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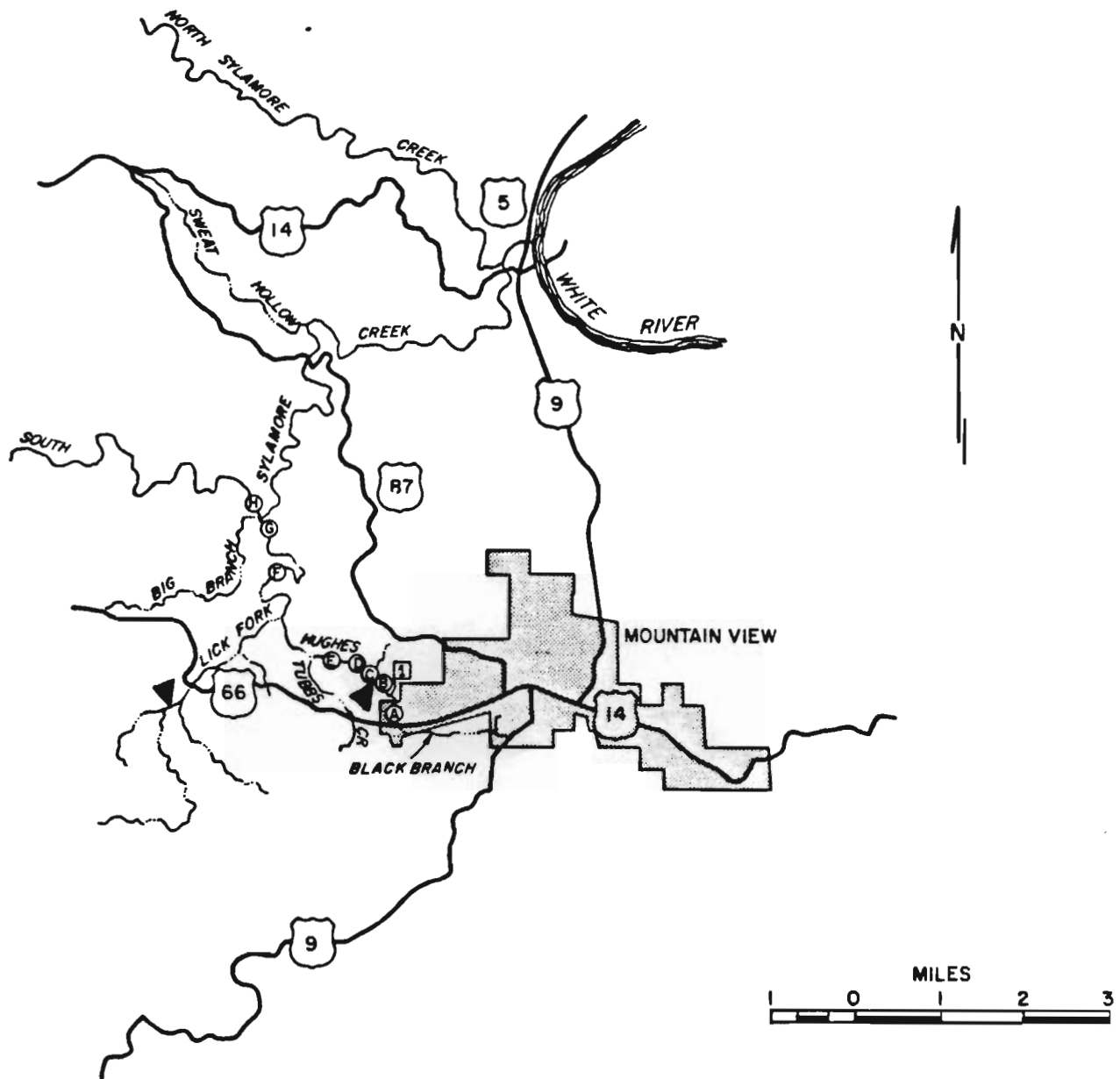
Use Attainability Analysis for Hughes Creek
and Lower Lick Fork Creek, Stone County, Arkansas

