ADDENDUM (June 2004) to:

Water Quality Permit Support Document to Assess the Proposed Expansion of the Butler Co. Upper Mill Creek WWTP
(1PK00016)

August 1998

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Based on Biological and Water Quality Sampling Conducted July-September, 2002

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Section 1: Summary

Upper Mill Creek Basin 2002

The upper Mill Creek basin was reassessed in 2002 to evaluate biological performance, particularly in the East Fork Mill Creek downstream from the Upper Mill Creek Water Reclamation Facility (WRF). Since a similar survey was conducted in 1997, the WRF increased the design capacity to 16 million gallons per day (MGD), installed ultraviolet disinfection, and upgraded other facilities. Also, in order to augment habitat quality, Butler County installed a series of 32 boulder riffles (*i.e.,* "Newbury Riffles") in 1999-2000 in the lower mile of the East Fork between the WRF and the mouth.

Based on 2002 sampling results, the Upper Mill Creek WRF continues to have a significant impact on biological and water quality conditions in the East Fork Mill Creek and in Mill Creek downstream. Fish community health plummeted from the good range upstream from the WRF, to the poor and very poor ranges downstream. Macroinvertebrates were not as severely impacted but, still declined from exceptional quality upstream, to marginally good quality downstream from the discharge.

Excessive nutrient enrichment associated with the Upper Mill Creek WRF was considered the primary cause of impairment in 1997. In 2002, macroinvertebrates continued to suggest enrichment impacts from sewage while fish communities, dominated by tolerant and pioneering species, along with low relative abundance, reflected symptoms associated with toxicity (Yoder and Rankin 1995). Water chemistry continued to reflect significant nutrient enrichment with elevated phosphorous levels and several Water Quality Standards criterion exceedences for ammonia detected downstream from the WRF. National Pollution Discharge Elimination System (NPDES) permit violations for ammonia and suspended solids (n=23) were also documented at the plant between 2000 and 2003. Nutrient enrichment was also reflected in sediment samples where phosphorus levels exceeded Severe Effect levels in the East Fork below the Upper Mill Creek WRF and for several miles downstream in the Mill Creek mainstem. Algal bioassays conducted on the WRF effluent in 1997 found no chronic toxicity at high concentrations but a biostimulatory effect, likely associated with elevated nutrients, at about 50% dilution. The inference is that chronic toxicity occurred at the high concentration but it was not caught statistically. Year 2002 results confirmed chronic effluent toxicity to algae but a biostimulatory effect was not detected at lower concentrations.

The installation of Newbury Riffles downstream from the WRF had not resulted in significant improvement in biological conditions by 2002. In the absence of water quality impacts, fish communities would be expected to show the most positive response to habitat improvements in this reach. However, fish community performance actually declined since 1997. Based on analysis of biological recovery patterns from other disturbed stream reaches in Ohio, the 2 to 3 year period following riffle installation in the East Fork Mill Creek should be more than adequate for post-construction recovery (*e.g.,* Scioto River downstream Columbus [file data], Ohio EPA 2000 [Mill Creek (Scioto) Draft TMDL], Tinkers Creek [Twinsburg, Ohio] channel relocation [file data]). These results, coupled with the severe, apparently toxic response in the fish, point to the Upper Mill Creek WRF as the

primary source of impairment. The placement of Newbury riffles in this reach did serve to increase speed over the riffle, a positive habitat attribute that would not otherwise be found in the historically channelized reach. However, potential benefits of the structures have not been fully realized due to the overriding water quality impairment. (Note: results from more recent sampling in 2003 by Butler County consultants suggests some improvement in East Fork biological communities compared to 2002, but use attainment remains impaired.)

In Mill Creek, full attainment of the WWH aquatic life use remains limited to the extreme upper reaches of the mainstem near Liberty Fairfield Road (RM 24.6). Biological performance was good, stream habitat has remained intact, and encroaching suburban development has not yet affected community health. Moving downstream, biological impairment became increasingly severe as a result of channelization, increased suburban development, and possible sewage impacts based on strong odors of raw sewage at Rialto Road (RM 21.1). Fish and macroinvertebrate communities declined to fair and poor quality by Windisch Road (RM 18.7), prior to the East Fork Mill Creek confluence. Biological impairment in this reach may have been exacerbated by the extreme low flow conditions encountered during the summer of 2002.

Additional mainstem impacts were observed downstream from the Upper Mill Creek WRF and Glendale WWTP discharges via the East Fork Mill Creek and Town Run, respectively. Fish community health dropped to the very poor range downstream from the confluences at Sharon Road (RM 16.5) and, like the East Fork, fish populations suggested possible toxic impacts. In contrast, Mill Creek macroinvertebrates exhibited slight to moderate improvement in the 9-mile reach downstream from the East Fork confluence. Factors that may have contributed to the positive trend included far field improvements well downstream from the Upper Mill Creek WRF, improvements in the Hamilton County Metropolitan Sewer District (MSD) collection system, or the general lack of urban runoff and combined sewer overflow (CSO) discharge events during the 2002 summer drought.

In Town Run, poor effluent quality from the Glendale WWTP resulted in grossly polluted conditions, numerous severe Water Quality Standards criterion exceedences, and very poor biological community performance downstream from the discharge.

Causes and sources of impairment in 2002 were generally similar to 1997 observations. Habitat alteration related to development and increased suburban development in Upper Mill Creek has had a significant impact on biological communities. Impairments in the upper basin appeared exacerbated by the summer drought.

In the East Fork Mill Creek, phosphorus levels downstream from the Upper Mill Creek WRF decreased compared to 1997 but remained quite elevated compared to background levels. In addition to nutrients, impacts from ammonia appeared to increase in severity between the surveys. Permit violations, WQS exceedences detected in chemical sampling, and increased ammonia-N loadings point to the potential for increased ammonia toxicity and oxygen demand downstream from the WRF. Variable effluent quality, possibly attributable to inflow and infiltration influences, treatment process disruptions, or inadequacies were of particular concern in evaluating the downstream impacts. Ammonia was also a concern

in 1997, but concentrations were within water quality standards and, unlike 2002 results, the magnitude of impacts to fish were not so severe.

Impairment in Town Run downstream from the Glendale WWTP should be attributed to excessive organic enrichment and ammonia. Upstream from the WWTP, organic enrichment associated with sewage bypasses and storm water, coupled with flow alteration and urban runoff, were considered the primary causes and sources of impairment, respectively.

Causes and sources of impairment in Mill Creek downstream from the East Fork and Town Run remain similar to the findings of the 1997 survey. However, the magnitude of impairment associated with ammonia loadings from point sources appeared to increase. Further downstream, an improving trend in the macroinvertebrates may reflect changes in the relative contribution of impairment sources since 1997. However, specific reasons for the trend were uncertain and may be related to far field improvements, well downstream from point source discharges, upgrades in the Metropolitan Sewer District of Greater Cincinnati, Ohio (MSD) sewer system, or simply a lessening of runoff and CSO discharge events during the extended summer drought. Fish were not collected from the lower reaches of the mainstem segment so possible changes in fish community performance are unknown.

Table 1. Aquatic life use attainment status in the Mill Creek basin based on data collected July-September, 1997-2002. East Fork Mill Creek consultant sampling data (Woolpert) have been recalculatated to fit Ohio EPA data analysis methods.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
East Fork Mill Creek (2003) Woolpert Data						
0.8(H)/0.8	30*	na	32	–	PARTIAL	Crescentville Rd.
0.3(H)/0.3	18*	na	40	–	**NON**	Dst. Crescentville Rd.
0.1(H)/0.1	32*	na	28ns	–	PARTIAL	Near mouth
East Fork Mill Creek (2002)						
			Interior Plateau - WWH Use Designation (Existing)			
– /4.7	–	--	F*	–	(**NON**)	Barret Rd. (intermittent?)
3.2(H)/3.2	42	na	36	69.0	FULL	West Chester Rd.
1.9(H)/2.0	45	na	46	76.5	FULL	Allen Rd.
0.8(H)/0.8	17*	na	26ns	62.5	**NON**	Crescentville Rd.
-- /0.5	–	--	26ns	–	**NON**[d]	Dst. Crescentville Rd.
0.3(H)/0.1	21*	na	32	62.5	**NON**	Near mouth
East Fork Mill Creek (2002) Woolpert Data						
0.8(H)/0.8	20*	na	30	–	**NON**	Crescentville Rd.
0.3(H)/0.3	22*	na	36	–	**NON**	Dst. Crescentville Rd.
0.1(H)/0.1	22*	na	28ns	–	**NON**	Near mouth
East Fork Mill Creek (2000) Woolpert Data						
-- /0.8	--	--	22*	–	(**NON**)	Crescentville Rd.
-- /0.3	--	--	34	–	(FULL)	Dst. Crescentville Rd.
-- /0.1	--	--	28ns	–	(FULL)	Near mouth
East Fork Mill Creek (1999) Woolpert Data						
-- /0.8	--	--	12*	–	(**NON**)	Crescentville Rd.
-- /0.3	--	--	24*	–	(**NON**)	Dst. Crescentville Rd.
-- /0.1	--	--	24*	–	(**NON**)	Near mouth
East Fork Mill Creek (1997)						
3.1(H)/4.7	46	na	MG	80.5	FULL	W. Chester Rd./Barret Rd.
1.9(H)/2.0	36ns	na	46	53.0	FULL	Allen Rd.
1.0(H)/1.0	*38*	*na*	*24*	--	*na*[c]	*UMC WRF Mix Zone*
0.9(H)/0.8	31*	na	28ns	69.0	PARTIAL	Crescentville Rd.
0.3(H)/0.1	34*	na	24*	64.0	**NON**	Near mouth

Table 1. (continued).

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
Mill Creek (2002)						
			Interior Plateau - WWH Use Designation (Existing)			
26.2(H)/26.3	42	na	G	74.5	FULL	Liberty-Fairfield Rd.
21.0(W)/21.1	23*	na	F*	47.5	**NON**	Rialto Rd. (channelized)
18.7(W)/18.9	25*	na	F*	67.5	**NON**	Windisch Rd.
17.5(W)/17.6	22*	5.0*	32	51.5	**NON**	Kemper Rd.
			Interior Plateau - WWH Use Designation (Existing)			
16.5(W)/16.5	14*	2.8*	22*	62.5	**NON**	Sharon Rd.
14.8(W)/14.9	19*	4.7*	28ns	62.0	**NON**	Formica Entrance
-- /13.3	–	--	38	–	(FULL)	Koenig Park
-- /8.9	–	--	26ns	--	(FULL)	North Bend Road
Mill Creek (1997)						
			Interior Plateau - WWH Use Designation (Existing)			
26.2(H)/26.4	43	na	MG	60.0	FULL	Liberty-Fairfield Rd.
21.0(W)/21.0	26*	6.1*	28ns	40.0	**NON**	Rialto Rd. (channelized)
18.9(W)/18.8	29*	6.0*	44	49.5	PARTIAL	Windisch Rd.
17.5(W)/17.6	26*	5.0*	26ns	59.0	**NON**	Kemper Rd.
16.5(W)/16.5	24*	4.1*	30	67.5	**NON**	Sharon Rd.
14.8(W)/14.9	27*	5.3*	22*	61.5	**NON**	Formica Entrance
13.5(W)/13.3	25*	5.0*	30	70.5	**NON**	Koenig Park
			Interior Plateau - MWH Use Designation(Existing)			
3.1(W)/3.1	18*	4.3*	14*	38.0	**NON**	Ust. Hopple St.
0.7(B)/ --	30	8.2	6*	34.0	**NON**	Dst. Lowhead Dam
0.3(B)/0.3	22*	8.0	6*	--	**NON**	Ust. Barrier Dam
Town Run (2002)						
			Interior Plateau - WWH Use Designation (Existing)			
1.0(H)/1.0	16*	na	P*	58.0	**NON**	Ust Glendale WWTP
– /0.7	–	--	VP*	--	(**NON**)	Chester Road
Beaver Run (1997)						
			Interior Plateau - WWH Use Designation (Existing)			
1.0(H)/0.9	28*	na	P*	55.0	**NON**	Heritage Hill ford

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

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

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

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

c Biocriteria do not apply in mixing zones.

d The ICI from RM 0.5 (2002) is marginally good but attainment is listed as NON based on the poor/very poor qualtiy fish communities from East Fork sites located immediately upstream and downstream.

W Wading site type

[H] Headwater site type
[B] Boat site type

Ecoregional Biocriteria: Interior Plateau Ecoregion (IP)
(OAC Chapter 3745-1-07, Table 7-17)

INDEX -	Site Type	WWH	EWH	MWH[e]
IBI -	Headwater/Wading	40	50	24
Mod. Iwb -	Wading	8.3	9.4	5.8
ICI		30	46	22

[e] - Modified Warmwater Habitat for channelized habitats

Section 2: Assessment of Impact on Receiving Waters

Pollutant Loadings: 1976 - 1995 (Figures 1, 10, 22)
Monthly effluent loadings are reported to the Ohio EPA by all NPDES permitted discharging entities. Annual Monthly Operating Report (MOR) data provided the quantity and character of pollutant loadings through the period of record for each entity evaluated within the 2002 Mill Creek study area. Pollutant loadings trends analyses typically include: Ammonia-nitrogen (NH_3-N), Five-day Biochemical Oxygen Demand (BOD_5), Carbonaceous Five-day Biochemical Oxygen Demand ($cBOD_5$), Total Suspended Solids (TSS), Nitrate+Nitrite-nitrogen (NO_3-NO_2-N), and Annual Discharge (MGD). Where available, bioassay results and other relevant compliance information are included. NPDES violations are included as part of the total facility evaluation.

Spills, Overflows and Unauthorized Releases (Appendix Tables 2-3)
Pollutant discharges from spills, overflows, permit violations and other unauthorized releases were evaluated from 1998-2002. Non sewage-related spills were taken from Emergency Response spill reports for Butler County (Appendix Table 2) while reported overflows from Butler County's sanitary sewer system are found in Appendix Table 3.

Note: A list of all 2002 chemical and biological sampling site locations can be found in Appendix Table 1.

Chemical Sampling: 1997 - 2002 (Figures 2-8,11-19, 23-27, Appendix Tables 4-11)
During the summer of 2002, water chemistry grab samples were collected every other week (six times) at 14 sites in the Mill Creek basin (including the Upper Mill Creek WRF final effluent) and analyzed for a variety of parameters. Water Quality Standards exceedences are listed in Appendix Table 4. Eleven of the 14 water chemistry sites were also sampled for organic compounds (volatile, semivolatiles, pesticides, and polychlorinated biphenyls [PCBs] twice during the 2002 survey.

Datasonde™ continuous monitors recorded hourly dissolved oxygen (D.O.) concentration, D.O. percent saturation, temperature, pH and conductivity at six sites (RMs 17.96-8.7) in the Mill Creek mainstem and three sites in the East Fork Mill Creek (RMs 1.84, 0.75, and 0.01) from July 30-August 1, 2002.

Sediment Sampling: 1997- 2002 (Appendix Tables 12-13)
Sediment samples were taken from seven locations in the Mill Creek study area. Five sites were sampled on the mainstem, the most upstream site at Crescentville Road (RM 18.7), upstream from the confluence with East Fork Mill Creek (RM 17.95) and the downstream site at North Bend Road (RM 8.9). The North Bend Road site was not sampled in 1997. East Fork Mill Creek was sampled at two locations, Allen Road (RM 1.9) and at the mouth (RM 0.1). The Upper Mill Creek WRF discharges into East Fork Mill Creek at RM 1.07. Both East Fork sites were sampled in 1997 and 2002.

Fine grain sediment samples were collected in the upper 4 inches of bottom material at all seven Mill Creek basin locations using decontaminated stainless steel scoops.

Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were homogenized in stainless steel buckets, transferred into glass jars with teflon-lined lids, placed on ice (to maintain 4°C) in a cooler, and shipped to the Ohio EPA DES laboratory. Sediment data is reported on a dry weight basis. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000, Ohio EPA Sediment Reference Values (SRV) (2003), and Ontario Sediment Quality Guidelines (Persuad 1993).

Consensus-based sediment quality guidelines for freshwater ecosystems were developed by MacDonald, Ingersoll and Berger (2000) to be used as an effective tool for assessing sediment quality. Sediment Quality Goals (SQGs) were developed using 12 previously published freshwater ecosystem studies derived from a variety of approaches. A consensus-based SQG developed 28 chemicals of concern matching sediment chemistry and toxicity data to provide a unifying synthesis of existing SQGs. The consensus-based SQGs are predictive of toxicity in sediments containing mixtures of contaminants, but do not consider the potential for bioaccumulation. Each of the 28 chemicals is evaluated in the following categories:

Threshold effect concentration (TEC) - Below which adverse effects are unlikely to occur.
Probable Effect Concentration (PEC) -Above which adverse effects usually or always occur.
Between the TEC and PEC - Between which adverse effects frequently occur.

Ohio Specific Sediment Reference Values (SRV) were developed by Ohio EPA to identify representative background sediment metal concentrations for lotic (flowing) water bodies. Sediment samples were taken from reference areas throughout the state that have been used historically to develop the biological criteria as part of the State of Ohio's water quality standards. These reference areas were selected as being representative of the least impacted conditions in the watershed. SRVs are site-specific background metal concentrations based upon ecoregions and identify whether a site has been contaminated. SRVs are not Ohio EPA standards or criteria.

A limited suite of nutrient parameters was evaluated in this report. Ontario Severe Effect Level (SEL) guidelines (Persuad 1993) were used to evaluate Total Organic Carbon and Total Phosphorus. Ohio and MacDonald SQGs do not have nutrient sediment parameter guidelines. No sediment guidelines were used to evaluate sediment ammonia.

Whenever possible, composite samples from a cross-section of the stream channel were collected with silts and clays comprising at least 30% of the sample. Sediments composed of sand and larger sized particles (>60 microns) are often stable inorganic silicate minerals and not usually associated with contaminants. Given that the finer grained silts and clays (<60 microns) are much more chemically, physically and biologically interactive, collection efforts were biased toward collecting these types of sediments. The % FGM category in the table is percent fine grained material that is defined as a particle size < 60 microns with a settling time > 30 seconds. In the 2002 survey, only the Crescentville Road site met the 30% fine grain material criteria. This could be due in part to the flashy nature of the Mill Creek watershed. High velocity stream flow carries away the finer particles.

Organic compounds detected in sediment samples were divided into two groups. One group of compounds which had quantifiable values (compounds detected were compared to a known standard at five different concentrations) and the second group were compounds whose peaks match the computer's spectral database, but are not compared to a known standard. The latter group of reported compounds is called tentatively identified compounds (TIC). Tentatively identified compound information is not as reliable as quantifiable compound information and is only used for screening in this report. The computer is approximately 80% accurate on TIC identification and concentrations can be off as much as 100%.

Biological Sampling: 1997 - 2002 (Figures 9, 20-21 Appendix Tables 14-16)
Fish were collected from 11 stations and macroinvertebrates were collected from 16 locations in the Mill Creek basin including the Mill Creek mainstem (RMs 26.3-8.9), East Fork Mill Creek (RMs 4.7-0.1), and Town Run at RMs 1.0 and 0.7. Fish were sampled using the headwater and wading sampling methods, while macroinvertebrates were collected using artificial substrates (quantitative) and qualitative sampling from the natural substrates. Due to small stream sizes, low summer flows, or loss of samplers, artificial substrate sampling was mostly limited to the East Fork Mill Creek (RMs 3.2-0.1) and the Mill Creek mainstem downstream from the East Fork (RMs 17.6-8.9).

East Fork Mill Creek

Pollutant Loadings: Upper Mill Creek Water Reclamation Facility -
East Fork Mill Creek (Figure 1)
Lat:39^{0}18'14";Long:84^{0}25'53"
Permit#:1PK00016

Construction of the original Upper Mill Creek WRF was completed in 1981 with a subsequent upgrade in 1993. The facility was designed as a regional treatment plant with an initial capacity of 4.0 MGD. Initially the treatment system consisted of an influent pumping station, preliminary treatment facilities, primary clarifiers, rotating biological contactors (RBCs), secondary clarifiers and a disinfection system. The upgrade in 1993 included the addition of an oxidation ditch, secondary clarifiers and an ultraviolet disinfection system. With the upgrade in 1993, the addition of a 4.0 MGD oxidation ditch increased the design capacity of the plant to 8.0. A subsequent upgrade in 2001 increased the design capacity to 16 MGD. The latest expansion at the facility included an influent pump station, grit chamber, oxidation ditch with an anoxic zone, two secondary clarifiers, ultraviolet disinfection and post aeration.

Overflows reported from 1996-2000 amounted to over 110 occurrences, some continuing for multiple days. Reported overflow incidences decreased over the 5 years evaluated. The North Pisgah Pump Station remained the most frequent overflow point for all of the 5 years documented as nearly 50% of the reported overflow events for 19 stations identified. A new pump station was added at this location at the end of 2001 and reported overflows appear to be declining. The Sharon and Windisch Road Interceptor overflows were second and third respectively in frequent events, sharing approximately 25% of the total events reported. The Sharon Road pump station was upgraded in 2003. The Windisch Road Interceptor overflows were mostly due to a hydraulic restriction on the influent which prompted a recent upgrade which was completed by 2001. Most overflow occurrences were related to hydraulic overloads brought about by storm events. Other causes for overflows were related to mechanical pump failures and power outages. Over the past 5 years, Butler County has completed needed infrastructure improvements to aid in the elimination of these unauthorized discharges.

Violations of the National Pollutant Discharge Elimination System (NPDES) were evaluated for part of 2000 through all of 2003. Twenty-six NPDES permit violations were documented at the Upper Mill Creek WRF between 2000 and 2003. For the nearly four years of data evaluated, violations for total suspended solids (18) and ammonia (5) were reported most frequently. Forty-two percent of violations occurred between 2002 and 2003.

Annual peak-flows were typically greater than the design flow of 4 and 8 MGD throughout most of the period of record. Annual median percentile flow exhibited a general increasing trend following the upgrade in 1993 suggesting greater volumes from population growth or an aging system (inflow and infiltration [I&I]) or both.

All conventional parameter characteristics mimicked one another in percentile variance and

lack of a discernible trend reflected in NPDES violations for TSS and ammonia-N (Figure 1). Notable percentile variances may be indicative of unpredictable flow volumes, possibly attributable to inflow and infiltration influences or treatment process disruptions, or inadequacies. From 1994 until 2001, median percentiles exhibited a general increasing trend and percentile variability is evident mostly attributable to nitrate variances (incomplete nitrification) probably linked to operational controls. The increase in the ammonia-N load increases the potential for increased ammonia toxicity and oxygen demand downstream from the Upper Mill Creek WRF with nitrification occurring in the stream rather than the WRF. Unpredictable parameter load characteristics, however, did not result in reported permit violations for Carbonaceous Biochemical Oxygen Demand ($cBOD_5$).

Fixed stations, 801 and 901 monitoring results (bracketing final outfall 001) demonstrated downstream concentrations of ammonia-N consistently more elevated than upstream for all years evaluated (Figure 1). Treatment improvements as a result of the plant's expansion in 1993 were graphically evident for ammonia-N until 1999 downstream concentrations began to climb.

Bioassay: Upper Mill Creek Water Reclamation Facility (file data)
Ohio EPA conducted three acute bioassay tests in 1992 and one event in 1997 indicated variable toxicity to both organisms (*C. dubia and P. promelas*) exposed to effluent and river samples. Acute toxicity was evident in five of nine 1992 effluents. When effluents were toxic to the test organisms in the 1992 effluents, the toxicity persisted in the mixing zone. Effluents in May, 1997 bioassays were acutely toxic to C. dubia with toxicity persisting into the mixing zone. The variability can be indicative of inconsistent plant performance and effluent quality.

A chronic toxicity test conducted in 1997, using a freshwater green alga, *Selenastrum capricornutum*, was for the purposes of differentiating chronic toxicity from nutrient enrichment causing biostimulation. Concurrent bioassays were conducted with effluent and ambient water samples using P. promelas and C. dubia resulting in no toxicity to either organism. Results showed biostimulation at 50% of effluent however, no toxic or stimulatory effects at 100%. These end results could be attributed to an overabundance of nutrients. Another set of chronic toxicity tests were conducted in 2002 and found a significant reduction in algal cell production in the acute mixing zone, effluent grabs, and composite effluent when compared with the East Fork Mill Creek upstream water. These results indicate outfall 001 effluents were chronically toxic to algal production. This is in contrast to screening results observed in 1997 in which the effluent had no adverse effect on algal production when compared to the reference water. Analysis conducted in 1997 did not indicate a significant difference in algal production in the East Fork Mill Creek upstream water, acute mixing zone, effluent grabs and composite effluent for biostimulation or toxicity.

Spills, Overflows and Unauthorized Releases - **East Fork Mill Creek and Mill Creek Basins** (Appendix Table 2-3)
Pollutant discharges from spills, overflows, permit violations and other unauthorized releases can be significant sources of lethal and sublethal stresses to the aquatic communities in the Mill Creek watershed.

Emergency Response spill reports in Butler County from 1998 to 2003 documented 248 spill events in the Mill Creek watershed. Sewage and wastewater discharges accounted for 116 events or 46.8% of total spills reported. Petroleum-related spills within the watershed were documented 63 times (25%).

Appendix Table 2 documents the nonsewage-related spills reported from 1998 to 2002. Appendix Table 3 lists reported overflows from the Butler County's sanitary sewer collection system during the same time period.

The Upper Mill Creek WRF reported 80 different overflows from its sewage collection system into the Mill Creek basin from January 7, 1998 to February 23, 2003. The North Pisgah Pump Station was documented as overflowing 29 times (36% of total) during this period (Note: see additional sewer overflow discussion in Upper Mill Creek WRF Pollutant Loadings Section, page 11).

Butler County has worked to decrease the amount of overflows from 24 events in 1998 to nine events in 2002. The amount of overflows from the North Pisgah Pump Station decreased from 14 events in 1998 to two events in 2002.

Overflows in Butler County's collection system were from the following causes:
Rain events 33 (41%) , pump and equipment failures 19 (24%), power outages 7 (9%), and sewer blockages 13 (16%).

Emergency Response spill reports in Hamilton County from 1998 to 2003 documented approximately 2020 spills in the Mill Creek watershed from 1998 to 2002. CSO overflows from the Metropolitan Sewer District accounted for 1172 events (58%), wastewater from non MSD sources 41 events (2%), and petroleum related spills 260 events(13% [no table included]).

Surface Water Quality: East Fork Mill Creek (Figures 2-5, Appendix Tables 4-11)
Many of the graphs included with the following summaries show dotted lines representing the 90th, 75th, or 50th percentile concentrations from least impacted regional reference sites of similar size (Ohio EPA 1999). Statistical data were segregated by ecoregion and further stratified by ranges of stream size for these analyses as follows: headwater streams (0-20 sq. mi.) and wadeable streams (> 20-200 sq. mi.) .]

The East Fork Mill Creek, draining approximately 9.5mi^2, receives the discharge from the Butler County Upper Mill Creek Water Reclamation Facility (WRF) at RM 1.07 before entering the Mill Creek mainstem at RM 17.95.

Datasondes™ monitored dissolved oxygen, temperature, pH, and conductivity hourly at three sites (RMs 1.84, 0.75, and 0.01) from July 30-August 1, 2002 (Figure 2, Appendix Table 5-9). (No dissolved oxygen data were collected at RM 1.84 due to reduced stream flows.) While dissolved oxygen concentrations at the two sites downstream from the Upper Mill Creek WRF remained above the WWH minimum D.O. criterion of 4 mg/l, a sag was apparent near the mouth at RM 0.01 with the majority of measurements (57%) below the WWH average D.O. criterion of 5 mg/l. Median D.O. saturations decreased from 74% at RM 0.75 (Crescentville Road) to 59% at RM 0.01. Respective pH, temperature, and conductivity medians of 7.96 SU, 24.9°C, and 690 µmhos/cm were recorded upstream of the Upper Mill Creek WRF at RM 1.84 (Allen Road). Sites downstream recorded lower pH and temperatures and higher conductivities. Minimal variation in pH was observed at downstream sites with values ranging from 7.35 SU to 7.53 SU. Median temperatures at both downstream sites approximated 23.7°C and median conductivities ranged from 1370 µmhos/cm at RM 0.75 to 1420 µmhos/cm at RM 0.01.

Water chemistry daytime grab samples were collected at six sites in the East Fork Mill Creek (including the Upper Mill Creek WRF final effluent) (Figures 3-5). D.O. concentrations dropped below WWH water quality criteria on lower flow days at RMs 3.19, 1.84, and 0.01. Median percent saturations ranged from 64% at RM 3.19 (West Chester Road) to 104% at Barrett Road (RM 4.68). BOD_5 concentrations, generally low, increased somewhat downstream from the Upper Mill Creek WRF on occasion with higher in-stream values correlating to higher effluent concentrations.

Ammonia-N concentrations, consistently less than the MDL of 0.05 mg/l at upstream sites, increased significantly downstream from the Upper Mill Creek WRF with concentrations exceeding water quality criteria at RM 0.75 (4.28 mg/l) and RM 0.01 (1.44 mg/l) on August 20 (effluent concentration 4.89 mg/l) (Appendix Table 4). Elevated levels persisted into the Mill Creek mainstem where median and maximum concentrations of 0.31 mg/l and 1.13 mg/l, respectively, were recorded at Kemper Road (RM 17.61) during the survey. Phosphorus followed a similar pattern with values increasing sharply downstream from the Upper Mill Creek WRF and remaining elevated into the Mill Creek mainstem. Respective overall median and maximum concentrations increased from 0.11 mg/l and 0.20 mg/l for upstream sites (RMs 4.68 - 1.84) to 1.61 mg/l and 3.94 mg/l for sites downstream from the WRF discharge (RMs 0.75 - 0.01). Nitrate-nitrite levels, while somewhat higher at sites downstream from the WRF, remained low throughout with overall median and maximum values of 0.3 mg/l and 2.06 mg/l recorded for the watershed.

Total suspended solids concentrations were low in the East Fork Mill Creek with an overall median of 5 mg/l. While fecal coliform and *E. coli* levels were elevated above recreational criteria on numerous occasions throughout the basin, concentrations remained low in the Upper Mill Creek WRF effluent.

