Fleming Creek Drainage
Biological and Water Quality Investigation

Kentucky Department for Environmental Protection
Division of Water
Biological Section

Technical Report No. 8

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Fleming Creek
Biological and Water Quality Investigation for Stream Use Designation

Biological Section
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Abstract

A biological and water quality investigation of the Fleming Creek segment (05029) of the Licking River basin was conducted in May, 1982 to determine the existing water quality, aquatic uses, causes of impairments of aquatic uses and what aquatic uses can be attained, based on the physicochemical and biological characteristics of the segment.

The Fleming Creek subbasin lies in the Outer Blue Grass and Eden Shale subsections of the Blue Grass, in Fleming and Nicholas counties. The major impacts to the streams of this segment are domestic wastewater and agricultural runoff. Violations of Kentucky Surface Water Standards for phthalate esters, aluminum and mercury were observed. One violation of the fecal coliform bacteria standard (for primary contact recreation) was also observed. Diverse habitats for aquatic life were present, as reflected by the diversity of organisms found.

It is recommended that all streams in the segment be designated for Aquatic Life/Warmwater Aquatic Habitat and Primary and Secondary Contact Recreation. In addition, the Flemingsburg Reservoir should be designated for Domestic Water Supply. Data from this study indicate that those uses are currently occurring, or are attainable with the application of appropriate point source pollution control technology.

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Recommendations

1. Based on the diversity of the aquatic biota and habitat, it is recommended that the Fleming Creek subbasin (segment 05029) be designated for Aquatic Life/Warmwater Aquatic Habitat per 401 KAR 5:031, Section 5 (1) and that the criteria of that section be applied throughout the segment without modification.
2. Based on the fecal coliform and pH data, it is further recommended that the segment be designated for Primary and Secondary Contact Recreation per 401 KAR 5:031, Section 7 and that the criteria of that section be applied throughout the segment without modification. Although a violation of fecal coliform bacteria standards was observed, the use is attainable through proper land management and WWTP operation.
3. Based on the fact that the use is occuring, it is recommended that the Flemingsburg Reservoir be designated for Domestic Water Supply per 401 KAR 5:031, Section 6 and that the criteria of that section be applied in addition to the above criteria without modification.
4. It is also recommended that further studies be conducted in the segment, especially in the area below the Flemingsburg WWTP, to determine the degree of impacts of that facility to Town Branch and the middle reach of Fleming Creek.

Summary

1. The Fleming Creek basin (including tributaries) in Fleming and Nicholas counties constitutes a single segment (05029).
2. The major impacts to the Fleming Creek segment are discharges of municipal wastewater and agricultural runoff.
3. Fleming Creek receives heavy fishing pressure and angler success is fair to good for game species.
4. No domestic water supplies are taken from Fleming Creek. A reservoir in the headwaters of an unnamed tributary provides drinking water for the city of Flemingsburg.
5. Violations of Kentucky Surface Water Standards (401 KAR 5:031, Section 5 (1)) were observed for phthalate esters, mercury and aluminum.
6. Fecal coliform standards for Primary Contact Recreation (401 KAR 5:031, Section 7) were violated at one site. However, it was determined that the source of contamination was both human and animal. Primary contact recreation standards should be attainable through proper land management and WWTP operation.
7. The Fleming Creek segment contained sufficient water quality and diverse habitats for aquatic organisms, as reflected by the diversity and numbers of those organisms. A total of 130 taxa of algae, 77 taxa of macroinvertebrates and 29 species of fish were collected from the stream. The presence of freshwater mussels at both sampling locations indicates that water quality has remained good throughout this century.

INTRODUCTION

The Fleming Creek basin lies within Fleming and Nicholas counties. This drainage, including its major tributaries (Allison Creek, Town Branch), from the headwaters to the confluence with the Licking River constitutes a single segment. This stream is designated as 05 (Licking River Basin) 029 (Fleming Creek segment).

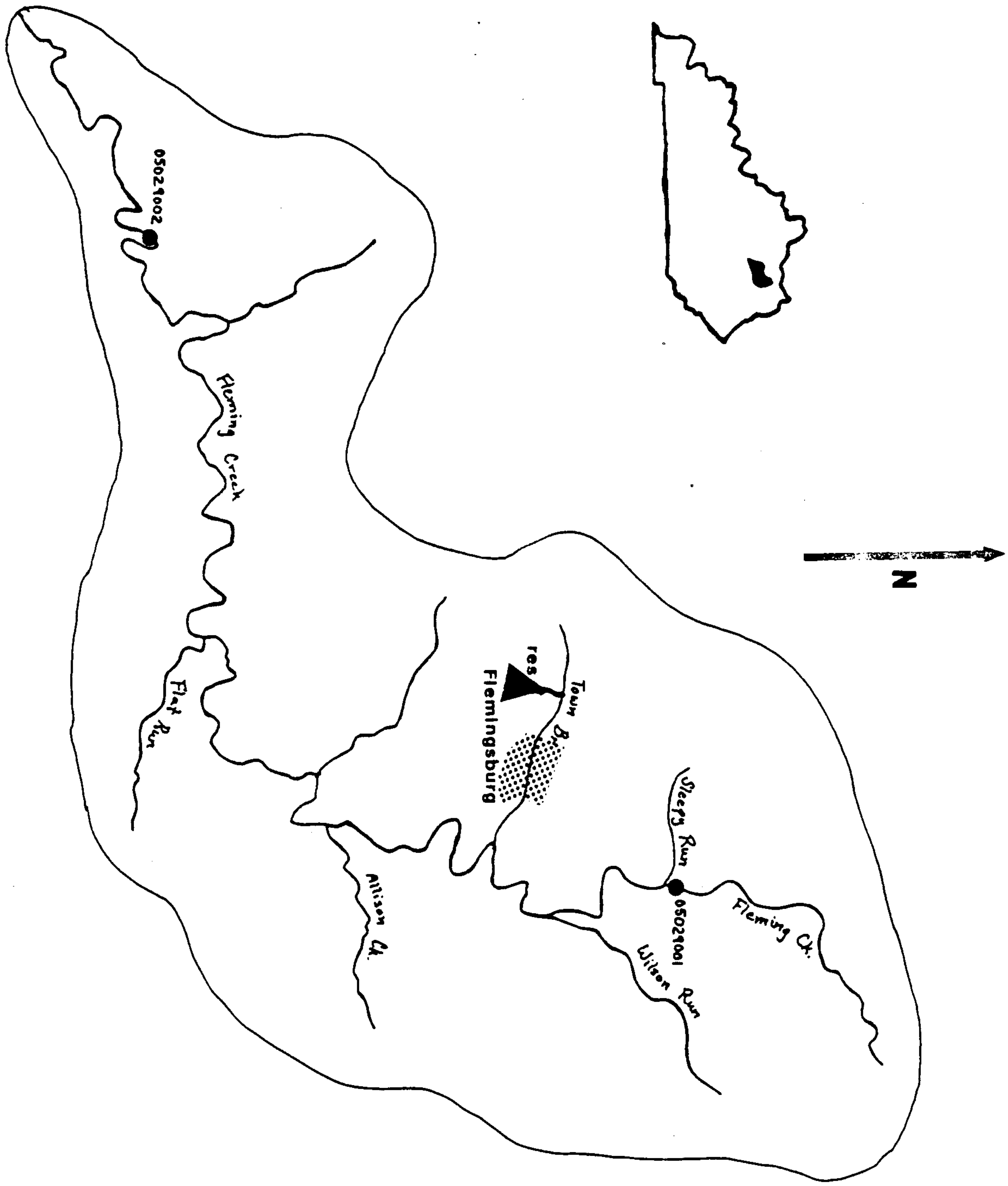
A survey of the Fleming Creek basin was undertaken by the Kentucky Department for Environmental Protection (DEP) in May, 1982. Two sampling stations were established in the drainage (Figure 1) and sampled during a low flow period. The location of these stations, dates sampled and parametic coverage are given in Appendix A. The purposes of this investigation were as follows:

1. To determine the existing water quality of the basin.
2. To determine the aquatic uses currently being achieved in the drainage.
3. To determine the causes of any impairments of the aquatic uses.
4. To determine what aquatic uses can be attained based on the physical, chemical and biological characteristics of the watershed and the application of appropriate point source pollution control technologies.

Literature Review

There is a paucity of existing water quality and biological information on the Fleming Creek drainage. Jones (1970) conducted a fish survey at one location on Fleming Creek. He included some basic physicochemical analyses in his report. Ortmann (1919) collected mussels from Fleming Creek in close proximity to station 29-2.

