK INC.	SUMMIT	3IN00104	ROCKY RIVER	CS
FOSECO INC.	CUYAHOGA	3IE00047	ROCKY RIVER	
GAS TECHNICS OF OHIO	CUYAHOGA	3IE00064	ROCKY RIVER	NC
HALL BROS. INC.	CUYAHOGA	3IH00056	ROCKY RIVER	
N.A.S.A	CUYAHOGA	3IO00001	ROCKY RIVER	CS,NC
UNITED AIRLINES	CUYAHOGA	3IN00140	ROCKY RIVER	CS

NC = NON-CONTACT COOLING WATER
S = SANITARY WASTES
CS = CONTAMINATED STORM WATER

Methods

All chemical, physical, and biological field, laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989c) and Biological Criteria for the Protection of Aquatic Life, Volumes II-III (Ohio Environmental Protection Agency 1987b, 1989a, 1989b), and The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989) for aquatic habitat assessment.

Attainment/nonattainment of aquatic life uses is determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. The biological community performance measures that are used include the Index of Biotic Integrity (IBI) and the Modified Index of Well-being (MIwb), both of which are based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. IBI and ICI are multi-metric indices patterned after an original IBI described by Karr (1981) and Fausch et al. (1984). The MIwb is a measure of fish community abundance and diversity using numbers and weight information; it is a modification of the original Index of Well-Being applied to fish community information from the Wabash River (Gammon 1976, Gammon *et al.* 1981).

Performance expectations for the basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use is FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if at least one of the indexes does not attain and performance does not fall below the fair category, and **NON** if all indices either fail to attain or any index indicates poor or very poor performance.

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to determine the QHEI score which generally ranges from 20 to 100. The QHEI is used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much 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 higher than 60 are generally conducive to the establishment of warmwater faunas while those scores in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

Table 4. Sampling locations (effluent sample - E, water chemistry - C sediment chemistry - S, benthos - B, fish - F, fish tissue - FT, continuous monitors- D) in the Rocky River study area, 1992.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Rocky River				
11.6	B	41 24 27 /81 52 52	Valley Parkway	North Olmsted
11.5	F,C,S,D	41 24 29 /81 52 48	Valley Parkway	North Olmsted
11.3	B,F,C	41 24 51 /81 52 45	N. Olm. WWTP mix	North Olmsted
11.1	B,F,C	41 24 48 /81 52 36	Adj. Park Blvd.	North Olmsted
10.4	D,S	41 25 05 /81 51 58	Dst. Abram Creek	Lakeview
10.0	F,FT	41 25 03 /81 51 32	Brookpark Rd.	Lakeview
9.8	B	41 25 12 /81 50 47	Brookpark Rd.	Lakeview
9.5	F	41 25 18 /81 51 12	Adj. Park Blvd.	Lakeview
9.3	D	41 25 33 /81 51 14	Adj. Park Blvd.	Lakeview
9.0	B,F,C	41 25 48 /81 51 03	Near.picnic area	Lakeview
5.8	B,F,C	41 27 20 /81 49 17	Dst. SR 10	Lakeview
3.0	F,C	41 28 11 /81 49 57	Park Blvd.	Lakeview
2.9	B	41 28 06 /81 49 47	Park Blvd	Lakeview
1.3	B	41 28 44 /81 49 24	Dst Lakewood WWTP	Lakeview
1.0	F	41 28 44 /81 50 02	Estuary	Lakeview
0.1	F,S	41 29 27 /81 50 16	Estuary	Lakeview
Abram Creek				
2.0	B	41 23 43 /81 51 57	Grayton Rd.	Lakeview
1.9	F,C	41 23 43 /81 51 57	Grayton Rd.	Lakeview
0.4	F	41 24 57 /81 52 09	West area Rd.	Lakeview
0.3	B,C,S	41 24 57 /81 52 07	West area Rd.	Lakeview
0.1	S		Near mouth	Lakewood
West Branch Rocky River				
33.5	B,F,C,S	41 06 23 /81 48 22	SR 162	Seville
33.3	B,F,C	41 06 33 /81 48 33	Ridgewood Rd.	Seville
27.3	B,F,C	41 10 17 /81 51 13	Fenn Rd.	Medina
17.2	B,F	41 15 13 /81 55 38	Ust. Grafton Rd.	West View
16.4	C	41 15 34 /81 55 47	Grafton Rd.	West View
14.9	D	41 16 21 /81 55 20	Ust. Medina 500 trib.	West View
14.8	C	41 16 25 /81 55 20	adj. West River Rd.	West View
13.8	D	41 16 48 /81 55 40	Dst. Medina 500 trib.	West View
13.3	F,C	41 17 03 /81 55 57	adj. West River Rd.	West View
13.1	B	41 17 10 /81 55 54	adj. West River Rd.	West View
11.5	D	41 17 38 /81 55 17	Columbia Hills CC	West View
4.8	F	41 21 21 /81 53 46	I-80	West View
4.7	B,C	41 21 25 /81 53 45	I-80	West View
3.6	F	41 22 19 /81 53 55	Bagley Rd.	West View
3.5	B,C	41 22 21 /81 52 55	Bagley Rd.	West View
2.1	B,F,C	41 23 21 /81 53 35	adj. Lewis Rd.	West View
0.4	B,F,C,S	41 24 16 /81 53 35	Lewis Rd.	West View

Table 4. (continued)

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
East Branch Rocky River				
26.7	B,F	41 12 39 /81 41 07	Harter Rd.	W. Richfield
26.6	C,S	41 12 38 /81 41 08	Harter Rd.	W. Richfield
22.1	B	41 14 18 /81 43 39	SR 303	W. Richfield
21.9	F,C,S	41 14 24 /81 43 40	SR 303	W. Richfield
18.2	B,F,C	41 16 45 /81 44 28	Medina 300 WWTP Mix	W. Richfield
18.0	D	41 16 34 /81 44 29		
17.5	B,F	41 16 45 /81 44 28	Private road. nr. SR 3	Broadview Hts.
17.1	C	41 16 59 /81 44 41	SR 3	Broadview Hts.
17.0	D	41 17 03 /81 44 47	Dst. Healey	Broadview Hts.
15.3	D,F	41 17 38 /81 45 29	Ust. Bennett Rd.	Berea
15.2	B,C	41 17 40 /81 45 31	Bennett Rd	Berea
13.0	D	41 18 29 /81 46 58	Ust. N. Royalton A Trib.	Berea
12.5	D	41 18 37 /81 47 20	Dst. N. Royalton A Trib.	Berea
12.2	C,D	41 18 40 /81 47 37	Mill Stream Run Rd.	Berea
11.6	B,F	41 18 45 /81 47 54	SR 82	Berea
10.7	B,C	41 19 10 /81 48 29	Adj. Valley Parkway	Berea
10.0	B,F,C	41 19 29 /81 49 05	Mill Stream bridge	Berea
6.5	F	41 21 00 /81 50 45	Park Blvd. ford	Berea
6.4	B,C	41 21 03 /81 51 35	Park Blvd. ford	Berea
4.9	B,F,C	41 22 00 /81 51 16	Bridge St.	Berea
1.4	F	41 23 45 /81 53 04	Spafford Rd.	North Olmsted
1.3	C,S	41 22 46 /81 53 00	Spafford Rd.	North Olmsted
1.2	B	41 23 46 /81 52 55	Spafford Rd.	North Olmsted
Baldwin Creek				
7.5	B	41 20 56 /81 46 23	Ust.N Royalton "B" WWTP	Berea
7.4	F,C	41 20 58 /81 46 36	Ust.N Royalton "B" WWTP	Berea
7.0	B,C	41 20 01 /81 46 38	Adj. Abbey Rd.	Berea
5.8	B,F,C	41 21 47 /81 46 55	Bagley Rd.	Berea
3.0	B,F,C	41 21 02 /81 49 14	Sprague Rd.	Berea
2.6	B,F,C	41 21 01 /81 49 33	Main Rd.	Berea
1.4	B,F,C	41 21 28 /81 50 21	Eastland Rd.	Berea
1.0	S		Coe Lake	Berea
North Royalton "A" Tributary				
0.6	B,F	41 18 46 /81 46 29	Ust. N. Royalton "A" WWTP	Berea
0.2	B,F,C	41 18 30 /81 46 51	Edgerton Rd.	Berea

Table 4. (continued)

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
North Branch Rocky River				
5.5	B,F,C	41 11 09 /81 46 59	Remsen Rd.	Medina
Plum Creek				
0.3	B,F,C	41 22 33 /81 54 08	SR 252	North Olmsted
Baker Creek				
0.5	B	41 20 54 /81 54 01	Sprague Rd.	West View
0.3	F,C	41 21 04 /81 54 08	Sprague Rd.	West View
Blodgett Creek				
0.1	B,F,C	41 21 30 /81 53 37	Lindburgh Rd.	West View
Mallet Creek				
0.7	F,C	41 12 26 /81 54 54	Neff Rd.	Mallet
0.6	B	41 12 33 /81 54 48	Neff Rd.	Mallet

During this survey, macroinvertebrates were sampled using modified Hester/Dendy multiple-plate artificial substrate samplers supplemented with a qualitative assessment of the available natural substrates. Exceptions included those locations where the artificial substrate samplers were buried or lost due to the extreme flows that occurred during the six week colonization period. At these locations, only qualitative samples were collected. A current velocity of 0.3 ft/sec across the artificial substrates is generally required for direct application of the resultant ICI score in determining aquatic life use attainment.

Macroinvertebrate sites in the study area were also evaluated using a new assessment tool which utilizes the qualitative, natural substrate collections available from each site. This method relies on tolerance values derived for each macroinvertebrate taxon collected. Unlike tolerance values used in other common indices (e.g., the Hilsenhoff Biotic Index), these tolerance values are based on abundance data for a given taxon collected using artificial substrates. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon has been collected with artificial substrates are weighted by the abundance data of that taxon at those sites. The mean of the weighted ICI scores for the taxon results in the tolerance value of that taxon. Thus, a taxon's tolerance value represents its relative level of tolerance on the ICI's 0 to 60 scale. High tolerance values are calculated for the more intolerant taxa which tend to reach their greatest abundance at undisturbed sites (i.e., sites with highest ICI scores). Conversely, more pollution tolerant taxa attain their greatest abundances at highly disturbed sites with low ICI scores, which results in a lower tolerance value. For the qualitative macroinvertebrate collections in the Rocky River study area, the median tolerance value, based on all tolerance values of the organisms collected at a site, resulted in what has been termed the Qualitative Community Tolerance Value (QCTV). Though

only in the developmental stage, the QCTV shows potential as a method to supplement existing assessment methods using the qualitatively collected macroinvertebrate information. Its use in evaluating sites in the Rocky River study area was restricted to relative comparisons between sites with no attempt to interpret quality of the sites or aquatic life use attainment status.Fish were sampled 2-3 times using pulsed DC electrofishing gear using either the wading method (150 meter zones) or boat method (500 meter zones). Chemical/physical and biological sampling locations are listed in Table 4.

An Area Of Degradation Value (ADV; Rankin and Yoder 1992) was calculated for the study area based on the longitudinal performance of the biological communities. The ADV portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, and ICI) departs from the stream criterion or the upstream level of performance (Figure 2). The amount of impact refers to the vertical departure of each index below the criterion. The total ADV is the area beneath the ecoregional criterion when the results for each index are plotted against river mile. This is also expressed as ADV/mile to normalize comparisons between segments and other areas. For the purpose of generating the ADV, ICI values were assigned based on the narrative evaluation for sites that lacked valid quantitative data due to loss or disturbance of the artificial substrates.

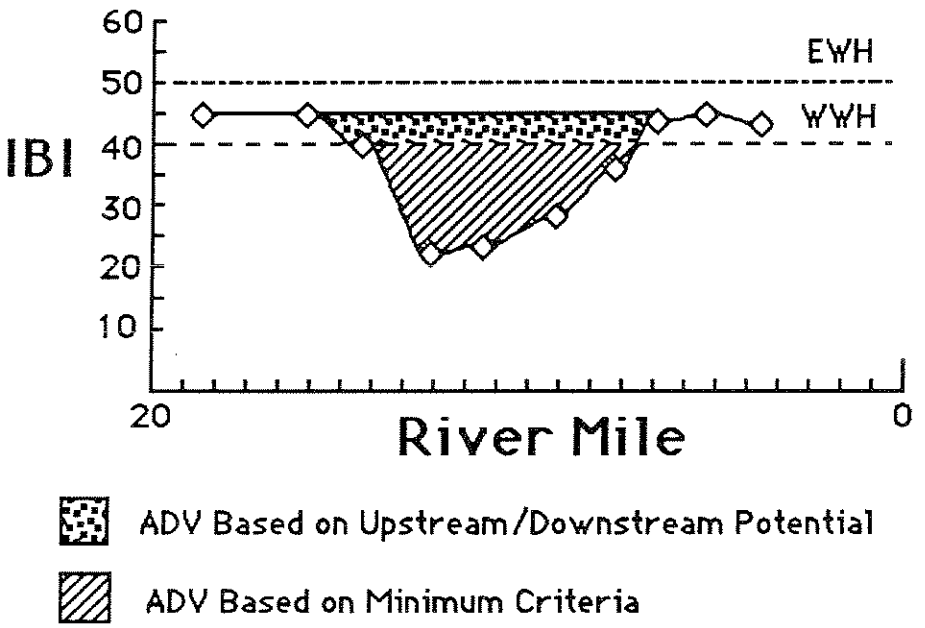

Figure 2. Graphic illustration of the calculation of Area of Degradation Values (ADV) based on upstream potential and the ecoregion warmwater habitat use or minimum criteria (WWH). Criteria for exceptional warmwater habitat use (EWH) is provided for reference.

Results and Discussion

Rocky River
Pollutant Loadings: 1976- 1992

North Olmsted WWTP

The North Olmsted WWTP (RM 11.4) is an advanced secondary plant served by separate sewers. The plant is equipped with microscreens and nonactivated carbon treatment. These units are only occasionally on-line. This WWTP is one of the few plants in the Rocky River Basin that has reduced flows in recent years primarily because of a sewer rehabilitation program to reduce infiltration and inflow. However, some of the sewers are still hydraulically overloaded. The city has pumped sewers into ditches during wet weather to relieve the hydraulic load and prevent sewer backups into homes. They are under Directors Findings and Orders to stop this practice.

The North Olmsted discharge has had reduced loadings of several heavy metals since 1981. Although North Olmsted does not have a robust pretreatment program, the reductions of heavy metals began after the start of pretreatment regulations in 1981. There has been no significant change in total suspended solids (TSS) because all of the apparent changes in TSS loadings can be attributed to the reduced flows. Loadings of carbonaceous biochemical oxygen demand ($CBOD_5$) have remained constant despite the flow reductions, but ammonia-N and oil & grease loadings appear to be gradually increasing. Figure 3 shows graphs of average flow and loading trends for ammonia-N, $CBOD_5$, TSS, and total nickel from the North Olmsted WWTP from 1981 to 1992.

NASA-Lewis Research Center

The Lewis Research Center is one of NASA's primary research and development centers for power and propulsion systems for air and space. Their main work is now centered on developing power systems for the proposed space station. They currently have a hazardous waste storage permit for solvents and other compounds such as hydrazine. Prior work on a deep space engine based upon ionization of mercury has left portions of the facility contaminated with mercury and mercury wastes. At one time, NASA was the single largest purchaser of mercury in the free world. NASA is currently voluntarily investigating past waste disposal practices and is also under consideration for legal action by Ohio EPA. NPDES permitted outfalls include non-contact cooling water, storm water and boiler blowdown.

No evaluation of loadings from NASA is possible because of monitoring problems at this facility. Flows at NASA are only estimated and a contractor for NASA was investigated for falsification of monitoring reports. Heavy metals (especially mercury), oil and grease and solvents are the primary contaminants from this facility.

Chemical Water Quality

- Water quality sampling was conducted during the summer of 1992 that was among the wettest summers on record in Northeastern Ohio. The flow hydrograph for the Rocky River at Cedar Point Road (RM 12.07) is shown in Figure 4. As indicated on the graph, natural $Q_{7,10}$ flow for the Rocky River mainstem near the confluence of the East and West branches is estimated by U.S. Geological Survey at 1.4 cubic feet per second (cfs). However, wastewater discharges and water supply removal in the basin result in an effective $Q_{7,10}$ of 30.6 cfs (J.D. Jones and Assoc.). The city of Berea uses between 2.0 and 2.5 million gallons per day

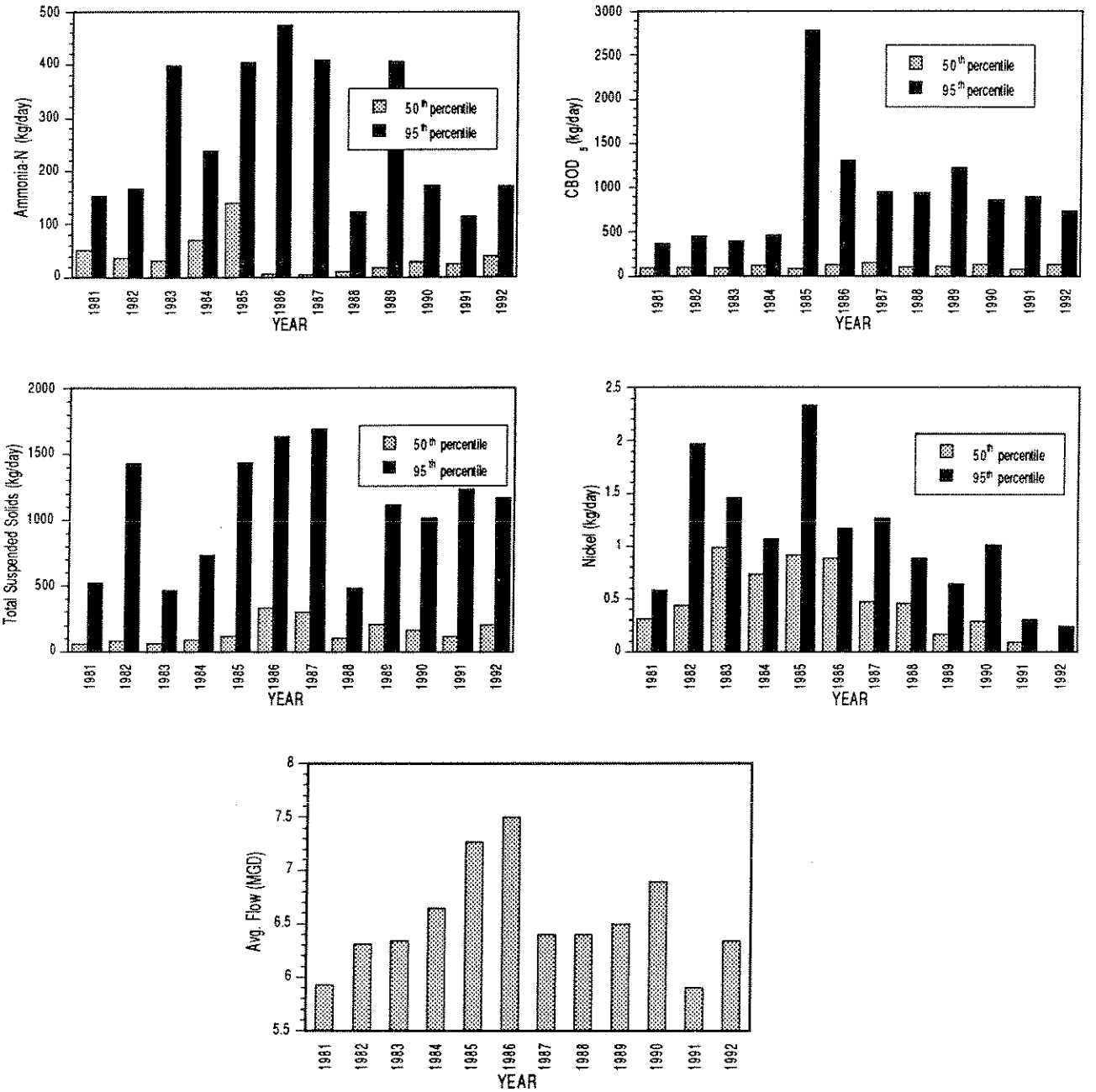

Figure 3. Annual loadings (kg/day) of ammonia-N, carbonaceous biochemical oxygen demand (CBOD5), total suspended solids (TSS), nickel, and average flow from the North Olmsted WWTP to the Rocky River, 1981 to 1992. CBOD5 loading for 1981 through 1984 are calculated based on reported five-day biochemical oxygen demand (BOD5) values.

(MGD) of water from either the East Branch, Baldwin Creek or Coe Lake as a drinking water supply. One storm in July 1992 resulted in a stream flow that approached 9,000 cfs. The average discharge for the period of record at Cedar Point Road is 276 cfs. The maximum measured flow was 21,400 cfs in 1959 and the minimum flow was 0.2 cfs in 1932 and again in 1933. The average flow for the period July through October 1992 was 307.48 cfs and the median flow was 105 cfs.

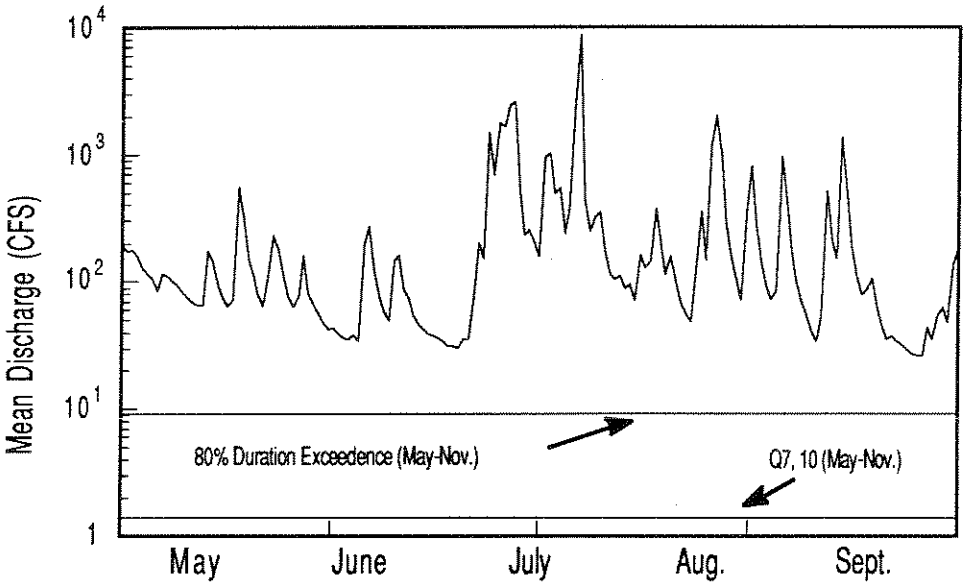

Figure 4. Flow hydrograph for the Rocky River at Cedar Point Rd.(RM 12.07), May through September, 1992 (USGS 1992). May through November low-flow conditions ($Q_{7,10}$ [1.4 cfs] and 80% duration flow [9.2 cfs]); period of record 1923 to 1978 (USGS 1981)

- A single exceedence of the chronic WWH ammonia-N criterion was recorded at RM 1.28. No other exceedences of either chronic or acute water quality criteria were documented (Table 5).

- Phosphorus concentrations increased downstream from the North Olmsted WWTP discharge. One instream value of 4.94 mg/l was recorded downstream from the North Olmsted WWTP, Abram Creek, NASA and Cleveland Hopkins Airport at RM 9.0. A dissolved oxygen (D.O.) concentration of 16.1 mg/l was also recorded on the same day at this location. This high phosphorus concentration could have stimulated photosynthesis in algae and macrophytes in the river and produced the supersaturated D.O. The phosphorus and D.O. concentrations returned to expected concentrations after the initial high value. There was a slightly higher concentration of phosphorus (0.22 mg/l) at the mouth of Abram Creek, which suggests the WWTPs on Abram Creek as a possible source of the high phosphorus concentration. The North Olmsted WWTP discharge increased the average chemical oxygen demand (COD) concentration in the mixing zone dramatically, but concentrations returned to below upstream concentrations within two miles. Average ammonia-N concentrations were higher upstream

Table 5. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the Rocky River study area, 1992 (units are µg/l for metals, # colonies/100 ml for fecal coliform, and mg/l for all other parameters).

Stream Name	River Mile	Violation: Parameter (value)
Rocky River		
Abram Creek		
	10.38/1.9	fecal coliform bacteria (12,000)‡‡
	10.38/1.9	D.O. (4.5, 4.7)*; NH3-N (3.06, 2.8, 3.0)*
	10.38/1.9	NH3-N (1.53)*
East Branch		
	3.0	fecal coliform bacteria (2,100)‡
	1.4	fecal coliform bacteria (6,100)‡‡,NH3-N (2.35)*
Unnamed Tributary to the East Branch (North Roylaton "A" Trib.)		
	12.92/0.25	TRC (0.10, 0.18, 0.08, 0.18)**
Baldwin Creek		
	5.08/1.4	fecal coliform bacteria (2,100)◊
West Branch Rocky River		
Baker Creek		
	5.07/0.5	fecal coliform bacteria (5,000)‡‡
Blodgett Creek		
	4.54/0.17	NH3-N (9.86, 7.00, 6.54)*
Plum Creek		
	3.06/0.25	D.O. (4.8)*
	3.06/0.25	fecal coliform bacteria (8,400)‡‡

* indicates an exceedence of numerical criteria for prevention of chronic toxicity (CAC).
** indicates an exceedence of numerical criteria for prevention of acute toxicity (AAC).
*** indicates an exceedence of numerical criteria for prevention of lethality (FAV).
‡ violation of the average dissolved oxygen (D.O.) criterion.
‡‡ violation of the minimum dissolved oxygen (D.O.) criterion.
‡‡‡ violation of the "nuisance prevention" minimum dissolved oxygen (D.O.) criterion.
◊ exceedence of the Primary Contact Recreation criterion.
◊◊ exceedence of the Secondary Contact Recreation criterion.

than in the North Olmsted WWTP mixing zone. The high upstream ammonia-N value can be attributed to the Berea WWTP discharge on the East Branch. The concentration of ammonia-N steadily decreased downstream until RM 5.8 where it increased slightly. The lowest average D.O. in the mainstem at 7.5 mg/l and the highest fecal coliform bacteria counts and total suspended solids (TSS) concentrations were also recorded at RM 5.8. This data suggests an unknown source of sewage in Fairview Park somewhere upstream from RM 5.8 (near State Route 10-Detroit Avenue). Figure 5 shows graphs of phosphorus, D.O., chemical oxygen demand (COD), and ammonia-N in the Rocky river from river mile 11.5 to 3.0.

- Results from August 25-28 Datasonde© continuous monitoring sampling show only a slight reduction of D.O. downstream from the North Olmsted, Abram Creek, NASA and Cleveland Hopkins Airport discharges (Figure 6). The lowest value reported was 5.85 mg/l. It is important to note, however, that high water levels experienced during the sampling period likely affected the results. Elevated flows tend to limit photosynthesis that in turn decreases the amount of diurnal D.O. flucuation and result in considerable turbulance that can enhance reaeration.

- The Lakewood WWTP discharge near RM 1.7 was abandoned and diverted to a direct discharge to Lake Erie in February, 1985. Lakewood has reported several combined sewer overflows that discharge to the mainstem downstream from the Rockcliff Ford at RM 3.0. This site was the most downstream chemical sampling site of the 1992 survey. A significant discharge of unknown origin was observed by Ohio EPA staff on September 2,1992 at RM 1.3. It occured during and immediately after a heavy rain event of approximately one hour in duration. The water level of the stream increased about six inches and the water color turned from brownish green to gray and smelled of raw sewage. This was preceded by a bloated dead rat that floated downstream. The change in the stream occured so quickly that the source of the discharge had to have been nearby, possibly a bypass from the Lakewood WWTP or a CSO. Further investigation is needed to identify the source of this discharge and the human health threat that is posed. Notification of the many recreational users of the Rocky River estuary may be warrented following rain events of similar magnitude.

Sediment Chemistry

- In general, heavy metal concentrations in the Rocky River increased steadily toward the mouth. The sediment results are presented Table 6. This increasing trend suggested impacts of urban runoff and the cumulative effect of point sources. Most metals were in the low to non-elevated range using the Kelly and Hite criteria. However, lead, iron and zinc concentrations were elevated at RM 0.3; arsenic was highly elevated at RM 0.3; and extremely elevated at RM 11.5. Samples collected in 1991 were in the highly elevated range both upstream (RM 10.4) and downstream (RM 0.1) from Abram Creek. The river's morphology creates a very high percentage of sands and gravels in the sediments that may account for the relatively low concentration of heavy metals. Concentrations of heavy metals in stream sediments are usually inversely related to sediment particle size. Septic odors were detected in the sediments in the mainstem at RM 11.5 and RM 0.3.

Physical Habitat for Aquatic Life

- Macrohabitats of the Rocky River were evaluated at nine fish sampling stations. Qualitative Habitat Evaluation Index (QHEI) values ranged between 80.5 (RM 3.0) and 34.0 (RM 0.1), with a mean value of 65.0 (Table 7). A mean QHEI value greater than 60.0 suggests that near and instream habitats of the Rocky River are of a sufficient quality to support and maintain an aquatic community capable of attaining WWH biological criteria (Rankin 1989).

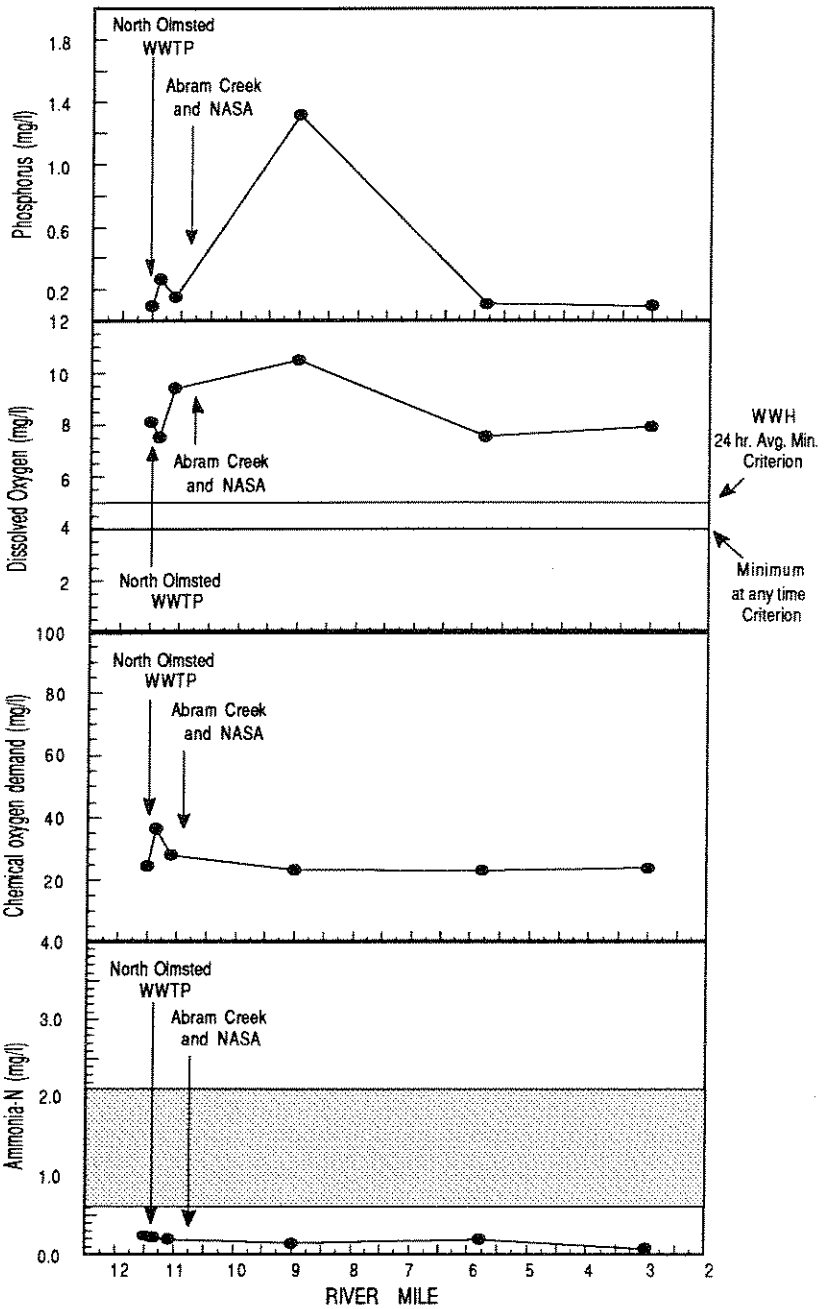

Figure 5. Longitudinal trends of mean phosphorus, dissolved oxygen, chemical oxygen demand (COD), and ammonia-N in the Rocky River, 1992. Shaded area in the ammonia-N plot represents the range of WQS criteria based on 90th and 25th percentile pH and temperature values from the study area.

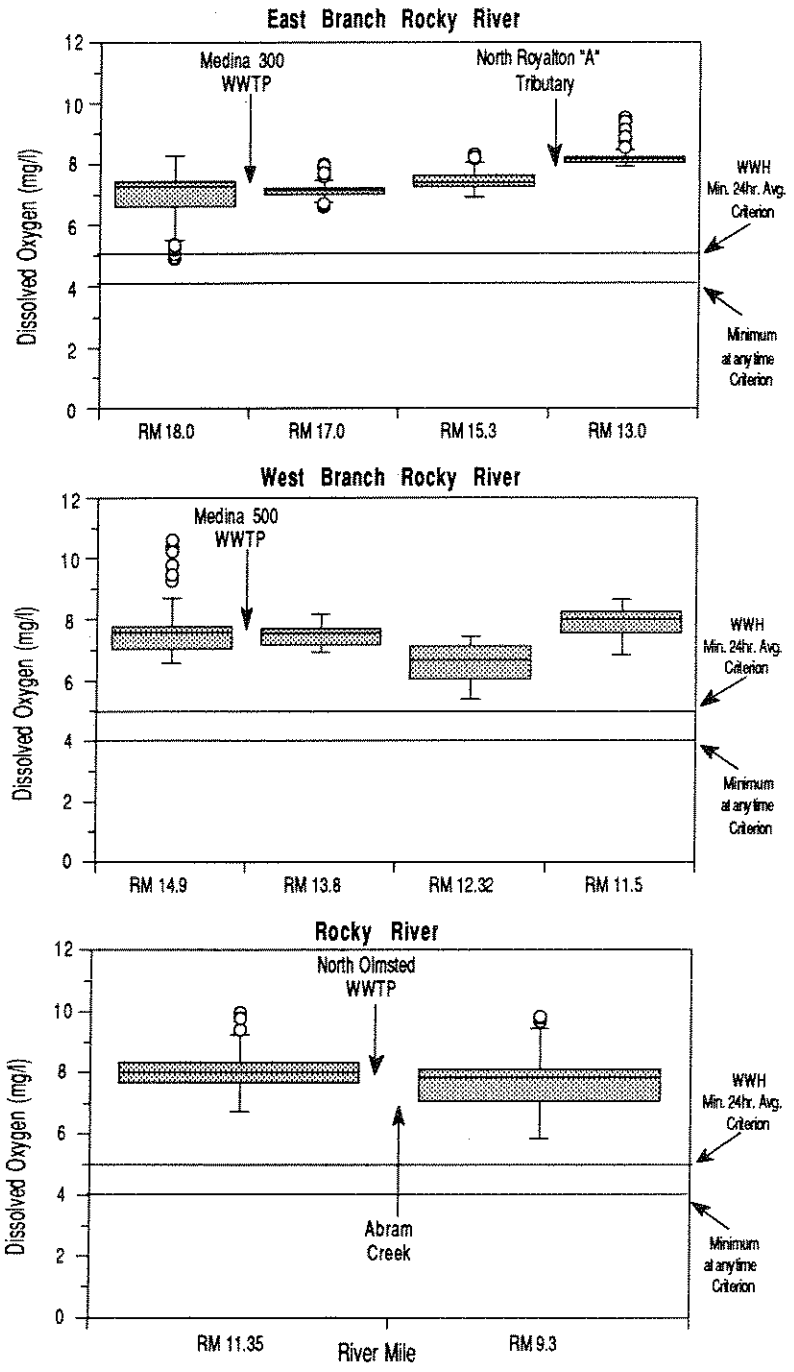

Figure 6. Boxplots of dissolved oxygen data recorded with continuous monitors at selected locations in the East Branch, West Branch, and the Rocky River mainstem, August 25-28, 1992.

Table 6. Concentrations of heavy metals in sediments in the Rocky River basin collected on October 7, 1992. All parameter concentrations were ranked based on a stream sediment classification system described by Kelly and Hite (1984). The Coe Lake sediment sample was ranked on a lake sediment classification system described by Kelly, Hite and Rogers (1984).

River Mile	As	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Zn
Rocky River									
11.5	**36.4**[e]	0.463[a]	15.8[a]	17.8[a]	22100[b]	22.4[a]	0.0213[a]	27.8	88.9[b]
10.0	12.4[b]	0.407[a]	16.3[b]	19.4[a]	20200[b]	20.8[a]	0.0171[a]	9.80	113[c]
0.9	**20.0**[d]	0.337[a]	18.6[b]	21.9[a]	27700[c]	42.5[c]	0.0203[a]		145[c]
Abram Creek									
0.4	10.3[b]	0.477[a]	19.2[b]	26.9[a]	19200[b]	30.2[b]	0.0239[a]	24.5	151[c]
East Branch Rocky River									
26.7	4.34[a]	0.0644[a]	7.24[a]	6.28[a]	9830[a]	16.5[a]	0.0142[a]	8.23	34.5[a]
21.9	5.87[a]	0.076[a]	9.24[a]	6.93[a]	8480[a]	19.8[a]	0.0124[a]	10.6	50.2[a]
1.4	10.9[b]	0.548[b]	21.0[b]	29.4[a]	22100[b]	46.1[c]		28.2	155[c]
West Branch Rocky River									
33.5	9.20[b]	0.162[a]	8.28[a]	8.80[a]	14600[a]	16.6[a]	0.0133[a]	11.9	46.3[a]
0.4	9.91[b]	0.786[b]	15.0[a]	16.1[a]	15200[a]	22.8[a]		20.9	88.7[b]
North Branch Rocky River									
5.5	6.23[a]	0.111[a]	7.71[a]	9.01[a]	2200[a]	16.8[a]	0.0135[a]	11.7	52.9[a]
Coe Lake									
	16.1[b]	0.626[b]	35.3[c]	48.8[b]	31400[b]	59.9[b]		49.3	**289**[d]

[a]Non-elevated; [b]Slightly elevated; [c]Elevated; [d]**Highly elevated**; [e]**Extremely elevated**
For Coe Lake: [a]Below Normal; [b]Normal; [c]Elevated; [d]**Highly elevated**
Note: The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity.