INTRODUCTION

Regulation # 2, as amended, "Regulation Establishing Water Quality Standards for the Surface Waters of the State of Arkansas", designates South Sylamore Creek for the following uses: coolwater fishery, primary and secondary contact recreation, public, industrial and agricultural water supply. Neither Lick Fork Creek nor Hughes Creek is listed in the "Regulation" and therefore is protected for the same uses as South Sylamore Creek. This Use Attainability Analysis will attempt to define the attainable uses in these waters in accordance with 40 CFR, parts 35, 120 and 131 as published in the Federal Register/vol. 48, No. 217 Tuesday, Nov. 8, 1983. "The Waste Load Allocation Study" by Summerlin Associates, Inc., September 1982, "Procedures for Implementation of the Intermittent Stream Policy" by McClelland Consulting Engineers, Inc., January 1984 and field investigations by Department of Pollution Control and Ecology staff on December 4, 1984, were used in the analysis.

DESCRIPTION OF AREA

Section II of the "Waste Load Allocation Study" provides an adequate description of the study area including the existing



- ⊙ Intensive Survey Instream Sampling Stations
- ☐ City of Mountain View Sewage Treatment Plant
- ▲ Use Attainability Analysis Sampling Site

STONE COUNTY
ARKANSAS



Figure 1
MAP OF STUDY AREA

segment rating system was developed to compare the physical characteristics of the streams in relation to their biological potential (Appendix A).

Benthic macroinvertebrates were collected qualitatively using a Turtox Indestructible d-frame dip net and sampling all available microhabitats for 30 minutes. During this period, all material collected was placed in a five gallon plastic container, preserved with 10% formalin and then sealed for transport to the laboratory. In the lab, samples were initially sorted using a # 30 U.S. Standard mesh sieve. Macroinvertebrates were then hand picked from all material retained by the # 30 sieve. After sorting, benthos were identified, enumerated and stored in 70% ETOH. The collections were analyzed to indicate similarity of the two benthic community structures and the relative abundance of typical and indicative taxa.

The Jaccard Coefficient (Jaccard, 1912), Dice Index and Ochiai Index (EPA, 1983), three qualitative similarity indices were calculated to determine the similarity of benthic samples from Hughes and upper Lick Fork Creeks. These three indices are the most attractive qualitative similarity measures according to Boesch (1977) and have been widely used by stream pollution investigators (Cairns and Dickson, 1971; Johnson and Brinkhurst, 1971; Kaesler and Cairns, 1972; and Foerster, 1974).

In addition, several indices, which have been developed to evaluate benthic communities as indicators of water quality, were calculated for both collections. These include Shannon-Weiner diversity index (Wihlm and Dorris, 1968), index of evenness, variety, and equitability (ADPC&E, 1984); Biotic Condition Index (Winget and Mangum, 1979); Chandler Biotic Score as modified by Cook (1976); and a modification of Hisenhoff's Biotic Index (1982).

Fishes were collected with backpack electrofishing gear producing 110 volts of alternating current with a maximum output of 300 watts. Approximately 200 yards of the stream were sampled for about one hour. All fishes dipped from the stream were preserved in 10% formalin and returned to lab for identification. After enumeration, a relative abundance value was assigned to each species. These values ranged from 1 to 4 in increments of 0.5 for each age group i.e., adult, intermediate and young, for each species. The maximum possible score for a species is 12 with a minimum of 1 (See Appendix B). The Shannon-Weiner dominance diversity index and other population metrics were calculated using the relative abundance values rather than numbers of individuals collected. A fish population rating system was devised to compare the population structure of physically similar streams (See Appendix C).

RESULTS AND DISCUSSION

Physical Characteristics

There was substantial physical similarity between the two streams (Table 1). The major differences were in the stream-bottom substrate type, the stream canopy and in the watershed uses. The Stream Segment Rating System produced a score of 25.1 for Hughes Creek and 18.8 for upper Lick Fork Creek. The numerical values of the score are most important for their comparative value rather than actual value. A higher score for Hughes Creek was a result of more useful instream substrate cover dominated by rubble, boulders and gravel in comparison to bedrock dominated substrate in upper Lick Fork Creek and more stream canopy on Hughes Creek. Upper Lick Fork Creek scored slightly higher in instream cover and less disturbance in the watershed. The rock substrate immediately below the Mt. View STP in Hughes Creek had a distinct green stain from algae growth and approximately 100 feet below the outfall, the rocks were covered with a dark, brownish fungi coating.

