AR0020117



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

## INTRODUCTION

Regulation # 2, as amended, "Regulation Establishing Water Ouality 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

treatment facilities, the proposed project modifications and the existing water quality. Figure 2 (from Summerlin, 1982) depicts the geographic relationships of Hughes Creek, Lick Fork Creek and South Sylamore Creek. The study area is in a transition zone between the Ozark Highlands and the Boston Mountains physiographic regions and characteristics of both regions are apparent at sample sites on Hughes Creek and Lick Fork Creek; however Hughes Creek seemed to exhibit more characteristics of the Boston Mountains, whereas Lick Fork Creek appeared more similar to the Ozark Highlands, particularly the stream substrate type and riparian vegetation. However, since both are side-by-side tributaries of South Sylamore Creek and they have similar watershed size and stream gradient, the biological characteristics should be very similar.

## METHODOLOGY

The standard procedures developed for the Statewide Stream Classification Program 205(j) were used to evaluate the physical habitat of Hughes Creek immediately downstream from the Mt. View sewage treatment plant discharge and for upper Lick Fork Creek (above confluence of Hughes Creek) approximately one-fourth mile upstream from Highway 66 bridge. Stream width, channel width, flow volume, substrate types, instream cover, amount of stream canopy and types of riparian stream cover were measured. A stream

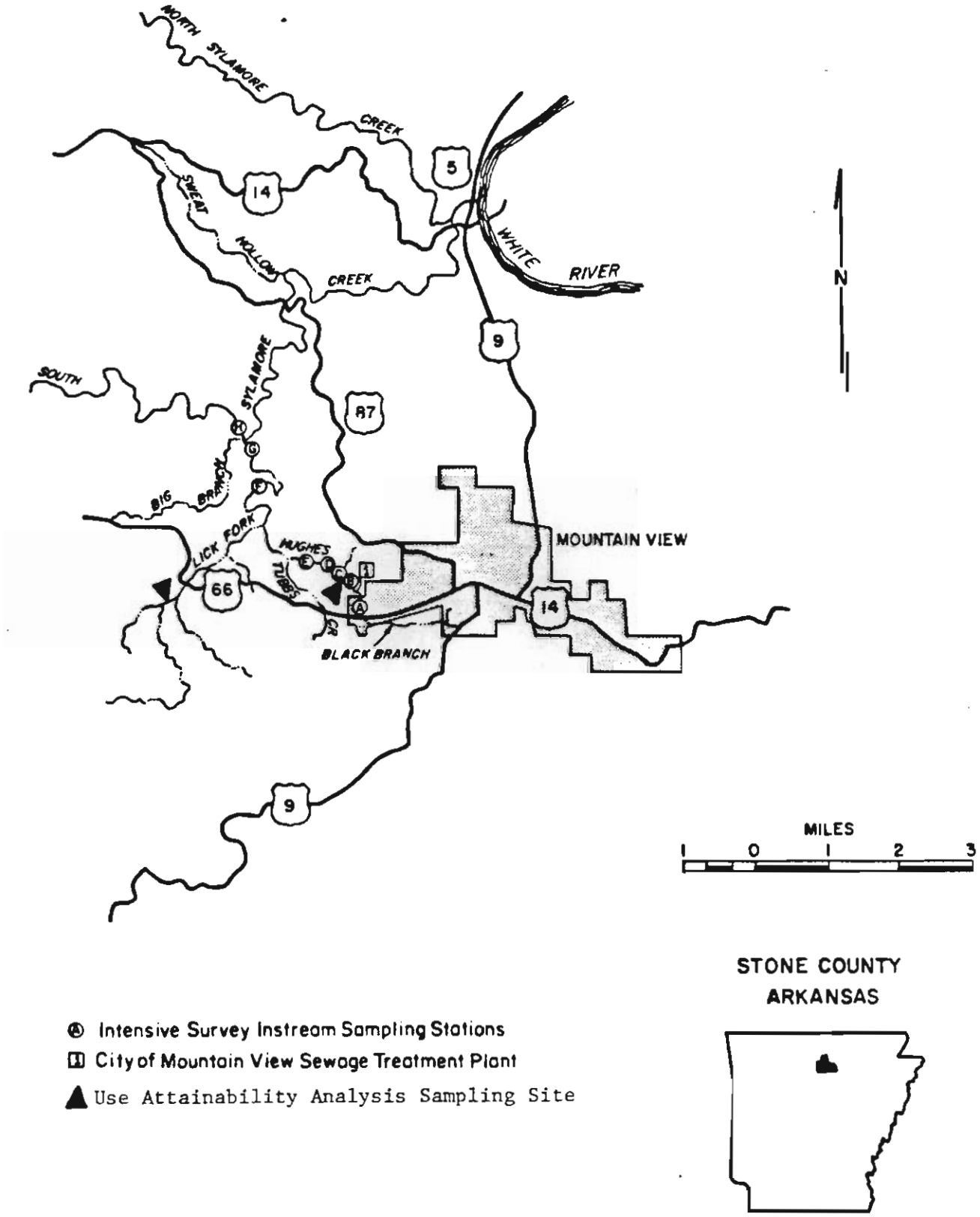



Figure 1

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 initally 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.

| | Hughes Creek | Upper Lick Fork Creek |
|---|---|---|
| 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<br>20% mod. stable |
| Watershed Land Uses | 40% Urban-heavy grazing<br>60% undisturbed | 20% heavy grazing<br>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 caculated to compare Lick Creek and Hughes Creek macroinvertebrate samples taken 5-6 Dec. 1984.

| COMMUMITY 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 | | | | |
| Corydalus 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 (cranefly) comprising 58.9% of the sample. Of these 5 dominant taxa only the cranefly 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 org. indv. | % of Total cuml. | % of Total indv. |
|---|---|---|---|---|---|
| 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 vittatta | 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 faciatus | 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 fron below MT.View STP outfall. 30 min. sample taken 5 Dec. 1984.

| TAXA | Fd. Gr. | no. of org. cuml. | no. of org. indv. | % of Total cuml. | % of Total 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.

| | Hughes Cr | Upper Lick Fork Cr |
|---|---|---|
| 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.

