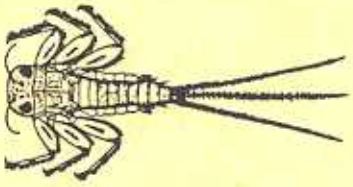
State of Ohio
Environmental Protection Agency

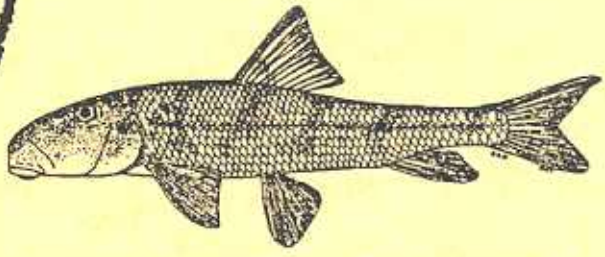
Southwest District Office &
Ecological Assessment Section
Division of Surface Water

Biological and Water Quality Study of Mill Creek and Tributaries

Butler and Hamilton Counties, Ohio



Mayfly (*Stenonema sp.*)



Hog Sucker (*Hypentelium nigricans*)

April 15, 1994

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P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43266-0149

Biological and Water Quality Study of Mill Creek And Tributaries

Butler and Hamilton Counties, Ohio

Volume 1

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prepared by

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

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 - DSW
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1685 Westbelt Drive
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Biological and Water Quality Survey of Mill Creek
(Butler and Hamilton Counties, Ohio)

Ohio Environmental Protection Agency
Division of Surface Water
1800 WaterMark Drive
Columbus, Ohio 43266-0149

Introduction

During 1992, Ohio EPA conducted its first comprehensive water quality survey of the Mill Creek basin. Some prior biological sampling had been conducted in the basin during the late 1980s and early 1990s as well as chemical data from the late 1970s and early 1980s, but none of the previous sampling covered the extent of the 1992 survey. The 1992 Mill Creek study area extended from upstream, northeast of the City of Fairfield (RM 26.35) in Butler county to downstream, near the confluence with the Ohio River (RM 0.3, 472.5) in Hamilton County. The main channel of Mill Creek and several of its tributaries were sampled. Twenty-nine sites were selected for weekly water chemistry analyses, 21 sites were assessed for biological quality and 19 sites were sampled for sediment chemistry assessment during the 1992 survey (Table 1).

Specific objectives of this evaluation were to:

1) Evaluate the physical, chemical and biological water quality in the Mill Creek basin.

2) Evaluate the existing aquatic life use designations of Mill Creek and its tributaries and determine use designations for several undesignated streams.

3) Evaluate potential impacts from point source dischargers, combined sewer overflows, and nonpoint sources (i.e. old landfills, industrial sites).

4) Identify pollution sources not previously identified.

This survey was not designed to isolate individual dischargers or point sources through water quality assessment because the extent of those sources is so great within the lower 17 miles of the stream. The survey was designed to evaluate the water quality in sections or reaches of the creek. 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).

Table 1. Sampling locations in the Mill Creek study area, 1992.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Mill Creek				
26.35/26.4	C/F,B,S	39°22'44"/84°28'44"	Liberty-Fairfd Rd.	Trenton, OH
24.64	S	39°21'43"/84°29'47"	Hamtn-Tylsvil. Rd.	Trenton, OH
19.05/19.1	C/F,B	39°18'18"/84°26'07"	Windisch Rd.	Glendale, OH
17.61/17.6	C/F,B	39°17'03"/84°25'58"	Kemper Rd.	Glendale, OH
16.57	C,S/F,B,FT	39°16'06"/84°25'56"	Sharon Rd.	Glendale, OH
14.75/14.8	C/F,B,S	39°14'47"/84°25'44"	Formica entrance	Cincinnati E., OH
13.89	S	39°14'14"/84°26'22"	Upst G.E. Trib.	Cincinnati E., OH
13.72	S	39°14'07"/84°26'26"	Adj. Cincin. Drum	Cincinnati E., OH
13.35/13.2/13.13	C/F,B/S	39°13'45"/84°26'46"	West Columbia Rd.	Cincinnati E., OH
11.73	C	39°12'43"/84°27'15"	Galbraith Rd.	Cincinnati E., OH
9.97	C	39°12'16"/84°28'15"	Vine St.	Cincinnati E., OH
8.92/9.02	C/S	39°11'56"/84°29'18"	North Bend Rd.	Cincinnati E., OH
8.7	F,B	39°11'48"/84°29'22"	State Route 561	Cincinnati E., OH
8.38	S	39°11'31"/84°29'21"	Ridgewood Arsenal	Cincinnati E., OH
7.8/7.86/7.85	F, B,FT/S/C	39°11'07"/84°29'45"	Center Hill Rd.	Cincinnati E., OH
6.53	C	39°10'19"/84°30'21"	Spring Grove Ave.	Cincinnati W.,OH
5.85	C	39°09'50"/84°30'39"	Mitchell Ave.	Cincinnati W.,OH
5.2/5.1/4.9	S/F,B/C	39°09'44"/84°31'24"	Salway Park	Cincinnati W.,OH
3.1/2.9	F,B/C,S	39°08'39"/84°32'52"	Upst. Hopple St.	Cincinnati W.,OH
0.51/0.5	C/S	39°06'27"/84°32'41"	Gest St.	Covington, KY
0.3	F,B,FT	39°06'20"/84°32'42"	Upst. Barrier Dam	Covington, KY
East Fork Mill Creek				
4.7/4.69	F,B/C	39°20'00"/84°23'30"	Barret Rd.	Glendale, OH
3.8/3.78	F,B/C	39°19'50"/84°24'22"	Station Rd.	Glendale, OH
1.9/1.85	F,B/C,S	39°19'47"/84°25'36"	Allen Rd.	Glendale, OH
0.8/0.77	F,B/C	39°17'55"/84°25'47"	Cresentville Rd.	Glendale, OH
0.3	F	39°17'32"/84°25'51"	Dst. Lowhead Dam	Glendale, OH
0.1/0.01	S,B/C	39°17'23"/84°26'01"	Mouth	Glendale, OH
West Fork Mill Creek				
4.5/4.45/4.4	F,B,/S/C	39°15'14"/84°28'14"	Riddle Rd.	Glendale, OH
2.0	F,B,C,S	39°13'49"/84°27'26"	Gardner Park	Cincinnati E., OH
1.0	F,B	39°13'15"/84°27'23"	Dst. I-75 (S)	Cincinnati E., OH
0.2/0.1	F,B,C/S	39°12'48"/84°27'34"	Dexter Ave.	Cincinnati E., OH

Table 1 (continued). Sampling locations in the Mill Creek study area, 1992.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Sharon Creek				
0.2	F,B	39°15'37"/84°25'25"	Exon Ave.	Glendale, OH
0.01	C	39°15'29"/84°25'32"	Mouth	Gendale, OH
Town Run				
0.7	C	39°16'26"/84°26'41"	Chester Rd.	Glendale, OH
Cooper Creek				
3.64	C	39°13'09"/84°23'32"	Plainfield Rd.	Cincinnati E., OH
0.2	C	39°14'17"/84°25'58"	Ust. of Mouth	Cincinnati E., OH
Bloody Run				
0.31	C	39°10'57"/84°29'33"	Vine St.	Cincinnati E., OH
Ross Run				
0.01	C	39°10'14"/84°30'22"	Mouth	Cincinnati W., OH
Winton Ridge Tributary				
1.81	S	39°11'28"/84°31'18"	Upst. Dutch Colony	Cincinnati W., OH

C - water chemistry
S - sediment chemistry
B - benthos
F - fish
FT - fish tissue

Summary of Results

Aquatic Life Use Designations

Mill Creek

- Under the existing aquatic life use designations of Warmwater Habitat (WWH) for river miles 26.4 through 19.1, Mill Creek exhibits both full attainment and non-attainment of its use designation (Table 2). Non-attainment was documented at river mile 19.1. Channel modifications were documented from river mile 24.64 through 8.38 which influenced the aquatic communities in this region. From river mile 17.6 through 0.3 Mill Creek is presently designated Limited Warmwater Habitat (LWH). Limited Warmwater Habitat was a designation temporarily assigned in 1978 to streams not meeting specific Warmwater Habitat criteria. Variances from some of the individual chemical criteria regulated within the State of Ohio Water Quality Standards (OAC 3745-1) were assigned on a temporary basis due to extreme instream chemical conditions. Once streams designated LWH undergo use attainability analyses, a redesignation will be given based on current aquatic life classification. The designation of Limited Warmwater Habitat will no longer be assigned to any body of water as per OAC 3745-1.

- Under the **proposed** aquatic life use designation of **WWH** for river miles (RM) 17.6 through 8.7, Mill Creek is not meeting its designated use. Physically, the stream channel is capable of supporting the criteria representative of the WWH use designation but due to chemical and biological criteria violations, the designation is not being attained.

- The use designation of **Modified Warmwater Habitat (MWH)** has been **proposed** for RM 7.8 to 0.0 due to permanent stream channel modifications. Biologically and chemically the stream is degraded, but under the modified channel conditions, this section of the stream will not support viable, reproducing warmwater biological communities nor will it meet the goals of the Clean Water Act. Of the 27 miles of stream sampled, 2.3 miles are **fully** attaining the designated use and 24.7 river miles are **not** attaining.

East Fork Mill Creek

- East Fork Mill Creek is currently fully attaining its aquatic life use designation of Warmwater Habitat (WWH) from river miles 4.7 to 1.9. Downstream from the Butler County Upper Mill Creek Wastewater Treatment Plant, the stream is not attaining its designated use. Several elevations and violations of both chemical and biological WWH critieria were documented in this lower reach of the stream. Full attainment of the aquatic life use designation was documented in 3.3 river miles of East Fork Mill Creek surveyed. Non-attainment was reported for 1.5 miles surveyed.

West Fork Mill Creek

- The entire segment of West Fork Mill Creek sampled during the 1992 survey (RM 4.7-0.1) was not attaining its designated use of WWH. Violations of both biological and chemical WWH criteria were documented during this survey and biological survey work conducted during 1991 (Ohio EPA 1992). The highest concentrations of lead measured in sediments during the Mill Creek survey were collected from West Fork Mill Creek.

Sharon Creek

- Very limited sampling was conducted in Sharon Creek during the survey (one site each for biological and chemical sampling). Sharon Creek exhibited non-attainment of the WWH aquatic life use designation. Violations of the fish IBI criterion and some chemical criteria were documented.

Table 2. Aquatic life use attainment status for the existing and proposed Warmwater Habitat (WWH), Limited Warmwater Habitat (LWH), Modified Warmwater Habitat (MWH) use designations in Mill Creek based on data collected during July-October, 1992.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	Attainment Status	Comment
Mill Creek (1992)						
			*Interior Plateau - **WWH** Use designation (**existing**)*			
26.4/26.4	38[ns]	NA	MG	64	FULL	Liberty-Fairfield Rd.
19.1/19.1	25*	6.4*	F	60	**NON**	Windisch Rd.
			*Interior Plateau - **LWH/WWH** Use designation (**existing/proposed**)*			
17.6/17.6	21*	5.7*	F	63	**NON**	Kemper Rd.
16.5/16.6	24*	5.7*	P	63	**NON**	Sharon Rd.
14.8/14.8	20*	4.8*	P	60	**NON**	Formica Entrance
13.2/13.3	20*	4.3*	P	61	**NON**	West Columbia Rd.
8.7/8.7	25*	5.7*	P	66	**NON**	State Route 561
			*Interior Plateau - **LWH/MWH** Use designation (**existing/proposed**)*			
7.8/7.8	24	6.3	P	65	**NON**	Center Hill Rd.
5.1/5.1	17*	4.9*	P	52	**NON**	Salway Park
3.1/3.1	12*	2.3*	VP	40	**NON**	Upst. Hopple St.
0.3/0.3	21*	6.8	VP	26	**NON**	Upst. Barrier Dam
East Fork Mill Creek (1992)						
			*Interior Plateau - **WWH** Use designation (**existing**)*			
4.7/4.7	40	NA	MG	74	FULL	Barret Rd.
3.8/3.9	40	NA	MG	72	FULL	Station Rd.
1.9/1.9	40	NA	MG	61	FULL	Allen Rd.
0.8/0.8	24*	NA	F	61	**NON**	Cresentville Rd.
0.3/0.1	26*	NA	F	66	**NON**	Dst. Lowhead Dam

* - significant departure from biocriteria (>4 IBI units or >0.5 Iwb units); poor and very poor results are underlined.

ns - nonsignificant departure from biocriteria (≤4 IBI; ≤0.5 Iwb units).

a - Narrative evaluation used in lieu of ICI (E=Exceptional; G=good; MG=Marginally good; F=Fair; P=Poor; VP=Very Poor).

b - Qualitative Habitat Evaluation Index (QHEI) values from Rankin 1989.

c - Value in parentheses is Modified Warmwater Habitat for impounded areas.

d - Modified Warmwater Habitat for channel modified areas.

NA - Headwater site: MIwb is not applicable.

Table 2. (continued)

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	Attainment Status	Comment
West Fork Mill Creek (1992)						
		*Interior Plateau - WWH Use designation (**existing**)*				
4.5/4.7	22*	6.4*	F	76	**NON**	Riddle Road
2.0/2.0	24*	6.6*	P	71	**NON**	Gardner Park
1.0/1.0	21*	6.0*	F	70	**NON**	Dst. I-75 (S)
0.2/0.2	17*	5.6*	F	60	**NON**	Dexter Avenue
Sharon Creek (1992)						
		*Interior Plateau - WWH Use designation (**existing**)*				
0.2/0.3	26*	NA	MG	62	**NON**	Exon Avenue

Ecoregion Biocriteria: Interior Plateau (IP)

INDEX - Site Type	WWH	EWH	MWH[d]
IBI - Headwaters/Wading	40	50	24
IBI - Boat	38	48	24 (30)[c]
Mod. Iwb - Wading	8.1	9.4	6.2
Mod. Iwb - Boat	8.7	9.6	5.8 (6.6)[c]

* - significant departure from biocriteria (>4 IBI units or >0.5 Iwb units); poor and very poor results are underlined.

ns - nonsignificant departure from biocriteria (≤4 IBI; ≤0.5 Iwb units).

a - Narrative evaluation used in lieu of ICI (E=Exceptional; G=good; MG=Marginally good; F=Fair; P=Poor; VP=Very Poor).

b - Qualitative Habitat Evaluation Index (QHEI) values from Rankin 1989.

c - Value in parentheses is Modified Warmwater Habitat for impounded areas.

d - Modified Warmwater Habitat for channel modified areas.

NA - Headwater site: MIwb is not applicable.

Town Run, Cooper Creek, G.E. Tributary, Bloody Run, Ross Run and Winton Ridge Tributary

- Biological assessment of these streams was not conducted during the 1992 Mill Creek survey. Attainment status of aquatic life use designations is not available for these tributaries at this time.

West Fork

- West Fork was neither biologically nor chemically assessed during the 1992 survey due to the extent of permanent concrete revetments. It was biologically evaluated during 1991 and found to be severely degraded (Ohio EPA 1992). Not only has the stream channel been permanently concreted through the jurisdictional region of the City of Cincinnati, but the normal flow of the stream has been diverted to enter into the combined sewer system and is directed to the MSD Mill Creek WWTP. During field reconnaisance prior to the survey, it was noted that the City of Cincinnati asphalt plant has heavily impacted the banks of West Fork near the confluence with Mill Creek by dumping old asphalt, sealant and trash on the right bank of the stream. Most of this material was above the cemented area of the banks. Also noted during reconnaisance was the presence of several huge cable spools which a company near the most downstream railroad crossing had dumped into the stream channel.

Chemical Water Quality

Mill Creek

- Exceedences of the Primary Contact Recreation criteria for fecal coliform and *E. coli* (>20000/100ml was the highest value measured for both parameters) were detected at virtually every chemical sampling site (Table 4).

- Dissolved oxygen (D.O.) violations occurred at river miles 2.90 and 0.51. Extremely high D.O. readings recorded during the day at river miles 6.53 and 5.85 were indicative of heavy algal growth and subsequent photosynthetic/respiration activity which causes oxygen depletion during the night. Datasonde readings from Mill Creek at river miles 16.57, 14.74, and 14.06 also recorded violations of WWH criterion for dissolved oxygen.

- Raw sewage and elevated levels of ammonia-N in exceedence of numerical criteria for prevention of chronic toxicity were documented at RMs 6.53, 5.85, and 4.9. Elevated levels of ammonia, phosphorus and nitrate-nitrite were also recorded from RMs 17.61 (downstream from East Fork Mill Creek) and 16.57 (downstream from Town Run) (Table 4).

- Total suspended solids concentrations were consistently higher at RM 9.97 which was downstream of bridge replacement construction at Anthony Wayne Ave.; this may have accounted for the elevated concentrations.

- Exceedences of water quality criteria were documented for selenium at RM 16.57, cyanide at RM 11.73 and copper at RMs 4.9, 2.90, 0.51.

- Elevated levels of lead in exceedence of numerical criteria for prevention of chronic toxicity were documented in the lower reaches of the mainstem at RMs 7.85, 6.53, 5.85, 4.90, 2.90, and 0.51.

- The seven sites (RMs 16.57, 13.35, 8.92, 7.85, 5.85, 2.90, and 0.51) sampled for organic compounds experienced exceedences of Ohio Water Quality Standards for various

organochlorine pesticides, including DDT and its metabolites. Several other organic chemicals were also detected in the water samples from these sites.

East Fork Mill Creek

- No elevated concentrations or exceedences of chemical water quality criteria were detected at river miles 4.69 and 3.78. These sites bracket Skinner Landfill, a superfund site.

- River miles 1.85 and 0.77 bracket the Butler County Upper Mill Creek WWTP. Violations of water quality criteria for dissolved oxygen, ammonia, selenium and various pesticides were exhibited at river mile 0.77, downstream from the plant. Elevated concentrations of phosphorus, nitrate-nitrite nitrogen, carbonaceous biochemical oxygen demand ($CBOD_5$) and zinc were also recorded at river mile 0.77. River mile 1.85 did not exhibit any elevations or exceedences of chemical parameters. An expansion and upgrade of the Upper Mill Creek WWTP (resulting from negotiations with Ohio EPA) was completed in September 1993 and the violations documented during the 1992 survey are not expected from the upgraded plant.

- Exceedences of the Primary Contact Recreational Use Criteria for fecal coliform and *E. coli* existed at all sites from river mile 1.85 to 0.01 (>20000/100ml was the highest documented). The most elevated levels were documented at river mile 0.01, just downstream from a sewer line crossing in the stream bed. Investigation during October 1993 by the Hamilton County Metropolitan Sewer District discovered the stream had eroded the bed under the sewer line causing leakage of sewage into East Fork Mill Creek. The Metropolitan Sewer District repaired the sewer line during the Fall of 1993.

West Fork Mill Creek

- Violations of the WWH criterion for lead were documented at RM 2.0. Possible lead contamination may be migrating to the stream from a former industry which disposed of lead sulfate sludge on-site into shallow pits and directly onto the ground surface. Other sources may also have contributed to the violations (i.e., CSOs, an old car battery and old auto parts observed in the general vicinity, general urban runoff).

- Numerous violations of water quality criteria were noted at RM 0.19 including dissolved oxygen, ammonia, fecal coliform, *E. coli*, lead and various organochlorine pesticides, including DDT. The highest ammonia concentrations (i.e., 21.4 mg/l being the highest) in the survey were recorded from this site. Several CSOs and two closed landfills are located in the general area.

Sharon Creek

- Exceedences of the Primary Contact Recreation criteria for fecal coliform and *E. coli* were documented from Sharon Creek. Elevated concentrations of total suspended solids were also noted and one cyanide value exceeded the WWH criterion; however, no source of contamination was determined.

Town Run

- Elevated levels of ammonia, phosphorus, fecal coliform, *E. coli*, nitrate-nitrite nitrogen, and low dissolved oxygen levels were documented in Town Run at RM 0.70. The sampling location was 0.22 river miles downstream from the Glendale WWTP discharge.

Cooper Creek

- No exceedences of chemical water quality criteria were documented in Cooper Creek during the 1992 survey. Elevated levels of cyanide and conductivity were noted on separate sampling events at RM 0.2.

Bloody Run

- Several elevations and criteria violations of fecal coliform, *E. coli*, dissolved oxygen, organochlorine pesticides, other pesticides, copper, and volatile organic compounds (VOCs) were documented from Bloody Run. A direct permitted industrial discharge is located on Bloody Run and combined sewers with overflow points receive waste from several industries in the area .

Ross Run

- Elevated levels of ammonia, organochlorine pesticides, zinc, other pesticides, VOCs and semi-volatile organic compounds (SVOCs) were detected in the water samples. Oil and grease were visible in the creek during most sampling events. Sampling was conducted in an industrial area where several combined sewer overflow points were located.

Sediment Chemistry

Mill Creek

- Sediment assessment was based on the method of evaluation in Kelly and Hite (1984). Categories for classification are: non-elevated, slightly elevated, elevated, highly elevated and extremely elevated. Sediment metal chemistry results indicated several sites containing extremely elevated concentrations for a variety of metals. Elevated to extremely elevated levels of lead were detected from RM 16.57 to 0.5. Zinc concentrations ranged from slightly elevated to extremely elevated at eleven of the thirteen sites sampled. The site sampled near Salway Park at RM 5.2 exhibited the most numerous highly elevated and extremely elevated concentration of metals, including copper, cadmium, chromium, lead and zinc. River Mile 2.90, upstream from Hopple Street, had sediments with highly elevated to extremely elevated concentrations of copper, lead and zinc. Highly elevated to extremely elevated levels of lead and zinc were recorded from RM 0.5 near Gest Street.

- Organic compounds were detected at 89% of the sediment sites. Eighty-four percent of the sites revealed some level of organochlorine pesticide concentration. Highly elevated levels of DDT were detected at RM 0.5. Salway Park (RM 5.2) exhibited the most abundant number of volatile organic compounds. Aromatic hydrocarbons appeared from RM 14.8 to 0.5. No detectable concentrations of volatile, semi-volatile organic compounds, and pesticides were found from the background sites at RMs 26.40 and 24.6.

- Two PCB aroclors were detected in the sediments of Mill Creek. Polychlorinated biphenyl (PCB) 1248 first appeared at RM 13.13 in extremely elevated concentrations and was detected in highly elevated levels from RM 9.02 to 2.90. Aroclor 1260 was detected at a highly elevated concentration at Hopple Street, RM 2.90, yet was below chemical analysis detection at all other sediment sites sampled.

West Fork Mill Creek

- Lead concentrations in West Fork Mill Creek ranged from highly elevated to extremely elevated in all the sediment sites sampled. The highest level (8870 ppm) recorded in the entire Mill

Creek survey was taken upstream of Riddle Road from RM 4.45. This is also the second highest value recorded in the Ohio EPA sediment database for the entire State of Ohio. However, the highest concentration in the Ohio EPA database resulted from a stream sediment sample taken directly downstream from a metal plating industry discharge point. No direct source of contamination has been determined at the West Fork Mill Creek site. No known landfills, CSOs or direct discharges with lead concentrations are located in the area. Several culverts with foul smelling discharges were noted during the survey on the left bank of the stream upstream from Riddle Road.

Biological Quality

Mill Creek

- Fish communities within the Mill Creek were dominated by pollution tolerant species. Only one sampling location in the upper reaches of the mainstem of Mill Creek at RM 26.4 exhibited a fish community in the marginally good range of the Index of Biotic Integrity (IBI). The remainder of the river miles sampled had severely degraded fish communities.

- The physical condition of fish in Mill Creek was evaluated by recording gross DELT (deformities, fin erosion, lesions/ulcers and tumors) external anomalies. Biosurvey results throughout the State of Ohio indicate that a high rate of anomalies is an accurate indication of toxic pollution stress. The percent of anomalies was relatively high within the segment of Mill Creek impacted by combined sewer overflows. Of particular note was the site at RM 13.2 which had the highest level of anomalies (23.6%) recorded in the Mill Creek basin. This sampling location was located 0.5 miles downstream from a significant raw sewage discharge and was in the vicinity of a superfund site; two other potential hazardous waste sites and an area of concentrated industrial activity.

- Macroinvertebrate community results echoed the results of the fish biosurvey. The sampling site at RM 26.4 exhibited a marginally good macroinvertebrate community. Assessment in the urban and industrialized areas of Mill Creek indicated declining quality with poor to very poor macroinvertebrate communities being documented. The poorest quality invertebrate communities were collected from the lower two sampling sites (RM 3.1 and 0.3).

- Fish tissue samples were collected from representatives of four species at three locations in Mill Creek and analyzed for pesticides, PCBs, metals, semivolatile organic compounds and percent lipid content. Two PCB aroclors (1248 and 1260) were detected from eight samples. Three whole body samples from RMs 7.8 and 0.3 exceeded the FDA action level of 2.0 ppm for total PCBs in edible portions. Four of the eight samples from RMs 7.8 and 0.3 had PCB levels in violation of Ohio Water Quality Standards (0.64 ppm of any whole sample). All of the nineteen pesticide compounds tested in eight tissue samples were below laboratory instrument detection. Only two of the fifty-six semivolatile organic compounds tested were detected (phenol and 1,2,4-trichlorobenzene) in the fish tissue samples. Four metals (barium, lead, mercury and zinc) of the nine tested were detected in six of the whole body fish samples. The mercury concentration was below the FDA 1.0 ppm level of concern for edible portions.

East Fork Mill Creek

- Macroinvertebrate communities ranged from marginally good to fair in quality. The drop in quality occurred in sites downstream from the Butler County Upper Mill Creek WWTP. Fish communities were represented by a number of pollution intolerant species in the upper reaches

of East Fork Mill Creek (RM 4.7, 3.8, and 1.9); low numbers of pollution tolerant species were present. Degradation of the fish community was documented downstream from the Upper Mill Creek WWTP. The fish results from the sampling site 0.2 miles downstream from the Upper Mill Creek WWTP suggested a toxic impact probably due to the numerous ammonia violations from the WWTP. Some improvement or recovery in the population was evident near the mouth of East Fork Mill Creek.

West Fork Mill Creek

- The quality of macroinvertebrate communities in West Fork Mill Creek ranged from fair to poor. The lower performance rating occurred at river mile 2.0, downstream from an observed septic discharge and evident lime sludge from the water treatment plant of the Village of Wyoming. Trash and rubbish also was present at this site. Some improvement in the invertebrate community was observed at sites farther downstream. All sampling locations for fish communities documented populations indicative of poor water quality.

Sediment Toxicity

- Sediment samples from nine sites on the mainstem of Mill Creek were assessed for toxicity through USEPA using *Hyalella azteca*, an amphipod, in short-term bioassays. Data was statistically analyzed using two methods: 1) comparing the data as a whole to a control sample and 2) comparing each site individually to a control. The results of comparing the data as a whole to the control sample indicated that only one site, Gest St. (RM 0.5), exhibited toxicity. However, when the results from each sample were compared individually to the control sample eight of the nine sites exhibited toxicity.

Spills

- The spills reports from the Emergency Response Section of Ohio EPA for the period of 1988 through 1992 indicate significant numbers of spills occurring in the Mill Creek basin. Several entities have been documented as having repeated releases of a variety of substances ranging from raw sewage to toxic chemicals.