Zinc concentrations increased downstream from the Upper Mill Creek WRF. The overall median recorded upstream of the plant (RMs 4.68-1.84) was 10 µg/l compared to 59 µg/l for downstream sites. Higher chloride, sodium, COD, sulfate, and conductivity levels were also recorded at downstream sites. While one elevated copper concentration (19 µg/l) was

recorded at RM 0.75, all other copper values measured in the East Fork Mill Creek basin were less than the MDL of 10 µg/l.

Four of the six water chemistry sites in the East Fork Mill Creek basin (including the Upper Mill Creek WRF effluent) were sampled for organic compounds twice during the 2002 survey (Appendix Tables 10-11). Pesticides accounted for six of the nine compounds detected (17 of 26 detections). The most frequently detected compounds included gamma-hexachlorocyclohexane (Lindane) (27% of detections), chloroform (23% of detections), and endrin (19% of detections). Concentrations of dieldrin and heptachlor epoxide exceeded water quality criteria at Allen Road (RM 1.84) on one occasion.

Surface Water Quality Trends: East Fork Mill Creek (Figures 6-8)
A comparison of median water chemistry results for select parameters is presented in Figures 6-8 for the East Fork Mill Creek. Water samples were collected from six sites in 2002 (including the Upper Mill Creek WRF), five sites in 1997 (including the WRF), and five sites in 1992. There were four sites common to all three surveys (RMs 4.68, 1.84, 0.75, and 0.01). The WRF final effluent was sampled in both 2002 and 1997.

Three sites (RMs 1.84, 0.75, and 0.01) were monitored with Datasonde™ continuous monitors in all three surveys (Figure 6). Datasonde™ D.O. concentrations remained above the minimum WWH criterion of 4 mg/l in all survey years with greater diurnal variation observed at RM 1.84, upstream of the WRF discharge, and the lowest concentrations recorded near the mouth at RM 0.01. Daytime grab D.O. concentrations in the East Fork Mill Creek were significantly lower in 2002 compared to previous surveys reflecting lower flows.

Ammonia-N concentrations, low at all sites upstream of the Upper Mill Creek WRF, increased at downstream sites during all three surveys. Respective 2002, 1997, and 1992 median values of 0.21 mg/l, 0.14 mg/l, and 0.67 mg/l were documented at Crescentville Road (RM 0.75) compared to ammonia-N medians of 0.31 mg/l, 0.12 mg/l and 0.89 mg/l measured at RM 0.01 for the same years. Concentrations in 2002 and 1992 exceeded Water Quality Standards criteria at RMs 0.75 and 0.01 on one occasion each (Appendix Table 4).

Higher nitrate-nitrite-N levels were recorded during 1992 (the highest flow year), with concentrations in all survey years increasing downstream from the WRF. Overall median concentrations of 0.57 mg/l (2002), 3.76 mg/l (1997), and 7.39 mg/l (1992) were recorded for the two downstream sites (RMs 0.75 and 0.01), while the overall median for the two upstream sites common to all surveys ranged from 0.1 mg/l (2002 and 1997) to 0.36 mg/l (1992).

Similarly, total phosphorus concentrations increased markedly downstream from the Upper Mill Creek WRF in all surveys and remained elevated into the Mill Creek mainstem. Overall median phosphorus concentrations were less than 0.2 mg/l for the two common upstream sites (RMs 4.68 and 1.84) in all survey years, while overall medians of 1.61 mg/l (2002), 3.12 mg/l (1997) and 2.91 mg/l (1992) were measured for sites downstream from the WRF

discharge.

TSS concentrations remained low in the East Fork Mill Creek during all surveys with median concentrations near the minimum detection limit of 5 mg/l. Of the total 36 fecal coliform samples collected in 1992 from the three common sites (RM 4.68 was not sampled for bacteria in 1992), 15 values were elevated above the applicable maximum recreation criteria. (Nine of these 15 elevated values occurred at RM 0.01 where a leaking sewer line crossing caused exceptionally elevated concentrations (median 13350 colonies/100ml).) In 1997, one of eight fecal coliform samples collected at these three common sites exceeded maximum criteria compared to one of 17 values in 2002. *E. coli* values at these three sites were elevated above maximum criteria in 64% (23 of 36) of samples in 1992 compared to 71% (5 of 7) in 1997 and 53% (9 of 17) in 2002.

Sediment Quality (Metals and Nutrients): East Fork Mill Creek (Appendix Table 12
East Fork Mill Creek at Allen Road (RM 1.9) is upstream from the Upper Mill Creek WRF and recorded the highest sediment phosphorous (3540 mg/kg) and aluminum (35,900 mg/kg) levels of the survey in 1997. The phosphorus concentration was above the Ontario SEL and the aluminum concentration was above the Ohio SRV. Land use in the immediate area was agricultural, but the entire area was in transition to suburban development. The 2002 sediment results showed improvement, no sediment metals were above the Ohio SRV, and phosphorus was below the Ontario SEL.

The East Fork Mill Creek site at the mouth documented sediment mercury (1.61 mg/kg) at levels over the Ohio SRV and the MacDonald Probable Effect Concentration (PEC) in the 1997 survey. Mercury levels fell to below detection in the 2002 survey. Both years documented sediment phosphorus above the Ontario SEL**.**

Sediment metals generally improved in the East Fork Mill Creek and the mainstem downstream from 1997 to 2002. Sediment mercury concentrations were over the Ohio SRV guidelines (above background for this area) in three of six common sites in 1997 and were below the Ohio SRVs at all sites in 2002. Average sediment phosphorus for five sites on Mill Creek in 2002 was 1933 mg/kg. The 2002 survey documented phosphorus over the Ontario Severe Effect Level (SEL) (2000 mg/kg) at the mouth of East Fork Mill Creek and at three sites downstream of the mouth on the mainstem. Phosphorus concentrations in sediment over the SEL are expected to cause disturbances in the benthic community. The Kelley and Hite report (1984) documents an association of sediment phosphorus levels greater than 2000 mg/kg to WWTP point discharges or nonpoint urban sources. Only the Little Miami River, another effluent-dominated river, had higher average sediment phosphorus levels (2056.5 mg/kg). The Stillwater River and Sevenmile Creek, both agricultural watersheds, had sediment phosphorus levels of 696.5 mg/kg and 745 mg/kg.

Sediment Quality (Organics): East Fork Mill Creek (Appendix Table 13)
Samples from East Fork Mill Creek at Allen Road (RM 1.9) did not detect any sediment organics in either sampling year. Results from East Fork Mill Creek at the mouth detected the Polynuclear Aromatic Hydrocarbon (PAH), Fluoranthene (0.75 mg/kg) in 2002 and the plasticizer, bis(2-Ethylhexyl)phthalate (0.5 mg/kg) in 1997. Fluoranthene was between the

MacDonald TEC and PEC, where adverse effects frequently occur. There is no standard to measure bis(2-Ethylhexyl)-phthalate.

Fifteen tentatively identified compounds (TIC) were present in the semivolatile analysis and found in all five mainstream and two tributary sites. Most of the 15 tics fall into four classes of chemicals: alkane hydrocarbons (C_{23} H_{48}) to ($C_{43}H_{88}$), aliphatic aldehydes, fatty acids and sterols, with some outliers. Most are believed to be derived by the breakdown of plant material. Ubiquitous to most sediment sites was octameric sulfur (S_8), a product of the aquatic redox cycle of sulfur (Svenson, *et.al.*,1998).

(For more detailed discussion of Sediment Organics, see Mill Creek Sediment; page 35).

Physical Habitat Quality for Aquatic Life: East Fork Mill Creek (Figure 20, Appendix Table 14)
Like the Mill Creek mainstem, the lower mile of the East Fork Mill Creek was historically channelized and consequently has a relatively high number of negative attributes. Again, however, only one high-influence negative attribute was scored at the two sites sampled in this reach, and QHEI scores at both sites were 62.5. The placement of Newbury riffles in this reach to augment habitat quality did serve to increase speed over the riffle, a positive habitat attribute that would not otherwise be found in the historically channelized reach. Habitat quality upstream from the lower mile of the creek was sampled at RMs 1.9 and 3.2. The habitat at both locations was natural and largely devoid of any negative attributes, and fully capable of supporting WWH fish and macroinvertebrate communities. On the whole, habitat quality in the East Fork Mill Creek is sufficient to expect fish and macroinvertebrate communities typical of the ecoregion.

Fish Communities: East Fork Mill Creek (Figure 9, Appendix Table 15)
Fish communities in the East Fork Mill Creek fully met the ecoregion biocriterion for WWH at the two sites sampled upstream from the Upper Mill Creek WRF. IBI scores from two samples collected downstream from the plant plummeted over 20 points from good to the poor-very poor range (Figure 9). Few fish were collected and those that were, were primarily tolerant or pioneering fishes. This difference in fish community scores is simply too great to be explained by differences in habitat quality. Domination of the fish community by tolerant and pioneering species, combined with low relative abundance, is symptomatic of toxicity (Yoder and Rankin 1995).

Since 1997, fish sampling by Ohio EPA and Woolpert Inc.(Butler County consultants) indicates continued impairment downstream from the Upper Mill Creek WRF. In fact, 2002 community health showed actual declines (to the poor and very poor ranges) compared to the earlier survey (Figure 9). Communities upstream from the WWTP continue to maintain good quality and, as yet, show no ill effects from increasing suburban development in the upper watershed.

Macroinvertebrate Communities: East Fork Mill Creek (Figure 9, Appendix Table 16)
East Fork macroinvertebrates were sampled at three sites upstream and three sites downstream from the Upper Mill Creek WRF (Table 16). Artificial substrate samples were

collected from all sites except RM 4.7, where sampling was limited to qualitative collections from the natural substrates.

East Fork Mill Creek RM 4.7 was sampled on August 23, a few days after a heavy rainfall event. The site was free flowing but, earlier in the month, flow was intermittent following an extended drought. Qualitative collections in 2002 were roughly similar to the marginally good populations found in 1997, but only one EPT taxon was found, compared to four in 1997. The community was considered fair, representing a slight decline since 1997 attributed to the extreme low flow conditions.

As in previous surveys, 2002 ICI scores upstream from the Upper Mill Creek WRF were in the good or exceptional ranges. Artificial substrate communities were predominated by Stenonema mayflies (40.8-67.3% of total organisms) and characterized by low percentages of tolerant taxa. Natural substrate communities were similar to previous collections and predominated by pollution sensitive and facultative mayflies, water pennies, riffle beetles and midges. As yet, development pressures in the watershed have not resulted in appreciable impacts to macroinvertebrate populations.

Downstream from the Upper Mill Creek WRF, macroinvertebrate community health declined sharply, but ICI scores marginally met WWH criteria. Declines in index scores were characterized by sharp increases in the percentage of tolerant taxa and Other Diptera/Non Insects and corresponding declines in mayfly percentage and richness. Predominant populations from the artificial substrates were enrichment tolerant varieties and included “red” midges *(Glyptotendipes, Polypedilum illinoense, Chironomus decorus group*), sludge worms (Oligochaeteta), and flatworms (Turbellaria). More pollution-sensitive Tanytarsini midges tended to increase in abundance with increased distance downstream from the discharge.

On the natural substrates, moderate to high density populations of net-spinning caddisflies (most facultative varieties), enrichment tolerant midges, and flatworms appeared predominant. Masses of stalked protozoan colonies formed slimy, whitish patches on the natural and artificial substrates beginning at RM 0.1 and similar growths were observed for several miles downstream in Mill Creek. Massive growths of the protozoan colonies were also found in Town Run, in a grossly polluted section immediately downstream from the Glendale WWTP. The protozoans are a common component of “sewage fungus” and activated sludge in sewage treatment plants (Microorganisms and Their Role in the Activated-Sludge Process). Their presence in streams is often associated with excessive organic enrichment.

Artificial substrate samplers provide an ideal colonizing substrate and tend to minimize the influence of habitat variability. For this reason, the decline in macroinvertebrate quality downstream from the WWTP was considered primarily a reflection of water quality, not habitat quality.

When compared to Ohio EPA sampling in 1997 sampling, ICI scores exhibited minimal change in 2002. Communities in 1997 were in the upper fair and marginally good range

(ICIs = 24-28), while collections in 2002 were in the marginally good to lower good range (ICIs = 26-32). Population shifts and ICI metric scores showed both positive and negative trends between sampling years with little net change in the final index scores. Positive changes, such as increases in caddisfly percentage and EPT taxa richness, were mostly offset by additional increases in tolerant taxa. Blackfly populations (nutrient tolerant, facultative) were reduced in 2002 compared to 1997, but other enrichment tolerant populations remained abundant. Mayfly diversity and abundance remains low downstream from the Upper Mill Creek WRF in both the East Fork and Mill Creek downstream from the confluence.

Macroinvertebrate sampling was conducted before and after installation of the Newbury Riffles by Woolpert Inc. (consultants for Butler County) in 1999, 2001 and 2002 (Figure 9, Table 1). With the exception of one poor value in 1999, ICIs fell in the fair to good range and showed gradual improvement over the three year sampling period. Year 2002 evaluations were in line with Ohio EPA results but the consultants data indicated slightly better performance. Scores from both sources fell in the fair to good ranges but the Woolpert ICIs averaged 3 points higher.

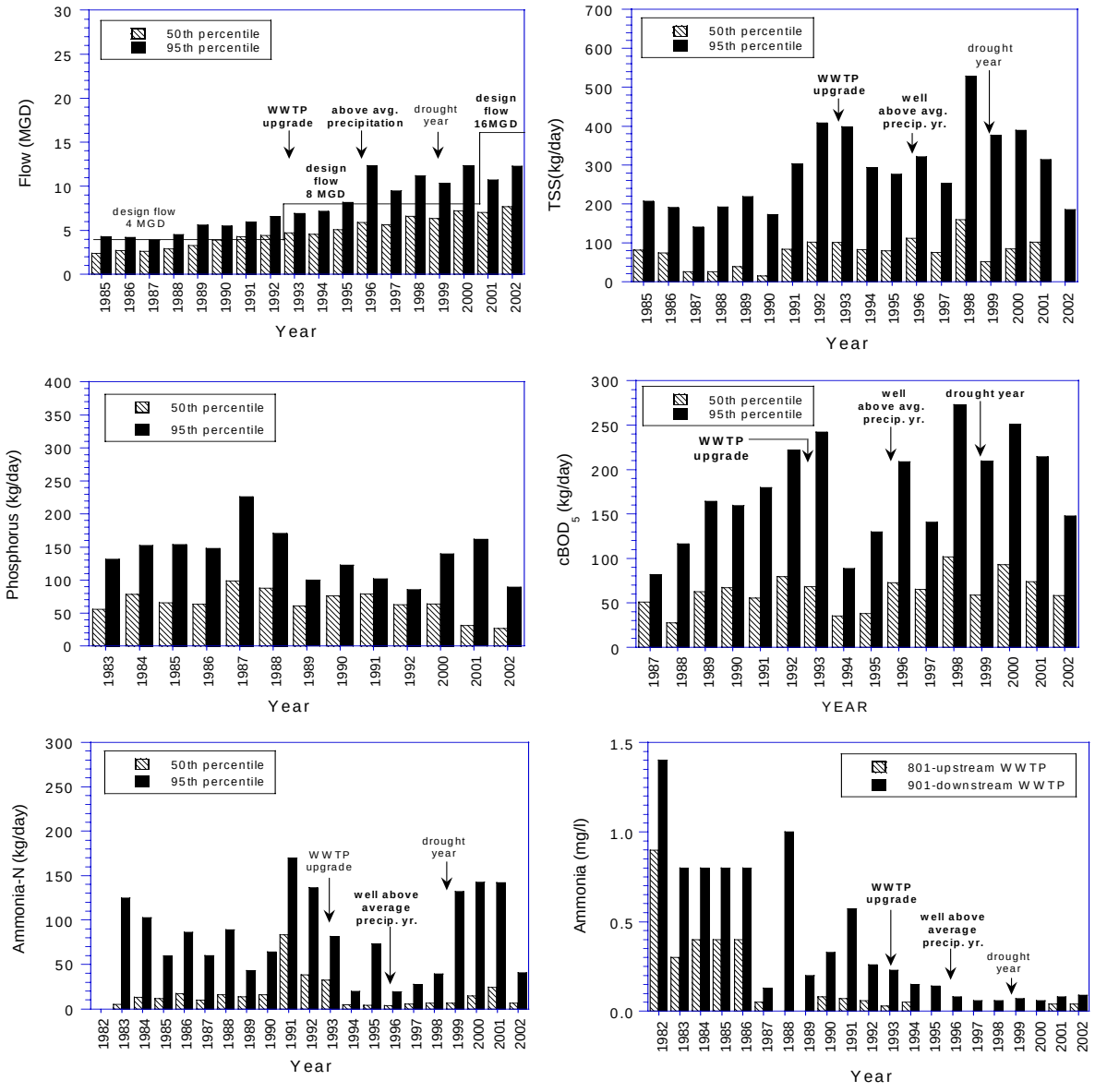

Figure 1. Conduit flow (mgd) and loadings trends (kg/day) at the Upper Mill Creek WRF, 1982-2002 (plots 1-5). Bottom plot (plot 6; lower right corner) displays annual mean Ammonia concentrations measured monthly upstream (801 site) and downstream (901 site) from the WWTP discharge (source =Upper Mill Creek WRF monthly operating reports [MORs]).

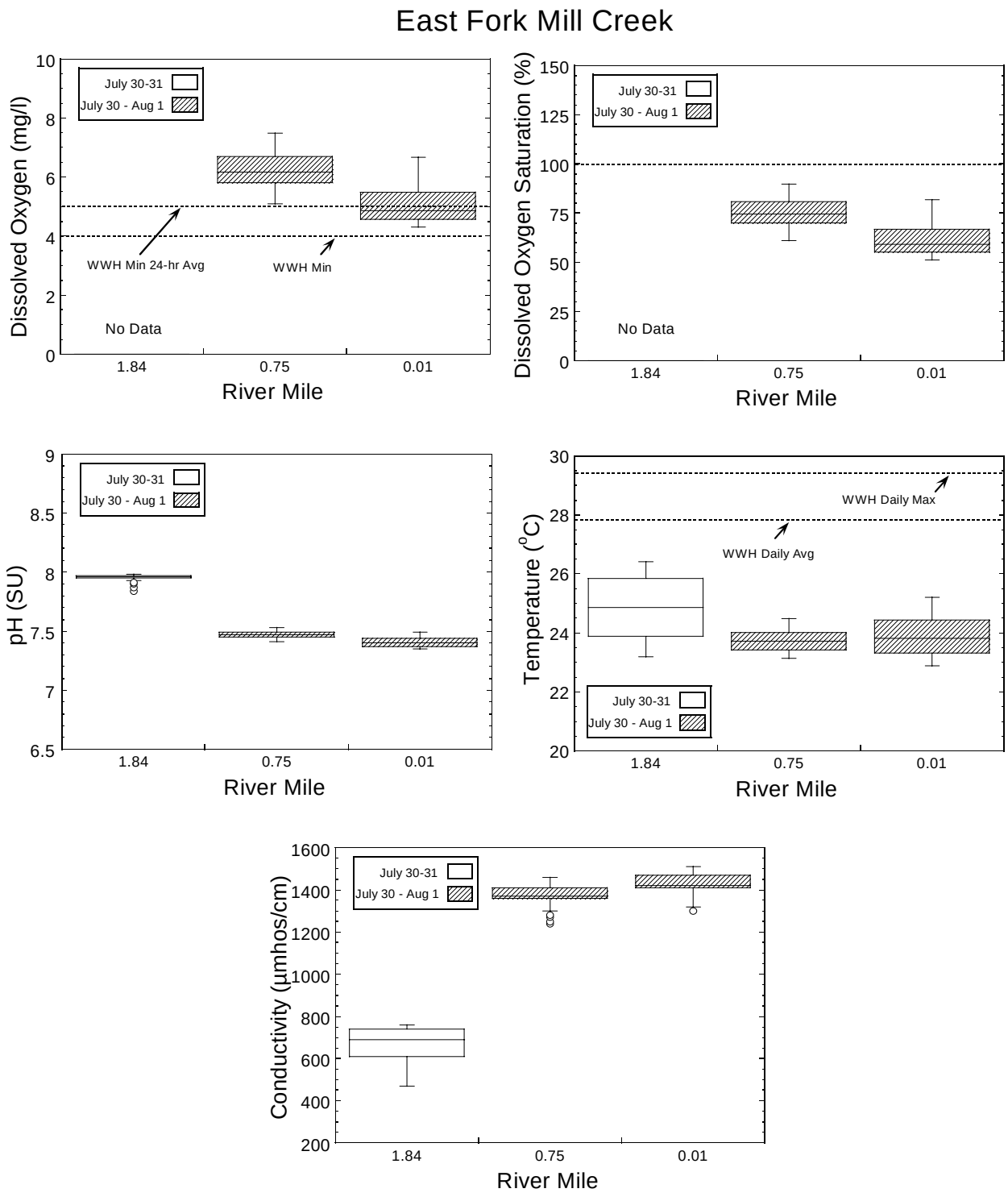

Figure 2 Left to right from the top: Distributions of dissolved oxygen concentration, percent dissolved oxygen saturation, pH, temperature, and conductivity recorded hourly with Datasonde™ continuous monitors in East Fork Mill Creek, 2002.

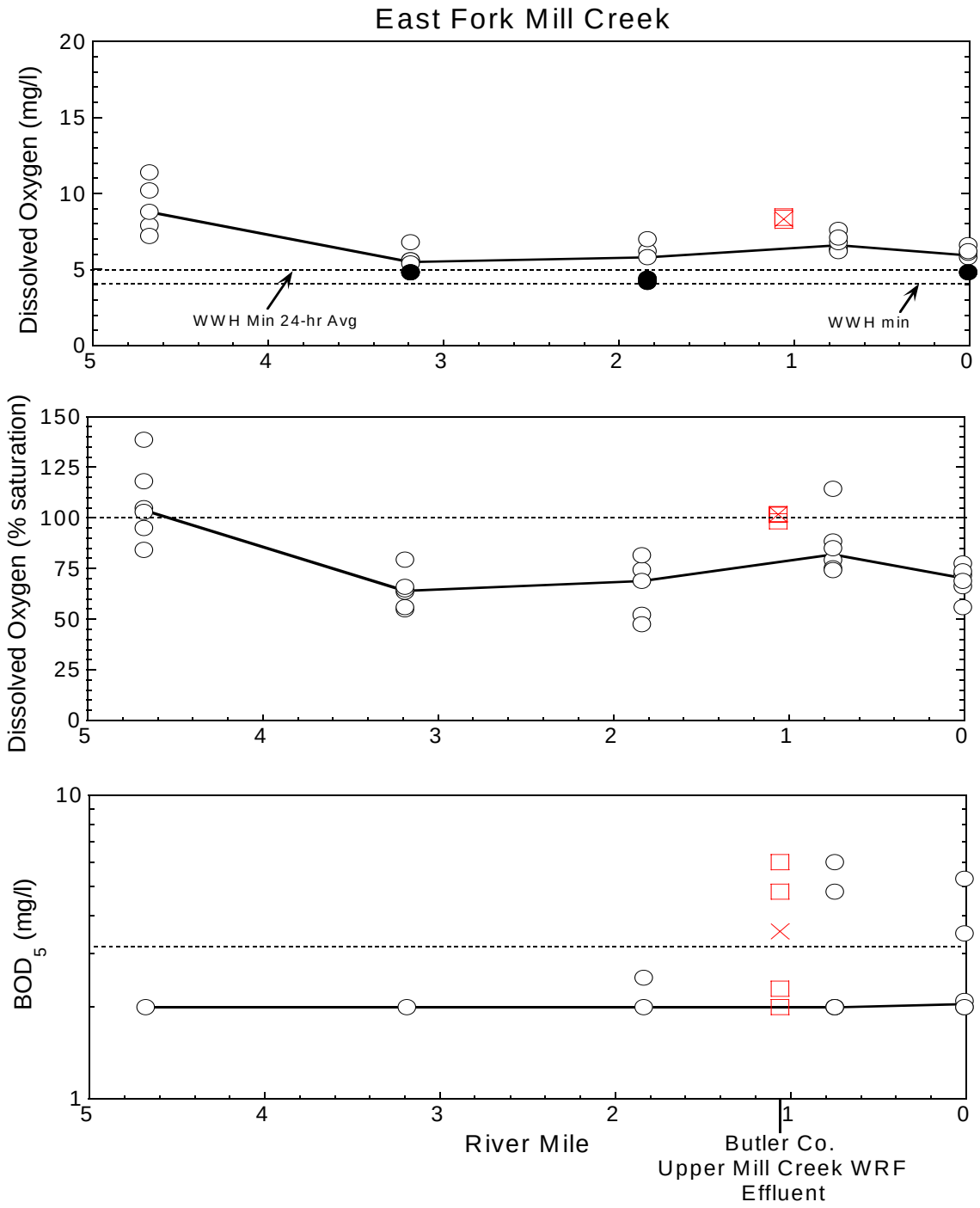

Figure 3. Longitudinal scatter plots of water chemistry results (daytime grabs) for East Fork Mill Creek (circles) and the Upper Mill Creek Water Reclamation Facility (WRF) effluent (squares) during the 2002 survey. Top to bottom: dissolved oxygen concentrations, dissolved oxygen percent saturations, and biochemical oxygen demand (BOD_5). The solid line depicts the median value at each river mile sampled, while an 'X' depicts the median for the WRF effluent. Water quality criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles.) The dotted line in the BOD_5 plot represents the 90th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

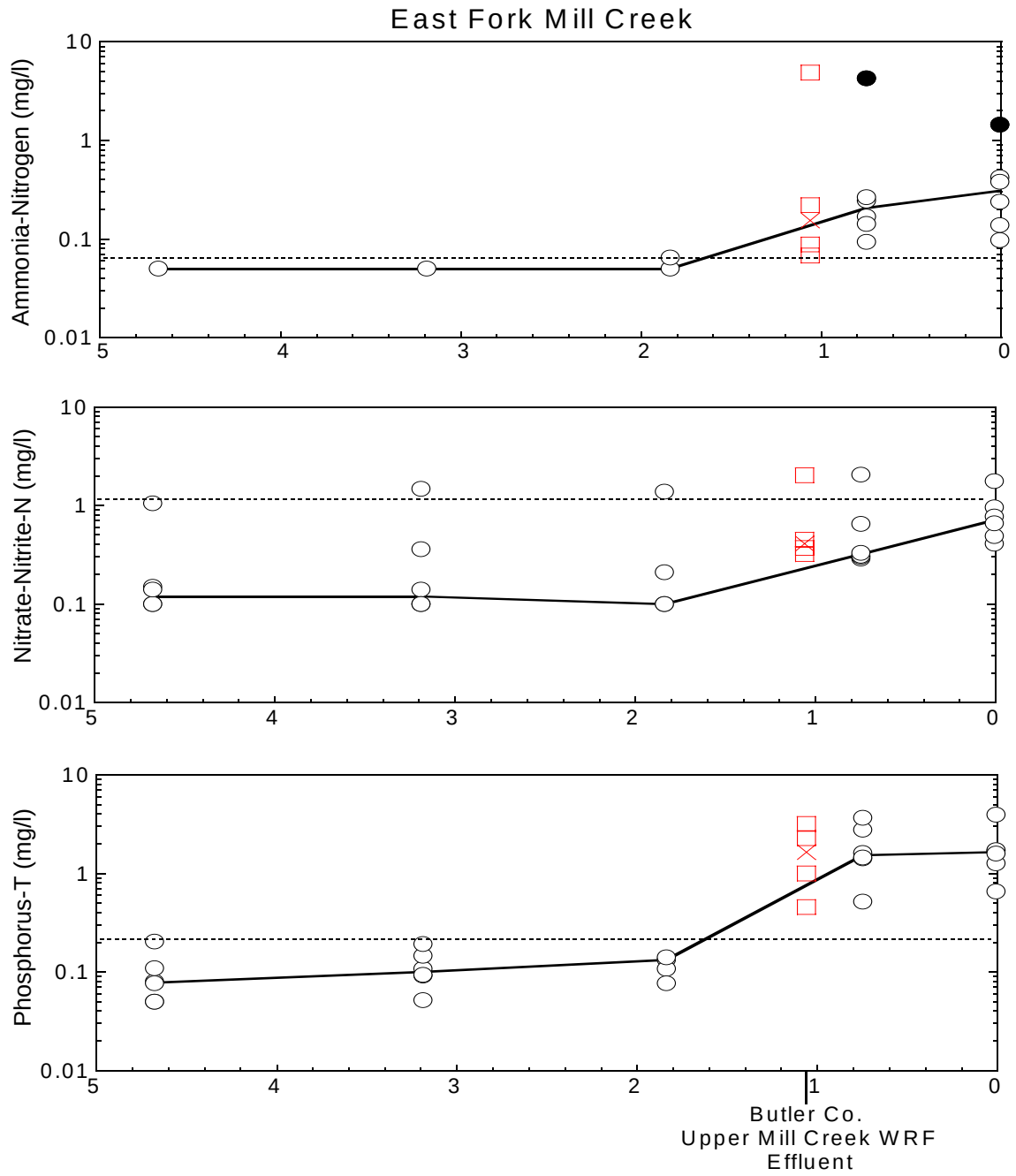

Figure 4. Longitudinal scatter plots of water chemistry results (daytime grabs) in East Fork Mill Creek (circles) and Upper Mill Creek Water Reclamation Facility (WRF) effluent (squares) during the 2002 survey. Top to bottom: ammonia-nitrogen, nitrate-nitrite-nitrogen, and total phosphorus (MDL is 0.05 mg/l for NH_3-N and TP and 0.1 mg/l for NO_3-NO_2-N). The solid line depicts the median value at each river mile sampled, while an 'X' depicts the median for the WRF effluent. Dotted lines in the ammonia-N plot represent the 90th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion, while dotted lines in the nitrate-nitrite-N and total phosphorus plots represent the 75th percentile concentrations. Values exceeding ammonia-N criteria are shown as solid circles.