The very small watersheds above these stream segments and the very high stream gradients provide stream flows at these sites (except for the Mt. View STP discharge) only during periods of frequent rainfall during the fall, winter and spring. Summerlin et.al. 1982, states "Flow in Hughes Creek is intermittent, with effluent from the City's wastewater treatment plant comprising the majority

TABLE 1. COMPARISON OF PHYSICAL FEATURES OF HUGHES CREEK AND UPPER LICK FORK CREEK MEASURED ON DECEMBER 4, 1984.

	<u>Hughes Creek</u>	<u>Upper Lick Fork Creek</u>
Watershed	3-5 mi ²	5-7 mi ²
Gradient	75 ft/mi	80 ft/mi
Stream Width	15.2 ft.	27.1 ft.
Measured Flow	2.94 CFS	2.64 CFS
Estimated Depth	1.5 ft.	1.0 ft.
Instream Cover		
undercut bank	2.6%	5.2%
brush, logs, debris	1.3%	1.5%
Substrate Types (%)		
Bedrock	-	72.4
Lg. Boulder	7.2	3.7
Boulder	16.9	0.7
Rubble	57.8	8.2
Gravel	14.5	11.2
Sand	2.4	1.5
Mud/Silt	1.2	2.2
Canopy	94%	32%
Bank Stability	100% stable	80% stable 20% mod. stable
Watershed Land Uses	40% Urban-heavy grazing 60% undisturbed	20% heavy grazing 80% undisturbed

of the flow during periods of low runoff". It was also stated that, "Lick Fork and Tubbs Creek... flow intermittently during the summer months". Below the confluence of upper Lick Fork and Hughes Creeks, the stream gradient flattens to 40 ft./mi. and the drainage area has increased to approximately 13.5 square miles. This provides permanent, flowing waters during wet periods and enduring pools with intergravel flows during critical, low-flow periods.

Biological Characteristics

By comparing the biological characteristics of upper Lick Fork and Hughes Creek, it quickly becomes apparent that the effects from the Mt. View STP discharge overrides the physical similarities of these two streams.

Macroinvertebrates- The qualitative similarity indices demonstrated that the Hughes Creek and upper Lick Fork Creek benthic communities were highly dissimilar. The range of these indices are from 0-1; the closer the value is to one the more the samples have in common. All three values calculated were well below 0.3 (Table 2). Of the 81 taxa indentified from the collection, only 13 were present at both sites. These 13 taxa composed only 13% and 9% of the numerical total from Hughes and upper Lick Fork Creeks, respectively (Table 3). Each of five

Table 2. Community parameters calculated to compare Lick Creek and Hughes Creek macroinvertebrate samples taken 5-6 Dec. 1984.

COMMUNITY PARAMETER	Lick Creek	Hughes Creek
TOTAL # ORG.	1011	1250
TOTAL # TAXA	57	37
Diversity	4.1434	2.9443
INDEX of VARIETY	5.6103	3.4993
INDEX of EVENNESS	0.7103	0.5650
INDEX of DOMINANCE	0.3959	0.6036
BCI	0.8695	0.6036
CBS	56.96	53.27
HBI	1.1236	2.5216
JACCARDS COEFF.		0.1605
DICE INDEX		0.2765
OCHIAI INDEX		0.2831

Table 3. Macroinvertebrates present in both Lick Creek and Hughes Creek samples taken 5 & 6 Dec.1984.

TAXA	LICK CREEK NO.	%TOT.	HUGHES CREEK NO.	%TOT.
EPHEMEROPTERA				
Caenis	36	3.6	48	3.8
Eurylophella bicolor	19	1.9	25	2.0
Stenonema femoratum	1	<0.1	3	0.2
ODANATA				
Argia	2	0.2	52	4.2
Dromogomphus	1	<0.1	1	<0.1
COLEOPTERA				
Copelatus c. princeps	1	<0.1	2	0.2
Helichus	1	<0.1	8	0.6
Peltodytes lengi	6	0.6	1	<0.1
Psephenus	1	<0.1	2	0.2
TRICHOPTERA				
Cheumatopsyche	18	1.8	4	0.3
MEGALOPTERA				
Corydalis cornutus	1	<0.1	5	0.4
ISOPODA				
Lirceus	6	0.6	4	0.3
GASTROPODA				
Physa	2	0.2	10	0.7
=====				
TOTAL TAXA	13		13	
TOTAL NO. ORG.	95		164	
TOTAL % SAMPLE	9		13	
=====				

orders were found to compose greater than 10% of the numerical total from the upper Lick Fork Creek sample, totaling 84.2%. In the Hughes Creek, sample only two orders dominated. They accounted for 84.3% of the sample.