Conclusions

- The lower 17 miles of Mill Creek are plagued by impacts from old industrial and municipal landfills, hazardous waste sites, industry, combined sewer overflows, raw sewage discharges, leaking sewer lines and general urban runoff. Heavy suburban development pressures have increased the nonpoint source pollution problems in the upper reaches of the stream which were and still are to some extent already impacted by agricultural activities.

- Water chemistry impairments are mainly found in the lower 17 miles of Mill Creek and include elevated concentrations of some heavy metals, organic compounds, pesticides, ammonia, nutrients and bacteria from sewage contamination.

- Sediment analyses indicated elevated concentrations of heavy metals, PCBs, organic compounds and pesticides also in the lower 17 miles of Mill Creek.

- Pollution impacts have reduced the biological community to a predominace of pollution tolerant species. Toxic conditions in certain areas of Mill Creek have resulted in high percentages of external anomalies in the fish population. Fish tissue analyses identified concentrations of PCBs in some species in exceedance of maximum FDA recommended levels.

- In addition to the chemical pollution impacts, permanent stream channel modifications to the lower eight miles of Mill Creek have made it improbable that this portion of the stream can achieve the WWH use and therefore goals of the Clean Water Act. Upstream from this area, previous stream modification projects and removal of riparian vegetation have impacted the stream. However, some channel recovery was apparent during the 1992 survey, indicating the potential of the stream to recover to natural channel conditions.

- All tributaries sampled exhibited some type of pollution problem and many were impacted by stream channel modifications. Parameters indicative of sewage treatment plant discharges were documented in the main channel of Mill Creek downsteam from East Fork Mill Creek and Town Run. Tributaries in the lower reaches exhibited contamination indicative of industrial activities and combined sewer overflows.

Recommendations

Status of Aquatic Life Uses

- Mill Creek and its tributaries were originally assigned aquatic life use designations 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 in the Mill Creek watershed, several 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 on Mill Creek of an objective and robust 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. Thus some of the following aquatic life use recommendations constitute a fulfillment of that obligation.

Mill Creek

- The main channel of Mill Creek can be subdivided into three segments: an upper unmodified reach (RM 27 to 24), a reach that experienced previous channel modifications, but which has undergone some recovery to natural conditions (RM 24 to 8) and the lower reach which has undergone permanent channel modification in several areas which will not be recoverable due to placement of concrete channels (RM 8 to 0).

- The recommended aquatic life use designation for Mill Creek from RM 27 to 8 (Center Hill Road) should be **Warmwater Habitat (WWH)**. This is a change in the previous use designation from RM 18 to 8 which was Limited Warmwater Habitat. Because the stream channel has shown sufficient recovery to its natural state through this section (RM 18 to 8), the previous LWH use designation is inappropriate and should be changed.

- The previous use designation for the lower reach (RM 8 to 0) of Mill Creek was Limited Warmwater Habitat. The recommended aquatic life use designation should be **Modified Warmwater Habitat (MWH)** because of the permanent modifications to the stream channel in this reach.

East Fork Mill Creek

- East Fork Mill Creek is presently designated Warmwater Habitat which is the appropriate designation. During low flow years, East Fork Mill Creek has been observed to turn interstitial upstream from Upper Mill Creek WWTP. East Fork Mill Creek enters Mill Creek at RM 17.95.

Town Run

- The tributary to which the of the Village of Glendale wastewater treatment plant discharges is officially unnamed. Through correspondence and regulatory documents, this tributary has been referenced as "Town Run" and should be documented as such in the Ohio Water Quality Standards, OAC, 3745-1. At this time, the recommended aquatic life use designation for Town Run is **Warmwater Habitat (WWH)**. No biological evaluation was conducted of Town Run during the 1992 survey, however based on the potential of the stream due to evaluation of the stream habitat it was determined WWH was the most appropriate use designation.

Sharon Creek

- Sharon Creek is presently designated Warmwater Habitat which is the appropriate use designation. The **State Resource Water** designation also is applicable from the headwaters to Sharon Lake because of the presense of Sharon Woods (a Hamilton County Park). Sharon Creek enters Mill Creek at RM 15.63.

Cooper Creek

- This tributary is unofficially named "Cooper Creek" for this survey and report. It receives the wastewater discharges from Steelcraft Manufacturing Company and Michelman, Inc. in the headwater region. The Steelcraft Manufacturing Company NPDES permit number 1IC00042*AD refers to this creek as Rossmoyne Creek. The recommended use designation for this tributary is **Warmwater Habitat (WWH)** based on the habitat evaluation. Because the name Rossmoyne Creek is already in the permits processing system and the stream originates near the community of Rossmoyne, it is recommended this stream be officially named "Rossmoyne Creek". Cooper/Rossmoyne Creek enters Mill Creek at RM 14.05.

G.E. Tributary

- The tributary which flows through the property of General Electric in Evendale is presently unnamed. Although it originated upstream from the property, the name "G. E. tributary" has been unofficially assigned for use during this survey and report. The recommended use designation for this stream is **Limited Resource Water** due to the channel modifications and the extent of wastewater discharges; multiple stormwater and direct outfalls are located on G.E.'s property. The habitat of this tributary was evaluated downstream of the G.E. outfall at RM 0.10 and the Qualitative Habitat Evaluation Index (QHEI) value of 68 indicated the potential to attain WWH use, however this portion of the stream is atypical of the remainder of the stream habitat and the QHEI score should not apply. The G.E. tributary enters Mill Creek at RM 13.85.

West Fork Mill Creek

- The present WWH use designation for the entire length of the stream and State Resource Water from headwaters to Winton Lake should be retained. West Fork Mill Creek enters Mill Creek at RM 11.57.

Winton Ridge Tributary

- The Winton Ridge Tributary is the unofficial name assigned to this stream which enters Mill Creek at RM 6.85. It is recommended this tributary be officially named "Winton Ridge Tributary" in the Ohio Water Quality Standards. In Appendix 9 this tributary is referred to as Cape Creek in the Winton Ridge Dump preliminary assessment. Based on the habitat evaluation, it is recommended the stream be afforded a higher level of protection, such as **Warmwater Habitat** until the use designation of **Headwater Habitat** has been established.

Bloody Run

- "Bloody Run" is the unofficial name given to this tributary which enters Mill Creek at RM 7.63. This stream once received waste fluids from animal slaughter houses, hence the name. Due to industrial combined sewer overflows "Bloody Run" frequently continues to change colors (red and green). The recommended use designation for this stream is **Limited Resource Water** until it can be biologically assessed.

Ross Run

- The present use designation of Limited Warmwater Habitat should be change to **Limited Resource Water** based on the channel modifications and heavy industrial influence this stream experiences. Ross Run enters Mill Creek at RM 6.45.

West Fork

- West Fork is presently designated Limited Warmwater Habitat. The recommended designation should be **Warmwater Habitat** from headwaters to Montana Avenue and **Limited Resource Water** from Montana Avenue (RMs 2.1 to 0.0) to the mouth due to permanent channel modifications and the biological results from the 1991 survey (Ohio EPA 1992). The **State Resource Water** designation also applies for the section of stream which flows through Mount Airy Forest, part of the Cincinnati Park system. West Fork enters Mill Creek at river mile 3.45.

Status of Non-Aquatic Life Uses

The non-aquatic life use designations of water supply are based on existing types of water intakes or the potential for the types of activities to occur in the basin (Agricultural or Industrial). It does not necessarily mean that these uses are actually occurring. The recreational water designations are based on the size of the stream and its potential to support this activity (full or partial body contact). It does not indicate that it is advisable for these recreational activities to occur, only that the stream has the potential for them to occur. Due to the contamination detected in the lower reaches of Mill Creek (RM 17.6 to the Ohio River) as well as some of the tributaries, **it is not recommended that recreational activity occur in these reaches of the streams at this time.**

Mill Creek

- The entire length of Mill Creek should remain designated as Industrial Water Supply. Changes in the Agricultural Water Supply use should be as follows. Mill Creek from headwaters to I-275 should remain Agricultural Water Supply. Because the Mill Creek basin is heavily urbanized downstream from I-275, the Agricultural Water Supply use would not apply. The recommened recreational designation for Mill Creek based on the size of the stream should be Primary Contact Water, however based on contamination concerns in Mill Creek from RM 17.6 to the Ohio River, recreational contact by the public is strongly discouraged.

East Fork Mill Creek

- The entire length of East Fork Mill Creek should be designated both Industrial and Aricultural Water Supply. The Secondary Contact Recreation use should apply from the headwaters to the discharge of the Butler County Upper Mill Creek Wastewater Treatment Plant. From the Upper Mill Creek WWTP to the confluence with Mill Creek, the Primary Contact Recreation use should apply based on the depth of the stream.

Town Run

- It is recommended Town Run be designated as an Industrial Water Supply and have a Secondary Contact Recreation use. Based on the levels of fecal coliform contamination measured in Town Run, public contact is not recommended at this time.

Sharon Creek

- Sharon Creek is presently designated as Agricultural and Industrial Water Supply and has a Primary Contact Recreation use. Due to development in the basin, the Agricultural Water Supply use should be dropped. Based on the levels of fecal coliform contamination measured in

Sharon Creek downstream of the lake, public contact is not recommended at this time.

Cooper Creek

- It is recommended Cooper Creek be designated as an Industrial Water Supply and have a Secondary Contact Recreation use. Based on the levels of fecal coliform contamination measured in Cooper Creek, public contact is not recommended at this time.

G.E. Tributary

- It is recommended the G.E. tributary be designated as an Industrial Water Supply and have a Secondary Contact Recreation use. Based on the levels of PCB contamination measured in the tributary (REMCOR 1993), public contact is not recommended at this time.

West Fork Mill Creek

- The present non-aquatic life use designations of Agricultural and Industrial Water Supply and recreational Primary Contact Recreation are appropriate for West Fork Mill Creek. Due to elevated levels of fecal coliform contamination measured, public contact is not recommended at this time.

Winton Ridge Tributary

- The appropriate non-aquatic use designations for this tributary are Industrial Water Supply and Secondary Contact Recreation use.

Bloody Run

- It is recommended Bloody Run be designated as an Industrial Water Supply and have a Secondary Contact Recreation use. Based on the levels of fecal coliform contamination measured in Bloody Run, public contact is not recommended at this time.

Ross Run

- It is recommended Ross Run be designated as an Industrial Water Supply and have a Secondary Contact Recreation use. Based on the levels of fecal coliform contamination measured in Ross Run, public contact is not recommended at this time.

West Fork

- From the headwaters of West Fork to Montana Avenue (RM 2.1) the stream should be designated Industrial Water Supply and Secondary Contact. Downstream of Montana Avenue the channel has been modified so that the stream enters the combined sewer system through grates in the cement channel. Neither water supply nor recreational contact designations would be appropriate.

Other Recommendations

- Based on the chemical data from Town Run, the effectiveness of the Glendale WWTP should be evaluated with both chemical and biological monitoring.

- The recent expansion and upgrade of the Butler County Upper Mill Creek WWTP should be closely monitored. Results from the 1992 survey suggest the stream is at or over capacity for assimilation of wastewater.

- Areas of contamination have been identified in the Mill Creek basin and more definitive

evaluations must now occur to identify contamination sources. This does not commit Ohio EPA to identifying and evaluating all of these sources. State government resources are not available for a study of this magnitude. Local government, industry, property holders, and the community will have to be involved in the planning and funding of this effort.

- An evaluation should be conducted on the effect of additional wastewater contributions to the Mill Creek system due to new development occuring in Hamilton and Butler Counties. What impacts have these loadings caused to nonpoint source pollution, wastewater treatment plants and combined sewer overflow frequency?

Future Monitoring Concerns (to be addressed by Ohio EPA)

- A follow-up survey should be conducted on East Fork Mill Creek to evaluate the expansion and upgrade of the Butler County Upper Mill Creek WWTP. Another water quality survey is scheduled during the summer of 1997 by Ohio EPA.

- Town Run needs to be biologically evaluated to support the appropriate aquatic life use designation.

- The extremely elevated lead concentrations at RM 4.45 in West Fork Mill Creek need to be investigated as soon as possible since there are no known sources of contamination in the area.

- The sources of PCB aroclors 1248 and 1260 in Mill Creek should be further investigated.

- The expense of another comprehensive intensive stream survey should not be undertaken until some improvements are made in the watershed to address CSOs, industrial sites and old landfill contamination. Smaller surveys are recommended to address specific reaches of the stream as improvements are made.

Study Area Description

Mill Creek flows 28.1 miles from the headwaters in southeastern Butler County through central Hamilton County to a confluence with the Ohio River (Figure 1) and is located in the Interior Plateau Ecoregion. The Mill Creek watershed drains an area of 166.2 square miles. Along its course the stream has an average gradient of 11.9 feet per mile (ODNR, 1960). Most of Mill Creek flows atop a buried valley aquifer composed of highly permeable sands and gravel from past glacial deposits and outwash. Major tributaries include: West Fork, Ross Run, West Fork Mill Creek, Sharon Creek, and East Fork Mill Creek. These tributaries as well as several smaller ones enter Mill Creek from the hillsides that characterize the watershed. They are generally underlain by thinly inter-bedded shales and limestone bedrock except for the lower reaches at the confluences with Mill Creek. The average gradient for the major tributaries is 51.8 feet per mile (Table 3).

Aquatic life uses for streams in the basin reflect the high degree of urban/industrial development that has occurred. Mill Creek is currently designated Warmwater Habitat (WWH) for that portion upstream of I-275 and Limited Warmwater Habitat (LWH) for the remainder of its length. Variances to State of Ohio Water Quality Standards (OAC 3745-1) for some parameters have been established in portions of Mill Creek based on standards established in 1978. West Fork and Ross Run have also been designated LWH because of modifications to the streams and the number and density of discharges they receive. The rest of the major tributaries are designated WWH and West Fork Mill Creek is additionally listed in the water quality standards as State Resource Water (SRW) due to the presence of Winton Lake/West Fork Mill Creek Reservoir. Though not presently listed in the State of Ohio Water Quality Standards, Sharon Creek also qualifies for SRW from the headwaters to and including Sharon Lake. Streams and lakes encompassed in publicly owned park systems are by definition classified as State Resource Waters.

Land uses in the watershed have evolved over the time of development which began in the late 1700's. Cincinnati has always been a principal port for river transportation to the west and east along the Ohio and became a major industrial and transportation center as the United States expanded westward. The abundant surface and groundwater supplies of the Mill Creek made it an ideal location for industrial development beginning with the establishment of the water driven mills that gave it its name. Unfortunately the same characteristics made it a convenient conduit for the removal of wastes. Attempts to manage the wastes date from the construction of the Mill Creek interceptor in 1913. This sewer which is still in use has not been able to carry all of the wastes and stormwaters that were added to its flow as the area expanded and as a result raw sewage continues to enter Mill Creek especially during rain events (HCEAC 1993).

Most of the sewers in the basin were designed to carry combinations of domestic sewage, stormwater, and industrial wastes. Additions to the system have resulted in too much flow for the system to handle. Combined sewer overflows occur at 158 locations in the basin (R.D. Zande, 1991). These overflows contribute fecal bacteria, BOD, COD, nutrients and industrial wastes to the streamflow and are currently being studied by the Metropolitan Sewer District as part of the NPDES permit for the system.

Over time the City of Cincinnati and surrounding suburbs have expanded to cover almost all of the watershed. The only portion of the watershed which still contains significant areas of agricultural land is in the upper reaches in Butler County. Development pressure is very high in this area and much, if not all of it is likely to be developed for residential and related commercial uses. Most of the development has occurred without sufficient provisions for stormwater control or control of

erosion from the construction sites. As a result, all of the streams in the watershed have received significant quantities of sediment from construction. Without stormwater control the high gradient of the tributaries makes them especially susceptible to streambed erosion. All of these streams evolved under conditions of forested watersheds that reduced the volume and rate of runoff. Development removed the protective cover and permeable natural surface and replaced them with impermeable surfaces. As a result both the volume and rate of runoff combine to exceed the capacity of the streams.

Winton Lake in Greenhills shows the impacts of uncontrolled development on waterbodies. The lake watershed has been almost totally developed for residential and commercial uses. The runoff into the lake has deposited sediments from construction sites and from eroding streams as well as discharges from combined sewers. As a result more than 50% of the volume and nearly one third of the surface area have been lost to public use. The Hamilton County Park District and the Army Corps of Engineers are cooperating on a project to remove the accumulated sediment. Unfortunately opportunities to reduce the excess runoff and stream erosion are nearly nonexistent in the watershed so the process will have to be repeated on a regular interval. Sharon Lake suffered from similar problems and was cleaned of accumulated sediment by the Park District starting in 1987 and completed in 1989.

In response to flooding that occurred in 1959 the Mill Creek Valley Conservancy District was formed to develop a comprehensive flood control plan. The plan formulated in cooperation with the Army Corps of Engineers called for channelization and concrete lining of Mill Creek to speed water flow to the Ohio River. Construction of this project began in 1981 and by May 1992, 41.9% of the proposed length had been completed. The completed sections of the channelization project have completely removed the natural ecosystem and replaced it with an artificial (concrete and rip-rap) substrate that eliminates any potential for recovery of a natural diversity in the biological communities. In response to concerns about the costs of the project and environmental degradation the Corps of Engineers has begun to reevaluate the project with the possibility of not completing the original design.

More than one hundred years of industrial usage in the basin with emphasis on the mainstem of Mill Creek has left a legacy of contamination that has been detailed in studies by Ohio EPA, the Army Corps of Engineers, the Mill Creek Conservancy District, and the City of Cincinnati. Contaminated sediments, leaking landfills, and U.S. EPA Super Fund sites are all present along Mill Creek. Ohio EPA's Division of Emergency and Remedial Response has identified 31 different sites along Mill Creek and its tributaries that have the potential to adversely affect water quality due to possible hazardous waste (Figure 2, Appendix 9). The Corps of Engineers surveyed the areas adjacent to Mill Creek that could be affected by the flood control/channelization of Mill Creek. Approximately 1.2 miles of old municipal landfills border both sides of Mill Creek in Section 8 of the project and 16 other sites were identified in other portions. These sites have been described in the draft report Mill Creek Ohio LPP Contamination Reconnaissance Report (USACOE, November 1990).

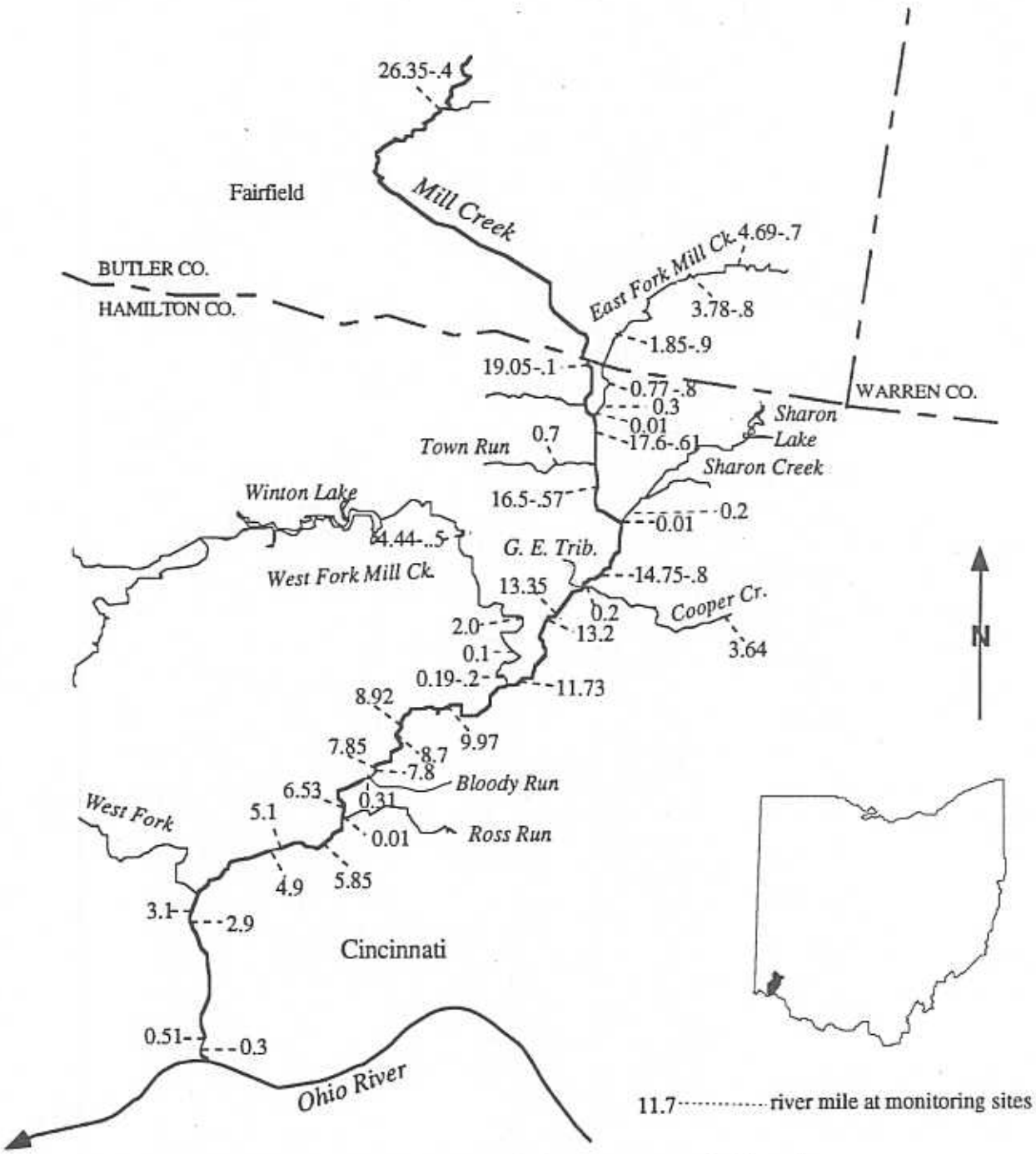


Figure 1. The Mill Creek study area showing principal streams and tributaries, and water quality monitoring sites.

1. B&O Dump
2. Borden Chemical-Galbraith Plant
3. Brighton Corp./Trinity Industries
4. Brighton Yard
5. Canal Ridge Road Dump
6. Carstab/Morton International
7. Carthage Ave. Landfill
8. Celotex
9. Mill Creek Dump
10. CSX
11. Elda Inc.
12. Emery Chemicals
13. Este Ave. Dump
14. General Electric (Evendale)
15. Highland Greens WWTP
16. Laidlaw City Dump
17. Lockland Works
18. Manville Forest Products
19. MSD
20. North Bend Dump
21. Galbraith Rd. Landfill
22. Pthalchem Inc.
23. Premium Finishes, Inc.
24. Pristine
25. Ridgewood Arsenal
26. St. Bernard Dump
27. Sherwin Williams Co./PMC Inc.
28. Skinner Landfill
29. Techno-Adhesives
30. Vine Street Dump
31. Winton Ridge Dump

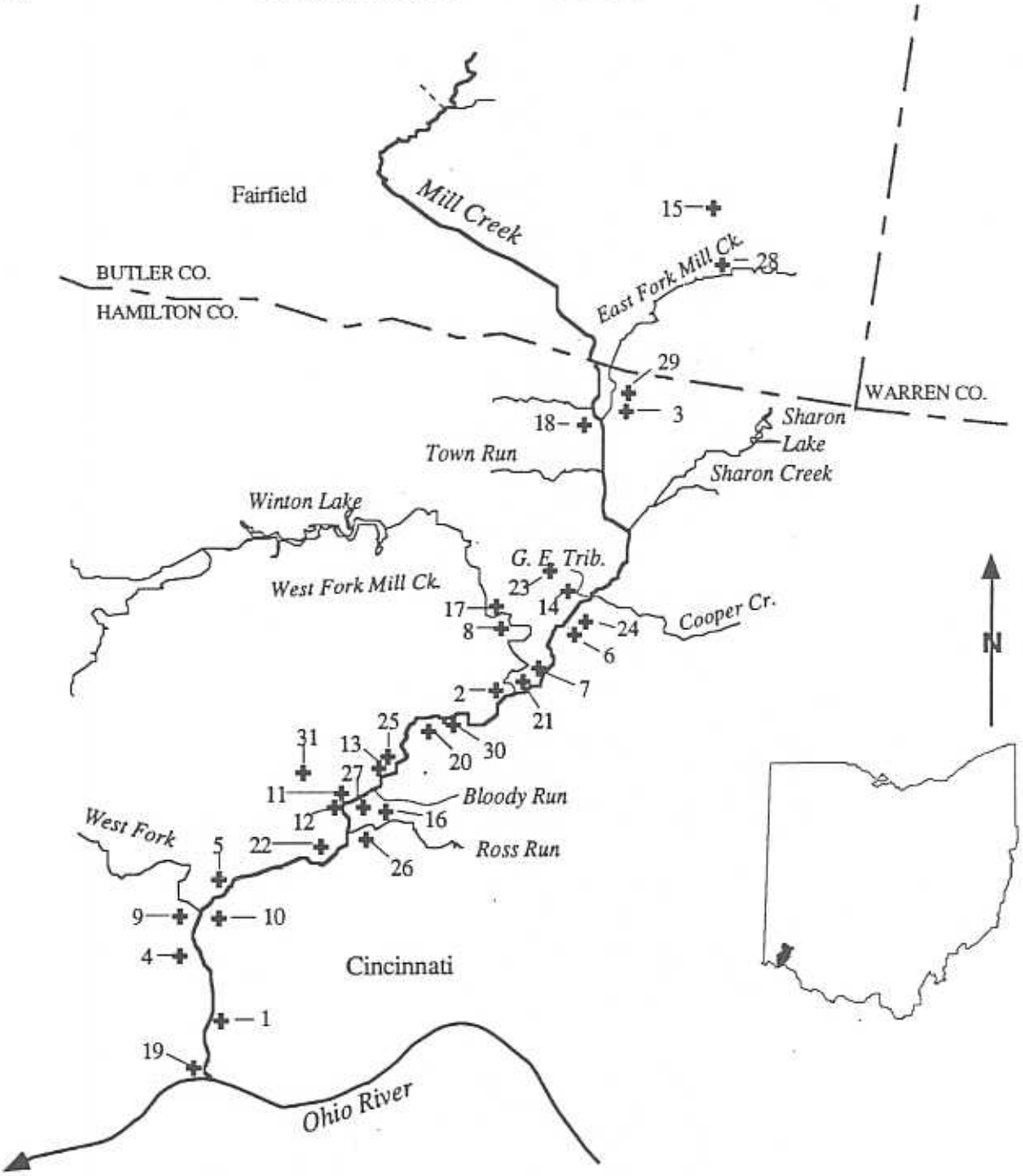


Figure 2. The Mill Creek study area showing principal streams and tributaries, and potential unregulated hazardous waste sites

Table 3. Stream characteristics and identified pollution sources in the Mill Creek study area.