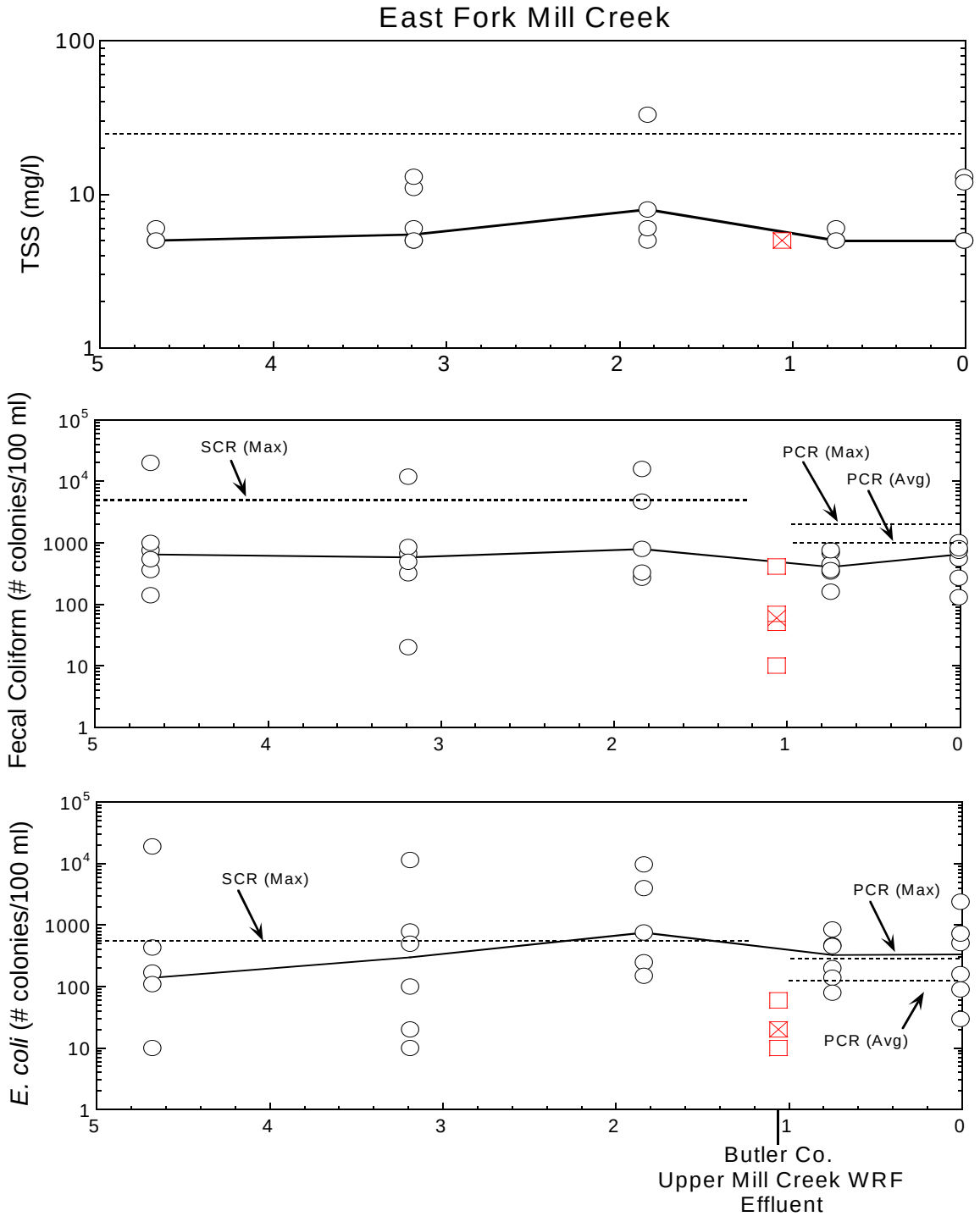

Figure 5 Longitudinal scatter plots of water chemistry results (daytime grabs) in East Fork Mill Creek (circles) and Upper Mill Creek Water Reclamation Facility (WRF) effluent (squares) during the 2002 survey. Top to bottom: total suspended solids (TSS), fecal coliform, and *E. coli*. The solid line depicts the median value at each river mile sampled, while an 'X' depicts the median for the WRF effluent. The dotted line in the TSS plot represents the 75th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

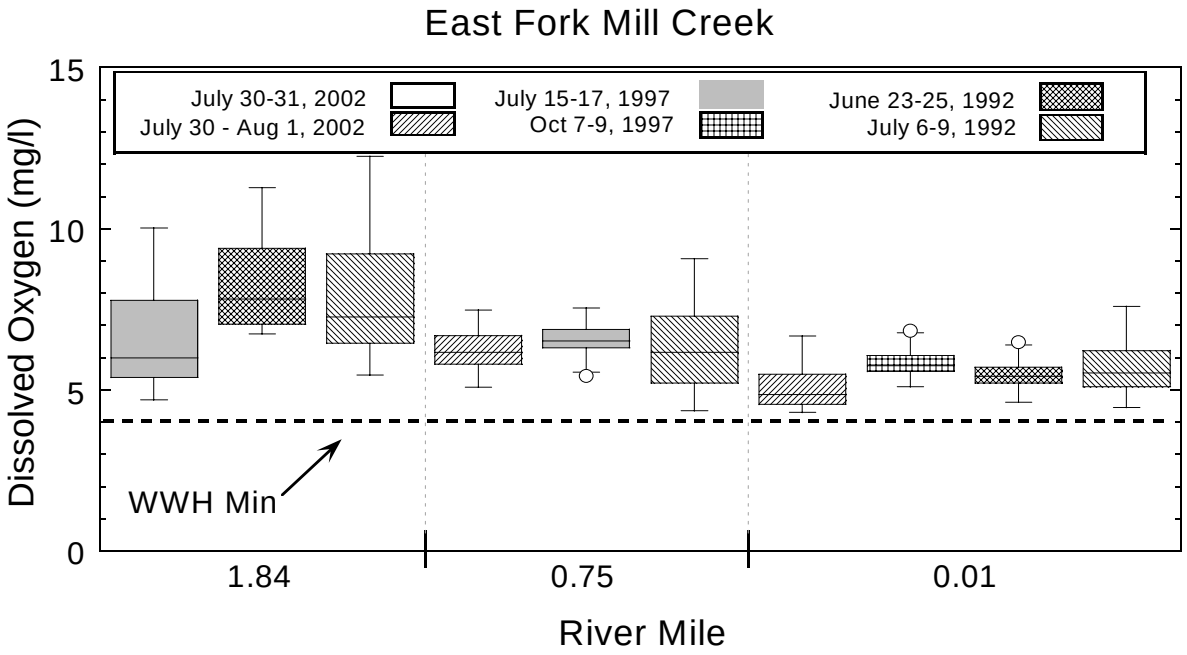

Figure 6. Distribution of dissolved oxygen concentrations recorded hourly with Datasonde™ continuous monitors in East Fork Mill Creek in 2002, 1997 and 1992.

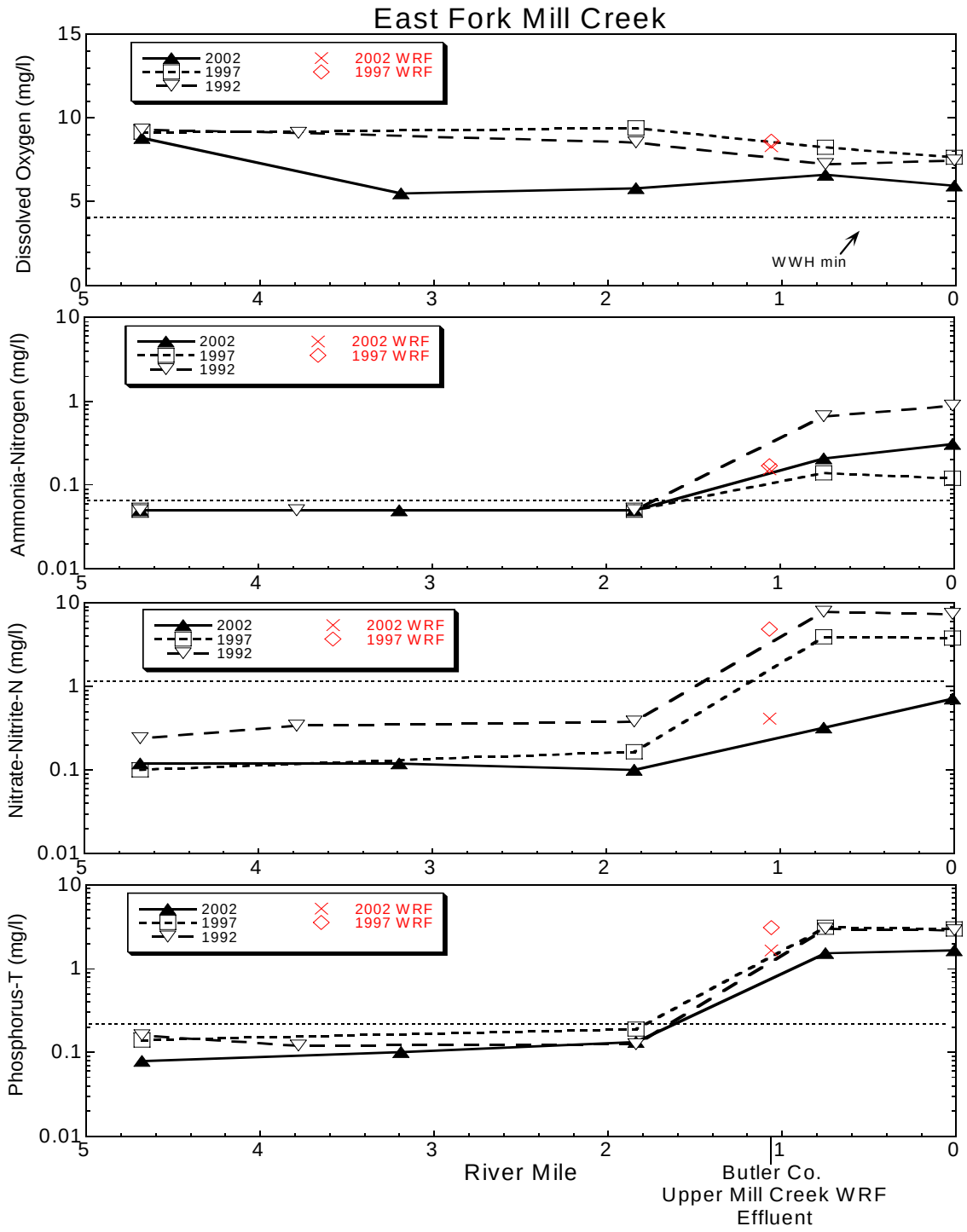

Figure 7. Median concentrations of dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-N, and total phosphorus in East Fork Mill Creek (2002, 1997 and 1992). Water quality minimum criterion is shown in the dissolved oxygen plot. The dashed horizontal line in the ammonia-N plot represents the 90th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion. Dashed horizontal lines in other plots represent the 75th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

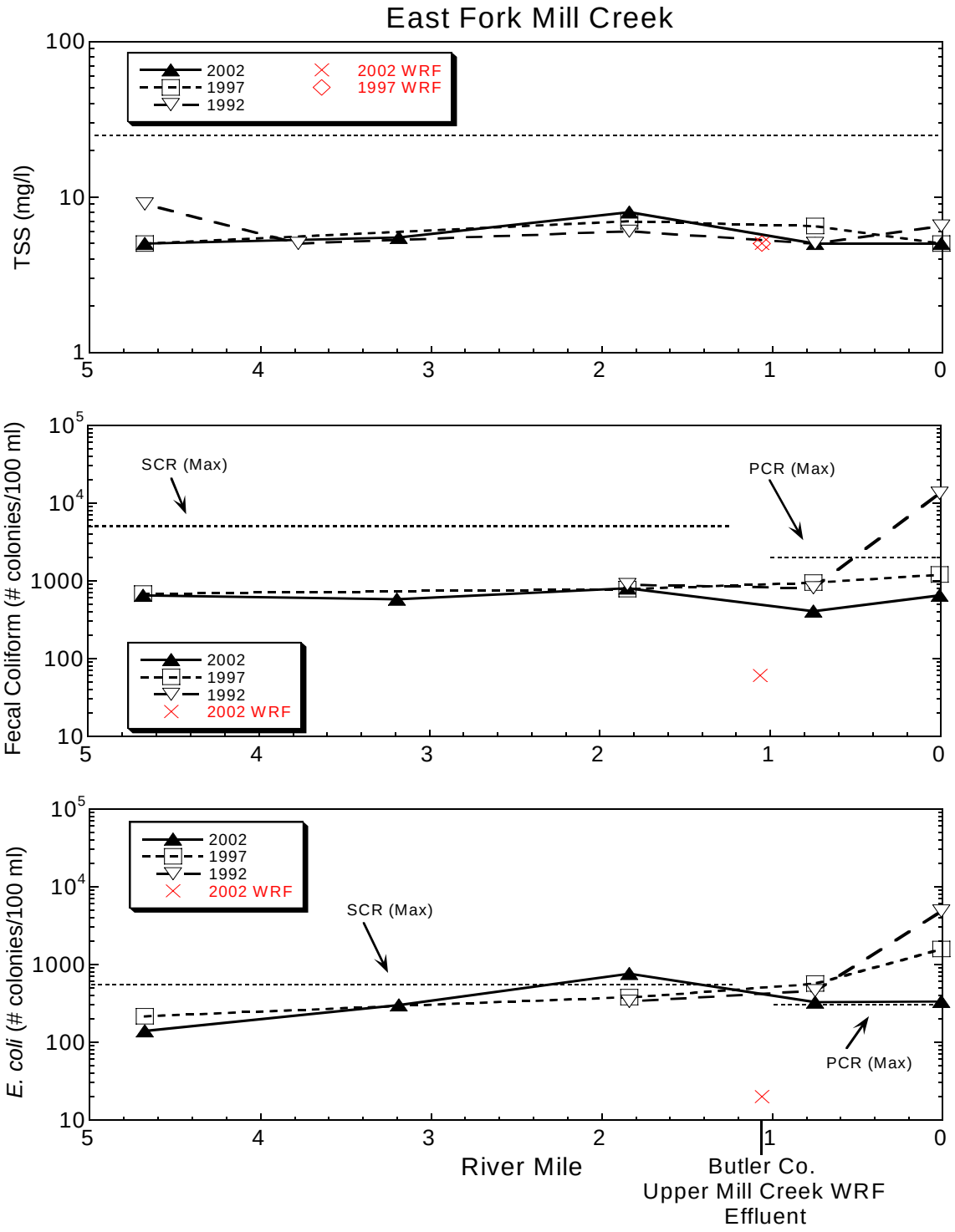

Figure 8 Median concentrations of total suspended solids (TSS), fecal coliform and *E. coli* in East Fork Mill Creek (2002, 1997 and 1992). The dashed horizontal line in the TSS plot represents the 75th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

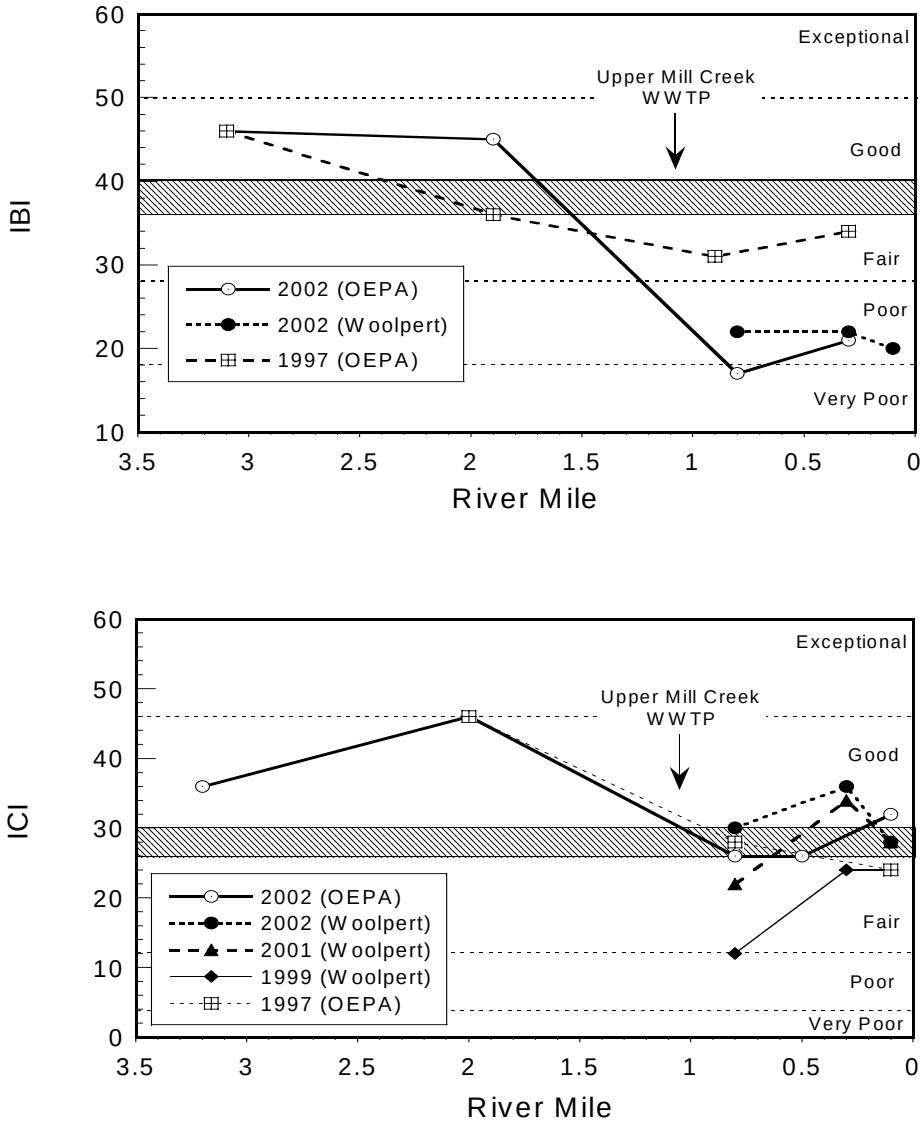

Figure 9 Historical trends in IBI and ICI scores from the East Fork Mill Creek sampled by Ohio EPA (2002, 1997) and Woolpert (2002, 2001, 1999).

Mill Creek

Pollutant Loadings: General Electric Aircraft Engine -Effluent Channel to Mill Creek
(Figure 10)
Lat:39^{0}14'16";Long:84^{0}26'34"
Permit#:1IN00006

General Electric Aircraft Engine (GEAE) is located at 1 Neumann Way in Evendale, Ohio and employs approximately 16,500 people. The GEAE Plant manufactures aircraft engines, turbine generators and rocket cases using metal alloys, fuel and nonmetallic composite materials. The daily production rate is approximately 1100 engines/turbines per year, creating a waste volume of approximately 5 million gallons per day (MGD). The production wastestream discharges to an effluent channel conveyance, subsequently discharging to Mill Creek through two outfalls, 001 and 002. Outfall 001 is located in the channel of the ditch that collects eight internal sources from the GEAE buildings. Outfall 001 consists of stormwater, contact and noncontact cooling water. Outfall 002 is located at the southeast corner of the GEAE property and consists of stormwater and noncontact cooling water.

In 1992, an Ohio EPA intensive stream survey found extremely elevated levels of PCB 1260 in the sediment just downstream from GEAE's discharge. In 1993, Ohio EPA issued Director's Orders requiring elimination of discharges of PCBs from GEAE in any detectable amounts to Waters of the State. In 1994, due to the presence of PCBs in the unnamed tributary to Mill Creek, GEAE undertook a Drainage Ditch Remediation Project as a directive from the USEPA. The project included the removal of impacted sediments and soils and the installation of a concrete ditch lining. Water produced during the decontamination of construction equipment and incidental water requiring treatment was treated as a batch system and required a temporary NPDES permit for discharge. GEAE reports that current use of PCBs does not occur on site.

GEAE was in the early stages of a PCB cleanup at Evendale under Federal orders at the time the NPDES permit and the Director's Orders were issued. The unnamed tributary was redirected to a a new channel and GEAE's outfalls were eliminated from the tributary. This enabled cleanup of the contaminated ditch that discharged to Mill Creek. A new discharge point was constructed, allowing GE to discharge to Mill Creek, as opposed to a conveyance pathway such as the original discharge to the unnamed tributary. The new effluent channel became operational in August, 1994.

In 1995, remediation continued and low levels of PCBs continued to be detected from the eight internal sources that collectively discharged to the new ditch. Negotiations continued between Ohio EPA's Division of Surface Water and GEAE on how to further mitigate the remaining PCB contamination.

In 1996, GEAE experienced a 1,000-gallon spill of acids and nickel that discharged to the GE Effluent Channel of Mill Creek from a ruptured tanker. Another incident within the same year involved the accidental release of a milky white substance thought to be a water based

coolant. The circumstance that allowed the release was human error, involving a valve that released coolant in the Fan Room to a floor drain.

In 2000, the Metropolitan Sewer District (MSD) reported to GEAE that a light blue color was visible in Mill Creek downstream from GEAE's new effluent channel. Investigation led back to GEAE's property and specifically to the Large Casings building. Although no direct link was correlated to the building's floor drains, it was suspected that a leaking sump well was the source of the material.

Surface Water Quality: Mill Creek (Figures 11-15, Appendix Tables 4-11)
(Many of the graphs included with the following summaries show dotted lines representing the 90th, 75th, or 50th percentile concentrations from least impacted regional reference sites of similar size [Ohio EPA 1999]). Statistical data were segregated by ecoregion and further stratified by ranges of stream size for these analyses as follows: headwater streams (0-20 sq. mi.) and wadeable streams (> 20-200 sq. mi.) .]

Stream flows from May through September 2002 (Figure 11) as measured by the USGS gage station in Mill Creek at Carthage (RM 10.5) remained above the 80% duration exceedence flow (USGS 2000 and 2002). (The 80% duration exceedence flow represents the discharge which was equaled or exceeded 80% of the time over the period of record (1952-1997) while the 7 Q_{10} represents the lowest mean discharge for seven consecutive days over 10 years during the period of record.) On specific water chemistry sampling days during the 2002 survey, the gage recorded a mean daily high of 96 cfs on August 20 and a mean daily low on September 4 of 20 cfs.

The relatively high summer flows encountered in Mill Creek during an extended drought points to the effluent dominated nature of the stream (Draft Mill Creek TMDL). For example, Whiteoak Creek at Georgetown, Ohio is another Interior Plateau stream located just to the east of Mill Creek in rural Brown County. The creek drains nearly twice the surface area of Mill Creek at Carthage (218 vs. 115 sq. mi.), but median flow at Georgetown was about one-sixth the flow at Carthage during the same May-September 2002 period (7.3 vs. 42 cfs, respectively).

Datasonde™ continuous monitors recorded hourly dissolved oxygen (D.O.) concentration, D.O. percent saturation, temperature, pH and conductivity from July 30-August 1 at six sites (RMs 17.96-8.7) in the Mill Creek mainstem in 2002 (Figure 12, Appendix Tables 5-9). Dissolved oxygen concentrations and saturations increased longitudinally (upstream to downstream) in the mainstem, with the lowest values measured at RM 17.96, upstream from the East Fork Mill Creek confluence. Median D.O. percent saturations increased from 54% at RM 17.96 to 82% at RM 8.7 (Seymour Road). Twenty-seven percent (27%) of recorded concentrations at RM 17.96 were below the WWH minimum criterion of 4.0 mg/l. Lower flows at this upstream site contributed to the depressed oxygen levels. Median temperatures ranged from 24.6 ˚C at RM 17.61 (Kemper Road) to 26.5 ˚C at both RM 17.96 and RM 8.7. Water temperatures were above the WWH average criterion (27.8˚C) in 27% of the samples at RM 17.96. This upstream site also experienced greater variation in diurnal pH than any other site in the survey, with values ranging from 7.44 SU to 8.18

SU. While conductivity remained low at RM 17.96 (median 530 µmhos/cm), concentrations peaked downstream from the East Fork Mill Creek at RM 17.61 (median 1210 µmhos/cm). Values gradually decreased longitudinally to a median concentration of 770 µmhos/cm at RM 8.7.

Water chemistry grab samples were collected every other week (six times) at eight sites in the Mill Creek mainstem and analyzed for a variety of parameters (Figures 13-15). As flows diminished throughout the summer, numerous dissolved oxygen concentrations fell below water quality criteria in the upper reaches of Mill Creek (RMs 26.35 - 18.69). Median dissolved oxygen percent saturations ranged from 47% at RM 26.35 to 87% at RM 13.35.

Five-day biochemical oxygen demand (BOD_5) concentrations in the Mill Creek mainstem remained low, with 96 % of values less than or equal to the 90^{th} percentile concentrations for reference sites of similar size in the Interior Plateau (IP) ecoregion. Median values increased slightly at RM 17.61, downstream from the East Fork Mill Creek confluence (RM 17.95).

Ammonia-N concentrations, low in the upper reaches of Mill Creek, increased significantly at RM 17.61 (median 0.31 mg/l) downstream from the confluence of the East Fork Mill Creek and peaked downstream from Town Run at RM 16.57 (median 0.49 mg/l). Phosphorus concentrations, also low in the upper reaches, spiked at RM 17.61 (median 1.0 mg/l) and remained elevated downstream to RM 13.35 (median 0.34 mg/l). Levels of nitrate-nitrite-N were low throughout the mainstem, with an overall median of 0.74 mg/l calculated for all concentrations. Median concentrations increased downstream from the East Fork Mill Creek confluence, with the highest values occurring at RM 13.35 (median 1.65 mg/l).

Median total suspended solids (TSS) concentrations ranged from 5.5 mg/l at RM 18.69 to 17 mg/l at RM 16.57, downstream from Town Run. (Values recorded in Town Run during the survey, however, were not elevated.) While most elevated values occurred on higher flow days, the highest concentration of the survey (90 mg/l) was recorded at RM 14.75 on September 18, a lower flow day. (Field notes indicate that the Glendale Water Treatment Plant discharge [RM 16.5] was turbid this day.)

Bacteria (fecal coliform and *E. coli*) were generally elevated throughout the mainstem, with respective overall medians of 990 and 720 colonies/100ml. Concentrations increased at RM 17.61, downstream from the East Fork Mill Creek confluence, and again at RM 16.57, downstream from Town Run. The highest values occurred at RM 8.9 (respective median fecal coliform and *E. coli* concentrations of 2150 and 2650 colonies/100).

Exceeding water quality criterion, the highest copper concentration of the survey (72 µg/l) was recorded at RM 13.35 (West Columbia Road) on September 4. All other copper concentrations recorded at the site during the survey were less than the minimum detection limit (MDL) of 10 µg/l and no other parameters were especially elevated at the site on that day. (Copper also exceeded criteria in the headwaters at RMs 26.35 and 20.98 on August 7. However, results were qualified due to quality control issues.)

While well within water quality criteria, zinc concentrations significantly increased downstream from the East Fork Mill Creek. Values recorded at upstream sites (RMs 26.35-18.69) ranged from less than the detection limit of 10 µg/l to 19 µg/l. Concentrations peaked downstream from the confluence at RM 17.61 (respective median and maximum values of 48 µg/l and 63 µg/l) and remained relatively elevated further downstream. Chloride, sodium, sulfate, and conductivity levels also increased downstream the East Fork Mill Creek confluence.

Seven of the eight water chemistry sites in the Mill Creek mainstem were sampled for organic compounds (volatiles, semivolatiles, pesticides, and polychlorinated biphenyls [PCBs]) twice during the 2002 survey (Appendix Tables 10-11). Four of the seven organic compounds (and 15 of the 26 detections) found in the mainstem were pesticides. The most frequently detected pesticide was gamma-hexachlorocyclohexane (Lindane). Dieldrin exceeded water qualtiy criteria at West Columbia Road (RM 13.35). Low levels of chloroform, a volatile organic compound (VOC), were detected at all five sites sampled downstream from the East Fork Mill Creek confluence. PCBs were not detected in the water column at any site in the Mill Creek watershed (mainstem or tributary) during the 2002 survey.

Surface Water Quality Changes: Mill Creek (Figures 16-19)
Ohio EPA previously conducted intensive biological and water quality studies of the Mill Creek basin in 1997 and 1992. July through September stream flows for 2002, 1997 and 1992, as measured by the USGS gage station in the Mill Creek at Carthage (RM 10.5), are compared in Figure 16. Daily flows were generally higher in 1992 compared to both 2002 and 1997. Median flows of 36 cfs (1992) and 28 cfs (1997 and 2002) were measured for the 3-month period (July through September). On specific water chemistry sampling days, the lowest flows occurred in 2002, with respective median and maximum flows of 26.5 cfs and 96 cfs (2002), 35.5 cfs and 300 cfs (1997), and 34 cfs and 1700 cfs (1992).

A comparison of 2002, 1997, and 1992 median water chemistry results for select parameters in the mainstem is presented in Figures 17-19. Water samples were collected from eight sites in the mainstem in 2002, seven sites in 1997, and 15 sites in 1992. There were five sites common to all surveys (RMs 26.35, 17.61, 16.57, 14.75, and 13.35), two sites common to the 2002 and 1997 surveys only (RMs 20.98 and 18.69), and one site (RM 8.9) common to the 2002 and 1992 surveys only.

Reflecting the diminishing flows, dissolved oxygen median concentrations (daytime grabs) were lower in 2002 compared to other survey years, most notably in the upper reaches. While numerous 2002 D.O. daytime grab concentrations in the headwaters fell below applicable water quality criteria, all 1992 and 1997 concentrations at common sites remained above criteria. With the exception of concentrations measured in October of 1997 during seasonally low flows, Datasonde™ continuous monitors also generally documented lower dissolved oxygen concentrations in 2002 compared to previous years.

Concentrations of ammonia-N recorded in the mainstem in all three survey years increased downstream from the confluence of the East Fork Mill Creek (RM 17.95) and remained

elevated downstream from the Town Run confluence (RM 16.93). Respective 2002, 1997, and 1992 survey median ammonia-N concentrations of 0.31 mg/l, 0.1 mg/l, and 0.46 mg/l were measured at RM 17.61 (Kemper Road). Ammonia-N medians of 0.49 mg/l (2002), 0.31 mg/l (1997), and 0.34 mg/l (1992) were recorded at RM 16.57, downstream from Town Run.

Phosphorus levels, low in the upper reaches, also increased downstream from the East Fork Mill Creek in all three survey years, with median concentrations at RM 17.61 ranging from 1.00 mg/l (2002) to 1.99 mg/l (1997). Concentrations remained significantly elevated at downstream sites, with medians well above the 90th percentile reference site benchmark concentration of 0.2 mg/l.