Figure 1
Map of Fleming Creek Showing Sampling Locations



Basin Impacts

According to Division of Water (DOW) waste load allocation (WLA) files, the major discharger to Fleming Creek is the city of Flemingsburg waste water treatment plant (WWTP). In addition, two small discharges are located in the watershed. These facilities are listed in Table 1, with location, flow and permit requirements. The other major impact to this segment is agricultural runoff, since 87 percent of the land use in the basin is agriculture (Proctor, Davis and Ray no date). Urban runoff should be a very minor impact, since Flemingsburg (pop 2,835) is the only urbanized area in the basin. There is a rock quarry near the stream at mile point (mp) 21. Current 201 Facility Plans for the Flemingsburg WWTP call for a 347% increase in design flow from 240,000 gallons per day (gpd) to 833,000 gpd.

Table 1
Fleming Creek Permitted Dischargers

Permit #	Facility Name	BOD-5	NH_3-N (mg/l)	D.O.	Flow (gpd)	Receiving Stream Name	M.P.
05029006	Sorrells Restaurant	30	4	7	1000	UT to mp 0.87 of UT to Fleming Creek	0.80
05029005	Flemingsburg, City of	10	1	7	833,000	Town Branch	0.25
05029002	Richie, Dave, Body Shop	25	4	7	500	Town Branch	2.55

Stream Uses

Jones (1970) reported that Fleming Creek receives heavy fishing pressure, especially from the mouth to about 20 miles upstream. Angler success was reported as fair to good for game species.

There are no domestic water withdrawals from Fleming Creek. The city of Flemingsburg obtains its water supply from a reservoir in the headwaters of an unnamed tributary (UT) to Town Branch (Figure 1).

Hunting for waterfowl, small mammals and deer occurs throughout the watershed in rural areas. Those game animals, as well as non-game species, utilize the various streams and adjacent buffer zones for breeding, rearing young and feeding, as well as a water supply for drinking. Trapping, principally for small mammals, such as muskrats, mink, etc., also occurs in rural sections of the drainage.

METHODS

Water samples were analyzed in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater (APHA 1981) and United States Environmental Protection Agency's (U.S. EPA) Methods for Chemical Analysis of Water and Waste (U.S. EPA 1979). Field turbidity measurements were taken with an HF Instruments Model DRT-15 turbidimeter. Field conductivity was determined with a Yellow Springs Instrument Company (YSI) Model 33 S-C-T meter. Field measurements for dissolved oxygen (DO) and water temperature were conducted with a YSI Model 54A oxygen meter. An Analytical Measurements Model 707B pH meter was used for field pH.

Biological samples were collected utilizing a variety of techniques. Qualitative algal samples were procurred by selectively scraping or suctioning material from all available habitats. Samples were preserved in the field with 5% buffered formalin and transported to the Division of Water (DOW) biological laboratory for analysis. Diatoms were treated with 30% hydrogen peroxide and potassium dichromate to remove organic material (van der Werff 1955), and several slides randomly scanned for the presence of rare taxa.

Macroinvertebrate qualitative samples were taken by selectively picking various substrate types and by collecting in different habitats with a triangular kick net. Quantitative samples were collected using a modified Hornig and Pollard (1978) travel-kick method. Three replicates were collected with a 0.045 m^2 triangular kick net by the travel-kick method over a 10 ft area for 60 seconds. All invertebrate samples were preserved in the field in 70% alcohol solution and transported to the DOW biological laboratory for enumeration and identification. The trophic relationships follow those outlined by Merritt and Cummins (1978) and Hawkins and Sedall (1982). Aquatic macroinvertebrates were placed into one of three pollution categories, (i.e. tolerant, facultative and intolerant), generally based on information presented by Weber (1973) and Hart and Fuller (1974). These categories are defined by Beck (1955) and Weber (1973) as follows: tolerant organisms are associated with gross organic contamination and are generally capable of thriving under anaerobic circumstances; facultative organisms are capable of tolerating a wide range of environmental conditions, including moderate levels of organic enrichment, but cannot exist under anaerobic conditions; intolerant organisms are sensitive to even moderate levels of organic enrichment and are generally unable to withstand even moderate reductions of dissolved oxygen.

Diatom and macroinvertebrate species diversity indices ($\bar{d}$) and equitability (e) were calculated using the procedure described by Weber (1973). Diatom relative abundance, $\bar{d}$ and e were generated by counting a minimum of 300 valves. Macroinvertebrate relative abundance was calculated with the pooled quantitative data.

Fish were collected using a 3.4 m by 1.2 m, 0.3 cm mesh, common sense minnow seine. Both pool and riffle areas and all recognizable habitat types were sampled. The fish samples were preserved in 10% formalin solution and transported to the DOW biological laboratory for enumeration and identification. Fish community structure was analyzed using the methods of Karr (1981).

Bacteriological samples were collected from directly below the water's surface in 250 ml, wide mouth, sterile nalgene jars, placed on wet ice and returned for analysis to the DOW biological laboratory within six hours. Analyses for fecal coliform and fecal streptocoecocus bacteria were performed using the membrane filter techniques outlined by Bordner et al. (1978).

PHYSICAL EVALUATION

The headwaters of Fleming Creek are located in northeastern Fleming County, Kentucky. The stream flows southwesterly for approximately 63 km (39 mi), joining the Licking River (RMI 106.9) southeast of Pleasant Valley in Nicholas County. Town Branch, a second order tributary to Fleming Creek, drains Flemingsburg, the only significant urban area in the basin. The remaining tributaries are second or third order, Allison Creek being the largest, and drain primarily agricultural areas. There are 250 km^2 (96.5 mi^2) of land area drained by the Fleming Creek system (Bower and Jackson 1981). The average stream gradient is 1.46 m/km (7.7 ft/mi) as measured from the United States Geological Survey (USGS) topographic maps.

The upper half of the Fleming Creek basin lies in the Outer Blue Grass, while the lower half is located in the Eden Shale Belt (Quarterman and Powell 1978). Both are subsections of the Blue Grass section of the Interior Low Plateaus Province. The Outer Blue Grass portion of the basin (in the headwaters) is underlain by clay, shale and dolomite, of Silurian and upper Ordovician age; just downstream the area is underlain by nodular limestone and closely interbedded limestone and shale, all of Ordovician age (McDowell et al. 1981). Moderate to gently rolling slopes are typical of the Outer Blue Grass topography. The Eden Shale Belt area of the basin is underlain by closely interbedded limestone and shale, as well as nodular and clastic limestone of Ordovician age (McDowell et al. 1981). The topography here is of dissected uplands with irregular, steep-sided hills, separated by narrow V-shaped valleys (Quarterman and Powell 1978). Elevations for Fleming Creek range from 268.2 m (880 ft) above mean sea level (msl) in the headwaters to 176.8 m (580 ft) above msl at the mouth. The two major soil groups and their characteristics are given in Table 2.

Table 2
Soils of the Fleming Creek Basin

Soil(1) Association	Slope(2) %	Drainage(2) Class	Potential(1) Sediment Runoff	Infiltration(1)	Septic Tank(1) Absorbtion Rating
Faywood	12-20	-	Medium	Slow	Severe
Fairmount	12-35	somewhat excessively drained	High	Very Slow	Severe
Eden	6-30	somewhat excessively drained	High	Slow	Severe
Lowell	3-30	well drained	Medium	Slow	Severe
Brashear	4-16	well to moderately-well drained	Medium	Slow	Severe

(1) Proctor et al. (no date)
(2) Bailey and Winsor (1964)

Flow data for Fleming Creek, taken by the USGS at a low-flow partial record station (RMI 12.2) from 1968 to 1972, list flows of 0.001 m^3/s (0.02 ft^3/s) on September 11, 1968 to 2.12 m^3/s (75.0 ft^3/s) on February 10, 1971 (USGS 1969, 1972). Proctor, Davis and Ray (no date) estimated the seven day, ten year low flow (7Q10) at 0.01 m^3/s (0.339 ft^3/s); however, Sullavan (1980) listed the 7Q10 as 0.0 m^3/s. There are no permanent USGS gaging stations located on Fleming Creek.