The benthic community of upper Lick Fork Creek was very diverse (57 taxa) and contained several taxa which are characteristic of clean, high-quality ecosystems. These include Allocapnia and Isoperla clio (stoneflies), Leptophlebia and Eurylophella bicolor (mayflies), and Chimarra obscura and Helicopsyche borealis (caddisflies). Numerically, the five dominant taxa from upper Lick Fork Creek were Isotomurus palustris (springtail), Allocapnia, Leptophlebia, Viviparus (snail), and Tipula (crane fly) comprising 58.9% of the sample. Of these 5 dominant taxa only the crane fly was collected from Hughes Creek (Table 4).

The benthic community of Hughes Creek was represented by 37 taxa, 20 fewer than from upper Lick Fork Creek. The benthic community was dominated by naidid worms and bloodworms comprising 72% of the sample numerically. The five dominant taxa collected from Hughes Creek were Haemonais (naidid worm), Glyptotendipes, Ablabesmyia, Phaenopsectra flavipes (all bloodworms) and Caenis (mayfly). They comprised 83.5% of the sample (Table 5). Of these only Caenis was collected from upper Lick Fork Creek. The domination of a benthic community by naidid worms and bloodworms is characteristic of streams which are receiving excessive organic enrichment.

Table 4. Macroinvertebrate community of Lick creek from above AR.hwy 66.
30 min Qual. sample taken 6 Dec. 1984.

TAXA	Fd. Gr.	no. of org. cuml.	no. of indiv.	% of Total cuml.	% of Total indiv.
PLECOPTERA		224		22.0	
Allocapnia	SH		187		18.5
Isoperla clio	PR		34		3.3
Taeniopteryx	SH		2		0.2
Acroneuria evoluta	PR		1		0.1
COLLEMBOLA		219		21.7	
Isotomurus palustris	CO		219		21.7
EPHEMEROPTERA		176		17.4	
Leptophlebia	SH		71		7.0
Cloeon rubropictum	CO		41		4.1
Caenis	CO		36		3.6
Eurylophella bicolor	CO		19		1.9
Baetis tricaudatus	CO		7		0.7
Stenonema femoratum	CO		1		<0.1
Stenonema luteum	CO		1		<0.1
DIPTERA		129		12.8	
Tipula	SH		51		5.0
Cricotopus	CO		31		3.1
Ablabesmyia	PR		17		1.7
Tribelos	CO		16		1.6
Tanytarsus	CO		7		0.7
Limnophora	SH		2		0.2
Simulium clarki	CO		2		0.2
Pilaria	CO		1		<0.1
Prosimulium mixtum	CO		1		<0.1
Tabanus	PR		1		<0.1
TRICHOPTERA		104		10.3	
Chimarra obscura	CO		32		3.2
Glossosoma	CO		20		2.0
Cheumatopsyche	CO		18		1.8
Helicopsyche borealis	SC		11		1.1
Hydroptila	CO		8		0.8
Agraylea	CO		4		0.4
Hydropsyche	CO		4		0.4
Pycnopsyche	SH		4		0.4
Polycentropus flavus	CO		3		0.3
GASTROPODA		70		7.0	
Viviparus	SC		68		6.7
Physa	SC		2		0.2
COLEOPTERA		39		3.9	
Coleoptera sp. (larva)	UN		15		1.5
Optioservis (larva)	CO		8		0.8
Peltodytes lengi (larva & adult)	CO		6		0.6
Helichus (larva & adult)	SC		2		0.2
Tropisternus elipiticus	CO		2		0.2
Uvarus	PR		2		0.2
Copelatus c. princeps	PR		1		0.1
Dubriaphia vitatta	CO		1		0.1
Lutrochus	SC		1		0.1
Psephenus	SC		1		0.1
Scirtes	SC		1		0.1
TURBELLARIA		21		2.1	
Dugnesia tigrina	CO		21		2.1
ODONATA		7		0.7	
Argia	PR		2		0.2
Calopteryx	PR		2		0.2
Basiaeschna janata	PR		1		0.1
Boyeria vinosa	PR		1		0.1
Dromogomphus spoilatus	PR		1		0.1
ANNELLIDA		6		0.6	
Amphichatae	CO		6		0.6
ISOPODA		6		0.6	
Lirceus hoppinae	CO		6		0.6
PELECYPODA		6		0.6	
Musculium	CO		6		0.6
AMPHIPODA		2		0.2	
Gammarus faciatatus	CO		2		0.2
ACARINA		1		0.1	
Lebertia	PR		1		0.1
MEGALOPTERA		1		0.1	
Corydalus cornutus	PR		1		0.1
Total Taxa = 57		PR= 6.4	SC= 11.1	UN= 2.0	
Total no. org. = 1011		CO= 51.0	SH= 31.2	MI= 0.0	