While nitrate-nitrite-N concentrations also increased at RM 17.61 in all survey years and remained at higher levels downstream, concentrations were generally higher in 1992 compared to more recent surveys, reflecting greater precipitation, higher stream flows, and the additional impact of nonpoint source runoff. Respective overall median and maximum values for the five mainstem sites common to all surveys were 2.81 mg/l and 10 mg/l (1992), 1.95 mg/l and 6.57 mg/l (1997), and 0.84 mg/l and 1.78 mg/l (2002).

An overall median of 12.5 mg/l was measured for all TSS concentrations recorded at the five common sites in the mainstem during the 2002 survey, compared to 10 mg/l for the 1997 survey and 13.5 mg/l in 1992. Elevated individual concentrations typically coincided with higher flow days. TSS concentrations increased at the Sharon Road site (RM 16.57) downstream from Town Run in all surveys. Of the five common mainstem sites, this site consistently recorded the highest TSS levels with respective 2002, 1997, and 1992 medians of 17 mg/l, 25.5 mg/l, and 21.5 mg/l. Given that Town Run TSS concentrations were not elevated (at least as far downstream as Chester Rd at RM 0.7), another TSS source may exist between RM 17.61 and RM 16.57.

Reflecting lower flows and less precipitation, fecal coliform and *E. coli* concentrations were generally lower during the 2002 survey when compared to previous years. Of the total 48 fecal coliform samples collected in 1992 from the four common mainstem sites (RM 16.57 was not sampled for bacteria in 1992), 63% of the samples were elevated above the maximum primary contact recreation (PCR) criterion for fecal coliform of 2000 colonies/100 ml. In 1997, 58% (7 of 12) of the samples at these same four sites exceeded the fecal coliform maximum PCR criterion, compared to 33% (8 of 24 samples) during the 2002 survey. *E. coli* concentrations at the four common sites in 1992 were above the maximum PCR criterion of 298 colonies/100 ml in 77% of samples (36 of 47), compared to 83% in1997 (10 of 12) and 67% (16 of 24) in 2002.

Sediment Quality, **(Metals and Nutrients): Mill Creek** (Appendix Table 12)
Sediment metals generally improved in the mainstem and East Fork Mill Creek from 1997 to 2002. Sediment mercury concentrations were over the Ohio SRV guidelines (above background for this area) in three of six common sites in 1997 and were below the Ohio SRV's at all sites in 2002. Average sediment phosphorus for five sites on Mill Creek in 2002 was 1933 mg/kg. The 2002 survey documented phosphorus over the Ontario Severe

Effect Level (SEL) (2000 mg/kg) at the mouth of East Fork Mill Creek and at three sites downstream of the mouth on the mainstem. Phosphorus concentrations in sediment over the SEL are expected to cause disturbances in the benthic community. The Kelley and Hite report (1984) documents an association of sediment phosphorus levels greater than 2000 mg/kg to WWTP point discharges or nonpoint urban sources. Only the Little Miami River, another effluent-dominated river, had higher average sediment phosphorus levels (2056.5 mg/kg). The Stillwater River and Sevenmile Creek, both agricultural watersheds, had sediment Phosphorus levels of 696.5 mg/kg and 745 mg/kg.

In the 1997 survey, the Sharon Road site (RM 16.6) documented the most sediment metal contamination of any sites in the survey. Arsenic, Cadmium, and Manganese were over the Ohio SRV guidelines and soil pH was a very alkaline 10.8. Phosphorus was not analyzed in 1997. In 2002, all other metal results were below the Ohio SRV guideline, being below background levels for this ecoregion. The 2002 survey documented phosphorus (2,250 mg/kg) over the Ontario SEL.

In 1997, (at the Formica Entrance site [RM 14.8]), Ohio EPA documented Mercury at 3.81 mg/kg, over the MacDonald Probable Effect Concentration (PEC) and the Ohio SRV guidelines. Adverse effects in benthic organisms nearly always occur at these concentrations. The 2002 sediment sampling results documented a reduction in Mercury to 0.053 mg/kg below the Ohio SRV guidelines and below the MacDonald Threshold Effect Concentration at this location. Both years had phosphorus sediment levels in excess of the Ontario SEL.

West Columbia Road (RM 13.2) documented sediment levels over the Ohio SRV for zinc (104 mg/kg) and mercury (0.133 mg/kg) in 1997. Both metals were reduced to below the Ohio SRV in 2002. Phosphorus sediment levels were above the Ontario SEL for both years.

North Bend (RM 8.9) was not sampled in 1997, but was used as a duplicate site in 2002. This site was very sandy and only 3.4% and 4.5% fine grained materials were collected in both samples. Wide discrepancies in results were documented in cadmium (1.64 mg/kg and 0.14 mg/kg). Cadmium, at 1.64 mg/kg, is over the Ohio SRV. All other metals were below the Ohio SRV and phosphorus was below the Ontario SEL.

Only one site, Crescentville Road (RM 18.7), did not document any exceedences of any of the sediment metal or nutrient guidelines in either year.

Sediment Quality (Organics): Mill Creek (Appendix Tables 13)
Polynuclear Aromatic Hydrocarbons (PAHs) were found at six of eight sites in the survey. There were ten different PAHs identified throughout the survey. All were part of the 16 priority pollutants PAHs identified by USEPA. Six of the ten PAHs were evaluated by the MacDonald Sediment Quality Guidelines. Individual and additive toxicity of PAH sediment compounds was evaluated using the MacDonald Sediment Quality Guidelines. If total PAH sediment concentrations exceeded 22.4 mg/kg, the mixture was considered over the Probable Effect Concentration (adverse effects nearly always occur). If any one PAH

compound was over the MacDonald PEC the entire mixture is considered over the PEC even if the total amount of PAHs was below 22.4 mg/kg.

Polynuclear Aromatic Hydrocarbons are classified as ”pyrogenic” or “petrogenic”. Pyrogenic PAH compounds are generated from combustion or pyrolysis of organic matter (wood, coal, petroleum or wastes). Petrogenic PAHs are generated from organic matter subjected to temperature and pressure over geologic time (Van Metre, 2003).

The fingerprint of PAH compounds found in the Mill Creek sediments would be classified as Pyrogenic. Possible sources of PAHs are from urban runoff/fallout from diverse organic mixtures of soot, atmospheric dust, internal combustion exhaust and storm water containing residual lubricating oils (Stout, 2001).

Used motor oil is a mixture of Pyrogenic and Petrogenic PAHs. The fingerprint of “fresh” used motor oil will have a wide range of PAHs, from the lighter naphthalene to heavier Benz(b)Fluoranthene, in addition to alkyl PAHs. As the motor oil ages, it will tend to concentrate the less degradable heavier pyrogenic PAH compounds.

Sediment organics generally improved in the mainstem and East Fork Mill Creek from 1997 to 2002. One site, Mill Creek at Crescentville Road (RM 18.7), did not detect any sediment organic compounds in either year.

PAHs were detected at every site on the mainstem starting at Sharon Road (RM16.6) and moving downstream. Mill Creek at the Formica (14.8) entrance was the only site on the mainstem having an increase in total PAH in 2002 (7.64 mg/kg) compared to 1997 (4.1 mg/kg).

Mill Creek at Sharon Road (RM 16.6) had the pesticides Endosulfan Sulfate (9.9 µg/kg) and Methoxychlor (7.8 µg/kg) present in sediment in 1997. No pesticides were detected in 2002. Total PAH levels in sediment dropped slightly from 2.6 mg/kg in1997 to 2.32 mg/kg in 2002. Both years were between the MacDonald PEC and TEC .

West Columbia Road (RM 13.2) was the most contaminated sediment organic site on the survey for both years. Ten of the same PAHs were identified in both survey years. All were part of the 16 priority pollutant PAHs identified by USEPA. In 1997, the West Columbia Road site had four PAHs - Chrysene (1.3 mg/kg), Fluoranthene (3.2 mg/kg), Phenanthrene (1.5mg/kg), Pyrene (2.5 mg/kg) and total PCBs (0.892 mg/kg), over the MacDonald PEC. Total PAHs were 14.3 mg/kg. The 2002 survey detected one compound, Chlordane (18.2 µg/kg), above the MacDonald PEC. Total PAHs were 8.43 mg/kg, between the MacDonald PEC and EEC.

Physical Habitat Quality for Aquatic Life: Mill Creek (Figure 20, Appendix Table 14)
Habitat quality in Mill Creek, despite being historically channelized, was generally of sufficient quality to support warmwater fish and macroinvertebrate communities typical of the ecoregion. This assertion is supported by the results from the Qualitative Habitat Evaluation Index (QHEI). The mean QHEI score for the reach sampled was 61.0 ± 9.5 SD,

n = 6. QHEI scores of 60.0 or better indicate that the habitat is generally capable of supporting fish assemblages typical for the stream size and ecoregion. More telling, however, is the number of negative habitat attributes at a site (Table 14). In Mill Creek, historic channelization caused a relatively high number of negative habitat attributes at all sites but the reference site at RM 26.2. Most of the negative attributes were moderate-influence, and recovery from channelization was evidenced by the fact that high-influence negative attributes were absent at four of six sites, and only one was found at the other two. Two or more high-influence negative attributes typically preclude a WWH fish assemblage (Ohio EPA, 1999). The poorest physical habitat was found at the Rialto Road site, RM 21.0, where it appeared to have also been the most recently channelized, least recovered or both.

Fish Communities: Mill Creek (Figure 20, Appendix Table 15)
Fish communities in Mill Creek were degraded by a combination of poor physical stream habitat, contamination from raw sewage, and poorly treated sewage from both the Upper Mill Creek WRF and the Glendale WWTP. The only site where fish met the ecoregional criterion for WWH was at the reference site at RM 26.2, otherwise all IBI and MIWb scores were in the poor to very poor range (Table 15). The site at Rialto Road (RM 21.0) had the poorest habitat and was impacted by organic enrichment from raw sewage as a heavy sewage odor was present at the site (Figure 20). Organic enrichment is further suspected because although the fish community was in poor condition, being dominated by tolerant fish, relative abundance was high.

IBI scores remained poor until downstream from the Upper Mill Creek WRF and the Glendale WWTP (RM 16.5), where the combination of pollutant loadings pushed the scores down into the very poor range, and the incidence of anomalous deformities, erosions, lesions, and tumors (DELT) increased sharply, particularly tumors. The combination of very poor biotic index scores, few fish in the samples, and high DELTs is a signature of toxicity (Yoder and Rankin 1995).

Macroinvertebrate Communities: Mill Creek (Figure 21, Appendix Table 16)
Mill Creek 2002 sites were similar to 1997 locations, but sampling was restricted to the WWH designated segment in the upper half of the mainstem (headwaters to Center Hill Road [RM 7.9]). An additional site added at RM 8.7 in 2002 was located near the downstream limit of the WWH segment.

Despite increased suburban development pressures in the headwaters of Mill Creek, the most upstream site at RM 24.3 continues to meet WWH expectations. The site supported dense populations of pollution sensitive caddisflies (*Chimarra obscura*), along with mayflies, water pennies, hydropsychid caddisflies and a number of pollution-sensitive midge taxa. The presence of large numbers of flatworms suggested enrichment, but community performance remained good. Previous sampling at RM 24.3 in 1997 and 1992 included similar populations and was evaluated as marginally good.

Artificial substrate samplers from Rialto Road RM 21.0 were buried by sediment and discarded at the extensively channelized site. Population densities on the natural

substrates were quite low and the community was predominated by facultative caddisflies and riffle beetles. Based on qualitative collections, community health declined compared to upstream collections and was considered fair. Habitat modification and the loose, unstable sand substrates were considered the primary causes of impairment. In 1997, the ICI score was in the marginally good range (26), the minimum score that still meets WWH criteria.

Artificial substrates from RM 18.9 were partially buried by sand so the ICI score of 20 (fair) was not used. The reach was historically channelized and substrates were primarily loose sand and silt, but some deposits of unembedded rubble were found in riffles. On the natural substrates, only five EPT taxa were collected and the community included a mixture of both pollution-sensitive and tolerant varieties. When compared to 1997 collections, enrichment-tolerant flatworms appeared more abundant and Qual. EPT taxa declined from seven to five. Community health was considered fair, a decline from the very good quality (based on artificial substrate samplers) found in 1997.

Mill Creek macroinvertebrates between the East Fork Mill Creek and North Bend Road (RMs 17.9-8.9) ranged from good to marginally good. Most collections reflected slight to moderate improvement over the fair to good quality found in 1997 with increases of 2-8 ICI points per site. Station RM 16.5 (downstream from Town Run and the Glendale WWTP) showed the least improvement, while RM 13.3 (Koenig Park) showed the greatest increase. Improvements at most sites were characterized by lower percentages of tolerant taxa and Other Diptera/Non Insects (negative metrics) and greater percentages of caddisfly and Tanytarsini midges (positive metrics). On the natural substrates, pollution-sensitive taxa richness also increased in 2002 within the same reach. The greatest number were found at the furthest downstream sites (RMs 13.3 and 8.9) and included good numbers of the caddisflies *Ceratopsyche morosa* group at RM 13.3 and *Chimarra obscura* at RM 8.9. Station RM 13.3 is located immediately downstream from a major PCB remediation project conducted in the mid 1990s, while station RM 8.9 is located downstream from the West Fork of Mill Creek. Concurrent biological sampling by the Ohio EPA Division of Emergency and Remedial Response (OEPA 2003) found substantial improvement in West Fork macroinvertebrates (from poor to marginally good), compared to an earlier 1992 survey.

Clearly defining the influence of the Upper Mill Creek WRF on 2002 mainstem macroinvertebrates was difficult due to the complexity of point and nonpoint sources affecting the urban drainage. A loss of artificial substrate samplers, coupled with the already marginal condition of populations upstream from the East Fork, were also confounding factors.

Factors that may have contributed to the downstream improving trend included far-field improvements well downstream from the Upper Mill Creek WRF, changes in the MSD sewage collection system, and continued recovery downstream from historic industrial sources (*e.g.,* GE PCB rededication). In addition, the general lack of urban runoff and CSO discharge events during the extended summer drought in 2002 may have also contributed to biological improvement.

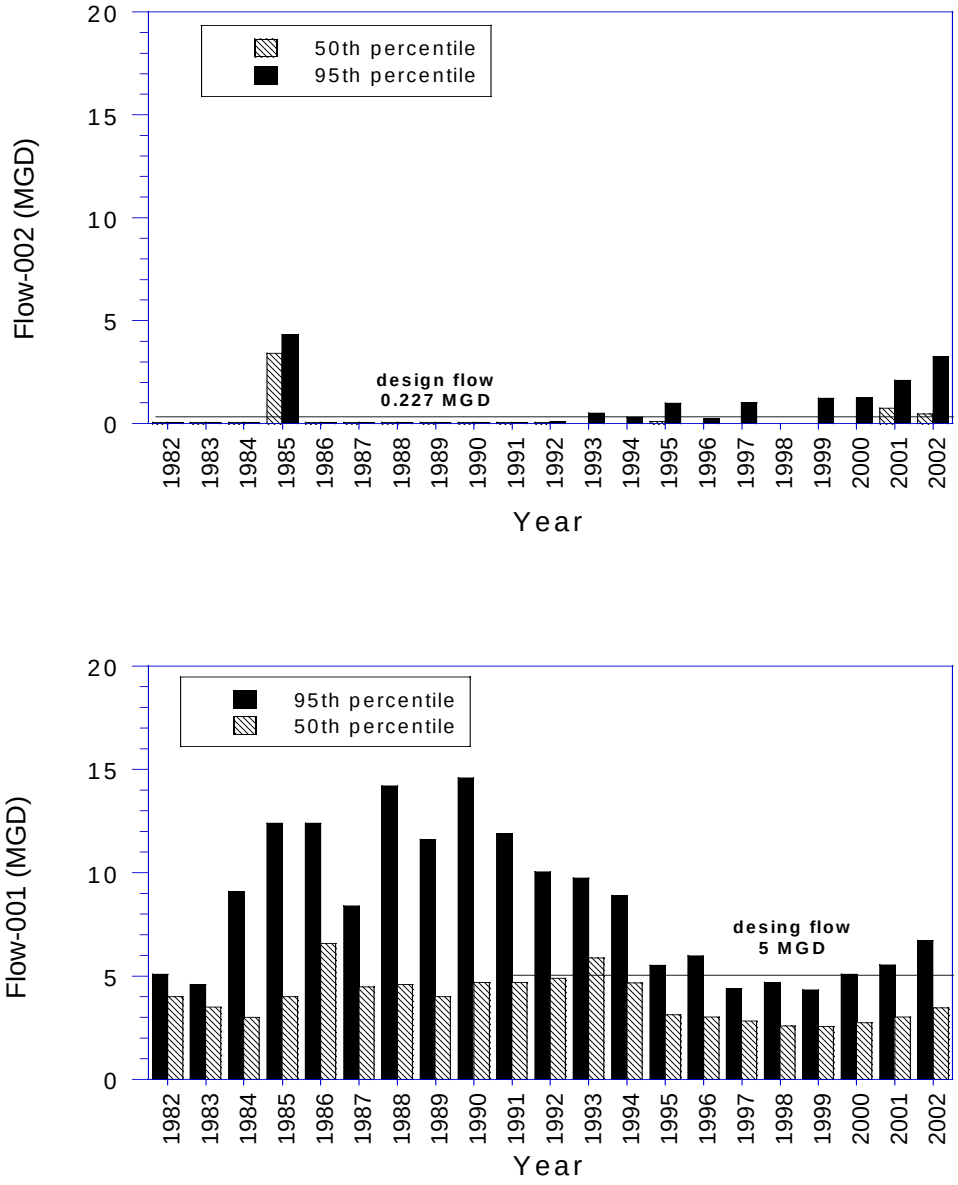

Figure 10 Annual trends in flow (mgd) from the General Electric Aircraft Plant 001 and 002 discharges to Mill Creek, 1982-2002.

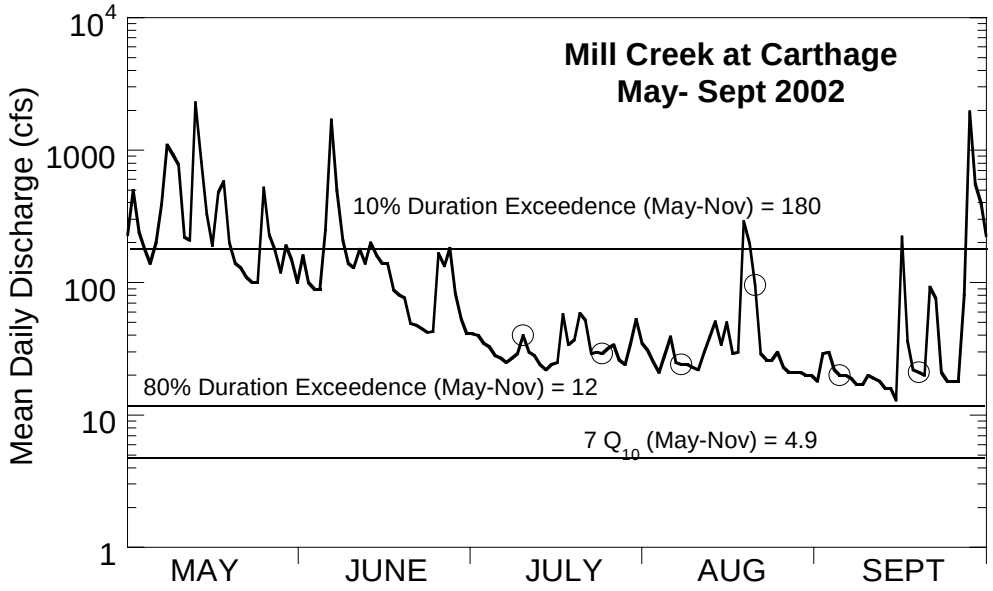

Figure 11. May through September, 2002 flow hydrograph for Mill Creek at Carthage (RM 10.5). Low flow conditions ($7Q_{10}$), 10% and 80% duration exceedence flows are based on USGS station #03259000 (period of record 1952-1997). Open circles indicate river discharge on water chemistry sampling days in the Mill Creek basin.

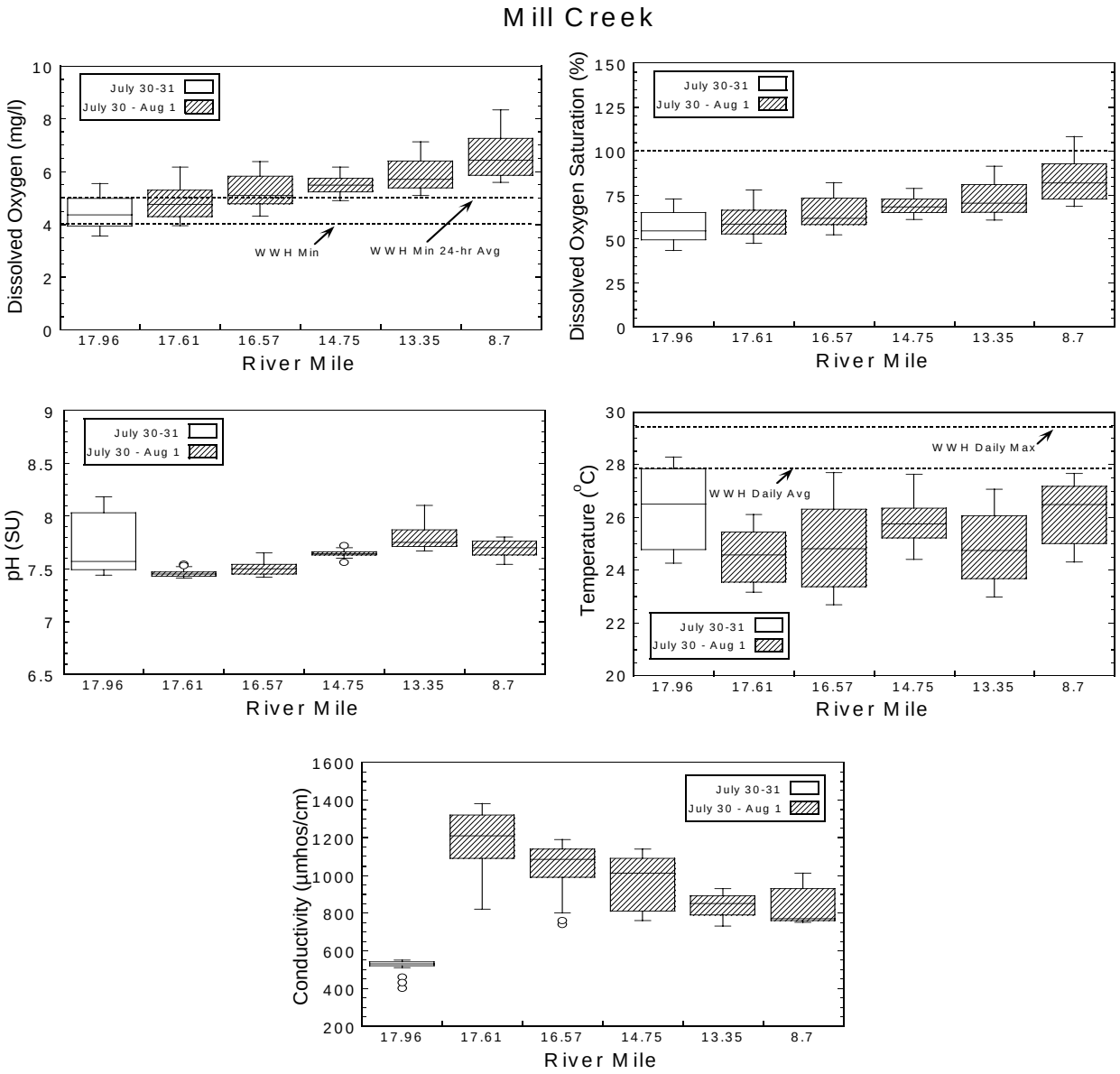

Figure 12 Left to right from the top: Distributions of dissolved oxygen concentration, percent dissolved oxygen saturation, pH, temperature, and conductivity recorded hourly with Datasonde™ continuous monitors in Mill Creek, 2002.

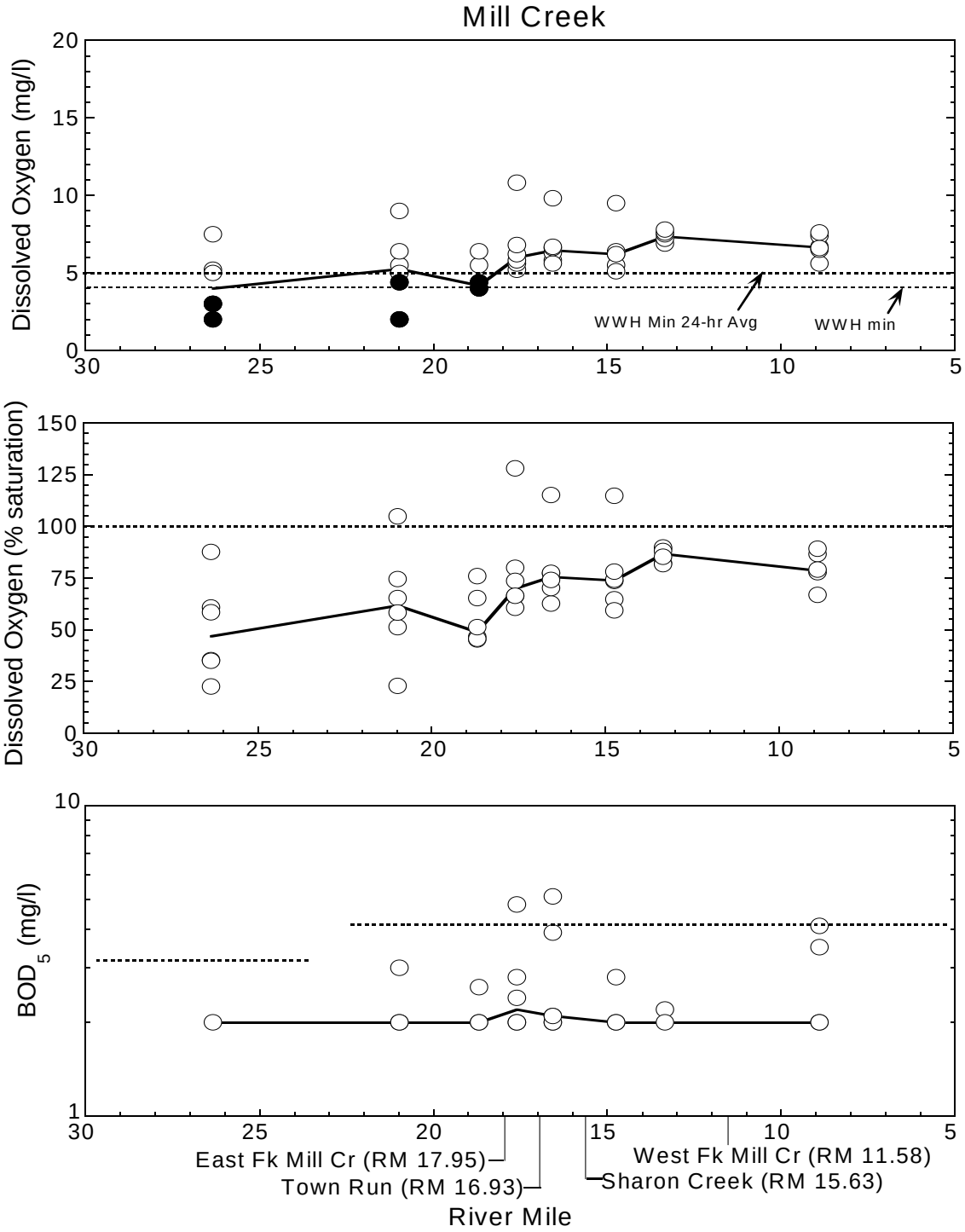

Figure 13. Longitudinal scatter plots of water chemistry results (daytime grabs) in Mill Creek during the 2002 survey. Top to bottom: dissolved oxygen concentrations, dissolved oxygen percent saturations, and biochemical oxygen demand (BOD_5). The solid line depicts the median value at each river mile sampled. Water quality criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles.) The dotted lines in the BOD_5 plot represent the 90th percentile concentrations from reference sites of similar size in the Interior Plateau (IP) ecoregion.

