Biological Assessment of the

Black Creek South Fork Watershed, including the Grand Olde Plaza and Penney Farms Wastewater Treatment Plants

Clay County

NPDES # FL0113735 and FL0032557

Sampled April 1997

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December 1997

Biology Section
Division of Administrative and Technical Services

Comprehensive Quality Assurance Plan No. 870346G

Department of Environmental Protection

Results of Fifth Year Inspections

Discharger: Grande Olde Plaza and Penney Farms WWTPs
County: Clay
NPDES Number: FL0113735 and FL0032557
State Permit Expiration Date: 7 April 1999 and 9 September 2001

Toxics Sampling Inspection (**XSI**)

Date Sampled: 8 April 1997

Results: No organic compounds were detected in the Grande Olde Plaza or Penney Farms effluents at detrimental levels. Copper (25 µg/L), silver (1.09 µg/L), and zinc (199 µg/L) were present in the Grand Olde Plaza effluent at levels which exceeded the Class III water quality standards, violating Rules 62-302.530 (24), 62-302.530 (60), and 62-302.530 (71) FAC, respectively.

Compliance Biomonitoring Inspection (**CBI**)

Date Sampled: 8 April 1997

Results: Neither the Grande Olde Plaza WWTP effluent nor the Penney Farms WWTP effluent was acutely toxic to the fish, *Cyprinella leedsi*, or to the invertebrate, *Ceriodaphnia dubia*.

Impact Bioassessment Inspection (**IBI**)

Date Sampled: 8 April 1997

Results: Based on the Stream Condition Index (SCI), all sites received an "excellent" rating. However, the low Florida Index and/or EPT Index values at SCI sites 6, 7, and 9, coupled with other observations, suggest moderate anthropogenic effects. SCI site 6 had low dissolved oxygen and suboptimal habitat. SCI station 7 (the Grand Olde Plaza WWTP test site) had low dissolved oxygen and elevated nutrients. The low EPT score at SCI site 9 (with 0 EPT), appeared to have been caused by the Penney Farms WWTP discharge. It is hypothesized that the rapid development in the northern part of the basin will become an increasingly negative source of stress to the stream biota. Imbalances in aquatic flora at SCI station 7 were attributed to the Grande Olde Plaza WWTP, indicated by decreases in periphyton taxa richness and diversity, as well as increases in density and chlorophyll *a*, a violation of Rule 62-302.530 (48) (b) FAC.

Water Quality Inspection (**WQI**)

Date Sampled: 8 April 1997

Results: Violations of Class III fecal and total coliform standards (Rules 62-302.530(6) and 62-302.530(7) FAC) occurred throughout the basin. Fecal coliform levels in the Penney Farms effluent and at SCI sites 1, 2, 4, 5, 6, 7, and 9 exceeded the allowed maximum of 800 organism/100 mL. Total coliforms in the Penney Farms effluent and at SCI sites 1, 2, 3, 4, 6, 7, and 9 exceeded the Class III water quality standard of 2,400 organisms/100 mL. Dissolved oxygen in the Penney Farms effluent violated its permit limit as well as the Class III standard (Rule 62-302.530(31) FAC). Nutrient enrichment in the basin appeared to be primarily associated with the two wastewater treatment facilities. Nitrate-nitrite and total phosphorus enrichment was observed at SCI 7 and at SCI 9, attributable to discharges from the Grande Olde Plaza WWTP and Penney Farms WWTP, respectively. The most elevated Algal Growth Potential values were also observed at these sites.

Introduction

The approximately 50 square mile Black Creek South Fork watershed lies west of Green Cove Springs, in Clay County. The majority of this watershed is situated within the Sea Island Flatwoods of the Southern Coastal Plain, draining the eastern portion of the Trail Ridge (White 1970, Griffith *et al.* 1994). This is an area of mostly clastic sediments where fluvial processes of eastward-flowing streams and rivers help create the landscape (Griffith *et al.* 1994). This geographical subregion contains upland plains of longleaf pine/turkey oak woods, marshes, swamps, flatwoods, and lakes. The soils are characterized generally as somewhat poorly to poorly drained spodosols.

In the latest 305(b) report, the Black Creek basin was reported to have fairly good water quality, but the report mentions that the area is threatened by urban and agricultural runoff (FDEP 1996b). Rapid development is affecting the system through increased domestic wastewater discharges and septic tank and stormwater runoff (FDEP 1996b).