Table.7 Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Rocky River, July - September, 1992.

Key QHEI Components

WWH Attributes

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 > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes
(13-001) – Rocky River													
Year: 92													
11.5	64.0	7.25	■	■		■	■		■	■	■	■	8
11.3	61.5	7.25	■	■		■						■	4
11.1	70.0	7.25	■	■		■	■		■	■	■	■	8
10.0	67.0	8.55	■	■		■	■		■	■	■	■	8
9.5	68.0	8.55	■	■		■	■		■	■	■	■	8
9.0	70.5	6.13	■	■		■	■		■	■	■	■	8
5.8	68.0	7.63	■	■		■				■	■	■	6
3.0	80.5	8.85	■	■	■	■		■	■	■	■	■	9
1.0	63.0	.10	■	■		■	■	■		■	■		7
0.1	34.0	.10						■		■	■		3
(13-002) – Abrams Creek													
Year: 92													
1.9	73.0	40.00	■	■		■	■	■	■	■	■		8
0.4	59.0	35.71	■	■	■		■		■	■	■	■	8
(13-100) – East Branch Rocky River													
Year: 92													
26.7	68.0	19.23	■	■		■	■	■	■		■		7
21.9	79.0	12.19	■	■		■	■	■	■	■	■	■	9
18.2	67.0	5.71	■	■		■	■	■	■		■		7
17.5	70.0	5.71	■	■			■	■	■		■		6
15.3	63.5	4.74	■	■		■	■	■	■		■		7
11.6	83.5	32.26	■	■		■	■	■	■		■		8
10.0	62.0	6.33	■					■	■	■	■	■	6
6.5	63.5	4.29	■					■	■	■	■	■	6
4.9	67.5	15.38	■	■		■		■	■	■	■	■	8
1.4	56.0	8.47	■							■	■	■	4
1.4	72.0	8.47	■	■		■				■	■	■	6
(13-101) – Baldwin Creek													
Year: 92													
7.4	54.5	35.71		■		■	■				■		4
5.8	80.5	11.76	■	■	■	■	■	■	■	■	■	■	10
3.0	42.5	6.25		■						■		■	3

MWH Attributes (High Influence; Moderate Influence)

River Mile	QHEI	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/Moderate Embeddedness	Ext./Moderate Riffle Embed.	No Riffle	Total M.I. MWH Attributes	MWH H.I./WWH Ratio	MWH M.I./WWH Ratio
(13-001) – Rocky River																						
Year: 92																						
11.5	64.0						0													0	.11	.11
11.3	61.5				●	●	2						▲	▲		▲				3	.60	1.20
11.1	70.0				●		1													0	.22	.22
10.0	67.0				●		1													0	.22	.22
9.5	68.0				●		1													0	.22	.22
9.0	70.5				●		1													0	.22	.22
5.8	68.0				●		1						▲			▲				2	.29	.57
3.0	80.5						0						▲							1	.10	.20
1.0	63.0						0		▲			▲				▲			▲	4	.13	.63
0.1	34.0	●					1					▲	▲			▲			▲	4	.50	1.50
(13-002) – Abrams Creek																						
Year: 92																						
1.9	73.0			●			1					▲	▲				▲	▲		4	.22	.67
0.4	59.0				●		1					▲								1	.22	.33
(13-100) – East Branch Rocky River																						
Year: 92																						
26.7	68.0				●		1		▲								▲	▲		3	.25	.63
21.9	79.0						0				▲									1	.10	.20
18.2	67.0						0		▲								▲	▲		3	.13	.50
17.5	70.0						0		▲		▲	▲					▲	▲		5	.14	.86
15.3	63.5				●		1		▲			▲					▲	▲		4	.25	.75
11.6	83.5						0		▲								▲	▲		3	.11	.44
10.0	62.0						0		▲			▲	▲							3	.14	.57
6.5	63.5						0		▲			▲	▲							3	.14	.57
4.9	67.5						0						▲							1	.11	.22
1.4	56.0				●		1		▲			▲	▲			▲				4	.40	1.20
1.4	72.0				●		1					▲	▲			▲				3	.29	.71
(13-101) – Baldwin Creek																						
Year: 92																						
7.4	54.5			●	●		2	▲	▲			▲	▲			▲	▲	▲		7	.60	2.00
5.8	80.5						0													0	.09	.09
3.0	42.5			●	●	●	3	▲				▲	▲			▲				4	1.00	2.00

Table 7. (continued)

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/ Eddies	Low/Normal Embeddedness	Max Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	MWH Attributes (High Influence): Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD,HW)	Total H.I. MWH Attributes	MWH Attributes (Moderate Influence): Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Moderate Embeddedness	Ext./Moderate Riffle Embed.	No Riffle	Total M.I. MWH Attributes	MWH H.I./WWH Ratio	MWH M.I./WWH Ratio
2.6	67.0	6.25	■■		■	■■■					■		6				●		0								▲	▲	▲	▲	4	.14	.71
1.4	58.5	7.52	■			■■■					■		5				●		1			▲						▲	▲		3	.33	.83
(13-103) – Trib. to E. Br. Rocky R. (N. Royal. "A")																																	
Year: 92																																	
0.6	44.5	31.25	■										1			●	●	●	3	▲	▲		▲	▲	▲		▲	▲	▲		8	2.00	6.00
0.2	70.5	26.30	■■			■■				■	■	■	7				●		1				▲					▲			2	.25	.50
(13-200) – West Branch Rocky River																																	
Year: 92																																	
33.5	68.5	13.33	■■		■	■■					■		7						0		▲		▲					▲	▲	▲		5	.13	.75
33.3	70.0	14.71	■■		■	■■					■		6						0		▲		▲					▲	▲	▲		5	.14	.86
27.3	72.5	3.48	■■		■	■■■					■		7						0		▲								▲	▲		3	.13	.50
17.2	61.5	5.71	■							■	■	■	5				●		1		▲		▲	▲								3	.33	.83
17.0	57.5	5.71	■			■■				■		■	5				●		1				▲						▲	▲		3	.33	.83
13.3	75.0	2.65	■■			■■■				■	■		7						0		▲							▲		▲		3	.13	.50
4.8	81.0	8.77	■■			■■■	■	■	■	■	■	■	9						0													0	.10	.10
3.6	68.0	14.49	■			■■		■	■	■	■	■	7				●		1													0	.25	.25
2.1	62.5	16.67	■			■■		■	■	■	■	■	7				●		1							▲						1	.25	.38
0.4	76.5	11.63	■■			■■■	■	■	■	■	■	■	9						0													0	.10	.10
(13-201) – Plum Creek																																	
Year: 92																																	
0.3	42.5	20.41	■										1	●		●	●	●	4	▲		▲	▲					▲	▲	▲		6	2.50	5.50
(13-202) – Baker Creek																																	
Year: 92																																	
0.3	68.0	37.03	■			■■■					■		5				●		1		▲		▲					▲	▲	▲		5	.33	1.17
(13-204) – Mallet Creek																																	
Year: 92																																	
0.7	69.0	37.04	■			■■■	■	■	■	■	■	■	8						0													0	.11	.11
(13-205) – North Branch Rocky River																																	
Year: 92																																	
5.5	73.5	12.05	■■			■■■	■	■	■	■	■		8						0		▲		▲						▲			3	.11	.44
(13-209) – Trib. to W. Br. Rocky R. (Strongs. "A")																																	
Year: 92																																	
0.1	63.5	10.64	■			■■		■	■	■	■	■	7				●		1													0	.25	.25

- The upper and middle reaches of the Rocky River (between RM 11.5 and RM 3.0) consisted of marginally good to good quality habitats. Stream segments in this reach were predominated by WWH attributes, with moderate and high influence modified habitat attributes occurring at a low frequency (Table 7). Warmwater habitat attributes observed during the field sampling efforts included: little or no direct channel modifications, persistent wooded riparian corridor, moderate sinuosity, good/fair channel development, and mixed current velocity. The only limiting aspects of natural habitat within this reach were a predominance of bedrock (limestone and shale) substrate and sparse instream cover. Though bedrock substrates were encountered throughout the Rocky River mainstem, habitat quality of this reach did not appear to significantly inhibit performance of instream biological communities. The middle reach of the Rocky River (between RM 5.8 and RM 3.0) demonstrated a slight increase in the frequency of moderate influence modified habitat attributes; however, this segment maintained a high percentage of WWH attributes (Table 7).

- The lowest reach of the Rocky River study area (between RM 0.3 and RM 0.1) represented the lake affected, estuarine segment. Habitats of this area tended to be more lentic in character, achieving lower QHEI values. The lower innate biological potential of these estuary areas was recognized by Ohio EPA in the development of interim Lake Erie estuary biological criteria. The habitats observed within this reach appeared atypical of non-industrial river mouth found within major tributaries to Lake Erie. Riparian and nearstream habitats have been significantly encroached upon by residential and commercial development, limiting the amount of naturally occurring estuarine habitat.

Biological Assessment: Macroinvertebrate Community

- As with the East and West Branches, the macroinvertebrate sampling effort on the Rocky River mainstem was hampered by high flows to which the artificial substrates were subjected. Often, even the largest pieces of slab boulder were relocated due to the force of the high water. A single quantitative sample (RM 9.0) was retrieved out of the seven that were set. Nevertheless, impacts attributable to point source and polluted runoff were evident. Excluding mixing zone samples, the average QCTV score for the mainstem was 34.0 compared to 37.0 for the West Branch and 38.2 for the East Branch (Table 8). By comparision, sites in the Erie-Ontario Lake Plain ecoregion that achieve the ICI biocriterion generally have QCTV scores that exceed 35.7 (the 25th percentile of the QCTV scores at these sites). Overall, the benthos was in marginally good to fair condition and was apparently degraded by point sources as well as CSOs and stormwater discharges. It appeared that the additive organic loads from these multiple sources threatened to overwhelm the assimilative capacity of the stream.

- The macroinvertebrate community at the uppermost site on the mainstem (RM 11.6) was apparently influenced by the numerous point sources on the two branches and constrained by a bedrock and fine shale substrate. This combination produced a relatively low density assemblage including a relatively diverse mayfly fauna. However, few taxa were collected that could be considered pollution sensitive. Overall, the macroinvertebrate community was considered to be in marginally good condition.

- The benthic assemblage present in the mixing zone of the North Olmsted WWTP (RM 11.3) was primarily limited by a marginal habitat (shallow flat bedrock) rather than the discharge of treated effluent. Twenty-four taxa were collected including a total of eight mayfly and caddisfly taxa which indicated that the effluent was not acutely toxic.

- Effluent mixing was incomplete at RM 11.1. A distinct effluent plume flowed along the left bank of the stream and was approximately 20 feet wide at this point. The macroinvertebrate community reflected the difference in effluent concentration between the left and right halves of the stream. Many of the same organisms were present on both sides; the difference was that tolerant midge taxa and oligochetes were predominant in high density along the left bank. Overall, the macroinvertebrate community reflected fair conditions as a result of significant enrichment from the North Olmsted WWTP effluent.

- An impact that may be attributable to the North Olmsted WWTP was still evident at RM 9.8. The macroinvertebrate community remained depressed compared to what was present upstream from the WWTP discharge. However, the failure of the macroinvertebrate community to attain the narrative WWH criterion may also be due to an as yet undefined impact from Abram Creek, CSOs, stormsewers and/or general urban runoff.

- The artificial substrates had been disturbed by high flow at RM 9.0, nevertheless, the ICI and qualitative sampling results reflected partial improvement in the macroinvertebrate community. An ICI value of 30 was recorded which marginally attained the WWH biocriterion. Compared to RM 9.8, the QCTV was increased as were the number of mayfly and caddisfly taxa collected from the natural substrates (Figure 7).

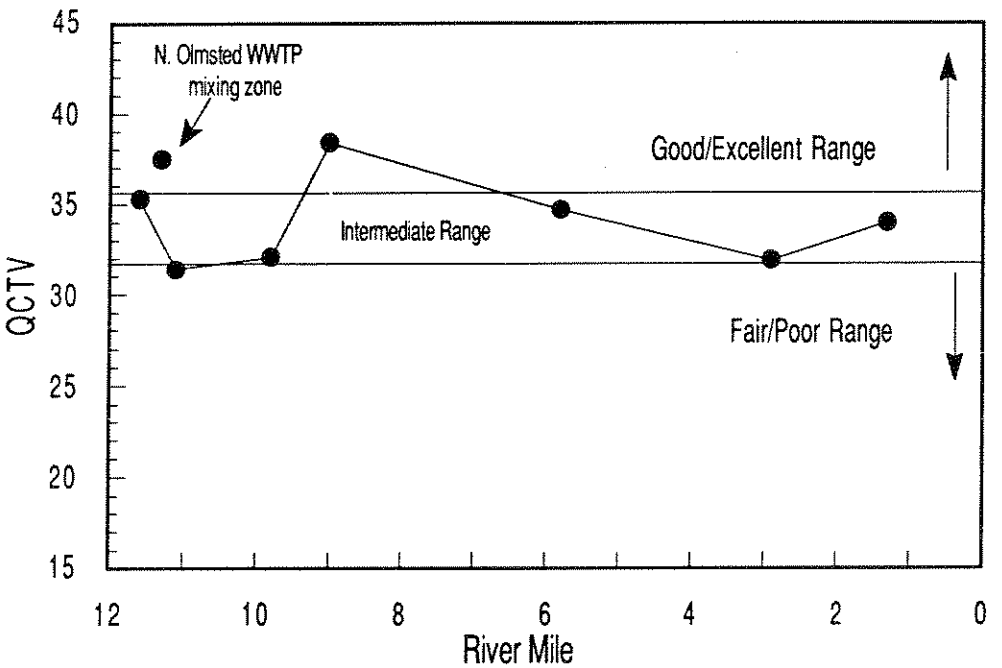

Figure 7. Longitudinal trend of Qualitative Community Tolerance Values (QCTV) in the Rocky River, 1992.

- The macroinvertebrate community continued to reflect marginally good conditions at RMs 5.8, 2.9, and 1.3. Midges and filter-feeding caddisflies predominated and few pollution sensitive taxa were collected. The lack of any significant improvement apparently reflected an inability of natural processes to decrease the level of instream pollutants that would allow for the

Table 8. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Rocky River basin August-October, 1992.

Quantitative Evaluation *Stream* River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Qual. EPT[b]	QCTV[c]	ICI	Narrative Evaluation
Rocky River							
11.6		Qual. Only	39	10	35.3	-	Marg. Good
11.3		Qual. Only	24	8	37.5	-	Fair
11.1		Qual. Only	32	7	31.4	-	Fair
9.8		Qual. Only	42	8	32.1	-	Fair
9.0	459	39	30	11	38.4	30	Marg. Good
5.8		Qual. Only	36	10	34.7	-	Marg. Good
2.9		Qual. Only	28	8	31.9	-	Marg. Good
1.3		Qual. Only	31	9	34.0	-	Marg. Good
Abram Creek							
2.0	1890	17	9	0	20.2	4	Poor
0.3	1025	19	14	1	30.3	8	Poor
West Branch Rocky River							
33.5	285	39	37	10	37.8	54	Exceptional
33.3	317	32	40	5	37.4	40	Good
27.3		Qual. Only	41	10	38.8	-	Very Good
17.2	449	47	40	14	38.9	48	Excellent
13.1	857	46	28	9	38.9	48	Excellent
4.7		Qual. Only	46	9	34.7	-	Marg. Good
3.5		Qual. Only	37	7	35.3	-	Marg. Good
2.1		Qual. Only	48	10	34.0	-	Marg. Good
0.4		Qual. Only	35	11	37.4	-	Good
East Branch Rocky River							
26.6	389	43	39	12	39.1	48	Exceptional
22.1	467	51	54	17	39.0	54	Exceptional
18.2	364	52	40	11	38.1	30	Good
17.5	113	26	35	9	39.0	24	Very Good
15.2	648	44	42	14	39.0	44	Very Good
11.6		Qual. Only	41	12	39.4	-	Good
10.7	278	50	43	11	38.5	42	Very Good
10.0	189	46	40	12	39.1	46	Exceptional
6.4		Qual. Only	48	15	37.5	-	Good
4.9		Qual. Only	42	16	39.0	-	Good
1.2	287	39	37	9	32.7	24	Good
Baldwin Creek							
7.5		Qual Only	32	3	30.6	-	Marg. Good
7.0	185	28	22	1	35.0	28	Fair
5.8	484	36	19	3	35.0	36	Good
3.0	434	31	26	3	34.7	32	Marg. Good
2.6	780	28	28	3	32.1	30	Marg. Good
1.4	611	28	22	5	34.0	40	Good
North Branch Rocky River							
5.5	974	44	37	9	39.1	50	Exceptional

Table 8 (continued).

Qualitative Evaluation *Stream* River Mile	No. Qual. Taxa	QCTV[c]	Qual. EPT[b]	Relative Density	Predominant Organisms	Narrative Evaluation[a]
Rocky River						
11.6	39	35.3	10	Low	Midges	Marg. Good
11.3	24	37.5	8	Low	Midges, Mayflies	Fair
11.1	32	31.4	7	Mod.	Midges, Aquatic worms	Fair
9.8	42	32.1	8	Mod.	Midges, Mayflies	Fair
5.8	36	34.7	10	Mod.	Midges, Caddisflies	Marg. Good
2.9	28	31.9	8	Mod.	Midges, Caddisflies	Marg. Good
1.3	31	34.0	9	Mod.	Midges, Caddisflies	Marg. Good
West Branch Rocky River						
27.3	41	38.8	10	Low	Midges, Caddisflies	Very Good
4.7	46	34.7	9	Mod.	Riffle beetles, Midges	Marg. Good
3.5	37	35.3	7	High	Midges	Marg. Good
2.1	48	34.0	10	Mod.	Midges	Marg. Good
0.4	35	37.4	11	Mod.	Midges, Flatworms	Good
East Branch Rocky River						
11.6	41	39.4	12	Mod.	Caddisflies, Riffle beetles, Mayflies	Good
6.4	48	37.5	15	Low	Caddisflies	Good
4.9	42	39.0	16	Mod.	Caddisflies, Elmids, Midges	Good
Baldwin Creek						
7.5	32	30.6	3	Low	Midges	Marg. Good
North Royalton "A" Tributary						
0.6	20	31.9	3	Low	Midges	Poor
0.2	15	31.4	3	Low	Midges	Poor
Plum Creek						
0.3	17	31.9	2	High	Midges	Fair
Baker Creek						
0.5	26	31.9	3	Mod.	Midges	Fair
Blugett Creek						
0.1	15	20.7	0	High	Midges	Poor
Mallet Creek						
0.6	39	34.3	5	Low	Midges	Fair

Ecoregional Biocriteria:
Erie-OntarioLake Plain (EOLP)

INDEX	WWH	EWH	MWH[d]
ICI	34	46	22

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

a A qualitative narrative evaluation is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores and where flow over artificail substrates was less than 0.3 ft/sec.

b EPT= total Ephemeroptera (mayflies), Plectoptera (stoneflies) and Tricoptera (caddisflies).

c Qualitative Community Tolerance Value (QCTV) calculated as the average of the weighted ICI for each taxa.

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

ns Nonsignificant departure from ecoregional biocriterion (≤4 ICI units).

survival of more sensitive taxa. Stormsewers and CSOs that service the surrounding urban area discharge along the length of this stream segment and apparently are a reoccuring source of pollutants following rain events.

Biological Assessment: Fish Community

- A total of 4,792 fish comprised of 49 species and five hybrids was collected from the Rocky River mainstem between July 7 and October 8, 1992. The sampling effort included a total of 18.35 Km at nine sampling stations between RM 11.5 (upstream from the North Olmsted WWTP) and RM 0.1 (near the mouth).

- The numerically predominate fish species were: striped shiner (15.4%), bluntnose minnow (15.0%), spotfin shiner (10.0%), sand shiner (9.6%) and central stoneroller (8.7%). Species that predominated in terms of biomass were: common carp (72%), largemouth bass (7.7%), freshwater drum (3.8%), striped shiner (1.3%) and coho salmon (1.3%). Species encountered within the Rocky River listed as threatened within the state of Ohio included the bigmouth shiner (Ohio DNR 1992). A total of three bigmouth shiners were collected during the 1992 field sampling effort.

- In terms of relative abundance, the community consisted mainly of tolerant and moderately intolerant, insectivorous and omnivorous cyprinid species. In terms of relative weight the community was predominated by highly tolerant and moderately tolerant forms. Based on IBI and MIwb scores and the accompanying narrative evaluations, overall fish community performance was characterized as fair.

- Community indices and narrative evaluations ranged from marginally good/good (most upstream sampling station) to fair/poor (downstream from the North Olmsted WWTP and within the estuarine protions of the study area). Exceptional or very poor performance was not observed.

- Upstream from the North Olmsted WWTP (RM 11.5), community performance was marginally good/good (IBI=44, MIwb=7.6). The fish assemblage at this station maintained a structural and functional organization reflective of instream habitats and ecoregional expectations. The fish community fully achieved applicable WWH biological criteria (Table 9, Figure 8).

- Within the North Olmsted WWTP mixing zone (RM 11.3), a moderate near field impact was observed (IBI=32, MIwb=9.0). Diminished community performance continued further downstream from the North Olmsted WWTP resulting in nonachievement of both WWH biological criteria at RM 11.1 (IBI=30, MIwb=7.2) (Figure 8). In comparison to the sampling station, upstream overall species richness was reduced, and the percent tolerant and omnivorous species demonstrated a marked increase. The observed shifts within the fish community were those typically associated with nutrient enrichment.

- Downstream from the confluence of Abram Creek (RM 10.0) the fish community preformed at a poor/marginally good level (IBI=26; MIwb=7.7)(Figure 8). The Index of Biotic Integrity was in the poor range, reflecting the continued predominance of tolerant and omnivorous species, and reduced species richness. However, the MIwb was a nonsignificant departure of the WWH biocriterion, indicating that structural components were improved. In response to moderate enrichment, stream fish communities typically demonstrate an increase in biomass and relative abundance. This response is manifest in an increase in MIwb values . The MIwb

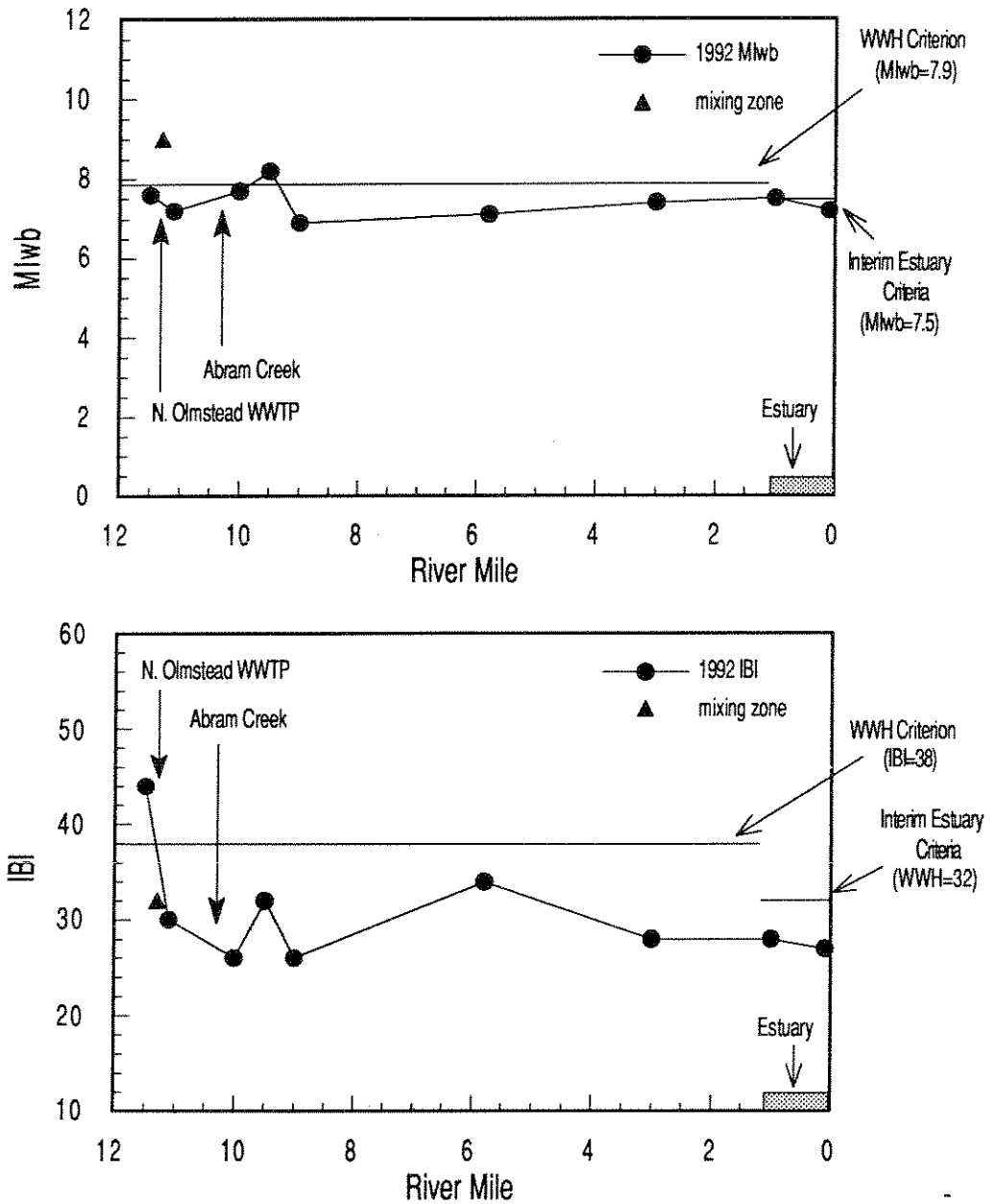

Figure 8. Longitudinal trend of the Index of Biotic Integrity (IBI; lower) and the Modified Index of Well-Being (MIwb; upper) in the Rocky River, 1992.

value observed at RM 10.0 did not suggest additional enrichment from Abram Creek. In comparison with sampling stations upstream, biomass and relative abundance at RM 10.0 were reduced, a response not indicative of additional enrichment (Table 9). Near achievement of the WWH criterion by the MIwb suggested an incomplete recovery within the fish community from the impact associated with the North Olmsted WWTP. Abram Creek dischargers (Brookpark WWTP, Middleburg Heights WWTP, and NASA) did not appear to contribute to the poor performance of the IBI; this performance most likely represented continued influence of theNorth Olmsted WWTP. Additional recovery within the fish community continued downstream to RM 9.5. Community performance at this station was fair/good (IBI=32; MIwb=8.2), with both indices improved.

- A significant decline in community performance at RM 9.0 marked an interruption in the process of recovery (Figure 8). The impact observed at this station may be associated with storm runoff from Hopkins International Airport. Both community indices at this station failed to achieve WWH criteria; narrative evaluations were poor/fair (IBI=26; MIwb=6.9).

- Fish assemblages at the sampling stations between RM 5.8 and RM 3.0 were characterized as fair to marginally good. The community within this reach failed to fully achieve WWH criteria, though partial achievement was observed. The diminished community performance observed within this reach most likely reflects strong influence of urban nonpoint source pollution.

- The remaining stations between RM 1.0 and RM 0.1 represent the lower reach of the study area. This segment is located within the lake effected estuary of the Rocky River. At present, the development of biological criteria for Lake Erie estuary areas has not been completed. In recognition of the innate potential of the lentic habitats encountered within this area and limitations of Ohio EPA's current sampling technique (developed primarily for the sampling of lotic habitats), interim biological criteria have been established. The fish community within this reach preformed at fair levels. Partial to full achievement of the interim estuary biological criteria were observed.

Fish Tissue

- Fish tissue sampling was conducted due to the concern that mercury from NASA could bioaccumulate. Three whole body composite samples of common carp were collected from the Rocky River at RM 10.0 (Brookpark Road) and analyzed for mercury. All three tissue samples contained mercury above detection limits. However, the values ranged between 38.6 and 71.9 µg/kg which is well below the FDA action limit of 1000 µg/kg.

Table 9. Fish community indices based on pulsed D.C. electrofishing samples at 30 locations sampled by Ohio EPA in the Rocky River study area during July - September, 1992.

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Rocky River								
11.5	23.0	23	365	17.31	68.0	7.6[ns]	44	M.Good/Good
11.3(mz)	14.0	14	3864	20.83	N/A	9.0	32*	Good/Fair
11.1	19.0	19	639	16.80	70.0	7.2*	30*	Fair/Fair
10.0	19.0	19	404	3.619	67.0	7.7[ns]	26*	M.Good/Poor
9.5	23.0	23	1474	7.867	69.0	8.2	32*	Good/Fair
9.0	13.0	13	333	6.319	70.5	6.9*	26*	Fair/Poor
5.8	13.0	13	332	2.853	62.0	7.1*	34[ns]	Fair/M.Good
3.0	17.0	17	234	2.706	80.5	7.4[ns]	28*	M.Good/Fair
1.0	19.0	27	349	97.66	58.0	7.5	29[ns]	Fair
0.1	16.0	27	335	94.51	34.0	7.2[ns]	27*	Fair/Poor
Abram Creek								
1.9	2.0	9	15	8.552	59.0	N/A	12*	Very Poor
0.4	7.5	13	10	0.042	73.0	N/A	16*	Very Poor
East Branch Rocky River								
26.7	13.5	15	694	6.329	69.0	N/A	45	Very Good
21.9	20.0	21	646	13.89	79.0	8.8	48	Good/V.Good
18.2(mz)	16.0	20	1112	10.70	N/A	8.4	43	Good
17.5	20.0	23	367	15.46	70.0	7.3*	38	Fair/Good
15.3	21.5	25	617	14.42	63.5	8.0	44	Good
11.6	17.5	22	1169	17.19	83.5	8.2	38	Good
10.0	15.0	16	1836	17.99	62.0	8.6	36[ns]	Good/M.Good
6.5	19.0	20	528	18.89	63.5	7.9	36[ns]	M.Good
4.9	13.5	17	87	9.071	70.0	5.6*	34[ns]	Poor/M.Good
1.4	12.5	15	358	35.44	70.0	4.4*	22*	V.Poor/Poor
Baldwin Creek								
7.4	8.0	9	923	12.52	54.5	N/A	31*	Fair
5.8	7.5	9	633	18.07	82.0	N/A	17*	Very Poor
3.0	11.5	14	2033	16.05	43.5	N/A	27*	Poor
2.6	9.5	12	724	23.33	68.5	N/A	22*	Poor
1.4	6.5	7	906	8.015	58.5	N/A	18*	Poor
North Royalton A Tributary								
0.6	7.5	8	839	5.001	44.5	N/A	35*	Fair
0.2	2.5	3	473	3.328	70.5	N/A	20*	Poor

Table 9. (continued)

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No. (No./Km)	Mean Rel. Wt. (Kg/Km)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
West Branch Rocky River								
33.5	20.5	23	884	28.47	66.5	N/A	43	Good
33.3	19.0	22	2547	15.55	70.0	N/A	49	Very Good
27.3	27.3	23	1256	13.35	73.0	8.3	42	Good
17.2	22.0	22	483	4.376	61.0	8.4	38	Good
13.3	22.0	24	772	4.750	75.0	8.0	32*	Good/Fair
4.8	15.5	19	481	16.69	81.0	7.6[ns]	42	M.Good/Good
3.6	10.5	13	275	11.36	69.5	6.7*	33*	Fair
2.1	14.0	14	630	9.621	58.0	6.7*	32*	Fair
0.4	15.0	15	881	3.811	71.5	7.6[ns]	30*	M.Good/Fair
Plum Creek								
0.3	7.5	10	608	9.545	43.5	N/A	18*	Poor
Baker Creek								
0.3	15.0	17	731	5.991	68.0	N/A	37[ns]	M. Good
North Branch Rocky River								
5.5	21.0	26	629	11.63	73.5	8.2	47	Good/V.Good
Blodgett Creek								
0.1	10.0	13	725	2.710	63.5	N/A	38[ns]	M. Good
Mallet Creek								
0.7	22.0	26	1866	9.206	68.5.	N/A	47	Very Good

Ecoregional Biocriteria: Erie-Ontario Lake Plain (EOLP)

INDEX - Site Type	WWH	EWH	MWH[b]
IBI - Headwaters/Wading	28	50	20
IBI - Wading	32	50	22
IBI - Boat	34	48	20
IBI - Estuary[c]	32	48	24
Mod. Iwb - Wading	8.3	9.4	5.6
Mod. Iwb - Boat	8.5	9.6	5.7
Mod. Iwb - Estuary[c]	7.5	9.6	5.8

[b] - Modified Warmwater Habitat for channel modified areas.
[c] - Interim Estuary WWH Criteria

* - Significant departure from applicable biological criterion (>4 IBI units or >0.5 Iwb units); underlined values are in the poor and very poor range.
ns - Nonsignificant departure from biocriterion (≤4 IBI units or < 0.5 MIwb units)
a - Narrative evaluation is based on both MIwb and IBI scores.
NA - Headwater site; MIwb is not applicable.

Abram Creek

Pollutant Loadings: 1976-1992

Middleburg Heights WWTP

Treatment at this WWTP consisted of extended aeration with phosphorus removal. There has been generally no increase in loadings from the WWTP since 1981. Despite increased flows, there were reduced loadings of ammonia-N and TSS over the last two years. Figure 9 depicts graphs of average flow and loading trends for ammonia-N and TSS from the Middleburg Heights WWTP from 1981 to 1992. This facility was eliminated via tie-in to the NEORSD Southwest Interceptor in December 1992.

Brookpark WWTP

This WWTP was an extended aeration plant with phosphorus removal. The plant has shown a reduction in metals, phosphorus, ammonia-N and BOD since 1981. With the exception of phosphorus, the reductions can be attributed to reduced plant flows. Figure 10 depicts graphs of average flow and loading trends for ammonia-N, $CBOD_5$, phosphorus, and total lead from the Brookpark WWTP from 1981 to 1992. This facility was eliminated via tie-in to the NEORSD Southwest Interceptor in December 1992.

Chemical Water Quality

- Abram Creek was severely impacted by the Brookpark and Middleburg Heights WWTPs with documented exceedences of the WWH chronic criteria for ammonia at both sampling locations (RM 0.4 and 1.9) in 4 of 8 samples and dissolved oxygen at RM 1.9 in 2 of 8 samples during the 1992 survey. One of two bacteria samples (12,000 colonies/100ml) exceeded the numerical criterion for secondary contact recreation. Since the survey, these discharges have been eliminated from Abram Creek and have been diverted to the NEORSD Southerly WWTP. Except for phosphorus which increased in concentration, Abram Creek did not have a significant influence on water quality in the mainstem of the Rocky River.

- During the survey, citizens informed Ohio EPA staff that discharges from the Brookpark service garage, a metal fabricator and the IX Center were entering Abram Creek. Follow-up work by the Ohio EPA resulted in the elimination of those discharges to the creek. During winter months, the Cleveland Hopkins airport uses glycol and urea for plane and runway deicing. Runoff from the de-icing operations had been going to Abram Creek and the mainstem untreated. The airport also had facilities on the property that discharged untreated waste to the Rocky River. The airport is enjoined under Directors Findings and Orders from discharging pollutants in violation of ORC 6111 and has been required to connect all of their facility point source discharges into sanitary sewers. The point sources were all connected by January 1993. The airport is currently investigating collection and treatment alternatives for their de-icing wastes.

Sediment Chemistry

- Sediment samples were collected from Abram Creek at RM 0.1 and analyzed for heavy metals. Concentrations of all metals except zinc were in the low to nonelevated range using the Kelly and Hite criteria. Zinc was in the elevated range. Samples collected in 1991 contained mercury in the elevated range while those collected in 1992 were in the non-elevated range. The morphology of the creek results in a very high percentage of sands and gravels in the sediments which may account for the relatively low concentration of heavy metals. Concentrations of heavy metals in stream sediments are usually inversely related to sediment particle size.

Physical Habitat for Aquatic Life

- Macrohabitats of Abram Creek were evaluated at two fish sampling stations (RM 1.9 and RM 0.4). Qualitative Habitat Evaluation Index values from these sampling stations had a mean value of 66.0. A mean QHEI value greater than 60 suggested that near and instream habitats of Abram Creek are of sufficient quality to support and maintain biological communities capable of attaining WWH biological criteria (Rankin 1989).

- Macrohabitats at RM 1.9 and RM 0.4 can be characterized as good/fair, achieving QHEI values of 73.0 and 59.0 respectively. Both stations were predominated by warmwater habitat attributes while high and moderate influence modified habitat attributes occurred at a low frequency. Prevalent features at RM 1.9 were mixed coarse substrates of native and glacial origin, good/fair channel development, pooled areas greater than 70 cm in depth, and little or no physical modification to the active channel (Table 7). Naturally occurring habitats appeared to be of a lesser quality at RM 0.4 in comparison with the station upstream. The primary factor responsible for the decline in QHEI values was the predominance of shale bedrock substrates within the lower reach of Abram Creek. Bedrock substrates found at this station tended to limit channel development, resulting in a widened, relatively shallow channel with abundant swift glide habitat. In addition, the only benthic interstices available were provided by fragmented friable shale. This substrate type is generally unstable, providing less than optimal refugia for stream dwelling organisms. Though habitat was of a lesser quality than that observed upstream, the station at RM 0.4 still maintained instream and near stream macrohabitats capable of supporting biological communities that achieve WWH biological criteria.

Biological Assessment: Macroinvertebrate Community

- The macroinvertebrate community was in poor condition at both Abram Creek sampling locations. An ICI score of 4 was recorded at RM 2.0 and was improved only marginally at RM 0.3 (ICI=8). Pollution tolerant midges and oligochaetes predominated on the natural substrates at both sites. The severely degraded condition of the stream appeared to be primarily due to inadequate treatment of effluent discharged from the Middleburg Heights and/or the Brookpark WWTP. Due to the degraded upstream condition, impacts associated with the NASA facility could not be addressed by this sampling effort.

Biological Assessment: Fish Community

- A total of 202 fish comprised of nine species and one hybrid was collected from Abram Creek between August 26 and September 22, 1992. The sampling effort included a total of 2.4 Km at two sampling stations between RM 1.9 (downstream from the Brookpark WWTP and Middleburg Heights WWTP) and RM 0.4 (downstream from NASA and Hopkins International Airport).