Table 5. Macroinvertebrate community of Hughes Creek from below MT.View
STP outfall. 30 min. sample taken 5 Dec. 1984.

TAXA	Fd. Gr.	no. of org. cuml.	indv.	% of Total cuml. indv.
DIPTERA		663		53
Glyptotendipes	CO		367	29.4
Ablabesmyia	PR		146	11.7
Phaenopsectra flavipes	CO		97	7.8
Cricotopus	CO		18	1.4
Microtendipes	CO		12	1.0
Polypedilum fallax	CO		9	0.7
Tipula	SH		5	0.4
Cryptochironomus	PR		4	0.3
Psycoda	CO		4	0.3
Helius	SH		1	<0.1
OLIGOCHAETAE		391		31.3
Haemonais	CO		391	31.3
EPHEMEROPTERA		86		6.9
Caenis	CO		48	3.8
Eurylophella bicolor	CO		25	2.0
Paraleptophlebia	CO		6	0.4
Stenonema femoratum	CO		3	0.2
Stenonema pulchellum	CO		3	0.2
Stenacron interpunctatum	CO		1	<0.1
ODONATA		54		4.3
Argia	PR		52	4.2
Neurocordulia	PR		1	<0.1
Dromogomphus spinosus	PR		1	<0.1
COLEOPTERA		23		1.8
Helichus (larva)	SC		8	0.6
Stenelmis (larva)	SC		4	0.3
Hydrovatus	PR		3	0.2
Laccophilus	PR		3	0.2
Copelatus c. princeps	PR		2	0.2
Psephenus herricki	SC		2	0.2
Peltodytes lengi	SH		1	<0.1
GASTROPODA		12		1.0
Physa	SC		10	0.7
Ferrissia	SC		1	<0.1
Heliosoma	SC		1	<0.1
MEGALOPTERA		5		0.4
Corydalus cornutus	PR		5	0.4
PLECOPTERA		5		0.4
Prostoia completa	SH		5	0.4
ISOPODA		4		0.3
Lirceus hoppinae	CO		4	0.4
TRICHOPTERA		4		0.2
Cheumatopsyche	CO		2	0.2
Limnephilus	SH		2	0.2
AMPHIPODA		2		0.2
Hyalella azteca	CO		2	0.2
PELECYPODA		1		<0.1
Corbicula fluminea	CO		1	<0.1
Total Taxa = 37	PR= 17.0	SC= 2.1	UN= 0.0	
Total no. org. = 1250	CO= 79.8	SH= 1.1	MI= 0.0	

In addition to the taxonomic differences, the community parameters calculated indicated that the upper Lick Fork Creek benthic community was characteristic of an undisturbed ecosystem with "good quality" water (Table 2). In all indices calculated, upper Lick Fork Creek was shown to be less impacted and of higher quality water.