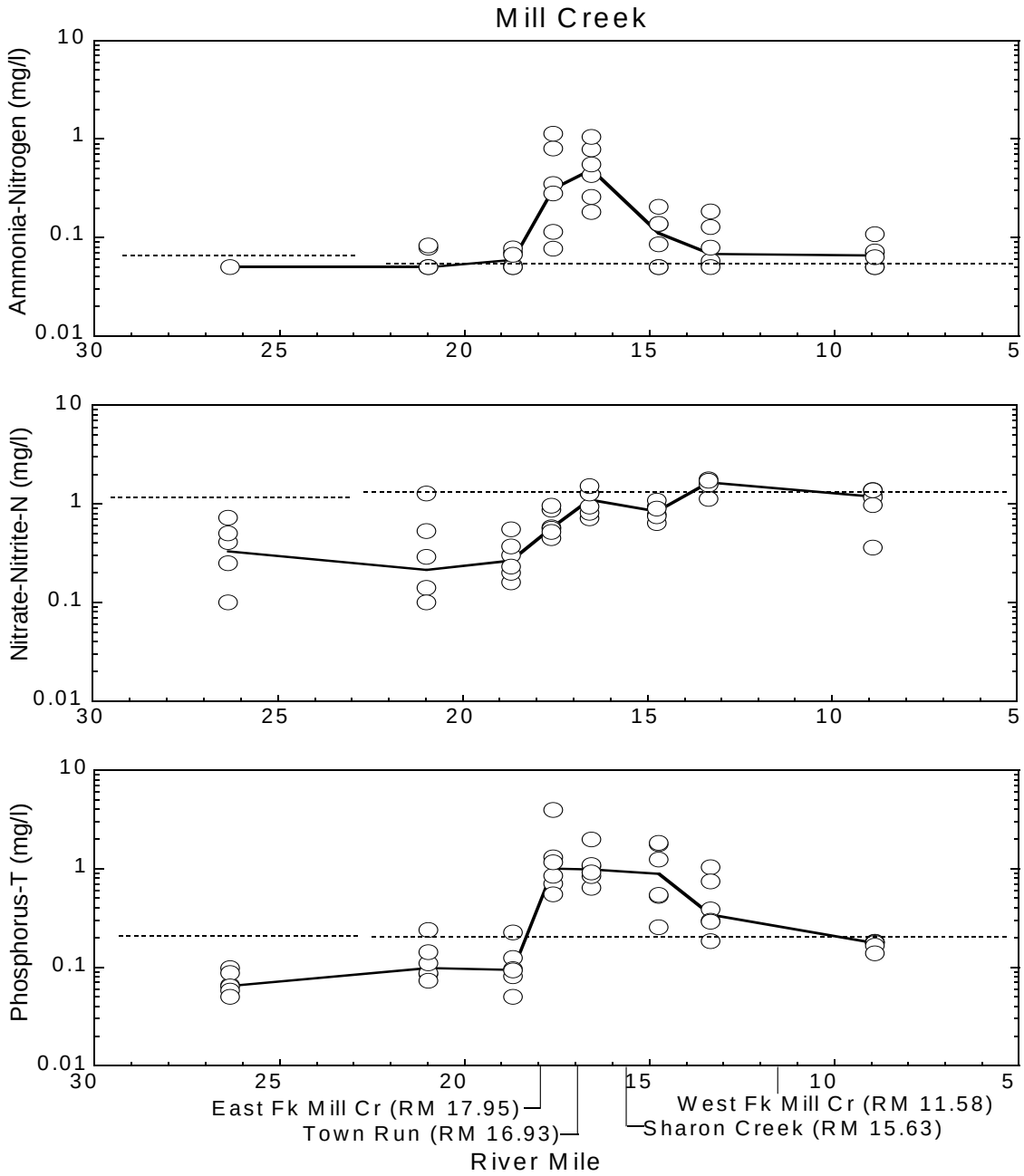

Figure 14. Longitudinal scatter plots of water chemistry results (daytime grabs) in Mill Creek during the 2002 survey. Top to bottom: ammonia-nitrogen, nitrate-nitrite-nitrogen, and total phosphorus (MDL is 0.05 mg/l for NH_3-N and TP and 0.1 mg/l for NO_3-NO_2-N). The solid line depicts the median value at each river mile sampled. The dotted lines represent the 90th percentile con-centration from reference sites of similar size in the Interior Plateau (IP) ecoregion. (Dotted lines in the nitrate-nitrite-N and total phosphorus plots represent the 75th percentile concentrations at RM 26.35.)

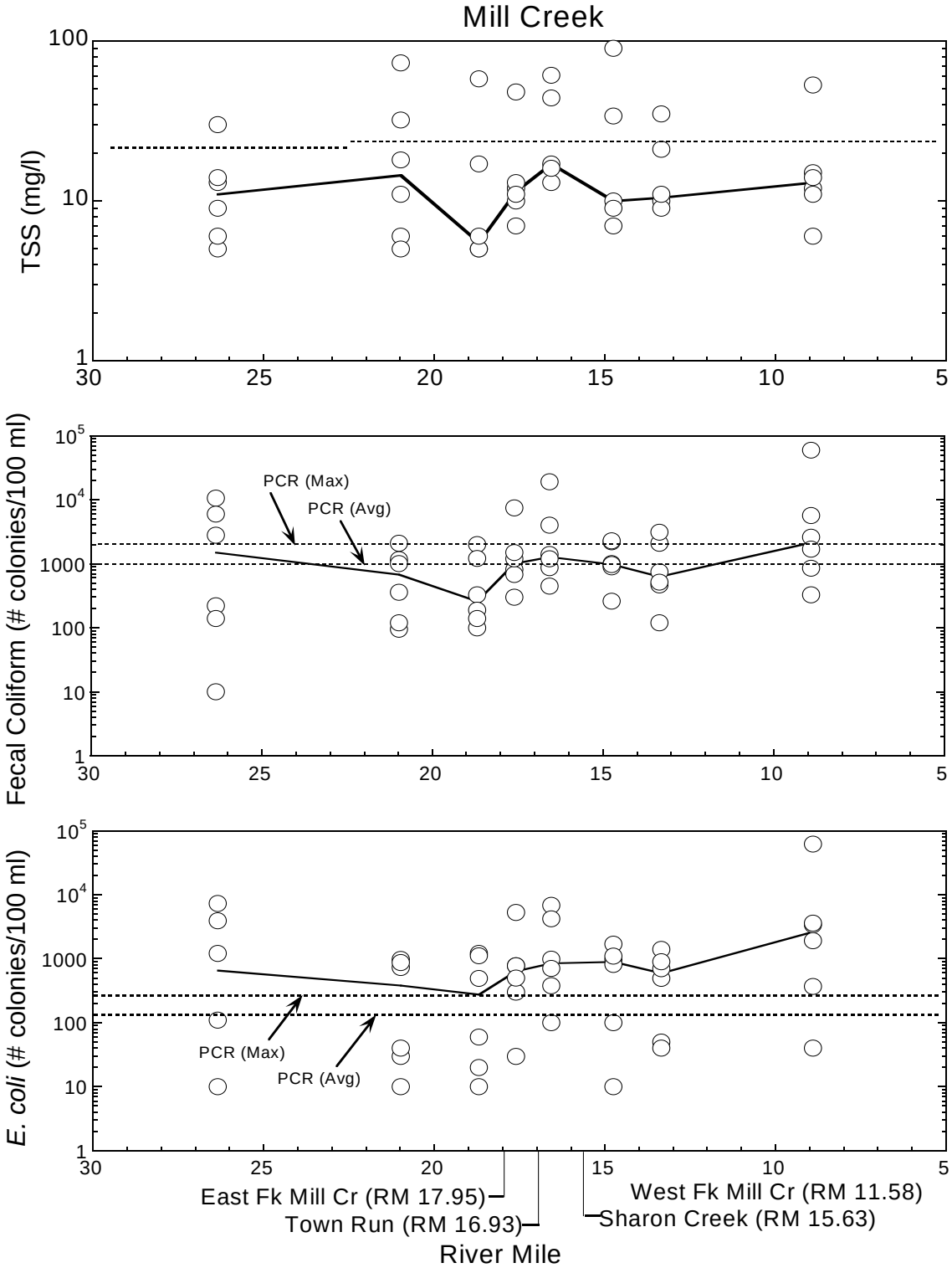

Figure 15. Longitudinal scatter plots of water chemistry results (daytime grabs) in Mill Creek during the 2002 survey. Top to bottom: total suspended solids (TSS), fecal coliform, and *E. coli*. The solid line depicts the median value at each river mile sampled. The dotted line in the TSS plot represents the 50th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

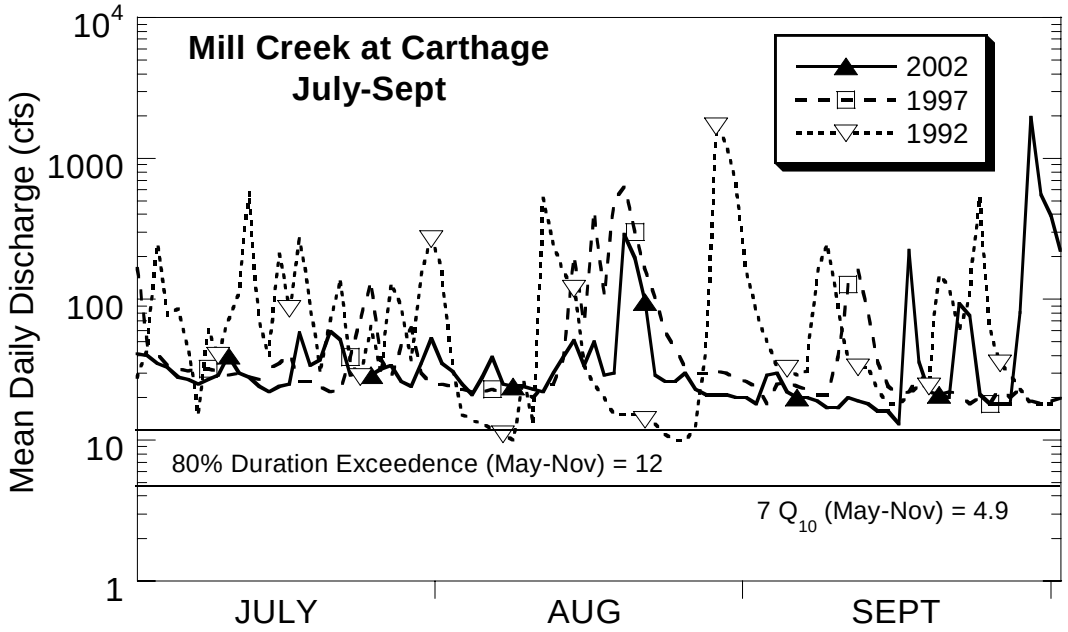

Figure 16 Flow hydrograph (2002, 1997, and 1992) for Mill Creek at Carthage (RM 10.5). Low flow conditions ($7Q_{10}$) and 80% duration exceedence flows are based on USGS station #03259000 (period of record 1952-1997) . Markers indicate river discharge on water chemistry sampling days for each survey.

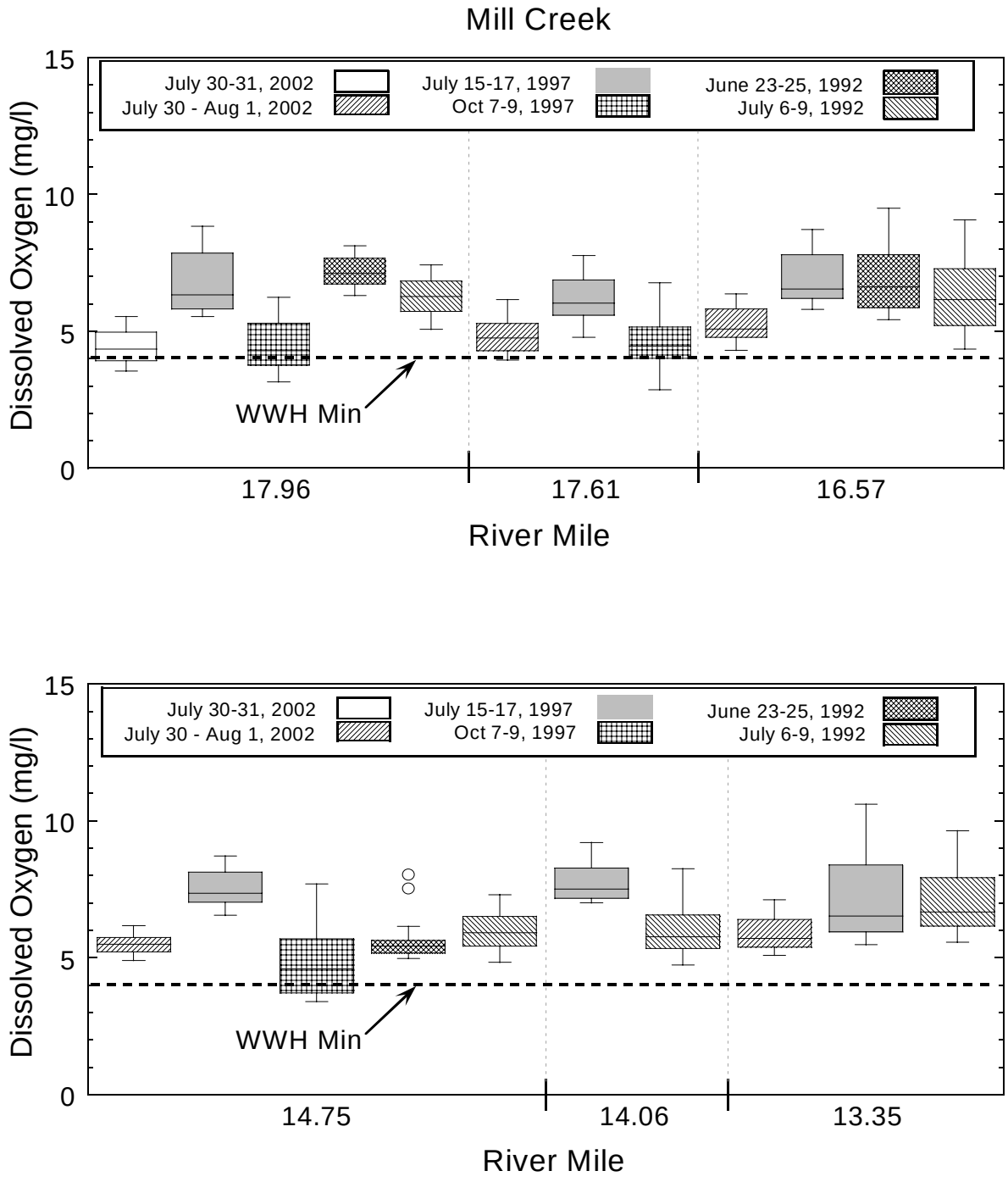

Figure 17 Distribution of dissolved oxygen concentrations recorded hourly with Datasonde™ continuous monitors in Mill Creek in 2002, 1997 and 1992 (Upper graph: RMs 17.96-16.57; Lower graph: RMs 14.75-13.35). Only sites common to two or more of the three survey years are depicted.

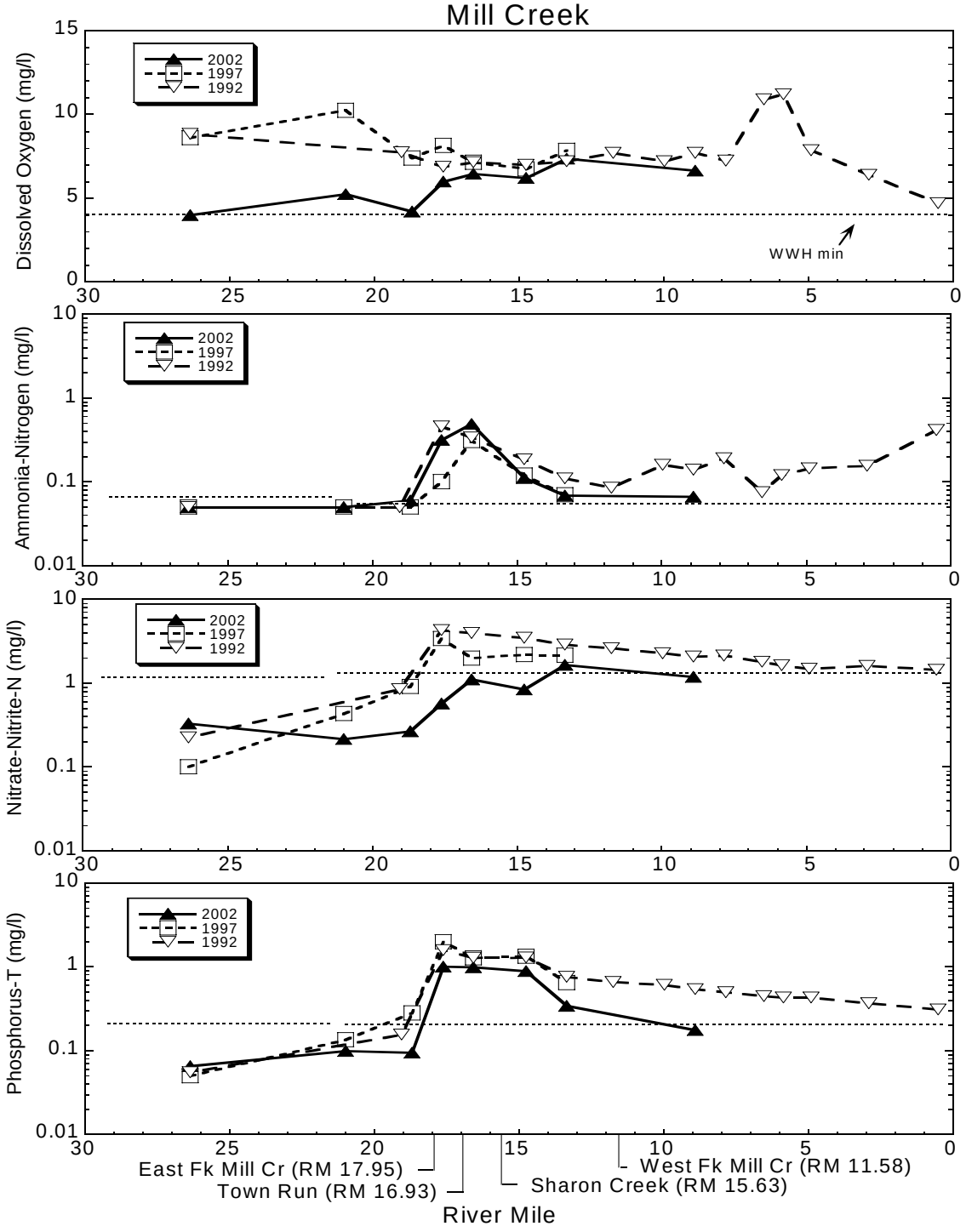

Figure 18 Median concentrations of dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-N, and total phosphorus in Mill Creek (2002, 1997 and 1992). Water quality minimum criterion is shown in the dissolved oxygen plot. Dashed horizontal lines in other plots represent the 90th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion. (Dotted lines in the nitrate-nitrite-N and total phosphorus plots represent the 75th percentile concentrations at RM 26.35.)

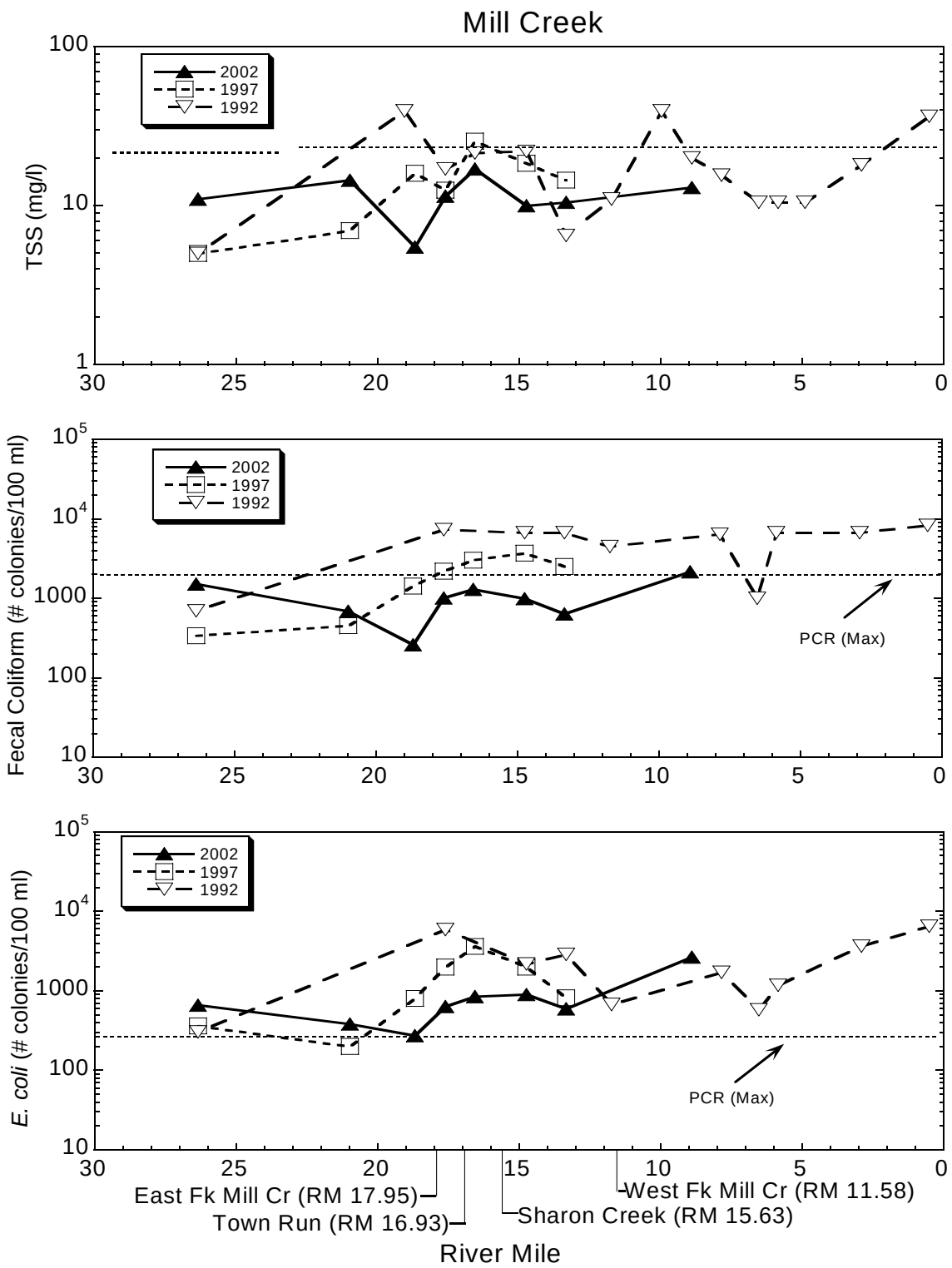

Figure 19 Median concentrations of total suspended solids (TSS), fecal coliform and *E. coli* in Mill Creek (2002, 1997 and 1992). The dashed horizontal line in the TSS plot represents the 50th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

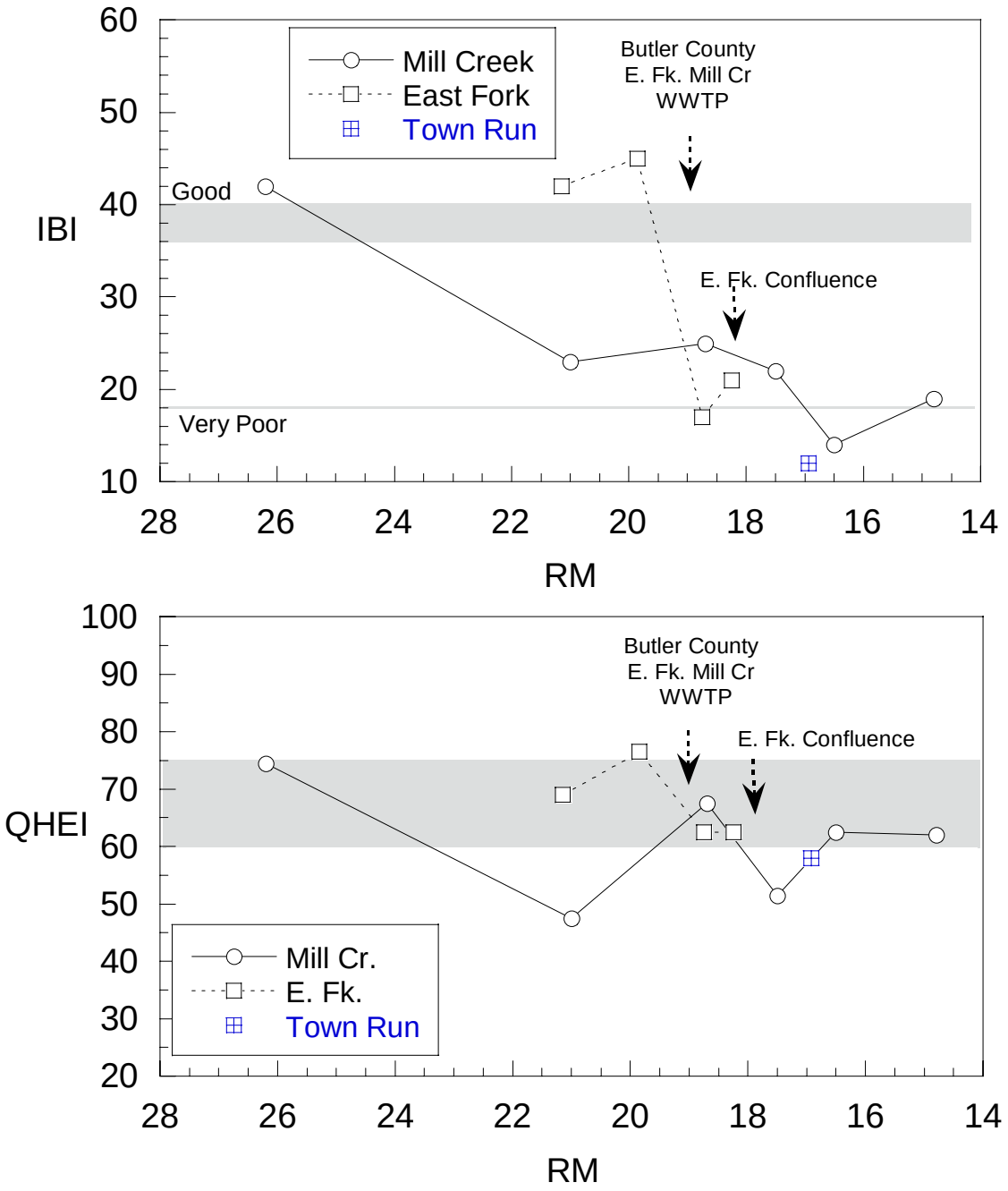

Figure 20. Upper) Plot of IBI scores by river mile for fish communities sampled in Mill Creek and the East Fork Mill Creek in relation to the Upper Mill Creek WRF. The shaded box shows the minimum IBI range meeting the applicable water quality standard for WWH. IBI scores less than 18 are in the very poor range and typically indicate toxicity. Lower) QHEI scores from fish sampling locations. In both plots, river miles for the East Fork and Town Run begin with their confluence river mile with Mill Creek.

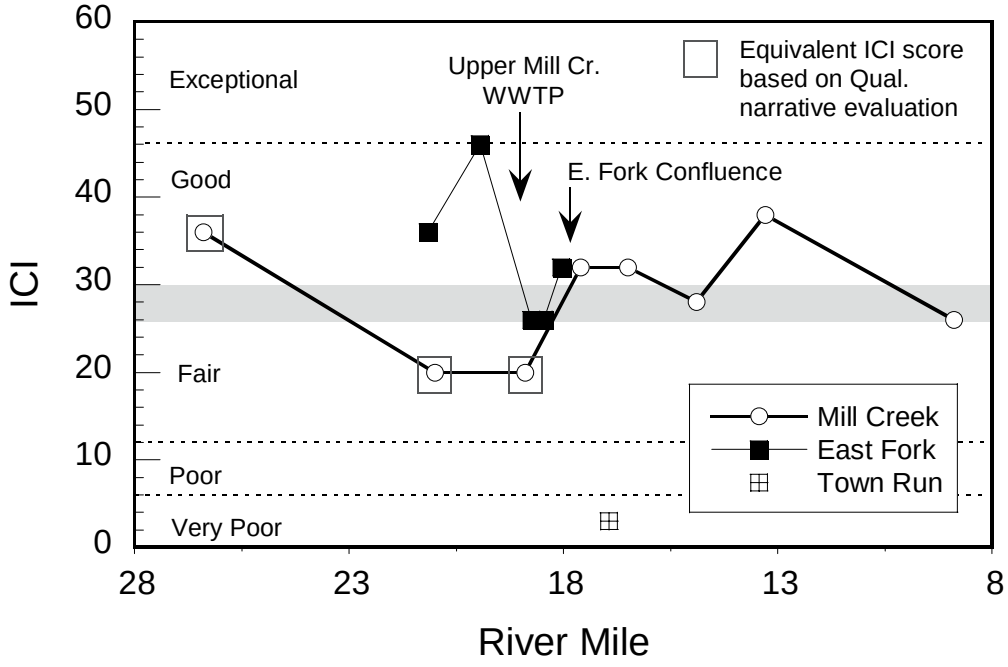

Figure 21. Longitudinal trend of the Invertebrate Community Index (ICI) in the Upper Mill Creek basin, 2002.

Town Run

Pollutant Loadings: Glendale WWTP - Town Run (Figure 22)
Lat:39^{0}16'20";Long:84^{0}26'47"
Permit#:1PB00012

Glendale WWTP is located at 528 Sharon Road in Glendale, Ohio in Hamilton County. The original facility was built in 1935, with a subsequent upgrade in 1988. Facility modifications included the addition of an equalization tank, adding two new secondary clarifiers, converting the existing secondary clarifiers to chlorine contact tanks, adding aerated sludge and a new lab. Glendale WWTP has a design capacity of 0.430 MGD and a hydraulic capacity of 1.4 MGD. The average daily flow rate in 2000 was 0.61 MGD. Current treatment consists of flow equalization (374,000 gallons total), bar screen, grit channel, two primary settling tanks, trickling filter with plastic media, two secondary clarifiers, sludge holding beds, anaerobic digester, chlorine contact and post aeration.

The current population of the Village of Glendale is estimated at 2,400. The entire service area is sewered with a collection system that contains two lift stations. There are reported overflow or bypass capabilities at the lift stations for the purposes of providing hydraulic relief to the collection system.

Manhole overflows are reported to exist at Little Creek Lane and Sharon Road. In 1998, a private engineering firm conducted an Inflow and infiltration (I/I) study which revealed an estimated 264 gallons per day (gpd) of ground and stormwater seeping into the wastewater system. Due to these findings, an infrastructure levy was passed by voters in 2000 to upgrade the sanitary sewer collection system.

Photos and field observations documented by Ohio EPA District personnel in September of 2002, noted a grey effluent wastestream flowing into Town Run from final outfall (001). Macroinvertebrate sampling crews also noted sewage solids and masses of sewage fungus blanketing the stream bottom below the discharge on August 23. An unplanned diversion of the wastestream, to a clarifier full of solids, was reported as the catalyst of the plant upset on September 18, 2002. A similar incident occurred in October of 2002 when inadequate tank cleaning procedures created deposition of solids to Town Run. Unacceptable chlorine and dissolved oxygen levels were discovered at this time and corrective actions were taken to assure compliance of these parameters in the future. Sampling Currently, discussions of a facility upgrade and the cost assessment of the upgrade project are ongoing.

Violations of the National Pollutant Discharge Elimination System (NPDES) were evaluated for part of 1999 through all of 2003. For the nearly 5 years of data evaluated, through SWIMS, an approximate 95 violations were documented. Constituents were typical of facility washout conditions and included carbonaceous oxygen demand ($cBOD_5$), total suspended solids (TSS) and dissolved oxygen(D.O) reported with the greatest frequency respectively. Eighty-nine percent of the documented violations occurred between 2002 and 2003.