- Fish in Abram Creek reflected very poor community conditions. Assemblages at both stations were characterized by extremely low diversity, relative abundance and biomass and little or no functional organization. The sampling station downstream from the two WWTPs (RM 1.9) was nearly devoid of fish and severely degraded. A total of only 13 individuals of the most pollution tolerant species were collected during the field sampling efforts.

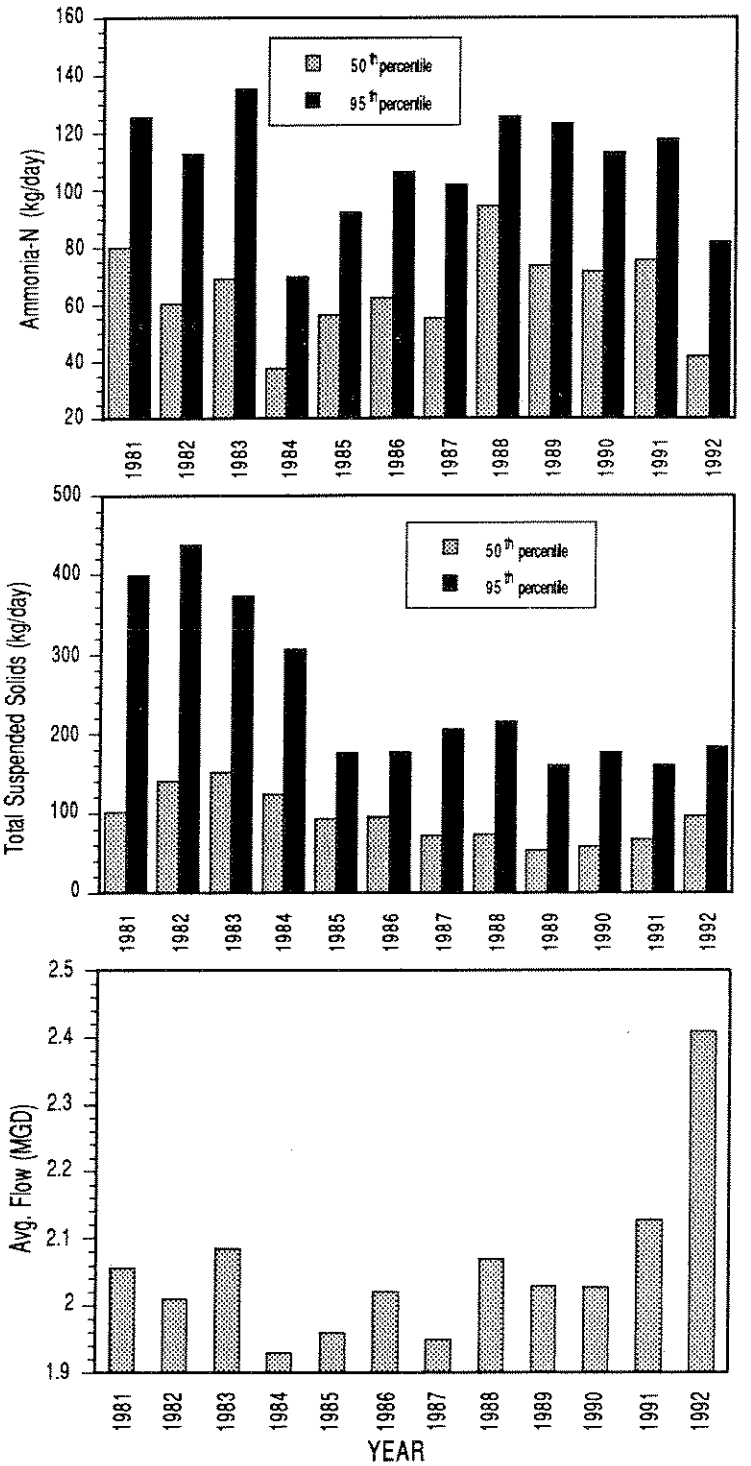

Figure 9. Average flow (MGD) and annual loadings (kg/day) of suspended solids and ammonia-N, from the Middleburg Heights WWTP, 1981-1992.

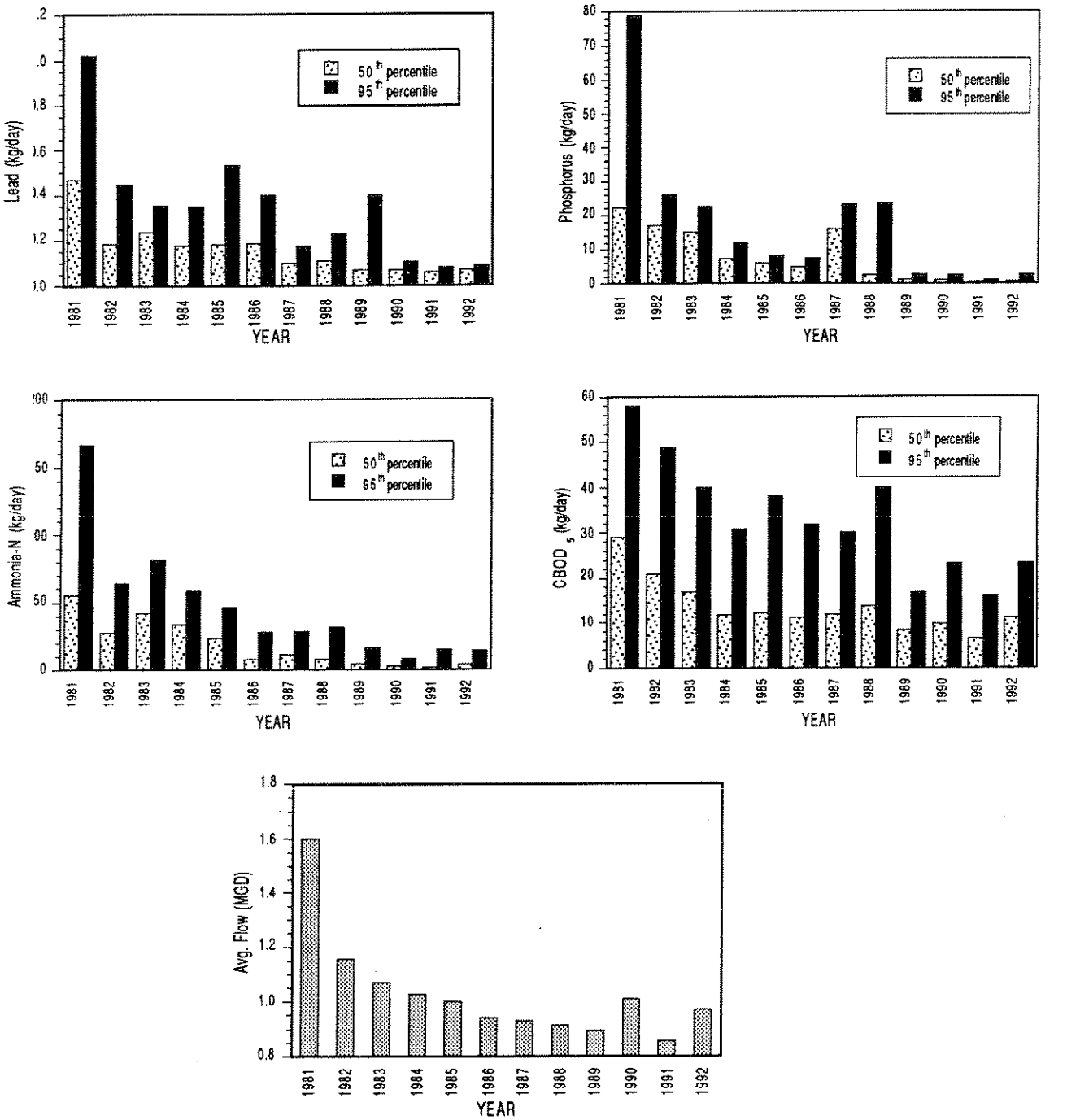

Figure 10. Average flow and annual loadings (kg/day) of lead, phosphorus, ammonia-N, and $CBOD_5$ from the Brookpark WWTP, 1981-1992. $CBOD_5$ loadings for 1981-1984 are calculated based on reported biochemical oxygen demand (BOD_5) values.

- The fish community at the station downstream from the NASA facility and Hopkins International Airport (RM 0.4) continued to reflect severely degraded conditions. Though biomass, relative abundance, and species richness were somewhat improved in comparison with the upstream station, very poor community performance (IBI=16) was still observed. It was unclear if NASA and/or Hopkins International Airport contributed additional impacts or if the very poor community performance was solely the product of continued influence from upstream point sources.

East Branch Rocky River

Pollutant Loadings: 1976-1992

Medina 300 WWTP

The Medina 300 WWTP is an extended aeration plant that utilizes rotating biological contactors with phosphorus removal and dechlorination. Flows at this plant have steadily increased since 1981. BOD5, phosphorus and TSS loadings have increased, while ammonia-N and $CBOD_5$ have remained constant. Microscreens are in place at the facility but are not in service. This facility has recently requested to increase their flows from 2.0 to 4.0 MGD. Figure 11 depicts graphs of average flow and loading trends for ammonia-N, $CBOD_5$, phosphorus, and TSS from the Medina 300 WWTP from 1981 to 1992.

Strongsville "B" WWTP

Treatment at this WWTP includes RBCs, tertiary treatment and ammonia and phosphorus removal. This facility's flows have increased while achieving a major decrease in ammonia loadings starting in 1986. Smaller decreases in BOD and TSS loadings have also occurred. Phosphorus and copper loadings appear to be increasing. Figure 12 depicts graphs of average flow and loading trends for ammonia-N, $CBOD_5$, phosphorus, TSS, and total copper from the Strongsville "B" WWTP from 1981 to 1992.

Berea WWTP

Most loadings from the Berea WWTP have remained constant. Reduced phosphorus loadings started in 1987. It is important to note that the Berea WWTP loadings are greater than all the rest of the East Branch dischargers combined (Figure 39). This facility is scheduled to be tied into the NEORSD Southwest Interceptor in the summer of 1993. Figure 13 depicts graphs of average flow and loading trends for ammonia-N, $CBOD_5$, and phosphorus from the Berea WWTP from 1981 to 1992.

Chemical Water Quality

- There were no exceedences of the WWH chemical criteria for the East Branch of the Rocky River. An exceedence of the secondary contact recreation use fecal coliform bacteria criterion was recorded at RM 1.4 (1 of 9 samples).

- Total dissolved solids (TDS) concentrations increased steadily from the headwaters to the mouth of the East Branch. COD concentrations also increased downstream with the Medina 300 WWTP having the biggest impact on the stream. The increasing TDS and COD concentrations can be attributed to the addition and increasing percentage of treated wastewater flow in the river its from headwaters to the mouth. Figure 14 depicts graphs of COD, TDS and D.O. concentrations in the East Branch of the Rocky River from RM 26.7 to RM 1.4.

- Instream D.O. concentrations were influenced by WWTP discharges, but the concentrations did not approach the water quality criterion. Results from August 25-28 Datasonde© sampling, however, indicated higher D.O. concentrations downstream from the Medina 300 and North Royalton "A" WWTP discharges (Figure 6). The lowest value reported on the East Branch was 4.89 mg/l upstream from the Medina 300 WWTP. The lowest value downstream from the WWTP was 6.58 mg/l. It is important to note, however, that high water levels experienced during the sampling period likely affected the results. Elevated flows tend to limit photosynthesis that in turn decreases the amount of diurnal D.O. fluctuation and result in considerable turbulence that can enhance reaeration..

- Failing septic systems were observed discharging into the East Branch near RM 15.15. Except possibly elevating TDS concentrations, these failing systems did not appear to have a significant effect on the chemical water quality of the East Branch.

- The Berea WWTP had a significant impact on instream ammonia-N concentrations in the East Branch and was apparently also responsible for the higher concentrations of ammonia-N in the mainstem upstream from the North Olmsted WWTP. One of two bacteria samples (6,100 colonies/100 ml) at RM 1.4 exceeded the numerical criteria for both primary and secondary contact recreation. Higher TSS concentrations were found downstream from Baldwin Creek and the Berea WWTP. The high average TSS concentration downstream from the Berea WWTP was a result of one extremely high value (335 mg/l) that could have been caused by construction of the Southwest Interceptor near the creek. One high value for phosphorus was recorded upstream from Baldwin Lake. Average zinc concentrations steadily increased from below detection limits in the headwaters to a high of 14 mg/l downstream from the North Royalton "A" WWTP (RM 12.2). Zinc concentrations increased again downstream from Berea and Baldwin Creek. The zinc concentrations appeared to correlate with TSS values (Figure 15). TSS and TDS has concerned the city of Berea because of the city's use of the East Branch for a water supply. The East Branch has tended to appear more turbid than either the mainstem or the West Branch. The East Branch TSS concentrations were only slightly higher than the West Branch and the mainstem TSS concentrations during the 1992 survey.

Sediment Chemistry

- In general, heavy metals in the East Branch of the Rocky River increased steadily toward the mouth (Table 6). This increasing trend suggested impacts of urban runoff and the cumulative effect of point sources. Septic sediments were found downstream from the Berea WWTP at Spafford Road (RM 1.4) which indicated inadequately treated wastes were discharged from the Berea WWTP or sewer system. All metals were in the low to nonelevated range using the Kelly and Hite criteria except concentrations of lead and zinc at RM 1.4 which were in the elevated range. The river's morphology creates a very high percentage of sands and gravels in the sediments that may account for the relatively low concentration of heavy metals. Concentrations of heavy metals in stream sediments are usually inversely related to sediment particle size.

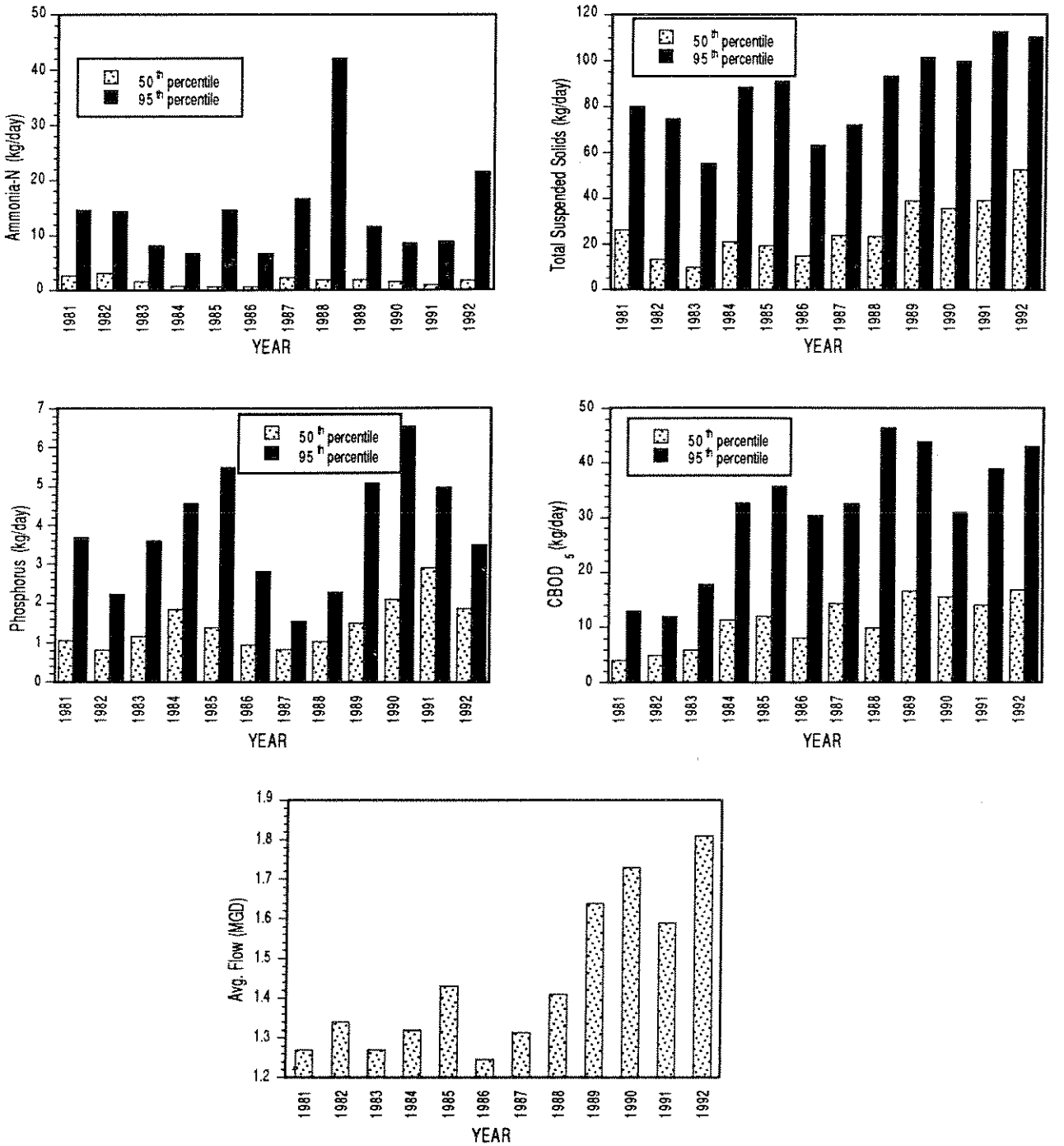

Figure 11. Average flow (MGD) and annual loadings (kg/day) of ammonia, suspended solids, phosphorus and $CBOD_5$ from the Medina 300 WWTP, 1981-1992. $CBOD_5$ loadings for 1981-1984 are calculated based on reported biochemical oxygen demand (BOD_5) values.

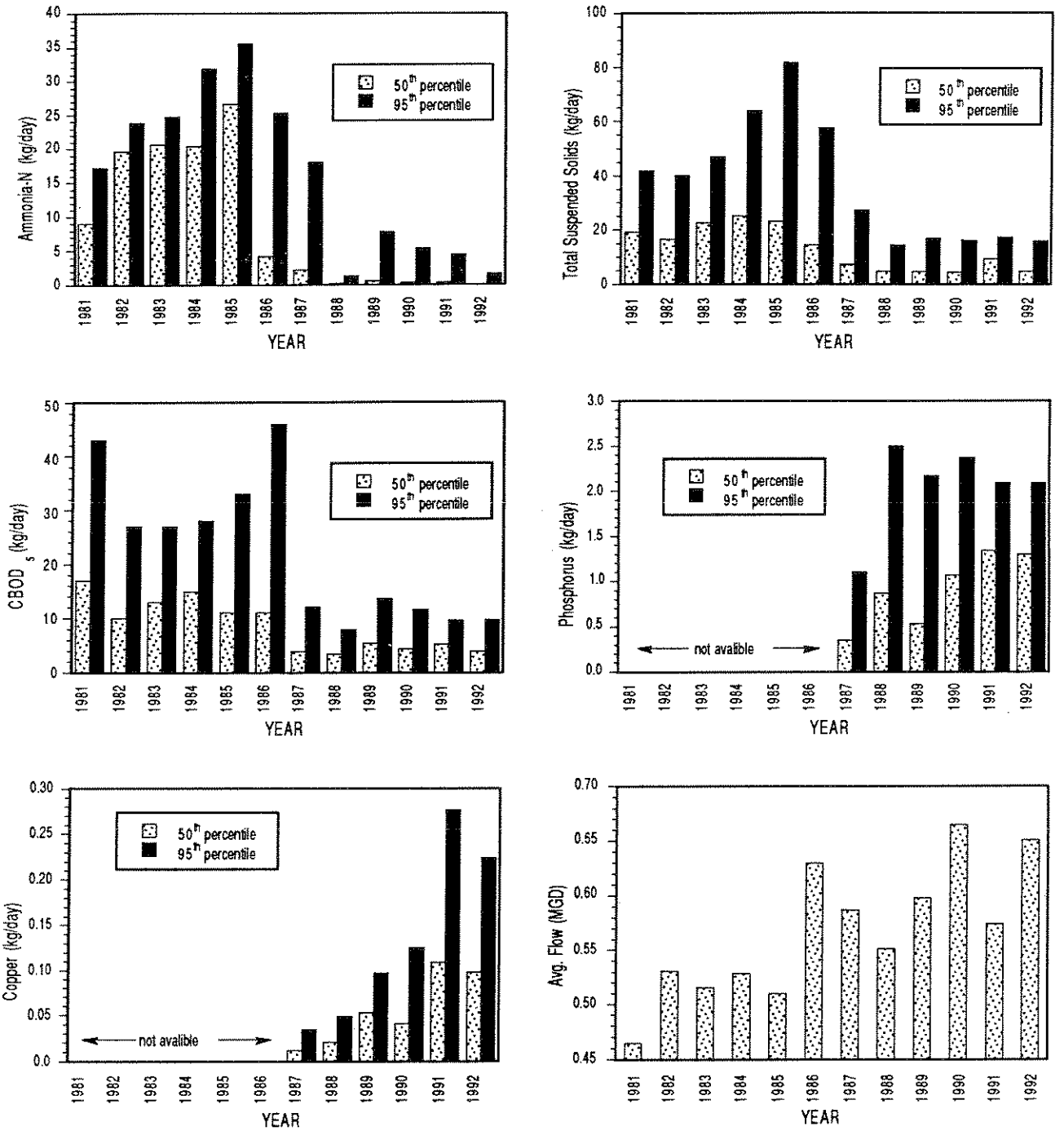

Figure 12. Average flow (MGD) and annual loadings (kg/day) of ammonia, suspended solids, $CBOD_5$, phosphorus and copper from the Strongsville "B" WWTP, 1981-1992. $CBOD_5$ loadings for 1981-1984 are calculated based on reported biochemical oxygen demand (BOD_5) values.

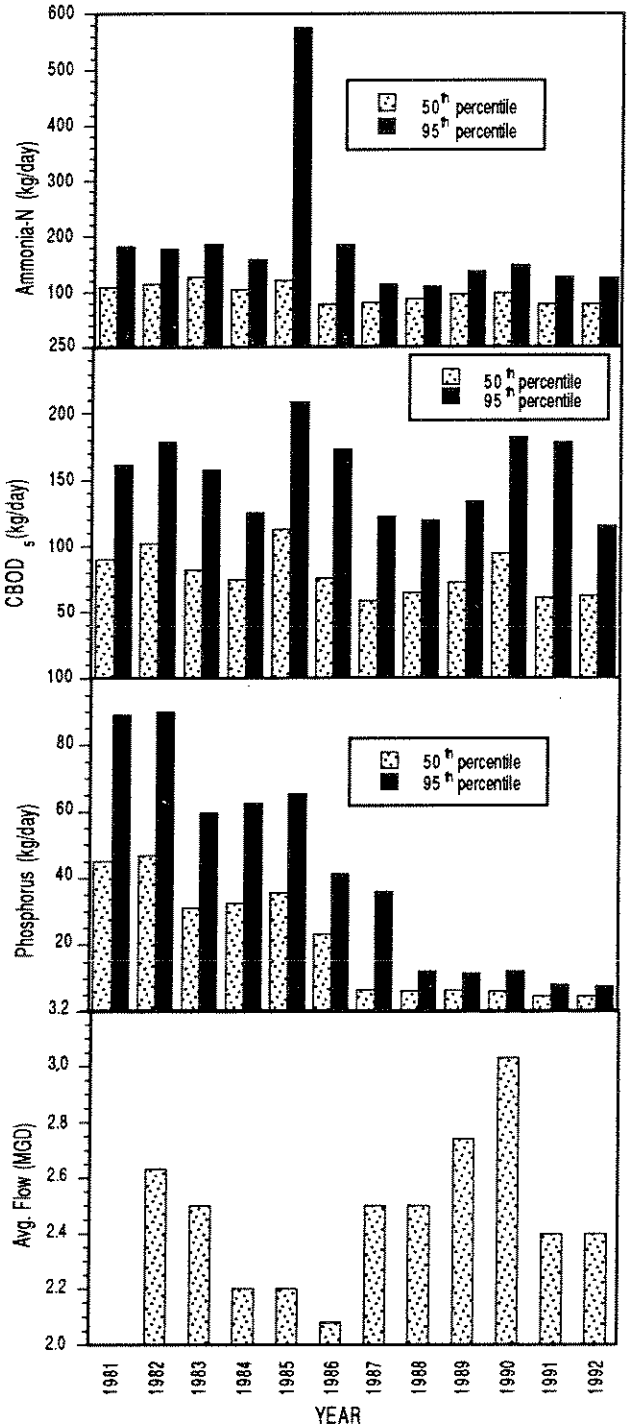

Figure 13. Average flow (MGD) and annual loadings (kg/day) of ammonia, suspended solids, $CBOD_5$ and phosphorus from the Berea WWTP, 1981-1992. $CBOD_5$ loadings for 1981-1984 are calculated based on reported biochemical oxygen demand (BOD_5) values.

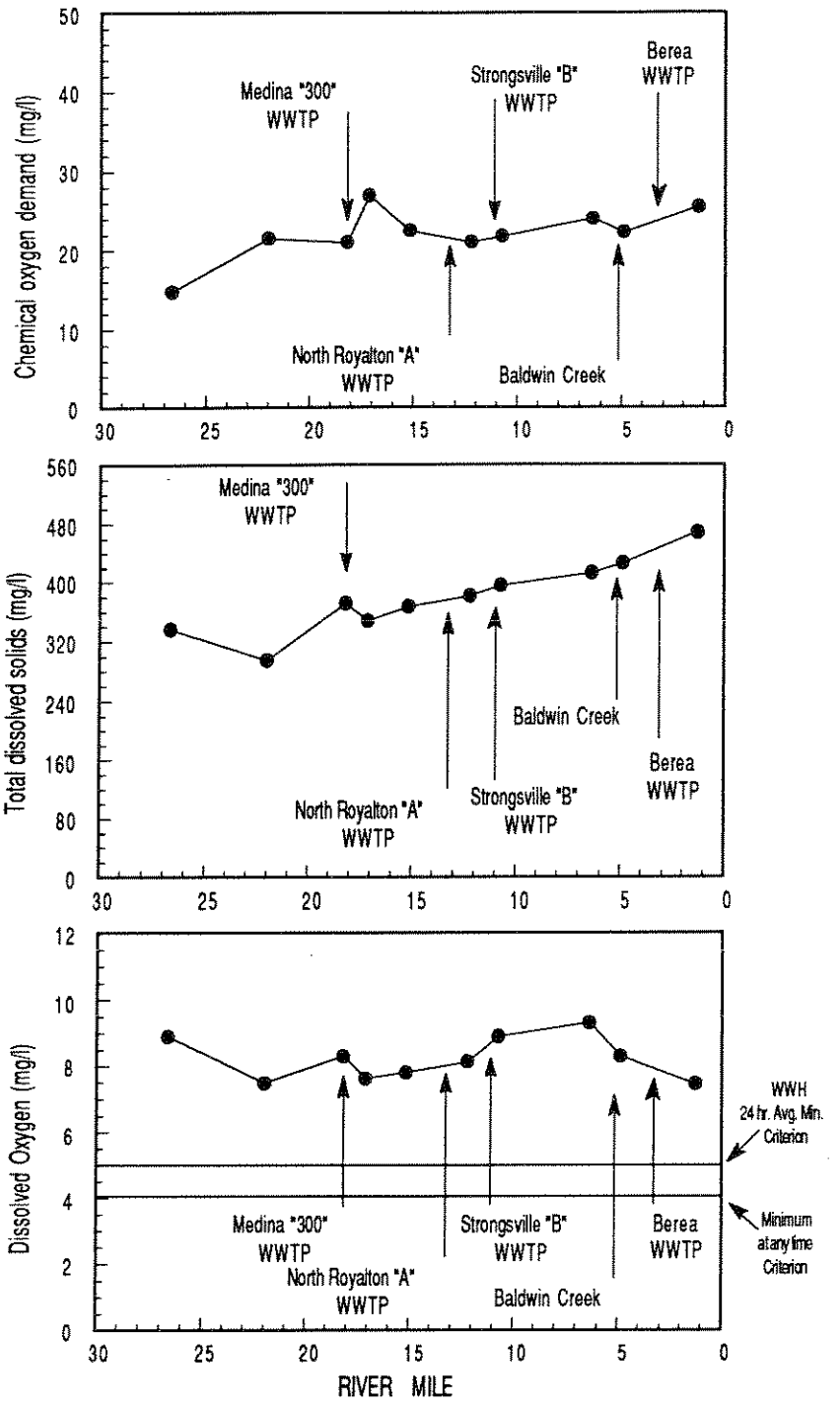

Figure 14. Longitudinal trends of mean chemical oxygen demand, total dissolved solids and dissolved oxygen from the East Branch Rocky River, 1992.

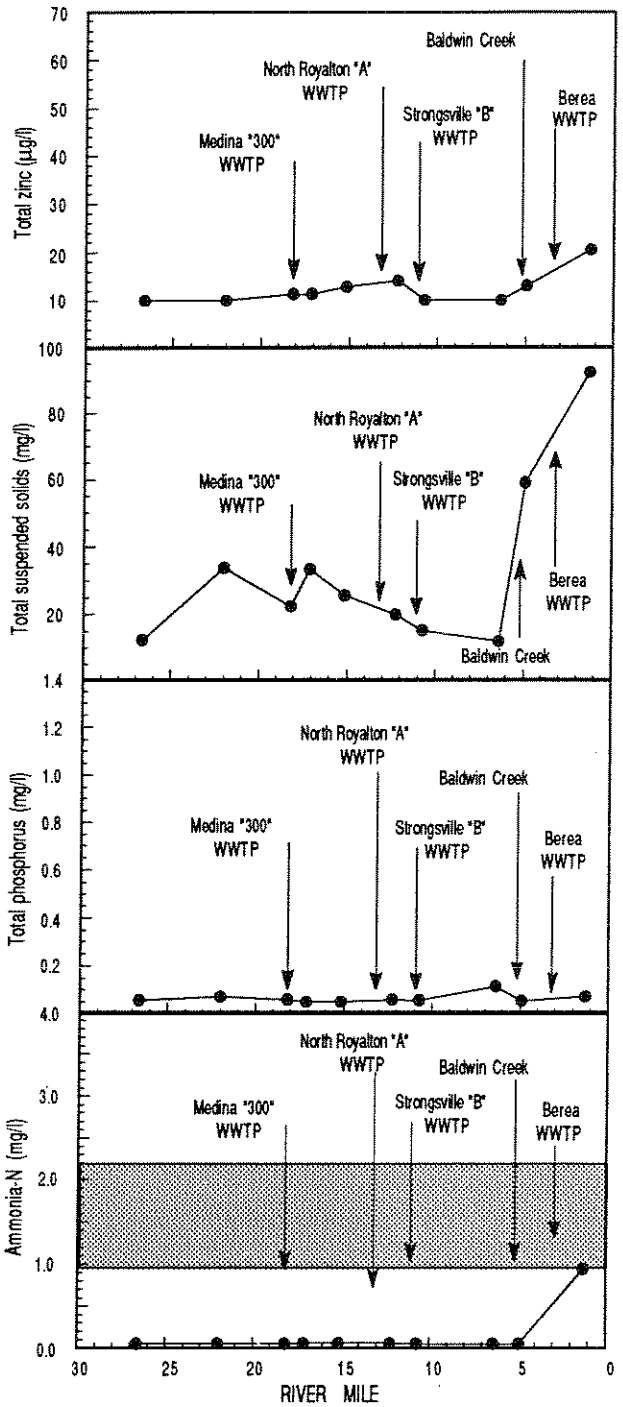

Figure 15. Longitudinal trend of mean zinc, total suspended solids, phosphorous and ammonia from the East Branch Rocky River, 1992. Shaded area represents the ammonia WQS range for 90th and 25th percentile pH and temperature values.

Physical Habitat for Aquatic Life

- Macrohabitats of the East Branch of the Rocky River were evaluated at nine fish sampling stations. Qualitative Habitat Evaluation Index values ranged from 83.5 (RM 11.6) and 62.0 (RM 10.0), with a mean score of 70.1. A mean QHEI value greater than 60.0 suggests that near and instream habitats of the East Branch Rocky River are of sufficient quality to support and maintain an aquatic community that can attain the WWH biological criteria (Rankin 1989).

- Habitat quality tended to decrease longitudinally; however, QHEI values below 60.0 were not observed. Warmwater habitat attributes predominated, with moderate and high influence attributes occurring at a much lower frequency (Table 7). Warmwater habitat attributes observed during the field sampling efforts included little or no direct channel modification, good/fair channel development, mixed current velocities, extensive/moderate instream cover types, and mixed coarse substrates. Moderate and high influence modified habitat attributes included moderate siltation, hardpan substrates, and moderate embedding of coarse substrates.

- A predominance of bedrock substrates tended to limit the development of pool/riffle/run complexes resulting in less overall habitat diversity. However, the predominance of bedrock did not appear to preclude the ability of the East Branch of the Rocky River to support and maintain a biological community capable of attaining WWH biological criteria.

Biological Assessment: Macroinvertebrate Community

- Macroinvertebrate sampling results from the East Branch were primarily affected by high flow conditions experienced during six weeks that the artificial substrates were in the stream. Three of the 11 sample sets were lost and another 3 were disturbed to such an extent that the quantitative sampling results were suspect. ICI scores in the marginally good to fair range were recorded from the disturbed artificial substrates (RMs 18.2, 17.5, and 1.2); however, ICI scores at adjacent sites and qualitative sampling results at all locations reflected good to exceptional conditions.

- There was no evidence of any significant impact from the either the Medina 300 WWTP, the Strongsville "B" WWTP, the North Royalton "A" tributary, Baldwin Creek or the Berea WWTP. Excepting the site at RM 1.2, QCTV values and the combined number of mayfly, caddisfly and stonefly taxa collected at sites on the East Branch were among the highest recorded for the entire study area (Table 8.). The benthic community and resultant QCTV at RM 1.2 appeared to be affected by lesser quality habitat compared to upstream sites, rather than an impact from the Berea WWTP.

Biological Assessment: Fish Community

- A total of 8,593 fish comprised of 33 species and four hybrids was collected from the East Branch Rocky River between August 8 and October 11, 1992. The sampling effort included a total of 40.7 Km at ten sampling locations between RM 26.7 (upstream from Harter Rd.) and RM 1.4 (downstream from Spafford Rd.).

- The fish community was numerically predominated by central stoneroller (28.6%), common shiner (12.3%), bluntnose minnow (11.6%), rainbow darter (7.74%), and northern hog sucker (7.17%). In terms of biomass the community was predominated by common carp (36.6%), northern hog sucker (17.5%), central stoneroller (11.8%), white sucker (9.93%), and common shiner (12.2%). Species encountered within the East Branch Rocky River listed as threatened within the state of Ohio included the bigmouth shiner (Ohio DNR 1992). A total of 309 bigmouth shiners was collected during the 1992 field sampling effort.

- In terms of numerical abundance, moderately intolerant and tolerant species predominated. The high abundance of the central stoneroller and bluntnose minnow (herbivorous and omnivorous cyprinid species) suggested moderately enriched conditions; however, rainbow darter, northern hogsucker, and common shiner (insectivorous and lithophilic species) were also a significant component of the fish community. The abundance of these species reflected the quality of the natural habitats found within the East Branch Rocky River and the absence of extensive water quality perturbations. Based on MIwb and IBI values, fish community performance was characterized as good.

- Fish communities collected from the most upstream sampling reach, between RM 26.7 and RM 21.9, were characterized as good/very good, exceeding WWH biological criteria (Figure 16). A high percentage of sensitive lithophilic and insectivorous species was a significant component of the fish fauna. Habitat generalists, omnivorous, and tolerant species composed only small percentage of the community. Performance within this reach was reflective of the instream habitats available and communities achieved the WWH biological criteria.

- A moderate near field impact was observed within the Medina 300 mixing zone at RM 18.2. Further downstream (RM 17.5) community performance declined further and received a narrative evaluation of good/fair (IBI=43; MIwb=7.3); this resulted in partial achievement of the WWH biological criteria (Figure 16). The impact noted downstream from the Medina 300 WWTP was distinct; however, full recovery within the fish community was apparent downstream at RM 15.3, where full achievement of the WWH biocriteria was again observed.

- A decline in community performance was observed downstream from the confluence of the North Royalton "A" WWTP tributary. A significant increase in the percent occurrence of bluntnose minnow and central stoneroller (omnivorous and herbivorous cyprinid species) suggested moderate nutrient enrichment at this station, though achievement of the WWH biocriteria was still observed (Figure 16).

- The reach between RM 10.0 and RM 1.4 showed a gradual longitudinal decline in community performance. Incremental impacts were evident downstream from the Strongsville "B" WWTP tributary, Baldwin Creek (North Royalton "B" WWTP and Strongsville "C" WWTP), and the Berea WWTP (Figure 16).

- Downstream from the Strongsville "B" WWTP (between RM 10.0 and RM 6.5) community performance was characterized as good/marginally good. Though achievement of the WWH biological criteria was observed, community performance was moderately reduced compared to upstream conditions. At RM 4.9, downstream from Baldwin Creek, community performance declined to marginally good/poor (IBI=34; MIwb=5.6). The IBI value at this station was within the nonsignificant departure range of the WWH criterion, however, the incidence of deformities, eroded fins/barbels, lesions, and tumors (DELT anomalies) increased to 1.8%, which indicated chronic, subacute stress within the fish community. Modified Iwb values fell into the poor range which indicated a diminished community structure; species richness, relative abundance and biomass were reduced at this station (Table 9).

- The fish assemblage downstream from the Berea WWTP (RM 1.4) also failed to attain the WWH biological criteria. The community performed at a poor/very poor level (IBI=22; MIwb=4.4). Both structural and functional components of the fish community were diminished. Species richness was reduced and omnivorous and tolerant species were numerically predominant. Additionally, an elevated incidence of DELT anomalies (1.5%) indicated continued subacute stress within the fish community.