The differences in the two benthic communities were also exhibited by the percent composition of the functional feeding groups (Tables 4 and 5). The upper Lick Fork Creek macroinvertebrate community was composed primarily of collectors (51%), closely followed by shredders (31.2%), then scrapers (11.1%) and predators (6.4%). In contrast Hughes Creek was dominated by collectors (79.8%), with predators (17%), scrapers (2.1%), and shredders (1.1%). The near absence of shredders from Hughes Creek is probably in response to the organic enrichment caused by Mt. View STP effluent.

Fish Populations - The fish populations in Hughes Creek and upper Lick Fork Creek were also highly dissimilar as shown in Table 6. The Jaccard qualitative similarity index of 0.25 demonstrates the degree of dissimilarity among the species present. A very few individuals were collected from Hughes Creek in relation to the area of stream sampled. In contrast the number of fish collected in upper Lick Fork was similar to the number anticipated. The fishes collected in Hughes Creek were predominantly adults and

TABLE 6. COMPARISON OF FISH POPULATION PARAMETERS OF UPPER LICK FORK CREEK AND HUGHES CREEK, SAMPLED DECEMBER 4, 1984.

	<u>Hughes Cr</u>	<u>Upper Lick Fork Cr</u>
Total Species	5	10
Total No. Individuals	17	380
Total Relative Abundance Value	11	59
Diversity Index	2.14	2.84
Sensitive Species	2	9
Fish Population Rating Score	45.9	93.6

Jaccard Qualitative Similarity Index = 0.25

most likely were recent migrants into the area. The upper Lick Fork fish population was also dominated by adult individuals, although other age classes of some species were prevalent. The type and small-size species present indicates that this also is predominantly an emigrant population composed of headwater-type species that inhabit intermittent streams. Figure 2 shows the characteristic species collected from upper Lick Fork Creek and the total individuals collected. Figure 3 shows the total fish collection made from Hughes Creek. Fish species and their relative abundance for both sites are listed in Table 7. In addition to the number of individuals, upper Lick Fork Creek had higher total species, relative abundance value, diversity index, and number of sensitive species than Hughes Creek. The fish population rating score, which rates the above and other features of the population, was 93.6 for upper Lick Fork Creek and 45.9 for Hughes Creek, indicating a substantial difference. These differences are a result of frequent or perhaps continuous deterioration of the Hughes Creek water quality by the Mt. View STP discharge.

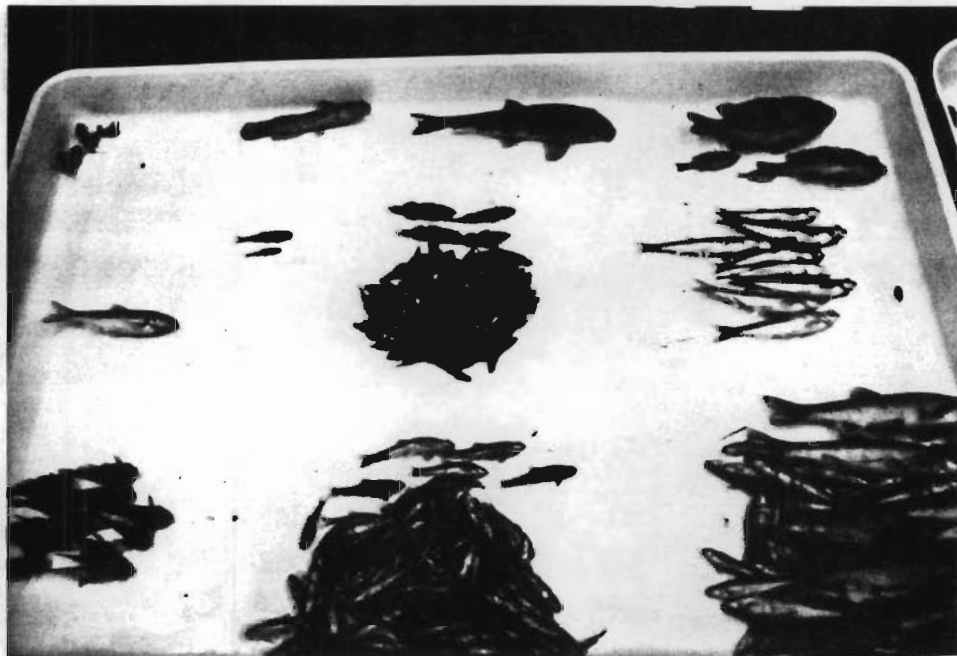
SUMMARY AND CONCLUSIONS

1. Mt. View STP discharge enters Hughes Creek approximately 2.1 miles above its confluence with Lick Fork Creek.
2. Upper Lick Fork Creek (above its confluence with Hughes

Figure 2. Fish Population Collection from Upper Lick Fork Creek December 4, 1984.