Stream Name	Length (miles)	Average Fall (ft/mi)	Drainage Area (mi^2)	Nonpoint Source Pollution Categories	NPDES Point Sources: Facility	River Mile	Latitude/ Longitude	Design Flow (MGD)
Mill Creek	28.1	11.91	166.2	Land Disposal Agriculture	Parkway Nursing Ctr.+	25.97	39°22'33"/84°28'54"	Unknown
					Hoesch Suspension Inc.++	-	39°20'32"/84°30'54"	0.0238
					Avon+++	-	39°17'50"/84°28'21"	0.051
					Ryder Truck Rental Inc.	-	39°17'17"/84°26'26"	0.000415
					Xtek, Inc. (Reading Rd.)	16.91,1.05	39°17'00"/84°25'00"	0.40
					Bedinghaus Business Communication Inc.	-	39°16'55"/84°26'50"	0.00144
					RJF International+++	-	39°16'41"/83°25'02"	0.000164
					National Starch & Chemical	15.6	39°15'26"/84°25'30"	0.001875
					Martest, Inc.	13.85,2.25	39°15'10"/84°26'45"	0.03168
					Formica Corp.	14.59	39°14'40"/84°25'46"	**1.525**
					General Electric Aircraft Engines			
					001	13.85,0.18	39°14'16"/84°26'34"	**5.0**
					002	13.30,0.11	39°13'59"/84°26'34"	0.2
					Sawbrook Steel Castings++	13.15	39°13'42"/84°26'51"	0.014
					Liquid Carbonic Corp.	11.51,0.60	39°12'26"/84°26'50"	0.009
					General Polymers	9.31,0.21	39°12'22"/84°28'59"	0.017
					Proctor & Gamble (Winton Hill Tech. Ctr.)	8.25,0.82	39°12'00"/84°30'15"	0.13
					Epcor+++	-	39°11'53"/84°29'15"	0.00012
					Proctor & Gamble (Ivorydale) 001	6.76	39°10'48"/84°29'34"	0.052
					007	6.62	39°10'23"/84°30'20"	0.753

Table 3. (cont.) Stream characteristics and identified pollution sources in the Mill Creek study area.

Stream Name	Length (miles)	Average Fall (ft/mi)	Drainage Area (mi^2)	Nonpoint Source Pollution Categories	NPDES Point Sources: Facility	River Mile	Latitude/ Longitude	Design Flow (MGD)
East Fork Mill Creek	7.1	45.8	9.42	Suspected Unverified	**Butler County Upper Mill Ck. Regional**	0.90	39°18'00"/84°26'00"	**8.0**
					Trinity Industries 001	0.48	39°17'26"/84°25'56"	0.026
					003	0.41	39°17'25"/84°25'57"	0.078
Town Run	1.9	51.4	2.9		Village of Glendale	0.92	39°16'20"/84°26'47"	0.43
Sharon Creek	5.5	57.3	11.46		Northeast Knolls	3.45,1.00	39°17'17"/84°22'18"	0.022
					Timber Ridge Apts.	3.00,1.05	39°16'52"/84°22'20"	0.08
					Consolidated Rail Corp.	0.79	39°16'04"/84°25'03"	0.02
Cooper Creek	3.9	70.3	5.1		Steelcraft 001	3.78	39°13'40"/84°23'30"	0.0274
					002	3.78	39°13'40"/84°23'40"	0.0803
					Michelman Inc.	3.78	39°13'27"/84°23'32"	0.018
					Shell Oil+++	-	39°13'34"/84°23'40"	0.0072
West Fork Mill Creek	15.2	23.8	36.42	Urban Runoff Construction Streambank Modification	Borden Packaging & Industrial Products	4.50,0.50	39°15'27"/84°27'47"	0.01
					City of Wyoming Waterworks	2.86	39°13'59"/84°27'53"	0.06
					Lockland WTP+	2.75	39°14'03"/84°27'34"	Unknown
Bloody Run	1.6	62.5	1.2		Xtek, Inc. (Township Rd.)	0.48	39°11'03"/84°29'14"	0.0378

Table 3. (cont.) Stream characteristics and identified pollution sources in the Mill Creek study area.

Stream Name	Length (miles)	Average Fall (ft/mi)	Drainage Area (mi^2)	Nonpoint Source Pollution Categories	NPDES Point Sources: Facility	River Mile	Latitude/ Longitude	Design Flow (MGD)
Ross Run	4.9	51.1	5.92		Proctor & Gamble (Ivorydale) 002-006	0.52	39°10'34"/84°29'22"	0.005
					Miami Margarine Co.	0.68	39°10'25"/84°29'35"	0.432
West Fork	5.0	81.1	9.74		Airy Pointe Condo Assoc.	4.45	39°11'00"/84°35'40"	0.016

\+ Entity does not have a NPDES permit.
++ Discharge and NPDES permit eliminated subsequent to 1992 survey.
+++ Entity currently discharging without a NPDES permit; permit in process.

Methods and Materials

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/non-attainment 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.

The IBI is a multi-metric index 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). The macroinvertebrate community was evaluated based on qualitative sampling of all available aquatic habitat types. Qualitative macroinvertebrate sampling consists of an inventory of species with no attempt to quantify the populations and a measure of EPT (Ephemeroptera - mayfly, Plecoptera - stonefly, and Trichloptera - caddisfly) taxa richness - an indication of the prevalence of pollution sensitive organisms.

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.

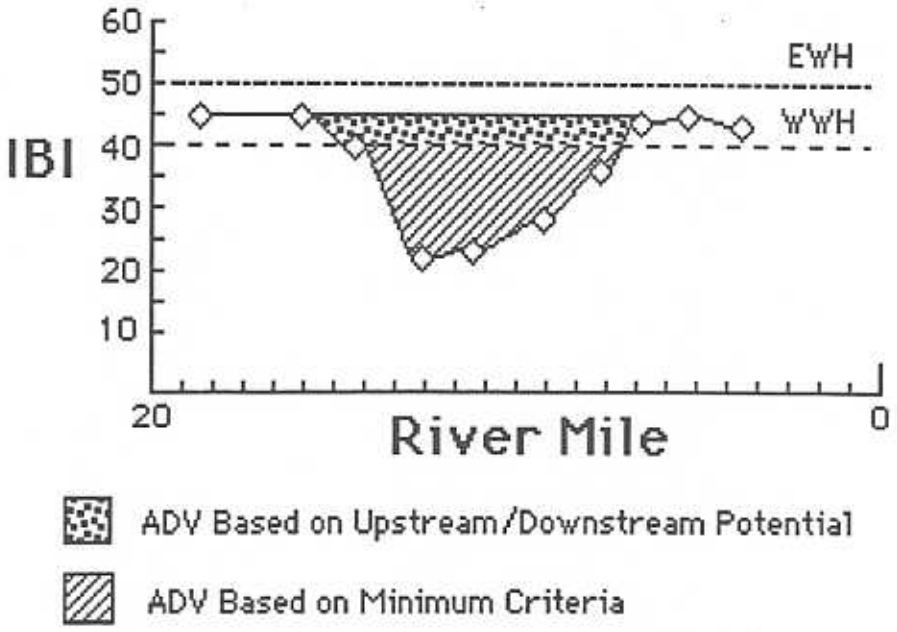
Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. 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.

Macroinvertebrate sites in the study area were also evaluated using an assessment tool currently in the developmental phase. This method utilizes the qualitative, natural substrate collections

available from each site and relies on tolerance values derived for each macroinvertebrate taxon collected. These tolerance values, unlike other tolerance values used in common indices (e.g., the Hilsenhoff Biotic Index), utilizes the abundance data for a given taxon collected with artificial substrates at sites around Ohio. 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, the 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 Mill Creek 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 Mill Creek 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 primarily the wading method (100 - 220 meter zones). The lower site on Mill Creek was sampled using the boat method (470 meter zone). The upper two sites on the East Fork Mill Creek were sampled using the backpack electrofishing method (150 meter zones). Chemical/physical and biological sampling locations are listed in Table EAS1 .

An Area Of Degradation Value (ADV; Rankin and Yoder 1991) 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 and MIwb) departs from the stream criterion or the upstream level of performance. The magnitude 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.



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

Pollutant Loadings

- Rapid population growth and development in the area has increased flows to the **Butler County Upper Mill Creek Regional WWTP** beyond the plant's capability to properly treat. Construction to expand capacity at the plant from 4.0 MGD to 8.0 MGD was completed September 1993.

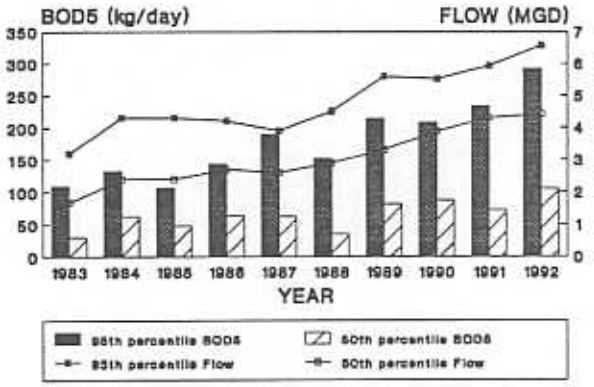
- Generally, annual flows and loadings gradually and consistently increased at the Upper Mill Creek WWTP from 1983 through 1992. Ammonia-N loadings increased significantly in 1991 and 1992 after remaining fairly stable from 1983 through 1990. Phosphorous loadings peaked in 1987 and have generally decreased through 1992 (Figures 3A and 3B).

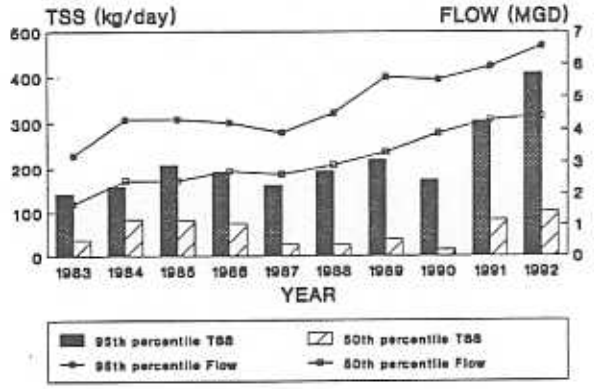
- Historically, an **excessive** number of **ammonia** NPDES violations have been recorded at the Upper Mill Creek WWTP (Appendix Table 1). In addition, the plant has periodically violated permit limitations for residual chlorine, oil and grease, fecal coliforms, $CBOD_5$, pH, and total suspended solids.

- Annual flows remained fairly stable from 1976 through 1989 at the **Village of Glendale WWTP** but increased sharply in 1990 and 1991 before dropping somewhat in 1992. Annual BOD_5 loadings generally increased from 1976 through 1985, dropped steadily from 1986 through 1989, and then increased significantly in 1990 and 1991before dropping again in 1992. Total suspended solids loadings followed a similar pattern, peaking in 1990 after relatively stable levels from 1986 through 1989. Ammonia-N loadings dropped significantly in 1986 and remained relatively low through 1992 (Figure 3C).

- The **Village of Glendale** WWTP's self-monitoring monthly operating reports did not reveal any violations or elevated concentrations during the survey sampling period (July-September, 1992). However, this data and the loading data discussed above do *not* appear to adequately reflect the problems and generally poor chemical water quality found in Town Run.

Butler County Upper Mill Creek WWTP
001 Annual Effluent Loadings





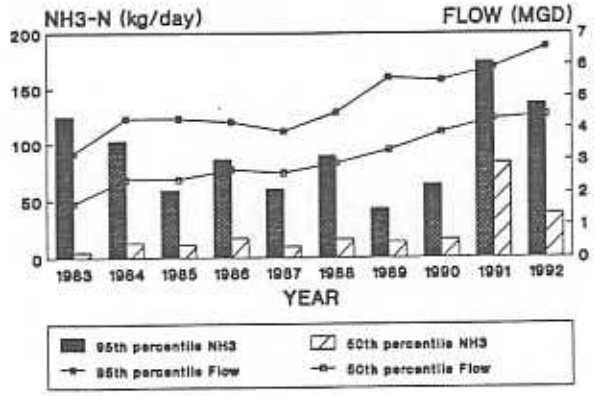
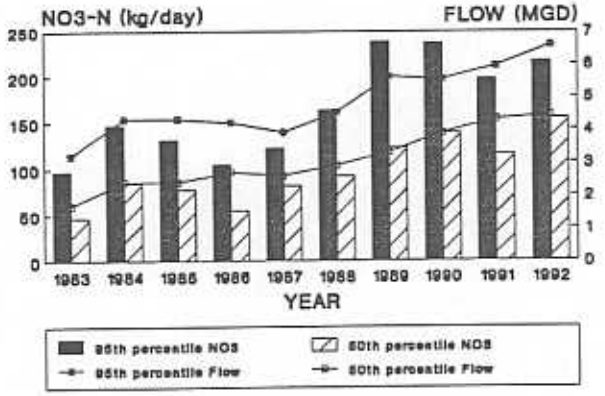


Figure 3A. Butler County Upper Mill Creek WWTP Annual Effluent Loadings (kg/day) of BOD_5, total suspended solids (TSS), and NH_3-N from 1983-1992.

Butler County Upper Mill Creek WWTP
001 Annual Effluent Loadings



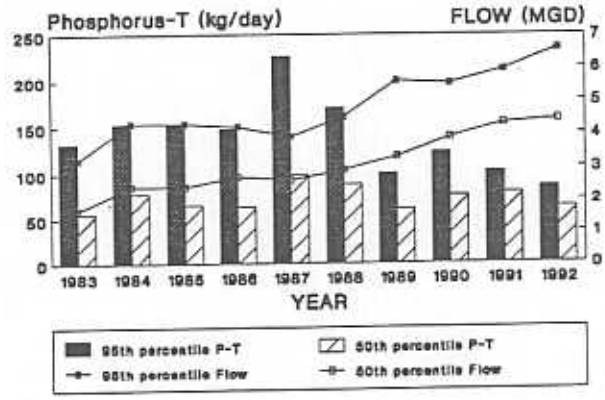


Figure 3B. Butler County Upper Mill Creek WWTP Annual Effluent Loadings (kg/day) of nitrate-N and total phosphorous from 1983-1992.

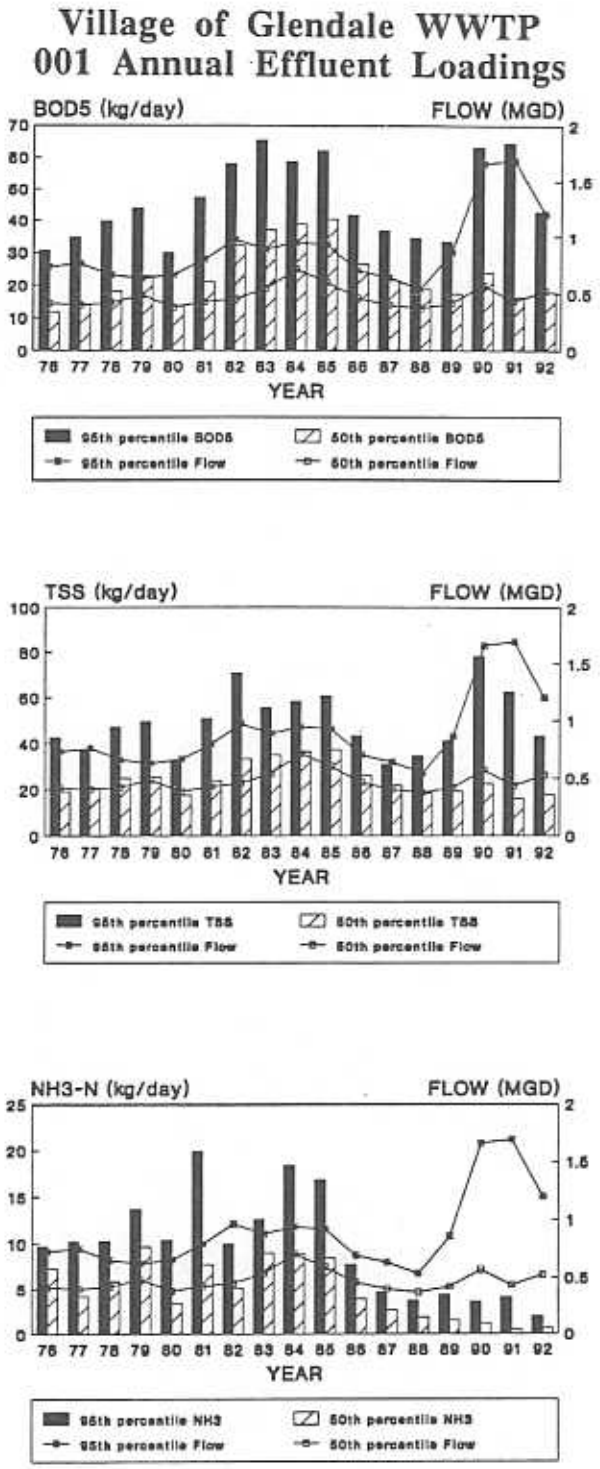


Figure 3C. Village of Glendale WWTP Annual Effluent Loadings (kg/day) of BOD_5, total suspended solids (TSS), and NH_3-N from 1976-1992.

Chemical/Physical Results

Mill Creek

- Virtually every site on the mainstem which was sampled for **fecal coliform** and **E. coli** experienced numerous exceedences of the recreation criteria (Figures 4, 5; Table 4). RM 17.61 and RM 0.51 had the highest median E. coli and fecal coliform values. High values at RM 17.61, the first site on the mainstem downstream of the confluence of the East Fork Mill Creek (RM 17.95) may be a reflection of problems found at the mouth of the East Fork (discussed below). The MSD Mill Creek WWTP, just upstream of RM 0.51, often discharges untreated or partially treated sewage directly to the river during peak flow periods through combined sewer overflows (CSOs). The problem is further exacerbated by a permanent stagnant backwater area created throughout this reach by the Markland Pool of the Ohio River.

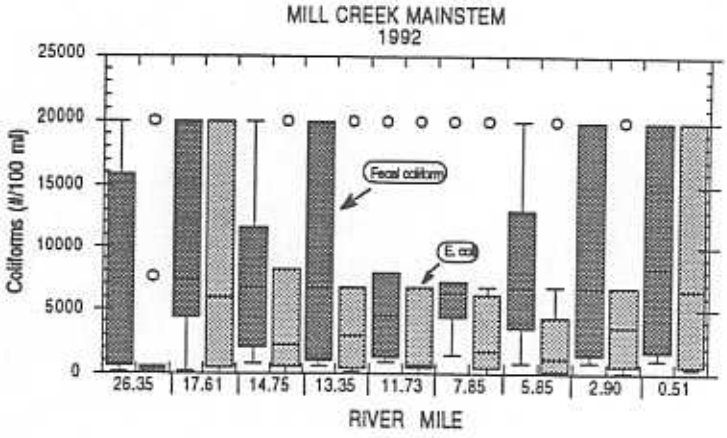


Figure 4. Longitudinal summary of fecal coliform and E. coli concentrations in Mill Creek during the 1992 survey. E. coli secondary contact criterion < 576 and primary contact criterion < 298. See Figure 5 for fecal coliform criteria.

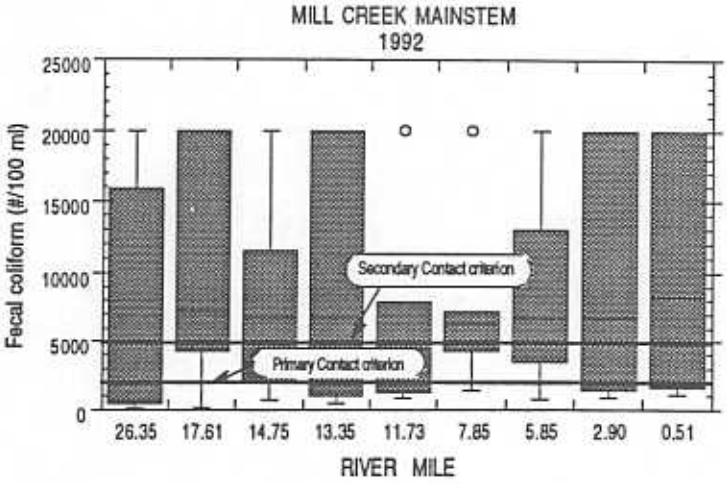


Figure 5. Longitudinal summary of fecal coliform concentrations in Mill Creek during the 1992 survey.

Note: Many of the graphs in this document are of the box plot type as exhibited in Figures 4 and 5. A box plot represents each plotted variable as a separate box. In Figures 4 and 5 the variable is river mile (X axis). The Y axis is the range of all the data. The top of the box marks the 75th percentile of the variable population and the bottom of the box marks the 25th percentile. The median value is marked as a bold line within each box. The whiskers extending from the top and bottom of each box mark the maximum and minimum for each variable. The circles represent outlier values which result because they are two times the interquartile range in the boxes.

- Dissolved oxygen (D.O.) levels recorded in the mainstem on survey days were generally above water quality criteria (Figure 6). Open channels at RMs 6.53 and 5.85 created conditions conducive to algal growth and account for the generally high D.O. readings at these locations. Dissolved oxygen dropped below the WWH average criterion at RM 2.90 on one occasion. Nine of the twelve D.O. measurements taken at RM 0.51 on survey days were below WWH criteria. Datasonde values at this location also indicate a severely stressed (oxygen depleted) environment. Again, nutrient loading from CSOs and impounded backwater contribute to the deteriorated water quality at this site.

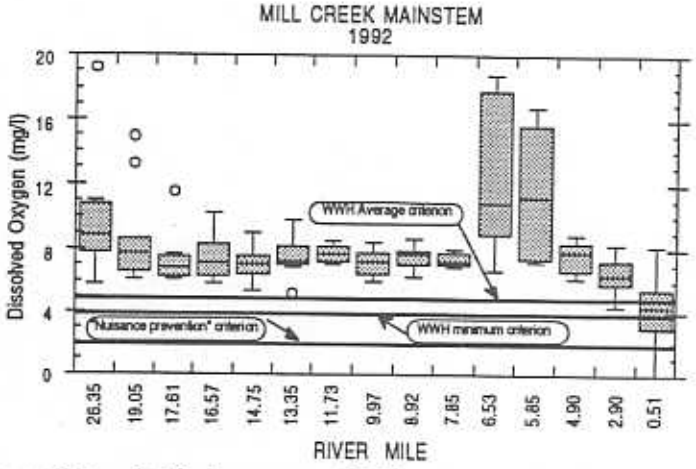


Figure 6. Longitudinal summary of D.O. concentrations from day time grab samples in Mill Creek during the 1992 survey.

Datasonde continuous monitors also recorded dissolved oxygen levels below WWH criteria at RMs 16.57 (Sharon Road), 14.74 (Formica entrance), and 14.06 (upstream of the Cooper Creek confluence), Figure 7. Nutrient loading and organic enrichment from the Village of Glendale WWTP on Town Run (confluence @ RM 16.93) may be impacting dissolved oxygen levels at RM 16.57. Evaluation of the data is difficult due to a twelve mile gap in the data from RM 13.25 to 0.51 (Appendix Table 2).

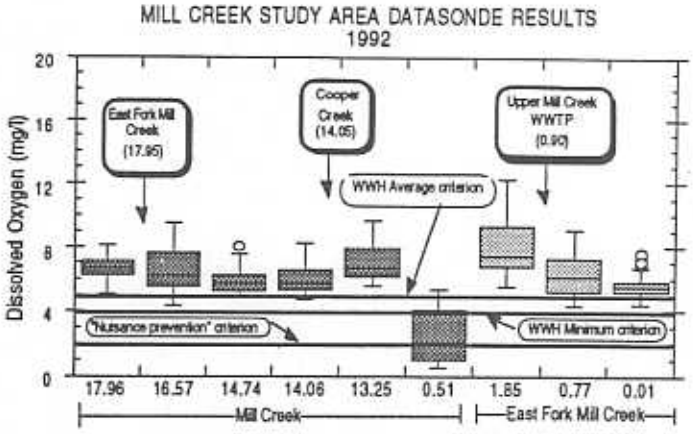


Figure 7. Longitudinal summary of D.O. datasonde results in Mill Creek and East Fork Mill Creek during the 1992 survey.

- The entry of the East Fork Mill Creek (and its associated problems (see below)) at RM 17.95 may account for the increased ammonia, phosphorous, and nitrate-nitrite nitrogen levels recorded at RM 17.61 as compared to those found in the mainstream upstream of the East Fork confluence (Figures 8-11). Similarly, nutrient loading from the Village of Glendale WWTP discharge on Town Run (confluence @ RM 16.93) may be reflected in the elevated ammonia, phosphorus, and nitrate-nitrite nitrogen levels found at RM 16.57 in the mainstem.

- Work throughout the summer on replacement of the Anthony Wayne bridge just upstream of RM 9.97 may account for the consistently higher **total suspended solids** at this site.

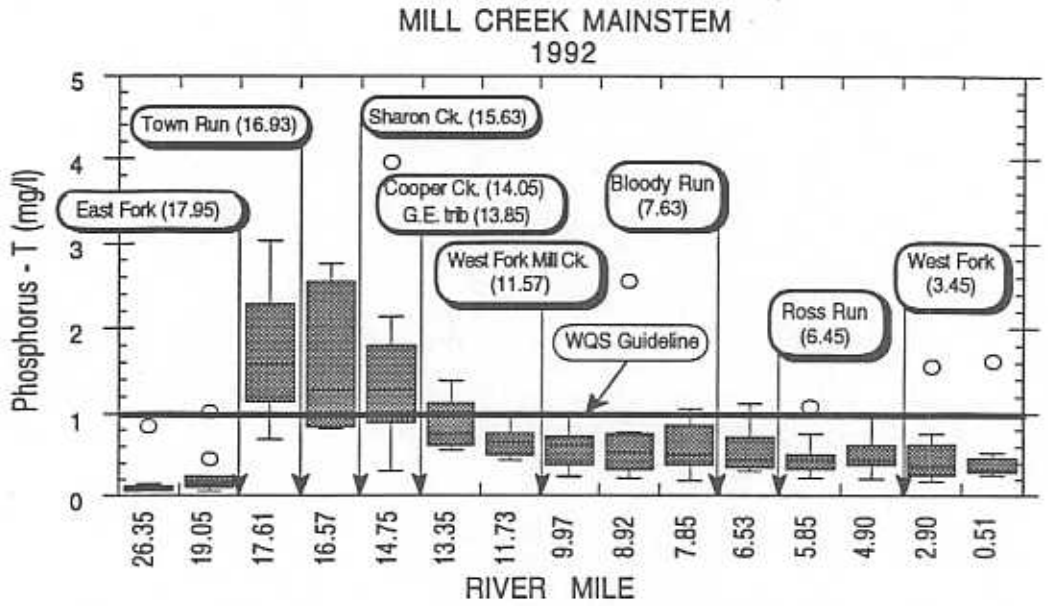


Figure 8. Longitudinal summary of total phosphorus concentrations in Mill Creek during the 1992 survey.