The pool/riffle habitat was well developed, with the ratio varying according to location. Other stream habitats included gravel bars, undercut banks, log piles, submerged logs and roots, Justicia (water willow) beds and a variety of substrates. Streamside vegetation was generally well developed in the sampling areas. A total of 40 plant taxa (Appendix B) included a diversity of young hardwoods and herbaceous species. These riparian zones provided some shade, a buffer zone from sediments and nutrients in surface runoff, erosion control and general bank stability, as well as food and cover for invertebrates, fish and wildlife. Some studies indicating the importance of riparian vegetation to fauna and to stream water quality include Karr and Schlosser (1978), Nelson et al. (1978), USDA (1978) and Schlosser and Karr (1981).

Following is a brief description of the sampling stations. More detailed information is given in Appendix A. Riparian vegetation is listed in Appendix B.

Station 05029001 (29-1)

Fleming Creek

This station was located at the Fox Spring Road bridge, RMI 28.1 (2.1 miles above the mouth of Town Branch), in Fleming County. The stream is fourth order with moderate gradient and was characterized by long, shallow pools and small, shallow riffles. There was a diversity of stream habitats and substrates throughout the site (Appendix A). Both banks were low, gently to moderately sloping and well vegetated (Appendix B). The buffer zone consisted of a variety of hardwoods and herbaceous plants and extended for 50 to 100 m before reaching farm pastures.

Station 05029002 (29-2)

Fleming Creek

This station was located 2.9 air km (1.7 air mi) southeast of Pleasant Ridge church, RMI 6.15 (19.8 miles below the mouth of Town Branch), in Fleming County. The stream is fourth order with moderate to low gradient and traversed a narrow floodplain. Long, fairly deep pools predominated, with occasional riffles near gravel bars. There was a variety of stream habitats and substrates (Appendix A). Both banks were steep, 2 to 4 m high and overgrown with hardwoods and herbaceous vegetation (Appendix B). An old field and cedar thicket was adjacent to a 5 to 10 m buffer zone along the south bank. A small gravel road cut across a steep, wooded hillside beyond the north bank.

PHYSICOCHEMICAL EVALUATION

A total of 59 physicochemical parameters were analyzed from surface grab samples taken at both sampling locations. A review of this data (Table 3) indicates that Fleming Creek is a highly buffered hardwater stream (e.g. Sawyer 1960, Durfor and Becker 1964). Conductivity and total dissolved solids (TDS) are within the range expected for streams draining limestone lithologies (e.g. STORET 1979-1981). Dissolved oxygen (DO) and pH are sufficient to support aquatic life and do not violate any Kentucky Surface Water Standards. Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) did not pose a threat to aquatic life and are considered within the ambient range of alkaline streams when compared to STORET (1979-1981) data. Also, sulfate ($SO_4^{=}$) and chloride (Cl^-) were similar to mean values for streams of the Commonwealth (STORET 1979-1981).

The nutrient concentrations were, with the exception of total phosphorous (TP), all at or below the mean ambient levels, as compared to STORET (1979-1981) data available for the Licking River drainage. The un-ionized ammonia (NH_3-N) concentrations observed during this study did not violate Kentucky Surface Water Standards. The nitrite plus nitrate-nitrogen (NO_2+NO_3-N) concentrations were well below the mean STORET (1979-1982) values for the Commonwealth.

Total phosphorous concentrations in flowing waters are generally below 0.1 mg/l (NTAC 1968, Keup 1968) except in streams receiving agricultural runoff (Omernik 1977) or effluents from WWTPs (Goldman and Horne 1983). The TP level at station 29-2 slightly exceeded this 0.1 mg/l concentration (Table 3). However, these values did not exceed the mean STORET (1979-1981) values for the Commonwealth. This is probably attributable to the large agricultural area and resultant runoff in the watershed above this site.

Phthalate esters concentration violated the Kentucky Surface Water Standards, 401 KAR 5:031, Section 5 (1)(h)(3) at both sampling locations (Table 3). According to U. S. EPA (1980a), phthalate esters concentration as low as 940 ug/l can be acutely toxic to freshwater aquatic life, and chronic toxicity may occur at levels as low as 3 ug/l for more sensitive aquatic species.

The concentrations of total aluminum (Al) and total mercury (Hg) violated Kentucky Surface Water Standards, 401 KAR 5:031, Section 5 (1)(h)(2) and 401 KAR 5:031, Section 5 (1)(h)(3) respectively, for warmwater aquatic habitat at both sampling locations (Table 3). Birge et al. (1978) found that Al was toxic to largemouth bass eggs and fry at extremely low concentrations. Of the 11 metals tested, Al was the third most toxic. They found the LC1 for largemouth bass fry and eggs to be 1.0 ug/l. Since Al is known to bioaccumulate (Phillips and Russo 1978) and such small concentrations are known to be toxic, the levels observed at 29-1 and 29-2 are possibly toxic to aquatic organisms.

Mercury exists in the environment in various forms, with mercuric salts being the most common (U.S. EPA 1980b). However, the ability of certain microorganisms to convert inorganic and organic forms of Hg to the highly toxic methyl and dimethyl Hg has made any form of Hg highly hazardous to the environment (Jensen and Jernelou 1979). In water, under naturally occurring conditions of pH and temperature, inorganic Hg can be readily converted to methyl Hg (Bisogni and Lawrence 1973). Data presented by U.S. EPA (1980b) show that, depending on the Hg form and species and life stage of the organism, Hg can be either acutely or chronically toxic in low concentration. Since Hg is known to bioaccumulate (Phillips and Russo 1978, U.S. EPA 1980b), concentrations observed at 29-1 and 29-2 may be toxic to aquatic life.

Table 3: Physicochemical data for Fleming Creek

Parameter	Stations 29-1	29-2
Conductivity (umhos/cm @ 25°C)	270.0	385.0
pH	8.3	7.9
Air temperature (°C)	15.0	24.0
Water temperature (°C)	16.0	19.0
Turbidity (NTU)	26.0	22.0
DO (mg/l)	7.80	8.4
Acidity (mg/l)	12.0	19.0
Alkalinity (mg/l)	116.2	160.2
BOD_5 (mg/l)	1.3	1.4
Chloride (mg/l)	7.1	10.0
COD (mg/l)	8.2	8.2
CN (free) (mg/l)	K0.01	K0.01
Total Dissolved Solids (mg/l)	202.0	286.0
Fluoride (mg/l)	0.11	0.15
Total Hardness (mg/l)	169.0	234.0
Sulfide (mg/l)	K0.1	K0.1
Phenols (mg/l)	K0.1	K0.1
Sulfate (mg/l)	43.2	58.5
Suspended Solids (mg/l)	22.0	106.0
NH_3-N (mg/l)	0.19	0.17
NO_2 + NO_3 - N (mg/l)	0.035	0.025
TKN (mg/l)	0.55	0.46
Phosphorous (total) (mg/l)	0.089	0.103
Phosphorous (dissolved) Ortho (mg/l)	0.013	0.025
Phthalate Esters (ug/l)	11.0	15.0
Benzyl butyl phthalate (ug/l)	2.0	3.0
Bis (2-ethylhexyl) phthalate (ug/l)	2.0	3.0
Bi-n-butal phthalate (ug/l)	2.0	5.0
Di-n-octyl phthalate (ug/l)	K1.0	K1.0
Di-ethyl phthalate (ug/l)	5.0	4.0
Di-methyl phthalate (ug/l)	K1.0	K1.0
Al (total)) (ug/l)	641.0	989.0
As (total) (ug/l)	2.0	2.0
Ba (total) (ug/l)	76.0	65.0
Be (total) (ug/l)	K1.0	K1.0
Cd (total) (ug/l)	2.0	3.0
Ca (total) (mg/l)	50.0	82.0
Cr (total) (ug/l)	1.0	K1.0
Cu (total) (ug/l)	7.0	4.0
Fe (total) (ug/l)	944.0	516.0
Pb (total) (ug/l)	15.0	13.0
Mg (total) (mg/l)	13.9	13.5
Mn (total) (ug/l)	126.0	92.0
Hg (total) (ug/l)	1.4	1.3
Ni (total) (ug/l)	8.0	8.0
K (total) (mg/l)	2.9	3.15
Se (total) (ug/l)	K1.0	K1.0
Ag (total) (ug/l)	K1.0	1.0
Na (total) (mg/l)	4.85	8.0
Zn (total) (ug/l)	11.0	7.0
Al (dissolved) (ug/l)	641.0	336.0
Cd (dissolved) (ug/l)	1.0	3.0
Cr (dissolved) (ug/l)	1.0	K1.0
Cu (dissolved) (ug/l)	4.0	4.0
Fe (dissolved) (ug/l)	34.0	26.0
Pb (dissolved) (ug/l)	6.0	13.0
Mn (dissolved) (ug/l)	68.0	22.0
Hg (dissolved) (ug/l)	0.5	0.9
Se (dissolved) (ug/l)	K1.0	K1.0
Zn (dissolved) (ug/l)	ND	ND

K - below detection limit listed
ND - not determined

BIOLOGICAL EVALUATION

Biological data were collected and analyzed for the following groups of aquatic organisms: fecal coliform and fecal streptococcus bacteria, algae, macroinvertebrates and fish. Site specific data were compared with other sites sampled in the Licking River Basin, available historical data and appropriate scientific literature regarding environmental tolerances and requirements of aquatic organisms. It was determined that the Fleming Creek segment contained a diverse assemblage of aquatic organisms.