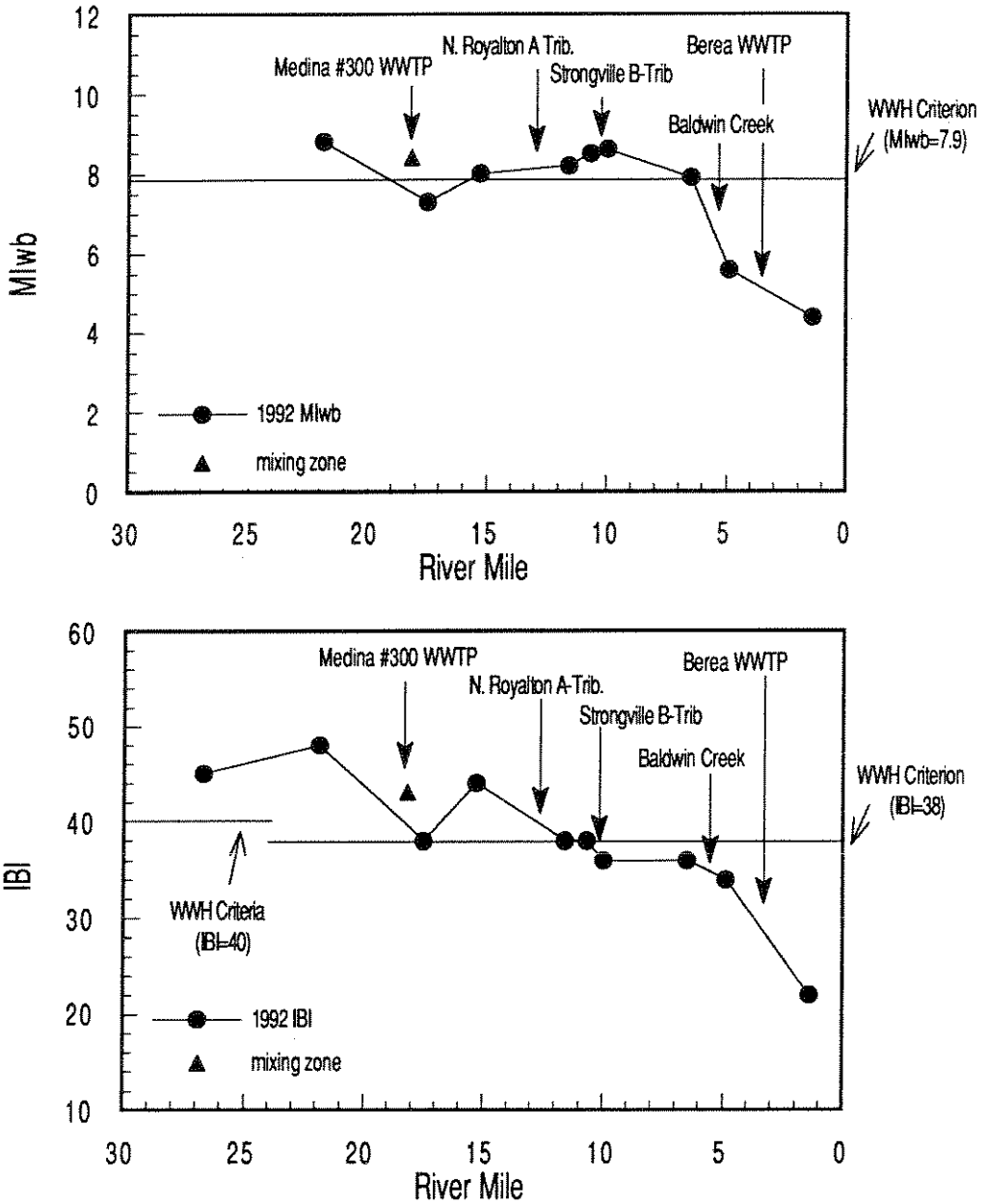

Figure 16. Longitudinal trend of the Modified Index of Well-Being (MIwb; upper) and the Index of Biotic Integrity (IBI; lower) in the East Branch Rocky River, 1992.

West Branch Rocky River
Pollutant Loadings: 1976 - 1992
Medina 500 WWTP

This facility is a powdered activated carbon (PAC) plant with extended aeration and tertiary treatment and phosphorus removal. The plant is at 80% of design capacity during dry weather, but exceeds the 10 MGD design capacity during "wet" weather conditions. Flows have increased while phosphorus and ammonia-N loadings have decreased. $CBOD_5$ loadings have remained constant. Figure 17 depicts graphs of average flow and loading trends for ammonia-N, $CBOD_5$ and phosphorus at the Medina 500 WWTP from 1981 to 1992.

Chemical Water Quality

- There were no exceedences of the WWH water quality criteria for the West Branch of the Rocky River or its tributaries.

- Slightly higher COD and ammonia-N concentrations were found downstream from the Montville landfill tributary (Figure 18). TSS concentrations in the West Branch increased steadily from the headwaters to the mouth, with the largest increase downstream from the Medina "500" WWTP. The high ammonia-N concentrations in Blodgett Creek (average 7.8 mg/l) subsequently increased the ammonia-N concentration in the West Branch. Results from August 25 - 28 Datasonde© sampling showed a reduction of D.O. approximately 2 miles downstream from the Medina "500" WWTP discharge (Figure 6). The lowest value reported was 5.37 mg/l. It is important to note, however, that high water levels experienced during the sampling period likely affected the results somewhat. Elevated flows tend to limit photosynthesis that in turn decreases the amount of diurnal D.O. fluctuation and result in considerable turbulence that can enhance reaeration..

- No appreciable impact was detected in the chemical water quality of the West Branch downstream from the confluences of Plum Creek, Baker Creek, or Mallet Creek.

- Higher than background bacteria concentrations were found in the Olmsted Falls area downstream from several small package plants and in Plum Creek, Baker Creek and Blodgett Creek (Table 5). There was an increase in TSS, fecal coliform bacteria, and phosphorus between the Olmsted Falls area at RM 2.1 and Lewis Road at RM 0.39. The likely source of these increases was the Columbia Hills Trailer Park that discharges to an unnamed tributary that enters the West Branch at RM 1.8. Instream D.O. concentrations declined in response to WWTP and nutrient discharges but never fell below the water quality criteria. Figure 18 depicts graphs of TSS, dissolved oxygen, chemical oxygen demand, and ammonia-N in the West Branch of the Rocky River from river mile 11.5 to 3.0.

Sediment Chemistry

- Sediment samples were collected from the West Branch of the Rocky River at RM 33.5 and RM 0.4 and analyzed for heavy metals. All metals were in the low to non-elevated range using the Kelly and Hite criteria. However, all metal concentrations increased near the mouth (Table 6). This increasing trend suggested impacts from urban runoff and the cumulative effect of point sources.

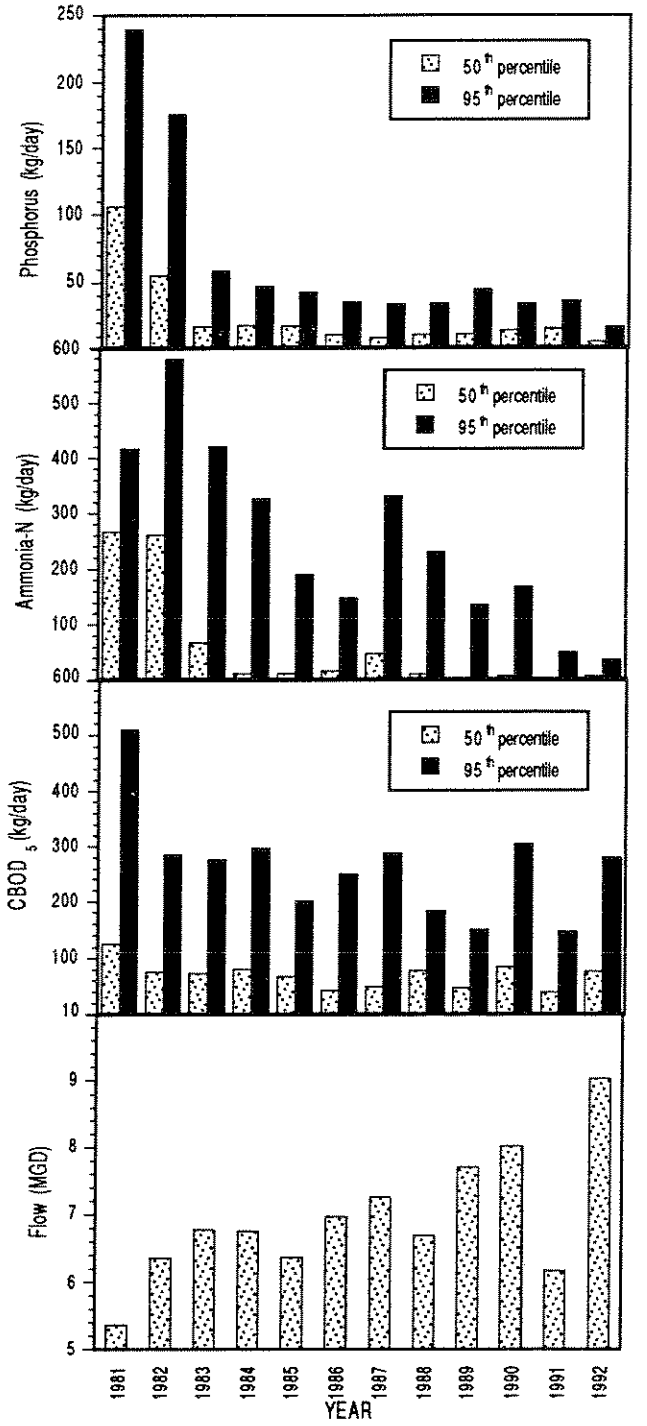

Figure 17. Average flow (MGD) and annual loadings (kg/day) of phosphorus, ammonia-N, and $CBOD_5$ from the Medina 500 WWTP to the West Branch Rocky River, 1981-1992. $CBOD_5$ loadings for 1981-1984 are calculated based on reported biochemical oxygen demand (BOD_5) values.

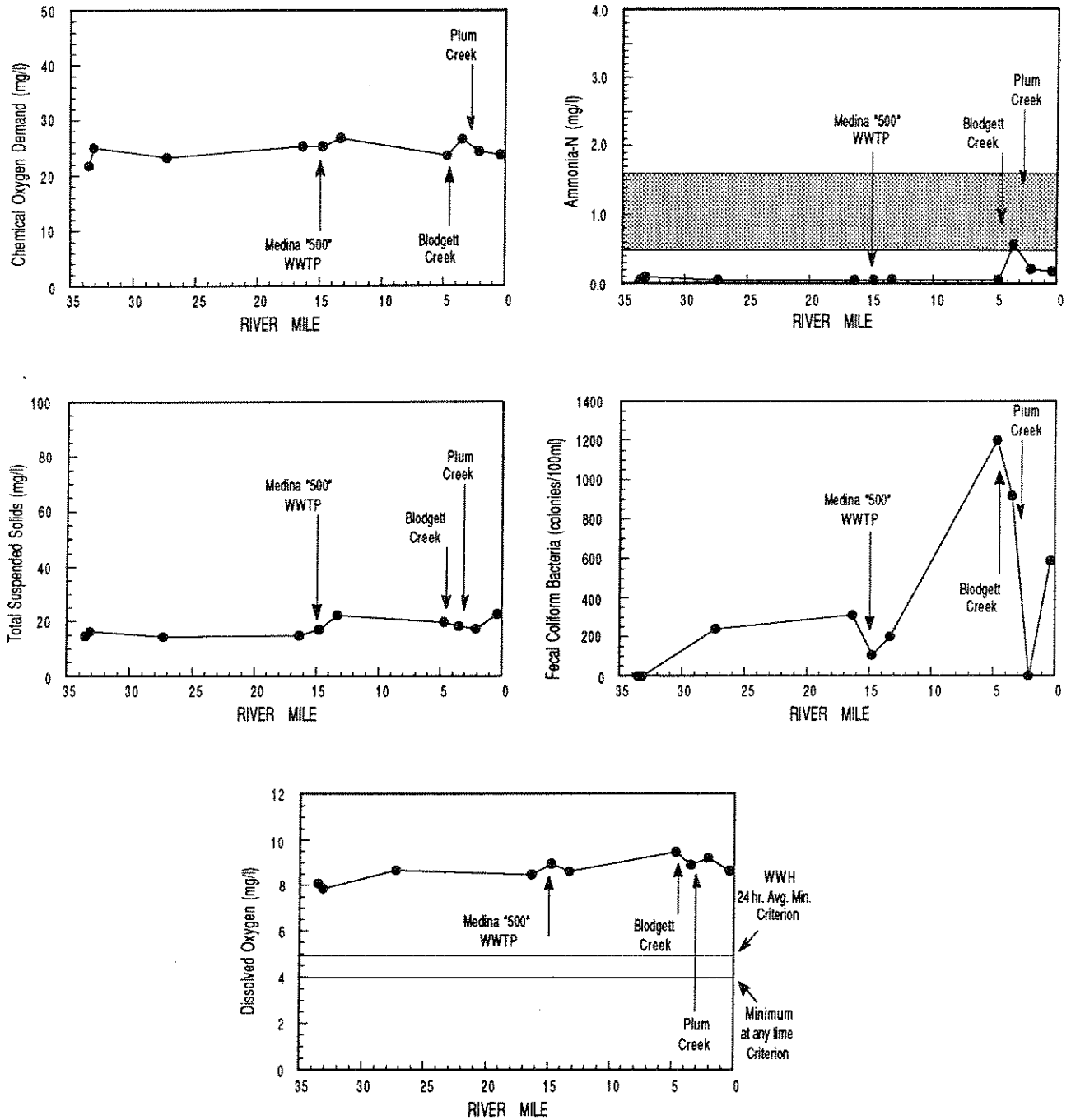

Figure 18. Longitudinal trend of mean chemical oxygen demand, ammonia-N, total suspended solids, fecal coliform bacteria, and dissolved oxygen in the West Branch Rocky River study area, 1992. Shaded area represents the ammonia-N criteria range between the 90th and 25th percentile pH and temperatures.

Physical Habitat for Aquatic Life

- Macrohabitats of the West Branch Rocky River were evaluated at nine fish sampling stations. QHEI values ranged from 81.0 (RM 4.8) to 58.0 (RM 2.1), with a mean reach value of 69.5. A mean QHEI value greater than 60.0 suggested that near and instream habitats of the West Branch Rocky River were of a sufficient quality to support and maintain biological communities capable of attaining the WWH biological criteria.

- Generally, warmwater habitat attributes were more frequently observed than moderate and high influence modified habitat attributes (Table 7). The upper reach of the West Branch Rocky River between RM 33.5 and RM 13.3 was composed of a higher frequency of moderate influence habitat attributes in comparison to the lower reaches; however, WWH attributes were predominant.

- The upper reach of the West Branch Rocky River between RM 33.5 and RM 13.3 was less predominated by native bedrock, and included a greater diversity of coarse substrate. Warmwater habitat attributes observed during the 1992 field sampling effort included little or no direct channel modification, good channel development, moderate/high functional sinuosity, mixed coarse substrates, and pools greater than 40 cm in depth. Moderate influence modified habitat attributes observed within the upper reach included moderate siltation, moderate embeddedness of coarse substrates, and a lack of diverse current velocity.

- The lower reach of the West Branch Rocky River between RM 4.8 and RM 0.4 exhibited an overwhelming predominance of WWH attributes, with moderate and high influence modified habitat attributes occurring at a very low frequency. One aspect of physical habitat that may have exerted a limiting effect upon the instream biota was the predominance of bedrock substrates; however, components of quality habitat were abundant, and overall habitat quality did not appear to inhibit biological community performance.

Biological Assessment: Macroinvertebrate Community

- The upper most sampling location on the West Branch yielded results that exceeded the criterion for an Exceptional Warmwater Habitat (EWH) aquatic life use. The ICI score was 54, and included among the organisms collected in the quantitative and/or the qualitative sample were numerous sensitive taxa including the stonefly species, *Acroneuria evoluta*, and the caddisfly genus, *Pycnopsyche* and six typically cool-water taxa (*e.g.*, *Diplectrona modesta*, a hydropsychid caddisfly, and the midge genera, *Trissopelopia* and *Micropsectra*). A decline of the ICI to 40 at RM 33.3 resulted from a lack of current over the artificial substrates rather than a problem with water quality downstream from the Montville Landfill. However, the community composition was changed; the number cool-water taxa was reduced as were the observed densities of riffle beetles and heptageniid mayflys. The reason for these changes was not entirely clear, although, the Montville Landfill Tributary was contributing a significant sediment load to the West Branch immediately upstream from the sampling site. Overall, the macroinvertebrate community was considered in good condition at RM 33.3.

- The effects of high flows experienced during the artificial substrate colonization period became evident at subsequent downstream sites. The artificial substrates were not found at RM 27.3 and had obviously been disturbed at RMs 17.2 and 13.1. However, quantitative samples from these latter two sites did provide useful results. All three sites supported relatively diverse and sensitive assemblages and ICI scores of 48 at both 17.2 and 13.1 exceeded the EWH criterion. Organism density was increased on the artificial substrates downstream from the Medina 500

WWTP, but overall sampling at RM 13.1 suggested only minor enrichment. The benthic assemblages were considered in very good to excellent condition at these three sites.

- Beginning at RM 4.7, the general condition of the macroinvertebrate communities at the four remaining sites on the West Branch was reduced compared to the upstream sampling locations. This decline was most readily apparent in the QCTV scores that averaged 38.4 at the five upper sites versus 35.4 at the four lower sites (Figure 19). By comparison, sites in the Erie-Ontario Lake Plain ecoregion that achieve the ICI biocriterion generally have QCTV scores that exceed 35.7 (the 25th percentile of the QCTV scores at these sites). Nutrient enrichment appeared to be the primary influence on the benthos throughout this lower reach. Sources of enrichment included an extensive impounded stream segment bordered by a golf course upstream from RM 4.7 and organic loads from Blodgett Creek and Plum Creek which join the West Branch at RMs 4.5 and 3.1, respectively. The macroinvertebrates collected at RMs 4.7, 3.5, and 2.1 were reflective of a marginally good condition. Sufficient improvement was seen at RM 0.4 to classify this site as having a good macroinvertebrate community.

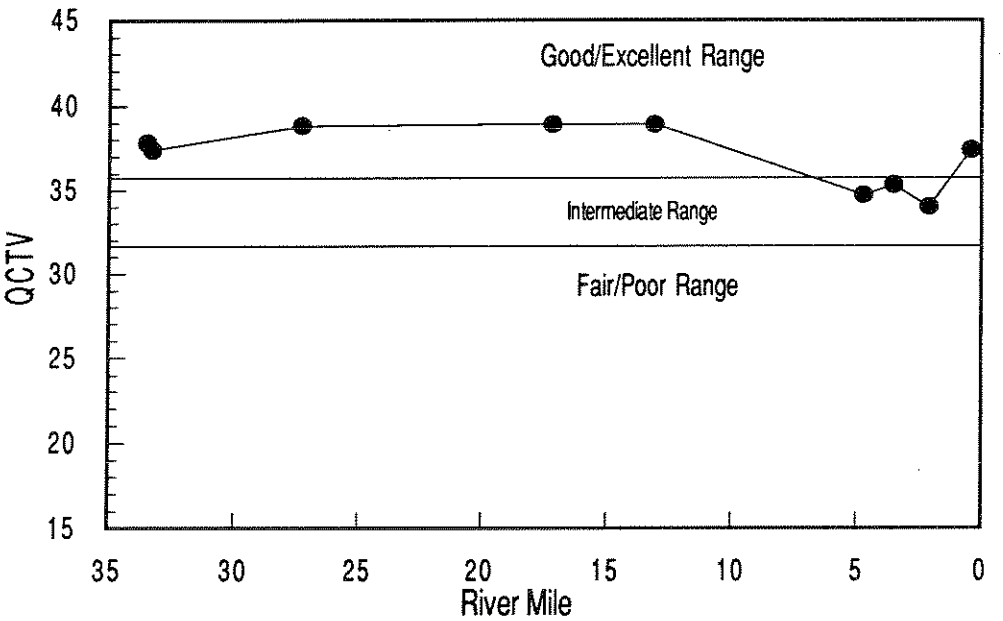

Figure 19. Longitudinal trend of the Qualitative Community Tolerance Value (QCTV) in the West Branch Rocky River, 1992.

Biological Assessment: Fish Community

- A total of 10,282 fish comprised of 32 species and two hybrids was collected from the West Branch Rocky River between August 12 and October 11, 1992. The sampling effort included a total of 53.3 Km at nine stations between RM 33.5 (downstream from SR 162) and RM 0.4 (upstream from Lewis Rd.).

- The numerically predominant fish species were: bluntnose minnow (18.7%), sand shiner (16.0%), creek chub (8.2%), stoneroller minnow (5.7%), johnny darter (5.7%), and greenside darter (5.6%). Species that predominated in terms of biomass were: white sucker (32.6%), northern hogsucker (19.4%), smallmouth bass (9.9%), creek chub (7.6%), and rockbass (3.9%). Species encountered within the West Branch Rocky River listed as threatened within the state of Ohio included the bigmouth shiner (Ohio DNR 1992). One bigmouth shiner was collected during the sampling effort.

- Both in terms of relative abundance and biomass, the community was predominated by tolerant and moderately intolerant omnivorous, insectivorous, and lithophilic species. Viewed in total, community samples indicated that the fish community of the West Branch Rocky River generally maintained structural and functional organization reflective of instream habitat and ecoregional expectation. Community indices and narrative evaluations ranged from very good (IBI=49) at RM 33.3 to fair (IBI=32; MIwb=6.7) at RM 2.1; overall performance was characterized as marginally good.

- The upper reach of the West Branch Rocky River between RM 35.5 and RM 33.3, supported a fish assemblage comparable in structure and function to ecoregional expectations, fully achieving the WWH biological criteria (Figure 20). No impact was evident downstream from the Montville Landfill. The reach between RM 27.3 and RM 17.2 supported fish assemblages that met or exceeded the WWH biological criteria and received a narrative evaluation of good. Fish assemblages in the upper reach of the West Branch Rocky River generally contained that possessed relatively high species richness with abundant lithophilic, insectivorous and sensitive species present.

- An impact was observed downstream from the Mediana 500 tributary at RM 13.3. In comparison to upstream sampling stations, community performance was reduced, receiving a narrative evaluation of good/fair (IBI=32; MIwb=8.0). Diminished performance of the IBI resulted in partial achievement of the WWH biological criteria. Shifts within the fish community were those typically associated with modest nutrient enrichment including a marked increase in the abundance of omnivorous and tolerant species. Recovery within the fish community downstream from the Mediana 500 WWTP was largely completed at RM 4.8. Community performance at this station received a narrative evaluation of marginally good/good and reflected full achievement of the WWH biological criteria (Figure 20).

- The lower reach of the West Branch Rocky River between RM 3.6 and RM 0.4 appeared to be impacted by Blodgett Creek (Versailles WWTP and Strongsville "A" WWTP), Plum Creek (Brentwood WWTP), and an unnamed tributary (Columbia trailer park WWTP) (Figure 20). The community response relative to these sources was not typical of nutrient enrichment. The IBI values reflected reduced species richness, particularly the loss of intolerant and moderately intolerant lithophilic forms. However, a predominance of tolerant and omnivorous species was not observed. Shifts within the fish community such as these suggested episodic or chronic toxicity, possibly due to excessive chlorine and/or ammonia-N discharges.

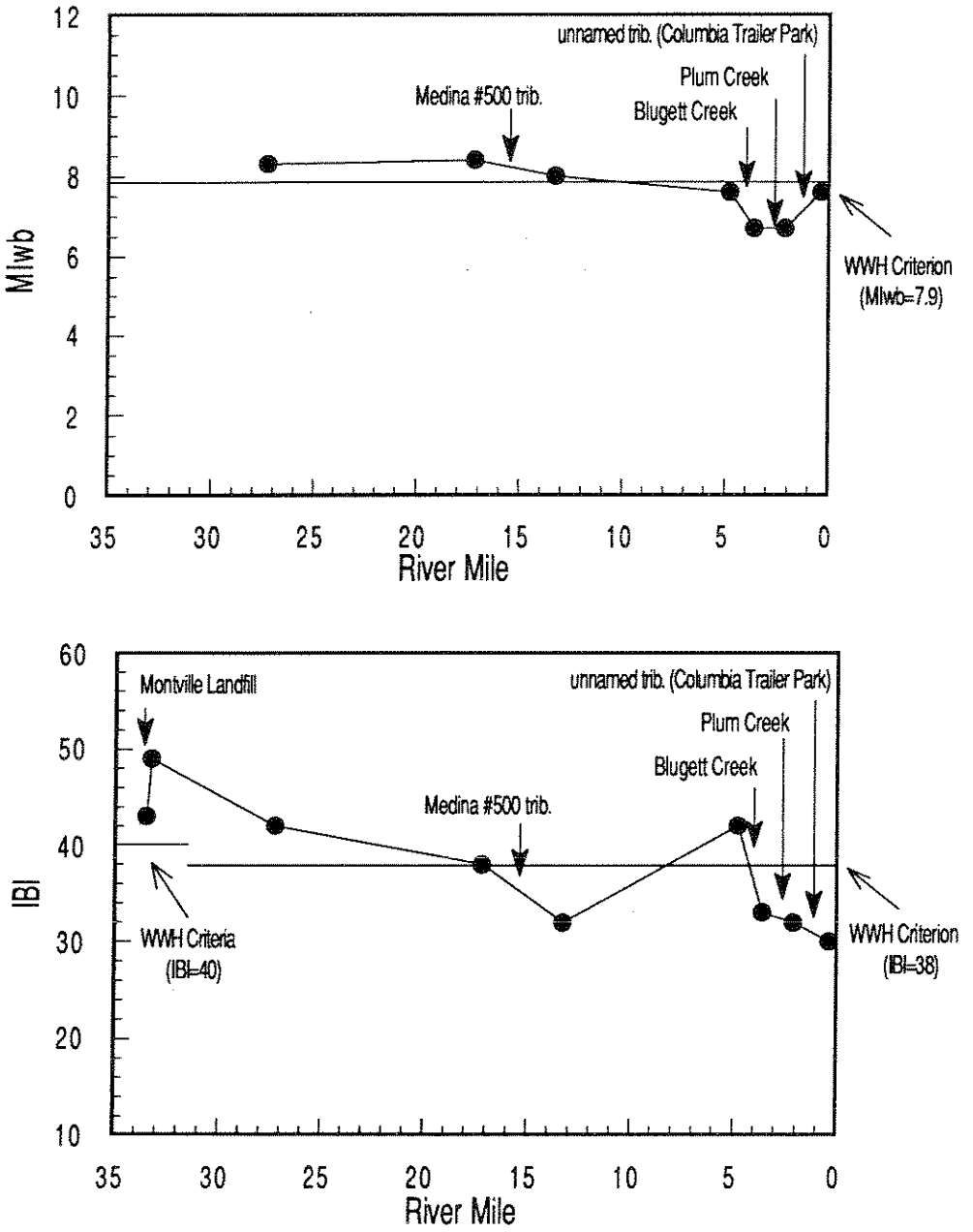

Figure 20. Longitudinal trend of the Modified Index of Well-Being (MIwb; upper) and the Index of Biotic Integrity (IBI; lower) in the West Branch Rocky River, 1992.

- The station immediately downstream from the confluence Blodgett Creek was in not achieving the WWH biological criteria; the fish community received a narrative evaluation of fair (IBI=33; MIwb=6.7). Community performance downstream from the confluence of Plum Creek (RM 2.1) also failed to achieve the WWH biological criteria and received a narrative evaluation of fair (IBI=32; MIwb=6.7). The most downstream sampling station within the West Branch Rocky River study area (RM 0.4) was in partial achievement of WWH biological criteria. The MIwb value suggested incomplete recovery at RM 0.4, however; IBI values continued to decline and most likely reflected the continued influence of upstream point sources.

Baldwin Creek

Pollutant Loadings: 1976 - 1992

North Royalton "B" WWTP

Treatment at this facility includes extended aeration and ammonia-N and phosphorus removal. Flows and ammonia-N and phosphorus loadings have decreased since 1981. This facility has been located in the headwaters of Baldwin Creek but changed the location of their discharge from another first order stream in 1986. Figure 21 depicts graphs of average flow and loading trends for ammonia-N, and phosphorus from the North Royalton "B" WWTP from 1981 to 1992.

Strongsville "C" WWTP

Treatment at this WWTP includes RBCs, tertiary treatment, and ammonia and phosphorus removal. Major decreases in ammonia-N loadings have occurred along with smaller reductions in TSS and $CBOD_5$ loadings since 1981. These reduced loadings have occurred despite increased flows and can be attributed to an upgrade at the WWTP. Figure 22 depicts graphs of average flow and loading trends for ammonia-N, $CBOD_5$, and TSS from the Strongsville "C" WWTP from 1981 to 1992.

Chemical Water Quality

- Exceedences of the PCR fecal coliform bacteria criterion in Baldwin Creek occurred in 2 of 3 samples at RM 1.4 and 3.0.

- Baldwin Creek sampling showed classic responses of stream water quality to WWTP discharges. These responses included lowered D.O. and higher ammonia-N and nutrients immediately downstream from the discharge followed by increasing D.O. and decreasing nutrients and ammonia-N further downstream from the discharge. Failing septic systems were also observed discharging into Baldwin Creek from RM 3.0 to near the mouth. These failing systems could have contributed to the reduced oxygen content and higher ammonia-N and nutrients in this portion of the creek. Figure 23 depicts graphs of phosphorus, dissolved oxygen (D.O.), and ammonia-N in Baldwin Creek from river mile 7.4 to 1.4.

Physical Habitat for Aquatic Life

- Macrohabitats of Baldwin Creek were evaluated at five fish sampling stations. The QHEI values ranged between 82.0 (RM 5.8) and 43.5 (RM 3.0), with a mean reach QHEI value of 61.4. A mean QHEI value greater than 60 suggested that near and instream macrohabitats of Baldwin Creek are of a sufficient quality to support and maintain biological communities capable of attaining the WWH biological criteria.

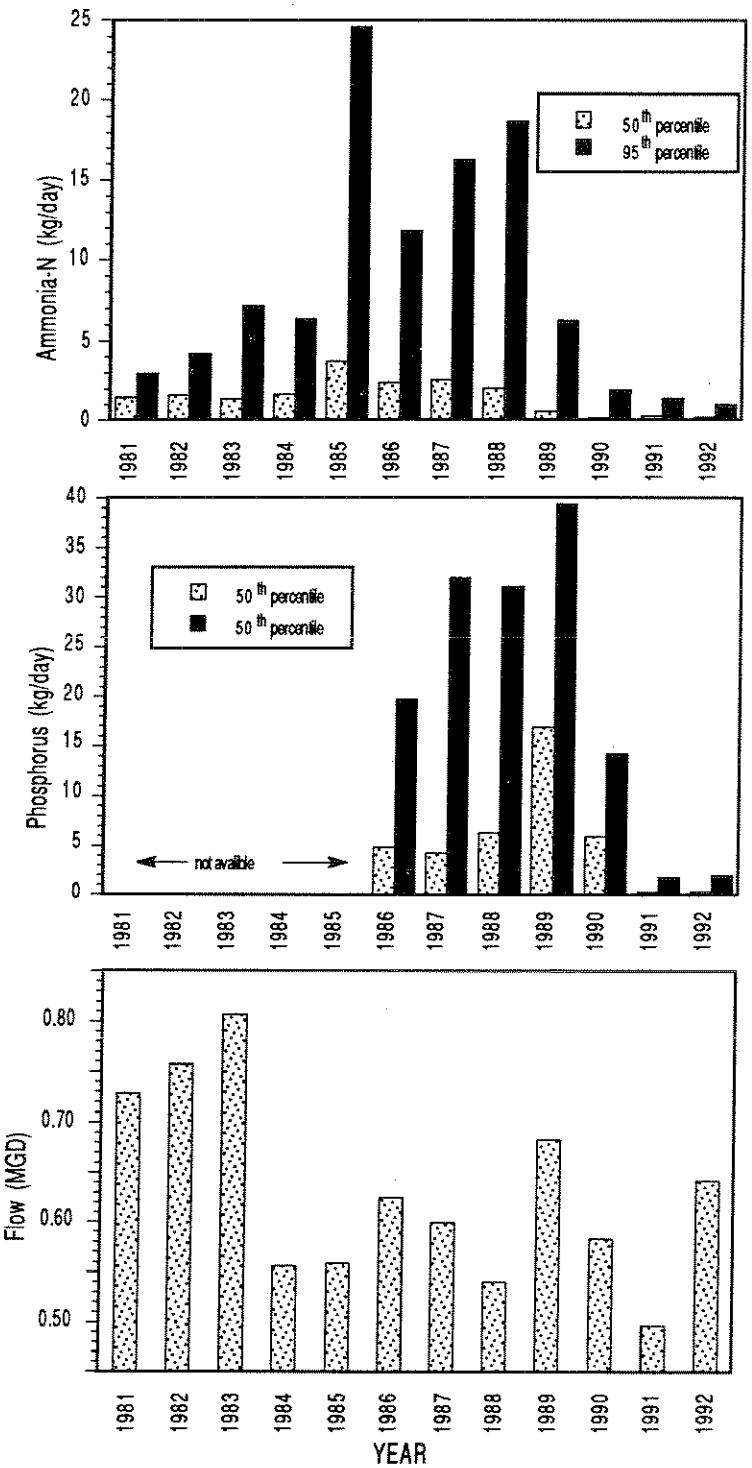

Figure 21. Average flow (MGD) and annual loadings (kg/day) of ammonia-N, phosphorus and from the North Royalton "B" WWTP to Baldwin Creek, 1981-1992.

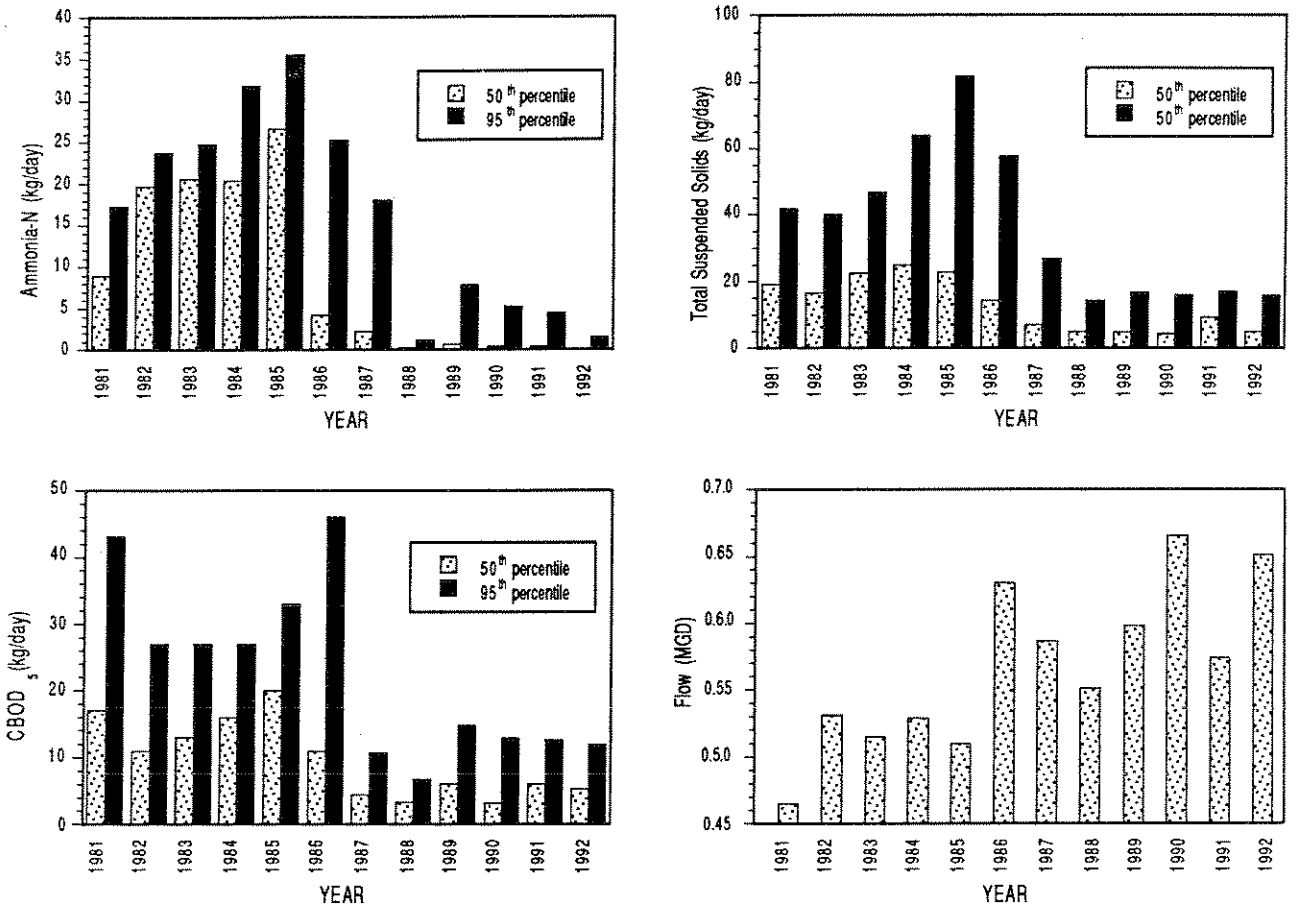

Figure 22. Average flow (MGD) and annual loadings (kg/day) of ammonia-N, total suspended solids, $CBOD_5$ from the Strongsville "C" WWTP to Baldwin Creek, 1981-1992. $CBOD_5$ loadings for 1981-1984 are calculated based on reported biochemical oxygen demand (BOD_5) values.