Ninety-fifth percentile flow exceeded average design flow for the design period of 0.43 MGD of 1988. Peak flows, as represented by the 95th percentile, consistently exceeded design flow for the majority of record and increased in percentile variability after the upgrade of 1988. Both TSS and $cBOD_5$ characteristics were commensurate with flow behavior, revealing noteworthy variation in percentile behavior. This is most likely due to unpredictable flow volumes, possibly attributable to inflow and infiltration influences (currently being evaluated by the Village of Glendale) or likely attributed to occasions where unplanned diversions of the wastestream to a clarifier full of solids occurred. Graphically, this is commensurate with NPDES violations for these parameters as predominant constituents in the 95 total violations during the 5 years evaluated. Unpredictable flow characteristics did not result in permit violations for ammonia-N.

Fixed stations, 801 and 901, monitoring results (bracketing final outfall 001) demonstrated downstream concentrations of ammonia-N consistently more elevated than upstream for all years evaluated, except 2002. Since 1996, downstream (901) concentrations have demonstrated a slight increase over the prior 5 years.

Toxicity testing conducted on April 9-10 2001 revealed no toxicity to either test organisms in facility effluents or mixing zone samples. Bioassay effluents had not been previously conducted by the Ohio EPA.

Surface Water Quality: Town Run (Figures 23-25, Appendix Tables 4-11)
Town Run enters Mill Creek at RM 16.93. The Glendale wastewater treatment plant (WWTP) discharges to this small tributary at RM 0.92. Hourly dissolved oxygen (concentration and percent saturation), temperature, pH and conductivity were measured by a Datasonde™ continuous monitor downstream from the Glendale WWTP at RM 0.70 from July 30-August 1 (Figure 23, Appendix Table 5-9). Dissolved oxygen levels were exceptionally depressed at this site. All concentrations were well below the minimum WWH criterion, with values ranging from 1.26 mg/l to 2.66 mg/l. Temperature, pH, and conductivity remained stable with respective medians of 23.8°C, 7.68 SU, and 940 µmhos/cm.

Water chemistry daytime grab samples were collected upstream and downstream from the Glendale WWTP discharge at RMs 0.93 and 0.70. (Late in the survey [Sept. 18] it was discovered that the upstream sampling location (RM 0.93) was downstream from the Glendale WWTP equalization basin bypass. Records indicate that there were no bypasses from this basin to Town Run on any of the six water chemistry sampling days. There is also a potential impact from a storm sewer upstream of RM 0.93 which drains the Princeton Junior High School area.)

Similar to Datasonde™ measurements, all D.O. concentrations measured throughout the survey downstream from the Glendale WWTP at RM 0.70 fell below water quality criteria. Median saturation dropped from 77% at the upstream site to a survey low of 32% downstream. While higher BOD_5 concentrations were generally recorded downstream from the WWTP, both Town Run sampling sites recorded a survey high concentration of 26 mg/l on July 10. (Numerous parameters were elevated on this day at both sampling locations

in Town Run including total organic carbon [TOC], chemical oxygen demand [COD], conductivity, total dissolved solids [TDS], chloride, manganese, sodium, fecal coliform, *E. coli*, and copper. Field notes indicate there was precipitation in the basin and storm sewers may have been active.)

Nitrate-nitrite-N remained low, with median levels increasing from 0.55 mg/l at RM 0.93 to 1.5 mg/l at RM 0.70. Total suspended solids also remained low with median and maximum concentrations of 5 mg/l and 11 mg/l recorded at both sites. Concentrations of ammonia-N and phosphorus, however, increased significantly at RM 0.70, with ammonia-N exceeding water quality criteria on four occasions. Median phosphorus concentrations increased from 0.16 mg/l at RM 0.93 to 1.7 mg/l at the downstream sampling location (RM 0.70).

Exceptionally elevated fecal coliform and *E. coli* concentrations were measured in Town Run. Concentrations frequently exceeded the maximum secondary contact recreation criteria upstream at RM 0.93 and all values were above criteria at RM 0.70. Median fecal coliform concentrations increased from 2,100 colonies/100 ml at RM 0.93 to 11,150 colonies/100 ml downstream at RM 0.70.

Additionally, copper exceeded water quality criteria twice at RM 0.93 and four times at RM 0.70. (Two of the four exceedences recorded at RM 0.70, however, were qualified due to quality control issues.)

Water samples were analyzed for organic compounds twice at both sites in Town Run (Appendix Tables 10-11). Thirteen compounds were detected with concentrations of dieldrin and heptachlor epoxide above water quality criteria at both sites.

Surface Water Quality Trends: Town Run (Figures 26-27)
One common site (RM 0.70) was sampled in this tributary during both the 2002 and 1992 surveys (Figures 26-27). Downstream from the Glendale WWTP discharge, this site was characterized by consistently elevated concentrations of ammonia, bacteria, and phosphorus, as well as depressed dissolved oxygen levels in both survey years.

Daytime grab dissolved oxygen concentrations in 2002 fell below the minimum WWH criterion of 4.0 mg/l in five of six samples, while 50% of measurements (6 of 12) in 1992 were below the average WWH criterion of 5.0 mg/l. Elevated ammonia-N concentrations were common during both surveys, with respective median and maximum values of 3.35 mg/l and 5.82 mg/l recorded in 2002, compared to 1.33 mg/l and 3.1 mg/l in 1992. Concentrations exceeded water quality criterion in four of six samples in 2002 and in five of 12 samples in 1992. Total phosphorus concentrations at the site were also elevated, with median values approximating 1.7 mg/l in both survey years.

Bacteria levels (fecal coliform and *E. Coli*) were exceptionally elevated. All 2002 concentrations exceeded the maximum secondary contact recreation (SCR) criteria. Respective median and maximum fecal coliform counts of 11,150 colonies/100ml and 79,000 colonies/100 ml were recorded at the site in 2002, compared to1992 median and maximum concentrations of 3750 colonies/100 ml and >20,000 colonies/100ml. Five of the

12 fecal coliform samples collected in 1992 exceeded SCR maximum criterion. *E. Coli* concentrations were similarly elevated during both surveys.

Copper concentrations, elevated upstream and downstream from the Glendale discharge during the 2002 survey, exceeded water quality criteria on one occasion in 1992 at RM 0.70.

Physical Habitat Quality for Aquatic Life - Town Run (Appendix Table 14)
Town Run is a natural, high gradient stream with sufficient habitat quality (QHEI = 58.0) to expect fish and macroinvertebrate communities typical of the ecoregion.

Fish Communities - Town Run (Appendix Table 15)
Only two species of fish were found in Town Run, green sunfish (*Lepomis cyanellus*) and creek chub (*Semotilis atromaculatus*), both highly tolerant of pollution and both pioneering species. This combination indicates periodic acute toxicity.

Macroinvertebrate Communities - Town Run (Appendix Table 16)
Macroinvertebrates were of poor quality upstream from the Glendale WWTP and very poor quality downstream from the discharge. Masses of sewage fungus were observed immediately below the outfall and extensive blankets of sewage solids covered the stream bottom downstream at RM 0.7. The presence of extremely dense populations of sludge worms (Oligochaeta), hemoglobin utilizing midges (*Chironomus riparius group*), leeches and pulmonate snails (*Physella sp*) reflected grossly polluted conditions.

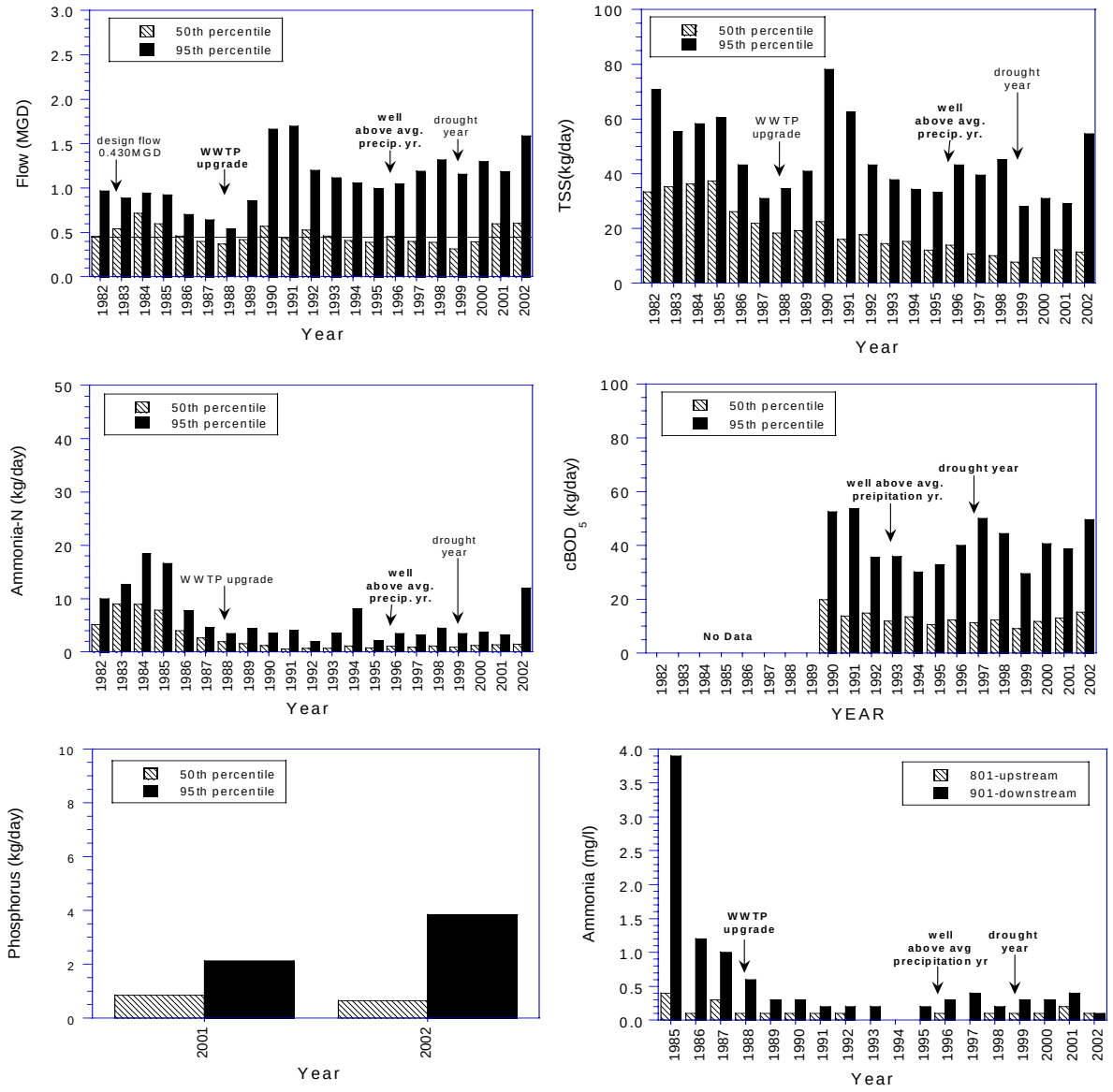

Figure 22 Conduit flow (mgd) and loadings trends (kg/day) at the Glendale WWTP, 1982-2002 (plots 1-5). Bottom plot (plot 6; lower right corner) displays annual mean Ammonia concentrations measured monthly upstream (801 site) and downstream (901 site) from the WWTP discharge [source = Glendale WWTP monthly operating reports (MORs)].

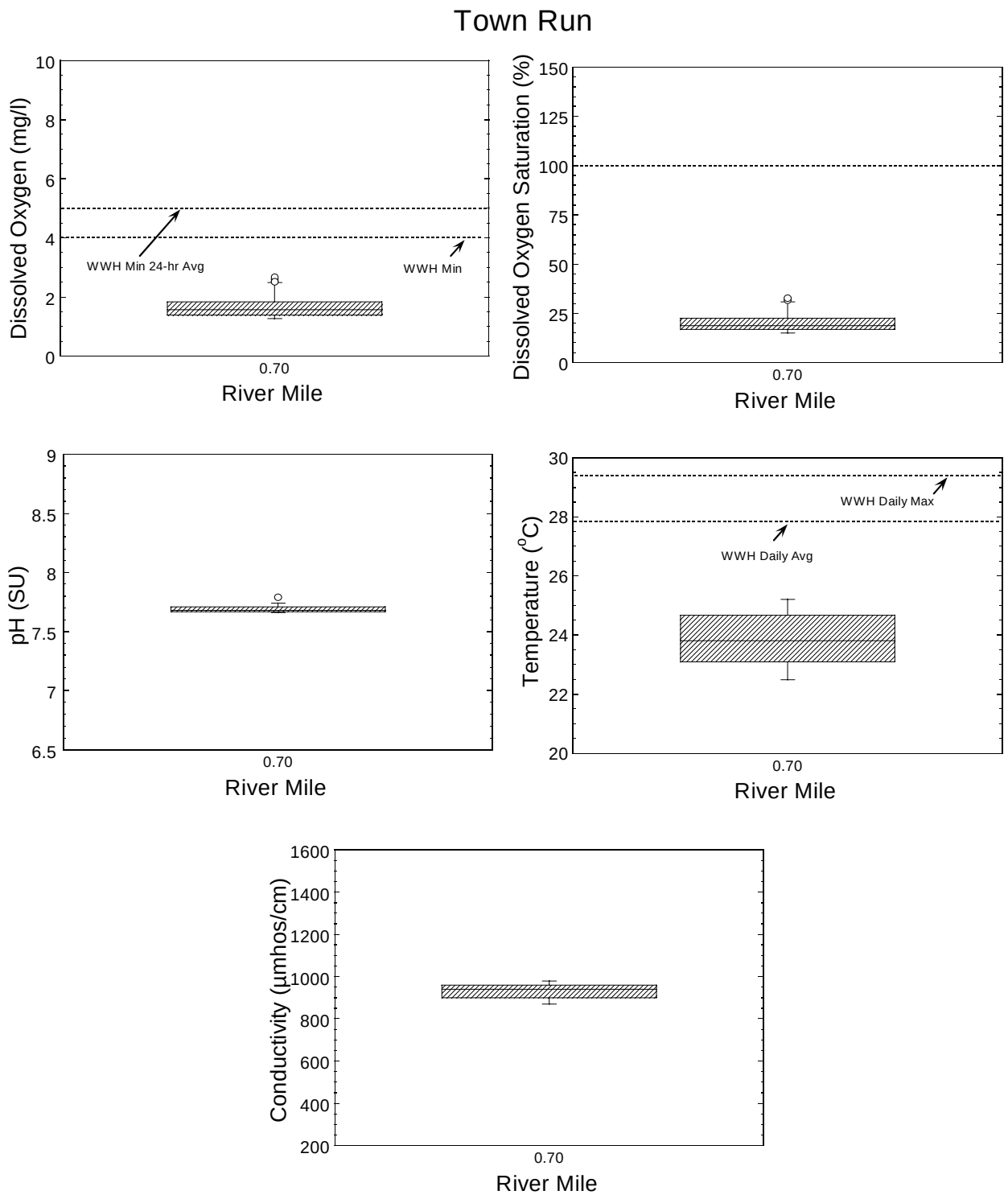

Figure 23 Left to right from the top: Distributions of dissolved oxygen concentration, percent dissolved oxygen saturation, pH, temperature, and conductivity recorded hourly with Datasonde™ continuous monitors in Town Run, July 30-August 1, 2002.

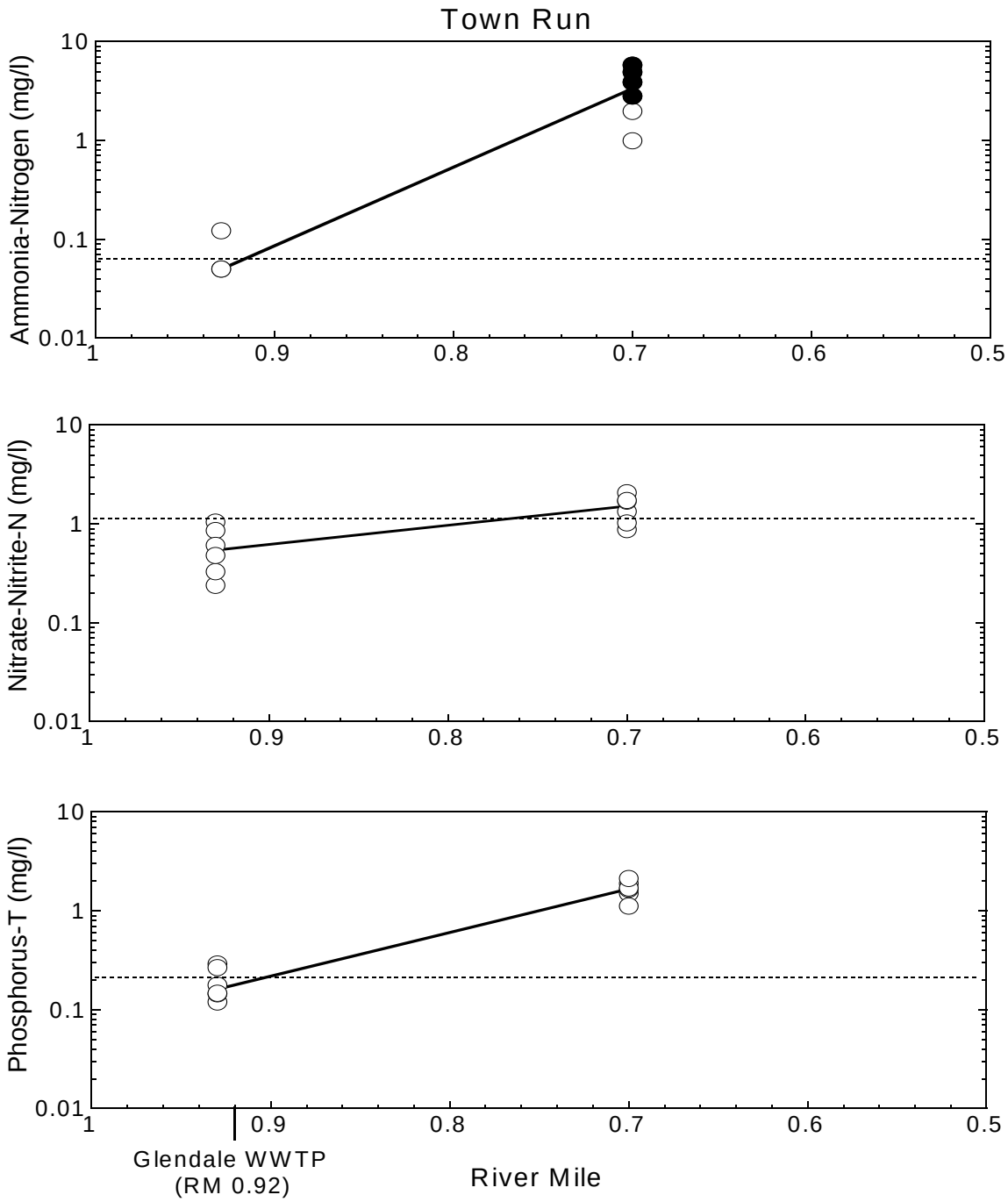

Figure 24 Longitudinal scatter plots of water chemistry results (daytime grabs) in Town Run during the 2002 survey. Top to bottom: ammonia-nitrogen, nitrate-nitrite-nitrogen, and total phosphorus. The solid line depicts the median value at each river mile sampled. The dotted line in the ammonia-N plot represents the 90th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion. (Values above ammonia-N water quality criteria are shown as solid circles.) Dotted lines in the nitrate-nitrite-N and total phosphorus plots represent the 75th percentile concentrations from reference sites of similar size in the Interior Plateau (IP) ecoregion.

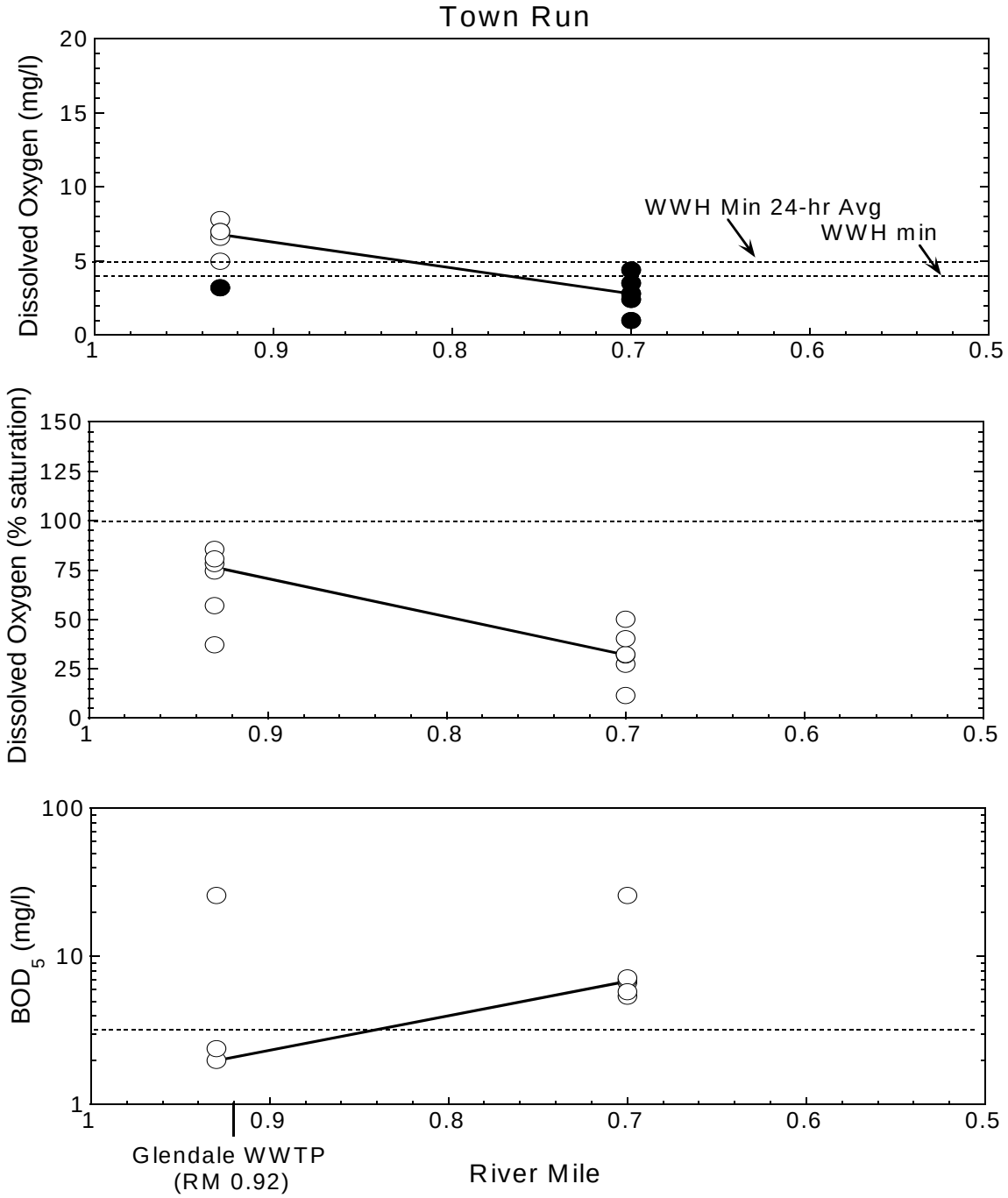

Figure 25 Longitudinal scatter plots of water chemistry results (daytime grabs) in Town Run during the 2002 survey. Top to bottom: dissolved oxygen concentrations, dissolved oxygen percent saturations, and biochemical oxygen demand (BOD_5). The solid line depicts the median value at each river mile sampled. Water quality criteria are shown in the dissolved oxygen plot. (Values below criteria are shown as solid circles.) The dotted line in the BOD_5 plot represents the 90th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

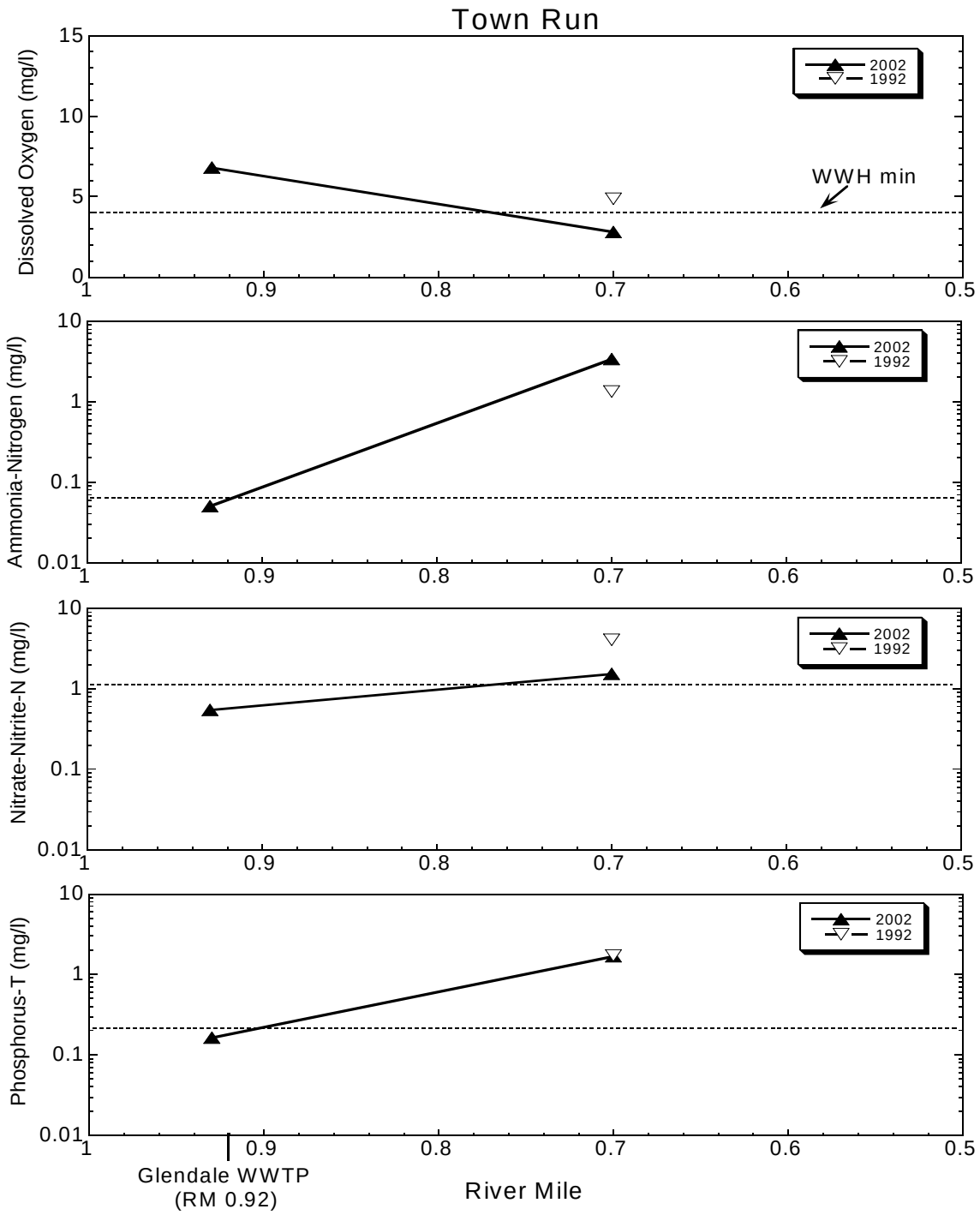

Figure 26 Median concentrations of dissolved oxygen, ammonia-nitrogen, nitrate-nitrite-N, and total phosphorus in Town Run (2002 and 1992). Water quality minimum criterion is shown in the dissolved oxygen plot. The dashed horizontal line in the ammonia-N plot represents the 90th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion. Dashed horizontal lines in other plots represent the 75th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

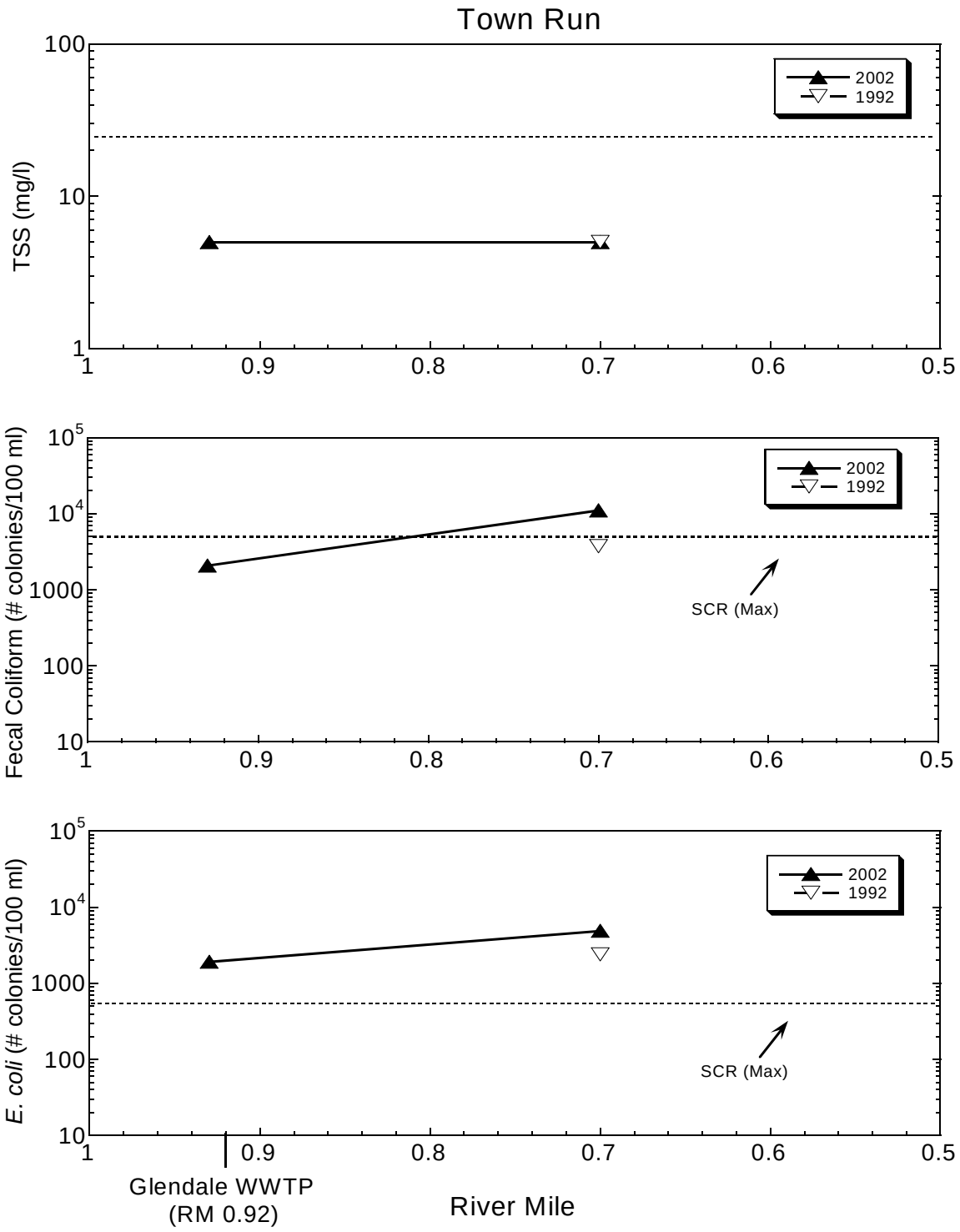

Figure 27 Median concentrations of total suspended solids (TSS), fecal coliform and *E. coli* in Town Run (2002 and 1992). The dashed horizontal line in the TSS plot represents the 75th percentile concentration from reference sites of similar size in the Interior Plateau (IP) ecoregion.