Although fecal coliform standards for primary contact recreation were violated at one site (29-1), the FC/FS ratio showed the source to be both human and animal in origin. However, through proper land and WWTP management, primary contact recreation standards should be attainable and Fleming Creek can support a primary contact recreation designation. Secondary contact recreation standards are currently being met at both sites.

A total of 130 taxa of algae were collected, which is a moderately diverse flora. The drainage supports a diverse macroinvertebrate fauna with a total of 77 taxa collected at the two sites. Twenty nine species of fish are known from the drainage and sport fishing pressure is heavy in some reaches of the stream.

Based on the diversity of habitat and aquatic organisms and the heavy use as a fishing stream, it is recommended that Fleming Creek be designated for Aquatic Life/Warmwater Aquatic Habitat per 401 KAR 5:031, Section 5 and that the criteria listed in that section be applied to the entire segment, without modification.

Bacteria

Of the two stations sampled, station 29-1 violated the fecal coliform standard for primary contact recreation, while the other station (29-2) had acceptable fecal coliform levels in two samples (Table 4). The FC/FS ratios indicated the source of pollution to be mixed (animal and human) in nature, and in the grey zone of interpretation (U.S. EPA 1972). Neither station violated the standard for pH. The probable causes of fecal coliform level violation for primary contact recreation are (1) improperly operating sewage treatment plant(s), (2) septic tank infiltration, and/or (3) agricultural runoff.

Table 4
Bacteriological Results From Fleming Creek

Date	Station/Location	Fecal Coliforms per 100 ml	Fecal Streptococci per 100 ml	FC/FS Ratio
6/May/82	29-1 Fleming Creek above Flemingsburg	1300	770	1.75
6/May/82	29-2 Fleming Creek below Flemingsburg	80 72	40 48	2.0 1.5

FC = Fecal Coliform
FS = Fecal Streptococcus

It is recommended that Fleming Creek and its tributaries be designated for primary and secondary contact recreation use (401 KAR 5:031, Section 7). The rationale is that the fecal coliform standard for primary contact recreation is attainable in Fleming Creek and its tributaries through proper land, water and wastewater operation.

Algae

The periphyton community consisted of a moderately diverse assemblage of typical stream forms, as well as eutrophic, planktonic algae. A total of 130 taxa (Appendix C) were encountered in the drainage with 97 taxa occurring at station 29-1 and 98 at 29-2. Diatom $\bar{d}$ and e appeared to be similar at both sites. While periphytometers were not utilized in this study, the qualitative differences noted in periphyton abundance on natural substrates seemed to indicate that station 29-2 receives greater nutrient impacts. Dense growths of Cladophora and Tetraspora were observed in riffle areas. The abundance of planktonic forms in Fleming Creek is probably due to the physical characteristics of the stream, which consisted mainly of pools. The plankton community at 29-1 was characterized by a diversity of mainly green and euglenoid algae, while station 29-2 was dominated by centric diatoms (indicative of eutrophic conditions).

The diatom community at 29-1 was typical of moderate to high quality eastern Kentucky streams, while station 29-2 was dominated by centric and pennate diatoms. The occurrence of soil diatoms and epipelic (associated with sediments) taxa is possibly reflective of land disturbance activities (e.g. agriculture and rock quarry) occurring in the watershed.

Fleming Creek

Station 29-1

The periphyton community consisted of moderate growths of filamentous green, blue-green and red algae (Appendix C). Planktonic species, representative of five algal divisions, were common due to the physical characteristics of the sampling site (mainly pools). Placoderm desmids were speciose. The community was dominated by alkaliphilous, pennate diatoms and Cladophora, a filamentous green alga typically found in productive, hardwater streams. The occurrence of certain euglenoid, green and blue-green algal taxa is suggestive of a moderate degree of nutrient enrichment (Palmer 1969, 1977), most likely from agricultural activities, although nutrient values were low at the time of sampling.

The diatom community was dominated by typical cool water stream species (Stephen Porter, unpublished data) characteristic of moderate to high quality eastern Kentucky streams (Harker et al. 1979). The presence of soil diatoms and epipelic species (Lowe 1974) is possibly reflective of agricultural station 29-2 receives greater nutrient impacts. Dense growths of Cladophora and Tetraspora were observed in riffle areas. The abundance of planktonic forms in Fleming Creek is probably due to the physical characteristics of the stream, which consisted mainly of pools. The plankton community at 29-1 was characterized by a diversity of mainly green and euglenoid algae, while station 29-2 was dominated by centric diatoms (indicative of eutrophic conditions).

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The diatom community was dominated by typical cool water stream species (Stephen Porter, unpublished data) characteristic of moderate to high quality eastern Kentucky streams (Harker et al. 1979). The presence of soil diatoms and epipelic species (Lowe 1974) is possibly reflective of agricultural siltation. Diatoms which are commonly observed as epiphytes of Cladophora were well represented in the community. The occurrence of Navicula protracta represents a new collection record for Kentucky (refer to Camburn 1982).

Fleming Creek

Station 29-2

The attached algal community (Appendix C) was dominated by dense growths of green algae, notably Cladophora and Tetraspora, blue-green algae and eutrophic indicator diatoms. Planktonic taxa were common due to the physical characteristics of the site (mainly pools); however, in contrast to station 29-1, the plankton community was dominated by centric diatoms. These species are generally found in the plankton of eutrophic lakes (Hutchinson 1967, Lowe 1974), as well as attached to Cladophora in littoral areas (Stevenson and Stoermer 1982). While periphytometers were not utilized in this study, qualitative differences noted in periphyton abundance on natural substrates seem to indicate that station 29-2 receives greater nutrient impacts. Although nutrient values were similar at both sites, station 29-2 has a greater potential for nutrient enrichment due to the presence of the Flemingsburg WWTP (located 32 km upstream), as well as from agricultural runoff.

The diatom community was dominated (23% relative abundance) by Stephanodiscus and Cyclotella, the centric diatom taxa referred to previously. The occurrence of Navicula tripunctata var. schizonemoides (10%) is often associated with nutrient rich waters (Lowe 1974) of high mineral content (Patrick and Reimer 1966). Those diatoms were either not present at 29-1 or relatively insignificant in the community. The balance of the diatom community consisted of typical cool water stream species, similar to that observed at the upstream site. The presence of soil diatoms and epipelic species suggests sedimentation impacts.

Macroinvertebrates

The invertebrate collections from this drainage contain most of the functional feeding groups associated with stream habitats (Appendix D). Species composition was evenly distributed among feeding groups and expressed considerable partitioning of the available habitats at both sites. The virtual absence of filterer organisms at 29-1 is most likely related to natural stream characteristics, since no obvious impacts to the community could be detected. Station 29-2 contained more diversity of habitats for invertebrates, which is reflected in the community structure.

The presence of freshwater mussels at both stations indicates a long term stability of acceptable water quality. This is due to their unique life history features, such as being sessile and siphoning (filtering) water internally to extract food. Collections of mussels by Ortmann (1919), from Fleming Creek in close proximity to station 29-2, indicates that an extant naiad fauna has existed in this stream throughout this century. This is a further indication that the water quality in this stream has remained stable during this century.

The communities at both sampling locations exhibited high taxa richness (50 at 29-1 and 54 at 29-2) and high species diversity ($\bar{d}$) (Appendix D). In addition, the majority of macroinvertebrates observed at both stations were considered to exhibit a facultative tolerance to environmental perturbations. Therefore, the macroinvertebrate data indicates that the Fleming Creek system has exhibited high water quality throughout this century.