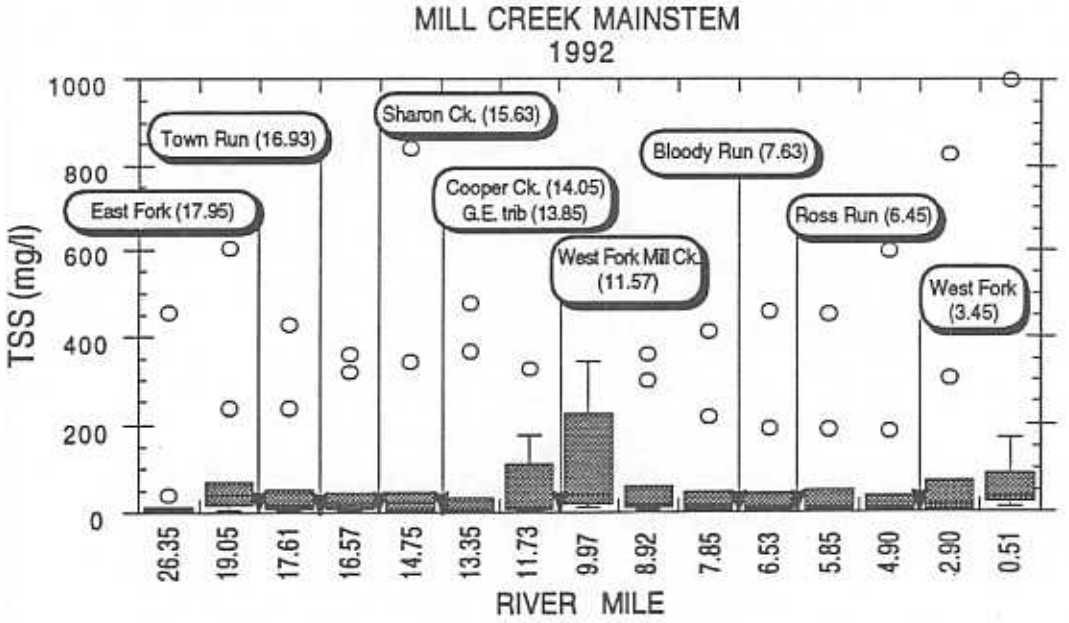


Figure 9. Longitudinal summary of total suspended solids concentrations in Mill Creek during the 1992 Survey.

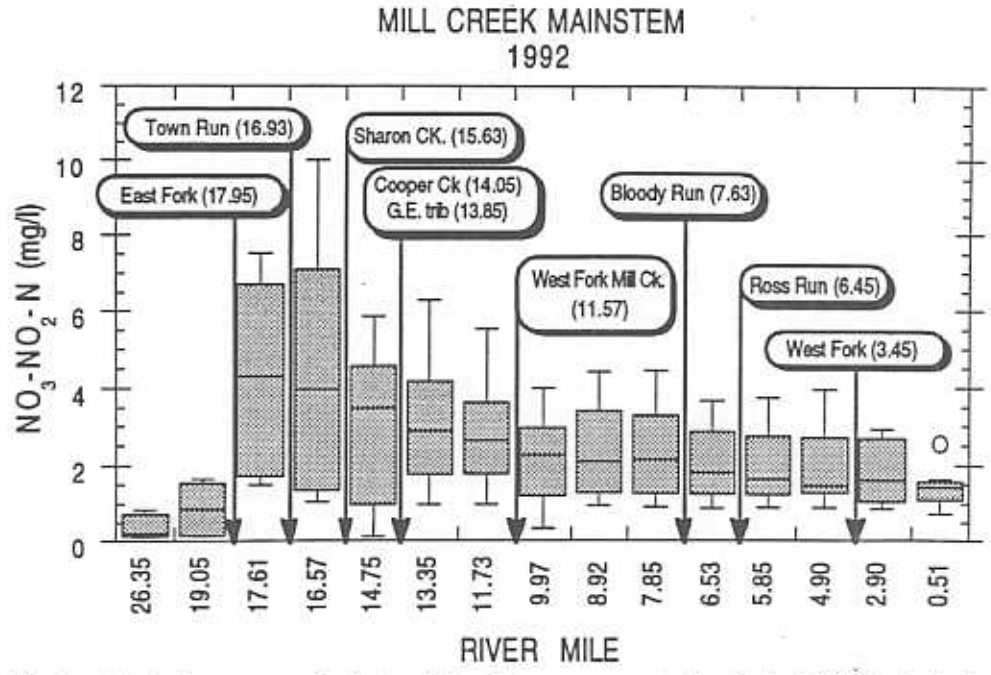


Figure 10. Longitudinal summary of nitrate-nitrite nitrogen concentrations in the Mill Creek during the 1992 survey.

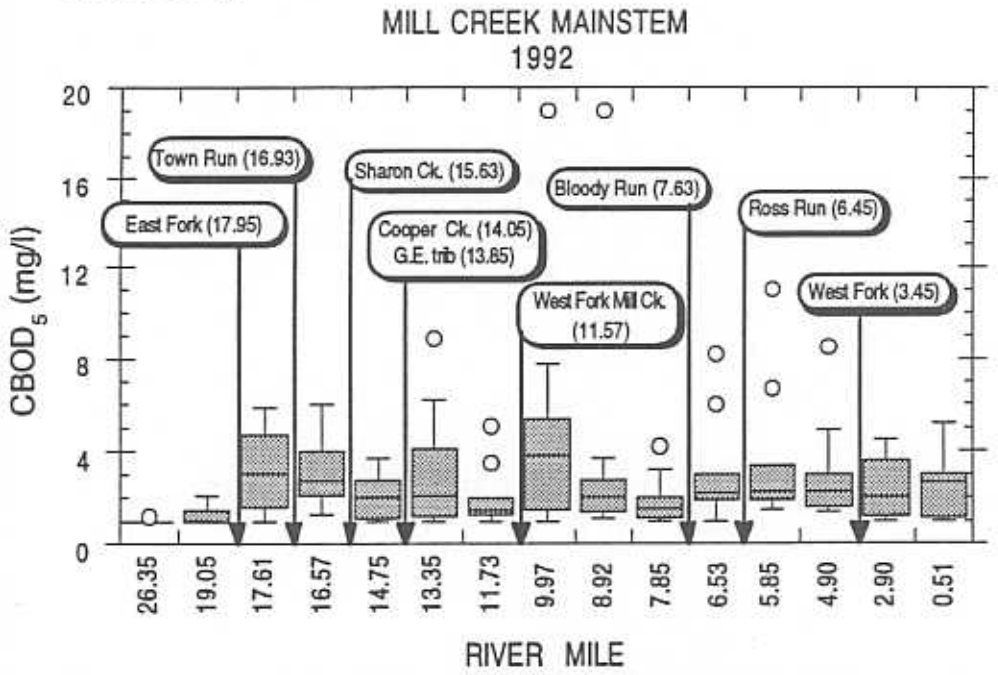


Figure 11. Longitudinal summary of $CBOD_5$ concentrations in Mill Creek during the 1992 survey.

- On July 16 and July 30 **ammonia-N** concentrations recorded at RMs 6.53, 5.85, and 4.90 (while meeting Limited Warmwater Habitat criteria, exceeded WWH water quality criterion) (Figure 12). Raw sewage was observed in the river at these sites on several survey days. Elevated concentrations found at RM 5.85 may also be partially attributable to the consistently elevated ammonia levels in Ross Run (confluence @ RM 6.45). CSOs impact the water quality of the river in this area.

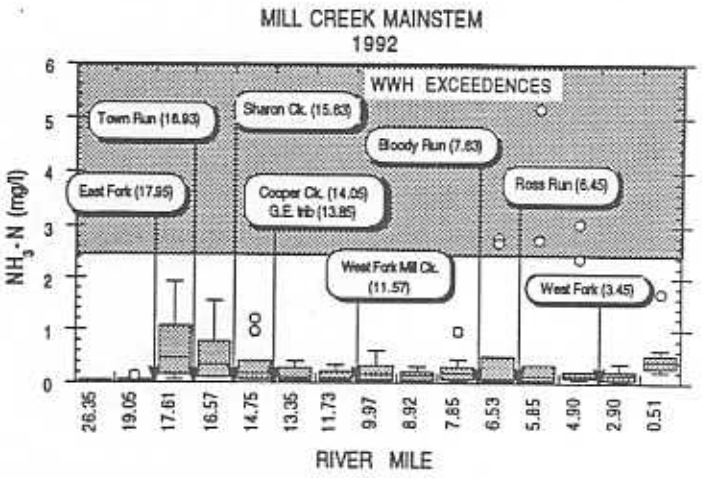


Figure 12. Longitudinal summary of ammonia-nitrogen concetrations in Mill Creek during the 1992 survey.

- Several exceedences of the WWH/MWH criteria for **lead** were noted in the lower reaches of the mainstem (RMs 7.85, 6.53, 5.85, 4.90, 2.90, and 0.51), Figure 13. CSOs and numerous landfills including the Este Avenue Dump (Center Hill Dump), Elda Landfill, Saint Bernard Dump, Canal Ridge Dump, B&O Dump, and the City of Cincinnati Mill Creek Dump lie in close proximity to Mill Creek and may be detrimentally impacting the water quality of the river. Exceedences of WWH/MWH criteria were used because that criteria for lead will apply for the proposed use designation.

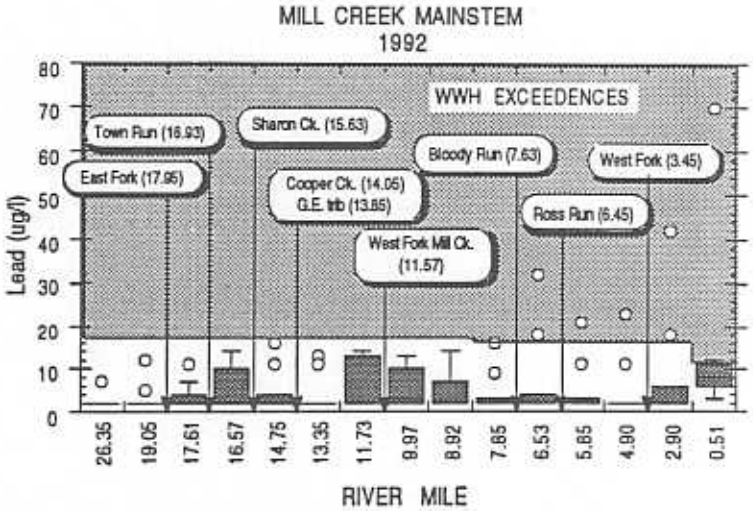


Figure 13. Longitudinal summary of total lead concentrations in Mill Creek during the 1992 survey.

Note: Graphs with water quality limits indicated by a line with a shadowed area above the line may show varied water quality limits as in Figure 13. Water quality standards for some parameters such as metals and ammonia vary depending on instream conditions. Metals limits are dependent on instream hardness. The limits for ammonia are dependent upon the instream measurements of pH and temperature (Figure 28).

- Other exceedences of water quality criteria noted in the mainstem include **selenium** (6 µg/l) at RM 16.57, **cyanide** (18 µg/l) at RM 11.73, and **copper** (22 µg/l, 35 µg/l and 51 µg/l) at RMs 4.90, 2.90, and 0.51, respectively.

- All seven sites on the mainstem sampled for organic compounds experienced exceedences of water quality criteria for various organochlorine pesticides, including DDT compounds. In addition, several other organic chemicals were detected in the water samples at all sites (Appendix Table 3). Adjacent landfills and industrial sites as well as runoff from CSOs contribute to the problem.

East Fork Mill Creek

- No exceedences of water quality criteria or elevated concentrations were noted at RM 4.69 or RM 3.78. Pesticides were detected in the water at both sites and chloromethane, a volatile organic compound (VOC), was detected once in low concentrations at RM 3.78 (Appendix Table 3). These two sampling locations, bracketing Skinner landfill, were sampled only on organic sampling days (three times) in order to monitor and document any organic impacts from the landfill area.

- RMs 1.85 and 0.77 bracketed the **Butler County Upper Mill Creek Regional WWTP** (RM 0.90). The upstream site (RM 1.85) experienced exceedences of the primary contact recreation criteria for both fecal coliform and E. coli, Figures 14 and 15. No other parameters at this site were elevated. In addition to frequent exceedences of the primary contact recreation criteria, RM 0.77, downstream from the WWTP, incurred exceedences of criteria for dissolved oxygen, ammonia, selenium and various pesticides (Figures 16-21; Appendix Tables 3 and 7). The majority of phosphorous concentrations recorded here were well above the WQS guideline (1.0 mg/l). Nitrate-nitrite nitrogen, $CBOD_5$, and zinc levels were also significantly higher than at RM 1.85.

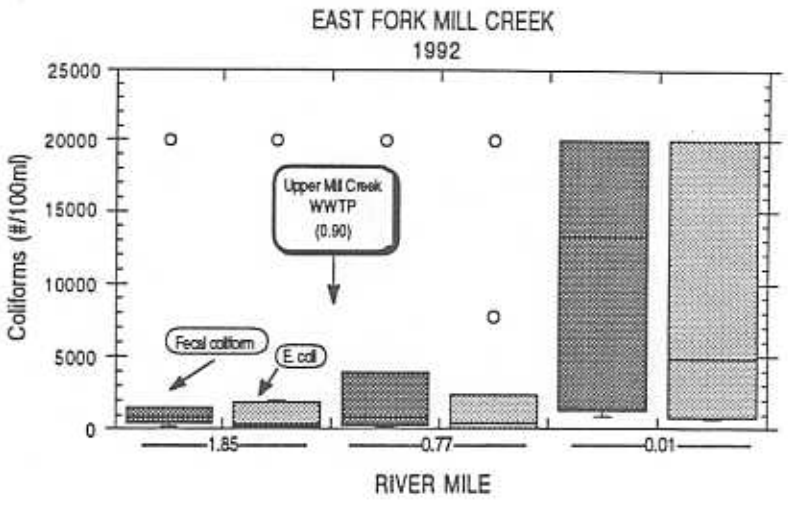


Figure 14. Longitudinal summary of fecal coliform and E. coli concentrations in East Fork Mill Creek during the 1992 survey.

Pesticides were detected at both sites and several VOCs (chloroform, bromodichloromethane, dibromochloromethane) while not elevated, were detected at RM 0.77.

- While all three coliform sampling locations on the East Fork of Mill Creek experienced exceedences of the fecal coliform and E. coli primary contact recreation criteria, the most pronounced impacts occurred at RM 0.01. Seventy-five percent (75%) of fecal coliform samples and 100% of E. coli samples exceeded the primary contact recreation criteria. Ninety-two percent (92%) of phosphorous concentrations recorded at this site were measured in levels higher than the WQS guideline (1.0 mg/l). Elevated levels of nitrate-nitrite nitrogen, $CBOD_5$, and ammonia (including one exceedence of the WWH criterion) were also noted. In addition, Datasonde monitors measured the lowest average dissolved oxygen level (5.58 mg/l) in the East Fork Mill Creek and recorded exceedences of the WWH dissolved oxygen average criterion (Appendix Table 2; Fig. 7). Post survey sampling and investigation identified a leaking sewer line located in the stream bed near RM 0.01. Hamilton County Metropolitan Sewer District repaired the sewer line during 1993.

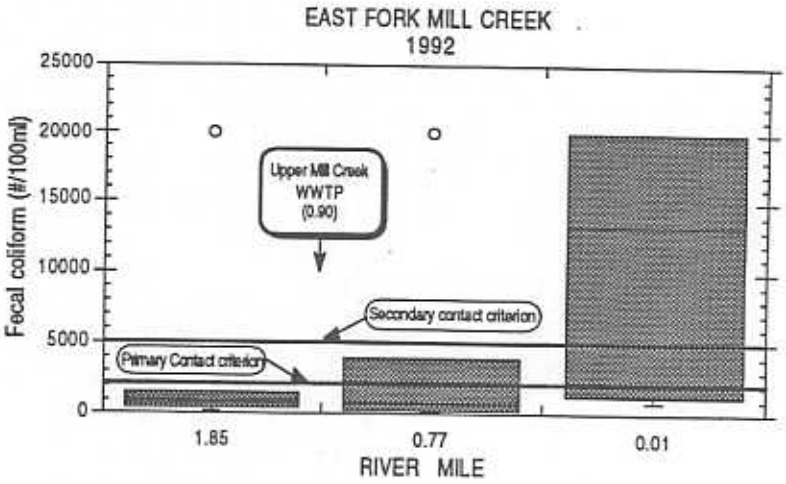


Figure 15. Longitudinal summary of fecal coliform concentrations in East Fork Mill Creek during the 1992 survey.

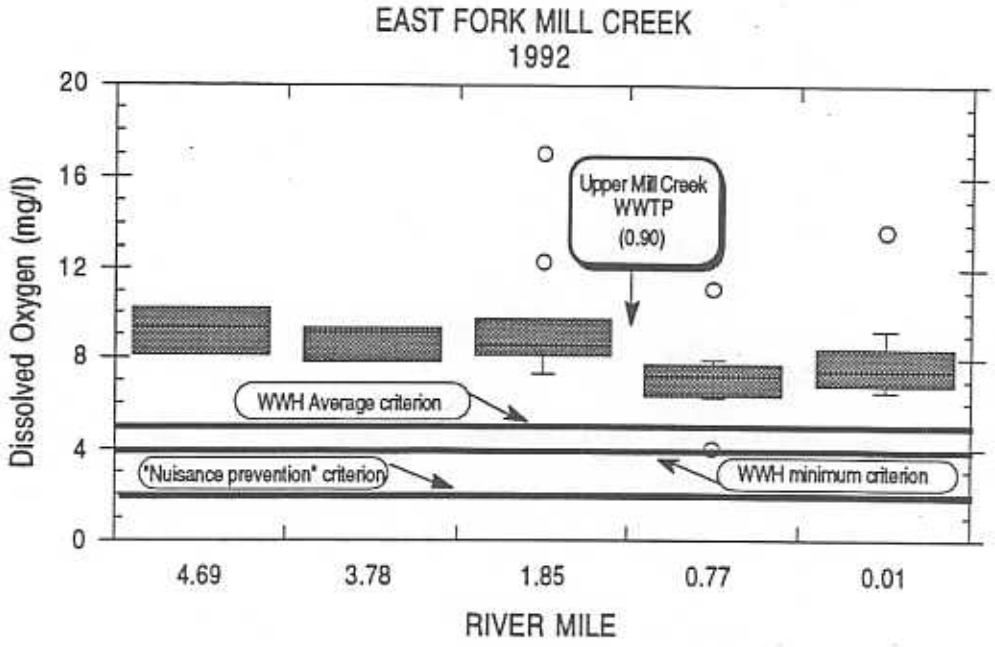


Figure 16. Longitudinal summary of dissolved oxygen concentrations from day time grab samples in East Fork Mill Creek during the 1992 survey.

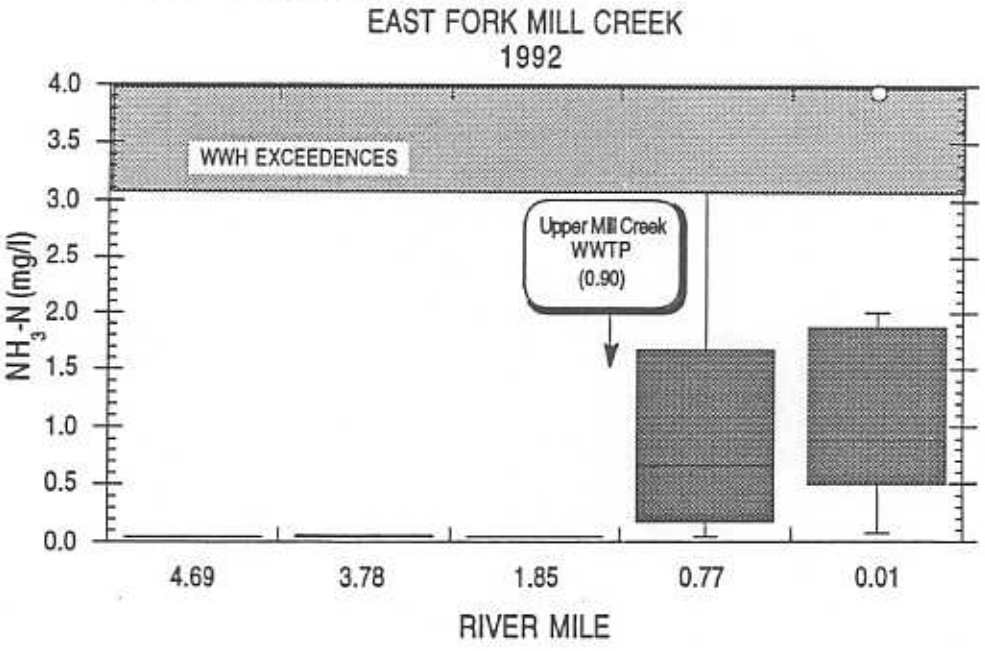


Figure 17. Longitudinal summary of ammonia-nitrogen concentrations in East Fork Mill Creek during the 1992 survey.

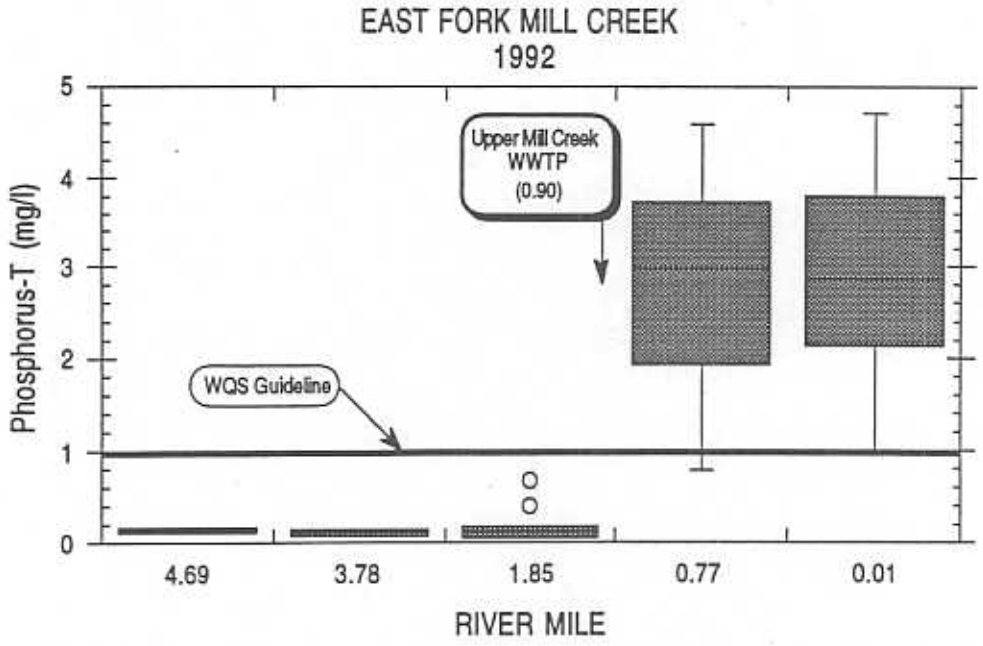


Figure 18. Longitudinal summary of total phosphorus concentrations in East Fork Mill Creek during the 1992 survey.

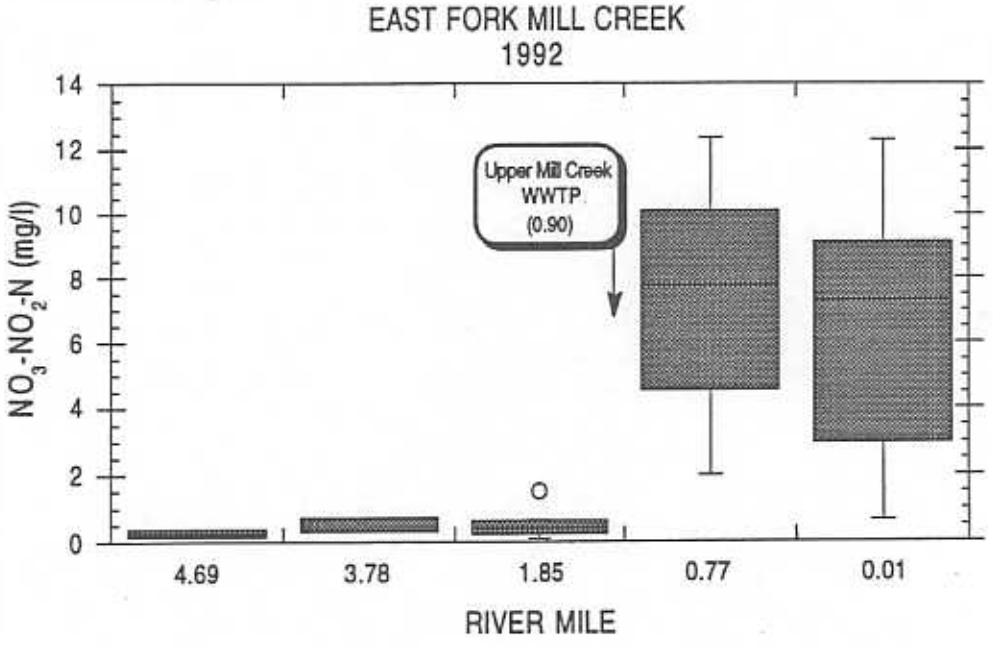


Figure 19. Longitudinal summary of nitrate-nitrite nitrogen concentrations in East Fork Mill Creek during the 1992 survey.

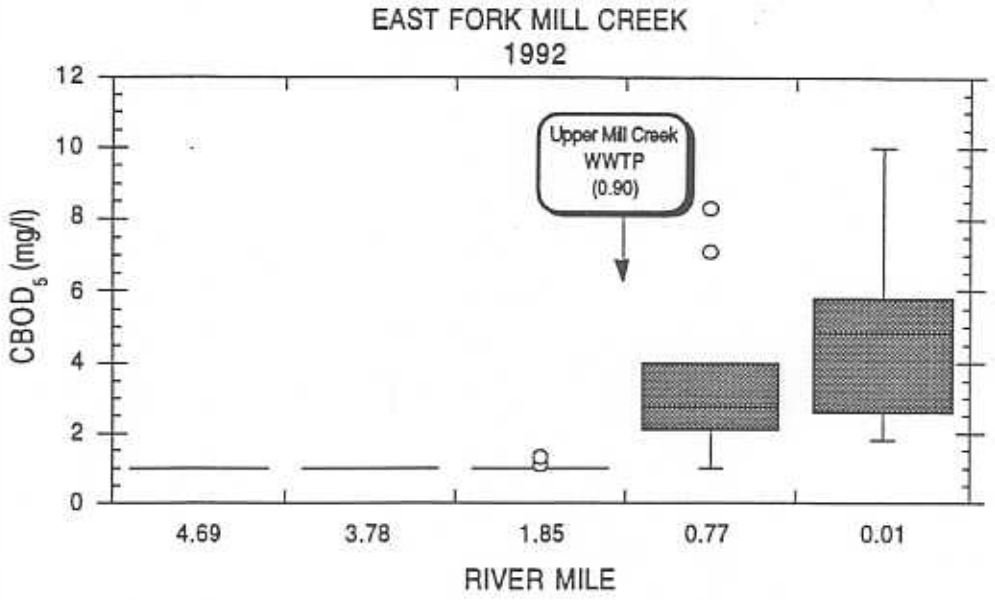


Figure 20. Longitudinal summary of $CBOD_5$ concentrations in East Fork Mill Creek during the 1992 survey.