For this study, biological, physical, chemical, and habitat information was collected from sixteen stations in the Black Creek South Fork Basin. These receiving water sites were selected to assess the effects of human activities in the watershed. These include the Grande Olde Plaza and Penney Farms wastewater treatment plants, as well as stormwater inputs from residential, commercial, and municipal land uses. (Due to the large size of this report, a separate document containing all of the appendices was prepared in order to reduce its size and the photocopying associated with its publication. A copy of this document is available from FDEP, Division of Administrative and Technical Services – Biology Section. It is entitled, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed".)

The Grande Olde Plaza Wastewater Treatment Plant (WWTP) is a 0.040 MGD wastewater treatment facility serving the Grande Olde Plaza shopping center. Wastewater passes through a bar screen to a 12,300 gallon aerated surge tank and then to a 40,000 gallon extended aeration plant. The clarified water receives chlorination for disinfection, is then dechlorinated, and enters one of two slow sand filters. The treated effluent is discharged into an unnamed tributary of the Black Creek South Fork (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). The discharge is located between SCI stations 6 and 7 in this study.

State permit limits for the Grande Olde Plaza facility's discharge are: fecal coliforms (800 organisms/100 mL maximum), dissolved oxygen (5.0 mg/L minimum), CBOD (25 mg/L as a monthly average), unionized ammonia (0.02 mg/L maximum), nitrate (12 mg/L maximum), TSS (20 mg/L as an annual average), pH (6.0 SU to 8.5 SU), and total residual chlorine (0.01 maximum after dechlorination) (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A).

Monthly operating report data for Grande Olde Plaza WWTP, from January, 1996, through November, 1996, indicate several occasions when permit and water quality limits have been exceeded. Unionized ammonia and nitrate levels exceeded permit limits on two occasions, and copper, silver, and zinc were above the Class III water quality standards in November, 1996.

The Penney Farms Wastewater Treatment Plant is a 0.090 MGD treatment facility serving the Penney Farms Retirement Community. Wastewater treatment consists of a 65,590 gallon septic tank, sand filtration, chlorination for disinfection, dechlorination, and reaeration. The reaeration chamber was not in service at the time of this inspection. The treated effluent is discharged into an unnamed tributary of the Black Creek South Fork (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). The discharge is located upstream of SCI station 9 in this study.

State permit limits for the Penney Farms facility's discharge are as follows: fecal coliforms (800 organisms/100 mL maximum), dissolved oxygen (7.0 mg/L minimum), CBOD (10 mg/L as a monthly average), ammonia (2.0 mg/L as a monthly average), organic nitrogen (2.0 mg/L monthly average), TSS (30 mg/L as a monthly average), pH (6.0 SU to 8.5 SU), and total residual chlorine (0.01 maximum after dechlorination) (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). The facility permit requires the Penney Farms WWTP to achieve full compliance with nutrient limits and water quality standards by 1 July 1998.

Monthly operating report data for January, 1996, through December, 1996, indicate unionized ammonia and organic nitrogen concentrations have exceeded permit limits on multiple occasions. One violation of the limit for total ammonia occurred in 1996. A 1996 biological sampling in the unnamed tributary which receives the Penney Farms discharge suggested there may be problems in the receiving water biological communities which were attributable to the outfall (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A).

Methods

The focus of this investigation was to determine if human activities within the basin were affecting the health of receiving water biota. Potential pollution sources include stormwater runoff from various land uses, as well as the discharges from two wastewater treatment facilities (the Grande Olde Plaza and Penney Farms WWTPs) (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). A total of 16 stations were sampled within the Black Creek South Fork Basin. At 9 sites, benthic macroinvertebrate communities were evaluated by collecting invertebrates from multiple substrates (*e.g.*, snags, leaf packs, vegetation) using 20 discrete dip net sweeps (FDEP 1996a, Biology Section Standard Operating Procedure #BA-7). These 9 sites were designated as SCI sites 1 through 9. SCI 1 (Mill Creek), SCI 2 (Bull Creek), SCI 4 (Ates Creek), and SCI 5 (Greens Creek) were located on four tributaries of South Fork Black Creek. SCI 3 was located on the main stem of the river. SCI sites 6 and 7 served as reference and test sites, respectively, for the Grande Olde Plaza WWTP. SCI sites 8 and 9 served as reference and test sites, respectively, for the Penney Farms WWTP.