Fleming Creek

Station 29-1

This site supported a diverse assemblage of macroinvertebrates including annelids, crustaceans, mollusks and all major groups of aquatic insects (Appendix D). The species diversity and total number of taxa were high, but the equitability was low. The riffle beetle Stenelmis sexlineata numerically dominated the quantitative collections. Most species observed at this location would be considered facultative to the impacts of municipal waste.

The benthic organisms collected from this site include most of the functional feeding groups and show ample partitioning of the habitats and food resources. Most of those habitats are associated with pool and bank areas. Filterer organisms, particularly the Hydropsychidae (which often dominate invertebrate collections) were not collected. This functional group appears to be the only component of the community that is not represented. Since no other alterations in the community structure were obvious, the absence of this particular group is attributed to insufficient stream flow, which is critical for their occurrence. In quantitative collections, the macroinvertebrates were evenly distributed among the functional groups, without excessive numbers of any group or species.

Fleming Creek

Station 29-2

Most of the available habitats for invertebrates are centered around the well defined riffle areas. Flat pieces of limestone rock of all sizes provided ample surface areas for periphyton colonization and invertebrate habitation. The community is composed of annelids, mollusks, crustaceans and all major groups of aquatic insects (Appendix D). The total number of taxa and species diversity were high and the equitability was moderate. As at station 29-1, the riffle beetle Stenelmis sexlineata exhibited the highest relative abundance. The community was numerically dominated by organisms that are considered facultative to the effects of municipal waste.

The scraper-grazer functional groups associated with riffle areas expressed most of the taxa richness. However, in the quantitative collections, the macroinvertebrates were speciose and evenly distributed between functional groups. In addition, a red alga Lemanea and the filamentous green algae Cladophora provided habitats for several hydroptilid caddisflies collected only in the qualitative samples. One of those Dibusa angata is considered rare in occurrence throughout the Commonwealth because of its strict environmental requirements and unique life history features (Houp and Resh 1983, in prep).

Fishes

Twenty three species of fish were collected at two stations during this survey (Appendix E). Jones (1970) reports an additional six species (Appendix E) from sampling and creel censuses. Habitat was diverse at both locations; i.e., long, deep pools, with undercut banks and exposed tree roots, interspersed with riffle areas. The fish community structure at both stations is rated as good by the assessment methods of Karr (1981).

Jones (1970) reported that fishing pressure on Fleming Creek is heavy, especially in the lower 20 miles of the stream, and fisherman success is considered fair to good. Species frequently occurring in the creel included bass (smallmouth, largemouth, spotted and rock), sunfish, crappie and carp.

Fleming Creek

Station 29-1

Fifteen species from five families and a total of 179 individuals were collected by seining. Redfin shiners (Notropis umbratilis) and bluntnose minnows (Pimphales notatus) were the most abundant cyprinids and the longear sunfish (Lepomis megalotis) was the most common centrarchid. Good populations of sport fish such as spotted bass (Micropterus punctulatus), rock bass (Ambloplites rupestris) and bluegill (Lepomis macrochirus) were present. The most common darter taken was the rainbow darter (Etheostoma caeruleum), a species fairly intolerant of pollution (Smith 1979, Pflieger 1975). Based on the present collection, the ichthyofauna at this site is rated as good (Karr 1981).

Fleming Creek

Station 29-2

Nineteen species from five families and a total of 300 individuals were collected by seining. As at the previous site, redfin shiners and bluntnose minnows were the most common species. The main differences between the stations were the higher diversity of cyprinids and the lower diversity of centrarchids at this site. The lower diversity of sunfish could be accounted for by the presence of deeper pools, which could not be sampled as effectively. In addition, four species that are somewhat intolerant were collected at this site as opposed to only three at the upstream site (29-1). The biotic integrity, based on fishes, was in the good range (Karr 1981).

Appendix A

Site Information

Site No:	05029001
Stream:	Fleming Creek
County:	Fleming
Location:	Below bridge on Fox Spring Road
Latitude:	38° 24' 49"
Longitude:	83° 41' 48"
Stream Order:	IV
USGS Topo Quad:	Flemingsburg, Kentucky
DOW Map No.:	16-51
RMI:	28.1
Sampling Dates:	6-May-82
Type Sampling:	Biological, Physicochemical
Stream Gradient:	Moderate
Pool Width:	10.9 m
Pool Depth:	0.1 to 0.6 m
Pool Substrate:	Bedrock with fines up to boulder size materials
Riffle Width:	ND
Riffle Depth:	0.05 to 0.3 m
Riffle Substrate:	Materials ranged from fines to boulders
Bank Height:	ND
Bank Slope:	East - <30%, West - 30 to 40%
Riparian Vegetation - %	
Trees:	60
Shrubs:	15
Herbs:	25
Exposed:	0

Width:	7.6 to 30.5 m
Canopy over Stream - %:	50 to 75
Bank Stability:	Good
Erosion:	Moderate, agricultural runoff
Sedimentation:	Slight
Imbeddedness:	1/4
Stream Habitat:	Undercut banks, submerged roots and logs, water-willow beds, various substrates
Hydraulic Obstructions:	Bridge abutment, log pile, large boulders
Physical Impacts:	None
Nonpoint Sources:	Farm pastures, Fox Spring Road

ND - Not Determined

Site Information

Site No:	05029002
Stream:	Fleming Creek
County:	Fleming
Location:	1.7 air miles SE of Pleasant Ridge church
Latitude:	38° 23' 04"
Longitude:	83° 53' 05"
Stream Order:	IV
USGS Topo Quad:	Cowan, Kentucky
DOW Map No.:	16-49
RMI:	6.15
Sampling Dates:	6-May-82
Type Sampling:	Biological, Physicochemical
Stream Gradient:	Moderate
Pool Width:	14.6 m
Pool Depth:	0.1 to 0.6 m
Pool Substrate:	Bedrock overlain with fines to boulder size materials
Riffle Width:	ND
Riffle Depth:	0.05 to 0.3 m
Riffle Substrate:	Materials ranged from fines to boulders
Bank Height:	ND
Bank Slope:	40 to 50%
<u>Riparian Vegetation - %</u>	
Trees:	60
Shrubs:	10
Herbs:	20

Exposed:	10 (lower bank)
Width:	North - >30.5 m, South - 8.0 to 15.0 m
Canopy over Stream - %:	25 to 50
Bank Stability:	Good
Erosion:	Slight along lower bank
Sedimentation:	Slight
Imbeddedness:	1/4
Stream Habitat:	Gravel bars, undercut banks, submerged roots and logs, water-willow, various substrates
Hydraulic Obstructions:	Log piles, large boulders
Physical Impacts:	None
Nonpoint Sources:	Pastures, tilled fields

ND - Not Determined

Appendix B

Riparian Vegetation for
Fleming Creek

Taxa	Stations 29-1	29-2
Acer negundo (boxelder)	X	X
A. saccharinum (silver maple)	-	X
A. saccharum (sugar maple)	X	-
Allium cernuum (wild onion)	X	-
Aquilegia canadensis (columbine)	-	X
Asarum canadense (wild ginger)	-	X
Barbarea vulgaris (winter cress)	X	-
Carex sp. (sedges)	X	-
Celtis occidentalis (hackberry)	X	-
Claytonia virginiana (spring beauty)	-	X
Collinsia verna (blue-eyed Mary)	-	X
Conium maculatum (poison hemlock)	-	X
Delphinium tricorne (spring lackspur)	-	X
Desmodium sp. (beggars lice)	-	X
Eleocharis sp. (spike rush)	-	X
Erigeron philadelphicus (fleabane)	X	-
Festuca arundinacea (fescue)	X	-
Galium sp. (bedstraw)	X	-
Glechoma hederacea (ground ivy)	X	-
Impatiens sp. (jewelweed)	X	-
Jeffersonia diphylla (twin leaf)	-	X
Justicia americana (water-willow)	X	X
Lamium amplexicaule (henbit)	X	-
Phlox divaricata (blue phlox)	-	X
Platanus occidentalis (sycamore)	X	X
Podophyllum peltatum (mayapple)	-	X
Polygonatum biflorum (solomon's-seal)	-	X
Ranunculus sp. (crowfoot)	X	X
Salix nigra (black willow)	-	X
Saururus cernuus (lizards tail)	-	X
Sedum ternatum (stonecrop)	-	X
Senecio aureus (ragwort)	-	X
Stellaria pubera (chickweed)	X	-
Taraxacum officinale (dandelion)	X	-
Ulmus americana (American elm)	X	X
Viola papilonacea (blue violet)	X	X
V. striata (white violet)	-	X
Total Species	19	24