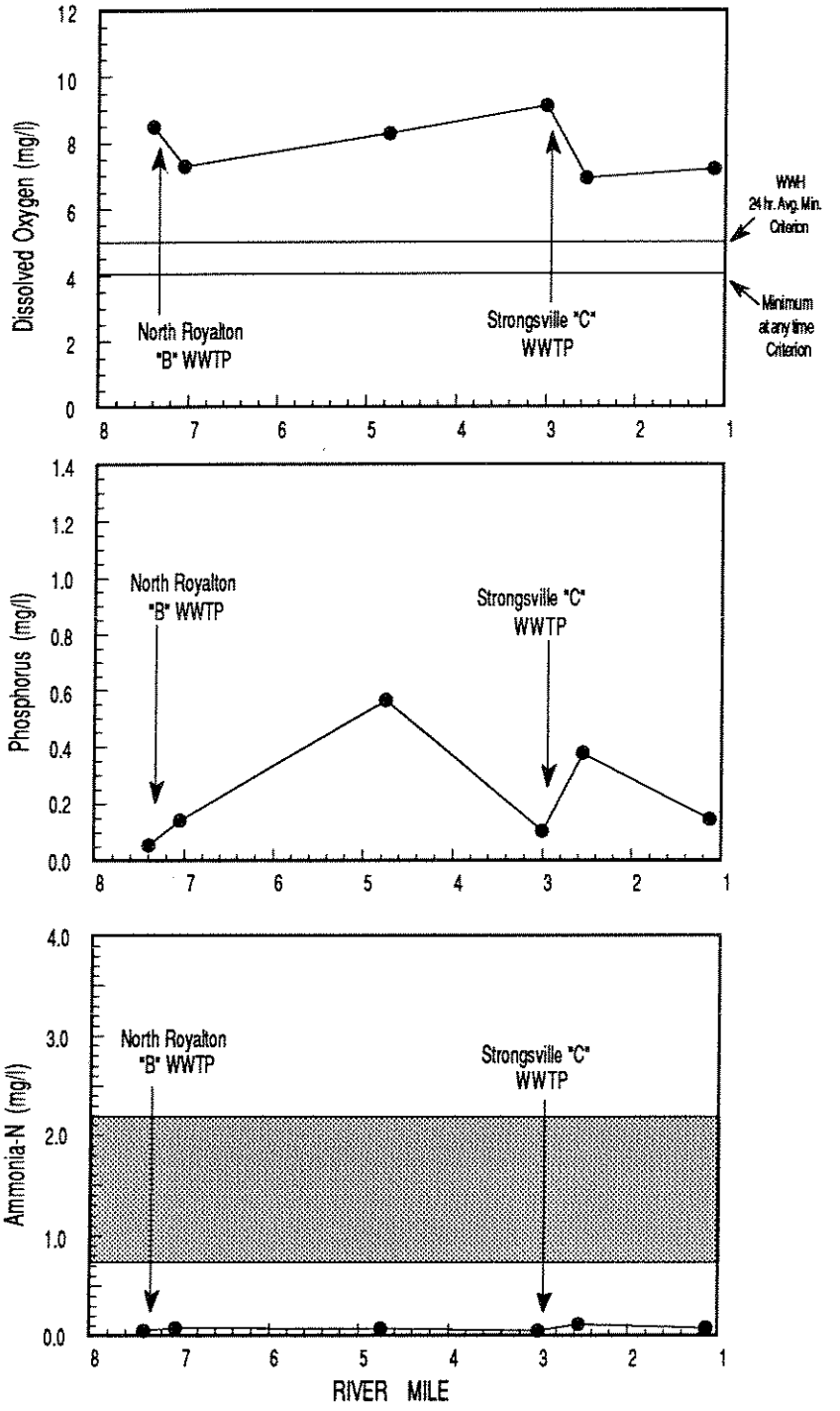

Figure 23. Longitudinal trend of mean D.O., phosphorus and ammonia-N in Baldwin Creek, 1992. Shaded area represents the range of ammonia WQS criteria between the 90th and 25th percentile pH and temperatures.

- Generally, warmwater habitat attributes occurred at a greater frequency than did moderate and high influence modified attributes (Table 7). Warmwater habitat attributes observed during the field sampling efforts included coarse native and glacial substrates, moderate functional sinuosity, and pools greater than 40 cm in depth. Moderate and high influence modified habitat attributes included past channel modification, fair channel development, and moderate embeddness of coarse substrates (Table 7).

- The sampling station at RM 3.0 exhibited the poorest habitats within Baldwin Creek, achieving a QHEI value of 43.5. The primary factors contributing to the low QHEI value were a predominance of shifting, unstable fragmented shale substrates, relatively monotonous channel development, and a narrow or nonexistent wooded riparian corridor.

Biological Assessment: Macroinvertebrate Community

- Baldwin Creek at RM 7.5 was little more than an urban drainage ditch that likely was subjected to severe scouring during high flows. The stream was culverted immediately downstream from RM 7.5 to near RM 7.3, where the North Royalton "B" WWTP discharge enters. The macroinvertebrate community at RM 7.5 appeared to be moderately impacted by a combination of polluted urban runoff and instability associated with scouring. Qualitative sampling yielded 32 primarily pollution tolerant and ubiquitous taxa. Based on a narrative evaluation the macroinvertebrate community was considered in marginally good condition.

- Downstream from the North Royalton "B" WWTP (RM 7.0) treated effluent comprised the great majority of flow in Baldwin Creek under low flow conditions. Quantitative sampling produced an ICI score in the fair range (Figure 24). The total number of organisms on the artificial substrates was relatively low and suggested a chronic toxic impact. Further downstream, the WWH criterion was exceeded at RM 5.8 (ICI=36); however, attainment seemed to be rather tenuous based on the results of the qualitative sample. A predominance of blackflies of the genus *Simulium* observed in riffles at this site suggested that nutrient levels were significantly elevated. Large numbers of blackflies typically occur in Ohio streams when elevated nutrients and fine particulate organic matter are present.

- Blackflies were not one of the predominant taxa collected from the natural substrates upstream from the Strongsville "C" WWTP (RM 3.0) and the ICI score of 32 marginally attained the WWH criterion. These results suggested a decreased enrichment impact from the North Royalton "B" WWTP. Downstream from the Strongsville "C" WWTP (RM 2.6) the macroinvertebrates again marginally attained the criterion (ICI=30), however, increased enrichment was evidenced by greater total organism density on the artificial substrates and the recurrence of relatively high numbers of blackflies. Macroinvertebrate communities at both sites were probably somewhat negatively affected by an unconsolidated shale substrate.

- Habitat conditions and the macroinvertebrate community were improved at RM 1.4. This site supported a relatively good macroinvertebrate fauna (ICI=40) that reflected an assimilation of the introduced organic load from upstream sources. The macroinvertebrate community appeared to be performing as well as could be expected given the extensively urban land use and effluent dominated nature of the watershed.

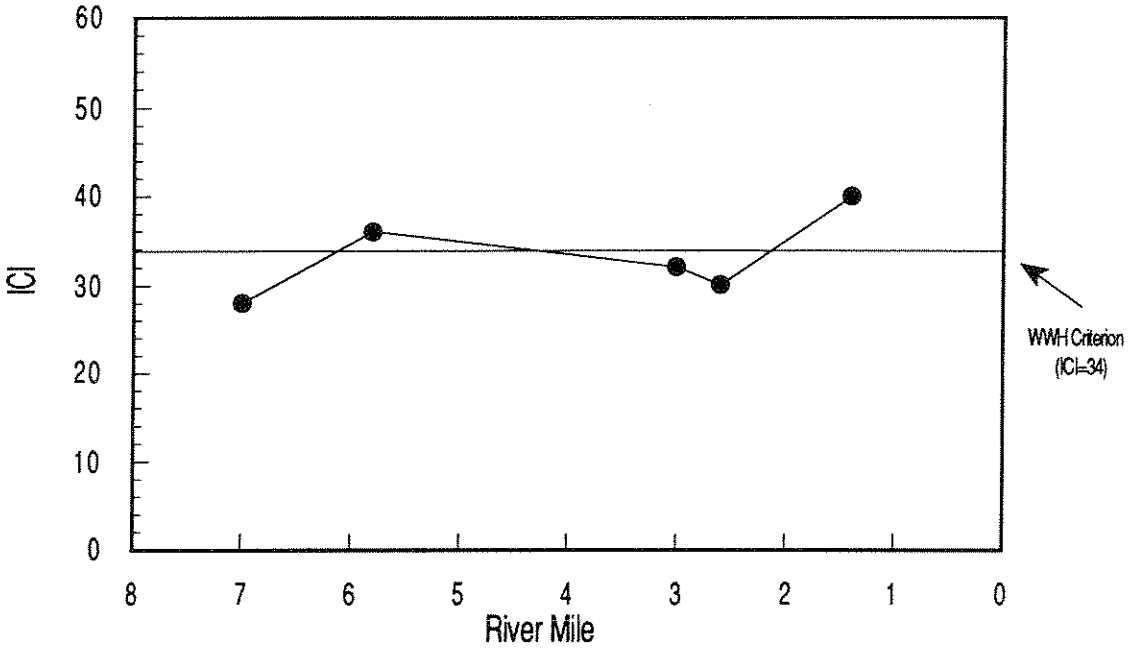

Figure 24. Longitudinal trend of the Invertebrate Community Index (ICI) in Baldwin Creek, 1992.

Biological Assessment: Fish Community

- A total of 6,944 fish comprised of 16 species and two hybrids was collected from Baldwin Creek between July 21 and September 22, 1992. The sampling effort included a total of 9.7 Km at five sampling locations between RM 7.4 (upstream from the North Royalton WWTP) and RM 1.4 (adjacent to Eastland Rd.).

- The numerically predominant fish species were: creek chub (31.8%), white sucker (21.4%), bluntnose minnow (17.3%), central stoneroller (12.7%), bigmouth shiner (9.9%), and green sunfish (4.3%). Species that predominated in terms of biomass were: white sucker (66.7%), creek chub (22.8%), central stoneroller (3.8%), bluntnose minnow (3.3%), green sunfish (1.1%), and bigmouth shiner (1.1%). Species encountered within Baldwin Creek listed as threatened within the state of Ohio included the bigmouth shiner (Ohio DNR 1992). A total of 687 bigmouth shiners were collected during the field sampling effort.

- In terms of relative abundance and biomass, pollution tolerant and omnivorous species predominated within the fish community. Species richness was diminished, species within specialized feeding and breeding guilds (insectivorous and lithophils) were in low abundance or absent, and pollution sensitive species were lacking. Community indices and narrative evaluations ranged between fair (upstream from the North Royalton "B" WWTP) and very poor (downstream from the North Royalton "B" WWTP). Based upon IBI values, overall community performance was characterized as poor. Achievement of WWH biological criteria was not observed at any sampling station within the Baldwin Creek study area (Figure 25).

- Community performance at the most upstream sampling station (RM 7.4) was characterized as fair (IBI=31). Downstream from the North Royalton "B" WWTP, community performance declined to very poor (IBI=17). In comparison with the sampling station upstream, the fish assemblage was dominated by pollution tolerant and omnivorous species. Additional evidence of chronic stress within the community was a significant increase in the incidence of DELT anomalies (2.8%).

- Modest recovery within the community was observed at RM 3.0 (upstream from the Strongsville "C" WWTP), but performance remained within the poor range (IBI=17). The remaining sampling stations (RM 2.6 and RM 1.4) reflected an impact downstream from the Strongsville "C" WWTP. Community performance within this reach remained within the poor range and no recovery was observed.

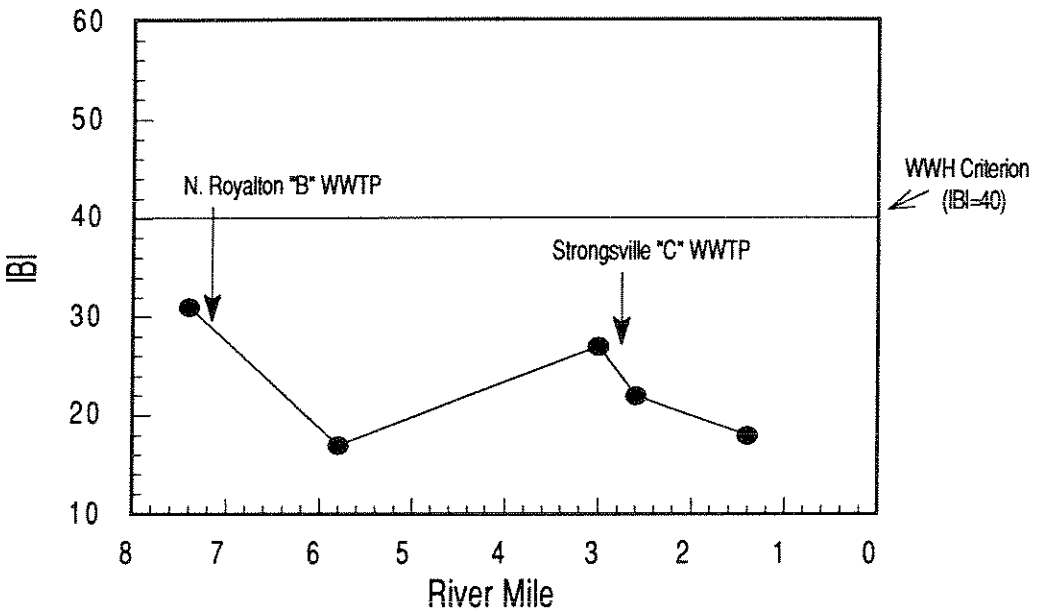

Figure 25. Longitudinal trend of the Index of Biotic Integrity (IBI) in Baldwin Creek, 1992.

North Branch Rocky River

Chemical Water Quality

- Water quality in the North Branch of the West Branch of the Rocky River was very good. There were no exceedences of the chronic or acute water quality criteria.

Sediment Chemistry

- Heavy metal concentrations in the North Branch Rocky River at RM 5.5 were all in the non-elevated range using the Kelly and Hite criteria (Table 6).

Physical Habitat for Aquatic Life

- Macrohabitats of the North Branch Rocky River were evaluated at one fish sampling station (RM 5.5) which achieved a QHEI score of 73.5. A QHEI value greater than 60 suggests that near and instream habitats of the North Branch Rocky River were of sufficient quality to support and maintain biological communities capable of achieving the WWH biological criteria (Rankin 1989).

- This station exhibited a high percentage of warmwater habitat attributes. Components of quality habitat observed during the field sampling effort included little or no direct channel modification, mixed coarse substrates of native and glacial origin, good/fair channel development, moderate functional sinuosity, and pools greater than 70 cm in depth.

Biological Assessment: Macroinvertebrate Community

- The macroinvertebrate community at RM 5.5 on the North Branch Rocky River was considered to be in exceptional condition. The artificial substrates yielded an ICI score of 50, exceeding the EWH criterion and were predominated by the midges of the *Rheotanytarsus exiguus* group. This midge species group is one of the more pollution sensitive of filter-feeding taxa found commonly in Ohio. The natural substrates also yielded a relatively pollution sensitive assemblage as evidenced by the QCTV score of 39.1.

Biological Assessment: Fish Community

- One sampling station was located on the North Branch Rocky River at RM 5.5. A total of 838 fish comprised of 26 species was collected during the 1992 sampling effort. The numerically predominant fish species were: striped shiner (12.8%), rainbow darter (11.1%), creek chub (10.4%), northern hog sucker (19.2%), central stoneroller (8.7%), and bluntnose minnow (7.3%). Species that predominated in terms of biomass were: white sucker (32.2%), common carp (24.2), northern hog sucker (18.5%), creek chub (7.7%), striped shiner (5.2%), and rockbass (2.7%). In terms of relative abundance, the community was predominated by insectivorous and lithophilic species.

- Community performance at this station was characterized as very good and fully achieved the WWH biological criteria. Relatively high species richness, abundant lithophilic and insectivorous species, and the presence of intolerant species were reflected the good instream habitat and water quality conditions.

North Royalton "A" Tributary

Pollutant Loads: 1976-1992

North Royalton "A" WWTP

This WWTP is an extended aeration plant with phosphorus and ammonia-N removal. Flows have steadily increased since 1981 while most conventional pollutant loadings have remained

constant or declined. Because of upgrades, ammonia and phosphorus loadings have decreased despite the increased flows. The facility discharge creates exceedences of the total residual chlorine criteria in the unnamed tributary to the East Branch. Loadings of heavy metals appeared to be increasing. However, since many reported values were at or near method detection limits (MDLs), the increases may just be a statistical aberration created by MDLs and reporting methods. The city has requested an expansion from 1.5 to 3.3 MGD. Figure 26 depicts graphs of average flow and loading trends for ammonia-N, and phosphorus from the North Royalton "A" WWTP from 1981 to 1992.

Chemical Water Quality

- Water quality criteria were exceeded for chlorine on every sampling date. There were no other exceedences of either chronic or acute water quality criteria.
- The North Royalton "A" tributary created a slight dissolved oxygen depression in the East Branch Rocky River downstream from its confluence.

Physical Habitat for Aquatic Life

- Macrohabitats of the North Royalton "A" tributary were evaluated at two fish sampling stations. Qualitative Habitat Evaluation Index (QHEI) values from the North Royalton "A" tributary ranged from 44.5 at RM 0.6 to 70.5 at RM 0.2, with a mean reach score of 57.5. A mean reach QHEI value approaching 60 suggests that instream habitats of North Royalton "A" tributary were generally of sufficient quality to support a biological community that attained the WWH biological criteria (Rankin 1989).

- The quality of physical habitat at RM 0.6 was less than optimal (QHEI=44.5) and exhibited a high percentage of modified habitat attributes (Table 7). High and moderate influence modified habitat attributes observed during the field sampling efforts included low functional sinuosity, fair/poor channel development, sparse instream cover, and pools less than 40 cm in depth. The quality of physical habitat was significantly improved at RM 0.2 (downstream WWTP) and achieved a QHEI score of 70.5. This station exhibited a predominance of warmwater habitat attributes that included moderate/high functional sinuosity, abundant instream cover, relatively clean coarse substrate, and pools greater than 40 cm in depth.

Biological Assessment: Macroinvertebrate Community

- A severe impact due to polluted runoff from the surrounding urban area masked any direct effects attributable to the North Royalton "A" WWTP. Qualitative sampling produced 20 taxa at RM 0.6 and 15 taxa at RM 0.2, upstream and downstream from the North Royalton "A" WWTP, respectively. Both sites were predominated by pollution tolerant midge taxa and total organism density was considered low. The macroinvertebrate communities were in poor condition and the sampling results suggested that toxicity may be involved and limiting the establishment of a more diverse benthic fauna.

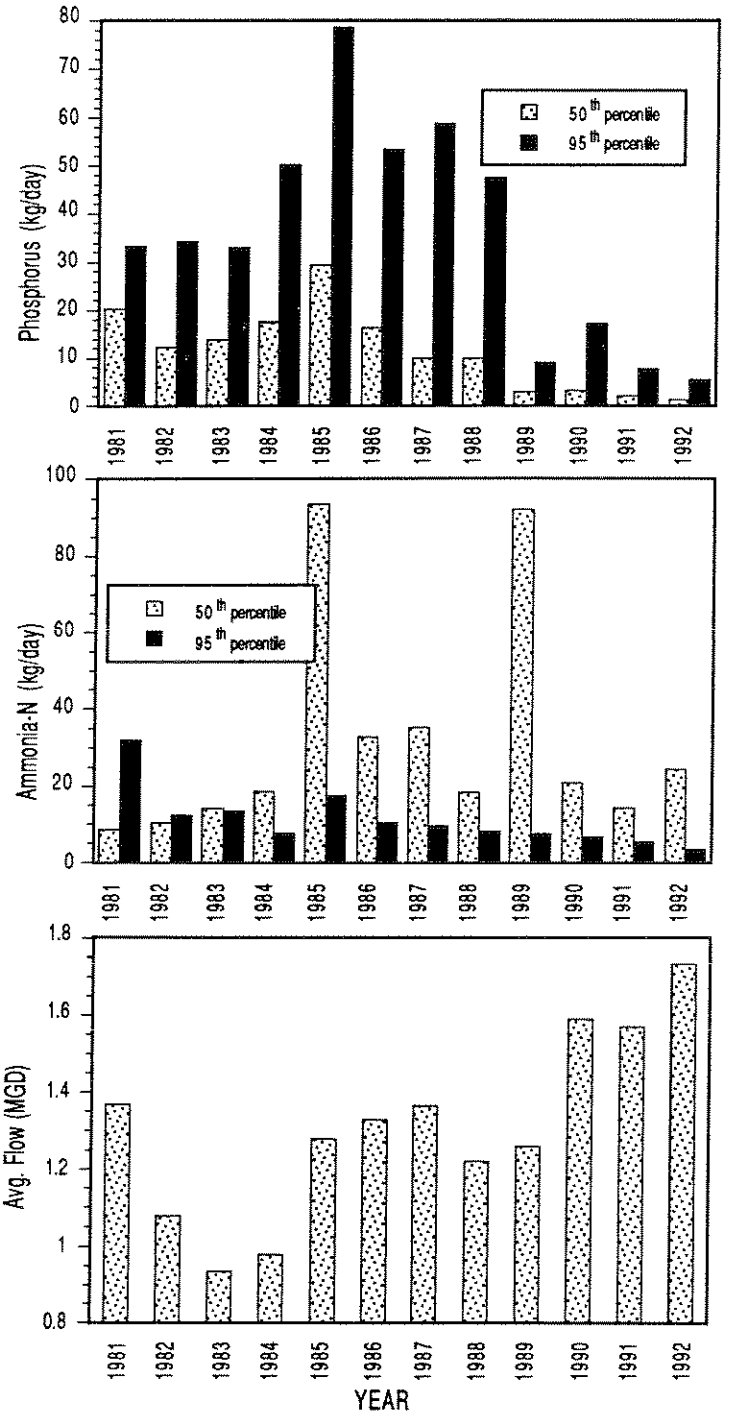

Figure 26. Averge flow (MGD) and annual loadings (kg/day) of phosphorus and ammonia-N, from the North Royalton "A" WWTP to the North Royalton "A" WWTP tributary, 1981 to 1992.

Biological Assessment: Fish Community

- A total 1,691 fish comprised of eight species was collected from the North Royalton "A" tributary between August 24 and September 22, 1992. The sampling effort included two sampling stations located at RM 0.6 (upstream from the North Royalton "A" WWTP) and RM 0.2 (downstream from the North Royalton "A" WWTP)

- The community performance at RM 0.6 was characterized as fair (IBI=35) and failed to achieve the WWH biological criteria. An abundance of pollution tolerant species, low species richness and the absence of intolerant taxa appeared to reflect an impact from urban nonpoint sources upstream. Physical habitat at RM 0.6 may have exerted some negative influence upon the biological community; nevertheless, the extent of degradation suggested perturbations to water quality from upstream urban sources.

- The fish community at RM 0.2 consisted entirely of pollution tolerant forms and species richness was greatly reduced in comparison to the sampling station upstream. Nearly every component of the fish community (structural and functional) was significantly diminished, despite marked improvement of physical habitat at this station. The poor performance of the community downstream from the North Royalton "A" WWTP (IBI=20) most likely reflected the combined influences of urban polluted runoff and WWTP discharge.

Plum Creek

Chemical Water Quality

- The Primary and Secondary Contact Recreation fecal coliform bacteria recreation criteria were exceeded in the single sample from Plum Creek. Elevated bacteria levels are a concern in that a series of falls and rapids near the confluence with the West Branch is used by area residents as an undeveloped swimming and water recreation area. Additionally, an exceedence of the dissolved oxygen WWH chronic criteria was recorded in one of four samplings.

- It appears the Plum Creek water quality has improved since the 1981 survey, but it is still impacted by three small WWTP discharges located upstream. Plum Creek did not greatly affect water quality of the West Branch.

Physical Habitat for Aquatic Life

- Macrohabitats of Plum Creek were evaluated at one fish sampling station (RM 0.3), where a QHEI score of 43.5 was scored. A QHEI value below 60 suggests that near and instream habitats of Plum Creek may adversely affect biological community performance. This station exhibited a predominance of moderate and high influence modified habitat attributes, with warmwater habitat attributes occurring at a low frequency. Components of physical habitat contributing to the low QHEI value included recent modification to the physical channel, low functional sinuosity, sparse instream cover, fair to poor channel development, and high/moderate embeddedness of coarse substrates (Table 7).

- Although the habitat quality at RM 0.3 appeared to the poorest observed within the entire Rocky River study area, this sample only represented one station. The QHEI requires interpretation on a reach or segment basis to define general habitat quality. Based on the data collected at this station, the lack of quality habitat may contribute to reduced biological community performance.

Biological Assessment: Macroinvertebrate Community

- The benthic assemblage at RM 0.3 was indicative of highly enriched water quality. Tolerant and ubiquitous midge taxa were predominant and present in high numbers. Filter feeding blackflies and caddisflies were common. Although specific sources could not be identified by this single sample, it was obvious that upstream WWTP discharges and the unsewered area in Olmsted Falls were having a significant negative effect on the macroinvertebrate community at RM 0.3.

Biological Assessment: Fish Community

- A total of 810 fish comprised of 10 species and one hybrid was collected at RM 0.3 during the 1992 sampling effort.

- The numerically predominant fish species were: white sucker (91.4%), green sunfish (4.0%), creek chub (3.1%), yellow bullhead (0.4%), and fathead minnow (0.4%). Species that predominated in terms of biomass were: white sucker (90.9%), creek chub (6.1%), bluegill sunfish (1.9%), and green sunfish (0.7%). The fish assemblage at this station, in terms of relative abundance and biomass, was dominated by pollution tolerant, feeding and/or habitat generalists, and omnivorous species. Species richness was greatly diminished and species intolerant of environmental disturbances were absent.

- The fish community at this station performed at a poor level (IBI=18)and failed to achieve the WWH biological criterion. Less than optimal habitat quality (QHEI=43.2) may have contributed to the poor performance within the fish community, but did not appear to be the sole cause of nonachievement. The composition of the fish community was typical of that associated with gross organic enrichment.

Baker Creek

Chemical Water Quality

- Baker Creek was evaluated to assess the impact from nonpoint source pollution. Baker Creek contained detectable concentrations of ammonia and an exceedence of the primary contact recreation criterion for fecal coliform bacteria was recorded. Likely sources of the ammonia-N and bacteria are septic systems.

Physical Habitat for Aquatic Life

- Macrohabitats of Baker Creek were evaluated at one fish sampling station (RM 0.5), where a QHEI value of 68.5 was scored. A QHEI value greater than 60 suggests that near and instream habitats at this station are of a sufficient quality to support and maintain biological communities capable of attaining the WWH biological criteria (Rankin 1989).

- Occurrences of modified and warmwater habitat attributes were equal and indicated less than optimal habitat even though a QHEI score greater than 60 was recorded. Warmwater attributes included mixed coarse substrates of glacial origin, good/fair channel development, moderate functional sinuosity, and pools greater than 40 cm in depth (Table 7). Moderate influence modified habitat attributes observed included moderate siltation, extensive/moderate embeddedness of coarse substrates, and a lack of swift current.

- The QHEI requires interpretation on a reach or segment basis to measure overall habitat quality. Though modified habitat attributes did occur at a high frequency, warmwater attributes were of

sufficient quality that a QHEI value above 60 was scored. Based on available data, Baker Creek appears have available habitat capable of supporting warmwater biological community.

Biological Assessment: Macroinvertebrate Community

- Qualitative sampling produced 26 taxa with pollution tolerant midges of the genus *Cricotopus* predominating. Overall organism density was moderate and a total of three mayfly and caddisfly taxa were collected. The macroinvertebrate community reflected of significant organic degradation and was considered in fair condition.

Biological Assessment: Fish Community

- A total of 974 fish comprised of 17 species and two hybrids was collected during the 1992 sampling effort in Baker Creek at RM 0.5.

- The numerically predominant fish species were: bluntnose minnow (24.9%), sand shiner (18.8%), central stoneroller (10.7%), striped shiner (8.7%), silverjaw minnow (6.4%), and bluegill sunfish (4.1%). Species that predominated in terms of biomass were: white sucker (23.8%), striped shiner (16.4%), northern hog sucker (15.7%), bluntnose minnow (9.5%), creek chub (7.9%), and central stoneroller (6.7%). Both in terms of relative abundance and biomass, the fish community was predominated by tolerant and moderately intolerant lithophilic and insectivorous species.

- Though tolerant species were a substantial component of the fish assemblage, the community maintained minimal functional organization reflecting ecoregional expectations and the presence of adequate instream habitat. Community performance at this station was characterized as marginally good (IBI=37) and achieved the WWH biological criteria.

Blodgett Creek

Pollutant Loads: 1976-1992

Strongsville "A" WWTP

Flows have steadily increased while TSS, phosphorus and BOD loads have remained the same. Ammonia-N loadings have increased and resulted in violations in Blodgett Creek. This facility is expected to be tied into the Southwest Interceptor in 1994. Figure 25 depicts graphs of average flow and loading trends for ammonia-N, $CBOD_5$, phosphorus and total suspended solids from the Strongsville "A" WWTP from 1981 to 1992.

Chemical Water Quality

- An exceedence of the PCR fecal coliform bacteria criterion in Blodgett Creek was recorded in one sample collected. The coliform count also exceeded the Secondary Contact Recreation criterion.

- Exceedences of the WWH chronic criteria ammonia-N occurred in 3 of 3 samples collected.

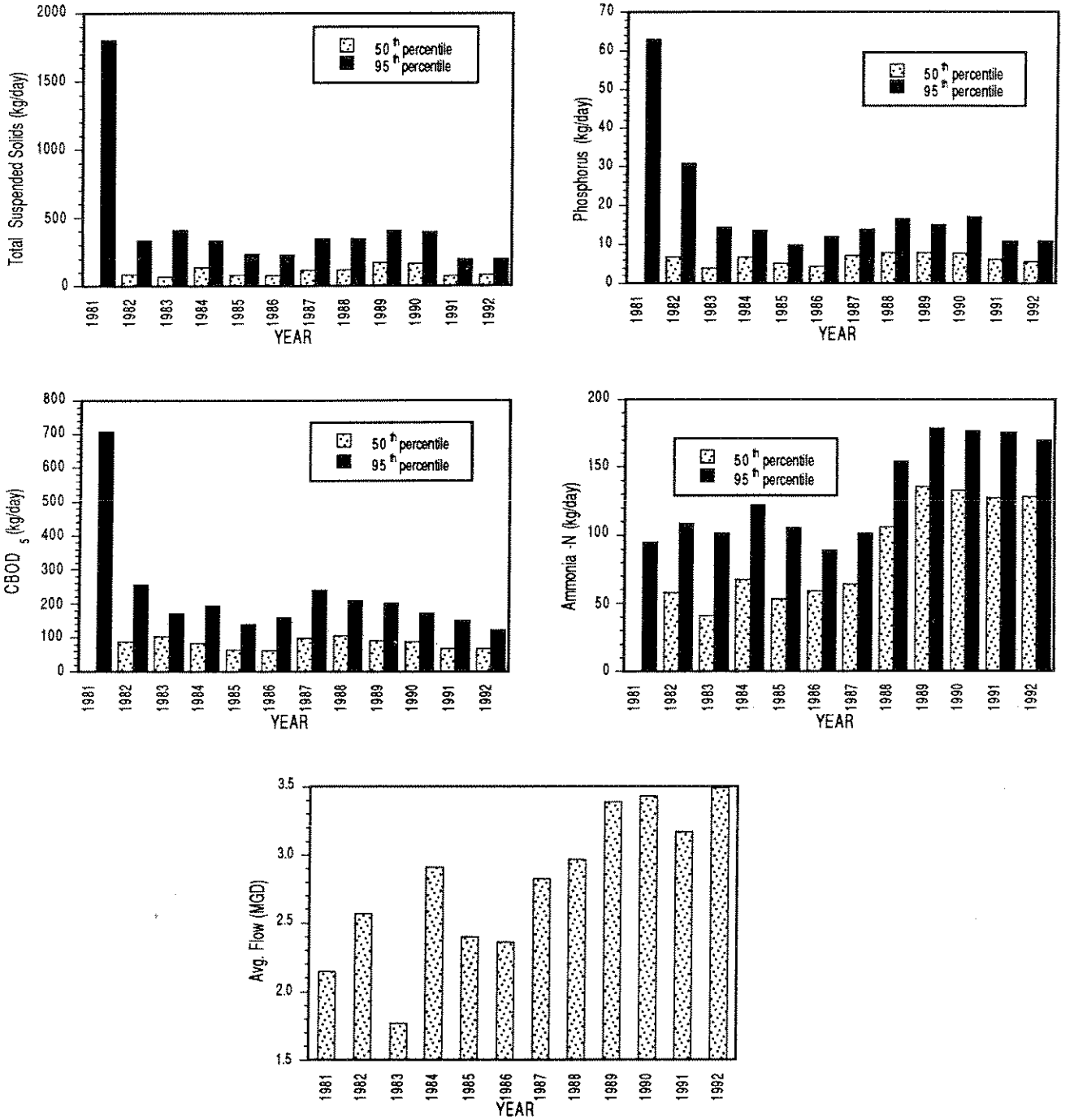

Figure 27. Average flow (MGD) and annual loadings (kg/day) of phosphorus, ammonia-N, $CBOD_5$ and total suspended solids from the Strongsville "A" WWTP to Blodgett Creek, 1981 to 1992. $CBOD_5$ loadings for 1981-1984 are calculated based on reported biochemical oxygen demand (BOD_5) values.

- Blodgett Creek water quality was severely degraded by the discharges from the Versailles WWTP and Strongsville "A" WWTP. The stream had a strong sewage odor on all days sampled and a citizen reported a fish kill on Blodgett Creek upstream from the Strongsville "A" WWTP. Personnel from the Ohio EPA and the City of Strongsville were able to trace the source to a tank truck parked at a commercial facility that was leaking solvents into a storm sewer. The discharge was stopped and Ohio EPA staff followed up with an inspection and suggestions for better management of the facility's stormwater.

Physical Habitat for Aquatic Life

- Macrohabitats of Blodgett Creek were evaluated at one fish sampling station (RM 0.1), where a QHEI of 63.5 was scored. A QHEI value greater than 60 suggests that near and instream habitats of the Blodgett Creek were of a sufficient quality to support and maintain a biological communities capable of attaining the WWH biological criteria.

- This station exhibited a predominance of warmwater habitat attributes. Components of quality habitat observed at this station included no direct channel modification, good channel development, and moderate functional sinuosity. Two aspects of physical habitat that may have somewhat limited community performance were the predominance of bedrock substrates and sparse instream cover.

Biological Assessment: Macroinvertebrate Community

- During low flow conditions flow in Blodgett Creek appeared to be comprised entirely of WWTP effluent. The macroinvertebrate community was in poor condition. Fifteen taxa were collected and tolerant midges predominated. It was readily apparent that considerable improvement in effluent quality at the Strongsville "A" WWTP and the Versailles WWTP would be required to affect any significant change in the macroinvertebrate community at this site. It appeared likely that a significant nutrient load is being contributed to the West Branch Rocky River via this tributary.

Biological Assessment: Fish Community

- A total of 1,008 fish comprised 13 species was collected during the 1992 field sampling efforts at RM 0.1 downstream from the Strongsville "A" WWTP and Versailles WWTP.

- The numerically predominant fish species were: central stoneroller (78.1%), creek chub (15.3%), white sucker (1.7%), sand shiner (1.4%), bluegill sunfish (1.0%). Species that predominated in terms of biomass were: central stone roller (51.0%), creek chub (36.6%), white sucker (7.0%), and bluegill sunfish (1.5%). Both in terms of biomass and relative abundance,the fish assemblage was characterized by a very high percentage of herbivorous, omnivorous, and pollution tolerant species; this suggested nutrient enrichment from upstream sources. However, the community at this station nearly achieved the WWH biocriterion (IBI=38).

Mallet Creek

Chemical Water Quality

- Only one very small point source (Buckeye High School) is known to discharge to Mallet Creek at RM 2.35.

- No demonstrable nonpoint water quality problems were detected in Mallet Creek during dry weather flows; samples were not collected during storm events.

Physical Habitat for Aquatic Life

- Macrohabitats of Mallet Creek were evaluated at one fish sampling station (RM 0.7) which achieved a QHEI score of 68.5. A QHEI value greater than 60 suggests that near and instream habitats at this station were of sufficient quality to support and maintain biological communities capable of attaining the WWH biological criteria (Rankin 1989).

- This station exhibited a high percentage of warmwater habitat attributes with moderate and high influence modified habitat attributes absent. Quality habitat attributes observed during sampling efforts included coarse substrates, good channel development, and pools greater than 70 cm in depth (Table 7). The only limiting aspect of the instream habitat observed was a predominance of shale bedrock substrates. However, channel heterogeneity at this station was maintained to some extant by developed rock ledge riffles and plunge pools.

Biological Assessment: Macroinvertebrate Community

- Qualitative sampling at RM 0.6 produced 39 primarily pollution tolerant or ubiquitous taxa. Midges predominated and the mayfly species *Baetis flavastriga* and the caddisfly genus *Cheumatopsyche* were common in the riffles. In total, five mayfly and caddisfly taxa were collected. The macroinvertebrate community appeared to be in marginally good condition.

Biological Assessment: Fish Community

- A total of 2,206 fish comprised of 26 species was collected from Mallet Creek at RM 0.7 during the 1992 sampling effort. The numerically predominant species were bluntnose minnow (27.1%), central stoneroller (19.1%), rainbow darter (15.4%), sand shiner (14.5%), silverjaw minnow (5.8%), and creek chub (3.0%). In terms of biomass, the species that predominated were: common carp (33.8%), central stoneroller (22.3%), bluntnose minnow (10.6%), rainbow darter (3.4%), and creek chub (4.5%). In terms of relative abundance, tolerant and moderately intolerant insectivorous species were abundant. The fish community at this station performed at a very good level (IBI=47) and fully achieved the WWH biological criterion.

Trend Assessment

Rocky River and Abram Creek

Chemical Water Quality Changes: 1975-1992.

- Compared to 1981 survey results, concentrations of ammonia-N declined in the mainstem of the Rocky River, particularly downstream from the confluence of the East and West branches. IJC/NAWQMN data collected at the two sites at Cedar Point Road (RM 12.7) and Rockcliff Ford (RM 3.0) suggested the same decreased ammonia-N trend (Figures 28 and 29). Reduced ammonia concentrations in the mainstem of the Rocky River can be attributed to treatment plant improvements (Table 10) and subsequent reduction of ammonia loadings from WWTPs (i.e., Brookpark, Medina 500 and North Olmsted WWTPs) as shown in Figure 30. Increased nitrate concentrations also indicate that the improved water quality is a result of improved treatment at WWTPs rather than a reduction in the volume of treated effluent discharged to the river.