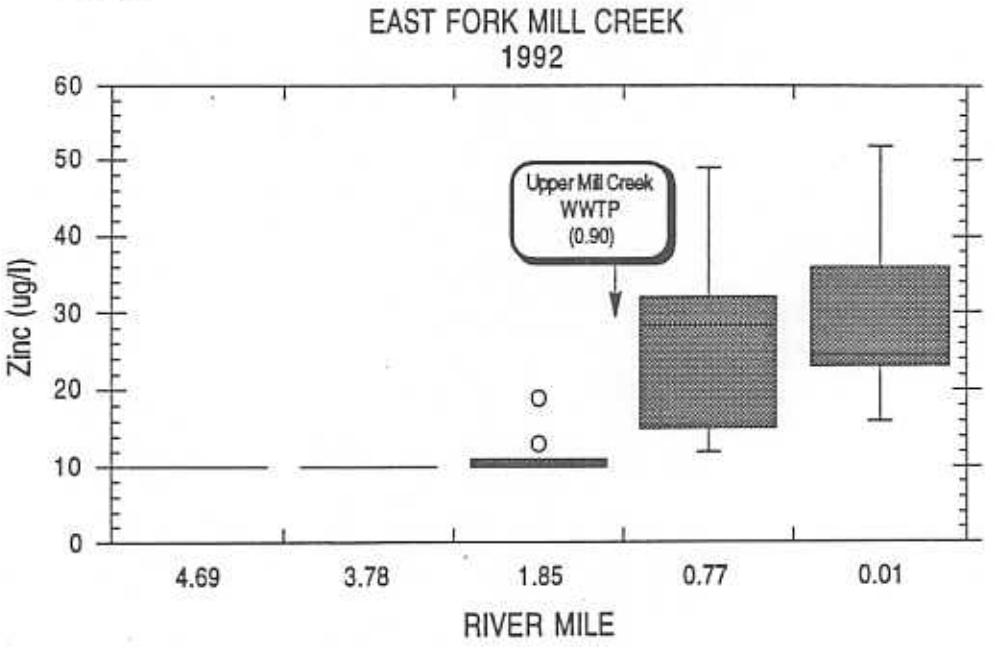


Figure 21. Longitudinal summary of total zinc concentrations in East Fork Mill Creek during the 1992 survey.

Town Run

- Chemical/physical parameters measured at RM 0.70 met the water quality criteria for Limited Resource Water use designation. However, forty-two percent (42%) of **ammonia** concentrations would have exceeded WWH criterion and fifty percent (50%) of the **dissolved oxygen** concentrations recorded were below WWH criteria. Nutrient loading from the Village of Glendale WWTP at RM 0.92 is also evidenced by elevated levels of phosphorous, fecal coliform, E. coli, (Figure 22, 23, 28 and 29) and nitrate-nitrite nitrogen. One elevated copper concentration (38 µg/l) recorded on August 13 exceeded the WWH chronic criterion.

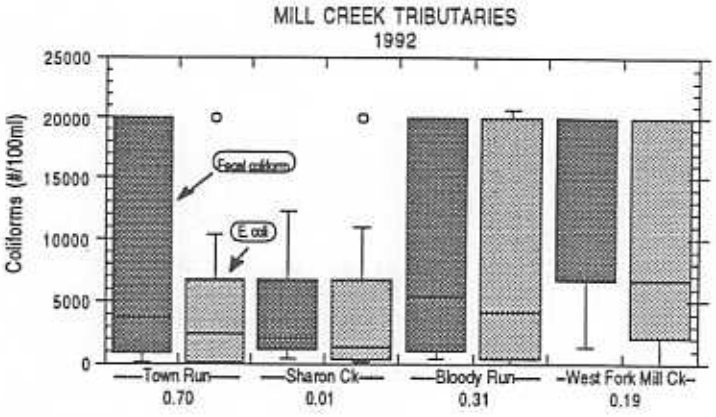


Figure 22. Summary of fecal coliform and E. coli concentrations in Town Run, Sharon creek, Bloody Run, and West Fork Mill Creek during the 1992 survey.

Sharon Creek

- Fifty-eight percent (58%) of fecal coliform and eighty-three percent (83%) of E. coli concentrations recorded at RM 0.01 of Sharon Creek exceeded the recreation criteria (Figure 22 and 23). In addition, total suspended solids were somewhat elevated and one cyanide value (17 µg/l) exceeded the WWH criterion for prevention of chronic toxicity. The source is unknown.

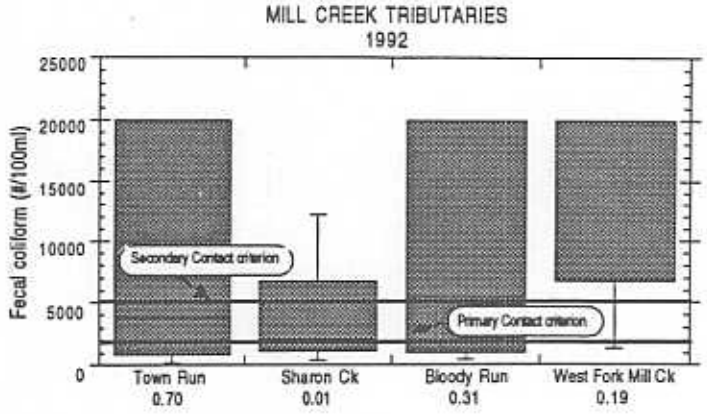


Figure 23. Summary of fecal coliform concentrations in Town run, Sharon Creek, Bloody Run, and West Fork Mill Creek during the 1992 survey.

Cooper Creek

- No exceedences of Limited Resource Water use designation water quality criteria were noted on Cooper Creek during the survey. However, cyanide (17 µg/l) and conductivity (2640 µmhos/cm) at RM 0.20 were elevated on separate occasions and would have exceeded the WWH criteria for prevention of chronic toxicity. No other parameters analyzed were elevated.

West Fork Mill Creek

- Two exceedences of the lead criterion were noted at RM 2.00. Chemical Incorporated (Lockland Works) is located about 500 feet west of the river (Appendix 9). A previous owner (E.I. Dupont de Nemeurs and Company) manufactured sulfuric acid by the lead chamber process. The process generated a lead sulfate sludge which was disposed of on-site in shallow pits as well as directly onto the ground surface. Runoff, overland flow and subsurface seeps may have accelerated contaminant migration toward the river. In addition, old auto parts (including a discarded battery) were observed in this area. CSOs may also contribute to the problem.

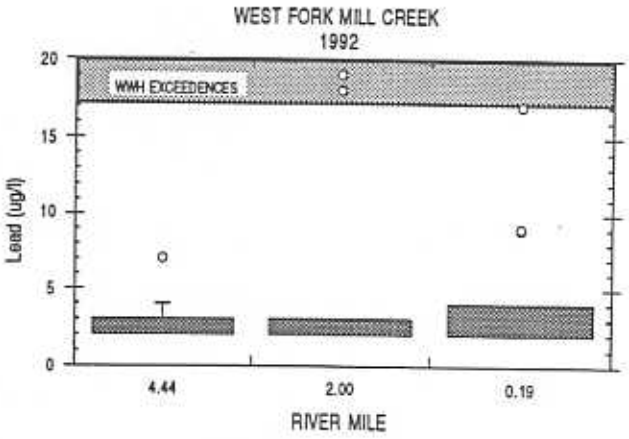


Figure 24. Longitudinal summary of total lead concentrations in West Fork Mill Creek during the 1992 survey.

- Numerous exceedences of water quality criteria were noted at RM 0.19 including dissolved oxygen (Figure 25), ammonia, fecal coliform, E. coli, lead, and various organochlorine pesticides, including DDT. The **highest ammonia** (Figure 26) concentrations in the survey were recorded at this site. Nitrate-nitrite nitrogen and $CBOD_5$ were also somewhat higher here than in the upper reach of the stream. Problems may be partially attributable to the many CSOs in the area. There is also the potential for surface water contamination from two old landfills in the Arlington Heights area (Carthage Avenue Landfill (closed in 1969) and the Galbraith Road Landfill (closed in 1965)).

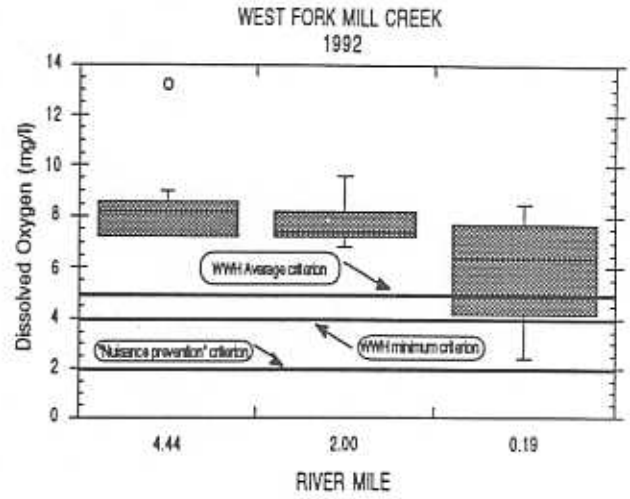


Figure 25. Longitudinal summary of dissolved oxygen concentrations from day time grab samples in West Fork Mill Creek during the 1992 survey.

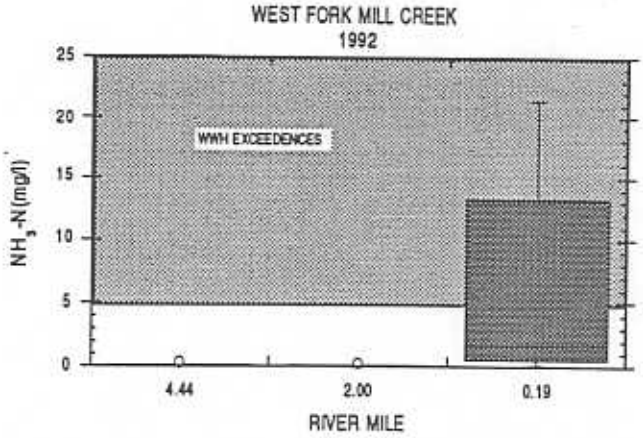


Figure 26. Longitudinal summary of ammonia-nitrogen concentrations in West Fork Mill Creek during the 1992 survey.

Bloody Run

- Chemical/physical sampling at RM 0.31 revealed several exceedences of Limited Resource Water criteria for dissolved oxygen (1.3, 2.8, 0.6, 2.2, and 0.4 mg/l) (Figure 27) and one exceedence for copper (35 µg/l). An additional two dissolved oxygen measurements recorded were below the WWH average criterion. The majority of fecal coliform and E. coli concentrations exceeded the secondary contact recreation criteria and several organochlorine pesticide values recorded (aldrin, dieldrin, methoxychlor) surpassed the WWH criteria for prevention of chronic toxicity. Various other pesticides and VOCs were also detected in water samples at this site (Appendix Table 3). This tributary receives frequent color discharges (red, green) from CSOs in the area which receive industrial discharges. A green discoloration noted at this site by field crews on September 24, 1992 may have been the reminants of an Xtec, Inc. coolant spill (25 gallons) on September 3, 1992.

Ross Run

- Water samples from RM 0.01 of Ross Run indicate elevated levels of ammonia (Figure 28) and organochlorine pesticides. (Physical topography at this site made measurement of dissolved oxygen impossible.) While Ross Run was designated Limited Warmwater Habitat at the time of the survey, 100% of ammonia concentrations would have exceeded WWH chronic criterion. Zinc levels were somewhat elevated. In addition, several other organochlorine pesticides, VOCs and semi-volatile organic compounds (SVOCs) were detected in the water. Again, this tributary receives overflows from several CSOs in the area which receive industrial discharges.

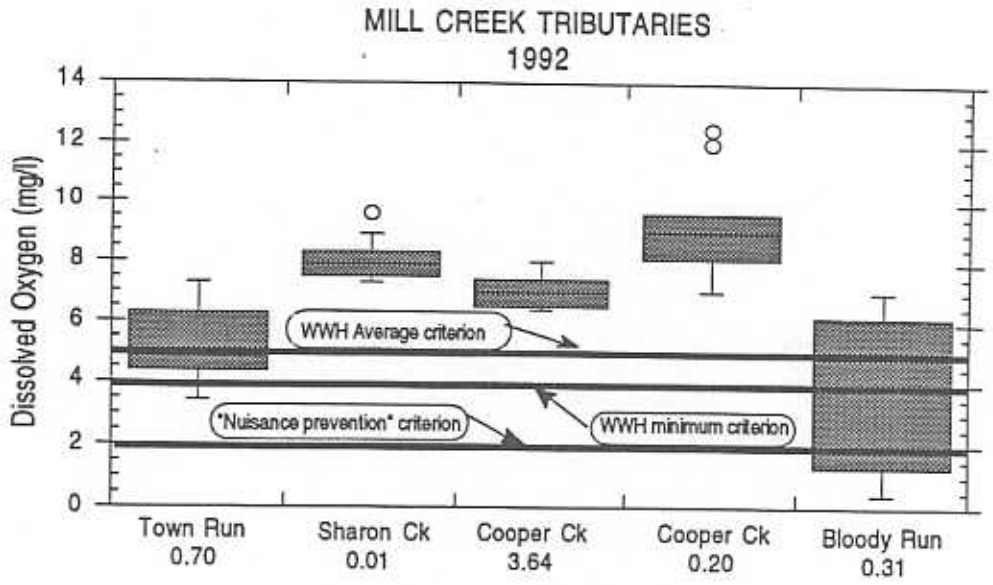


Figure 27. Summary of dissolved oxygen concentrations from day time grab samples in Town Run, Sharon Creek, Cooper Creek, and Bloody Run during the 1992 survey.

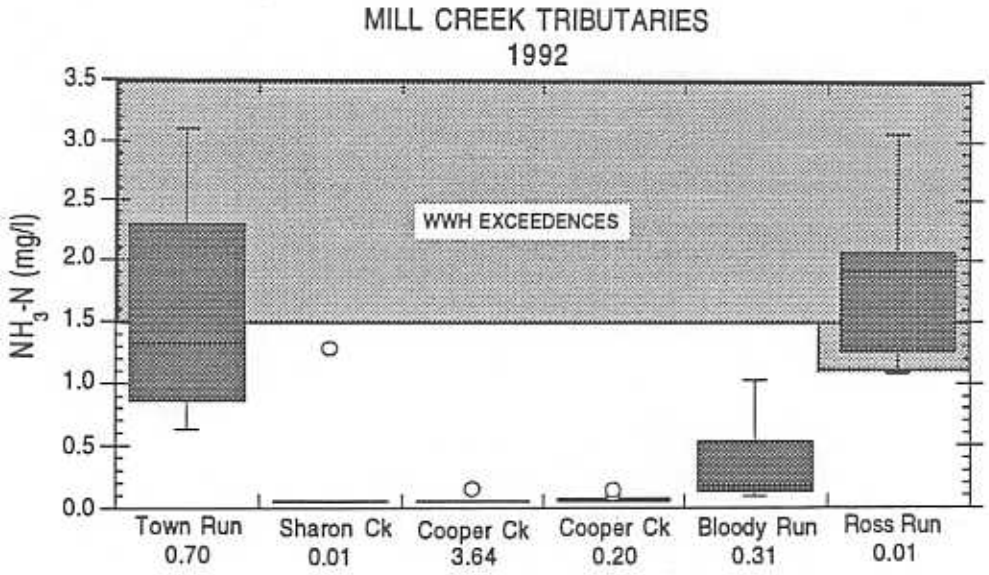


Figure 28. Summary of ammonia-nitrogen concentrations in Town Run, Sharon Creek, Cooper Creek, Bloody Run, and Ross Run during the 1992 survey. Ammonia exceedences are dependent upon instream pH and temperature which may vary between streams (ie., Ross Run).

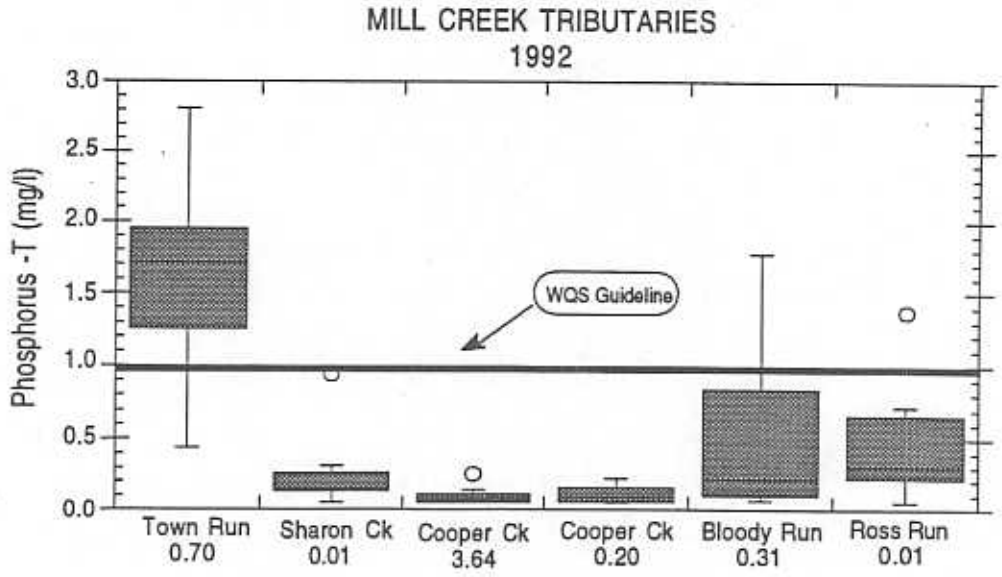


Figure 29. Summary of total phosphorus concentrations in Town Run, Sharon Creek, Cooper Creek, Bloody Run, and Ross Run during the 1992 survey.

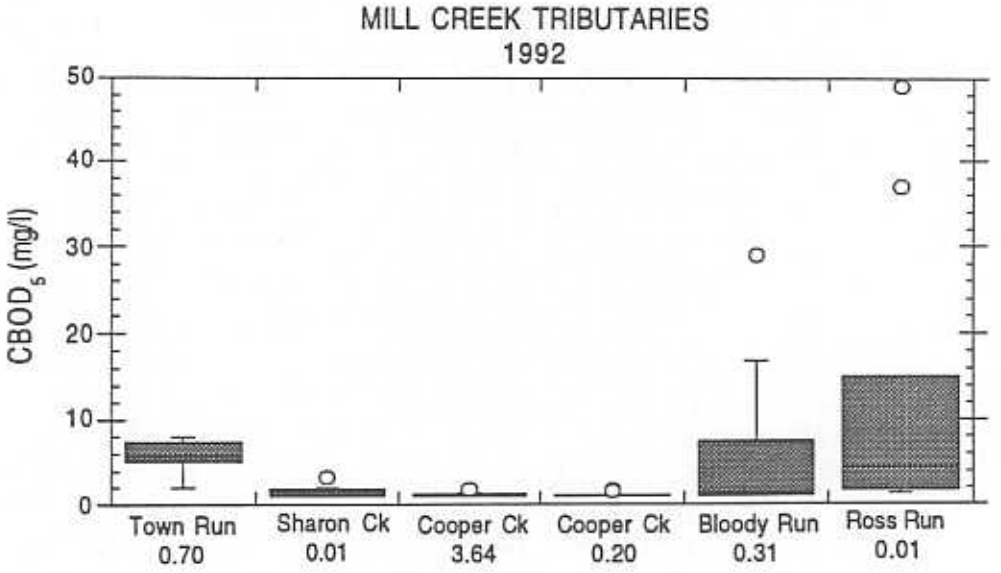


Figure 30. Summary of $CBOD_5$ concentrations in Town Run, Sharon Creek, Cooper Creek, Bloody Run, and Ross Run during the 1992 survey.

Table 4. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the Mill Creek study area, 1992 (units are µg/l for metals and organics, #/100ml for fecal coliform and E. coli, µmhos/cm for conductivity, and mg/l for all other parameters).

Stream Name	River Mile	Violation: Parameter (value)
Mill Creek	26.35	Fecal coliform (8000◊◊, 17600◊◊, >20000◊◊, 15900◊◊); E.coli (390◊, 500◊, 490◊, 400◊, >20000◊◊, 7500◊◊);
	19.05	Phosphorus (1.02†)
	17.61	Phosphorus (1.66†, 1.22†, 1.59†, 2.51†, 1.57†, 2.28†, 1.15†, 1.41†, 3.04†, 2.05†); Fecal coliform (>6700◊◊, 5330◊◊, 9700◊◊, >20000◊◊, 4300◊, 7800◊◊, >20000◊◊, 5700◊◊, 13700◊◊, >20000◊◊); E.coli (>6700◊◊, 2470◊◊, >20000◊◊, 8400◊◊, 2170◊◊, 410◊, >20000◊◊, 5100◊◊, 8400◊◊, >20000◊◊)
	16.57	Phosphorus (1.84†, 2.76†, 1.22†, 2.54†, 1.03†, 1.33†, 2.55†, 1.71†); Selenium (6*); gamma-Hexachlorocyclohexane (0.017*, 0.011*,0.020*); Heptachlor (0.003*); 4,4'-DDT (0.027*)
	14.75	Phosphorus (2.14†, 1.18†, 3.95†, 1.67†, 1.68†, 1.22†, 1.80†, 1.35†); Fecal coliform (>6700◊◊, >6700◊◊, >20000◊◊, 7100◊◊, 11500◊◊, 2500◊, >20000◊◊, 7800◊◊, 2600◊); E. coli (>6700◊◊, >6700◊◊, >20000◊◊, >2000◊◊, 2330◊◊, 730◊◊, >20000◊◊, 490◊, 400◊, 8200◊◊, 1250◊◊)
	13.35	Phosphorus (1.13†, 1.39†, 1.30†); Fecal coliform (>6700◊◊, >6700◊◊, >20000◊◊, >20000◊◊, >20000◊◊, 16100◊◊, 8600◊◊); E. coli (2870◊◊, >6700◊◊, 5100◊◊, >20000◊◊, 390◊, 708◊◊, >20000◊◊, 340◊, 3580◊◊); gamma-Hexachlorocyclohexane (0.018*); 4,4'-DDT (0.017*, 0.033*); Methoxychlor (0.015*); Dieldrin (0.014*)

See last page of Table 4 for explanation of notations

Table 4. (cont.)

Stream Name	River Mile	Violation: Parameter (value)
Mill Creek	11.73	Cyanide (0.018*); Fecal coliform (>6700◊◊, >6700◊◊, 7900◊◊, >20000◊◊, 3700◊, >20000◊◊, 4800◊, 4100◊); E. coli (2870◊◊, >6700◊◊, 600◊◊, >20000◊◊, 510◊, 754◊◊, >20000◊◊, 590◊◊, 380◊, 2280◊◊)
	9.97	Phosphorus (1.01†)
	8.92	Phosphorus (2.55†); 4,4'-DDT (0.013*); Endosulfan II (0.005*)
	7.85	Phosphorus (1.06†); Fecal coliform (>6700◊◊, >6700◊◊, 4300◊, >20000◊◊, 6400◊◊, 4600◊, >20000◊◊, 3900◊, 5400◊◊, 7200◊◊); E. coli (1200◊◊, >6700◊◊, 1430◊◊, >2000◊◊, 400◊, 4100◊◊, >20000◊◊, 3500◊◊, 1200◊◊, 6200◊◊); Lead (16*); 4,4'-DDT (0.026*); Endosulfan II (0.007*)
	6.53	Ammonia (***2.80****, ***2.69****); Phosphorus (1.12†); Lead (***32****, ***18****)
	5.85	Ammonia (***2.75****, ***5.18****); Phosphorus (1.08†); Fecal coliform (>6700◊◊, >6700◊◊, 8100◊◊, >20000◊◊, ***4200***◊, 13000◊◊, >20000◊◊, ***3500***◊, 6300◊◊, 9400◊◊); E. coli (733◊◊, >6700◊◊, 4300◊◊, >2000◊◊, 3000◊◊, >20000◊◊, ***500***◊, 900◊◊, 1450◊◊); Lead (***21****); gamma-Hexachlorocyclohexane (0.014*); Heptachlor (0.004*); Dieldrin (0.015*); 4,4'-DDT (0.026*); Endrin (0.010*); Endosulfan II (0.004*)

Table 4. (cont.)

Stream Name	River Mile	Violation: Parameter (value)
Mill Creek	4.90	Ammonia (***2.38****, ***3.06****); Copper (22*); Lead (***23****)
	2.90	D.O. (***4.4***‡); Phosphorus (1.56†); Fecal coliform (>6700◊◊, >6700◊◊, >20000◊◊, >20000◊◊, 6600◊◊, 9500◊◊, >20000◊◊, >20000◊◊); E. coli (>6700◊◊, >6700◊◊, 5900◊◊, >20000◊◊, 2000◊◊, ***533***◊, >20000◊◊, 620◊◊, 933◊◊, 5300◊◊); Copper (35*); Lead (***18****, ***42****); gamma-Hexachlorocyclohexane (0.016*); Heptachlor (0.004*); Dieldrin (0.011*); 4,4'-DDT (0.031*, 0.007*); Endosulfan I (0.009*); Endosulfan II (0.004*, 0.006*)
	0.51	D.O. (***3.8***‡‡, ***3.3***‡‡, ***2.2***‡‡, ***4.7***‡, 0.0‡‡‡, ***4.7***‡, ***4.7***‡, ***3.0***‡‡, ***4.0***‡); Phosphorus (1.62†); Fecal coliform (>6700◊◊, >6700◊◊, 8900◊◊, >20000◊◊, >20000◊◊, 7700◊◊, >20000◊◊, 15300◊◊, >20000◊◊); E. coli (>6700◊◊, >6700◊◊, 4400◊◊, >20000◊◊, >20000◊◊, 4800◊◊, ***480***◊, >20000◊◊, ***510***◊, 6300◊◊, ***350***◊, 9500◊◊); Copper (51**); Lead (***11****, ***70****); Dieldrin (0.011*, 0.007*); 4,4'-DDT (0.050*, 0.051*); Endrin (0.006*); Endosulfan II (0.005*)

Table 4. (cont.)