Appendix C

Algal Synoptic List for

Fleming Creek

Taxa	Station 29-1	Station 29-2
Chlorophycophyta (Green Algae)		
Chlamydomonas sp.	-	X
Cladophora glomerata	X	X
Closteriopsis longissima	X	-
Closterium acerosum	X	X
C. moniliferum	X	X
Cosmarium spp.	X	X
Scenedesmus sp.	X	-
Sc. quadricauda	X	-
Spirogyra sp.	X	-
Stigeoclonium sp.	-	X
Tetraspora gelatinosa	-	X
Ulothrix sp.	X	-
unidentified green algal flagellates	X	X
Chrysophycophyta		
Chrysophyceae (Golden Algae)		
Mallomonas sp.	X	-
Bacillariophyceae (Diatoms)		
Achnanthes sp.	X	X
Ach. affinis	X	X
Ach. deflexa	X	-
Ach. lanceolata	-	X
Ach. lanceolata var. *dubia*	X	X

Algal Synoptic List for

Fleming Creek

Taxa	Station 29-1	Station 29-2
Ach. minutissima	X	X
Amphora perpusilla	X	X
Am. submontana	X	X
Am. veneta	X	X
Aulacosira distans var. alpigena	X	-
Caloneis bacillum	-	X
Cocconeis pediculus	X	X
Coc. placentula var. euglypta	X	X
Coc. placentula var. lineata	X	X
Cyclotella atomus	-	X
Cyc. meneghiniana	X	X
Cyc. pseudostelligera	-	X
Cyc. stelligera	-	X
Cymatopleura solea	X	X
Cymbella affinis	X	-
Cym. minuta	X	-
Cym. naviculiformis	X	-
Cym. prostrata	-	X
Cym. sinuata	X	X
Cym. sp. K	X	-
Eunotia sp.	-	X
Fragillaria capucina var. mesolepta	X	-
F. construens var. venter	-	X

Algal Synoptic List for

Fleming Creek

Taxa	Station 29-1	Station 29-2
F. vaucheriae	X	X
Frustulia vulgaris	X	X
Gomphonema spp.	X	X
G. angustatum	X	X
G. brasiliense	-	X
G. cf. intricatum	X	X
G. olivaceum	X	X
G. parvulum	X	X
G. tenellum	X	-
Gyrosigma scalproides	X	X
Gy. spencerii	X	X
Hantzschia amphioxys	X	X
Melosira varians	X	X
Meridion circulare	-	X
Navicula spp.	X	X
Nav. accomoda	-	X
Nav. arvensis	-	X
Nav. contenta var. biceps	X	X
Nav. cryptocephala	X	X
Nav. cryptocephala var. veneta	X	X
Nav. gottlandica	X	-
Nav. hustedtii	-	X
Nav. lanceolata	X	X

Algal Synoptic List for

Fleming Creek

Taxa	Station 29-1	Station 29-2
Nav. meniscuulus var. upsaliensis	X	X
Nav. minima	X	-
Nav. mutica	X	X
Nav. protracta	X	-
Nav. pupla	X	-
Nav. pygmaea	-	X
Nav. radiosa	-	X
Nav. radiosa var. parva	-	X
Nav. radiosa var. tenella	X	X
Nav. salinarum var. intermedia	X	X
Nav. secreta var. apiculata	X	X
Nav. subhamulata	X	X
Nav. symmetrica	X	X
Nav. tripunctata var. schizonemoides	X	X
Neidium affine	X	X
Nitzschia spp.	X	X
Nit. acicularis	X	X
Nit. acula	X	-
Nit. amphibia	X	-
Nit. angusta	-	X
Nit. apiculata	X	X
Nit. dissipata	X	X
Nit. gandersheimiensis	X	X

Algal Synoptic List for

Fleming Creek

Taxa	Station 29-1	Station 29-2
Nit. gracilis	X	X
Nit. hungarica	X	X
Nit. intermedia	X	X
Nit. linearis	X	X
Nit. palea	X	X
Nit. paleacea	X	-
Nit. parvula	-	X
Nit. sigma	X	-
Pinnularia sp.	X	X
P. borealis	-	X
P. obscura	-	X
Rhoicosphenia curvata	X	X
Stauroneis anceps f. gracilis	X	-
S. smithii	X	-
Stephanodiscus alpinus	-	X
St. hantzschii	-	X
St. subtilis	-	X
St. tenuis	-	X
Surirella sp.	-	X
Sur. angusta	X	X
Sur. ovalis	-	X
Sur. ovata	X	X
Sur. ovata var. salina	X	X

Algal Synoptic List for

Fleming Creek

Taxa	Station 29-1	Station 29-2
Synedra acus	X	X
Syn. radians	X	X
Syn. rumpens var. *familiaris*	X	X
Syn. ulna	X	X
Euglenophycophyta (Euglenoid Algae)		
Euglena sp.	X	X
E. acus	-	X
E. oxyuris	X	-
E. polymorpha	X	-
Trachelomonas sp.	X	-
Cryptophycophyta (Other flagellate algae)		
Cryptomonas ovata	X	-
Rhodophycophyta (Red Algae)		
Audouinella violacea	X	-
Lemanea sp.	-	X
Cyanochloronta (Blue-green Algae)		
Anabaina oscillarioides	-	X
Dactylococcopsis rhaphidioides	X	-
Microcoleus lyngbyaceous	X	-
M. vaginatus	X	-
Oscillatoria lutea	-	X
Schizothrix calcicola	X	X
Sch. mexicana	X	X
Total Taxa:	97	98

Fleming Creek Diatom Species Proportional Count

for Station 29-1

Taxa	Relative Abundance
Gomphonema olivaceum	29.5%
Cocconeis pediculus	19.3%
Surirella ovata	13.6%
Nitzschia dissipata	7.7%
Nitzschia intermedia	5.9%
Gomphonema parvulum	2.7%
Navicula salinarum var. intermedia	2.5%
Gomphonema angustatum	2.3%
Cocconeis placentula var. euglypta	1.8%
Achnanthes lanceolata var. dubia	1.2%
Fragillaria vaucheriae	1.1%
Navicula cryptocephala var. veneta	1.1%
Navicula lanceolata	1.1%
Nitzschia recta	0.7%
Synedra ulna	0.7%
Achnanthes deflexa	0.5%
Achnanthes minutissima	0.5%
Amphora perpusilla	0.5%
Navicula spp.	0.5%
Navicula pupula	0.5%
Navicula radiosa var. tenella	0.5%
Nitzschia spp.	0.5%
Achnanthes sp.	0.4%
Navicula cryptocephala	0.4%

Fleming Creek Diatom Species Proportional Count

for Station 29-1

Taxa	Relative Abundance
Navicula tripunctata var. schizonemoides	0.4%
Nitzschia acicularis	0.4%
Stauroneis smithii	0.4%
Surirella angusta	0.4%
Synedra radians	0.4%
Synedra rumpens var. familiaris	0.4%
Amphora veneta	0.2%
Cymatopleura solea	0.2%
Gomphonema cf. intricatum	0.2%
Gyrosigma scalproides	0.2%
Navicula secreta var. apiculata	0.2%
Nitzschia acula	0.2%
Nitzschia gandersheimiensis	0.2%
Nitzschia paleacea	0.2%
Pinnularia sp.	0.2%
Stauroneis anceps f. gracilis	0.2%
Surirella ovata var. salina	0.2%
Synedra acus	0.2%
Diversity ($\bar{d}$)	3.5385
Equitability (e)	0.4048

Fleming Creek Diatom Species Proportional Count

for Station 29-2

Taxa	Relative Abundance
Stephanodiscus subtilis	15.1%
Nitzschia dissipata	14.1%
Gomphonema olivaceum	11.7%
Surirella ovata	11.7%
Navicula tripunctata var. schizonemoides	10.3%
Cocconeis pediculus	6.3%
Stephanodiscus tenuis	5.2%
Navicula salinarum var. intermedia	2.6%
Navicula radiosa var. tenella	2.4%
Nitzschia linearis	2.4%
Rhoicosphenia curvata	2.4%
Cocconeis placentula var. euglypta	1.4%
Gomphonema angustatum	1.4%
Navicula secreta var. apiculata	1.2%
Cyclotella meneghiniana	1.0%
Navicula cryptocephala var. veneta	1.0%
Gomphonema parvulum	0.9%
Achnanthes lanceolata var. dubia	0.7%
Amphora perpusilla	0.7%
Stephanodiscus alpinus	0.7%
Cyclotella atomus	0.5%
Cymbella sinuata	0.5%
Navicula lanceolata	0.5%
Nitzschia recta	0.5%