Representative Individuals of all Species



Total Fish Population Collection

Figure 3. Total Fish Population Collection from Hughes Creek below the Mt. View STP on December 4, 1984.



TABLE 7. LIST OF SPECIES AND RELATIVE ABUNDANCE VALUE FROM
UPPER LICK FORK CREEK AND HUGHES CREEK, DECEMBER 4, 1984.

<u>Species</u>	<u>Hughes Cr.</u>	<u>Upper Lick Fork Cr.</u>
Campostoma anomalum	4	12
*Notropis chrysocephalus	-	1
*Notropis pilsbryi	-	3
*Phoxinus erythrogaster	1	12
*Pimephales tenellus	-	2
*Hypentelium nigricans	-	1
*Noturus exilis	-	1
Lepomis cyanelus	3	-
Lepomis megalotis	-	6
*Etheostoma punctulatum	1.5	-
*Etheostoma spectabile	1.5	12
*Cottus carolinae	-	9
Total	11	59

* Sensitive Species

Creek) and Hughes are physically similar headwater streams with high gradient (75 to 80 ft./mi.) and very small watersheds (3-5 square miles). Both have intermittent flows and during dry periods the only flow in Hughes Creek is from the STP.

3. Between the confluence of Hughes Creek to the confluence of South Sylamore Creek, Lick Fork Creek flattens to a gradient of about 40 ft/mi with a watershed of over 13 square miles. This produces permanent flowing waters or enduring pools with intergravel flows and a permanent coolwater fish population.

4. The qualitative similarity indices demonstrated that substantial differences exist between upper Lick Fork Creek and Hughes Creek macroinvertebrate communities. Taxonomically, the upper Lick Fork Creek community was characterized by species of stoneflies, mayflies, and caddisflies which are typically euoxyphilous, oligothermal, and saprobic (Harris and Lawrence, 1978; Hubbard and Peters, 1978; Surdick and Gaufin, 1978). The calculated community parameters characterized upper Lick Fork Creek as having a very diverse invertebrate fauna typical of undisturbed aquatic ecosystems having "high quality" clean water.

5. The Hughes Creek community was dominated by naidid worms and bloodworms which are typical indicators of saprophytic conditions (Simpson and Bode, 1980). Community parameters inferred reduced water quality when compared to upper Lick Fork

Creek. This is a result of the Mt. View STP discharge into Hughes Creek. The microhabitat diversity (substrate types) was greatest in Hughes Creek. In addition, the percent canopy and stream bank vegetation, which are the greatest source of energy input into small ecosystems, was more extensive at Hughes Creek. These factors indicate Hughes Creek has a greater potential for macroinvertebrate community stability and production than upper Lick Fork Creek.

6. The fish community in Hughes Creek also indicated a severely impacted population as a result of poor water quality. The fish population during above average flows in December 1984, contained very few species, few individuals of each species, and adult specimens which were probably only temporary migrants into the area.

7. In comparison, upper Lick Fork Creek supports a healthy, diverse, typical, headwater-species population of fish which seasonally inhabit, feed and reproduce in this segment of the stream.

8. Under natural conditions, neither upper Lick Fork nor Hughes Creek contain sufficient quantities of water to support a resident fish population. However, during wet weather periods, both should support temporary populations of typical headwater-habitat fishes.

9. Lower Lick Fork Creek (below the confluence of Hughes Creek) and South Sylamore Creek provide refuge for fishes from upper Lick Fork Creek and Hughes Creek during periods of low flow.

RECOMMENDATIONS

It is recommended that the existing water quality criteria for a coolwater fishery in Lick Fork Creek below its confluence with Hughes Creek be maintained and that similar criteria be implemented to protect a seasonal headwater fishery in Hughes Creek during November through June when substantial background flows normally exist and a fishery should be present.