Stream Name	River Mile	Violation: Parameter (value)
East Fork Mill Creek	1.85	Fecal coliform (>20000◊◊,>20000◊◊); E. coli (350◊, 1830◊◊, 810◊◊, >2000◊◊, 400◊, >20000◊◊, 320◊)
	0.77	D.O. (4.0‡); Ammonia (3.08*); Phosphorus (3.73†, 2.09†, 3.08†, 4.59†, 2.89†, 3.58†, 1.93†, 2.82†, 4.12†, 3.52†); Fecal coliform (3930◊, >20000◊◊, 2700◊, >20000◊◊); E. coli (380◊, 2070◊◊, 540◊, >20000◊◊, 2400◊◊, 7700◊◊, 1000◊◊); Selenium (7*); gamma-Hexachlorocyclohexane (0.018*, 0.040*); Heptachlor (0.030*, 0.014*, 0.007*); Endrin (0.004*, 0.006*)
	0.01	Ammonia (3.95*); Phosphorus (3.80†, 2.13†, 2.92†, 1.42†, 4.71†, 2.83†, 3.62†, 2.50†, 2.49†, 3.92†, 3.07†); Fecal coliform (>6700◊◊, >20000◊◊, >20000◊◊, >20000◊◊, >20000◊◊, >20000◊◊, 3000◊, >20000◊◊, >6700◊◊); E. coli (1230◊◊, 700◊◊, 767◊◊, >6700◊◊, >20000◊◊, >20000◊◊, >20000◊◊, 10300◊◊, 640◊◊, 1270◊◊, >20000◊◊, 3000◊◊)
Town Run	0.70	D.O. (**4.6**‡, **4.7**‡, **4.7**‡, **4.2**‡, **4.4**‡, **3.4**‡‡); Ammonia (**1.48***, **3.10***, **2.20***, **2.30***, **3.03***`) Phosphorus (1.53†, 1.32†, 1.82†, 1.95†, 1.25†, 2.49†, 1.78†, 1.82†, 2.81†, 1.65†); Fecal coliform (>**6700**◊◊, >**20000**◊◊, >**20000**◊◊, **4700**◊, **12500**◊◊, **2800**◊, >**20000**◊◊); E. coli (**3833**◊◊, **1000**◊◊, >**20000**◊◊, >**6700**◊◊, **5700**◊◊, **6300**◊◊, **300**◊, **10400**◊◊); Copper (**38***)

Table 4. (cont.)

Stream Name	River Mile	Violation: Parameter (value)
Sharon Creek	0.01	Cyanide (0.017*); Fecal coliform (>6700◊◊, 2070◊, 7800◊◊, 12200◊◊, 2800◊, 2200◊, 2100◊); E. coli (>6700◊◊, 2470◊◊, 1380◊◊, 10900◊◊, 1300◊◊, 1100◊◊, 830◊◊, >20000◊◊, 300◊, 2200◊◊)
Cooper Creek	0.20	Conductivity (**2640***); Cyanide (**0.017***)
West Fork Mill Creek	2.00	Lead (19*, 18*)
	0.19	D.O. (4.2‡, 3.1‡‡, 2.4‡‡); Ammonia (6.24*, 21.40**, 13.30**, 4.45*, 16.10**); Fecal coliform (>6700◊◊, >6700◊◊, >20000◊◊, >20000◊◊, 8600◊◊, >20000◊◊, >20000◊◊, >20000◊◊, >20000◊◊, >20000◊◊, 14000◊◊); E. coli (>6700◊◊, >6700◊◊, 2030◊◊, >20000◊◊, >20000◊◊, 1900◊◊, >20000◊◊, >20000◊◊, >20000◊◊, 4230◊◊); Lead (17*); Dieldrin (0.006*); Heptachlor (0.003*); 4,4'-DDT (0.007*); Methoxychlor (0.025*); Endosulfan II (0.004*)
Bloody Run	0.31	D.O. (1.3‡‡‡, **4.9**‡, 2.8‡, 0.6‡‡‡, 2.2‡, **4.9**‡, 0.4‡‡‡); Phosphorus (1.50†, 1.77†); Fecal coliform (>**6700**◊◊, >**6700**◊◊, **3600**◊, >**20000**◊◊, **2700**◊, **19400**◊◊, >**20000**◊◊, **4200**◊, >**20000**◊◊); E. coli (>**6700**◊◊, >**6700**◊◊, **667**◊◊, >**20000**◊◊, **1600**◊◊, **20700**◊◊, **400**◊, >**20000**◊◊, **1600**◊◊, >**20000**◊◊); Copper (35**); Aldrin (**0.055***); Dieldrin (**0.011***, **0.006***); Methoxychlor (**0.032***)

Biological Assessment

Macroinvertebrate Community

Macroinvertebrate communities were qualitatively sampled at 21 locations in the Mill Creek watershed during 1992. At each site, all available habitats were sampled for macroinvertebrates and representative specimens were collected along with observations of predominant taxa in each habitat type. Data were used to generate species lists; taxa composition and diversity, EPT (Ephemeroptera - mayflies, Plecoptera - stoneflies, Trichoptera - caddisflies) taxa richness, and the Qualitative Community Tolerance Value (QCTV) scores were used to evaluate the performance of the site. Summarized data are compiled in Table 6 and depicted in Figures 31 - 34. Species lists by river mile (RM) are compiled in Appendix Table 7.

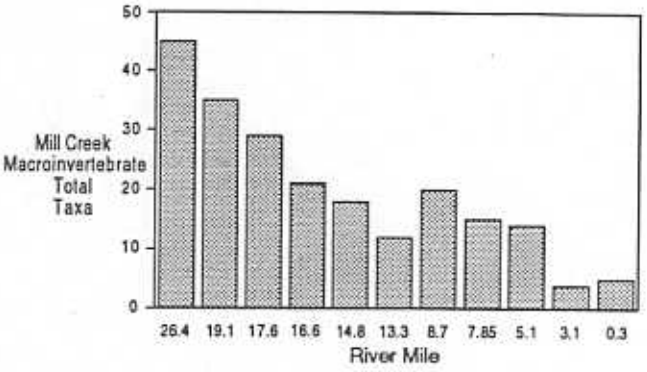


Figure 31. Trend of the total number of taxa present in qualitative samples from Mill Creek in 1992.

Mill Creek

- Qualitative sampling of the macroinvertebrate communities was conducted at eleven Mill Creek locations (Table 6, Fig. 31-33).

- The most upstream site in Mill Creek (RM 26.4) was located in an unmodified area and had a macroinvertebrate community in the marginally good range. The total number of taxa collected was 45 and included an EPT taxa richness of 6 (four mayfly taxa and two caddisfly taxa) and median QCTV score of 35.4, in the low performance range based on the Interior Plateau ecoregion (below 37.4). The macroinvertebrate community was predominated by midges which made up twenty of the forty-five taxa; the species *Cricotopus bicinctus*, *Polypedilum convictum* and *Polypedilum illinoense* were the most numerous midges collected.

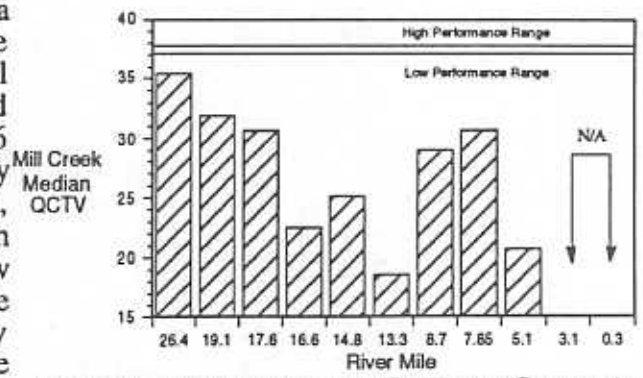


Figure 32. Trend of the median Qualitative Community Tolerance Value scores in Mill Creek in 1992.

- Six sites from RM 19.1 to 8.7 were located in a previously channel modified section (RMs 24.0 to 8.0) which was showing some signs of habitat recovery. Impacts to the macroinvertebrate community became more severe as urban and industrial land usage increased in predominance from upstream to downstream. Benthic communities at RMs 19.1 and 17.6 were in the fair range; all other communities (RMs 16.6, 14.8, 13.3 and 8.7) were in the poor range. The total taxa ranged between 12 and 35, EPT taxa richness ranged between 0 and 7 and the median QCTV scores ranged between 18.5 and 31.9; all sites were in the low performance range based on QCTVs from the Interior Plateau ecoregion (below 37.4). The site at RM 13.3 appeared to be the most severely impacted; the total taxa was 12, the EPT taxa richness was 0 and the median QCTV score was 18.5. This site is downstream from a raw sewage discharge, the Pristine Superfund site and an area of concentrated industry.

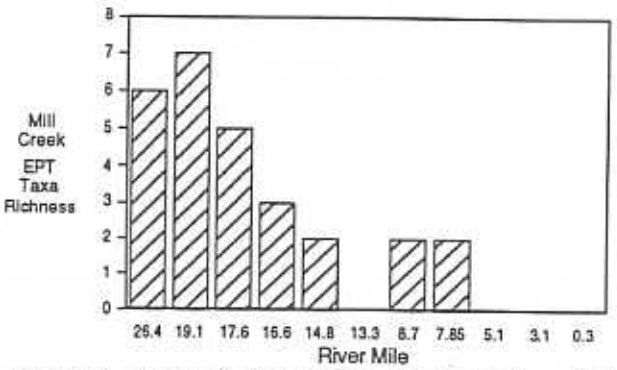


Figure 33. Trend of the EPT Taxa Richness values in Mill Creek in 1992.

- The lower eight miles of Mill Creek exhibited severely impacted macroinvertebrate communities. Total taxa ranged between 4 and 15 and EPT taxa richness ranged between 0 and 2. QCTV scores were calculated for RMs 7.8 (30.6) and 5.1 (20.7); however, at RMs 3.1 and 0.3, no QCTV scores were calculated due to few taxa being present. The upper two sites (RM 7.8 and 5.1) indicated poor macroinvertebrate community performance; the lower two sites (RM 3.1 and 0.3) indicated very poor macroinvertebrate community performance. The poor physical habitat conditions throughout the lower eight miles of Mill Creek, while contributing to the poor macroinvertebrate communities, do not fully explain these performances. Toxic stresses and oxygen demanding wastes associated with combined sewer overflows, combined with slower flow velocities at RM 0.3 are affecting these communities as well.

Sharon Creek

- Sharon Creek was sampled at one location (RM 0.3) during the 1992 survey (Table 6). The total taxa present was 29, EPT taxa richness was 7 and the QCTV score was 35.4, in the low performance range (below 37.4). The macroinvertebrate community was evaluated as marginally good.

Table 6. Macroinvertebrate community performance evaluation at 21 locations sampled by Ohio EPA in the Mill Creek study area during August through September, 1992.

Stream River Mile	Total Taxa	EPT Taxa Richness	Median QCTV	Narrative Evaluation
Mill Creek				
26.4	45	6	35.4	Marginally Good
19.1	35	7	31.9	Fair
17.6	29	5	30.6	Fair
16.6	21	3	22.5	Poor
14.8	18	2	25.1	Poor
13.3	12	0	18.5	Poor
8.7	20	2	29.0	Poor
7.8	15	2	30.6	Poor
5.1	14	0	20.7	Poor
3.1	4	0	NA	Very Poor
0.3	5	0	NA	Very Poor
East Fork Mill Creek				
4.7	27	5	34.3	Marginally Good
3.9	26	5	37.7	Marginally Good
1.9	37	6	34.7	Marginally Good
0.8	37	5	30.1	Fair
0.1	38	4	30.1	Fair
West Fork Mill Creek				
4.4	31	4	31.8	Fair
2.0	17	3	30.0	Poor
1.0	23	4	31.4	Fair
0.2	25	4	31.8	Fair
Sharon Creek				
0.3	27	7	35.9	Marginally Good

East Fork Mill Creek

Macroinvertebrate communities were qualitatively sampled at five locations in East Fork Mill Creek (Table 6, Figure 34). Sample data were used to generate QCTV scores, EPT taxa richness and an assessment of total number and kinds of taxa present (based on pollution tolerance). Species collected at each site are compiled in Appendix Table 7.

- East Fork Mill Creek sites upstream from the Upper Mill Creek WWTP (RMs 4.7, 3.9 and 1.9) indicated marginally good macroinvertebrate communities. Total taxa ranged from 26 to 37, EPT taxa richness ranged between 5 and 6 and the median QCTV scores ranged between 34.4 and 37.7. RM 3.9 had a median QCTV score of 37.7 which fell in the indeterminate performance range based on QCTVs of the ecoregion (between 37.7 and 37.4); both RMs 4.7 and 1.9 were in the low performance range (below 37.4).

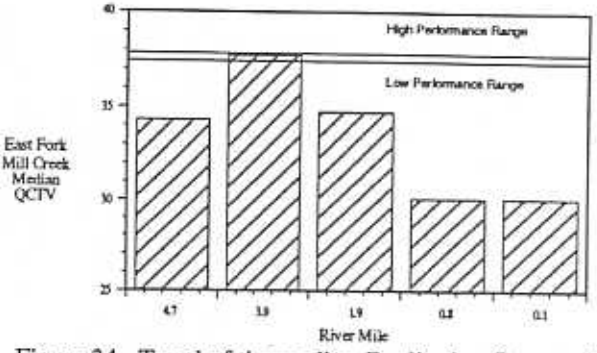


Figure 34. Trend of the median Qualitative Community Tolerance Value scores in East Mill Creek in 1992.

- Sampling in East Fork Mill Creek downstream from the Butler County Upper Mill Creek WWTP (RMs 0.8 and 0.1) indicated degraded macroinvertebrate communities evaluated in the fair range. Total taxa were 37 and 38 respectively, EPT taxa richness were 5 and 4 respectively, and the median QCTV scores were both in the low performance range at 30.1 (below 37.4). Although total taxa were higher than upstream, both sites were predominated by pollution tolerant organisms including dense populations of the midge *Polypedilum (P.) illinoense*, oligochaetes and blackflies. The downstream sites reflected impacts from poorly treated organic wastes.

West Fork Mill Creek

Macroinvertebrate communities were qualitatively sampled at four locations in West Fork Mill Creek (Table 6). Species collected at each site are presented in Appendix Table 7.

- All macroinvertebrate communities sites on West Fork Mill Creek were evaluated in the fair range, except RM 2.0 which was in the poor range. Total taxa ranged from 31 to 17 (RM 2.0) and the median QCTV scores ranged between 31.8 and 30 (RM 2.0), all in the low performance range based on QCTVs for the ecoregion (below 37.4). The EPT taxa richness was 4 at all sites except RM 2.0, which had an EPT taxa richness of 3; all of these values are low when compared to values observed from similar sized drainage basins in the Interior Plateau ecoregion. While all West Fork Mill Creek sites performed below ecoregional expectations, communities appeared to reflect additional declines downstream from RM 4.4. Predominant populations shifted from more pollution sensitive mayflies and riffle beetles to more tolerant oligochaetes and fingernail clams at RM 2.0. A strong odor of raw sewage was present at RM 2.0, thick deposits of lime slurry were observed along the stream margins and the creek was littered with trash and rubbish. Some improvement was observed at the two

downstream sites but communities continued to be predominated by relatively pollution tolerant populations including oligochaetes, midges, leaches, and baetid mayflies.

Fish Community

Mill Creek

A total of 4,611 fish representing 30 species and 3 hybrids were collected from Mill Creek between July and October, 1992. The sampling effort included a cumulative total of 4.76 km at eleven locations (Table 7). Relative numbers and species collected per location is presented in Appendix Table 8.

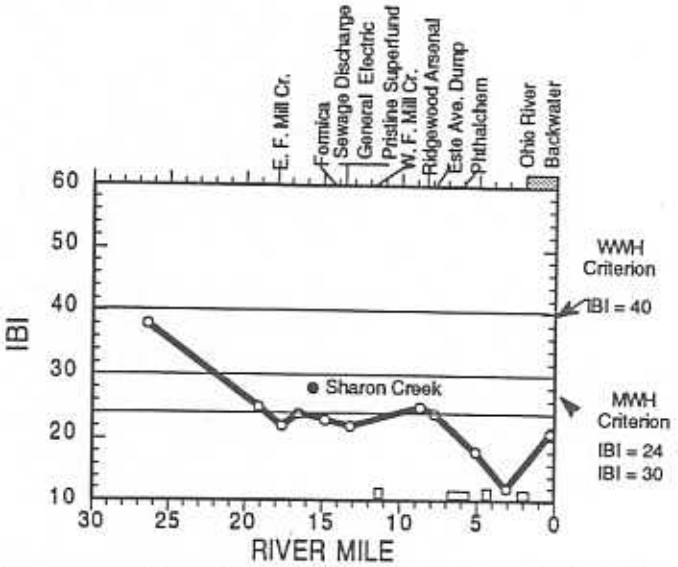


Figure 35. Longitudinal trend of the IBI in Mill Creek, 1992. Clear boxes along RM axis indicate concrete-lined channel areas of Mill Creek.

- The most upstream site in Mill Creek (RM 26.4), located in an unmodified area, had a fish community in the marginally good range with an IBI of 38 (nonsignificant departure of the WWH ecoregional biocriteria), Figure 35. This site was the only location in the Mill Creek mainstem where significant numbers of darters (9 %) were collected.

- In the section of Mill Creek previously channel modified but showing signs of recovery to natural conditions (RM 24 - 8), fish communities were significantly degraded with none of the locations sampled attaining the WWH ecoregional criteria. IBI scores ranged between 20 and 25 (poor quality) and MIwb values ranged between 4.3 and 6.4 (very poor to fair quality), Figure 36. The fish community was predominated by pollution tolerant species, with tolerant individuals comprising between 41 and 80 percent of the catch. The lowest IBI and MIwb scores within this section occurred at RM 13.2, an area within one-half mile downstream from a large raw sewage discharge and an area of concentrated industrial activity.

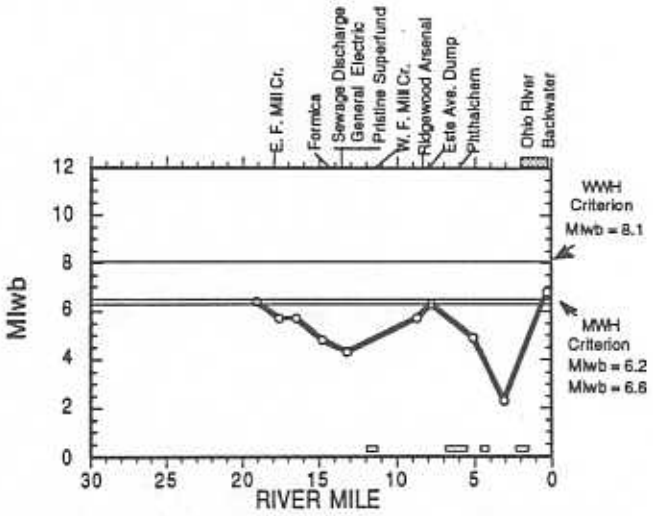


Figure 36. Longitudinal trend of the MIwb in Mill Creek, 1992. Clear boxes along the RM axis indicate concrete-lined channel areas of Mill Creek.

- The fish communities in the lower five miles of Mill Creek exhibited severe biological degradation. Due to physical habitat modifications, the lower eight miles of Mill Creek have a recommended use designation of Modified Warmwater Habitat. Excluding the impounded backwater site near the mouth of Mill Creek and the upper site in this section (RM 7.8), IBI (12 and 17) and MIwb (2.3 and 4.9) scores were reflective of poor to very poor water quality and the MWH use was not being attained. Physical habitat conditions in the lower eight miles of Mill Creek have been substantially altered due to past channel modifications (channel dipout, canopy removal); however, these conditions alone have not caused the severe disruption of the fish communities. The fish communities at RM 5.1 and 3.1 clearly were impacted by toxic stresses as well as oxygen demanding wastes associated with numerous combined sewer overflows. Results of fish sampling at RM 7.8 revealed fair biological conditions, with both the IBI and MIwb scores meeting the MWH criteria. Sampling in the impounded/ channelized area near the mouth revealed improvement compared with the upstream locations at RM 5.1 and 3.1; however, the MWH biological criteria was only partially being attained.

- A significant decline in darter numbers was noted in Mill Creek within areas receiving combined sewer overflow discharges. Habitat suitable for supporting healthy populations of darters was evident from the headwaters (RM 26) downstream to the concrete-lined section (RM 7). The three most upstream sites (RM 26.4, 19.1 and 17.6) were numerically represented by 9%, 1% and 5% darters, respectively. From RM 16.5 to the mouth, darters represented less than 0.5% of the population, with five of eight sites completely devoid of darters. The number of individual darters collected in the lower 16 miles of Mill Creek was four (out of a total of 2,226 fish collected).

- Within the entire Mill Creek mainstem, fish species intolerant of pollution were absent. Fish species highly tolerant to a wide variety of environmental disturbances predominated in Mill Creek. Of the 13 fish species listed as highly tolerant in Ohio, nine were collected in Mill Creek. The nine highly tolerant species comprised numerically 55% and in weight 64% of the Mill Creek mainstem catch.

- The physical condition of fish in Mill Creek was monitored at each fish sampling site by recording the incidence of gross DELT (deformities, fin erosion, lesions/ulcers and tumors) external anomalies. Biosurvey results collected by Ohio EPA from throughout the state show a high frequency of DELT anomalies is an accurate indication of pollution stress usually caused by multiple sublethal stresses as the result of degraded water quality (i.e. often a combination of toxic impacts combined with marginal D.O. concentrations). The percent of DELT anomalies is a metric used in Ohio EPA's modified version of the IBI. Variation in the percent of DELT anomalies was relatively high within the combined sewer overflow segment of Mill Creek (0.3 - 23.6%). Of particular note was the site (RM 13.2) with the highest level of DELT anomalies (23.6 %). The dominant type of DELT anomaly at RM 13.2 was lesions/ulcers (75 % of DELT anomalies recorded). Lesions/ ulcers can be caused by viral and bacterial infections and often times appear in areas impacted by multiple stresses, particularly marginal D.O. in combination with sublethal levels of toxics. This sampling location was located 0.5 miles downstream from a substantial raw sewage discharge and an area of concentrated industrial activity.

- Redhorse suckers and northern hog suckers, pollution intolerant species commonly found in Southwest Ohio, were absent from the collections made in Mill Creek.

- Sharon Creek was sampled at one location (RM 0.2) during the 1992 survey. The fish community was in the poor range (IBI = 26) and not attaining the WWH ecoregional biocriteria. Highly pollution tolerant species of fish dominated the site (65% numerically).

Table 7 . Fish community indices based on pulsed D.C. electrofishing samples at 21 locations sampled by Ohio EPA in the Mill Creek study area during July - October, 1992.

Stream River Mile	Mean Number of Species	Cumulative Species	Mean Rel. No.	Mean Rel. Wt. (Kg)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Mill Creek								
26.4	11	13	876	NA	64	NA	38ns	Marg. Good
19.1	13	15	636	5.42	60	6.4*	25*	Fair - Poor
17.6	10.5	14	317	2.19	63	5.7*	21*	Poor
16.5	12	16	250	29.75	63	5.7*	24*	Poor
14.8	9.5	12	203	10.13	60	4.8*	20*	Poor
13.2	8.5	10	187	8.85	61	4.3*	20*	Poor-V Poor
8.7	8.5	12	419	3.28	66	5.7*	25*	Poor
7.8	11	15	572	18.37	65	6.3*	24*	Fair - Poor
5.1	7	9	176	0.70	52	4.9*	17*	Poor-V Poor
3.1	5	8	32	1.08	40	2.3*	12*	Very Poor
0.3	6	11	327	70.62	26	6.8	21*	Fair - Poor
East Fork Mill Creek								
4.7	8.5	9	670	NA	74	NA	40	Good
3.8	8	9	582	NA	72	NA	40	Good
1.9	10.5	11	2045	NA	61	NA	40	Good
0.8	7.5	9	106	NA	61	NA	24*	Poor
0.3	-	9	338	NA	66	NA	26*	Poor
West Fork Mill Creek								
4.5	12	16	757	18.58	76	6.4*	22*	Fair - Poor
2.0	11.5	12	1626	3.82	71	6.6*	24*	Fair - Poor
1.0	9.5	10	506	2.06	70	6.0*	21*	Fair - Poor
0.2	7	8	765	1.20	60	5.6*	17*	Poor-V Poor
Sharon Creek								
0.2	11	13	461	NA	62	NA	26*	Poor

Ecoregion Biocriteria: Interior Plateau (IP)

INDEX - Site Type	WWH	EWH	MWH[b]
IBI - Headwaters	40	50	24
IBI - Wading	40	50	24
IBI - Boat	38	48	24 (30)[c]
Mod. Iwb - Wading	8.1	9.4	6.2
Mod. Iwb - Boat	8.7	9.6	5.8 (6.6)[c]

* - 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.

b - Modified Warmwater Habitat for channel modified areas.

c - Value in parentheses is Modified Warmwater Habitat for impounded areas.

NA - Headwater site; MIwb is not applicable.

East Fork Mill Creek

A total of 3,607 fish representing 15 species and one hybrid were collected from the East Fork Mill Creek between July and October, 1992. The sampling effort included a cumulative total of 1.45 km at five locations (Table 7, Figure 37).

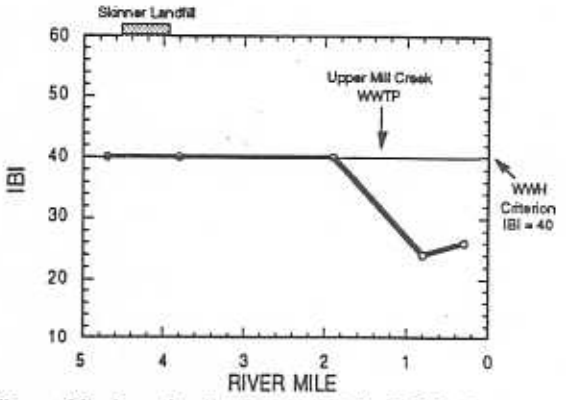


Figure 37. Longitudinal trend of the IBI in East Fork Mill Creek, 1992.

- East Fork Mill Creek sites upstream from the Upper Mill Creek WWTP (RMs 4.7, 3.8 and 1.9) attained the WWH ecoregional biocriteria during the 1992 survey. All three sites had IBI scores of 40 (good range), low numbers of highly tolerant species and significant populations of orangethroat darters (89 - 216 / 0.3 km). The upper two sites (RMs 4.7 and 3.8) bracketed the EF Skinner Landfill Superfund site. No impairment of the fish community was observed at the site immediately downstream from the landfill.

- Degradation of the fish community was documented in the East Fork Mill Creek downstream from the Upper Mill Creek WWTP. IBI values at RM 0.8 and RM 0.3 were 24 and 26, respectively, indicative of a poor quality fishery. A substantial reduction in total number of fish collected occurred downstream from the WWTP (2045 upstream, 106 downstream), as well as a significant reduction in orangethroat darter numbers (216 upstream, 16 downstream). The fish results from the sampling site 0.2 miles downstream from the Upper Mill Creek WWTP suggest a toxic impact; some improvement occurred further downstream near the mouth of the East Fork.

West Fork Mill Creek

A total of 3,399 fish representing 17 species and three hybrids were collected from the West Fork Mill Creek between August and September, 1992. The sampling effort included a cumulative total of 1.00 km at four locations (Table 7).

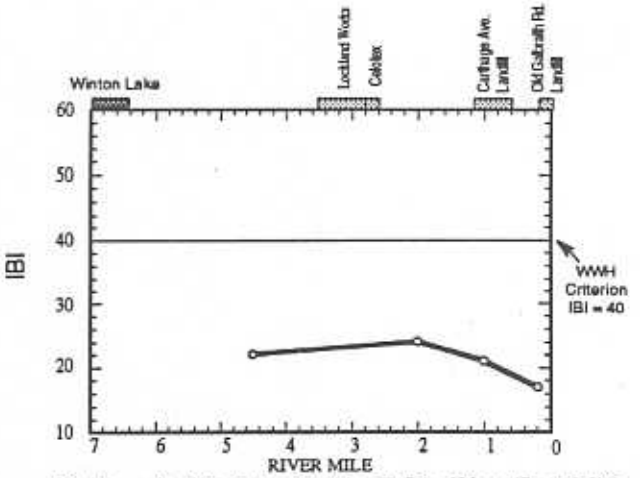


Figure 38. Longitudinal trend of the IBI in West Fork Mill Creek, 1992.