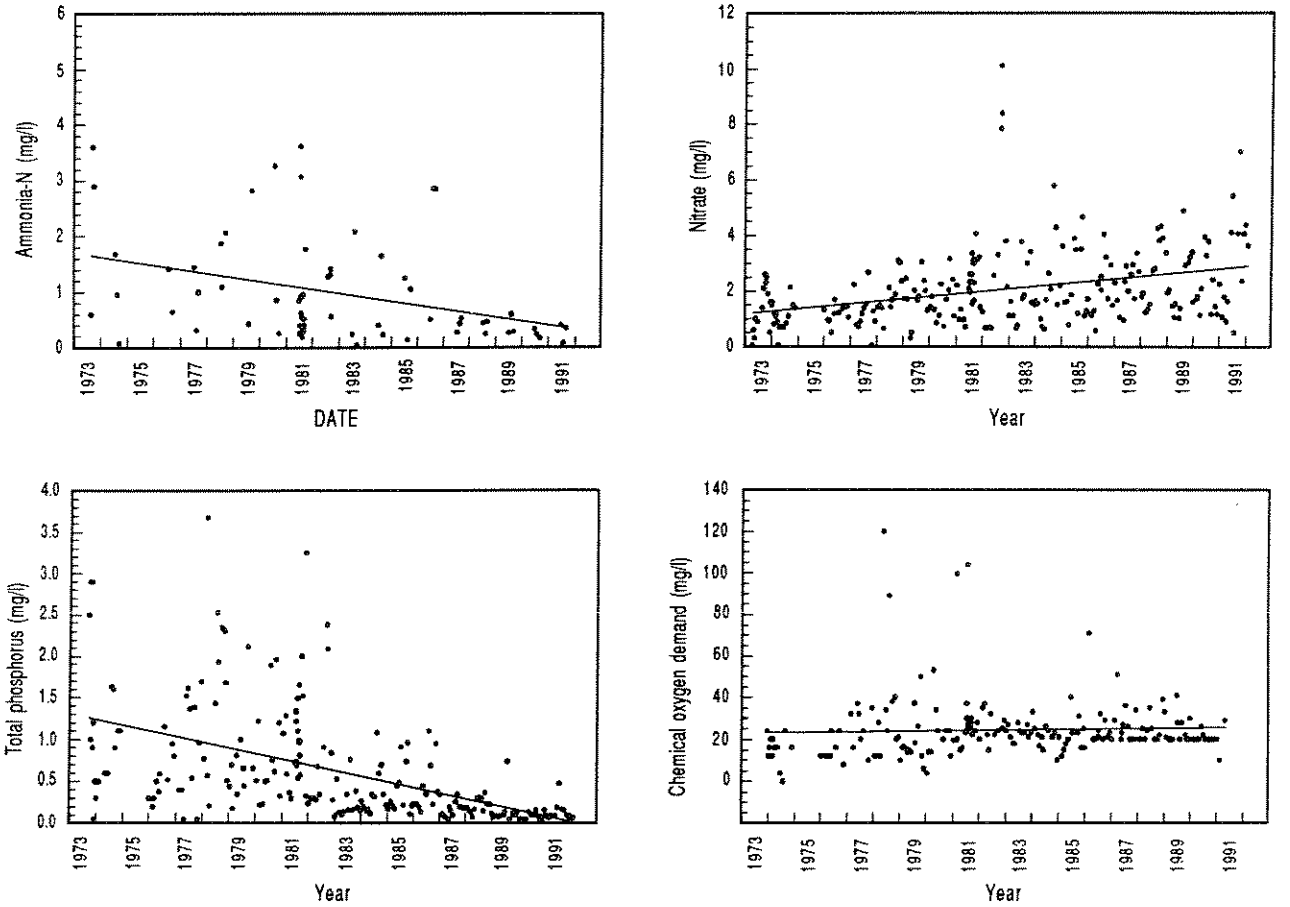

Figure 28. Linear regressions of nitrate ($p<0.001$), phosporus ($p<0.001$), chemical oxygen demand ($p<0.20$) and 3rd quarter ammonia-N ($p<0.01$) concentrations from grab samples collected from the Rocky River at Cedar Point Rd. (RM 12.7), 1973-1992.

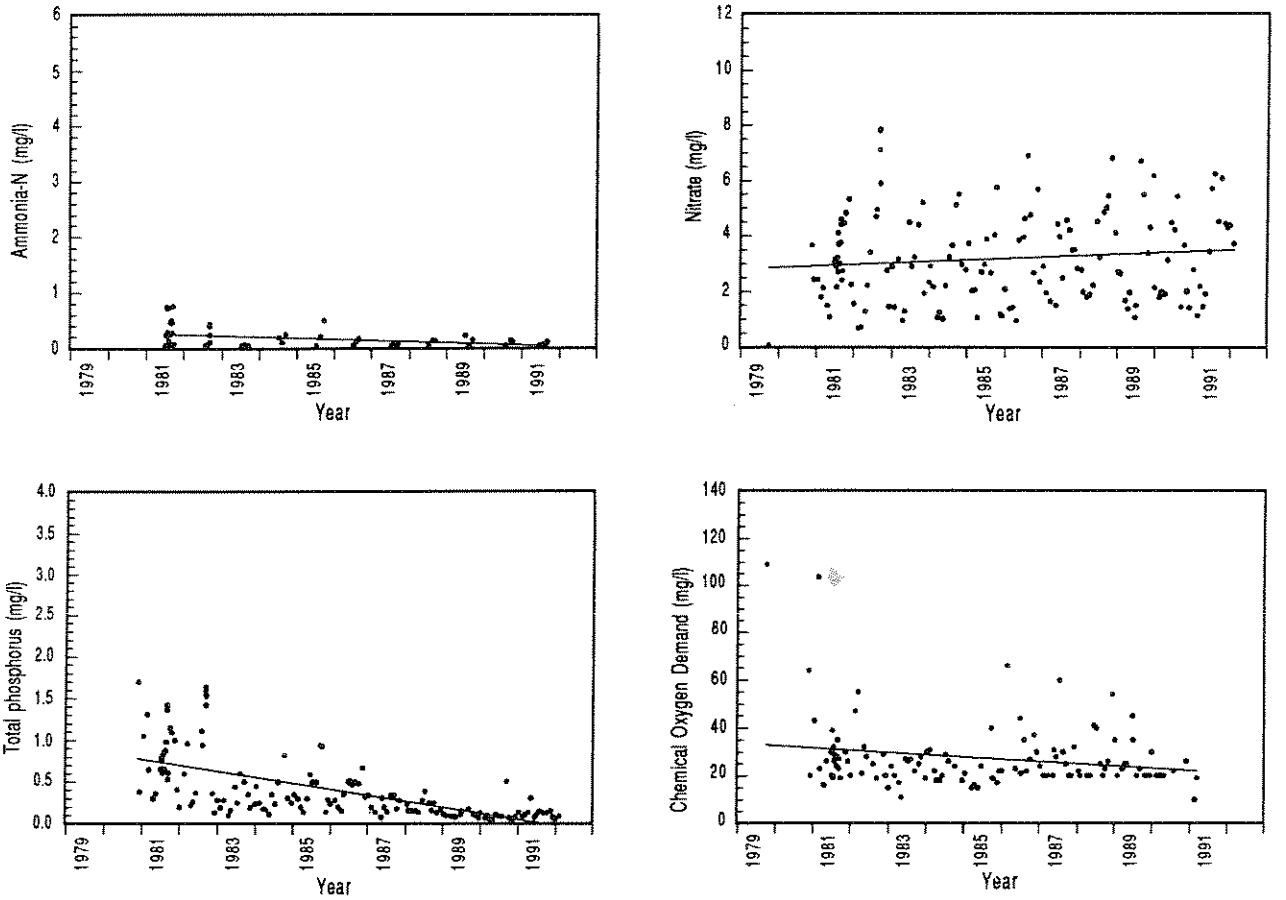

Figure 29. Linear regressions of nitrate ($p<0.10$), phosporus ($p<0.001$), chemical oxygen demand ($p<0.005$) and 3rd quarter ammonia-N ($p<0.01$) concentrations from grab samples collected from the Rocky River at Rockcliff ford (RM 3.0), 1979-1992.

Table 10. WWTP process changes in the Rocky River Basin since 1981.

Facility	Receiving stream	Change
Montville Landfill	West Branch (RM 33.4)	Interim Remedial Action
Falls Subdivision	Adams Rd south of turnpike	Abandoned
Medina "300"	E. Branch (RM)	De-chlorination
Girl Scout Camps	UT to E. Branch (RM 0.4/29.15)	Filters added
Mt Augustine	UT to E. Branch (RM 2.75/29.15)	Upgrade to advanced secondary/refurbished plant.
Union Carbide	UT to E. Branch (1.35/13.88)	Non-contact cooling water only
Cleveland Builders Supply	UT to Mainstem (RM 1/3.81)	Stormwater only
Foseco	Abram Creek (RM 3.65/10.38)	Process wastewater recycled
Standard Oil	Rocky River (RM 9.5)	Sanitary abandoned to sewers
Lakewood	Rocky River (RM 1.72)	Diverted to Lake Erie
Stongsville "C"	Baldwin Creek (RM 2.9)	Expansion & upgrade to tertiary, NH3 & P removal
Stongsville "B"	E Branch (RM 11.1)	Expansion & upgrade to tertiary, NH3 & P removal
North Royalton "B"	Baldwin Creek (RM 7.3)	Expansion & upgrade, NH3 & P removal
North Royalton "A"	UT to E. Branch (RM 0.5)	Expansion & upgrade, NH3& P removal
North Olmsted	Rocky River (RM 11.4)	Reduction in design flows-NH3 removal
Middleburg Heights	Abram Creek (RM 4.0)	P removal
Brookpark	Abram Creek (RM 3.7)	P removal
Olmsted Falls H.S	UT to W. Branch	Abandoned
Olmsted Falls Easterly	West Branch	Abandoned
Olmsted Falls LOG	Plum Creek	Abandoned

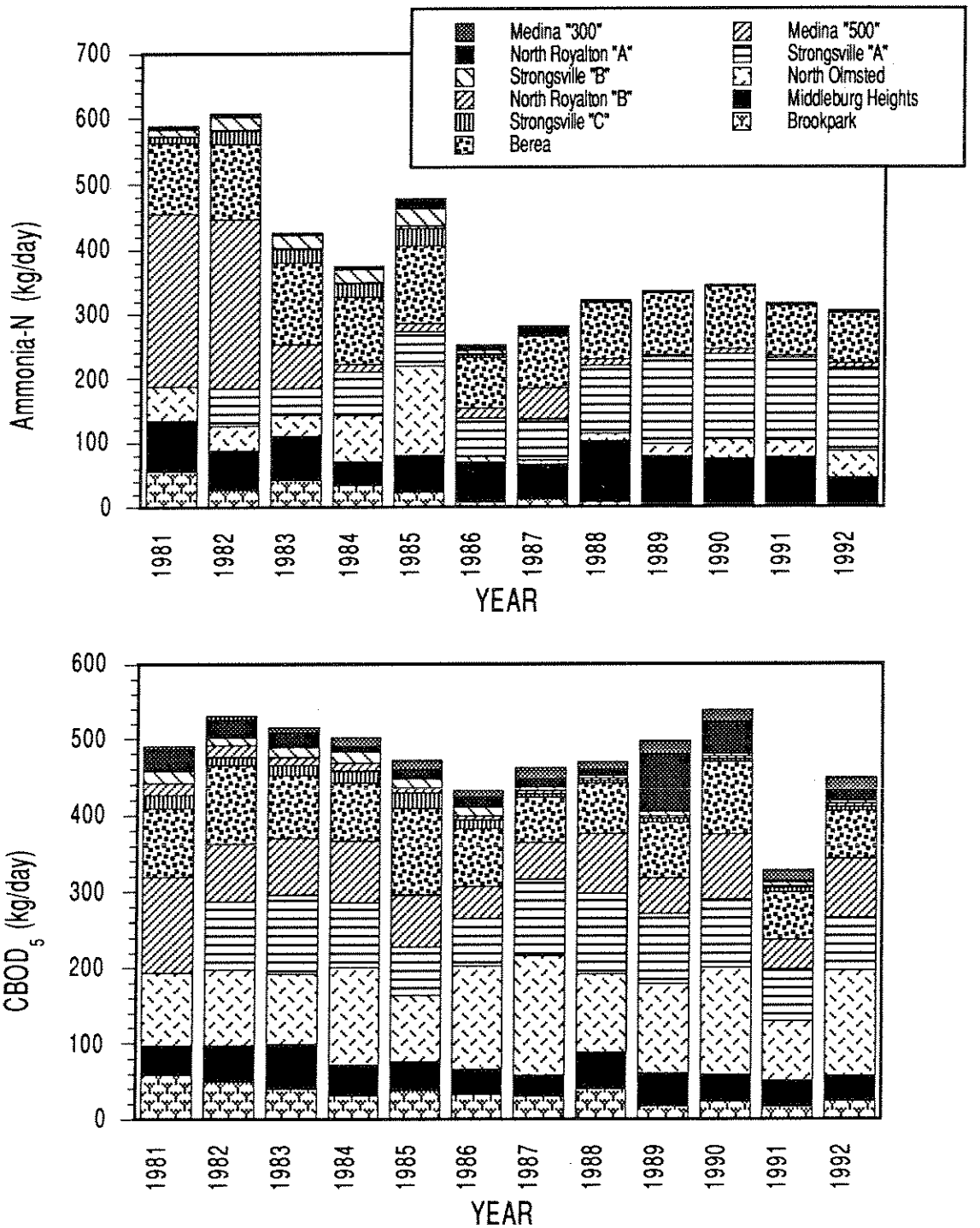

Figure 30. Cumulative 50th percentile Ammonia-N (kg/day) and $CBOD_5$ loadings for eleven dischargers in the Rocky River basin, 1981-1992.

- Decreased concentrations of heavy metals were noted between 1981 and 1992 (*e.g.*, copper, zinc, and lead) (Figure 31). However, this reduction was attributed to the collection of all 1991 samples during "dry weather" conditions. High heavy metal concentrations are often associated with increased TSS that occur during high runoff events. Samples collected in 1981 were taken during both dry and wet weather events.

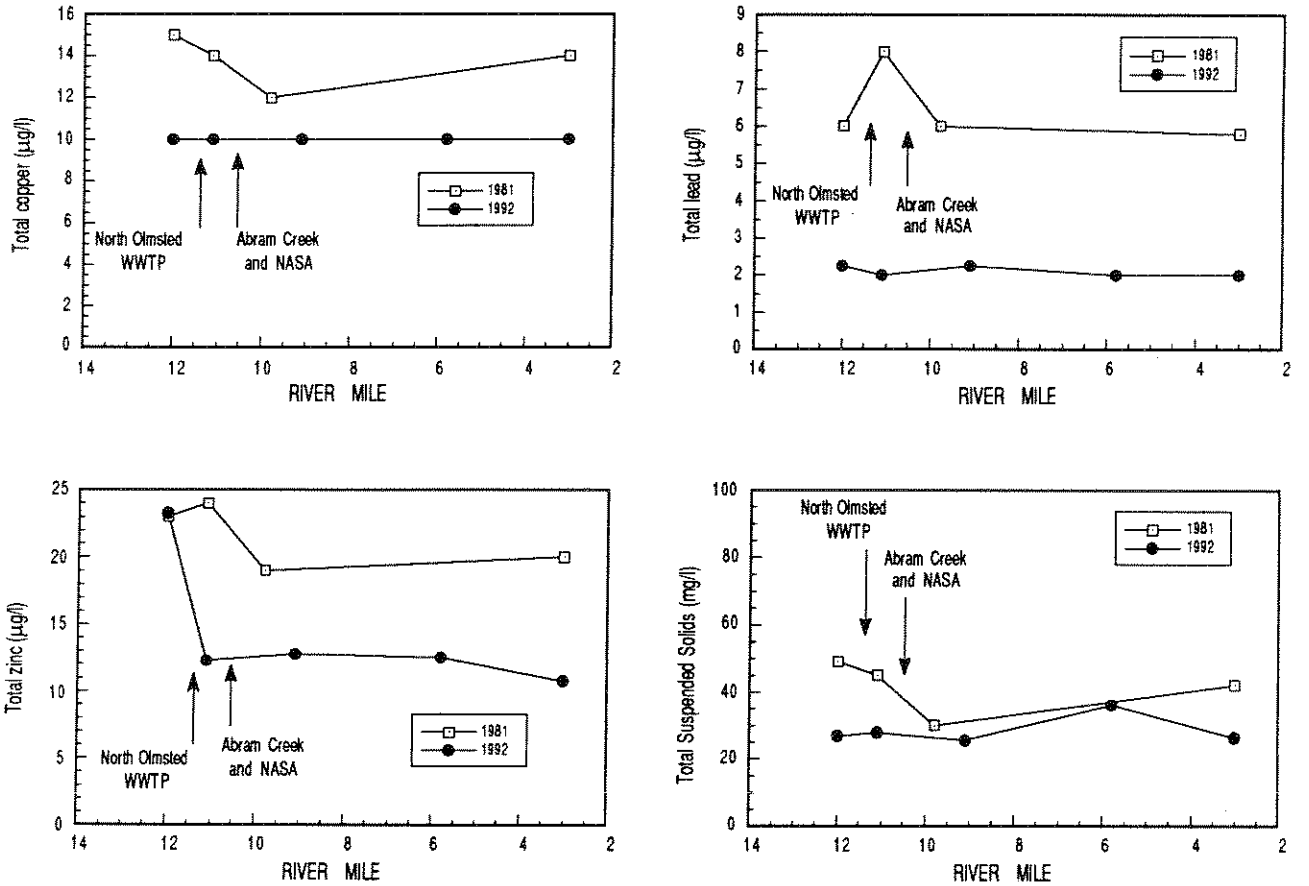

Figure 31. Longitudinal trends of mean copper, lead, zinc, and total suspended solids in the Rocky River, 1981 and 1992.

- Decreased COD and a dramatic improvement in phosphorus concentrations (except the one high value) (Figure 32) were noted in the mainstem in 1992 compared to 1981. IJC/NQWMA data from Rockcliff ford (RM 3.0) also indicates a decline in COD values (Figure 29), but the data from Cedar Point Rd. (RM 12.7) suggests that COD as remained relatively stable and may actually be increasing slightly (Figure 28). The reduced phosphorus concentrations can be attributed to reduced phosphorus loadings from WWTPs within the basin. As shown in Figure 34, significant phosphorus reductions have occurred at all WWTPs in the basin, except Middleburg Heights.

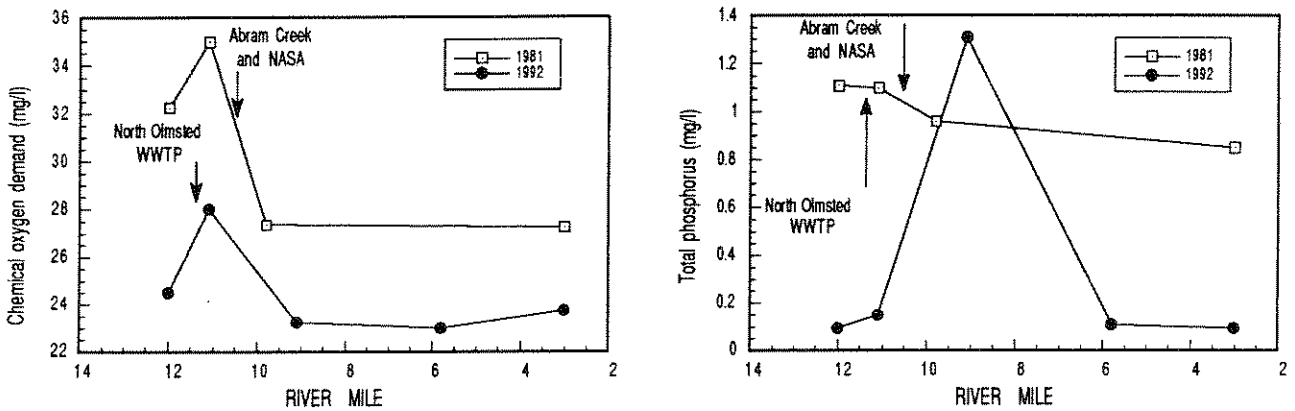

Figure 32 Longitudinal trends of mean cchemical oxygen demand (COD) and phosporus in the Rocky River, 1981 and 1992

- Despite increased flows from the two WWTPs that discharge to Abram Creek, water quality improved slightly since 1981 for all parameters sampled. As shown in Figure 33, loadings of phosphorus and ammonia-N declined at the Middleburg Heights and Brookpark WWTPs. The improvements in water quality are not dramatic, however, and exceedences of water quality criteria were documented in 1992 for D.O., ammonia-N, and fecal coliform bacteria.

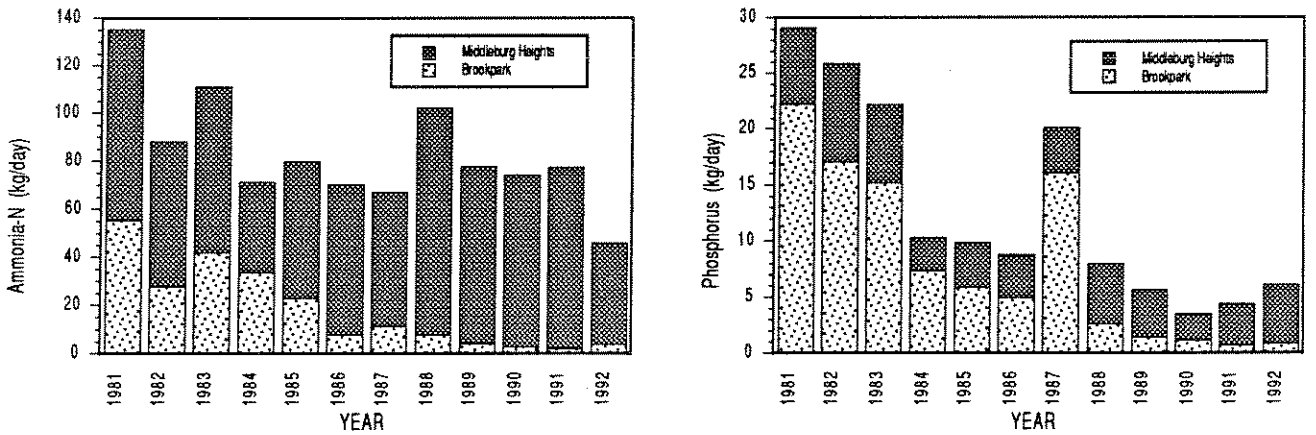

Figure 33. Cumulative 50th pecentile ammonia-N and phosphorus loadings in Abram Creek, 1981-1992.

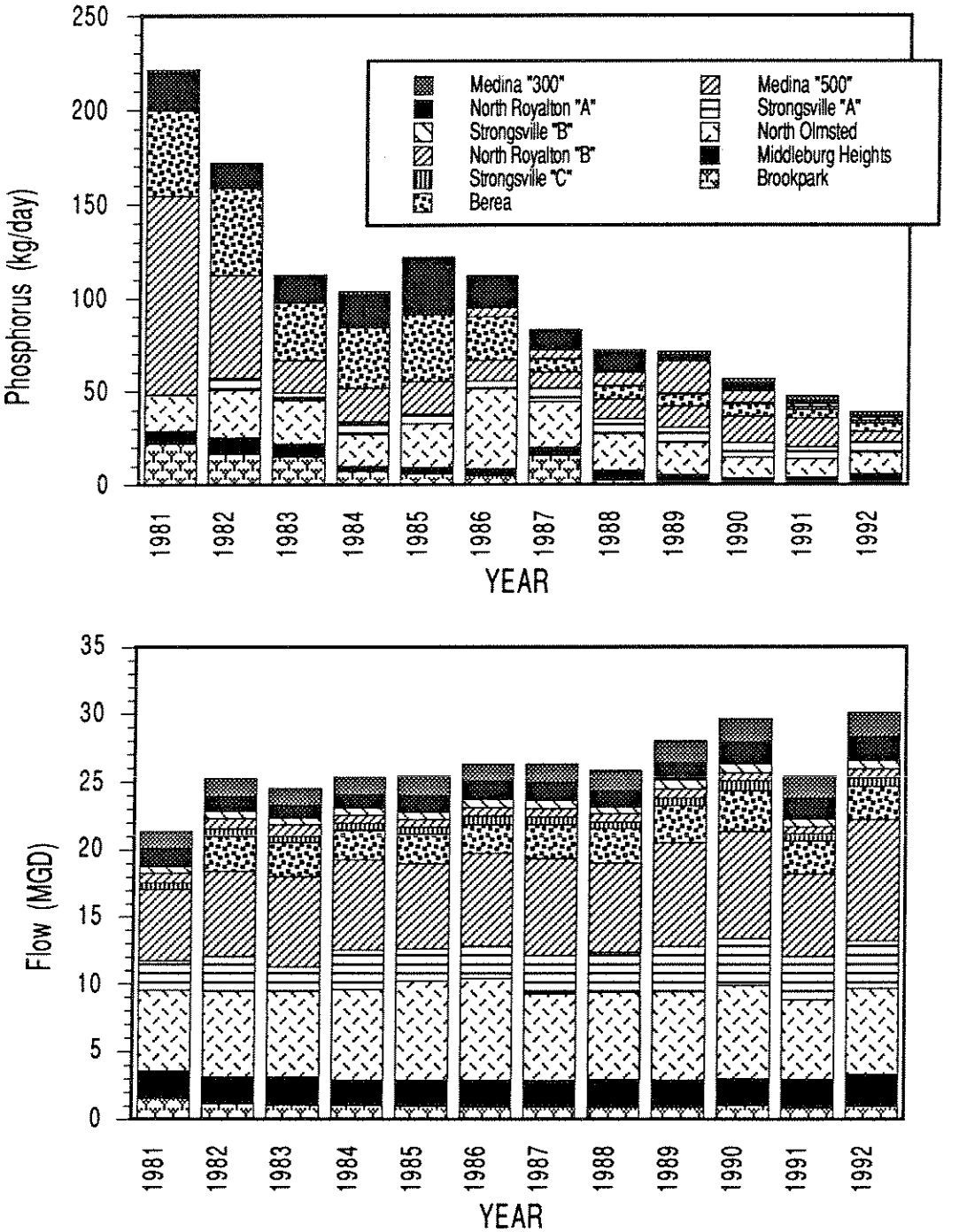

Figure 34. Cumulative 50th pecentile phosphorus (kg/day) and flow (MGD) for eleven discharges in the Rocky River basin.

Changes in Biological Community Performance: 1981- 1992

- The macroinvertebrate community in the Rocky River demonstrated improvement in 1992 compared to 1981, but still was not fully achieving the WWH aquatic life use. Though an impact was apparent, the most improved macroinvertebrate results were recorded from the North Olmsted to RM 9.0. Conversely, the results of the 1992 fish sampling effort indicated reduced community performance within the upper portion of the Rocky River mainstem. In 1992, community performance as measured by the MIwb and IBI indicated a significant impact within the reach between RM 11.1 and RM 10.3 (downstream from the North Olmstead WWTP) (Figure 36). In 1981 and 1986 this reach fully achieved ecoregional expectations. Over this eleven year period, the fish assemblage demonstrated significant shifts in functional organization and reduced condition (health of individual fish). The percent occurrence of tolerant species increased from 8% in 1981 to 40% in 1992 within this reach. A similar trend was observed in the percent occurrence of omnivorous species, increasing from 6% in 1981 to 34% in 1992. Additionally, the incident of DELT anomalies increased from 0.0% in 1981 to 0.2% in 1986 to 1.3% in 1992. The temporal shifts observed within the fish community were those typically associated with increased nutrient and organic enrichment. Community performance in the remaining downstream segment was relatively unchanged in the interim since 1981. Changes in the biological communities in the Rocky River, as a whole, are best represented by the ADV/mile statistic due to differences in segment length between years. The ICI/ADV/mile statistic declined from 40 in 1981 to 16 in 1992 (Table 11). Decreases in ADV scores over time are an indication of improving biological performance (see Methods section; page 19). Comparision of Qualitative Community Tolerance Values from 1981 and 1992 produced similar results (Figure 34). The IBI/ADV/mile statistic declined from 62 in 1981 to 51 in 1992, however, this preceived improvement in the fish community is probably due to the sampling of an addtional of site at RM 5.8 in 1992 (Figure 35).

- Fish and benthic communities in Abram Creek were severely degraded by the Brookpark and Middleburg Heights WWTPs in 1981 and1992. Stations sampled during 1981 were not exactly duplicated in the 1992 survey; nevertheless, biological sampling yielded poor to very poor results during both sampling efforts. Significant improvement is anticipated now that discharges from both plants have been eliminated.

Table 11. Area of Degradation (ADV) statistics for the Rocky River study area, 1981 and 1992 ADVs are calculated using ecoregion biocriteria as the background community performance.

	Biological Index Scores				ADV Statistics			Attainment Status (miles)[a]			
Stream Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	**ADV**	ADV/ Mile	Poor/VP ADV	FULL	PARTIAL	**NON**	Poor/VP
Rocky River (1981)											
IBI	11.5	2.9	26	40	**532**	62	61	0.00	2.4	6.3	6.3
ICI			6	36	**420**	40	0				
Rocky River (1992)											
IBI	11.5	0.1	26	44	**583**	51	4	0.6	8.8	2.1	1.3
MIwb			6.9	9.0	**65**	6					
ICI			22	30	**156**	16					
East Branch Rocky River (1981)											
IBI	26.7	1.1	25	48	**531**	21	40	16.6	4.6	4.5	4.3
ICI			22	54	**139**	5	0				
East Branch Rocky River (1992)											
IBI	26.7	1.4	22	48	**240**	9	40	20.5	1.8	3.1	1.7
MIwb			4.4	8.8	**390**	19	30				
ICI			38	54	**0**	0	0				
West Branch Rocky River (1981)											
IBI	33.6	0.3	15	43	**384**	11	98	18.5	12.1	2.8	2.6
ICI			8	44	**900**	29	58				
West Branch Rocky River (1992)											
IBI	33.5	0.4	30	49	**160**	5	0	27.5	5.7	0.0	0.0
MIwb			6.6	8.4	**10**	0.4	0				
ICI			30	54	**0**	0	0				
Abram Creek (1981)											
IBI	4.6	0.9	15	24	**754**	204	367	*0.0*	*0.0*	*4.3*	*4.3*
Abram Creek (1992)											
IBI	2.0	0.3			**456**	217	267	0.0	0.0	2.1	2.1
ICI					**498**	237	120				
Baldwin Creek (1981)											
IBI	5.8	0.2	15	28	**812**	145	279	*0.0*	*0.0*	*6.1*	*4.5*
Baldwin Creek (1992)											
IBI	7.4	1.4	17	31	**948**	158	340	0.0	0.0	7.1	6.1
ICI			30	40	**0**	0	0				
North Royaton "A" tributary (1981)											
IBI	0.6	0.2	12	26	**172**	140	73	*0.0*	*0.0*	*1.1*	*1.1*
North Royaton "A" tributary (1992)											
IBI	0.6	0.2	20	35	**56**	430	21	*0.0*	*0.0*	*1.1*	*0.3*

[a] - Attainment status based on one organism group are in itallics.

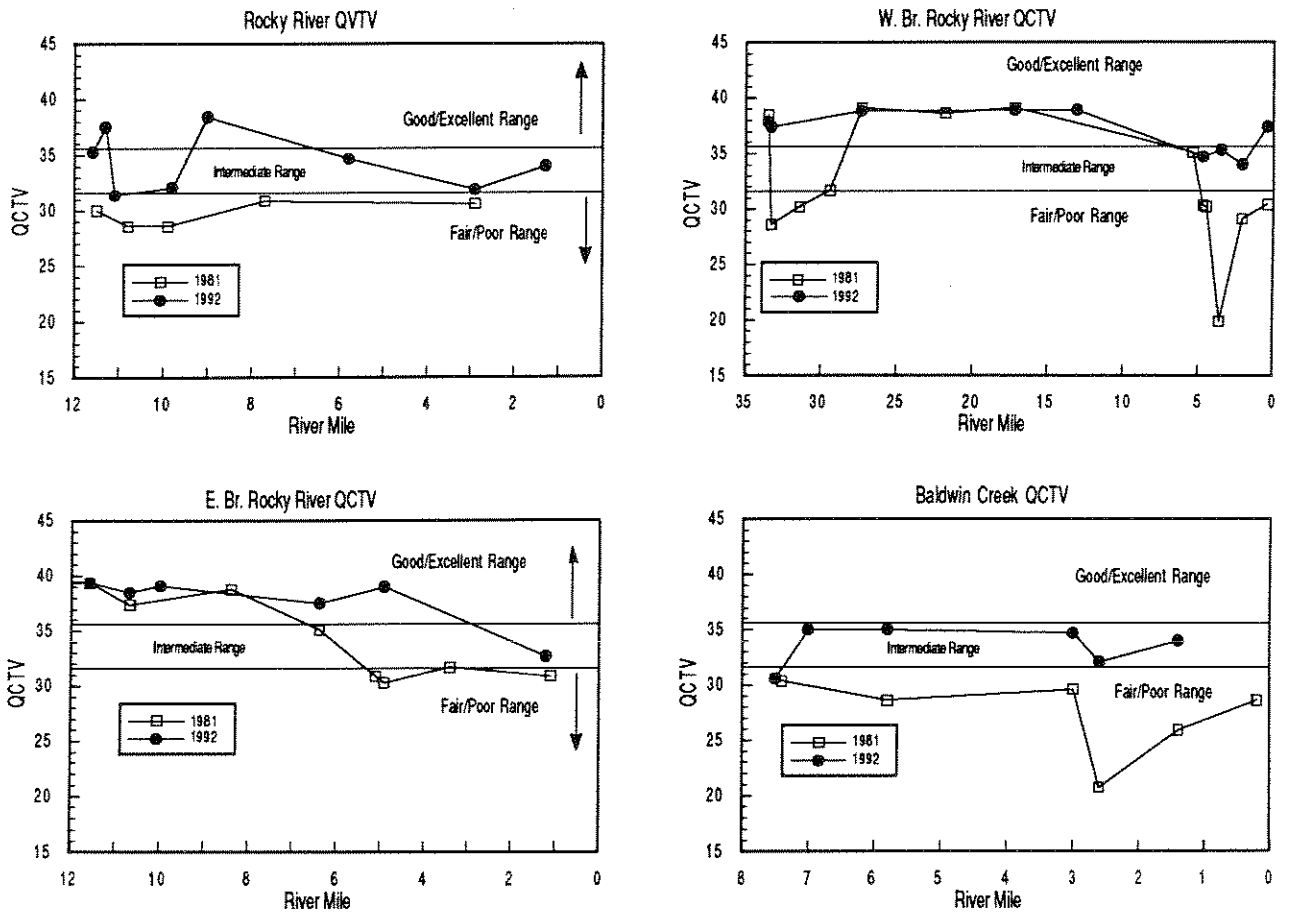

Figure 35. Longitudinal trend of Qualitative Community Tolerance Values (QCTV) scores from the Rocky River, East Branch Rocky River, West Branch Rocky River, and Baldwin Creek, 1981 and 1992.

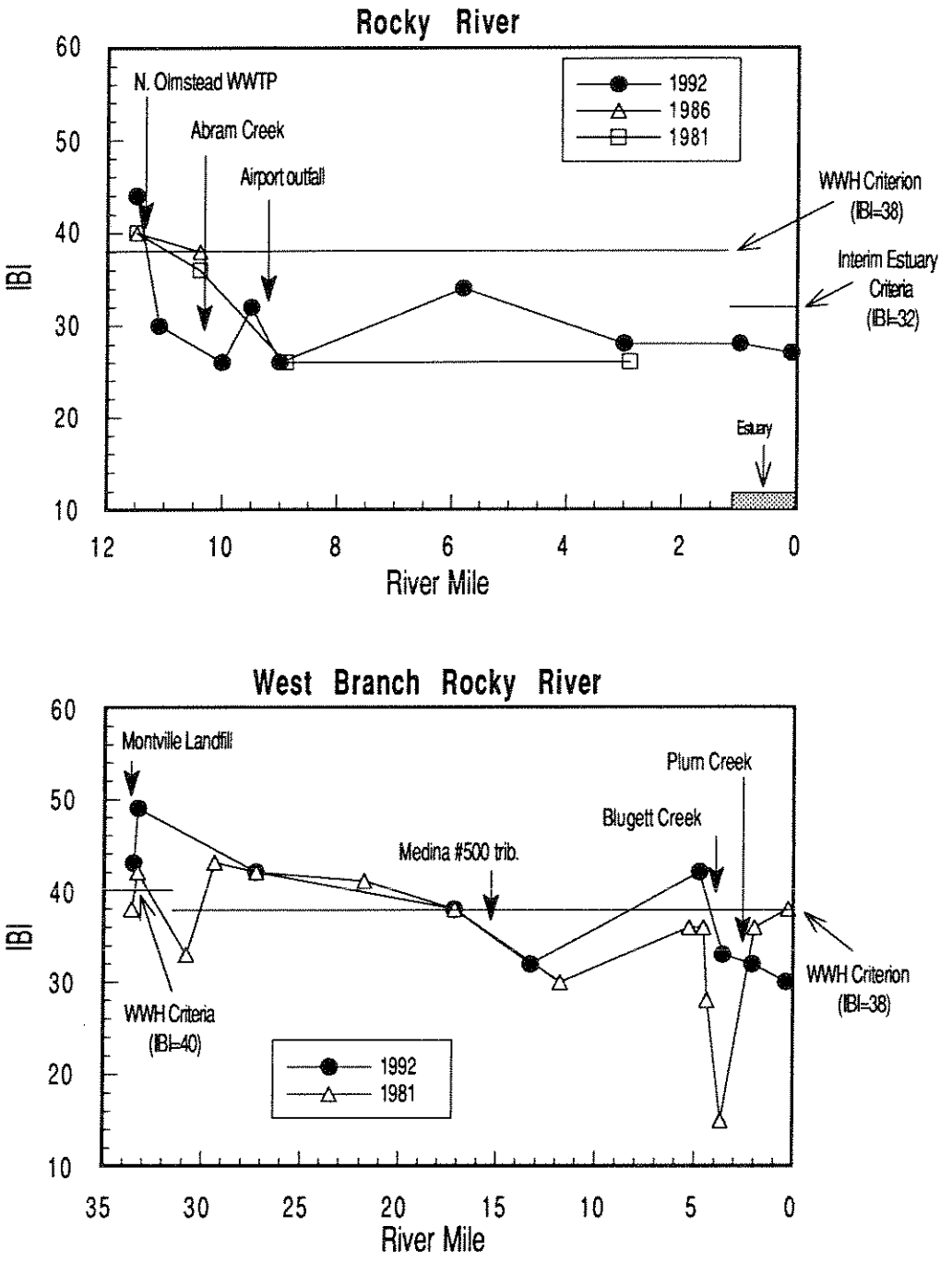

Figure 36. Longitudinal trends of the Index of Biotic Integrity (IBI) in the Rocky River mainstem and the West Branch Rocky River study areas; 1981,1986 and 1992.

East Branch Rocky River and Tributaries

Chemical Water Quality Changes: 1981-1992.

- Instream concentrations of lead reflected dramatic improvements from 1981 to 1992 (Figure 37). This improvement was probably due to reduced aerial deposition of lead due to the decline in use of leaded gasolines.