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APPENDIX A

STREAM SEGMENT RATING SYSTEM

I. Physical Features	<u>Score</u>
A. Instream Habitat	
(1) Instream Cover	
>40% = 4 pts.	
21-40% = 3 "	
11-20% = 2 "	
5-10% = 1 "	
>5% = 0 "	
	subtotal A(1) _____
(2) Substrate Cover	
Lg. boulders (>18") = 2 x % = _____	
Boulders (10"-18") = 3 x % = _____	
Rubble (2 1/2"-10") = 3 x % = _____	
Gravel (1/4"-2 1/2") = 1 x % = _____	
Sand/mud/silt = 0	0
	subtotal A(2) _____
Sub total A(1) + sub total A(2) x 4 =	Total (A) _____
B. Outstream Features	
(1) Disturbance in Watershed	
<u>disturbed</u> <u>points</u>	
< 25% = 4 pts.	
25 - 50% = 3 pts.	
50 - 75% = 2 pts.	
> 75% = 1 pts.	
	subtotal B(1) _____
Disturbed = cultivated, heavy grazing, urban development, clear cut timber harvest.	
Undisturbed = natural vegetation, improved pasture, timber production w/ selective cutting only.	
(2) Drainage Area	
>500 mi ² = 6 pts.	
251-500 mi ² = 5 "	
101-250 mi ² = 4 "	
51-100 mi ² = 3 "	
16-50 mi ² = 2 "	
<15 mi ² = 1 "	
	subtotal B(2) _____
(3) Stream Gradient	
<1 ft/mi = 6 pts.	
1-4 ft/mi = 5 "	
5-9 ft/mi = 4 "	
10-19 ft/mi = 3 "	
20-35 ft/mi = 2 "	
> 35 ft/mi = 1 "	
	subtotal B(3) _____

(4) Channel Width - summer stream width

- > 3 = 5 pts.
- 2.1-3 = 4 "
- 1.76-2.0 = 3 "
- 1.51-1.75 = 2 "
- 1-1.5 = 1 "

subtotal B(4) _____

(5) Canopy

- 75-100% = 5 pts.
- 50-75% = 4 "
- 25-50% = 3 "
- 10-25% = 2 "
- < 10% = 1 "

subtotal B(5) _____

(6) Bank Stability

- stable (<10% sloughing) = 3 pts.
- Mod. stable (10-30% sloughing) = 2 pts.
- Unstable (>30% sloughing) = 1 pt.

subtotal B(6) _____

Physical Features - Grand Total Score = _____
 (Total A + subtotal B(1) + B(2) + B(3) + B(4) + B(5) + B(6))

APPENDIX B

RELATIVE ABUNDANCE BY SPECIES BY AGE GROUP

VALUE

- 4 - Abundant - Species or age group collected easily in a variety of habitats where species expected; numerous individuals seen with consideration of sample gear limitations and expected abundance of such species; a dominant species of the species group.
- 3.5 - Common to Abundant
- 3 - Common - Species or age group collected in most areas where such species would exist; individuals frequently seen and apparently well established in population; one of the more frequent species of the species group.
- 2.5 - Present to Common
- 2 - Present - Species or age group collected with frequency to indicate the likely presence of an established population but definitely a subordinate species in species group.
- 1.5 - Rare to Present
- 1 - Rare - Species or age group represented by only one or very few individuals in the population; more than likely a remnant, migrant or a displaced species.

APPENDIX C

FISH POPULATION RATING SYSTEM

	Score
1. Total Number of Species = (actual number)	_____
2. Relative Abundance Value ÷ total species x 3 =	_____
3. Shannon - Weiner diversity index x 10 =	_____
4. Primary feeders value ÷ carnivores value =	
<0.5 = 35 pts.	
0.5-1.0 = 30 "	
1.0-1.3 = 25 "	
1.3-2.0 = 20 "	
2.0-3.5 = 15 "	
3.5-5.0 = 10 "	
>5.0 = 5 "	_____
5. Number of sensitive species x 3 =	_____
6. Common species:(a/(a-b)) x 3	_____
a = total No. species uncommon in both collections	
b = No. of uncommon species in rating collection	
Total	_____