- Biological sampling sites during the 1992 survey were established in the West Fork Mill Creek downstream from Winton Lake (RM 4.5 - 0.2). All four sampling sites had fish communities indicative of poor water quality, with IBI scores in the poor to very poor range (17 - 24) and MIwb values in the poor to fair range (5.6 - 6.6), (Figures 38 and 39). Eight highly tolerant species of fish were collected in the West Fork, comprising 61% numerically and 83% by weight of all the fish observed. Despite excellent habitat available for pollution intolerant darters, none were collected in the

West Fork Mill Creek. The entire segment of the West Fork sampled during 1992 did not attain the WWH ecoregional biocriteria. Results suggest that combined sewer overflows and possibly landfills adjacent to the stream are causing the non-attainment of the stream use.

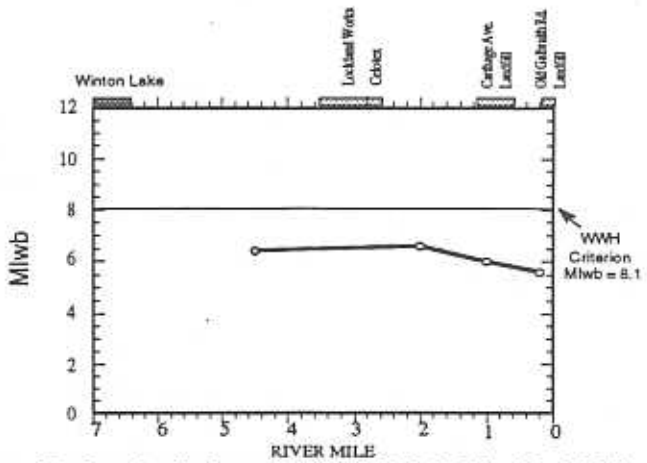


Figure 39. Longitudinal trend of the MIwb in West Fork Mill Creek, 1992.

Fish Tissue Summary

Fish tissue samples were collected from the Mill Creek mainstem at three locations by the Ohio EPA during 1992. Whole body composites and individual fish representing four species were analyzed for pesticides, Polychlorinated biphenyls (PCBs), metals, semivolatile organic compounds and percent lipid (Table 8).

- Two PCB aroclors (1248 and 1260) were identified and quantified. Eight samples representing four species were analyzed for PCBs in Mill Creek during 1992. Six of the samples had detectable levels of Aroclor-1248 (160-6000 µg/kg) and two had detectable levels of Aroclor-1260 (210 and 690 µg/kg) Three whole body samples from RM 7.8 and 0.3 exceeded the FDA 2000 µg/kg (2.0 ppm) total PCB level of concern in edible portions. Four of the eight samples from RM 7.8 and 0.3 analyzed had PCB levels in violation of Ohio's Water Quality Standards (any whole sample of any representative aquatic organism shall not exceed 640 µg/kg PCBs). The upstream sampling location (RM 16.5) detected Aroclor-1260 in one sample (210 µg/kg).

- Nineteen pesticide compounds were tested for in eight fish tissue samples (four species). All values were below lab detection limits. Detection levels for pesticides generally varied from between 33 µg/kg and 330 µg/kg (toxaphene = 1700 µg/kg).

- Fifty-six semivolatile organic compounds were measured in eight fish samples representing four species. Only two parameters (phenol and 1,2,4-trichlorobenzene) were detected; all other parameters were reported as 'not detected'. Phenol was reported as 400J µg/kg in one sample at RM 16.5 and 1,2,4-trichlorobenzene was reported as 2600J µg/kg in one sample at RM 0.3. 1,2,4-Trichlorobenzene has been documented to bioconcentrate in aquatic organisms, with Bioconcentration Factor (BCF) values for various fish species ranging between 51 and 2800 (Howard 1990). Lab detection limits were generally quite high for semivolatile organic compounds (range: 2700 to 85000 µg/kg).

- Four metals (barium, lead, mercury, and zinc) were detected in six fish whole body samples from the 1992 sampling sites. Five other metal parameters (arsenic, cadmium, chromium, selenium and silver) tested in whole body fish samples were reported as 'not detected'. Two of six fish samples had detectable levels of mercury (0.10mg/kg and 0.18 mg/kg); however, values were below the FDA 1.0 mg/kg (1.0 ppm) level of concern in edible portions. Zinc was detected in all six fish samples analyzed, with values ranging from 11.5 mg/kg to 84.2 mg/kg. Lead was reported at or above the lab detection limit of 0.30 mg/kg in four of six fish samples analyzed, with values ranging from 0.33 mg/kg to 1.9 mg/kg.

Table 8. Summary of contaminant levels in fish collected in Mill Creek during October, 1992

River Mile Species	Lead mg/kg	Mercury mg/kg	Zinc mg/kg	Phenol µg/kg	Aroclor 1248 µg/kg	Aroclor 1260 µg/kg	1,2,4-Tri chloro benzene µg/kg	Percent Lipid
FDA Action Levels (in fish fillets)		1.0			2000*	2000*	---	
16.5								
Common Carp (4 fish composite - WB)	0.33	ND	58.8	NA	NA	NA	NA	6.0
Common Carp (2 fish composite - WB)	NA	NA	ND	ND	ND	ND	ND	3.3
Yelow Bullhead (5 fish composite - WB)	ND	0.18	17.0	NA	NA	NA	NA	1.3
Yellow Bullhead (5 fish composite - WB)	NA	NA	NA	400J	ND	210	ND	1.0
7.8								
Common Carp (4 fish composite - WB)	0.33	ND	84.2	NA	NA	NA	NA	3.3
Common Carp (3 fish composite - WB)	NA	NA	NA	ND	**960**	ND	ND	0.66
Yellow bullhead (5 fish composite - WB)	ND	ND	15.8	NA	NA	NA	NA	3.0
Yellow bullhead (5 fish composite - WB)	NA	NA	NA	ND	**6000**	ND	ND	1.6
Channel Catfish (1 fish - WB)	NA	NA	NA	ND	**4800**	ND	ND	5.6
0.3								
Common Carp (1 fish - WB)	0.38	ND	42.7	NA	NA	NA	NA	2.0
Common Carp (1 fish - WB)	NA	NA	NA	ND	**3000**	**690**	2600J	8.0
Channel Catfish (1 fish - WB)	NA	NA	NA	ND	610	ND	ND	5.6
River Carpsucker (3 fish composite - WB)	1.9	0.10	11.5	NA	NA	NA	NA	2.0
River Carpsucker (3 fish composite - WB)	NA	NA	NA	ND	160	ND	ND	ND

J - Detected but less than quantitation limits, estimated value
NA - not available
ND - not detected
* - these values are for total PCBs

Sediment

Sediment samples were collected from the Mill Creek, West Fork Mill Creek, East Fork Mill Creek and Winton Ridge (seventeen sites total) and analyzed for metals, pesticides, polychlorinated biphenyls (PCBs), semi-volatile organic compounds and volatile organic compounds. These samples were collected to assess levels of contaminants present in stream sediments in Mill Creek and the above mentioned tributaries.

While bank seeps and oil slicks were noted throughout most of the industrialized areas of the main stem, visually RM 13.72 (adjacent Cincinnati Drum and Pristine) appeared to contain a multitude of problems. This site harbored an extensive quantity of bank leachate and impacted sediment. It also contained oil laden sediments, that when disturbed, bubbled to the surface of the stream and coated the area with an oil slick.

Metals

Mill Creek

Sediment chemistry results from thirteen sites within the Mill Creek mainstem indicate nearly half contain highly to extremely elevated metal concentrations (based on Kelly and Hite sediment classification system, 1984), Table 9. Heavy metal parameters were detected in the sediments throughout the survey area. Highly elevated lead levels first appeared at W.Columbia Rd. (RM 13.13) and with one exception increased steadily to Gest St (RM 0.50), Figure 40. Zinc concentrations peaked at Salway Park (RM 5.2) and Center Hill Rd. (RM 7.86) and remained highly elevated to Gest Street. Sixty-two percent of the metals demonstrated highly to extremely elevated concentrations at Salway Park (RM 5.2), Table 9. The increasing trend of heavy metal concentration suggest impacts of urban runoff and the cumulative effect of point sources.

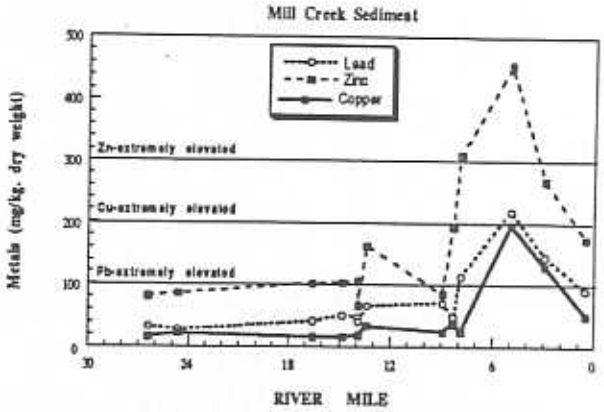


Figure 40. Sediment metal concentrations in Mill Creek mainstem.

West Fork Mill Creek

The West Fork Mill Creek near Riddle Rd. (RM 4.45) revealed the highest lead concentration in the survey with a level of 8870 mg/kg dry weight, Figure 41. There is a high concentration of industries in this area which may have influenced the stream through storm

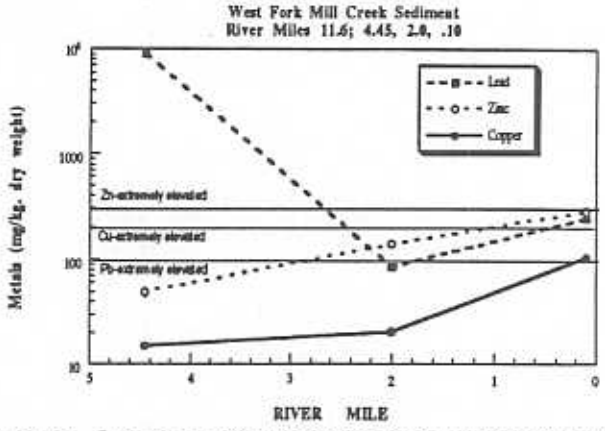


Figure 41. Sediment metal concentrations in West Fork Mill Creek.

water sewers but no direct cause can be associated to the high lead levels at this time. Other West Fork Mill Creek sites reflected the pattern by exhibiting high concentrations of lead. As noted in the water chemistry section, Chemical Incorporated (Lockland Works), is located near West Fork Mill Creek RM 2.00 and is a possible source of lead contamination in the basin. The lower stretch of West Fork Mill Creek receives flow from several combined sewer overflows and runoff from industrial sites as well as old landfills.

East Fork Mill Creek

The East Fork Mill Creek at Allen Rd. (RM 1.85) demonstrated elevated levels of chromium, zinc and iron. Elevated levels of chromium and iron were not detected at the downstream site (RM 0.1). Slightly elevated levels of lead were noted at Allen Rd. (RM 1.85) and at the mouth (RM 0.1). Zinc showed a reduction in concentration at the downstream site (RM 0.1).

Winton Ridge

The Winton Ridge site (RM 6.85, 1.81) revealed highly elevated levels of lead, elevated levels of chromium, iron and slightly elevated levels of zinc. The site location perimeter is predominantly residential however a one-two acre dump site referred to as Winton Ridge Dump (situated upstream of our site) has existed since the late 1960's (Appendix 9). Formerly an unrestricted dump site this location is known to have contained drums of paint-like materials and foundry sands. Additional drums and garbage are thought to be buried at the site. Historical sediment sample data collected by Ohio EPA exhibited lead concentrations [determined with Extraction Procedure Toxicity Test (EP Tox)] considered elevated enough to be listed as hazardous waste (Resource Conservation and Recovery Act). Heavy metals such as chromium and cadmium were also detected.

Polychlorinated Biphenyl's

Mill Creek

Polychlorinated biphenyl (PCB) 1248 was detected at W. Columbia Rd. (RM 13.13) at extremely elevated status, remaining highly elevated to Gest. St. (RM 0.50), Table 10; Figure 42. The W. Columbia Rd. site was located near the right bank of Mill Creek downstream of a large raw sewage discharge, the confluence of the G.E. tributary, Pristine (superfund site) as well as Carstab and Cincinnati Drum and other industrial sites. Although probably not the only contributor to PCB 1248 in Mill Creek, elevated levels of PCB 1248 (Kelly & Hite, 1984) were detected in the G.E. tributary by consultants for General Electric (Remcor, 1993). General Electric, under the directive of the USEPA, has commenced remediation of soils and sediments on site and has documented concentrations of PCB 1248 in G.E.'s discharge to the G.E. tributary.

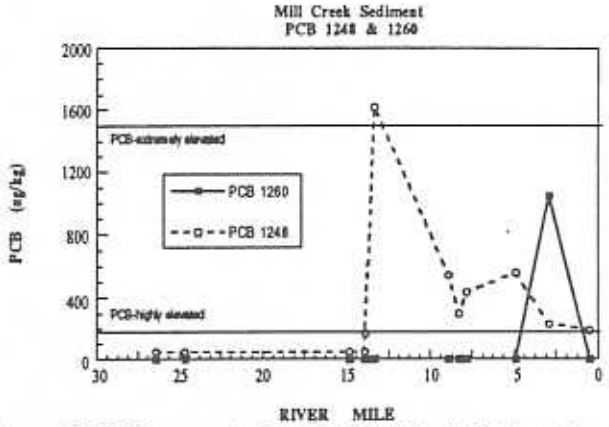


Figure 42. PCB concentrations in Mill Creek Sediments

PCB 1260 remained below detection limits the entire stream reach until Hopple St. (RM 2.90) where the concentration spiked to a highly elevated level (Figure 42). The reason for an isolated occurrence of aroclor 1260 at Hopple St. can be theorized but not traceable at this time. Numerous industrial sites and industrial and municipal landfills line the banks of Mill Creek, many of which have been observed leaching various substances. A thorough investigation of each site has not been undertaken.

Detection of PCB aroclors 1248 and 1260 can best be explained by their past frequency of use in electrical and non-electrical equipment such as transformers, capacitors and heat transfer systems. Approximately two hundred compounds of PCBs were developed since the initial production in 1929. PCB production was banned in 1979, however PCB materials remained in use until replacement with a non-hazardous material was enforced. Polychlorinated biphenyls are extremely stable substances and are not known to break down readily in the environment. Their high affinity for soil and sediment particles facilitates a mode of transport as soils and sediments are washed along with rainfall and stream movement.

Organic Compounds

Mill Creek

Detectable levels of either volatile organic compounds (VOC's) or semi-volatile organic compounds (BNA's - base, neutral, acid extractible compounds) or both were noted at 89% of sites sampled for sediments (Appendix Table 5). Eleven polycyclic aromatic hydrocarbons (PAH) were identified and quantified in the Mill Creek. Values ranged between 0.6 to 8.7 mg/kg, many of the highest concentrations appearing at RM 5.2 (Salway Park). A number of the PAH compounds identified in the Mill Creek have been identified as known human carcinogens and tend to accumulate in the food chain. Eighty-four percent of the sites revealed some level of organochlorine pesticide concentration, Table 10. Background sites (Tylersville Rd., RM 24.64 and Liberty-Fairfield Rd., RM 26.4) revealed the absence of volatile and semi-volatile organic compounds and no detectable levels of pesticides. The most abundant number of VOC-priority pollutant compounds were recorded at Salway Park (RM 5.2) where benzene compounds were detected (chlorobenzene most prevalent at all four sites). The highest concentration of chlorobenzene (a commercial solvent) was noted at Salway Park (RM 5.2). Salway Park data exhibited the greatest number of detectable organic parameters for each organic category analyzed. Gest St. (RM 0.50) was second in number of organic parameters detected.

Aromatic hydrocarbons appeared from RM 14.80 to RM 0.5. With one exception, aliphatic hydrocarbons exhibited the same pattern. Many organic compounds appearing in the survey data are found in organic synthesis as solvents and in petroleum products such as motor fuel (Ege, 1984). Polycyclic aromatic hydrocarbons (PAH) are known to be the most potent carcinogens of the aromatic hydrocarbon group. PAHs are slightly soluble to insoluble in water and have a tendency to sorb to particulate matter such as sediments where they accumulate in the aquatic environment. Anthropogenic activities such as oil refining, iron and steel manufacturing, power generation, coke production, wood preservation and coal pile storage and fossil fuels are responsible for the majority of PAHs released into the environment.

West Fork Mill Creek

Polycyclic aromatic hydrocarbons appeared at all three West Fork Mill Creek sites within the survey reach. The highest concentration of PAH's quantified during the survey appeared in the West Fork Mill Creek with a range of 0.9 to 37.9 mg/kg. Pyrene, a known carcinogen, appeared in greatest quantity (25.1 mg/kg) at Gardner Park near Bacon Road, RM 2.0. Within the stream reach studied (RMs 4.45 to 0.1) organic compounds increased in number from the upstream to downstream. RM 0.1 data displayed a nearly 60% increase in the number of detectable organic compounds than RM 4.45.

East Fork Mill Creek

No organic compounds were detected at the Allen Rd. site (RM 1.85). The East Fork Mill Creek mouth site (RM 0.1) data revealed the presence of non-priority VOCs similar in numbers to the mainstem Gest St. site (Appendix Table 5). The East Fork Mill Creek mouth site was similar in number of non-priority semivolatile organic compound detections to the mainstem sites Salway Park and Gest St.

Winton Ridge

Three semivolatile priority organic compounds were noted in the Winton Ridge tributary (RM 1.81) fitting into the classification of aromatic hydrocarbons. Two compounds within the PAH group appeared.

Table 9. Concentrations of heavy metals in sediments of the Mill Creek study area, 1992. All parameter concentrations, excluding aluminum and nickel, were ranked based on a stream sediment classification system described by Kelly and Hite (1984).

	Sediment Concentration (mg/kg. dry weight)							
River Mile	**As**	**Cu**	**Cd**	**Cr**	**Fe**	**Pb**	**Ni/**	**Zn**
Mill Creek								
26.40	6.56a	15.5a	0.122a	21.3a	20800a	31.6a	22.1	80.6b
24.64	7.99	23.4a	0.10a	18.3	31200c	26.6a	30.0	84.9b
16.57	*0.10a	15.4a	0.277a	25.2a	11200a	40.7c	26.0	101c
14.80	5.33a	15.7	0.226a	21.7	11800a	49.7c	21.2	103c
13.89	7.32a	18.2	0.204a	19.7	13700a	49.3c	21.1	105c
13.72	6.25a	18.3a	0.329a	29.5a	14500a	39.8c	37.5	65.3a
13.13	5.48	33.6a	0.548b	32.9a	16200a	**65.0d**	34.3	161c
9.02	6.55a	23.2a	0.264a	19.7a	14800a	**70.0d**	22.9	84.3a
8.38	6.10a	36.8a	0.693b	28.9a	12300a	47.5c	28.9	**192d**
7.86	6.210a	23.5a	0.323a	19.2a	14900a	**112e**	21.1	**310e**
5.2	9.70b	**195d**	***6.10d**	**60.5e**	21000b	**217e**	44.8	**456e**
2.90	10.2b	**128d**	0.879b	35.8c	22200b	**144e**	57.6	**267d**
0.50	6.69a	50.0b	0.956b	29.7c	14100a	**89.5d**	33.4	**173d**

Table 9. (continued)

	Sediment Concentration (mg/kg. dry weight)							
River Mile	**As**	**Cu**	**Cd**	**Cr**	**Fe**	**Pb**	**Ni *f***	**Zn**
East Fork Mill Creek								
17.95, 1.85	7.56a	17.8a	0.0986	25.9c	23100c	32.9b	21.5	138c
17.95, 0.1	6.15a	15.9a	0.149a	27.0a	12100a	37.3b	24.79	6.0b
West Fork Mill Creek								
11.6, 4.45	9.06	14.9a	0.0502a	18.4b	19800b	***8870e**	23.0	48.7a
11.6, 2.0	8.56b	20.4a	0.371a	18.9b	13500a	**83.5d**	17.7	136c
11.6, 0.10	12.0c	102d	0.595b	23.9c	11800a	**236e**	24.3	**276d**
Winton Ridge Tributary								
6.85, 1.81	6.32a	21.8a	0.143	26.9c	31300c	**65.0d**	30.3	88.4b

[a] Non-Elevated; [b] Slightly Elevated; [c] Elevated; [d] **Highly elevated**; [e]**Extremely elevated**
f Not evaluated by Kelly and Hite
* Ohio EPA laboratory confirmed through QA/QC

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

Table 10. Concentration (µg/kg) of pesticides/PCBs in the sediments of the Mill Creek study area, 1992.[1]

	Sediment Concentration (ug/kg.)				
River Mile	Heptachlor Epoxide	Dieldrin	PCB 1248	PCB 1260	DDT Total
Mill Creek					
26.40	<0.48a	<0.48*	<24.07*	<24.07*	<1.44a
24.64	<0.60a	1.00a	<30.06*	<30.06*	<1.80a
14.80	<0.57a	1.82a	<28.69*	<28.69*	<1.72a
13.89	<0.58a	2.32a	<28.68*	<28.68*	<1.73a
13.72	<0.53a	5.29b	169c	<26.40*	<1.58a
13.13	<0.60a	**16.40d**	**1616e**	<30.17*	3.94a
9.02	<0.64a	5.69b	**543d**	<32.22*	<1.93a
8.38	<0.53a	6.83c	**295d**	<26.56*	3.55a
7.86	<0.58a	6.18c	**433d**	<28.99*	1.98a
5.2	**20.72e**	**11.52d**	**553d**	<33.03*	23.25b
2.90	**11.11d**	**10.25d**	**232d**	**1041d**	4.33a
0.50	<0.75a	7.83c	192c	<37.65*	**381d**
East Fork Mill Creek					
17.95, 1.85	<0.53a	<0.53a	<26.36*	<26.36*	<1.58a
17.95, 0.1	<0.74a	**10.71d**	<37.23*	<37.23*	<2.23a

Table 10 (continued).

River Mile	Heptachlor	Sediment Concentration (ug/kg.) Dieldrin Epoxide	PCB 1248	PCB 1260	DDT Total
West Fork Mill Creek					
11.6,4.45	<0.45a	<0.45a	<22.56*	<22.56*	<1.35a
11.6, 2.0	<0.65a	3.91b	<32.62*	<32.62*	2.62a
11.6, 0.10	<0.67a	1.06a	<33.38*	<33.38*	45.10b
Winton Ridge Tributary					
6.85, 1.81	<0.57a	<0.57a	<28.29*	<28.29*	1.86a

1 - All pesticide concentrations were ranked on a stream sediment classification system described by Kelly and Hite (1984).
a - Non-elevated
b - Slightly elevated
c - Elevated
d - **Highly elevated**
e - **Extremely elevated**
* - detection limit greater than Kelly and Hite classification limits

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

Particle Size

The adsorptive capacity of bed load materials is believed to be size dependent (Burton 1992, Horowitz 1985) therefore attempts were made during sampling of sediments to obtain only fine particle sized materials. Concentrations of heavy metals in stream sediments appear to be inversely related to sediment particle size. Generally, as silt and clay percentages in the sediment samples increased, metal concentrations in the sediment increased. High percentages of sand and and greater sized particles in bottom sediments may account for relatively low concentrations of metals. Particle size determinations revealed over half the sites (55%) displayed favorable sediment components of silt and clay (Horowitz 1985), Table 11. Quantified silt and clay particles ranged from 35 to 70% per site. Background sites, Liberty Fairfield Rd. on Mill Creek (RM 26.4) and Allen Rd on East Fork Mill Creek (RM 1.85) contained preferred silt and clay components approaching 50%. Gest St. (RM 0.50) featured sediment components of silt and clay of over 60%.

Table 11. Sediment Particle Size Determinations in the Mill Creek Basin during 1992. Particle size analysis was achieved utilizing the Hydrometer method.

Sample Location	Date Analyzed	Stream	River Mile	Sand & Greater %	Coarse Silt %	Med-Fine Silt %	Clay %
				[Numbers represent % in each class]			
Liberty-Fairfield Rd.	03 24 93	Mill Ck	26.4	38.5	17.0	31.9	12.6
Tylersville Rd	03 17 93	Mill Ck	24.64	73.5	7.1	12.5	6.9
Allen Rd	03 17 93	E. Fork	17.95; 1.85	55.0	8.4	21.1	15.5
US of GE trib	03 24 93	Mill Ck	13.89	67.9	12.3	11.2	8.6
Adj Cincinnati Drum	04 05 93	Mill Ck	13.72	67.3*	6.5*	15.2*	11.1*
W. Columbia Rd.	03 24 93	Mill Ck	13.13	38.1	14.9	34.9	12.1
Riddle Road	04 05 93	W. Fork Mill Ck.	11.6; 4.45	39.5	9.2	31.5	19.8
Gardner Park	03 31 93	W. Fork Mill Ck.	11.6; 2.0	45.6	6.1	33.7	14.6
Dexter Rd	03 31 93	W. Fork Mill Ck.	11.6; 0.1	72.3	7.3	11.7	8.7
North Bend	03 24 93	Mill Crk	9.02	55.1	17.0	17.7	10.2
Ridgewood Arsenal	04 05 93	Mill Crk	8.38	73.8*	9.2*	9.3*	7.8*
Center Hill Rd	04 05 93	Mill Crk	7.86	74.2	5.7	12.8	7.3
Winton Ridge Dump	04 05 93	Winton Ridge Trib.	6.85; 1.81	29.5*	13.8*	33.8*	23.1*
Salway Park	03 31 93	Mill Crk	5.2	14.2	12.5	47.4	25.9
Hopple St. Viaduct	03 24 93	Mill Crk	2.9	14.9	21.9	47.5	15.7
Gest St.	03 31 93	Mill Crk	0.5	25.0	9.3	43.1	22.6

* Mean value of duplicate pairs

Sediment Toxicity

Sediment bioassays were conducted through U.S. EPA for nine sites on the mainstem of Mill Creek from which sediment samples were collected (Table12). Short-term sediment toxicity tests were conducted using the species *Hyalella azteca*, an amphipod. The data was statistically analyzed using two methods: 1) assessment of the data as a whole compaired to the control sample and 2) comparing each site individually to the control. In summary, when assessing the data as a whole the only site which exhibited significant reduction in survival versus the control sample was at Gest Street, near the barrier dam at RM 0.5. However, if each site was assessed individually using a pairwise basis then eight of the nine sites tested showed a significant decrease in survival from the control.

At the end of the survival experiment the organisms were dried and weighed to measure growth effects. None of the sites tested showed a significant reduction in growth versus the control sample, even assessing on the pairwise basis.

Table 12. Results from the 1992 Mill Creek Sediment Toxicity Study using *Hyalella azteca*.