Fleming Creek Diatom Species Proportional Count

for Station 29-2

Taxa	Relative Abundance
Synedra acus	0.5%
Fragillaria vaucheriae	0.3%
Melosira varians	0.3%
Navicula spp.	0.3%
Nitzschia spp.	0.3%
Stephanodiscus hantzschii	0.3%
Surirella ovata var. salina	0.3%
Achnanthes sp.	0.2%
Cyclotella pseudostelligera	0.2%
Gomphonema cf. intricatum	0.2%
Navicula radiosa	0.2%
Navicula radiosa var. parva	0.2%
Navicula subhamulata	0.2%
Nitzschia hungarica	0.2%
Nitzschia intermedia	0.2%
Nitzschia palea	0.2%
Surirella sp.	0.2%
Synedra radians	0.2%
Synedra rumpens var. familiaris	0.2%
Diversity ($\bar{d}$)	4.0667
Equitability (e)	0.5581

Appendix D

Macroinvertebrate Synoptic List for
Fleming Creek

Taxa	Stations 29-1	Stations 29-2
Haplotaxida		
Tubificidae		
Limnodrilus hoffmeisteri	-	X
Tubifex tubifex	-	X
Lumbriculida		
Lumbriculidae		
Limbriculus sp.	X	-
Basommatophora		
Ancylidae		
Ferrissia sp.	X	X
Physidae		
Physella sp.	X	X
Planorbidae		
Helisoma anceps	X	-
Mesogastropoda		
Pleuroceridae		
Elimia sp.	-	X
Pleurocera acuta	X	-
Heterodonta		
Sphaeriidae		
Sphaerium simile	X	X
Schizodonta		
Unionidae		
Alasmidonta viridis	X	-
Anodonta grandis grandis	X	X
Fusconaia flava f. flava	-	X
Lampsilis radiata luteola	X	X
Isopoda		
Asellidae		
Lirceus fontinalis	X	X
Amphipoda		
Gammaridae		
Gammarus sp.	-	X
Decapoda		
Cambaridae		
Orconectes rusticus	X	X
Ephemeroptera		
Baetidae		
Baetis tricaudatus	X	X
B. sp.	X	X
Caenidae		
Caenis sp.	-	X
Ephemerellidae		
Ephemerella sp.	-	X
Heptageniidae		
Heptagenia sp.	X	X

Macroinvertebrate Synoptic List for
Fleming Creek

Taxa	Stations 29-1	29-2
Stenacron interpunctatum	X	X
Stenonema pulchellum	-	X
Oligoneuriidae		
Isonychia pictipes	-	X
Odonata		
Calopterygidae		
Calopteryx sp.	-	X
Coenagrionidae		
Argia sp.	X	-
Enallagma sp.	X	X
Aeschnidae		
Boyeria vinosa	-	X
Gomphidae		
Dromogomphus sp.	X	-
Plecoptera		
Nemouridae		
Nemoura vinosa	-	X
N. sp.	X	-
Perlidae		
Acroneuria sp.	X	X
Perlodidae		
Isoperla sp.	-	X
Hemiptera		
Belostomatidae		
Belostoma sp.	-	X
Gerridae		
Gerris sp.	X	-
Coleoptera		
Dytiscidae		
Dytiscus sp.	X	-
Laccophilus sp.	-	X
Gyrinidae		
Dineutus sp.	X	-
Gyrinus sp.	-	X
Haliplidae		
Peltodytes simplex	X	-
P. sp.	-	X
Dryopidae		
Helichus sp.	X	-
Elmidae		
Dubiraphia vittata	X	X
Stenelmis sexlineata	X	X
S. sp. (larvae)	X	X
Psephenidae		
Psephenus herricki	X	X

Macroinvertebrate Synoptic List for
Fleming Creek

Taxa	Stations 29-1	29-2
Megaloptera		
Corydalidae		
Corydalus cornutus	X	X
Diptera		
Ceratopogonidae		
Bezzia-Johannsenomyia-Palpomyia	X	X
Chironomidae		
Cricotopus bicinctus	X	X
C. intersectus gp.	X	-
C. laricomalis gp.	-	X
C. tremulus gp.	-	X
Eukiefferiella brevicalcar gp.	X	-
E. pseudomontana gp.	X	X
Hydrobaenus sp.	X	-
Nanocladius spiniplenus	X	-
Orthocladius obumbratus	X	X
Parakiefferiella sp.	X	X
Parametriocnemus lundbecki	-	X
Paratendipes albimanus	X	-
Polypedilum convictum	X	X
P. illinoense	-	X
Thienemannimyia sp.	X	X
Simuliidae		
Simulium venustum	X	-
S. sp.	-	X
Tipulidae		
Limnophila sp.	-	X
Pedicia sp.	X	-
Pseudolimnophila sp.	X	-
Tipula strepens	-	X
T. sp.	X	-
Trichoptera		
Helicopsychidae		
Helicopsyche borealis	-	X
Hydropsychidae		
Cheumatopsyche sp.	-	X
Hydroptilidae		
Dibusa angata	-	X
Ochrotrichia sp.	X	X
Stactobella sp.	-	X
Philopotamidae		
Chimarra sp.	-	X
Polycentropodidae		
Polycentropus sp.	X	-
Rhyacophilidae		
Rhyacophila lobifera	X	X
Total	50	54

Macroinvertebrate Quantitative and Qualitative
Data and Relative Abundance (RA) for
Fleming Creek at Station 29-1

TAXA	QUAL	Quantitative 1	2	3	TOT	RA(%)
Haplotaxida						
Tubificidae						
Limnodrilus hoffmeisteri	-	2	3	3	8	1
Tubifex tubifex	-	6	4	2	12	1
Basommatophora						
Ancylidae						
Ferrissia sp.	5	1	2	-	3	1
Physidae						
Physella sp.	3	-	-	-	-	-
Planorbidae						
Helisoma anceps	2	-	-	-	-	-
Mesogastropoda						
Pleuroceridae						
Pleurocera acuta	8	-	-	-	-	-
Heterodonta						
Sphaeridae						
Sphaerium simile	8	2	4	-	6	1
Schizodonta						
Unionidae						
Alasmidonta viridis	3	-	-	-	-	-
Anodonta grandis grandis	4	-	-	-	-	-
Lampsilis radiata luteola	6	-	-	-	-	-
Isopoda						
Asellidae						
Lirceus fontinalis	27	30	33	25	88	8
Decapoda						
Cambaridae						
Orconectes rusticus	-	3	2	1	6	1
Ephemeroptera						
Baetidae						
Baetis tricaudatus	15	2	4	2	8	1
Baetis sp.	12	-	-	-	-	-
Heptageniidae						
Heptagenia sp.	10	5	10	8	23	2
Stenacron interpunctatum	1	2	3	2	7	1
Leptophlebiidae						
Leptophlebia sp.	-	6	8	4	18	2
Odonata						
Coenagrionidae						
Argia sp.	1	-	-	-	-	-
Enallagma sp.	13	-	-	-	-	-
Gomphidae						
Dromogomphus sp.	1	-	-	-	-	-

Macroinvertebrate Quantitative and Qualitative Data and Relative Abundance (RA) for Fleming Creek at Station 29-1

TAXA	QUAL	Quantitative 1	2	3	TOT	RA(%)
Plecoptera						
Nemouridae						
Nemoura sp.	16	10	12	3	25	2
Perlidae						
Acroneuria sp.	20	12	10	8	30	3
Hemiptera						
Gerridae						
Gerris sp.	1	-	-	-	-	-
Coleoptera						
Dytiscidae						
Dytiscus sp.	2	-	-	-	-	-
Gyrinidae						
Dineutus sp.	-	1	-	-	1	1
Haliptidae						
Peltodytes simplex	8	-	-	-	-	-
Dryopidae						
Helichus sp.	1	-	-	-	-	-
Elmidae						
Dubiraphia vittata	37	1	1	-	2	1
Stenelmis sexlineata	51	130	60	56	264	24
S. sp. (larvae)	-	120	111	116	347	33
Psephenidae						
Psephenus herricki	-	15	17	11	43	4
Megaloptera						
Corydalidae						
Corydalus cornutus	-	1	3	-	4	1
Diptera						
Ceratopogonidae						
Bezzia-Johannsenomyia-Palpomyia	-	*	*	*	3	1
Chironomidae						
Cricotopus bicinctus	-	*	*	*	1	1
C. intersectus gp.	-	*	*	*	2	1
Eukiefferiella brevicalcar gp.	-	*	*	*	3	1
E. pseudomontana gp.	-	*	*	*	20	2
Hydrobaenus sp.	-	*	*	*	5	1
Nanocladius spiniplenus	-	*	*	*	3	1
Orthocladius obumbratus	-	*	*	*	67	6
Parakiefferiella sp.	-	*	*	*	2	1
Paratendipes albimanus	-	*	*	*	1	1
Polypedilum convictum	-	*	*	*	11	1
Thienemannimyia sp.	-	*	*	*	2	1
Simuliidae						
Simulium venustum	13	7	11	3	21	2
Tipulidae						
Pedicia sp.	1	-	-	-	-	-