- There was a significant improvement in the East Branch downstream from the North Royalton "A" and Strongsville "B" WWTPs for ammonia-N, phosphorus and all other parameters sampled except for D.O. and TDS (Figure 37). 1992 TDS and D.O. profiles in the East Branch were remarkably similar to the profiles measured during the 1981 survey. The improvement of ammonia-N and phosphorus concentrations in the East Branch were correlated with the reduction of loadings of phosphorus and ammonia-N from the North Royalton "A" and Strongsville "B" WWTPs (Figure 38).

- There was an across the board improvement in water quality in Baldwin Creek from 1981 to 1992. The improved water quality in Baldwin Creek was attributed to improvements and subsequent reductions in pollutant loadings from the North Royalton "B" and Strongsville "C" WWTPs.

Changes in Biological Community Performance: 1981-1992

- In 1981, the macroinvertebrate community in the East Branch demonstrated impacts that were attributed to organic enrichment from the North Royalton "A" and Strongsville "B" WWTPs. ICI scores generally delined in a downstream direction; however, the only location that did not meet ecoregional expectations was at RM 3.4. This site was apparently degraded by inputs from CSOs. No impacts on the benthos were attributed to the Medina 300 or the Berea WWTPs. Improvements to the North Royalton "A" and Strongsville "B" WWTPs after 1981 (see Table 10) resulted in improved macroinvertebrate preformance in 1992. The macroinvertebrate community was of good to excellent quality throughout the study area in 1992; and ADVs were reduced from 139 in 1981 to zero in 1992. The QCTV also demonstrated generally good conditions in 1992 and suggested an improvement in the benthic community beginning at RM 6.4 and extending to the mouth (Figure 35).

- Fish community sampling downstream from the Medina 300 WWTP (17.5) reflected a significant decline in fish community performance as measured by the IBI. In 1981, this station received a narrative evaluation of very good (IBI=47). However, in 1992, the fish assemblage was characterized as marginally good (IBI=38) (Figure 39). The most notable changes within the fish community at this station over the eleven year period were a reduction in species richness, an increase in the abundance of tolerant and omnivorous species, and an increase in the incidence of DELT anomalies. In 1981, the percent occurrence of tolerant and omnivorous species was 26.5% and 8%, respectively. In 1992, the percentages had increased to 36% (tolerant) and 44% (omnivorous). The predominance of these species is typically associated with nutrient and organic enrichment. In 1981, the occurrence of DELTs was 0.0%; this increased to 0.75% in 1992. Though the elevated incidence of external anomalies was not extreme, this phenomenon was additional evidence of increased stress within the fish community.

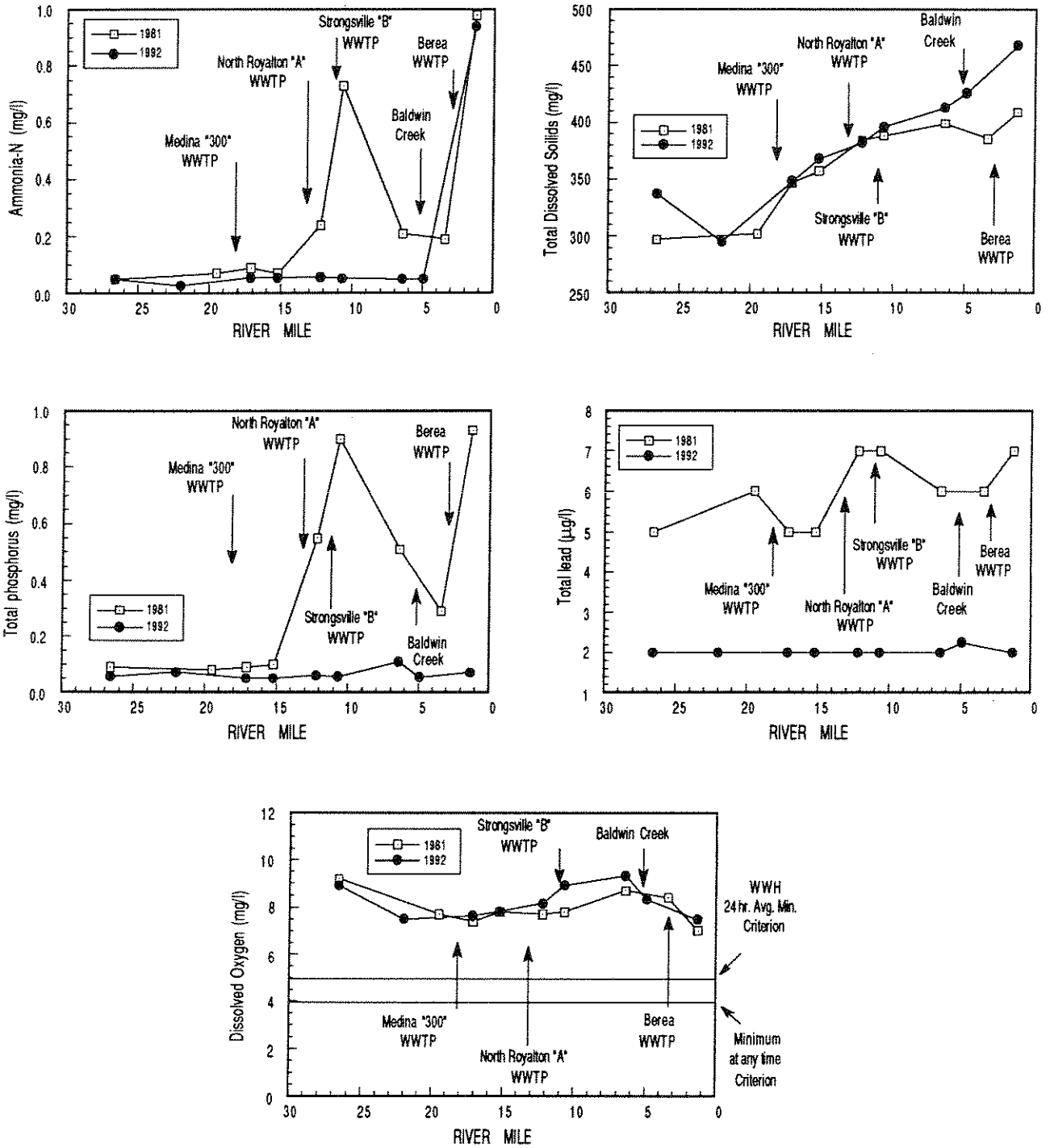

Figure 37. Longitudinal trend of mean ammonia-N, total dissolved solids, phosphorus, lead, and dissolved oxygen in the East Branch Rocky River study area, 1981-1992.

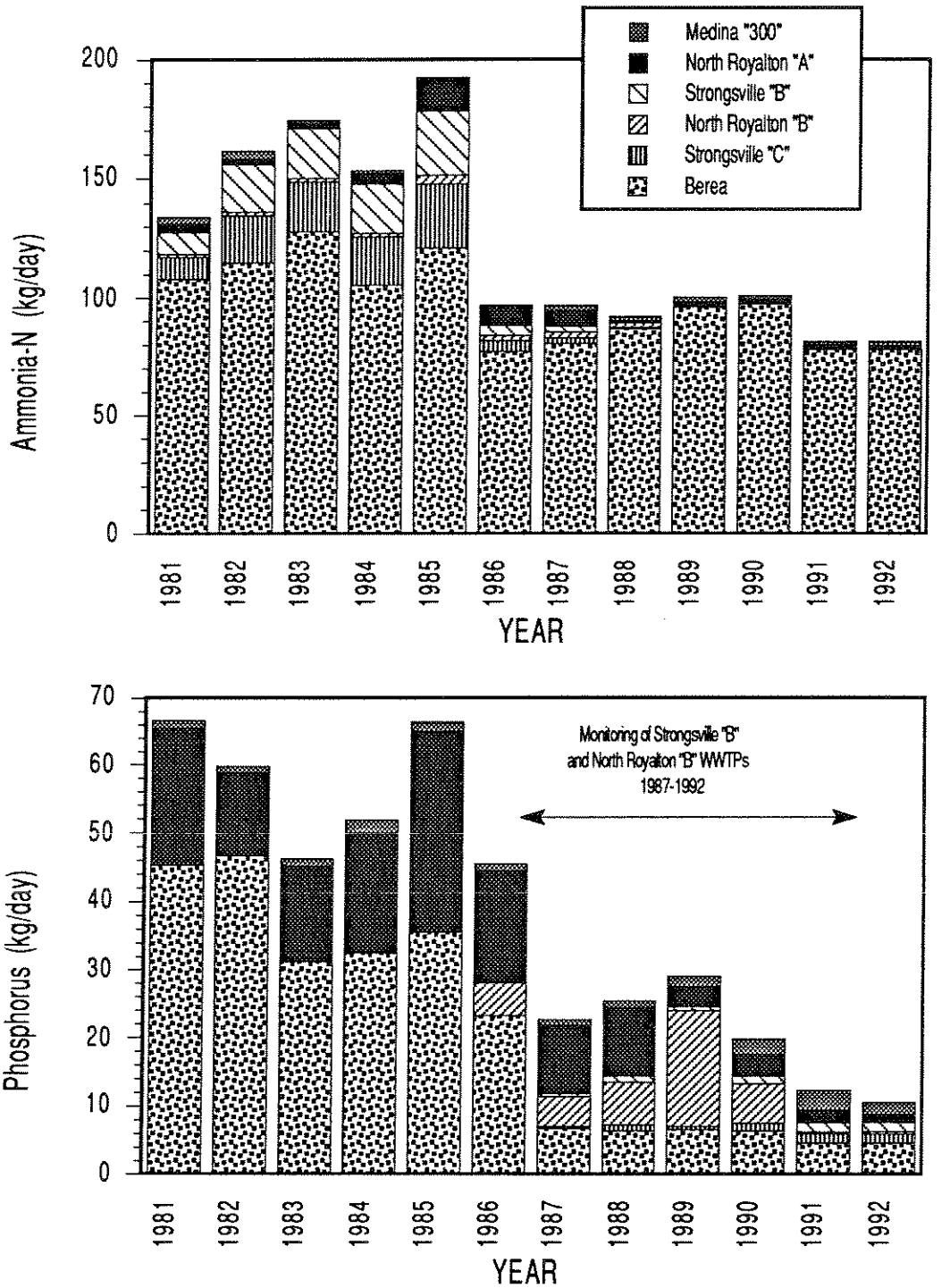

Figure 38. Cumulative 50th percentile annual ammonia-N and phosphorus loadings from six dischargers to the East Branch Rocky River study area, 1981-1992.

- Fish communities between RM 10.0 and RM 4.9 were significantly improved when compared with the 1981 survey results. In 1981, the IBI failed to atttain the WWH biological criteria. Sampling stations within this reach received narrative evaluations ranging from fair to poor. The 1992 survey results within the same reach documented full and partial achievement of the WWH biological criteria (Figure 39). Improvement in the fish community in the East Branch is best represented by the IBI/ADV/mile statistic due to differences in segment length. The IBI/ADV/mile statistic declined from 21 in 1981 to 9 in 1992.

- Macroinvertebrate sampling in Baldwin Creek documented impacts from the North Royalton "B" and the Strongsville "C" WWTPs in both 1981 and 1992. However, there appeared to be a lesser impact in 1992 as demonstrated by the QCTV graph (Figure 35). An ICI/ ADVwas avalible only for 1992 and, though the score was zero, it is important to note that significant enrichment was evident at the majority of sites sampled.
- In comparison with the 1981 survey results, the 1992 sampling effort documented continued impacts on the fish assemblage of Baldwin Creek (Figure 39). Achievement of the WWH biological criteria was not observed at any station during either sampling effort. The condition of the fish community downstream from the Strongsville "C" WWTP appeared to have declined in 1992 compared to 1981 based on the IBI scores. The net result was that the IBI/ADV/mile statistic increased from 145 in 1981 to 158 in 1992.

- In comparison with the 1981 survey results, the 1992 sampling effort on the North Royalton "A" tributary documented limited improvement upstream and downstream from the North Royalyton "A" WWTP. The fish assemblage at RM 0.6 performed at a poor level (IBI=26) in 1981. In 1992, community performance improved and received a narrative evaluation of fair (IBI=35). The fish assemblage at RM 0.2 (downstream from the North Royalton "A" WWTP) was characterized as very poor in 1981 (IBI=12). The 1992 sampling efforts at this station found modest improvement within the fish community (IBI=20). The macroinvertebrate community was characterised as being in poor condition in 1992 and was not sampled in 1981.

West Branch Rocky River andTributaries

Chemical Water Quality Changes: 1981-1992.

- Upstream /downstream data from the Medina 500 WWTP monthly operating reports show significant improvement in both the upstream and downstream water quality in the West Branch Rocky River in the vicinity of the treatment facility. This improvement probably resulted from the consolidation of smaller Medina WWTPs into the Medina 500 plant, subsiquent improved operation and maintenence at the WWTP, and remedial measures at the Montville landfill.

- Sampling conducted in 1981 and 1992 demonstrated a large improvement in D.O., phosphorus and ammonia-N downstream from the Medina 500 WWTP (Figure 40). This improvement was attributed to the significant reduction of pollutant loadings from the Medina 500 WWTP from 1981 to 1992 (Figure 17). Concentrations of lead have also declined (Figure 40) and was best attributed to the reduction in use of leaded gasolines.

- There was a large decline in COD concentrations downstream from the Montville Landfill tributary and a general decline of COD in the basin (Figure 40). Interim remedial measures at the Montville Landfill including leachate collection was likely respondsible for the improved water quality in the upper West Branch.

- Blodgett Creek water quality has not significantly improved since 1981. The Strongsville "A" WWTP loadings for phosphorus have remained constant and reported ammonia-N loadings have actually increased slightly since 1981 (Figure 27).

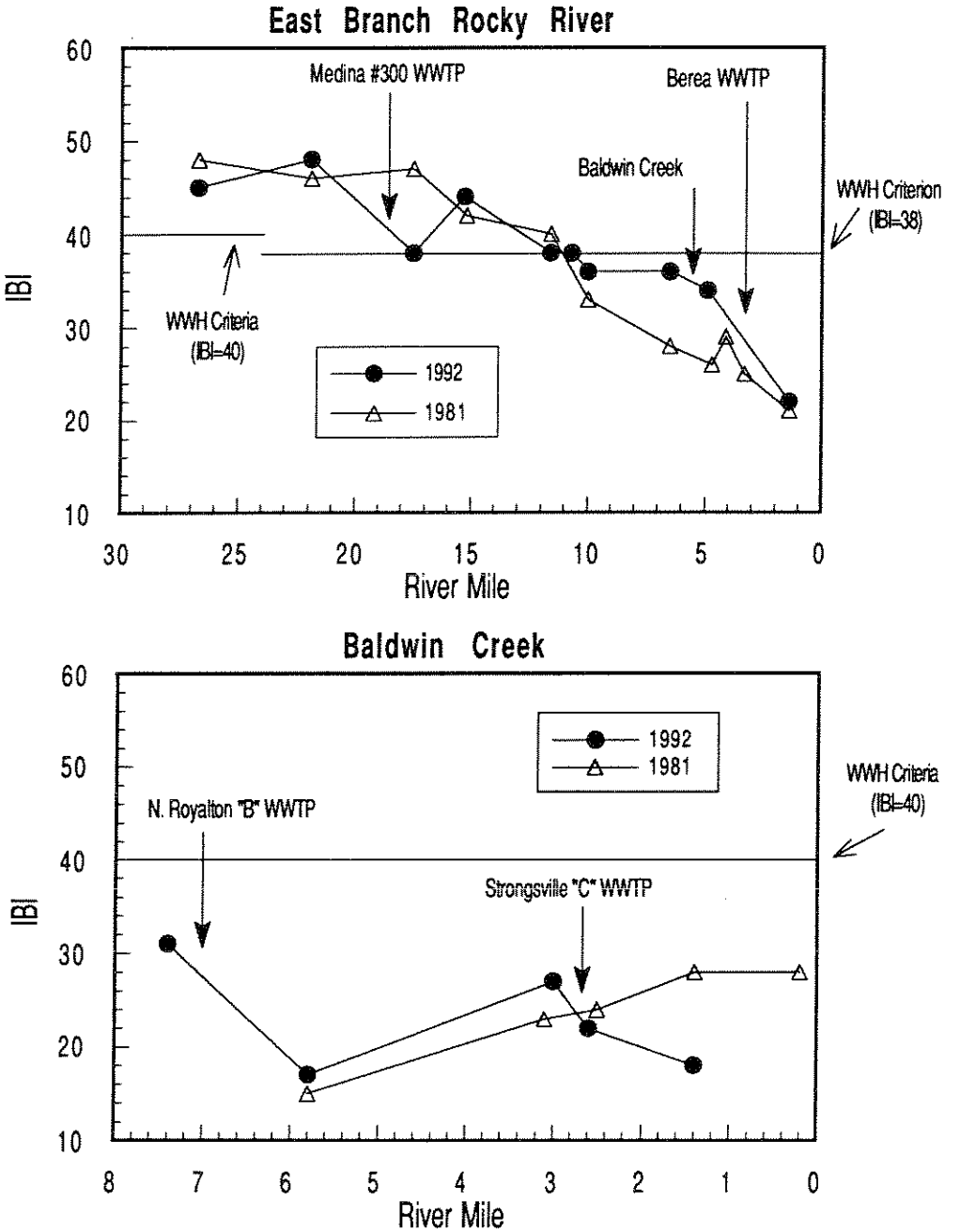

Figure 39. Longitudinal trends of the Index of Biotic Integrity (IBI) in the East Branch Rocky River and Baldwin Creek study areas, 1981 and 1992.

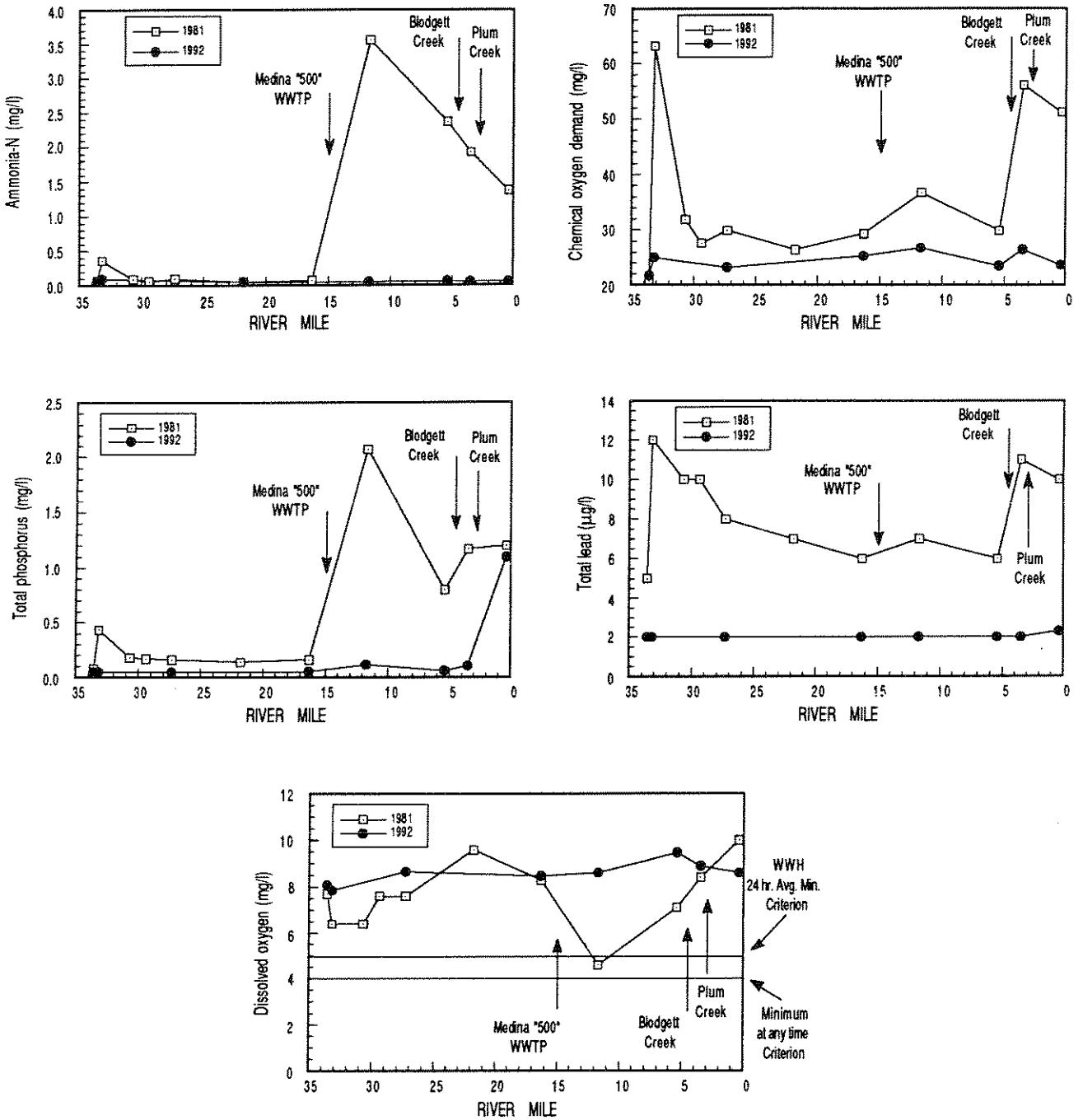

Figure 40. Longitudinal trend of mean ammonia-N, chemical oxygen demand, phosphorus, lead, and dissolved oxygen in the West Branch Rocky River study area, 1981-1992.

Changes in Biological Community Performance: 1981- 1992

- In 1981, severe toxic impacts to the macronivertebrate and fish communities in the West Branch Rocky River were attibuted to the Montville Landfill (RM 33.4) and the Strongsville "A" WWTP (Blodgett Cr. RM 1.8). Fish and macroinvertebrate assemblages were not significantly affected by the Montville Landfill in 1992. The Strongsville "A" WWTP likely contributed to a decline in the benthic community downstream from the confluence of Blodggett Creek in 1992 but the benthos still marginally met biological expectations. The QCTV graph from the two years demonstrated an improved macroinvertebrate community in 1992 (Figure 35). The fish assemblage at this station was characterized as fair (IBI=33) and, though full achievement of the WWH biological criteria was not observed, it appeared that substantial recovery had occurred. Fish community performance at locations downstream from Plum Creek achieved WWH biological criteria in 1981. The 1992 survey results indicated diminished performance within this reach, resulting in nonachievement of WWH biological criteria (Figure 36). The net result was a decrease in the ICI/ADV from 900 in 1981 to zero in 1992. Improvement in the fish community is best represented by the IBI/ADV/mile statistic due to differences in segment length. The IBI/ADV/mile statistic declined from 40 in 1981 to 16 in 1992.

- One Plum Creek station sampled in 1981 was replicated in 1992. The fish assemblage in 1981 at RM 0.3 was severely degraded (IBI=19). The 1992 sampling effort indicated a similar degraded condition (IBI=18). There has been no apparent change to the fish assemblage over the past eleven years.

- Fish and macroinvertebrate community performance exceeded ecoregional expectations in both 1981 and 1992 at RM 5.5 in the North Branch Rocky River. The fish assemblage at this station was characterized as good to very good and the macroinvertebrate community was considered in exceptional condition.

- In comparison with the 1981 survey results, the 1992 sampling effort on Blodgett Creek indicated significant improvement in fish downstream from the Strongsville "A" WWTP. Though the exact sampling stations from the 1981 surveys were not replicated, significant improvement was observed. In 1981, fish community performance was characterized as poor at RM 0.5. In 1992, fish collected at RM 0.1 performed at a marginally good level (IBI=34). The macroinvertebrate community was severely impacted in 1981 at RM 0.1 and little improvement was indicated in 1992.

Sediment Chemistry Trends 1981-1992

- There appeared to be no significant trend in the concentrations of heavy metals in sediments of the Rocky River collected from 1981 to 1992. Nearly all heavy metal concentrations collected on the East Branch at RM 1.4 in 1992 were twice as high as the concentrations reported at RM 26.7 or 21.9. This site was downstream from the Berea WWTP which, along with the urbanized nature this portion of the watershed,may have contributed to heavy metal concentrations higher than those measured at upstream sites on the East Branch.

Publicly Owned Lakes

There are a number of publicly owned lakes within the Rocky River watershed (Hinckley Lake, Coe Lake, Baldwin Lake, Wallace Lake, and Lake Medina). Hinckley Lake was recently evaluated by OhioEPA and pertinent information as to the status of the lake is as follows.

Hinckley Lake

Owner:	Cleveland Metro Parks
County at Dam:	Medina
Waterbody ID#:	OH 87-7-246 (East Branch Rocky River)
Mile at Dam:	23.16
Surface Area:	88 acres
Uses:	Recreation
Type:	Impoundment of E. Br. Rocky River, (1938)
Dates sampled:	April, 1989 (OhioEPA) July, 1989 (OhioEPA) August, Nov., 1977 (NOACA)

Use Attainment:

Use	Status	Comments
EWH	Impaired	Unbalanced fishery
PWS	Full Use, Threatened	Elevated Fe and Mn in bottom waters in summer
REC	Impaired	Unbalanced fishery, high Secchi Disk turbidity, Water aesthetics poor
FISH TISSUE	Unknown	Not Sampled

Ohio Lake Condition Index: 28.33
Surface Water Trophic State: Final TSI = 49, Low Eutrophic Range

Narrative evaluation:

Lake use is limited to shoreline fishing, electric motor, and paddleboats. Picnic areas around lake. Boat launching area and boat rentals available.

In 1977, NOACA found low dissolved oxygen in surface and bottom waters in August. In 1989, OEPA did not find low dissolved oxygen in July--sample was after rainy period and may have stirred lake water. Additional late summer D.O. surveys are needed.

In 1989, OEPA sampling showed a much higher Secchi Disk Trophic State Index (TSI) (65) than Chl-a TSI (51), which indicates that green algae productivity was being reduced by soil turbidity. Similar low Chl-a values were found by NOACA in 1977. Low algal production is most likely an important factor limiting the fish community of the lake.

Based on the best professional judgement of the lake manager, the fish community of the lake is unbalanced and impaired. Low food chain production due to high clay soil turbidity is believed to be the major problem. Lake has a stunted crappie population. Lake is stocked with channel catfish and has been stocked with rainbow trout.

Water chemistry and sediment sampling in 1989 did not show any priority pollutants at levels of concern. No pesticides were detected in a water sample. Three pesticides were found at very low levels in a sediment sample (aldrin--2.06 ug/kg; 4,4-DDE--1.77 ug/kg; endosulfan II--1.38 ug/kg). Iron was the only heavy metal found at elevated levels in the sediment (38,000 mg/kg) using Kelly, Hite and Rogers criteria (1984).

Restoration/Protection:

Sources of highly erodible clay soils need to be identified and controlled in the upper East Branch Rocky River basin. A watershed protection plan for erosion control needs to be implemented. A detailed survey of soil and nutrient (total-P, nitrates) loadings to the lake should be conducted.

Selective dredging of the inlet, with creation of wetland habitat, would help to control and filter soil loadings. The costs of constructing upstream sediment basins to reduce sediment loadings to Hinckley Lake should be investigated.

Detailed sampling of phytoplankton and zooplankton communities should be initiated in order to determine the degree of food chain impairment. Biological manipulations of fish and plankton populations should be considered to help maintain a well balanced sport fishery. Species that are more tolerant to clay turbidity should be investigated for future stocking.

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Appendix Tables

Appendix Table 1. Results of chemical/physical sampling conducted in the Rocky River study area during July-October, 1992. Violations of WWH water quality standards are noted with an asterisk (*) and values below detection limits are noted with a less-than symbol (<).

Stream Location /RM Date	pH	D.O.	Cond.	As	Cd	Ca	Cr	Cu
Rocky River								
Valley Parkway /RM 11.6								
92/07/01	7.90	5.30	780.0	<2.0	<0.20	60.0	<30.0	<10.0
92/07/22	8.30	8.30	440.0	3.0	<0.20	54.0	<30.0	<10.0
92/09/02	8.10	9.60	460.0	<2.0	<0.20	58.0	<30.0	<10.0
92/09/16	7.90	9.20	640.0	<2.0	<0.20	66.0	<30.0	<10.0
North Olmsted WWTP mixing zone /RM 11.3								
92/07/01	7.40	7.30	865.0	<2.0	<0.20	62.0	<30.0	<10.0
92/07/22	8.10	8.00	570.0	2.0	<0.20	56.0	<30.0	<10.0
92/09/02	7.40	6.50	80.0	<2.0	<0.20	62.0	<30.0	<10.0
92/09/16	7.52	8.30	590.0	<2.0	<0.20	66.0	<30.0	<10.0
Adj. Park Blvd. /RM 11.1								
92/07/01	8.23	11.10	90.0	<2.0	<0.20	62.0	<30.0	<10.0
92/07/22	8.10	8.30	472.0	4.0	<0.20	51.0	<30.0	<10.0
92/09/02	7.50	9.30	596.0	<2.0	<0.20	60.0	<30.0	<10.0
92/09/16	7.65	9.00	575.0	<2.0	<0.20	65.0	<30.0	<10.0
near picnic area /RM 9.0								
92/07/01	9.06	16.10	875.0	<2.0	<0.20	59.0	<30.0	<10.0
92/07/22	8.20	8.50	560.0	3.0	<0.20	54.0	<30.0	<10.0
92/09/02	7.80	9.40	515.0	<2.0	<0.20	57.0	<30.0	<10.0
92/09/16	7.50	8.00	610.0	<2.0	<0.20	63.0	<30.0	<10.0
S.R. 10 /RM 5.8								
92/07/01	8.24	8.10	860.0	<2.0	<0.20	62.0	<30.0	<10.0
92/07/22	8.20	7.80	540.0	3.0	<0.20	55.0	<30.0	<10.0
92/09/02	7.90	8.30	510.0	<2.0	<0.20	60.0	<30.0	<10.0
92/09/16	7.45	6.00	670.0	<2.0	<0.20	63.0	<30.0	<10.0
Park Blvd. /RM 3.0								
92/07/01	8.83	9.00	840.0	<2.0	<0.20	56.0	<30.0	<10.0
92/07/22	8.20	8.00	580.0	3.0	<0.20	61.0	<30.0	<10.0
92/09/02	7.70	7.60	525.0	<2.0	<0.20	58.0	<30.0	<10.0
92/09/16	7.48	7.10	630.0	<2.0	<0.20	61.0	<30.0	<10.0
Abram Creek								
Grayton Rd. /RM 1.9								
92/07/01	7.54	4.50	830.0	<2.0	<0.20	57.0	<30.0	<10.0
92/07/22	7.90	5.20	90.0	2.0	<0.20	73.0	<30.0	<10.0
92/09/02	7.50	7.30	929.0	<2.0	<0.20	67.0	<30.0	<10.0
92/09/16	7.40	4.70	80.0	<2.0	<0.20	65.0	<30.0	20.0
West Area Rd. /RM 0.3								
92/07/01	7.73	7.20	785.0	<2.0	<0.20	57.0	<30.0	<10.0
92/07/22	8.00	7.50	850.0	<2.0	<0.20	73.0	<30.0	<10.0
92/09/02	7.70	7.70	787.0	<2.0	<0.20	65.0	<30.0	<10.0
92/09/16	7.68	7.60	690.0	<2.0	<0.20	58.0	<30.0	<10.0

Appendix Table 1. cont.

Stream Location /RM Date	pH	D.O.	Cond.	As	Cd	Ca	Cr	Cu
West Branch Rocky River								
S.R. 162 /RM 33.5								
92/07/01	8.10	7.30		2.0	<0.20	76.0	<30.0	<10.0
92/07/22	7.65	8.10	357.0	<2.0	<0.20	44.0	<30.0	<10.0
92/09/02	7.92	8.50	50.0	3.0	<0.20	63.0	<30.0	<10.0
92/09/16	8.20	8.40	510.0	<2.0	<0.20	69.0	<30.0	<10.0
Ridgewood Rd. /RM 33.3								
92/07/01	7.90	7.30		3.0	<0.20	86.0	<30.0	<10.0
92/07/22	7.82	8.20	367.0	<2.0	<0.20	46.0	<30.0	<10.0
92/09/02	7.79	8.10	550.0	3.0	<0.20	65.0	<30.0	<10.0
92/09/16	8.00	7.80	60.0	<2.0	<0.20	71.0	<30.0	<10.0
Fenn Rd. /RM 27.3								
92/07/01	8.30	8.60		<2.0	<0.20	88.0	<30.0	<10.0
92/07/22	7.87	8.30	480.0	2.0	<0.20	58.0	<30.0	<10.0
92/09/02	8.03	8.70	60.0	<2.0	<0.20	72.0	<30.0	<10.0
92/09/16	8.30	9.00	620.0	<2.0	<0.20	82.0	<30.0	<10.0
Grafton Rd. /RM 16.4								
92/07/01	8.20	6.80		<2.0	<0.20	63.0	<30.0	<10.0
92/07/22	8.04	8.70	470.0	<2.0	<0.20	56.0	<30.0	<10.0
92/09/02	8.15	10.30	475.0	<2.0	<0.20	62.0	<30.0	<10.0
92/09/16	8.40	8.10	575.0	<2.0	<0.20	67.0	<30.0	13.0
Adj. West River Rd. /RM 14.8								
92/07/01	8.00	8.50		<2.0	<0.20	64.0	<30.0	<10.0
92/07/22	7.93	8.50	481.0	2.0	<0.20	57.0	<30.0	<10.0
92/09/02	7.96	10.20	60.0	<2.0	<0.20	64.0	<30.0	<10.0
92/09/16	8.30	8.60	680.0	<2.0	<0.20	68.0	<30.0	<10.0
Adj.. West River Rd. /RM 13.3								
92/07/01	8.10	7.50	90.0	<2.0	<0.20	66.0	<30.0	<10.0
92/07/22	7.92	8.30	510.0	2.0	<0.20	59.0	<30.0	18.0
92/09/02	7.79	10.80	610.0	<2.0	<0.20	65.0	<30.0	<10.0
92/09/16	8.10	7.80	70.0	<2.0	<0.20	70.0	<30.0	<10.0
I-80 /RM 4.7								
92/07/01	8.20	10.50	770.0	<2.0	<0.20	66.0	<30.0	<10.0
92/07/22	7.98	8.00	490.0	3.0	<0.20	50.0	<30.0	<10.0
92/09/02	8.00	10.80	50.0	<2.0	<0.20	60.0	<30.0	<10.0
92/09/16	8.20	8.60	60.0	<2.0	<0.20	66.0	<30.0	<10.0
Bagley Rd. /RM 3.5								
92/07/01	8.00	8.80	760.0	2.0	<0.20	64.0	<30.0	<10.0
92/07/22	8.09	9.00	520.0	2.0	<0.20	52.0	<30.0	<10.0
92/09/02	7.98	9.20	545.0	<2.0	<0.20	60.0	<30.0	<10.0
92/09/16	8.20	8.60	60.0	<2.0	<0.20	65.0	<30.0	<10.0
Adj. Lewis Rd. /RM 2.1								
92/07/01	8.40	10.20	790.0	<2.0	<0.20	61.0	<30.0	<10.0
92/07/22	8.14	8.70	530.0	3.0	<0.20	54.0	<30.0	<10.0
92/09/02	8.00	9.00	50.0	2.0	<0.20	58.0	<30.0	<10.0
92/09/16	8.20	8.20	505.0	<2.0	<0.20	64.0	<30.0	<10.0

Appendix Table 1. cont.

Stream Location /RM Date	pH	D.O.	Cond.	As	Cd	Ca	Cr	Cu
Lewis Rd. /RM 0.4								
92/07/01	8.30	7.40	750.0	<2.0	<0.20	59.0	<30.0	<10.0
92/07/22	8.18	8.70	530.0	2.0	<0.20	54.0	<30.0	<10.0
92/09/02	7.90	9.00	50.0	<2.0	<0.20	57.0	<30.0	<10.0
92/09/16	8.20	8.90	60.0	<2.0	<0.20	66.0	<30.0	13.0
East Branch Rocky River								
Harter Rd. /RM 26.6								
92/07/01	8.20	9.00	460.0	<2.0	<0.20	58.0	<30.0	<10.0
92/07/22	8.06	9.450	460.0	<2.0	<0.20	62.0	<30.0	<10.0
92/09/02	8.00	8.60	420.0	<2.0	<0.20	55.0	<30.0	<10.0
92/09/16	8.10	8.60	425.0	<2.0	<0.20	61.0	<30.0	<10.0
S.R. 303 /RM 21.9								
92/07/01	7.80	7.20	460.0	<2.0	<0.20	53.0	<30.0	<10.0
92/07/22	7.84	8.00	50.0	2.0	<0.20	48.0	<30.0	<10.0
92/09/02	7.80	8.40	380.0	<2.0	<0.20	44.0	<30.0	<10.0
92/09/16	8.00	6.40	40.0	<2.0	<0.20	51.0	<30.0	<10.0
Medina 300 WWTP mixing zone /RM 18.2								
92/07/01	7.40	8.00	633.0	<2.0	<0.20	57.0	<30.0	<10.0
92/07/22	7.79	8.70	60.0	<2.0	<0.20	53.0	<30.0	<10.0
92/09/02	7.80	8.50	470.0	<2.0	<0.20	50.0	<30.0	<10.0
92/09/16	7.90	8.10	50.0	<2.0	<0.20	56.0	<30.0	<10.0
S.R. 3 /RM 17.1								
92/07/01	7.40	6.60	541.0	2.0	<0.20	59.0	<30.0	<10.0
92/07/22	7.79	8.00	430.0	<2.0	<0.20	50.0	<30.0	<10.0
92/09/02	7.70	8.50	440.0	<2.0	<0.20	50.0	<30.0	<10.0
92/09/16	7.90	7.50	465.0	<2.0	<0.20	56.0	<30.0	<10.0
Bennett Rd. /RM 15.2								
92/07/01	7.30	7.00	667.0	<2.0	<0.20	58.0	<30.0	<10.0
92/07/22	7.75	8.10	465.0	2.0	<0.20	54.0	<30.0	<10.0
92/09/02	7.70	8.50	510.0	<2.0	<0.20	55.0	<30.0	<10.0
92/09/16	7.80	7.70	480.0	<2.0	<0.20	58.0	<30.0	<10.0
Mill Steam Run Rd. /RM 12.2								
92/07/01	7.80	7.30	563.0	<2.0	<0.20	60.0	<30.0	<10.0
92/07/22	7.91	8.30	510.0	<2.0	<0.20	56.0	<30.0	<10.0
92/09/02	7.70	8.90	40.0	<2.0	<0.20	58.0	<30.0	<10.0
92/09/16	7.90	8.10	575.0	<2.0	<0.20	60.0	<30.0	<10.0
Adj. Valley Parkway /RM 10.7								
92/07/01	7.70	8.50	747.0	<2.0	<0.20	61.0	<30.0	<10.0
92/07/22	8.13	8.70	480.0	2.0	<0.20	54.0	<30.0	<10.0
92/09/02	7.80	9.30	520.0	<2.0	<0.20	57.0	<30.0	<10.0
92/09/16	8.00	9.20	625.0	<2.0	<0.20	60.0	<30.0	<10.0
Park Blvd. ford /RM 6.4								
92/07/01	7.70	8.60	678.0	<2.0	<0.20	62.0	<30.0	<10.0
92/07/22	8.01	8.90	575.0	<2.0	<0.20	58.0	<30.0	<10.0
92/09/02	7.90	9.70	550.0	<2.0	<0.20	58.0	<30.0	<10.0
92/09/16	8.10	10.10	60.0	<2.0	<0.20	60.0	<30.0	<10.0

Appendix Table 1. cont.