Survival Data

River Mile	Percent Survival	Coefficient of Variation	Significant Vs. Control	Pairwise Significance
Control	100.0	0.0	NS	NS
13.89	95.0	4.3	NS	***
13.72	97.5	5.1	NS	***
13.13	76.3	53.6	NS	***
9.02	71.3	59.6	NS	***
8.38	93.8	5.1	NS	***
7.86	87.5	17.8	NS	***
5.2	81.3	20.3	NS	***
2.9	97.5	3.0	NS	***
0.5	15.0	66.7	***	***

*** - statistically significant from control
NS - not significant

Growth Data

River Mile	Average Weight (mg)	Coefficient of Variation	Significant Vs. Control	Pairwise Significance
Control	0.055	14.6	NS	NS
13.89	0.087	12.6	NS	NS
13.72	0.066	4.4	NS	NS
13.13	0.050	26.5	NS	NS
9.02	0.072	26.1	NS	NS
8.38	0.071	15.5	NS	NS
7.86	0.056	12.8	NS	NS
5.2	0.046	8.9	NS	NS
2.9	0.080	13.9	NS	NS
0.5	0.067	10.5	NS	NS

NS - not significant

Spills

The Ohio EPA Emergency Response Section of Columbus supplied spill reports for Hamilton County 1988-1992 (Appendix Table 6). Only spills documented as having potential movement into waterways such as Mill Creek and named tributaries of Mill Creek were tabled. Numerous other spills in the initial spill report (not tabulated) were reported as advancing (and entering) storm drains, sanitary sewers, unnamed tributaries, ditches and groundwater.

Entities tabled were chosen by having had reported two or more incidences (either impacting Mill Creek or its tributaries) in the past five years. Metropolitan Sewer District (MSD) reported the greatest number of releases into the mainstem followed by (in order of frequency) General Electric Aircraft Engines, Procter and Gamble (P&G), Henkle-Emery Industries, Phthalchem, Chemicals Inc., and Borden Packaging. One incident in 1988, occurring at General Electric Aircraft Engines, involved a PCB oil spill of unknown quantity.

Two extensive quantities of reported spill material occurred during the five year period examined for this report. General Electric Aircraft Engines reported 5000 gallons of oil (classification not documented) entered the G.E. tributary and later entering the Mill Creek. Henkle-Emery Industries in 1991 reported a 5000 gallon spill of sewage to the Mill Creek.

When spills are reported to the Ohio EPA Emergency Response duty officer, they are relayed to the Agency's on-scene coordinators. The type of response given by Ohio EPA to chemical spills is dependent upon several factors. Spills are prioritized by the nature of the spilled chemical and the quantity, the danger to human health and the environment, the location of the spill and action that has already been implemented at the spill site (i.e. containment or removal measures).

Trends Assessment

Chemical Trends

Historical trend data for the Mill Creek basin was gathered from Ohio EPA, Cincinnati Health Department and two sections within the U.S. Army Corp of Engineers (ACOE). Only data from complete data sets was utilized for historical and survey trend numerical comparisons.

Ohio EPA historical ambient data from the mid-seventies and early-eighties was accumulated through the National Ambient Water Quality Monitoring Network (NAWQMN) and ammonia-N and D.O concentrations compared to identical 1992 survey site data. Dissolved oxygen (D.O) and ammonia-N levels in Mill Creek illustrate improvement within the mainstem (Figures 43 and 44).

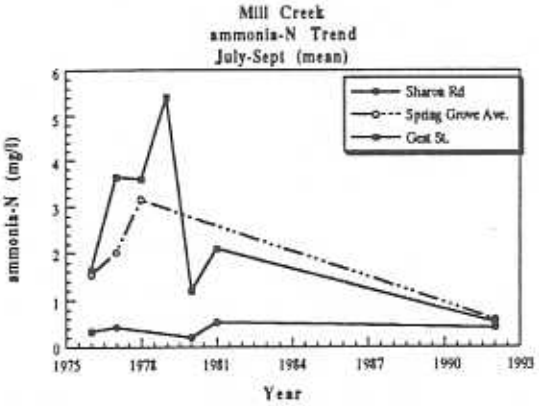


Figure 43. Longitudinal trends of the mean ammonia-N concentrations at RMs 16.57, 6.53 and 0.51.

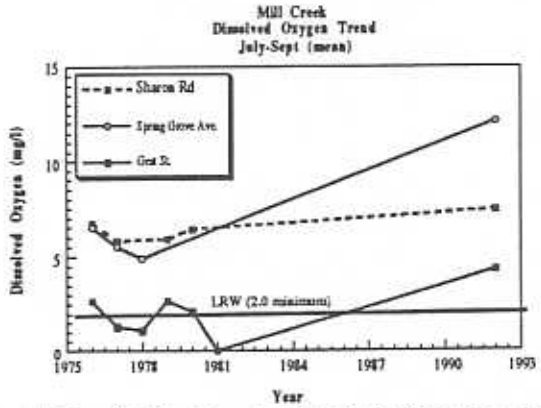


Figure 44. Longitudinal trends of the D.O. (day time grabs) at RMs 16.57, 6.53 and 0.51.

The Cincinnati Health Department (CHD) monitored fecals on Tuesdays of each week, simultaneous to the Ohio EPA survey period (July-Sept.). Longitudinal graphs for two selected sites (Galbraith Rd, RM 11.73; Mitchell Ave., RM 5.85) demonstrated similar patterns of increases and reductions in bacteriological enumeration for both agencies. Ohio EPA results from Galbraith Rd. revealed Water Quality Standard (WQS) exceedences for Primary Contact Recreation use criteria of approximately 72% of the sampling events. The Cincinnati Health Department documented approximately 54% exceedence in the recreation use criteria, Figure 45. Ohio EPA results from Mitchell Ave. samples indicated a 72% exceedence of the Water Quality Standard for Secondary Contact Recreation criteria. Cincinnati Health Department data indicates a 36% exceedence, Figure 46.

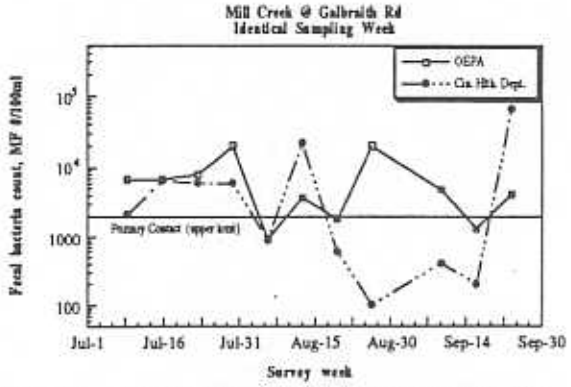


Figure 45. Longitudinal trend of fecal coliform data comparison from Ohio EPA and CHD at RM 11.73.

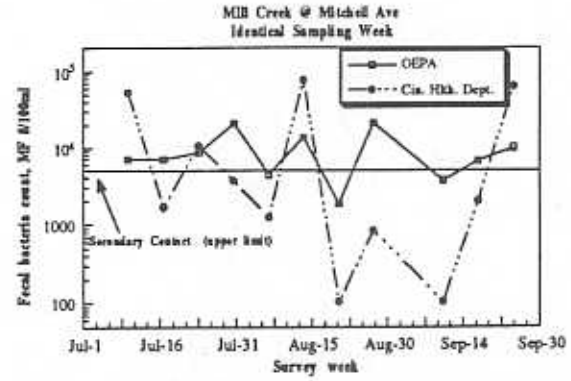


Figure 46. Longitudinal trend of fecal coliform data comparison from Ohio EPA and CHD at RM 5.85.

The U.S. Army Corp of Engineers Limnology Section (Louisville District Office) performed monitoring of Winton Lake and two sites on the West Fork Mill Creek from 1975-1991. Complete data sets were available for D.O and phosphorus from upstream Winton Lake (Hamilton Ave. bridge) and tailwater monitoring sites (lake outlet) within the West Fork Mill Creek. Dissolved oxygen values at Hamilton Ave. continually persisted above downstream values by an average of 2.5 mg/l (ppm) for all years but one, Figure 47. Phosphorus concentrations remained well below the water quality standards narrative guidelines (1.0 mg/l) upstream and downstream of Winton Lake, Figure 48. Fluctuations in phosphorus levels might be contributed to combined sewer overflow activity upstream of Winton Lake (Miller 1989) and the tendencies of phosphorus to adsorb to sediments and clays in lake bottoms and streams.

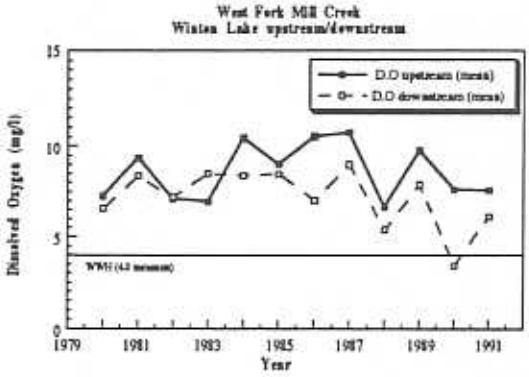


Figure 47. Longitudinal trends of mean D.O. (Hydrolab instantaneous read out) from USACOE. data from Hamilton Rd. and lake outlet.

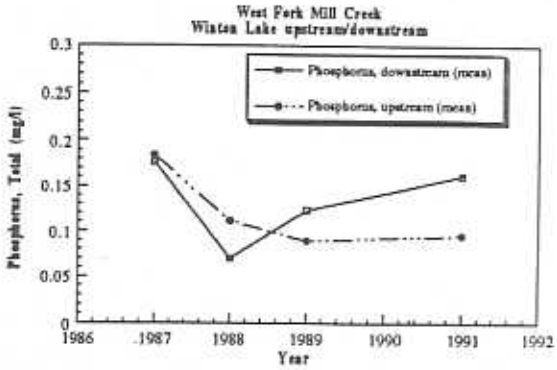


Figure 48. Longitudinal trends ot mean phosphorus from USACOE data from Hamilton Rd and lake outlet.

The U.S. Army Corp of Engineers (USACOE) conducted a multi-media study of air, soil, sediment, surface water and groundwater within the Hopple St. to Western Hills Viaduct stream reach (Section 8; RMs 1.6-2.7) as part of a comprehensive project authorized under the Flood Control Act of 1970 (USACOE, August 1, 1990). Ohio EPA's survey site, Gest St. (RM 0.50) is compared to the USACOE four nearest sites (separated by approximately 1.25 stream miles) approaching the Western Hills Viaduct (Table 13). Ohio EPA (1992) and USACOE sediment data (1990) are tabulated to corroborate metal concentrations within this region of Mill Creek. Sediment metal concentrations from both agencies are similar for most parameters.

Table 13. Comparison of Ohio EPA sediment sampling site with U.S. Army Corps of Engineers sampling locations.

Metals dry wt. (mg/kg)	OEPA Gest St. RM 0.50	USACOE B8175	USACOE B8169	USACOE B8161	USACOE B8157
As	7	3	2	2	2
Cu	50	178	9	21	24
Cd	0.956	<5	<5	<5	<5
Cr	30	35	28	39	43
Pb	90	12	16	16	36
Ni	33	31	22	37	55
Zn	173	111	41	103	

USACOE sampling locations lie between Gest St. and Western Hills Via Duct (RMs 1.6 to 2.7)

Trend

Changes in Fish Community Performance: 1988- 1992

Mill Creek

- A limited number of fish sampling locations (RM 17.7 to 12.2) were sampled during 1988 by the Ohio EPA in Mill Creek. IBI results from 1988 and 1992 were very comparable (Figure 49), reflecting severely degraded conditions. MIwb values varied between the 1988 and 1992 sampling period (Figure 50); however, biological conditions were reflective of severe water quality impairment.

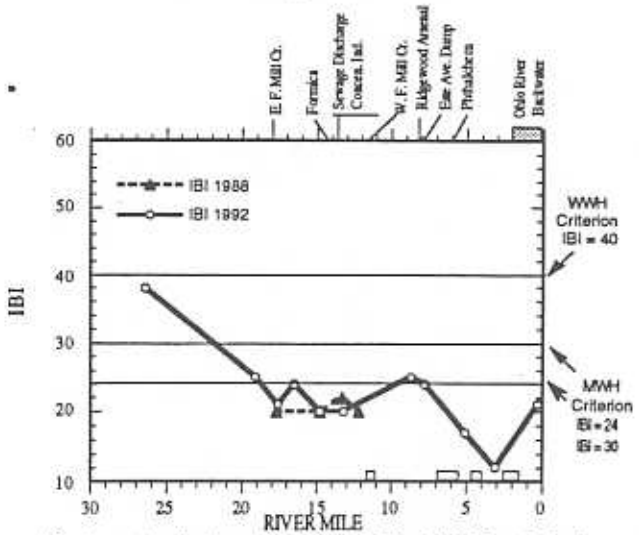


Figure 49. Longitudinal trend of the IBI in Mill Creek during 1988 and 1992.

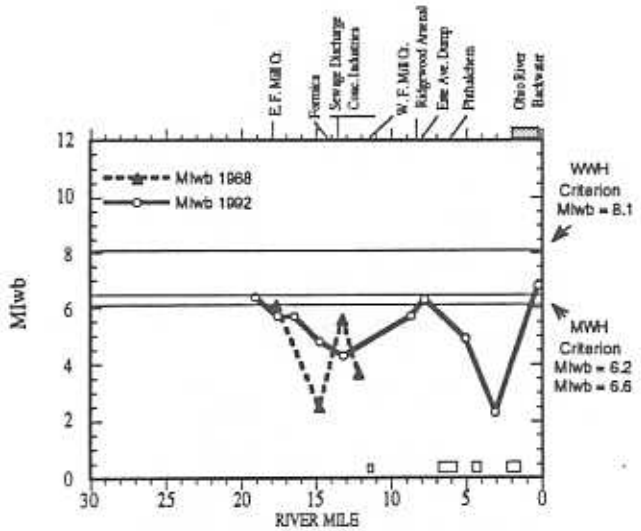


Figure 50. Longitudinal trend of the MIwb in Mill Creek during 1988 and 1992.

- Area of Degradation Values (ADV) for the 1992 and 1988 sampling effort (Table 14) provides a relative measure of performance of the IBI and MIwb. The ADV/ mile of the IBI and MIwb demonstrates the severe degradation in the fish community of Mill Creek. Slight improvement was observed in ADV/ mile values from 1988 to 1992 between RM 12 and 18 (IBI: 172.7 vs. 151.4; MIwb: 178.2 vs. 148.9); however, all ADV/ mile statistics were very high and within the range of values commonly encountered for streams that are impacted by toxic discharges. In the entire Mill Creek mainstem, ADV/ mile statistics from 1992 for IBI (83.4) and MIwb (104.0) reflect organic enrichment and toxic impacts.

Table 14. Area of Degradation (ADV) statistics for the Mill Creek study area, 1988 and 1992 (calculated using ecoregion criteria 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
Mill Creek (1988)											
IBI	17.7	12.2	20	22	950	**172.7**	401	0.0	0.0	**6.1**	6.1
MIwb			2.5	6.1	980	**178.2**	87				
Mill Creek (1992)											
IBI	17.6	13.2	22	26	666	**151.4**	180	0.0	0.0	**5.4**	5.4
MIwb			4.1	5.9	655	**148.9**	34				
IBI	26.4	0.3	12	38	2177	**83.4**	760	2.3	0.0	**24.7**	20.3
MIwb			2.3	6.8	1955	**104.0**	185				
West Fork Mill Creek (1988)											
IBI	1.1	6.4	22	24	784	**147.9**	244	0.0	0.0	**6.0**	6.0
MIwb			4.8	6.2	650	**122.6**	27				
West Fork Mill Creek (1992)											
IBI	4.5	0.2	17	24	718	**167.0**	259	0.0	0.0	**5.1**	5.1
MIwb			5.6	6.6	345	**80.2**	0				
East Fork Mill Creek (1992)											
IBI	4.7	0.3	20	40	106	**24.1**	12	3.3	0.0	**1.5**	0.7

West Fork Mill Creek

- A comparison of 1988 and 1992 West Fork Mill Creek stations downstream from Winton Lake revealed nearly identical IBI results (Figure 51). Some improvement was noted in MIwb values during 1992 (Figure 52). Overall, there was no significant improvement in the fish communities of the lower West Fork Mill Creek from 1988 to 1992 - conditions remain indicative of degraded water quality.

- Trends in ADV statistics between 1988 and 1992 revealed mixed results (Table 14). Index of Biotic Integrity ADV/ mile values were high both in 1988 and 1992 (147.9 and 167.0, respectively) as were MIwb scores (122.6 and 80.2). Overall, no significant improvement in ADV scores was observed in the West Fork Mill Creek between 1988 and 1992.

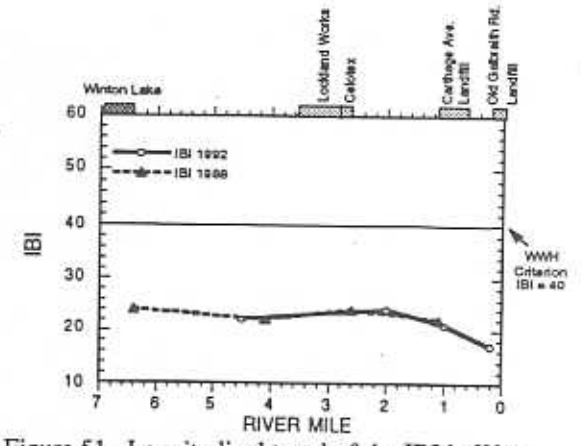


Figure 51. Longitudinal trend of the IBI in West Fork Mill Creek during 1988 and 1992.

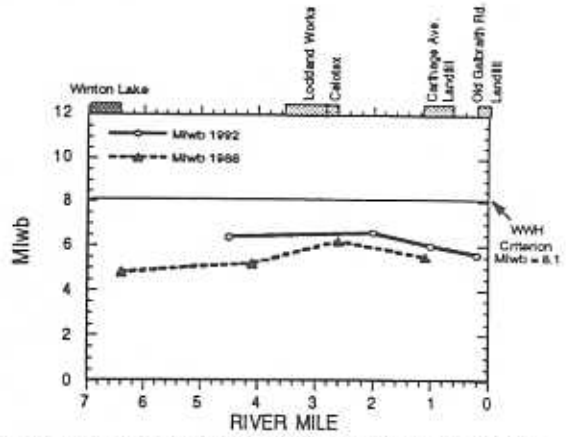


Figure 52. Longitudinal trend of the MIwb in West Fork Mill Creek during 1988 and 1992.

East Fork Mill Creek

- Evaluation of East Fork Mill Creek ADV/ mile IBI statistics revealed a significantly lower score (24.1) in comparison to the West Fork Mill Creek and Mill Creek (Table 14). Of the 5.5 mile stream reach evaluated, 3.3 miles fully attained the WWH use designation. The impaired stream reach contributing to the ADV score was located downstream from the Upper Mill Creek WWTP.

- One location was sampled in the East Fork Mill Creek during 1988 (RM 3.8). Fish community results (IBI) from 1988 were comparable to the 1992 sites sampled upstream from the Upper Mill Creek WWTP (RM 1.9 to 4.7).

Stream Flow

Historical data from U.S. Geological Services (U.S.G.S. 1982-92) indicates flows in Mill Creek at Carthage near Cincinnati during the 1992 water year (October 1991-September 1992) were low compared to the previous ten years, Figure 53. Precipitation in the early part of 1992 was at drought conditions, but heavy rainfall in the middle and latter part of 1992 caused flood conditions in southern Ohio. Flow conditions in Mill Creek during the survey period (May through September) are illustrated in Figure 54. Several high flow events occurred during the sampling period. Water transfers between the Mill Creek and the Great Miami basins due to human activities (industrial and municiple uses) made it irrelevant to statistically evaluate Mill Creek flow.

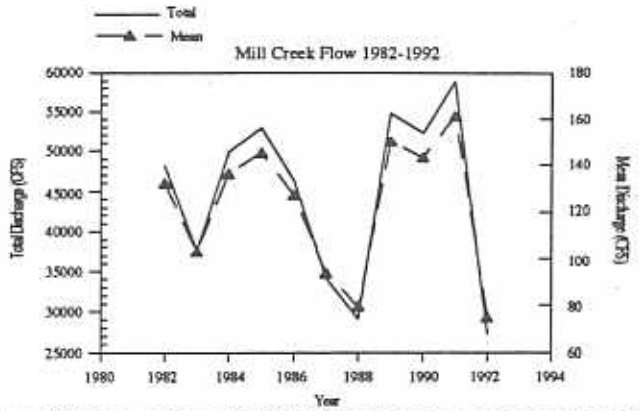


Figure 53. Comparison of 1982-92 total and mean flows in Mill Creek from the USGS gaging station at Carthage.

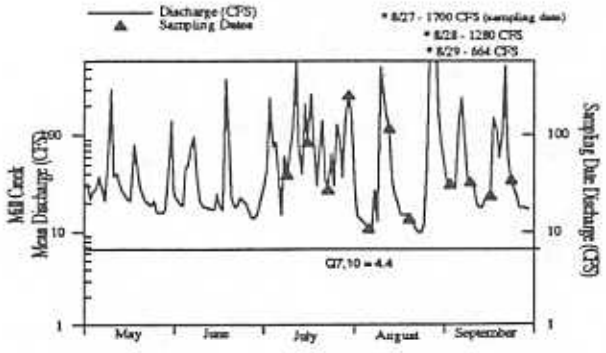


Figure 54. Mill Creek flow hydrgraph from USGS gage at Carthage. Data from May through September, 1992. *flows on dates 8/27-29 exceeded the upper range of the graph scale.

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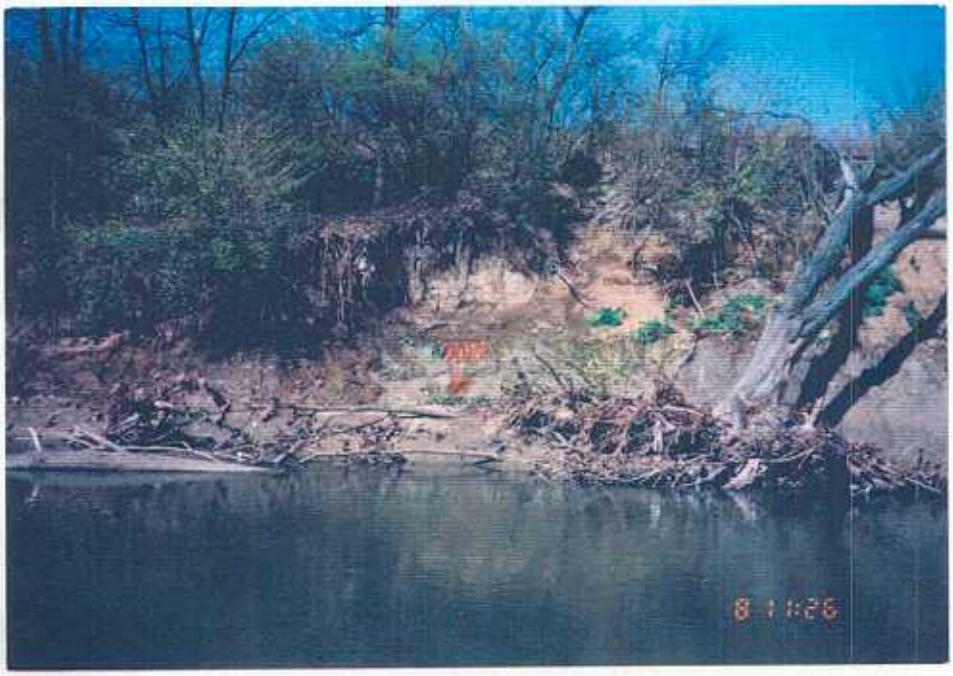

Plate 1. Seeps emanating from the banks of Mill Creek mainstem from potential hazardous waste sources. ***Top Photo***: Multi-colored seep staining the bank of Mill Creek near Pristine/Cincinnati Drum property near Reading. ***Bottom Photo***: Seep staining the bank of Mill Creek at the Ridgewood Arsenal site near Seymour Avenue in Cincinnati.

Plate 2. Sewer overflows in the Mill Creek basin. ***Top Photo***: Raw sewage discharge to Mill Creek from broken sewer line cleanout at Windisch Road. ***Bottom Photo***: Sewage solids trail leading to Mill Creek from an open manhole at the confluence of Mill Creek and Cooper Creek.

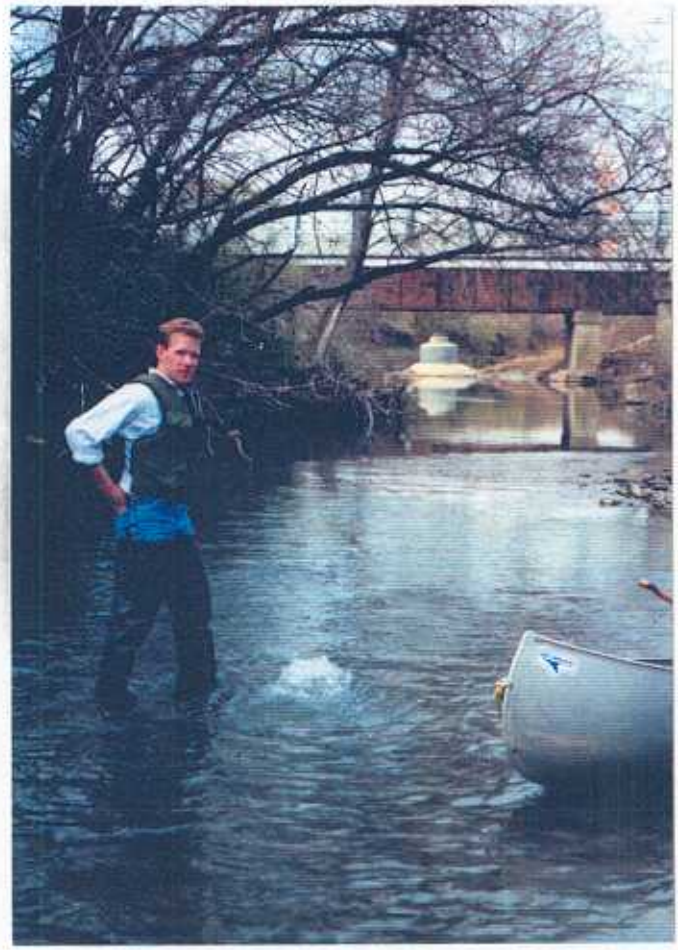

Plate 3. Sewer manhole located in the stream bed of Mill Creek discharging sewage into the stream downstream of the G.E. tributary.

Plate 4. Remains of lime sludge from the City of Wyoming Water Treatment Plant and sewage overflows evident in West Fork Mill Creek near Gardner Park in Lockland.

Plate 5. Discharges to Mill Creek from industrial activities. ***Top Photo***: Silt laden discharge from Rack Sand and Gravel operation to Mill Creek in the concrete channel area. ***Bottom Photo***: Cement discharge to Mill Creek from Plainville Concrete upstream from Clark Road. The concrete discharge had dried at the time of this photo.

Plate 6. Asphalt, sealant and trash piled along the bank and entering the concrete channel of West Fork at the City of Cincinnati asphalt plant.

Plate 7. Large cable spools dumped into the channelized section of West Fork from a near by company.