Macroinvertebrate Quantitative and Qualitative
Data and Relative Abundance (RA) for
Fleming Creek at Station 29-1

TAXA	QUAL	Quantitative 1	2	3	TOT	RA(%)
Pseudolimnophila sp.	-	1	1	-	2	1
Tipula sp.	1	1	1	-	2	1
Trichoptera						
Hydroptilidae						
Ochrotrichia sp.	15	4	5	3	12	1
Polycentropodidae						
Polycentropus sp.	-	2	-	-	2	1
Rhyacophilidae						
Rhyacophila lobifera	7	1	1	1	3	1
TOTAL					1039	

Total Number of Taxa = 50

Species Diversity ($\bar{d}$) = 3.3217

Equitability (e) = 0.3784

* = Samples were inadvertently combined

Macroinvertebrate Quantitative and Qualitative
Data and Relative Abundance (RA) for
Fleming Creek at Station 29-2

		Quantitative				
TAXA	QUAL	1	2	3	TOT	RA(%)
Lumbriculida						
Lumbriculidae						
Limbriculus sp.	-	14	9	-	23	2
Basommatophora						
Ancylidae						
Ferrissia sp.	-	8	-	-	8	1
Physidae						
Physella sp.	7	-	-	-	-	-
Mesogastropoda						
Pleuroceridae						
Elimia sp.	33	8	-	4	12	1
Heterodonta						
Sphaeriidae						
Sphaerium simile	2	37	27	14	78	6
Schizodonta						
Unionidae						
Anodonta grandis grandis	2	-	-	-	-	-
Fusconaia flava f. flava	1	-	-	-	-	-
Lampsilis radiata luteola	3	-	-	-	-	-
Isopoda						
Asellidae						
Lirceus fontinalis	4	-	13	8	21	2
Amphipoda						
Gammaridae						
Gammarus sp.	5	-	-	-	-	-
Decapoda						
Cambaridae						
Orconectes rusticus	-	-	1	1	2	1
Ephemeroptera						
Baetidae						
Baetis tricaudatus	8	23	14	16	53	4
B. sp.	5	-	-	-	-	-
Caenidae						
Caenis sp.	4	-	-	-	-	-
Ephemerellidae						
Ephemerella sp.	-	16	24	-	40	3
Heptageniidae						
Heptagenia sp.	-	14	-	18	32	2
Stenacron interpunctatum	1	-	6	-	6	1
Stenonema pulchellum	8	8	-	9	17	1
Oligoneuriidae						
Isonychia pictipes	-	4	-	2	6	1
Odonata						
Calopterygidae						
Calopteryx sp.	7	-	-	-	-	-

Macroinvertebrate Quantitative and Qualitative
Data and Relative Abundance (RA) for
Fleming Creek at Station 29-2

		Quantitative				
TAXA	QUAL	1	2	3	TOT	RA(%)
Coenagrionidae						
Enallagma sp.	11	-	-	-	-	-
Aeschnidae						
Boyeria vinosa	2	-	-	-	-	-
Plecoptera						
Nemouridae						
Nemoura vinosa	18	25	16	22	63	5
Perlidae						
Acroneuria sp.	22	17	23	14	54	4
Perlodidae						
Isoperla sp.	3	21	13	19	53	4
Hemiptera						
Belostomatidae						
Belostoma sp.	1	-	-	-	-	-
Coleoptera						
Dytiscidae						
Laccophilus sp.	1	-	-	-	-	-
Gyrinidae						
Gyrinus sp.	1	-	-	-	-	-
Haliplidae						
Peltodytes sp.	5	-	-	-	-	-
Elmidae						
Dubiraphia vittata	12	2	3	6	11	1
Stenelmis sexlineata	22	189	68	32	289	22
S. sp. (larvae)	-	213	63	28	304	24
Psephenidae						
Psephenus herricki	8	43	42	11	96	7
Megaloptera						
Corydalidae						
Corydalus cornutus	1	-	2	-	2	1
Diptera						
Ceratopogonidae						
Bezzia-Johannsenomyia-Palpomyia	-	1	-	-	1	1
Chironomidae						
Cricotopus bicinctus	-	-	1	-	1	1
C. laricomalis gp.	-	17	4	4	25	2
C. tremulus gp.	-	-	1	-	1	1
Eukiefferiella pseudomontana gp.	-	7	6	1	14	1
Orthocladius obumbratus	-	12	4	3	19	1
Parakiefferiella sp.	-	2	1	1	4	1
Parametriocnemus lundbecki	-	-	1	-	1	1
Polypedilum convictum	-	3	8	1	12	1
P. illinoense	-	-	1	-	1	1
Thienemannimyia sp.	-	1	4	1	6	1

Macroinvertebrate Quantitative and Qualitative
Data and Relative Abundance (RA) for
Fleming Creek at Station 29-2

		Quantitative				
TAXA	QUAL	1	2	3	TOT	RA(%)
Simuliidae						
Simulium sp.	14	18	-	-	18	1
Tipulidae						
Limnophila	-	2	2	-	4	1
Tipula strepens	1	-	-	-	-	-
Trichoptera						
Helicopsychidae						
Helicopsyche borealis	1	-	-	-	-	-
Hydropsychidae						
Cheumatopsyche sp.	4	-	-	-	-	-
Hydroptilidae						
Dibusa angata	6	-	-	-	-	-
Ochrotrichia sp.	16	1	-	-	1	1
Stactobiella sp.	5	-	-	-	-	-
Philopotamidae						
Chimarra sp.	4	6	-	-	6	1
Rhyacophilidae						
Rhyacophila lobifera	2	1	1	2	4	1
Total					1288	

Total Number of Taxa = 54

Species Diversity ($\bar{d}$) = 3.7144

Equitability (e) = 0.5278

Appendix E

Fish Synoptic List for Fleming Creek

Taxa	Stations 29-1	29-2
Cyprinidae		
Campostoma anomalum central stoneroller	8	11
**Cyprinus carpio* carp	-	-
Notropis ardens rosefin shiner	-	40
Notropis chrysocephalus striped shiner	7	28
Notropis stramineus sand shiner	-	3
Notropis umbratilis redfin shiner	63	90
Pimephales notatus bluntnose minnow	32	82
Semotilus atromaculatus creek chub	-	1
Catostomidae		
**Catostomus commersoni* white sucker	-	-
Hypentelium nigricans northern hog sucker	-	1
Minytrema melanops spotted sucker	1	-
Moxostoma erythrurum golden redhorse	-	2
Ictaluridae		
Noturus flavus stonecat	-	1
Atherinidae		
Labidesthes sicculus brook silverside	4	-

Fish Synoptic List for
Fleming Creek

Taxa	Stations 29-1	29-2
Centrarchidae		
Ambloplites rupestris rock bass	2	1
Lepomis cyanellus green sunfish	7	1
Lepomis macrochirus bluegill	4	-
Lepomis megalotis longear sunfish	18	2
*Micropterus dolomieui smallmouth bass	-	-
Micropterus punctulatus spotted bass	3	-
*Micropterus salmoides largemouth bass	-	-
*Pomoxis annularis white crappie	-	-
Percidae		
Etheostoma blennioides greenside darter	2	16
Etheostoma caeruleum rainbow darter	17	10
Etheostoma flabellare fantail darter	10	2
Etheostoma nigrum johnny darter	1	2
*Etheostoma spectabile orange throat darter	-	-
Percina caprodes logperch	-	6

Fish Synoptic List for
Fleming Creek

Taxa	Stations	
	29-1	29-2
Percina maculata blackside darter	-	1
Total Individuals	179	300
Total Species	15	19

Families = 6
Genera = 17
Species = 29

* Reported by Jones 1970

Appendix F

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