Stream Location /RM Date	pH	D.O.	Cond.	As	Cd	Ca	Cr	Cu
Bridge St. /RM 4.9								
92/07/01	7.40	7.30	690.0	<2.0	<0.20	58.0	<30.0	<10.0
92/07/22	7.80	8.60	60.0	2.0	<0.20	60.0	<30.0	<10.0
92/09/02	7.70	9.10	570.0	<2.0	<0.20	57.0	<30.0	<10.0
92/09/16	7.80	8.30	635.0	<2.0	<0.20	61.0	<30.0	<10.0
Spafford Rd. /RM 1.3								
92/07/01	7.60	5.30	805.0	<2.0	0.30	61.0	<30.0	<10.0
92/07/22	7.92	8.10	650.0	<2.0	0.30	59.0	<30.0	<10.0
92/09/02	7.90	8.60	50.0	<2.0	<0.20	55.0	<30.0	11.0
92/09/16	7.90	7.90	70.0	<2.0	<0.20	61.0	<30.0	<10.0
Baldwin Creek								
Ust. North Royalton "B" WWTP /RM 7.4								
92/09/02	8.20	8.80	622.0	<2.0	<0.20	76.0	<30.0	<10.0
92/09/16	8.15	8.20	860.0	<2.0	<0.20	79.0	<30.0	<10.0
Abbey Rd. /RM 7.0								
92/07/01	7.47	7.70	80.0	<2.0	<0.20	57.0	<30.0	<10.0
92/07/22	8.10	6.50	70.0	<2.0	<0.20	59.0	<30.0	<10.0
92/09/02	8.00	8.20	586.0	<2.0	<0.20	65.0	<30.0	<10.0
92/09/16	7.50	6.80	80.0	<2.0	<0.20	62.0	<30.0	12.0
Bagley Rd. /RM 5.8								
92/07/01	7.85	8.20	740.0	<2.0	<0.20	64.0	<30.0	<10.0
92/07/22	8.50	7.90	580.0	<2.0	<0.20	67.0	<30.0	<10.0
92/09/02	8.00	8.50	702.0	<2.0	<0.20	77.0	<30.0	<10.0
92/09/16	7.80	8.60	690.0	<2.0	<0.20	69.0	<30.0	<10.0
Sprague Rd. /RM 3.0								
92/07/01	8.02	9.10	840.0	<2.0	<0.20	68.0	<30.0	<10.0
92/07/22	8.10	8.20	70.0	<2.0	<0.20	67.0	<30.0	<10.0
92/09/02	7.90	9.60	606.0	<2.0	<0.20	73.0	<30.0	<10.0
92/09/16	8.05	9.60	820.0	<2.0	<0.20	74.0	<30.0	<10.0
Main St. /RM 2.6								
92/07/01	7.79	7.0	830.0	<2.0	<0.20	64.0	<30.0	<10.0
92/07/22	8.10	6.50	70.0	<2.0	<0.20	67.0	<30.0	<10.0
92/09/02	7.70	7.90	545.0	<2.0	<0.20	65.0	<30.0	<10.0
92/09/16	7.40	6.40	80.0	<2.0	<0.20	69.0	<30.0	<10.0
Eastland Rd. /RM 1.4								
92/07/01	7.75	6.80	810.0	<2.0	<0.20	60.0	<30.0	<10.0
92/07/22	8.00	6.60	70.0	2.0	<0.20	68.0	<30.0	<10.0
92/09/02	7.60	8.30	670.0	<2.0	<0.20	67.0	<30.0	<10.0
92/09/16	7.35	7.20	810.0	<2.0	<0.20	70.0	<30.0	<10.0

Appendix Table 1. cont.

Stream Location /RM Date	pH	D.O.	Cond.	As	Cd	Ca	Cr	Cu
North Royalton "A" WWTP tributary								
Edgerton Rd. /RM 0.2								
92/07/01	7.30	7.20	690.0	<2.0	<0.20	52.0	<30.0	<10.0
92/0722	7.36	8.60	835.0	<2.0	<0.20	64.0	<30.0	<10.0
92/09/02	7.40	7.60	580.0	<2.0	<0.20	59.0	<30.0	<10.0
92/09/16	7.50	7.20	80.0	<2.0	<0.20	59.0	<30.0	<10.0
North Branch Rocky River								
Remsen Rd. /RM 5.5								
92/07/01	8.00	6.60	632.0	<2.0	<0.20	82.0	<30.0	<10.0
92/07/22	7.67	7.60	435.0	2.0	<0.20	61.0	<30.0	<10.0
92/09/02	7.80	8.50	510.0	<2.0	<0.20	68.0	<30.0	<10.0
92/09/16	7.90	7.90	550.0	<2.0	<0.20	77.0	<30.0	<10.0
Plum Creek								
S.R. 252 /RM 0.3								
92/07/01	8.00	4.80	650.0	2.0	<0.20	62.0	<30.0	<10.0
92/07/22	7.80	7.00	449.0	<2.0	<0.20	51.0	<30.0	<10.0
92/09/02	7.82	7.30	450.0	2.0	<0.20	55.0	<30.0	<10.0
92/09/16	8.00	6.80	480.0	<2.0	<0.20	54.0	<30.0	<10.0
Baker Creek								
Sprague Rd. /RM 0.3								
92/07/01	8.00	4.60	760.0	<2.0	<0.20	56.0	<30.0	<10.0
92/07/22	7.84	7.60	704.0	<2.0	<0.20	59.0	<30.0	<10.0
92/09/02	7.88	8.90	50.0	<2.0	<0.20	57.0	<30.0	<10.0
92/09/16	8.10	6.50	605.0	<2.0	<0.20	62.0	<30.0	<10.0
Blodgett Creek								
Linburgh Rd. /RM 0.1								
92/07/01	7.80	5.90	810.0	<2.0	<0.20	51.0	<30.0	<10.0
92/07/22	7.74	6.70	867.0	<2.0	<0.20	60.0	<30.0	<10.0
92/09/02	7.67	7.80	840.0	<2.0	<0.20	60.0	<30.0	<10.0
92/09/16	7.70	5.30	80.0	<2.0	<0.20	57.0	<30.0	<10.0
Mallet Creek								
Neff Rd. /RM 0.7								
92/07/01	8.30	7.20		<2.0	<0.20	72.0	<30.0	<10.0
92/07/22	8.02	8.70	490.0	<2.0	<0.20	66.0	<30.0	<10.0
92/09/02	8.01	9.90	60.0	<2.0	<0.20	68.0	<30.0	<10.0
92/09/16	8.30	7.20	510.0	<2.0	<0.20	65.0	<30.0	<10.0

Appendix Table 1. cont.

Stream Location /RM Date	Pb	Zn	Hard.	NO3	NO2	NH3	TKN	TSS
Rocky River								
Valley Parkway /RM 11.6								
92/07/01	< 2.0	< 10.0	220.0	3.120	0.390	0.500	1.50	9.0
92/07/22	3.0	63.0	188.0	1.580	0.060	0.110	0.60	86.0
92/09/02	< 2.0	< 10.0	202.0	1.870	0.160	0.270	0.90	7.0
92/09/16	< 2.0	< 10.0	235.0	3.290	0.200	0.080	0.80	< 5.0
North Olmsted WWTP mixing zone /RM 11.3								
92/07/01	< 2.0	< 10.0	212.0	9.820	0.370	0.330	3.20	< 5.0
92/07/22	< 2.0	17.0	193.0	2.890	0.070	0.10	1.10	77.0
92/09/02	< 2.0	21.0	217.0	4.680	0.100	0.240	2.80	< 5.0
92/09/16	< 2.0	< 10.0	235.0	4.210	0.280	0.210	1.30	< 5.0
Adj. Park Blvd. /RM 11.1								
92/07/01	< 2.0	11.0	221.0	6.430	0.350	0.230	2.20	< 5.0
92/07/22	2.0	13.0	177.0	1.370	0.070	0.110	0.60	94.0
92/09/02	< 2.0	15.0	207.0	2.680	0.140	0.250	1.30	7.0
92/09/16	< 2.0	< 10.0	232.0	3.300	0.280	0.180	0.80	< 5.0
near picnic area /RM 9.0								
92/07/01	< 2.0	< 10.0	213.0	3.880	0.320	0.060	0.90	< 5.0
92/07/22	3.0	15.0	188.0	1.910	0.100	0.090		84.0
92/09/02	< 2.0	16.0	20.0?	2.370	0.200	0.270	1.00	8.0
92/09/16	< 2.0	< 10.0	223.0	3.920	0.290	0.150	1.10	< 5.0
S.R. 10 /RM 5.8								
92/07/01	< 2.0	< 10.0	221.0	3.910	0.180	0.080	1.20	8.0
92/07/22	2.0	20.0	191.0	1.910	0.140	0.170	0.70	115.0
92/09/02	< 2.0	10.0	207.0	2.600	0.180	0.200	1.60	14.0
92/09/16	< 2.0	< 10.0	223.0	3.520	0.280	0.320	1.30	7.0
Park Blvd. /RM 3.0								
92/07/01	< 2.0	< 10.0	202.0	3.380	0.080	0.060	1.10	15.0
92/07/22	< 2.0	11.0	210.0	2.070	0.120	0.140	0.80	67.0
92/09/02	< 2.0	12.0	202.0	1.330	0.110	< 0.050	0.70	16.0
92/09/16	< 2.0	< 10.0	214.0	2.920	0.100	< 0.050	0.70	7.0
Grayton Rd. /RM 1.9								
92/07/01	< 2.0	< 10.0	20.0	5.340	0.810	3.060	4.50	9.0
92/07/22	< 2.0	16.0	248.0	4.010	0.830	2.800	4.00	15.0
92/09/02	< 2.0	14.0	233.0	3.000	0.590	3.000	4.10	< 5.0
92/09/16	< 2.0	64.0	228.0	6.080	0.810	1.070	2.40	< 5.0
West Area Rd. /RM 0.3								
92/07/01	< 2.0	< 10.0	196.0	6.180	0.840	1.050	2.20	< 5.0
92/07/22	< 2.0	< 10.0	244.0	5.520	1.110	1.530	2.10	8.0
92/09/02	< 2.0	18.0	224.0	4.910	0.640	1.040	2.00	< 5.0
92/09/16	< 2.0	10.0	202.0	5.470	0.320	0.140	1.10	< 5.0

Appendix Table 1. cont.

Stream Location /RM Date	Pb	Zn	Hard.	NO3	NO2	NH3	TKN	TSS
West Branch Rocky River								
S.R. 162 /RM 33.5								
92/07/01	< 2.0	< 10.0	284.0	0.280	0.040	0.090	0.40	17.0
92/07/22	< 2.0	12.0	155.0	1.660	0.080	< 0.050	0.40	25.0
92/09/02	< 2.0	< 10.0	227.0	0.250	< 0.020	< 0.050	0.60	11.0
92/09/16	< 2.0	< 10.0	246.0	0.230	0.020	< 0.050	0.40	< 5.0
Ridgewood Rd. /RM 33.3								
92/07/01	< 2.0	< 10.0	318.0	0.370	0.040	0.090	0.50	16.0
92/07/22	< 2.0	< 10.0	160.0	1.700	< 0.020	< 0.050	0.60	32.0
92/09/02	< 2.0	< 10.0	236.0	0.360	0.020	0.190	0.70	10.0
92/09/16	< 2.0	< 10.0	260.0	0.410	0.050	< 0.050	0.06	7.0
Fenn Rd. /RM 27.3								
92/07/01	< 2.0	< 10.0	319.0	<10?	0.020	< 0.050	0.40	9.0
92/07/22	< 2.0	< 10.0	198.0	0.870	0.030	< 0.050	0.50	35.0
92/09/02	< 2.0	< 10.0	250.0	0.270	< 0.020	< 0.050	0.50	< 5.0
92/09/16	< 2.0	< 10.0	291.0	0.110	< 0.020	< 0.050	0.30	8.0
Grafton Rd. /RM 16.4??								
92/07/01	< 2.0	< 10.0	240.0	<10?	0.020	< 0.050	0.40	13.0
92/07/22	< 2.0	12.0	193.0	0.860	0.030	< 0.050	0.50	36.0
92/09/02	< 2.0	107.0	217.0	0.170	< 0.020	< 0.050	0.50	< 5.0
92/09/16	< 2.0	10.0	246.0	<10?	< 0.020	< 0.050	0.40	< 5.0
Adj.. West River Rd. /RM 14.8								
92/07/01	< 2.0	< 10.0	238.0	7.290	0.020	0.050	1.00	8.0
92/07/22	< 2.0	< 10.0	20.0	0.930	0.030	< 0.050	0.40	50.0
92/09/02	< 2.0	< 10.0	226.0	2.760	< 0.020	< 0.050	0.90	< 5.0
92/09/16	< 2.0	10.0	248.0	2.880	< 0.020	< 0.050	0.40	5.0
Adj.. West River Rd. /RM 13.3								
92/07/01	< 2.0	< 10.0	243.0	10.600	0.040	0.100	1.40	22.0
92/07/22	< 2.0	98.0	205.0	1.540	0.030	< 0.050	0.40	56.0
92/09/02	< 2.0	< 10.0	228.0	2.970	< 0.020	< 0.050	0.90	< 5.0
92/09/16	< 2.0	< 10.0	253.0	4.720	0.020	< 0.050	0.70	6.0
I-80 /RM 4.7								
92/07/01	< 2.0	< 10.0	239.0	3.280	0.050	0.050	0.80	8.0
92/07/22	2.0	< 10.0	170.0	1.220	0.030	0.080	0.60	59.0
92/09/02	< 2.0	14.0	207.0	1.860	< 0.020	< 0.050	0.70	7.0
92/09/16	< 2.0	< 10.0	235.0	2.940	0.020	< 0.050	0.50	5.0
Bagley Rd. /RM 3.5								
92/07/01	< 2.0	< 10.0	234.0	3.090	0.490	1.480	2.50	< 5.0
92/07/22	< 2.0	10.0	183.0	<10?	0.060	< 0.050	0.70	58.0
92/09/02	< 2.0	< 10.0	207.0	1.790	0.080	0.390	0.90	< 5.0
92/09/16	< 2.0	< 10.0	236.0	3.330	0.120	0.360	0.90	< 5.0
Adj. Lewis Rd. /RM 2.1								
92/07/01	< 2.0	< 10.0	218.0	3.550	0.350	0.100	1.00	< 5.0
92/07/22	< 2.0	< 10.0	188.0	1.350	0.070	0.120	0.60	54.0
92/09/02	< 2.0	< 10.0	202.0	1.790	0.140	0.330	0.90	< 5.0
92/09/16	< 2.0	< 10.0	234.0	3.460	0.210	0.300	0.90	< 5.0

Appendix Table 1. cont.

Stream Location /RM Date	Pb	Zn	Hard.	NO3	NO2	NH3	TKN	TSS
Lewis Rd. /RM 0.4								
92/07/01	< 2.0	< 10.0	221.0	3.090	0.220	0.050	0.80	8.0
92/07/22	3.0	13.0	188.0	1.440	0.080	0.100	0.20	58.0
92/09/02	< 2.0	< 10.0	20.0?	1.970	0.150	0.300	1.10	< 5.0
92/09/16	< 2.0	18.0	239.0	3.560	0.180	0.140	0.70	< 5.0
East Branch Rocky River								
Harter Rd. /RM 26.6								
92/07/01	< 2.0	< 10.0	202.0	0.390		0.050	0.20	28.0
92/07/22	< 2.0	< 10.0	212.0	0.680	< 0.020	< 0.050	0.20	10.0
92/09/02	< 2.0	< 10.0	183.0	0.580	< 0.020	< 0.050	0.30	6.0
92/09/16	< 2.0	< 10.0	206.0	0.510	0.020	< 0.050	0.20	< 5.0
S.R. 303 /RM 21.9								
92/07/01	< 2.0	< 10.0	190.0	0.230	0.030	0.070	0.40	32.0
92/07/22	< 2.0	10.0	165.0	0.710	0.040	< 0.050	0.40	40.0
92/09/02	< 2.0	< 10.0	147.0	0.290	< 0.020	< 0.050	0.40	30.0
92/09/16	< 2.0	< 10.0	173.0	0.310	0.020	< 0.050	0.30	33.0
Medina 300 WWTP mixing zone /RM 18.2								
92/07/01	< 2.0	< 10.0	204.0	3.650	0.020	0.050	0.60	27.0
92/07/22	< 2.0	12.0	190.0		0.020	< 0.050	0.60	26.0
92/09/02	< 2.0	< 10.0	170.0	1.730	0.020	< 0.050	0.50	20.0
92/09/16	< 2.0	13.0	193.0	2.690	0.020	< 0.050	0.40	16.0
S.R. 3 /RM 17.1								
92/07/01	< 2.0	< 10.0	209.0	5.350	0.040	0.070	0.70	32.0
92/07/22	< 2.0	14.0	174.0	1.290	0.030	< 0.050	0.40	50.0
92/09/02	< 2.0	< 10.0	170.0	0.900	< 0.020	< 0.050	0.40	30.0
92/09/16	< 2.0	11.0	193.0	1.770	0.020	< 0.050	0.30	21.0
Bennett Rd. /RM 15.2								
92/07/01	< 2.0	< 10.0	207.0	2.520	0.030	0.070	0.50	30.0
92/07/22	< 2.0	14.0	188.0	2.040	0.030	< 0.050	0.30	38.0
92/09/02	< 2.0	11.0	187.0	1.940	0.020	< 0.050	0.50	22.0
92/09/16	< 2.0	16.0	202.0	1.770	0.020	< 0.050	0.30	12.0
Mill Steam Run Rd. /RM 12.2								
92/07/01	< 2.0	< 10.0	216.0	3.960	0.050	0.080	0.50	21.0
92/07/22	< 2.0	26.0	197.0	2.320	0.030	< 0.050	0.40	36.0
92/09/02	< 2.0	< 10.0	198.0	1.920	0.020	< 0.050	0.50	13.0
92/09/16	< 2.0	< 10.0	207.0	2.820	0.020	< 0.050	0.40	9.0
Adj. Valley Parkway /RM 10.7								
92/07/01	< 2.0	< 10.0	214.0	7.350	0.070	0.060	0.70	11.0
92/07/22	< 2.0	< 10.0	192.0	1.950	0.030	< 0.050	0.40	34.0
92/09/02	< 2.0	< 10.0	196.0	2.020	< 0.020	< 0.050	0.40	10.0
92/09/16	< 2.0	< 10.0	212.0	4.140	0.030	< 0.050	0.20	< 5.0
Park Blvd. ford /RM 6.4								
92/07/01	< 2.0	< 10.0	221.0	4.890	0.050	< 0.050	0.70	< 5.0
92/07/22	< 2.0	< 10.0	207.0	2.170	0.030	< 0.050	0.60	30.0
92/09/02	< 2.0	< 10.0	198.0	1.970	< 0.020	< 0.050	0.40	7.0
92/09/16	< 2.0	< 10.0	212.0	2.230	0.020	< 0.050	0.20	< 5.0

Appendix Table 1. cont.

Stream Location /RM Date	Pb	Zn	Hard.	NO3	NO2	NH3	TKN	TSS
Bridge St. /RM 4.9								
92/07/01	< 2.0	< 10.0	211.0	2.760	0.080	0.080	0.80	59.0
92/07/22	3.0	17.0	216.0	1.970	0.040	0.050	0.30	80.0
92/09/02	< 2.0	< 10.0	196.0	1.490	0.020	0.060	0.50	42.0
92/09/16	< 2.0	15.0	218.0	2.600	0.040	0.010	0.20	55.0
Spafford Rd. /RM 1.3								
92/07/01	< 2.0	10.0	222.0	2.990	0.620	2.350	3.10	7.0
92/07/22	< 2.0	< 10.0	205.0	2.340	0.120	0.260	0.70	335.0
92/09/02	< 2.0	52.0	195.0	2.130	0.170	0.700	1.30	15.0
92/09/16	< 2.0	< 10.0	218.0	2.810	0.260	0.460	0.60	12.0
Baldwin Creek								
Ust. North Royalton "B" WWTP /RM 7.4								
92/09/02	< 2.0	112.0	280.0	4.380	< 0.020	< 0.050	0.50	< 5.0
92/09/16	< 2.0	< 10.0	304.0	0.10?	< 0.020	< 0.050	0.20	< 5.0
Abbey Rd. /RM 7.0								
92/07/01	< 2.0	22.0	208.0	14.300	0.090	0.160	0.90	< 5.0
92/07/22	< 2.0	15.0	213.0	8.730	0.040	< 0.050	0.90	6.0
92/09/02	< 2.0	25.0	236.0	4.380	< 0.020	< 0.050	0.80	< 5.0
92/09/16	< 2.0	27.0	233.0	13.80	0.020	< 0.050	1.00	< 5.0
Bagley Rd. /RM 5.8								
92/07/01	< 2.0	< 10.0	234.0	5.200	0.110	0.110	0.80	< 5.0
92/07/22	4.0	< 10.0	241.0	2.610	0.050	< 0.050	0.40	10.0
92/09/02	< 2.0	13.0	279.0	3.360	0.040	0.070	0.60	< 5.0
92/09/16	< 2.0	< 10.0	259.0	6.290	0.050	< 0.050	0.60	< 5.0
Sprague Rd. /RM 3.0								
92/07/01	< 2.0	< 10.0	252.0	4.550	0.060	0.050	0.70	< 5.0
92/07/22	< 2.0	< 10.0	237.0	2.100	0.030	< 0.050	0.30	< 5.0
92/09/02	< 2.0	< 10.0	265.0	2.490	0.020	< 0.050	0.50	< 5.0
92/09/16	< 2.0	< 10.0	275.0	4.990	0.030	< 0.050	0.50	< 5.0
Main St. /RM 2.6								
92/07/01	< 2.0	< 10.0	238.0	7.290	0.060	0.110	0.80	7.0
92/07/22	< 2.0	< 10.0	241.0	4.820	0.030	< 0.050	0.70	8.0
92/09/02	< 2.0	10.0	236.0	4.820	0.020	0.260	1.10	< 5.0
92/09/16	< 2.0	< 10.0	255.0	8.430	0.060	< 0.050	1.50	< 5.0
Eastland Rd. /RM 1.4								
92/07/01	< 2.0	< 10.0	224.0	7.300	0.060	0.140	1.12	9.0
92/07/22	< 2.0	< 10.0	244.0	5.430	0.040	< 0.050	0.80	10.0
92/09/02	< 2.0	19.0	241.0		0.060	0.070	1.00	< 5.0
92/09/16	< 2.0	< 10.0	257.0	8.010	0.110	0.060	1.00	< 5.0
North Royalton "A" WWTP tributary								
Edgerton Rd. /RM 0.2								
92/07/01	< 2.0	23.0	187.0	15.60	0.110	0.180	1.10	18.0
92/07/22	< 2.0	23.0	230.0	12.40	0.030	< 0.050	0.80	8.0
92/09/02	< 2.0	16.0	209.0	2.720	0.090		1.40	< 5.0
92/09/16	< 2.0	26.0	209.0	14.10	0.030	< 0.050	1.00	< 5.0

Appendix Table 1. cont.

Stream Location /RM Date	Pb	Zn	Hard.	NO3	NO2	NH3	TKN	TSS
North Branch Rocky River								
Remsen Rd. /RM 5.5								
92/07/01	< 2.0	< 10.0	283.0	0.360	0.030	0.070	0.60	7.0
92/07/22	< 2.0	< 10.0	202.0	0.960	0.030	< 0.050	0.80	14.0
92/09/02	< 2.0	< 10.0	227.0	0.440	0.020	< 0.050	0.70	8.0
92/09/16	< 2.0	< 10.0	258.0	0.430	< 0.020	< 0.050	0.30	< 5.0
Plum Creek								
S.R. 252 /RM 0.3								
92/07/01	< 2.0	< 10.0	221.0	3.650	0.260	0.370	1.20	< 5.0
92/07/22	< 2.0	< 10.0	177.0	2.980	0.120	0.250	1.10	16.0
92/09/02	< 2.0	17.0	191.0	2.760	0.060	0.230	1.20	10.0
92/09/16	< 2.0	< 10.0	188.0	3.340	0.070	< 0.050	1.0	< 5.0
Baker Creek								
Sprague Rd. /RM 0.3								
92/07/01	< 2.0	< 10.0	222.0	0.350	< 0.020	0.180	0.70	6.0
92/07/22	< 2.0	< 10.0	221.0	0.680	0.030	0.360	1.00	6.0
92/09/02	< 2.0	10.0	212.0	0.740	< 0.020	< 0.050	0.60	< 5.0
92/09/16	< 2.0	< 10.0	237.0	0.540	0.020	< 0.050	0.40	< 5.0
Blodgett Creek								
Linburgh Rd. /RM 0.1								
92/07/01	< 2.0	< 10.0	201.0	1.710	0.350	9.860	9.80	< 5.0
92/07/22	< 2.0	29.0	232.0	1.620	0.550	7.0	8.60	12.0
92/09/02	< 2.0	41.0	236.0	2.160	0.550		8.20	< 5.0
92/09/16	< 2.0	22.0	225.0	2.430	0.650	6.540	7.70	< 5.0
Mallet Creek								
Neff Rd. /RM 0.7								
92/07/01	< 2.0	< 10.0	262.0	<10?	0.020	< 0.050	0.40	< 5.0
92/07/22	< 2.0	< 10.0	235.0	0.480	< 0.020	< 0.050	0.50	< 5.0
92/09/02	< 2.0	< 10.0	248.0	<10?	< 0.020	< 0.050	0.40	< 5.0
92/09/16	< 2.0	< 10.0	232.0	0.100	< 0.020	< 0.050	0.30	< 5.0

Appendix Table 1. cont.

Stream Location /RM Date	Fecal	TDS	P	COD
Rocky River				
Valley Parkway /RM 11.6				
92/07/01		524.0	0.080	28.0
92/07/22		337.0	0.130	25.0
92/09/02		390.0	0.080	23.0
92/09/16		450.0	0.090	22.0
92/10/29	250			
North Olmsted WWTP mixing zone /RM 11.3				
92/07/01		556.0	0.440	51.0
92/07/22		910.0	0.080	34.0
92/09/02		572.0	0.410	41.0
92/09/16		482.0	0.130	20.0
Adj. Park Blvd. /RM 11.1				
92/07/01		548.0	0.320	38.0
92/07/22		344.0	0.060	24.0
92/09/02		485.0	0.160	29.0
92/09/16		454.0	0.070	21.0
92/10/29	500			
near picnic area /RM 9.0				
92/07/01		508.0	4.940	27.0
92/07/22		380.0	0.120	24.0
92/09/02		434.0	0.10	23.0
92/09/16		458.0	0.10	19.0
92/10/29	440			
S.R. 10 /RM 5.8				
92/07/01		526.0	0.10	21.0
92/07/22		378.0	0.110	23.0
92/09/02		438.0	0.090	23.0
92/09/16		452.0	0.130	25.0
92/10/29	1030			
Park Blvd. /RM 3.0				
92/07/01		428.0	0.120	27.0
92/07/22		412.0	0.080	24.0
92/09/02		430.0	0.080	24.0
92/09/16		432.0	0.10	20.0
92/10/29	480			
Abram Creek				
Grayton Rd. /RM 1.9				
92/07/01		536.0	0.520	34.0
92/07/22		618.0	0.180	75.0
92/09/02		594.0	0.180	32.0
92/09/16		624.0	0.160	24.0
92/10/29	12,000			

Appendix Table 1. cont.

Stream Location /RM Date	Fecal	TDS	P	COD
West Area Rd. /RM 0.3				
92/07/01		50.0	0.220	30.0
92/07/22		612.0	0.210	28.0
92/09/02		570.0	0.130	26.0
92/09/16		438.0	0.090	16.0
92/10/29	1350			
West Branch Rocky River				
S.R. 162 /RM 33.5				
92/07/01		430.0	< 0.050	16.0
92/07/22		298.0	0.050	27.0
92/09/02		394.0	< 0.050	25.0
92/09/16		416.0	< 0.050	19.0
Ridgewood Rd. /RM 33.3				
92/07/01		548.0	< 0.050	29.0
92/07/22		498.0	< 0.050	28.0
92/09/02		428.0	< 0.050	27.0
92/09/16		448.0	< 0.050	16.0
Fenn Rd. /RM 27.3				
92/07/01		574.0	< 0.050	22.0
92/07/22		374.0	< 0.050	30.0
92/09/02		402.0	0.050	24.0
92/09/16		482.0	< 0.050	17.0
92/10/28	240			
Grafton Rd. /RM 16.4				
92/07/01		482.0	< 0.050	19.0
92/07/22		348.0	< 0.050	44.0
92/09/02		376.0	< 0.050	21.0
92/09/16		410.0	0.060	17.0
92/10/28	310			
Adj.. West River Rd. /RM 14.8				
92/07/01		576.0	0.090	22.0
92/07/22		354.0	< 0.050	35.0
92/09/02		468.0	0.090	22.0
92/09/16		486.0	0.270	22.0
92/10/28	106			
Adj.. West River Rd. /RM 13.3				
92/07/01		641.0	0.120	26.0
92/07/22		368.0	0.070	39.0
92/09/02		472.0	0.080	23.0
92/09/16		506.0	0.190	19.0
92/10/28	200			

Appendix Table 1. cont.

Stream Location /RM Date	Fecal	TDS	P	COD
I-80 /RM 4.7				
92/07/01		522.0	0.050	23.0
92/07/22		358.0	< 0.050	30.0
92/09/02		395.0	0.070	22.0
92/09/16		430.0	0.080	19.0
92/10/28	1200			
Bagley Rd. /RM 3.5				
92/07/01		532.0	0.110	29.0
92/07/22		360.0	0.130	30.0
92/09/02		392.0	0.090	25.0
92/09/16		438.0	0.090	22.0
92/10/28	920			
Adj. Lewis Rd. /RM 2.1				
92/07/01		496.0	0.070	24.0
92/07/22		356.0	0.050	27.0
92/09/02		392.0	0.090	24.0
92/09/16		448.0	0.090	22.0
Lewis Rd. /RM 0.4				
92/07/01		504.0	0.110	29.0
92/07/22		350.0	3.040	34.0
92/09/02		394.0	0.080	21.0
92/09/16		454.0	0.180	16.0
92/10/28	590			
92/10/29	340			
East Branch Rocky River				
Harter Rd. /RM 26.6				
92/07/01		362.0	< 0.050	15.0
92/07/22		362.0	< 0.050	17.0
92/09/02		304.0	0.080	17.0
92/09/16		320.0	< 0.050	<10.0
92/10/13	270			
S.R. 303 /RM 21.9				
92/07/01		360.0	0.080	16.0
92/07/22		297.0	< 0.050	22.0
92/09/02		254.0	0.110	26.0
92/09/16		272.0	< 0.050	22.0
Medina 300 WWTP mixing zone /RM 18.2				
92/07/01		40.0	0.060	17.0
92/07/22		414.0	0.080	20.0
92/09/02		328.0	< 0.050	18.0
92/09/16		348.0	< 0.050	29.0

Appendix Table 1. cont.

Stream Location /RM Date	Fecal	TDS	P	COD
S.R. 3 /RM 17.1				
92/07/01		435.0	0.050	18.0
92/07/22		330.0	< 0.050	21.0
92/09/02		294.0	< 0.050	26.0
92/09/16		336.0	0.050	43.0
92/10/13	390			
Bennett Rd. /RM 15.2				
92/07/01		426.0	0.050	19.0
92/07/22		350.0	< 0.050	24.0
92/09/02		336.0	< 0.050	21.0
92/09/16		360.0	< 0.050	26.0
92/10/13	400			
Mill Steam Run Rd. /RM 12.2				
92/07/01		426.0	0.080	15.0
92/07/22		376.0	< 0.050	20.0
92/09/02		344.0	< 0.050	24.0
92/09/16		382.0	0.060	25.0
92/10/13	1660			
Adj.. Valley Parkway /RM 10.7				
92/07/01		452.0	0.080	19.0
92/07/22		368.0	< 0.050	20.0
92/09/02		360.0	< 0.050	22.0
92/09/16		406.0	< 0.050	26.0
92/10/13	570			
Park Blvd. ford /RM 6.4				
92/07/01		466.0	0.310	21.0
92/07/22		410.0	< 0.050	22.0
92/09/02		374.0	< 0.050	21.0
92/09/16		402.0	< 0.050	32.0
92/10/13	690			
Bridge St. /RM 4.9				
92/07/01		474.0	0.070	18.0
92/07/22		416.0	< 0.050	22.0
92/09/02		380.0	< 0.050	19.0
92/09/16		434.0	< 0.050	30.0
92/10/13	680			
Spafford Rd. /RM 1.4				
92/07/01		552.0	0.130	27.0
92/07/22		446.0	< 0.050	23.0
92/09/02		412.0	0.060	22.0
92/09/16		462.0	< 0.050	30.0
92/10/29	130			
92/10/13	6100			

Appendix Table1. cont.

Stream Location /RM Date	Fecal	TDS	P	COD
Baldwin Creek				
Ust. North Royalton "B" WWTP /RM 7.4				
92/09/02		534.0	0.060	18.0
92/09/16		448.0	< 0.050	14.0
Abbey Rd. /RM 7.0				
92/07/01		538.0	0.240	22.0
92/07/22		502.0	0.10	23.0
92/09/02		504.0	0.10	22.0
92/09/16		544.0	0.130	20.0
Bagley Rd. /RM 5.8				
92/07/01		496.0	0.130	21.0
92/07/22		510.0	1.720	22.0
92/09/02		554.0	0.110	16.0
92/09/16		496.0	0.30	11.0
Sprague Rd. /RM 3.0				
92/07/01		548.0	0.10	19.0
92/07/22		512.0	0.160	18.0
92/09/02		538.0	0.070	18.0
92/09/16		562.0	0.090	18.0
92/10/13	1070			
Main St./ RM 2.6				
92/07/01		550.0	0.940	23.0
92/07/22		506.0	0.090	29.0
92/09/02		498.0	0.20	28.0
92/09/16		530.0	0.280	30.0
Eastland Rd. /RM 1.4				
92/07/01		530.0	0.20	23.0
92/07/22		506.0	0.070	30.0
92/09/02		50.0	0.140	23.0
92/09/16		524.0	0.180	21.0
92/10/13	2100			
North Royalton "A" WWTP tributary				
Edgerton Rd. /RM 0.2				
92/07/01		512.0	0.360	23.0
92/07/22		574.0	0.130	23.0
92/09/02		494.0	0.220	27.0
92/09/16		522.0	0.70	26.0
North Branch Rocky River				
Remsen Rd. /RM 5.5				
92/07/01		482.0	< 0.050	33.0
92/07/22		352.0	< 0.050	35.0
92/09/02		376.0	< 0.050	32.0
92/09/16		434.0	< 0.050	37.0
92/10/28	310			

Appendix Table1. cont.

Stream Location /RM Date	Fecal	TDS	P	COD
Plum Creek				
S.R. 252 /RM 0.3				
92/07/01		420.0	0.880	36.0
92/07/22		340.0	0.480	38.0
92/09/02		372.0	0.470	32.0
92/09/16		380.0	0.540	20.0
92/10/28	8400			
Baker Creek				
Sprague Rd. /RM 0.3				
92/07/01		488.0	0.070	29.0
92/07/22		496.0	< 0.050	26.0
92/09/02		416.0	0.050	22.0
92/09/16		472.0	0.070	19.0
92/10/28	5000			
Blodgett Creek				
Linburgh Rd. /RM 0.1				
92/07/01		524.0	0.640	45.0
92/07/22		607.0	0.970	41.0
92/09/02		594.0	0.340	34.0
92/09/16		552.0	0.370	27.0
92/10/28	21,800			
Mallet Creek				
Neff Rd. /RM 0.7				
92/07/01		420.0	< 0.050	19.0
92/07/22		378.0	< 0.050	43.0
92/09/02		434.0	< 0.050	19.0
92/09/16		390.0	< 0.050	21.0
92/10/28	120			

Appendix Table 2. Summary of dissolved oxygen measurements recorded with Datasonde© continuous monitors at 10 locations in the Rocky River Basin from August 25 to August 28, 1992

River Mile	Total Hours	Mean (mg/l)	Median (mg/l)	Minimum (mg/l)	Maximum (mg/l)	25th %ile (mg/l)	75th %ile (mg/l)
Rocky River							
11.35	68	8.08	8.02	6.74	9.99	7.68	8.33
9.3	69	7.68	7.86	5.85	9.85	7.08	8.1
East Branch							
18.0	77	6.91	7.3	4.89‡	8.29	6.06	7.415
17.0	53	7.17	7.16	6.58	8.0	7.015	7.23
15.3	52	7.49	7.41	6.92	8.33	7.28	7.62
13.0	57	8.29	8.16	7.95	9.53	8.05	8.27
West Branch							
14.9	66	7.67	7.58	6.57	10.61	7.04	7.77
13.8	67	7.47	7.55	6.94	8.18	7.17	7.71
12.32	67	6.58	6.68	5.37	8.67	6.05	7.13
11.5	55	7.93	8.01	6.83	8.67	7.39	8.2

‡ violation of the average dissolved oxygen (D.O.) criterion.
‡‡ violation of the minimum dissolved oxygen (D.O.) criterion.
‡‡‡ violation of the "nuisance prevention" minimum dissolved oxygen (D.O.) criterion.