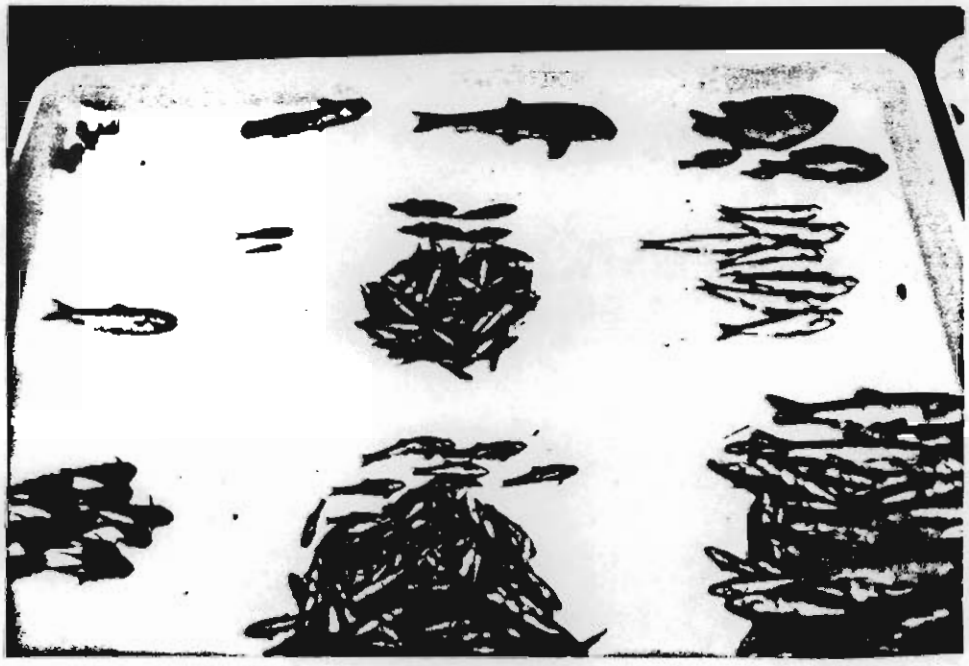
## SUMMARY AND CONCLUSIONS

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.

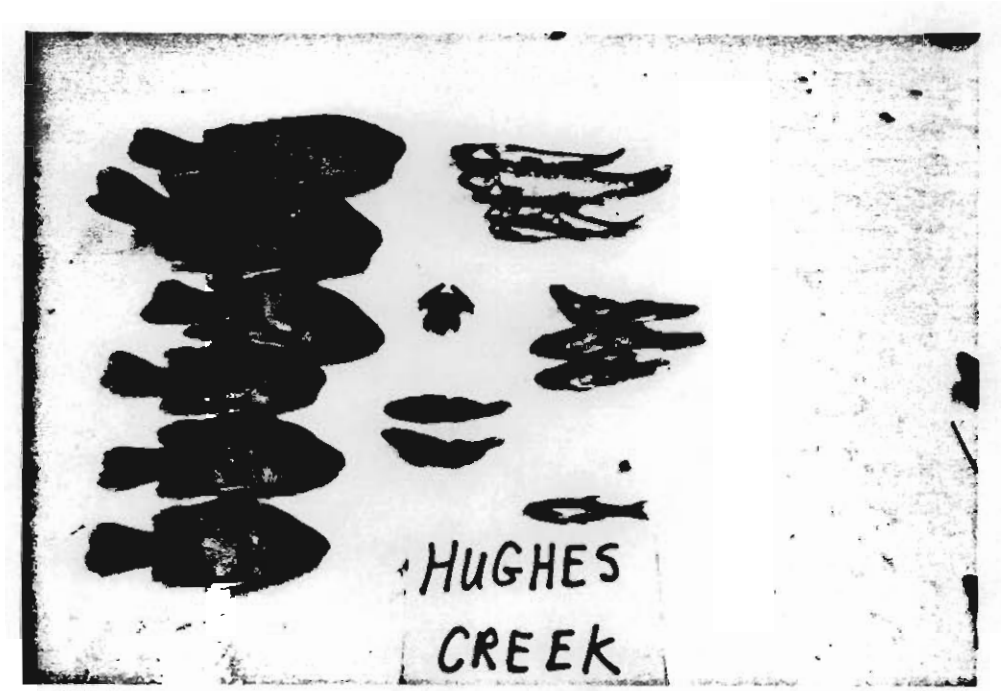


TABLE 7. LIST OF SPECIES AND RELATIVE ABUNDANCE VALUE FROM UPPER LICK FORK CREEK AND HUGHES CREEK, DECEMBER 4, 1984.

| Species | Hughes Cr. | Upper Lick Fork Cr. |
|---|---|---|
| Campostoma anomalum | 4 | 12 |
| *Notropis chrysocephalus | - | 1 |
| *Notropis pilsbryi | - | 3 |
| *Phoxinus erythrogaster | 1 | 12 |
| *Pimephales tenellus | - | 2 |
| *Hypentelium nigricans | - | 1 |
| *Noturus exilis | - | 1 |
| Lepomis cyanellus | 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 — Score

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

subtotal A(2)_____

Sub total A(1) + sub total A(2) x 4 = Total (A) _____

B. Outstream Features

(1) Disturbance in Watershed

| disturbed | points |
|---|---|
| < 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 ÷ carnivors 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 _____