Appendix Table 1. Sampling locations and samples collected from the Mill Creek study area in 2002 (F - fish, B - benthic macroinvertebrates (B_q - denotes a qualitative sample), C - conventional water chemistry, D - Datasonde™, O - organic water chemistry,E - effluent, S - sediment chemistry). Latitude/longitude coordinates are provided in WGS84 datum.

Stream RM	Sample Type	Latitude/Longitude	Location	USGS Quad
Mill Creek				
26.35	F,B_q,C,O	39.3793912 / 84.4783799	Liberty Fairfield Rd.	Trenton
20.98	F,B_q,C	39.3280583 / 84.4458361	Rialto Rd; Upst. bridge	Glendale
18.69	F,B,C,O,S	39.2994422 / 84.4343891	Crescentville Rd; Upst. bridge	Glendale
17.96	D	39.2894004 / 84.4341163	Upstream East Fork Mill Cr	Glendale
17.61	F,B,D,C,O	39.2844472 / 84.4330583	Kemper Road; Dst. East Fork Mill Cr.	Glendale
16.57	F,B,D,C,O,S	39.2694239 / 84.4321773	Sharon Rd; Dst. Town Run	Glendale
14.75	F,B,D,C,O,S	39.2452805 / 84.4283361	Formica entrance; Dst. Sharon Cr.	Cin. East
13.35	B,C,D,O,S	39.2311846 / 84.4444585	West Columbia Rd; Dst. Pristine & GE	Cin. East
8.9	B,C,O,S	39.1989591 / 84.4884112	North Bend Rd.	Cin. East
8.7	D	39.1957414 / 84.4897318	Seymour Rd.	Cin. East
East Fork Mill Creek				
4.68	B_q,C	39.3333361 / 84.3922249	Barrett Rd; Ust. Skinner landfill	Glendale
3.19	F,B,C	39.3260626 / 84.4151798	West Chester Rd.	Glendale
1.84	F,B,D,C,O,S	39.3133653 / 84.4264071	Allen Rd; Ust. Upper Mill Cr WRF	Glendale
1.07	E	39.3029361 / 84.4312194	Upper Mill Creek WRF	Glendale
0.75	F,B,D,C,O	39.2989087 / 84.4294988	Crescentville Rd; Dst Upper Mill WRF	Glendale
0.5	B		Dst. Crescentville Rd.	Glendale
0.3	F		Dst. Crescentville Rd.	Glendale
0.01	B,D,C,O,S	39.2895869 / 84.4337905	Upstream mouth	Glendale
Town Run				
0.93	F,B_q,C,O	39.2721694 / 84.4486555	Ust. Glendale WWTP; off Sharon Rd.	Glendale
0.70	B_q,D,C,O	39.2741047 / 84.4441100	Dst. Glendale WWTP; Chester Rd.	Glendale

Appendix Table 2. Overflows from the Upper Mill Creek WRF Sewage Collection System from January 1998 to March 2002

Date	Location	(Gallons)	Cause
1/7/98	North Pisgah Pump Station	228,000	Rain event
1/11/98	North Pisgah Pump Station	13,000	Rain event
4/8/98	North Pisgah Pump Station	12,000	Pump failure
4/9/98	North Pisgah Pump Station	61,000	Rain event
4/16/98	North Pisgah Pump Station	30,000	Rain event
4/16/98	Windisch Road Interceptor	unknown	Rain event
4/16/98	Sharon Creek Pump Station	unknown	Rain event
4/22/98	North Point Apartments	20,434	Sewer blockage
4/30/98	North Pisgah Pump Station	27,600	Rain event
5/7/98	North Pisgah Pump Station	unknown	Rain event
5/20/98	North Pisgah Pump Station	20,000	Rain event
6/11-12/98	North Pisgah Pump Station	25,500	Rain event
7/1/98	7744 Barrett Rd	100	Contractor ruptured forcemain
7/4/98	North Pisgah Pump Station	3,500	Power outage
7/24/98	North Pisgah Pump Station	92,160	Power outage
7/24/98	Woodbridge on the Lake Apartments	115,000	Sewer blockage
8/28/98	North Pisgah PS	20,000	Power outage
9/1/98	Liberty-Fairfield & Hamilton-Mason Rd	400	Contractor error
12/4/98	Windbrook & Smith Rd	9,800	Sewer blockage
12/8/98	Beckett Road	6,300	Sewer blockage
12/21/98	North Pisgah PS	130,500	Rain event
12/21/98	Windisch Road Interceptor	67,500	Rain event
12/24/98	North Pisgah PS	42,100	CG&E power outage
12/24/98	Sharon Creek PS	217,500	CG&E power outage
1/6/99	Woodbridge on the Lake Apartments	400	Sewer blockage
1/8/99	North Pisgah PS	32,500	Power outage
1/13/99	North Pisgah PS	52,700	Rain event
1/26/99	North Pisgah PS	6,400	Power outage
2/7/99	North Pisgah PS	92,800	Rain event
2/7/99	Windisch Road Interceptor	137,800	Rain event
2/23/99	7086 Iron Kettle Dr	unknown	Sewer blockage
6/30/99	4849 Fields Ertel Rd	5,000	Sewer blockage (large rock)
9/2/99	6267 Lakewood Dr	1,320	Leaking air release valve
9/4/99	6363 Lakewood Dr	18,084	Leaking air release valve
10/30/99	West Chester PS	100,000	Piping failure
1/3/00	Sharon Creek PS	17,200	Rain event
1/3/00	North Pisgah PS	50,200	Rain event
1/3-5/00	Windisch Road Interceptor	>100,000	Rain event
1/13/00	Sharon Creek PS	2,800	Rain event
1/24/00	9774 Deer Track Rd	7,900	Pump station failure

Appendix Table 3. Continued.

Date	Location	(Gallons)	Cause
1/25/00	Sharon Creek PS	57,000	Pump failure
2/18/00	Windisch Road Interceptor	500,000	Rain event
2/18/00	Sharon Creek PS	450	Rain event
2/18/00	North Pisgah PS	23,000	Rain event
3/14/00	Cox & Barrett Rd	2000	Contractor pumping mistake
4/5/00	Port Union & Gold Park Dr.	500	Sewer blockage
4/8/00	North Pisgah PS	11,300	Rain event
6/7/00	7924 Jessies Way	4200	Sewer blockage
7/14/00	North Pisgah Pump Station	16,600	PS valving problem
10/30/00	North Pisgah Pump Station	13,400	Power failure
1/14/01	9218 Revere Run Ct	372,600	Vandalism
2/5/01	9930 Cincinnati Dayton Rd	400	Sewer blockage
4/5/01	Tylersville Rd	250	Contractor ruptured sewer
4/11/01	North Pisgah PS	24,000	Rain event
6/6/01	North Pisgah PS	20,000	Rain event
6/6-7/01	Sharon Creek PS	500,000	Rain event / pump failure
6/7/01	9738 Bennington Dr	3600	Rain event
7/17/01	9738 Bennington Dr	15,000	Rain event
7/17/01	North Pisgah PS	unknown	Rain event
7/17/01	Sharon Creek PS	unknown	Rain event
7/18/01	9242 Gregg Dr	15,000	Rain event
7/17-18/01	8000 Putting Green	2400	Sewer washed away
10/14/01	Windisch Rd	60,000	Influent screen failure
10/24/01	Sharon Creek PS	5,000	Rain event / pump failure
10/30/01	6361 Fields Ertel Rd	50,000	Broken forcemain
12/17/01	Sharon Creek PS	41,000	Rain event
1/3/02	7858 Hickory Hill Ln	42,000	Sewer blockage
3/6/02	4700 Port Union Rd	6,000	Contractor ruptured sewer
3/14/02	416 Peak Dr	50	Water staff ruptured sewer
3/18/02	9410 Hadley Dr	11,000	Contractor ruptured sewer
4/14/02	Sharon Creek PS	1500	Rain event
11/27/02	Sharon Creek PS	455,000	Rain event
10/28/02	North Pisgah Pump Station	15,000	Pump station malfunction
11/7/02	North Pisgah Pump Station	20,000	Pump station malfunction
12/19/02	Sharon Creek PS	unknown	Pump failure
1/4/03	7005 Inverary Court	7900	Sewer blockage
1/23/03	Sharon Creek PS	unknown	Equipment failure
2/6/03	4579 Lakes Edge Court	800	Vandalism
2/8/03	North Pisgah Pump Station	1500	Pump station malfunction
2/22/03	Sharon Creek Pump Station	77,400	Rain event/pump failure

Appendix Table 3. Spill Reports (1998-2002) from the Butler County, Upper Mill Creek Watershed.

Date	Material	TWP/City	Spiller
2/16/1998	DIESEL FUEL	UNION TWP	CSX
2/18/1998	DIESEL FUEL	FAIRFIELD	UNK
2/25/1998	DIESEL FUEL	UNION TWP	TRISM SPECIALIZED CARRIERS
4/4/1998	MATERIAL UNKNOWN	FAIRFIELD	UNK
4/12/1998	FUEL OIL	FAIRFIELD	UNK
4/20/1998	HEAVY OXIDANT	WEST MIDDLETOWN	UNK
4/20/1998	WASTE WATER	WEST CHESTER	WATKINS MOTOR LINES
4/21/1998	PAINT	LIBERTY TWP	DWAINE BLAIR
4/22/1998	PAINT	UNION TWP	WATKINS MOTOR LINES
6/2/1998	ODOR	INDIAN SPRINGS	UNK
6/24/1998	DIESEL FUEL	UNION TWP	KOKOSING CONSTRUCTION
7/1/1998	CARBON DISULFIDE .	FAIRFIELD	TEDIA COMPANY INC
7/1/1998	FIRE	FAIRFIELD	TEDIA COMPANY INC
7/5/1998	GASOLINE	FAIRFIELD	ROBERT CROWE
7/6/1998	FUEL OIL	FAIRFIELD TWP	MR DAVID T MCFARLAND
7/9/1998	HYDRAULIC OIL	FAIRFIELD	RUMPKE CONTAINER
7/13/1998	ORPHAN DRUM	WAYNE TWP	UNK
7/31/1998	PAINT WASTE	SHARRONVILLE	SAFTEY KLEEN
8/29/1998	LUBE OIL	SHARONVILLE	NORFOLK SOUTHERN
9/17/1998	FISH KILL	FAIRFIELD	WMI
9/17/1998	MATERIAL GREEN	FAIRFIELD	WMI
9/28/1998	FUEL OIL	HANOVER TWP	NO SPILL
10/4/1998	MATERIAL UNKNOWN	RILEY TWP	UNK
10/6/1998	WASTE SOLVENT	SHARONVILLE	SAFETY KLEEN
10/12/1998	FUEL OIL	WESTCHESTER	COLUMBIA OIL CO
10/13/1998	DIESEL FUEL	MILFORD	UNK
10/19/1998	ACETYLENE CYLINDER	UNION TWP	AGA GAS INC
10/19/1998	OXYGEN CYLINDER	UNION TWP	AGA GAS INC
12/22/1998	DIESEL FUEL	LIBERTY TWP	LAKOTA SCHOOLS
1/25/1999	FLUORESCEIN PULP	UNION TWP	CARUSO CO
1/25/1999	GASOLINE	UNION TWP	EMERY TRANSPORTATION
2/8/1999	MATERIAL WHITE	WEST CHESTER	UNK
2/9/1999	FUEL OIL	FAIRFIELD TWP	MS PENNY BRANDNER
3/9/1999	HYDRAULIC OIL	FAIRFIEL TWP	RUMPKE WASTE
4/7/1999	ASPHALT	REILEY TWP	SK CONSTRUCTION
4/15/1999	OIL	UNION TWP	UNK
4/20/1999	PAINT LATEX	WEST CHESTER	PAUL POWELL PAINTERS
5/10/1999	COAL TAR	UNION TWP	ENVIRONMENTAL ENTERPRISES
5/10/1999	NAPA	UNION TWP	ENVIRONMENTAL ENTERPRISES
6/9/1999	TRANSFORMER OIL	RIALTO	CG&E
6/27/1999	DIESEL FUEL	UNION TWP	SPEEDWAY GAS STATION
6/30/1999	PAINT	WAYNE TWP	BARBOUR CO
8/5/1999	MATERIAL UNKNOWN	WESTCHESTER	MR CLANDIO
8/12/1999	MATERIAL UNKNOWN	WEST CHESTER	UNK
8/27/1999	OIL/GREASE	UNION TWP	PIERRE FROZEN FOODS
9/7/1999	DIESEL FUEL	UNION TWP	CLANCY MOTOR EXPRESS

Date	Material	TWP/City	Spiller
9/9/1999	PAINT OVERSPRAY	FAIRFIELD	TRI STATE BODY SHOP
9/20/1999	OIL	LIBERTY TWP	UNK
10/1/1999	GLUE	UNION TWP	USF HOLLAND INC
11/2/1999	TRANSFOMRER OIL	MILLVILLE	CG&E
11/12/1999	ASPHALT	UNION TWP	UNK
11/22/1999	DIESEL FUEL	SHARONSVILLE TWP	WATKINS TRUCKING
11/26/1999	DIESEL FUEL	COLLINSVILLE	NORFOLK SOUTHERN
11/26/1999	DIESEL FUEL	COLLINSVILLE	STEPHEN A ROOKE
12/17/1999	SULFUR COATED UREA	LIBERTY TWP	UNK
1/13/2000	MATERIAL RED	UNION TWP	MIDDLETOWN WWTP
1/19/2000	FUEL OIL	SEVEN MILE	MAIN STREET ANTIQUES & SUCH
2/10/2000	GASOLINE	WEST CHESTER	TODD CROSS
2/18/2000	FUEL OIL	SEVEN MILE	MAIN STREET ANTIQUES & SUCH
3/7/2000	GASOLINE	SHARONVILLE	EMERY TRANSP
3/23/2000	FUEL OIL	SUMMERVILLE	NATHAN BAKER CONSTRUCTION
4/11/2000	AUTOMOBILE	UNION TWP	MR KRISTOPHER KNOX
4/27/2000	GASOLINE	FAIRFIELD	MR PAUL THOMAS
4/27/2000	MATERIAL WHITE	FAIRFIELD	UNK
5/8/2000	TIRES	SPRINGDALE	RANCH EXCAVATION
5/10/2000	DIESEL FUEL	UNION TWP	BFL INC
5/10/2000	OIL MOTOR	UNION TWP	BFL INC
5/26/2000	WASTE PAINT	FAIRFIELD TWP	KEN REINER
7/5/2000	MC 30	FAIRFIELD TWP	BEACON CONSTRUCTION
7/5/2000	CHEMICALS	WEST CHESTER	MR MIKE CORY
7/5/2000	OIL	WEST CHESTER	MR MIKE CORY
7/29/2000	DISSOLVE	WEST CHESTER	RICHARD CRAWFORD
7/29/2000	GPR-1	WEST CHESTER	RICHARD CRAWFORD
7/29/2000	GPR-3	WEST CHESTER	RICHARD CRAWFORD
7/29/2000	REMOVE ALL	WEST CHESTER	RICHARD CRAWFORD
7/30/2000	OIL MOTOR	WEST CHESTER TWP	UNK
8/21/2000	HAZARDOUS WASTE	FAIRFIELD	HMS
8/22/2000	OIL USED	FAIRFIELD TWP	UNK
9/19/2000	DIESEL FUEL	COLLINSVILLE	ROADWAY EXPRESS
10/3/2000	UNK VAPOR/GAS PLUME	WEST CHESTER	THREE BOND
11/30/2000	OIL	WEST CHESTER	MOTOR SPORTZ
1/12/2001	HYDROCHLORIC ACID	FAIRFIELD	BAXTERS DIECAST
1/13/2001	FUEL OIL	WEST CHESTER	MR. OVERSTREET
1/23/2001	DIESEL FUEL	FAIRFIELD	GREG'S EXCAVATING
2/17/2001	HYDRAULIC FLUID	FAIRFIELD	BURKETT TRUCKING
3/14/2001	TRANSFORMER OIL	FAIRFIELD	CINERGY
3/14/2001	FERTILIZER	LIBERTY TWP	FOUR BRIDGES COUNTRY CLUB
3/14/2001	PESTICIDES	LIBERTY TWP	FOUR BRIDGES COUNTRY CLUB
3/15/2001	DRUM BURNOUT ASH	WEST CHESTER	DAYTON INDUSTRIAL DRUM
3/15/2001	DRUM BURNOUT ASH	WEST CHESTER	MIDWEST ENVIRONMENTAL
3/31/2001	MERCURY	WEST CHESTER	PRESERVE AT BECKETT RIDGE
4/11/2001	DIESEL FUEL	WEST CHESTER	PACKAGING GROUP
4/18/2001	TRANSFORMER OIL	FAIRFIELD	CINERGY
5/7/2001	DYE BLUE	WEST CHESTER	INTRASATE CARRIER
5/10/2001	DIESEL FUEL	WEST CHESTER	ATLAS MACHINE & SUPPLY
6/2/2001	DIESEL	MILFORD	RUMPKE

Date	Material	TWP/City	Spiller
6/7/2001	LAB CHEMICALS	FAIRFIELD	UNK
6/28/2001	DIESEL FUEL	WEST CHESTER	UNK
7/4/2001	DIESEL FUEL	WEST CHESTER	CHALLENGER MOTOR FREIGHT
7/18/2001	HEATING OIL	SOMMERVILLE	MOTHER NATURE
7/20/2001	HEATING OIL	SOMMERVILLE	UNK
7/25/2001	FISH KILL	FAIRFIELD	UNK
7/31/2001	SODIUM HYPOCHLORITE	WEST CHESTER	CINCINNATI POOL MANAGEMENT INC
8/14/2001	CONCRETE	FAIRFIELD TWP	EARNST
8/16/2001	DIESEL FUEL	FAIRFIELD	CAUDILL SEED
8/27/2001	OIL & GASOLINE	LIBERTY	UNK
9/7/2001	FUEL OIL	WEST CHESTER	ARMREL BYRNES CONSTRUCTION
9/25/2001	DIESEL FUEL	WEST CHESTER	WORTHY CARTHAGE INC
10/23/2001	BLUE LIQUID	LIBERTY TWP	UNKNOWN
12/3/2001	HEATING OIL	RIELLY TWP	WALTER GROSH
1/28/2002	GREEN WATER	WESTCHESTER	UNK
2/1/2002	ETHYLENE GLYCOL	FAIRFIELD	DYNAMIC MECHANICAL SYSTEMS
2/19/2002	DIESEL FUEL	WEST CHESTER	UNK
3/27/2002	GASOLINE	SHARONVILLE	TRIUMPH ENERGY CORP
5/21/2002	UNK CHEMICALS	WEST CHESTER	UNK
5/21/2002	HYDRAULIC OIL	FAIRFIELD	BOHLKE VENEER CORP
5/22/2002	DIESEL FUEL	WEST CHESTER	COCA-COLA BOTTLING CO
5/28/2002	DIESEL FUEL	HANOVER TWP	UNK
6/4/2002	ANIMAL WASTE	WEST CHESTER	UNK
6/13/2002	FERTILIZER & HERBICIDES	WEST CHESTER TWP	TRUGREEN CHEMLAWN
6/13/2002	DIESEL FUEL	LIBERTY TWPK	PI & I MOTOR EXPRESS INC
6/21/2002	ORPHAN DRUM	WEST CHESTER	UNK
7/3/2002	HYDROGEN PEROXIDE	WEST CHESTER	R&L TRANSFER
7/17/2002	WASTE WATER	SEVEN MILE	SEVEN MILE ELEMENTRAY
7/29/2002	HYDRAULIC FLUID	WEST CHESTER	JAMES BERRYMAN COMPANY
8/29/2002	CHLORIDE	FAIRFIELD	ELDORADO CHEMICAL
9/18/2002	HYDRAULIC OIL	WEST CHESTER TWP	ADVANCED ELECTRICAL SERVICE
9/27/2002	ODOR	FAIRFIELD	WALMART
9/30/2002	POTASSIUM HYDROXIDE	WEST CHESTER	ZEP MANUFACTURING
12/17/2002	TRANSFORMER	FAIRFIELD	CINERGY

Appendix Table 4. Exceedences of Ohio EPA water quality criteria (OAC 3745-1) (and other chemicals not codified for which toxicity data is available) for chemical/physical water parameters measured in grab samples taken from the Mill Creek study area during 2002 (units are µg/l for metals and organics, #colonies/100ml for fecal coliform and *E. coli*, °C for temperature, µmhos/cm for conductivity, SU for pH, and mg/l for all other parameters).

Stream (use designation [a])	River Mile	Parameter [b] (value)
Mill Creek	26.35	Dissolved oxygen (3.0‡‡, 3.0‡‡, 2.0‡‡)
-Headwaters to Center Hill Rd (RM 7.9)		Copper-T (62**[D])
(WWH, PCR, AWS, IWS)		pH (6.20[Δ])
		Fecal coliform (10600◊◊, 6000◊◊, 2800◊◊)
		E. coli (7300◊◊, 3900◊◊, 1210◊◊)
	20.98	Dissolved oxygen (2.0‡‡, 4.4‡)
		Copper-T (26*[J])
		Fecal coliform (1170◊, 1010◊, 2100◊◊)
		E. coli (730◊◊, 970◊◊, 880◊◊)
	18.69	Dissolved oxygen (4.4‡, 4.0‡, 4.0‡,4.0‡)
		Fecal coliform (2000◊, 1210◊)
		E. coli (1210◊◊, 490◊◊, 1110◊◊)
	17.61	Fecal coliform (7500◊◊, 1200◊, 1500◊[P])
		E. coli (5300◊◊, 780◊◊, 300◊◊, 780◊◊, 500◊◊[P])
	16.57	Fecal coliform (19000◊◊, 1400◊, 4000◊◊[P], 1190◊)
		E. coli (6800◊◊, 990◊◊, 380◊◊, 710◊◊, 4200◊◊[P])
	14.75	Fecal coliform (2200◊◊, 1010◊, 2300◊◊[P])
		E. coli (1700◊◊, 970◊◊, 820◊◊, 1100◊◊[P])
	13.35	Copper-T (72***)
		Fecal coliform (2100◊◊, 3100◊◊[P])
		E. coli (1400◊◊, 490◊◊, 700◊◊, 900◊◊[P])
		Dieldrin (0.0049#, 0.0052#)
	8.9	Fecal coliform (5700◊◊, 2600◊◊, 1700◊, 60000◊◊[P])
		E. coli (3400◊◊, 3600◊◊, 1900◊◊, 370◊◊, 62000◊◊[P])
East Fork Mill Creek	4.68	Fecal coliform (20000◊◊◊)
-Headwaters to Upper Mill Cr WRF (RM 1.07)		*E. coli* (19000◊◊◊)
(WWH, SCR, AWS, IWS)		
-Upper Mill Creek WRF to mouth	3.19	Dissolved oxygen (4.8‡, 4.8‡)
(WWH, PCR, AWS, IWS)		Fecal coliform (12000◊◊◊)
		E. coli (11500◊◊◊, 790◊◊◊)

Appendix Table 4. Continued.

Stream (use designation [a])	River Mile	Parameter [b] (value)
East Fork Mill Creek (continued)	1.84	Dissolved oxygen (4.2‡, 4.4‡) Fecal coliform (16000◊◊◊) *E. coli* (4000◊◊◊, 9730◊◊◊, 760◊◊◊) Dieldrin (0.0033#) Heptachlor epoxide (0.0031#)
	0.75	Temperature (23.5*) Ammonia-N (4.28*) *E. coli* (470◊◊, 850◊◊, 200◊P, 460◊◊, 140◊)
	0.01	Dissolved oxygen (4.8‡) Ammonia-N (1.44*) Fecal coliform (1020◊) *E. coli* (510◊◊, 2400◊◊, 160◊, 730◊◊)
Town Run (WWH, SCR, AWS, IWS)	0.93	Dissolved oxygen (3.2‡‡) pH (6.10Δ) Copper-T (32*, 55**) Total Dissolved Solids (2710*, 2830*, 2020*) Conductivity (5020*, 5180*, 3750*) Fecal coliform (58000◊◊◊, 13000◊◊◊) *E. coli* (48000◊◊◊, 3300◊◊◊, 5400◊◊◊) Dieldrin (0.0024#) Heptachlor epoxide (0.0092#)
	0.70	Dissolved oxygen (1.0‡‡, 3.5‡‡, 2.8‡‡, 2.8‡‡, 2.4‡‡, 4.4‡) Ammonia-N (4.92*, 3.89*, 2.81*, 5.82*) Copper-T (26*, 27*, 28*J, 53**B) Total Dissolved Solids (2480*) Conductivity (4570*) Fecal coliform (79000◊◊◊, 9300◊◊◊, 13000◊◊◊, 5800◊◊◊, 9090◊◊◊, 31000◊◊◊) *E. coli* (86000◊◊◊, 5700◊◊◊, 4100◊◊◊, 3500◊◊◊, 1200◊◊◊, 9300◊◊◊) Dieldrin (0.011#, 0.0095#) Heptachlor epoxide (0.0057#)

a Use designations: Aquatic Life Habitat WWH - warmwater habitat
Water Supply IWS - industrial water supply; AWS - agricultural water supply
Recreation PCR - primary contact recreation; SCR -secondary contact recreation

b Bacteriological data (fecal coliform, *E. coli*) are shown to gauge the potential for impacts to receiving waters and do not represent actual exceedences of criteria. Actual exceedences of the average primary contact recreation (PCR) criteria are based on a geometric mean of not less than five samples within a thirty-day period whereas PCR (and SCR) maximum criteria represent the values which are not to be exceeded in more than ten percent of the samples in a thirty-day period.

• exceedence of numerical criteria for prevention of chronic toxicity (CAC).
** exceedence of numerical criteria for prevention of acute toxicity (AAC).
*** exceedence of numerical criteria for prevention of lethality (FAV).
# exceedence of numerical criteria for the protection of human health (non-drinking).

‡ value is below the WWH minimum 24-hour average D.O criterion (5.0 mg/l)
‡‡ value is below the WWH minimum at any time D.O. criterion (4.0 mg/l)
◊ value is above the average PCR criteria (fecal coliform 1000/100ml; *E. coli* 126/100ml)
◊◊ value is above the maximum PCR criteria (fecal coliform 2000/100ml; *E. coli* 298/100ml)
◊◊◊ value is above the maximum SCR criteria (fecal coliform 5000/100ml; *E. coli* 576/100ml)
Δ exceedence of the pH criteria (6.5-9.0).
B Analytical result is estimated. Analyte was detected in the associated method/trip/field blank as well as in the sample.
D The analyte was positively identified, the associated numerical value is estimated. Copper was estimated due to poor agreement between field duplicates (duplicate sample Copper = 18µg/l; not an exceedence of water quality criteria)
J The analyte was positively identified, the associated numerical value is estimated due to poor agreement between field quality control samples.
P The reported result is estimated because the sample was not analyzed within the required holding time.

Appendix Table 5. Summary of diurnal dissolved oxygen (D.O.) concentrations recorded hourly with Datasonde™ continuous monitors at ten locations in the Mill Creek basin during 2002.

Stream [a] RM	Dates Sampled	Total Hours	Mean (mg/l)	Median (mg/l)	Minimum (mg/l)	Maximum (mg/l)
Mill Creek (WWH: Headwaters to Center Hill Rd.-RM 7.9)						
17.96	July 30-31	22	4.43 ‡	4.36 ‡	3.55 ‡‡	5.54
17.61	July 30-Aug 1	47	4.84 ‡	4.76 ‡	3.95 ‡‡	6.16
16.57	July 30-Aug 1	48	5.24	5.09	4.31 ‡	6.37
14.75	July 30-Aug 1	51	5.50	5.48	4.90 ‡	6.17
13.35	July 30-Aug 1	50	5.90	5.70	5.09	7.12
8.7	July 30-Aug 1	43	6.61	6.42	5.59	8.33
East Fork Mill Creek (WWH)						
1.84	July 30-31	*	*	*	*	*
0.75	July 30-Aug 1	48	6.19	6.17	5.09	7.48
0.01	July 30-Aug 1	47	5.03	4.86 ‡	4.30 ‡	6.67
Town Run (WWH)						
0.70	July 30-Aug 1	49	1.67 ‡‡	1.56 ‡‡	1.26 ‡‡	2.66 ‡‡

a Aquatic Life Use designations: WWH - warmwater habitat
* Data unavailable.
‡ value is below the WWH minimum 24-hour average D.O criterion (5.0 mg/l).
‡‡ value is below the WWH minimum at any time D.O. criterion (4.0 mg/l).

Appendix Table 6. Summary of diurnal dissolved oxygen (D.O.) % saturation data recorded hourly with Datasonde™ continuous monitors at ten locations in the Mill Creek basin during 2002.

Stream [a] RM	Dates Sampled	Total Hours	Mean (%)	Median (%)	Minimum (%)	Maximum (%)
Mill Creek (WWH: Headwaters to Center Hill Rd.-RM 7.9)						
17.96	July 30-31	22	56	54	44	73
17.61	July 30-Aug 1	47	60	58	47	78
16.57	July 30-Aug 1	48	65	62	52	82
14.75	July 30-Aug 1	51	69	68	61	79
13.35	July 30-Aug 1	50	73	70	61	91
8.7	July 30-Aug 1	43	84	82	69	108
East Fork Mill Creek (WWH)						
1.84	July 30-31	*	*	*	*	*
0.75	July 30-Aug 1	48	75	74	61	90
0.01	July 30-Aug 1	47	61	59	51	82
Town Run (WWH)						
0.70	July 30-Aug 1	49	20	19	15	33

a Aquatic Life Use designations: WWH - warmwater habitat

Appendix Table 7. Summary of diurnal temperature data recorded hourly with Datasonde™ continuous monitors at ten locations in the Mill Creek basin during 2002.

Stream [a] RM	Dates Sampled	Total Hours	Mean (˚C)	Median (˚C)	Minimum (˚C)	Maximum (˚C)
Mill Creek (WWH: Headwaters to Center Hill Rd.-RM 7.9)						
17.96	July 30-31	22	26.3	26.5	24.3	28.3 †
17.61	July 30-Aug 1	47	24.5	24.6	23.2	26.1
16.57	July 30-Aug 1	48	24.9	24.8	22.7	27.7
14.75	July 30-Aug 1	51	25.8	25.8	24.4	27.6
13.35	July 30-Aug 1	50	24.9	24.7	23.0	27.1
8.7	July 30-Aug 1	43	26.2	26.5	24.3	27.7
East Fork Mill Creek (WWH)						
1.84	July 30-31	26	24.8	24.9	23.2	26.4
0.75	July 30-Aug 1	48	23.7	23.7	23.1	24.5
0.01	July 30-Aug 1	47	23.9	23.8	22.9	25.2
Town Run (WWH)						
0.70	July 30-Aug 1	49	23.8	23.8	22.5	25.2

a Aquatic Life Use designations: WWH - warmwater habitat
† value is above the WWH average temperature criterion (27.8˚C)
†† value is above the WWH daily maximum temperature criterion (29.4˚C).

Appendix Table 8. Summary of diurnal pH data recorded hourly with Datasonde™ continuous monitors at ten locations in the Mill Creek basin during 2002.

Stream [a] RM	Dates Sampled	Total Hours	Mean (SU)	Median (SU)	Minimum (SU)	Maximum (SU)
Mill Creek (WWH: Headwaters to Center Hill Rd.-RM 7.9)						
17.96	July 30-31	22	7.71	7.57	7.44	8.18
17.61	July 30-Aug 1	47	7.46	7.45	7.41	7.54
16.57	July 30-Aug 1	48	7.50	7.50	7.42	7.65
14.75	July 30-Aug 1	51	7.65	7.64	7.56	7.72
13.35	July 30-Aug 1	50	7.80	7.75	7.67	8.10
8.7	July 30-Aug 1	43	7.68	7.70	7.54	7.80
East Fork Mill Creek (WWH)						
1.84	July 30-31	26	7.95	7.96	7.84	7.98
0.75	July 30-Aug 1	48	7.47	7.47	7.41	7.53
0.01	July 30-Aug 1	47	7.40	7.40	7.35	7.49
Town Run (WWH)						
0.70	July 30-Aug 1	49	7.69	7.68	7.66	7.79

a Aquatic Life Use designations:WWH - warmwater habitat
Δ exceedence of the pH criterion (6.5-9.0 SU).

Appendix Table 9. Summary of diurnal conductivity data recorded hourly with Datasonde™ continuous monitors at ten locations in the Mill Creek basin during 2002.

Stream [a] RM	Dates Sampled	Total Hours	Mean (µmhos/cm)	Median (µmhos/cm)	Minimum (µmhos/cm)	Maximum (µmhos/cm)
Mill Creek (WWH: Headwaters to Center Hill Rd.-RM 7.9)						
17.96	July 30-31	22	518	530	400	550
17.61	July 30-Aug 1	47	1205	1210	820	1380
16.57	July 30-Aug 1	48	1052	1085	740	1190
14.75	July 30-Aug 1	51	978	1010	760	1140
13.35	July 30-Aug 1	50	839	850	730	930
8.7	July 30-Aug 1	43	832	770	750	1010
East Fork Mill Creek (WWH)						
1.84	July 30-31	26	666	690	470	760
0.75	July 30-Aug 1	48	1371	1370	1240	1460
0.01	July 30-Aug 1	47	1423	1420	1300	1510
Town Run (WWH)						
0.70	July 30-Aug 1	49	929	940	870	980

a Aquatic Life Use designations: WWH - warmwater habitat

Appendix Table 10. Concentrations (µg/l) of organic compounds detected in water samples collected in the Mill Creek study area during 2002..

Stream	Date	
River Mile (Location)	-------Sample Collected-------	
Mill Creek		
RM 26.35 (Liberty Fairfield Rd)		
Parameter*	8/07/02	9/04/02
delta-Hexachlorocyclohexane	0.0033	--
bis(2-Ethylhexyl)phthalate	--	7.92
TICs† (number detected)	1	3
RM 18.69 (Crescentville Rd; Upstream bridge)		
Parameter*	8/07/02	9/04/02
alpha-Hexachlorocyclohexane	--	0.0029
delta-Hexachlorocyclohexane	--	0.0041
TICs† (number detected)	3	2
RM 17.61 (Kemper Rd; Downstream East Fork Mill Cr)		
Parameter*	8/07/02	9/04/02
Chloroform	3.67	3.65
gamma-Hexachlorocyclohexane	0.0062	0.013
bis(2-Ethylhexyl)phthalate	0.60	--
TICs† (number detected)	6	8
RM 16.57 (Sharon Rd; Downstream Town Run)		
Parameter*	8/07/02	9/04/02
Chloroform	3.08	3.23
gamma-Hexachlorocyclohexane	0.0040	0.0084
TICs† (number detected)	5	7
RM 14.75 (Formica entrance; Downstream Sharon Cr)		
Parameter*	8/07/02	9/04/02
Chloroform	1.33	0.53
delta-Hexachlorocyclohexane	--	0.0067
gamma-Hexachlorocyclohexane	0.0059	0.0074 UJ
TICs† (number detected)	3	6
RM 13.35 (West Columbia Rd)		
Parameter*	8/07/02	9/04/02
Chloroform	1.00	--
1,1,1-Trichloroethane	--	0.66
Dieldrin	0.0049	0.0052
delta-Hexachlorocyclohexane	--	0.0047
gamma-Hexachlorocyclohexane	0.0031	--
TICs† (number detected)	5	4

Appendix Table 10. Continued.

Stream **River Mile** (Location)	Date -------Sample Collected-------	
Mill Creek (continued)		
RM 8.9 (North Bend Rd)		
Parameter*	8/07/02	9/04/02
Chloroform	**	0.69
gamma-Hexachlorocyclohexane	**	0.0044
TICs† (number detected)	**	3
East Fork Mill Creek		
RM 1.84 (Allen Rd; Upstream Upper Mill Creek WRF)		
Parameter*	8/07/02	9/04/02
alpha-Hexachlorocyclohexane	0.0044	0.0026
delta-Hexachlorocyclohexane	0.0046	--
gamma-Hexachlorocyclohexane	--	0.0022
Dieldrin	0.0033	--
Heptachlor epoxide	0.0031	--
bis(2-Ethylhexyl)adipate	0.63	--
TICs† (number detected)	4	1
RM 1.07 (Upper Mill Creek WRF effluent)		
Parameter*	8/07/02	9/04/02
Chloroform	3.94	3.16
gamma-Hexachlorocyclohexane	0.0069	0.014
Endrin	0.0060 J	0.016
TICs† (number detected)	11	4
RM 0.75 (Crescentville Rd; Downstream Upper Mill Creek WRF)		
Parameter*	8/07/02	9/04/02
Chloroform	3.64	3.76
gamma-Hexachlorocyclohexane	0.0067	0.015
Endrin	0.015 J	--
bis(2-Ethylhexyl)phthalate	0.62 B	6.21
TICs† (number detected)	8	7
RM 0.01 (Upstream mouth)		
Parameter*	8/07/02	9/04/02
Chloroform	4.33	4.16
gamma-Hexachlorocyclohexane	0.0067	0.015
Endrin	0.013 J	0.012
TICs† (number detected)	8	7

Appendix Table 10. Continued.

Stream **River Mile** (Location)	Date -------Sample Collected-------	
Town Run		
RM 0.93 (Upstream Glendale WWTP)		
Parameter*	8/07/02	9/04/02
alpha-Hexachlorocyclohexane	0.0051	--
4,4'-DDE	0.0059 J	0.0029
Dieldrin	--	0.0024
Heptachlor epoxide	0.0092	--
TICs† (number detected)	4	3
RM 0.70 (Chester Rd; Downstream Glendale WWTP)		
Parameter*	8/07/02	9/04/02
delta-Hexachlorocyclohexane	0.012	0.0082
gamma-Hexachlorocyclohexane	--	0.015
Dieldrin	0.011	0.0095
Heptachlor epoxide	0.0057	--
bis(2-Ethylhexyl)phthalate	1.43	7.61
TICs† (number detected)	11	11

* Only compounds that were detected at least once are listed. Parameters in plain type are pesticides; parameters in italic type are *volatile organic compounds*; and parameters in bold type are **semivolatile organic compounds**. No polychlorinated biphenyls (PCBs) were detected at any site.

** No sample collected at site.

-- Compound not detected or below the method detection limit.

† TICs (Tentatively Identified Compounds)--Analysis indicates the presence of an analyte (non-priority pollutant) that has been "tentatively identified".

Qualifiers:

J The analyte was positively identified; the associated numerical value is estimated.

B Analytical result is estimated. Analyte was detected in the associated method/trip/field blank as well as in the sample.

UJ The analyte was not detected above the sample quantitation limit (QL). However, the reported QL is estimated.

Appendix Table 11. Frequency of organic compounds detected in water samples collected in the Mill Creek study area during 2002 (number of water quality criteria exceedences/number of detections).

Parameter	Mill Creek	East Fork Mill Creek	Town Run	TOTAL
Pesticides				
alpha-Hexachlorocyclohexane	-/1	-/2	-/1	-/4
delta-Hexachlorocyclohexane*	*/4	*/1	*/2	*/7
gamma-Hexachlorocyclohexane(Lindane)	-/8	-/7	-/1	-/16
4,4'-DDE	-	-	-/2	-/2
Dieldrin	2/2	1/1	3/3	6/6
Endrin	-	-/5	-	-/5
Heptachlor epoxide	-	1/1	2/2	3/3
Semivolatile compounds (SVOCs)				
bis(2-Ethylhexyl)adipate*	-	*/1	-	*/1
bis(2-Ethylhexyl)phthalate	-/2	-/2	-/2	-/6
Volatile compounds (VOCs)				
Chloroform	-/8	-/6	-	-/14
1,1,1-Trichloroethane	-/1	-	-	-/1
TOTAL	**2/26**	**2/26**	**5/13**	**9/65**

* No applicable water quality criteria available for parameter.

Appendix Table 12. Concentrations (mg/kg) of metals in sediment samples collected in Mill Creek study area during 2002 and *1997*. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG), and Persuad (1993). All sites are in the Interior Plateau.

Mill Creek----------Sediment Concentration (mg/kg dry weight)----------

Landmark	**Al-T ^{O}**	**As-T ^{OM}**	**Ba-T ^{O}**	**Ca-T ^{O}**	**Cd-T ^{OM}**	**Cr-T ^{OM}**	**Cu-T ^{O}**
#3 RM 18.7 2002	15400	NA	82.0	45800	NA	19 ☺	12.0
Crescentville Rd *1997*	*16500*	*6.62* ☺	*85.3*	*NA*	*0.231* ☺	*ND*	*14.2*
#5 RM 16.6 2002	7750	NA	57.7	43200	NA	18 ☺	13.0
Sharon Rd. *1997*	*11400*	*19.8* $^{+}_{\ominus}$	*92.8*	*NA*	*0.472* $^{+}$☺	*ND*	*23.6*
#6 RM 14.8 2002	8780	3.40 ☺	68.6	46900	0.125 ☺	14 ☺	8.4
Formica Entrance *1997*	*7600*	*2.88* ☺	*49.6*	*NA*	NA	*ND*	*9.29*
#7 RM 13.2 2002	11900	4.12 ☺	68.6	55400	0.290 ☺	23 ☺	15.5
W.Columbia Rd *1997*	*25500*	*4.95* ☺	*107.0*	*NA*	NA	*ND*	*24.2*
#8 RM 8.9 2002 Dupe A	6460	2.94 ☺	44.9	92300	1.64 $^{+}_{\ominus}$	<15	8.6
N.Bend Rd. 2002 Dupe B	5370	2.57 ☺	28.9	75600	0.140 ☺	<15	7.8

East Fork Mill Creek

#11 RM 1.9 2002	11600	NA	60.6	61500	NA	<14	6.0
Allen Rd. *1997*	*35900* $^{+}$	*5.8* ☺	*122*	*NA*	*0.163* ☺	*ND*	*14.1*
#14 RM 0.1 2002	14500	NA	68.7	53000	NA	19 ☺	11.0
Ust. Mouth *1997*	*18600*	*5.0* ☺	*97*	*NA*	*0.098* ☺	*ND*	*12.2*

%FGM Percent Fine Grain Material in sediment sample(<60 micron or >30 seconds settling time)
NA Compound not analyzed.
* Not evaluated
^{O} evaluated by Ohio EPA (2003)
^{M} evaluated by MacDonald (2000)
^{P} evaluated by Persuad (1993)
Ohio SRV Guidelines 2003:
+ above background for this area in Ohio

MacDonald (2000) Sediment Quality Guidelines (SQG)
Three toxicity ranges:
<TEC ☺ Threshold effect concentration (TEC)- Below which adverse effects are unlikely to occur.
TEC-EEC ⊖ above which adverse effects frequently occur
>EEC ☹ **Extreme effect concentration** (EEC) -above which adverse effects usually or always occur
Ontario Sediment Guidelines (Persuad 1993)
▲ > severe effect level (disturbance in benthic community can be expected)

Appendix Table 12. (con't) Concentrations (mg/kg) of metals in sediment samples collected in the Mill Creek study area during *1997* and 2000, continued.

Mill Creek----------Sediment Concentration (mg/kg dry weight)----------

Landmark	Fe-T^{O}	Hg-T^{OM}	K-T^{O}	Mg-T^{O}	Mn-T ^{O}	Na-T*	Ni-T^{OM}	NH_3-N*
#3 RM 18.7 2002	15200	NA	3670	13800	341	<2460	<20	18.0
Crescentville Rd *1997*	*17400*	*0.0666* ☺	ND	*9460*	*380*	NA	*<21*	ND
#5 RM 16.6 2002	12200	0.031	1440	10100	366	<2400	25 ⊖	18.0
Sharon Rd. *1997*	*20100*	*0.0899* ☺	NA	*24400* $^{+}$	*712*	NA	<32.6	ND
#6 RM 14.8 2002	9660	0.053 ☺	2360	11700	362	<2330	<19	<9
Formica Entrance *1997*	*10900*	***3.87*** $^{+}$☹	NA	*16400*	*460*	NA	*<17.7*	*<12.2*
#7 RM 13.2 2002	13100	0.038 ☺	3090	12500	436	<2600	<21	<10
W.Columbia Rd *1997*	*18800*	*0.133* $^{+}$☺	NA	*14800*	*543*	NA	*30.8* ⊖	*<14.6*
#8 RM 8.9 2002 Dupe A	10300	0.023 ☺	1690	15200	334	<2480	<20	<9
N.Bend Rd. 2002 Dupe B	9540	<0.024	1350	15100	290	<2470	<20	<9

East Fork Mill Creek

#11 RM 1.9 2002	11300	<0.022	2770	10400	448	<2320	<19	16
Allen Rd. *1997*	*19300*	*0.0616* ☺	NA	*10300*	*572*	NA	<21.7	*15.6*
#14 RM 0.1 2002	12100	<0.029	3440	12100	369	<2590	<21	28
Ust. Mouth *1997*	*16800*	***1.61*** $^{+}$ ☹	NA	*12700*	*586*	NA	<19.6	*<13.7*

%FGM Percent Fine Grain Material in sediment sample(<60 micron or >30 seconds settling time)
NA Compound not analyzed.
* Not evaluated
O evaluated by Ohio EPA (2003)
M evaluated by MacDonald (2000)
P evaluated by Persuad (1993)
Ohio SRV Guidelines 2003:
+ above background for this area in Ohio

MacDonald (2000) Sediment Quality Guidelines (SQG)
Three toxicity ranges:
<TEC ☺ Threshold effect concentration (TEC)- Below which adverse effects are unlikely to occur.
TEC-EEC ⊖ above which adverse effects frequently occur
>EEC ☹ **Extreme effect concentration** (EEC) -above which adverse effects usually or always occur

Ontario Sediment Guidelines (Persuad 1993)
▲ > severe effect level (disturbance in benthic community can be expected)

Appendix Table 12. (con't) Concentrations (mg/kg) of metals in sediment samples collected in the Mill Creek study area during 2002 and *1997*, continued.

Mill Creek----------Sediment Concentration (mg/kg dry weight)----------

Landmark	Pb-T[OM]	Se-T [O]	Sr-T[O]	Zn-T[OM]	TOC [P]	pH *	P-T [P]	%FGM
#3 RM 18.7 2002 Crescentville Rd *1997*	<20 *<21.0*	NA *<1.05*	77 *NA*	58.4 ☺ *63.0* ☺	2.8% *1.6 %*	7.4 *7.97*	1640 *NA*	43.7% *64.5%*
#5 RM 16.6 2002 Sharon Rd. *1997*	<19 *<32.6*	NA *<1.63*	88 *NA*	63.4 ☺ *89.5* ☺	3.6% *1.7%*	7.9 *10.8*	2250 ▲ NA	20.4% *72.1%*
#6 RM 14.8 2002 Formica Entrance *1997*	<19 *<17.7*	<0.88 *<0.885*	81 *NA*	48.8 ☺ *47.8* ☺	4.6% *0.7%*	7.9 *7.93*	2360 ▲ *2280* ▲	10.5% *18.1%*
#7 RM 13.2 2002 W. Columbia Rd *1997*	<21 *31.9*☺	<1.04 *<1.1*	104 *NA*	72.4 ☺ *104* [+]☺	3.3% *1.8%*	8.0 *7.89*	2040 ▲ *3120* ▲	18.4% *35.7%*
#8 RM 8.9 2002 Dupe A N.Bend Rd. 2002 Dupe B	<20 44 ⊖	<0.99 <0.99	159 104	44.6 ☺ 34.7 ☺	4.6% 4.8%	7.9 7.9	1470 1280	3.4 % 4.5%

East Fork Mill Creek

#11 RM 1.9 2002 Allen Rd. *1997*	<19 *21.7* ☺	NA *1.08*	135 *ND*	34.0 ☺ *62.4* ☺	3.3% *1.2%*	7.7 *7.67*	1190 *3540* ▲	20.8% *55.4%*
#14 RM 0.1 2002 ust. Mouth *1997*	<21 *19.6* ☺	NA *0.98*	109 *ND*	66.6 ☺ *72.5* ☺	4.1% *1.5 %*	7.8 *7.84*	2360 ▲ *2090* ▲	27.7% *38.3%*

%FGM Percent Fine Grain Material in sediment sample(<60 micron or >30 seconds settling time)
NA Compound not analyzed.
* Not evaluated
[O] evaluated by Ohio EPA (2003)
[M] evaluated by MacDonald (2000)
[P] evaluated by Persuad (1993)
Ohio SRV Guidelines 2003:
+ above background for this area in Ohio

MacDonald (2000) Sediment Quality Guidelines (SQG)
Three toxicity ranges:
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>EEC ☹ **Extreme effect concentration** (EEC) -above which adverse effects usually or always occur

Ontario Sediment Guidelines (Persuad 1993)
▲ > severe effect level (disturbance in benthic community can be expected)

Appendix Table 13. Sediment concentrations of semi-volatile, volatile, pesticide, and PCB compounds (priority pollutant scan) detected in Mill Creek and tributaries study area during 1997 and 2002. Individual compounds were evaluated by the MacDonald Sediment Quality Guidelines (MacDonald 2000).

Landmark River Mile	Analysis Performed	Compound Detected	Result (mg/kg)	
			1997	2002
#3) Mill Creek RM 18.7 Crescentville Rd. TOC = 2.8 % (2002) Fine grain material 43.7 % TOC = 1.6 % (1997) Fine grain material 35.5 %	1) VOC 2) BNA 3)Pesticides 4) PCBs		BDL BDL BDL BDL	BDL BDL BDL BDL
#5) Mill Creek RM 16.6 Sharon Road TOC = 3.6 % (2002) Fine grain material 20.4 % TOC = 1.7 (1997) Fine grain material 27.9 %	1) VOC 2) BNA 3)Pesticides 4) PCBs	 Chrysene Fluoranthene Pyrene **Total PAH's** Endosulfan Sulfate Methoxychlor 	BDL BDL 1.4 ⊖ 1.2 ⊖ **2.6** ⊖ 9.9* 7.8* BDL	BDL 0.56 ⊖ 1.02 ⊖ 0.82 ⊖ **2.32** ⊖ BDL BDL BDL
#6) Mill Creek RM 14.8 Formica Entrance TOC= 4.6 % (2002) Fine grain material 10.5% TOC= 0.7 % (1997) Fine grain material 81.9%	1) VOC 2) BNA 3)Pesticides 4) PCBs	 Benz(a)anthracene Benzo(a) pyrene Benzo(b)fluoranthene * Benzo(g,h,i)perylene * Benzo(k)fluoranthene * Chrysene Fluoranthene Indeno(1,2,3-cd)pyrene Phenanthrene Pyrene **Total PAH's** PCB-1254 **Total PCB**	BDL BDL BDL 0.5* BDL BDL 0.6 ⊖ 1.3 ⊖ BDL 0.6 ⊖ 1.1 ⊖ **4.1** ⊖ BDL 0.14 **0.14** ⊖	BDL 0.50 ⊖ 0.56 ⊖ 0.76 * 0.52 * 0.53 * 0.80 ⊖ 1.55 ⊖ 0.53 * 0.67 ⊖ 1.22 ⊖ **7.64** ⊖ BDL BDL BDL

Landmark River Mile	Analysis Performed	Compound Detected	Result (mg/kg) 1997	Result (mg/kg) 2002
#7) Mill Creek RM 13.2 West Columbia Road TOC = 3.3% (2002) Fine grain material 18.4% TOC = 1.8% (1997) Fine grain material 64.3%	1) VOC		BDL	BDL
	2) BNA	Benz(a)anthracene	1.0 ⊖	0.56 ⊖
		Benzo(a) pyrene	1.0 ⊖	0.62 ⊖
		Benzo(b)fluoranthene *	1.2*	0.79 ⊖
		Benzo(g,h,i)perylene *	0.8*	0.58 ⊖
		Benzo(k)fluoranthene *	1.0*	0.63 ⊖
		Chrysene	1.3 ☹	0.83 ⊖
		Fluoranthene	3.2 ☹	1.67 ⊖
		Indeno(1,2,3-cd)pyrene	0.8 *	0.61 *
		Phenanthrene	1.5 ☹	0.77 ⊖
		Pyrene	2.5 ☹	1.37 ⊖
		Total PAH's	**14.3** ☹	**8.43** ⊖
		Bis (2-ethylhexyl)phthalate	1.1 *	BDL
	3)Pesticides	gamma-Chlordane	6.1 µg/kg ⊖	18.2 µg/kg ☹
		Methoxychlor	11.0 µg/kg*	BDL
	4) PCBs	PCB-1242 *	BDL	0.548 *
		PCB-1248	0.810*	BDL
		PCB- 1260 *	0.082*	0.085 *
		Total PCB's	**0.892** ☹	**0.633** ⊖
#8) Mill Creek RM 8.9 North Bend Road TOC= A 4.6 % (2002) B 4.8 % (2002) Fine grain material A 3.4% B 4.5%			A (2002)	B (2002)
	1) VOC		BDL	BDL
	2) BNA	Benz(a)anthracene	0.66 ⊖	0.50 ⊖
		Benzo(a)pyrene	0.58 ⊖	BDL
		Benzo(b)fluoranthene	0.73 *	0.56 *
		Chrysene	0.81 ⊖	0.62 ⊖
		Fluoranthene	1.75 ⊖	1.39 ⊖
		Phenanthrene	0.99 ⊖	0.57 ⊖
		Pyrene	1.38 ⊖	1.04 ⊖
		Total PAH's	**6.90** ⊖	**4.68** ⊖
	3)Pesticides	gamma-Chlordane	9.5µg/kg ⊖	7.2µg/kg ⊖
	4) PCBs	PCB-1242 *	0.148 *	0.11 *
		PCB- 1260 *	0.043 *	0.028 *
		Total PCB's	**0.191** ⊖	**0.138** ⊖
#11) E. Fork Mill Creek RM 1.9 Allen Road TOC= 3.3% (2002) Fine grain material 20.8% TOC= 1.2% (1997) Fine grain material 55.4%	1) VOC		BDL	BDL
	2) BNA		BDL	BDL
	3)Pesticides		BDL	BDL
	4) PCBs		BDL	BDL
#14) E. Fork Mill Creek RM 0.1 ust mouth TOC= 4.1% (2002) Fine grain material 27.7% TOC=1.5% (1997) Fine grain material 38.3 %	1) VOC		BDL	BDL
	2) BNA	Fluoranthene	BDL	0.75 ⊖
		Total PAH's	BDL	**0.75** ⊖
	3)Pesticides	bis(2-Ethylhexyl) phthalate	0.5 *	BDL
	4) PCBs		BDL	BDL
			BDL	BDL

1) Base Neutral & Acid Extractibles (BNA) U.S. EPA Method 8270
2) Pesticides U.S. EPA Method 8082A
3) Polychlorinated biphenyls (PCBs) U.S. EPA Method 8082A

BDL Below Detection Limit

MacDonald (2000) Sediment Quality Guidelines (SQG)
Three toxicity ranges:

<TEC ☺ Threshold effect concentration (TEC)- Below which adverse effects are unlikely to occur.
TEC-PEC ⊖ above which adverse effects frequently occur
>PEC ☹ **Probable effect concentration** (PEC) -above which adverse effects usually or always occur.

Appendix Table 14. QHEI attributes from sites sampled in Mill Creek, East Fork Mill Creek and Town Run, 2003.

Appendix Table 15. Fish community attributes from electrofishing samples collected in Mill Creek, the East Fork Mill Creek and Town Run, 2002.

RM	Species	Cumulative of Species	Mean No. Number	Relative Weight	Relative QHEI	MIwb[†]	IBI	Narrative
Mill Creek (23-001)								
			Eastern Corn Belt Plains - WWH					
26.2	16	14.0	791	–	74.5	NA	42	Good
			Interior Plateau - WWH					
21.0	15	11.0	852	–	47.5	–	23[*]	Poor
18.7	8	6.0	221	–	67.5	–	25[*]	Poor
17.5	14	11.0	195	11.5	51.5	5.0[*]	22[*]	Poor
16.5	8	4.5	43	12.9	62.5	2.8[*]	14[*]	Very Poor
14.8	15	11.0	170	21.0	62	4.6[*]	19[*]	Poor
East Fork Mill Creek (23-006)								
3.2	14	14.0	310	–	69	NA	42	Good
1.9	14	12.5	1899	–	76.5	NA	45	Good
0.8	10	7.0	111	–	62.5	NA	17[*]	Very Poor
0.3	11	8.0	131	–	62.5	NA	21[*]	Poor
Town Run (23-010)								
1.0	2	2.0	57	–	58	NA	12[*]	Very Poor

[•] Indicates significant departure from applicable biocriteria (>4 IBI units or >0.5 MIwb units).
[†] MIWb is not applicable in headwaters less than 20 mi^2 drainage area.

Ecoregion Biocriteria (ECBP & IP)

	IBI	MIWb
Headwaters	40	NA
Wading	40	8.3

Appendix Table 16. Summary of macroinvertebrate data collected from artificial substrate samplers (quantitative sampling) and natural substrates (qualitative sampling) in the Mill Creek basin study area, July -September, 2002.

Stream River Mile	Relative Density	Quant. Taxa	Qual. Taxa	Total Taxa	Qual. EPT[a]	QCTV[b]	ICI	Narrative Evaluation[c]
East Fork Mill Creek (2002)								
		Interior Plateau WWH Use Designation (Existing)						
4.7	NA	--	23	23	1	35.9	F*	Fair (intermittent)
3.2	41	26	31	46	6	35.9	36	Good
2.0	110	32	29	44	6	36.2	46	Exceptional
0.8	414	30	37	46	7	35.6	26[ns]	Marg. Good
0.5	364	35	31	46	6	34.8	26[ns]	Marg. Good
0.1	515	36	34	46	4	35.8	32	Good
Mill Creek (2002)								
		Interior Plateau WWH Use Designation (Existing)						
26.3	NA	--	36	36	5	35.9	G	Good
21.1	NA	--	30	30	4	32.7	F*	Fair
18.9	145	33	35	49	5	33.8	20*/F*	Fair
17.6	496	29	39	46	6	34.8	32	Good
16.5	654	25	30	37	6	36.2	32	Good
14.9	700	25	30	38	6	34.8	28[ns]	Marg. Good
13.3	760	29	33	41	7	34.8	38	Good
8.9	319	43	33	57	9	39.0	26[ns]	Marg. Good
Town Run (2002)								
		Interior Plateau WWH Use Designation (Existing)						
1.0	NA	--	16	16	2	33.2	P*	Poor
0.7	NA	--	6	6	0	15.4	VP*	Very Poor

[a] EPT= total Ephemeroptera (mayflies), Plectoptera (stoneflies) and Tricoptera (caddisflies).
[b] Average Tolerance Value calculated as the average of the weighted ICI for each taxa.
[c] A qualitative narrative evaluation based on best professional judgement is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.
* Significant departure from ecoregion biocriteria (>4 ICI units); poor and very poor results are underlined.
[ns] Nonsignificant departure from biocriterion (<4 ICI units).

Ecoregional Biocriteria: Interior Plateau (IP)

INDEX	WWH	EWH	MWH[d]
ICI	30	46	22

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

Raw chemical and biological sampling results from the 2002 survey can be obtained by contacting:

Dennis Mishne @
Ohio EPA Division of Surface Water
Groveport Field Facility
4675 Homer Ohio Lane
Groveport Ohio, 43125

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