SCI 1 was on Mill Creek, 100 yards upstream of the bridge on SR 21, south of Middleburg. The land use in the Mill Creek drainage is primarily low density residential (52%) accompanied by open and cleared land, natural forest and

Table 1. Results of Chemical and Other Analyses for Selected Black Creek Basin SCI Sites	Mill Creek SCI1	Bull Creek SCI2	S. Fork Black Crk SCI3	Ates Creek SCI4	Greens Creek SCI5
Nutrients (mg/L)					
Ortho-phosphate	0.006 I	0.10	0.11	0.17	0.004 I
Total phosphorus	0.038 I	0.18	0.17	0.26	0.034 I
Ammonia	0.020 I	0.015 I	0.012 I	0.016 I	0.010 U
Nitrate+Nitrite	0.025	0.12	0.040	0.005 I	0.004 U
TKN	0.32	0.21	0.33	0.40	0.46
General Phys-Chem Parameters					
Habitat Assessment	120	128	128	131	139
D.O. (mg/L)	9.3	8.9	9.0	8.4	7.7
pH (SU)	6.3	6.3	5.9	4.5	5.6
Conductivity (µmhos/cm)	92	67	50	50	68
Temperature (°C)	16.2	16.1	16.6	16.3	16.7
Total Suspended Solids (mg/L)	4 U	5	7	4	4
Biological Oxygen Demand (mg/L)	0.5 I	0.7 I	0.5 I	0.6 I	0.5 I
Turbidity (NTU's)	19.0	4.7	2.8	2.7	3.5
Hardness (mg CaCO3)					
Algal Growth Potential (mg dry wt/L)	5.8	10.1	4.5	2.6	6.1
Microbiological Communities (org/100 mL)					
Fecal coliform	3200	2500	730	1766	2000
Total coliform	6700	5270	4800	5500	2666

A - Value reported is the mean of two or more determinations

I - Value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit

U - Material analyzed for but not detected; value reported is the minimum detection limit

Table 2. Results of Chemical and Other Analyses for the Grande Olde Plaza and Penney Farms WWTPs, and Selected SCI Sites	Grande Olde Plaza WWTP			Penney Farms WWTP		
	Ref Site SCI6	Test Site SCI7	Effluent	Ref Site SCI8	Test Site SCI9	Effluent
Organic Constituents (ug/L)						
Atrazine			0.091 I			0.047 U
Metals (ug/L)						
Aluminum			155			35 U
Arsenic			40 U			40 U
Cadmium			0.22			0.05 U
Copper			10 U			10 U
Chromium			25			10 U
Iron			853			28 A
Lead			20 U			20 U
Mercury			0.10 U			0.10 U
Nickel			6 U			6 U
Selenium			50 U			50 U
Silver			1.09			0.04 U
Zinc			199			26 A
Nutrients (mg/L)						
Ortho-phosphate	0.014	0.23 A	1.6 A	0.011	3.0	3.5
Total phosphorus	0.039 I	0.29 A	1.9	0.043	3.1	3.4 A
Ammonia	0.015 I	0.039	0.089 A	0.051	0.24	0.25 A
Nitrate+Nitrite	0.025 I	2.8	12	0.022 I	20	23
TKN	0.35	0.73 A	1.9	0.51	0.77	0.76 A
General Phys-Chem Parameters						
Habitat Assessment	103	96		111	106	
D.O. (mg/L)	3.9	3.7	7.6	2.0	4.9	4.6
pH (SU)	6.6	6.9	7.6	5.4	6.3	6.1
Conductivity/Salinity (µmhos/cm or ppt)	155	389	613	84	484	534
Temperature (°C)	19.5	20.2	24.8	19.7	22.4	22.7
Total Suspended Solids (mg/L)	4 U	4 U	5 A	4 U	4 U	4 U
Biological Oxygen Demand, 5 day (mg/L)	0.3 I	0.5 I	3.0	0.4 IA	0.8 I	1.0
Turbidity (NTU's)	8.5	5.0	2.7	1.4	1.0	1.0
Hardness (mg CaCO3)			87.2			203.3
Algal Growth Potential (mg dry wt/L)	3.6	71.1	438.8	1.9	41.5	32.1
Toxicity						
Bioassay Fish			95% Survival			Not Toxic
Bioassay Invertebrate			Not Toxic			Not Toxic
Microbiological Communities (org/100 mL)						
Fecal coliform	1900	2700 A	240	420	1800	1170 B
Total coliform	8000	7500	1420 B	2100 A	16800 B	29000

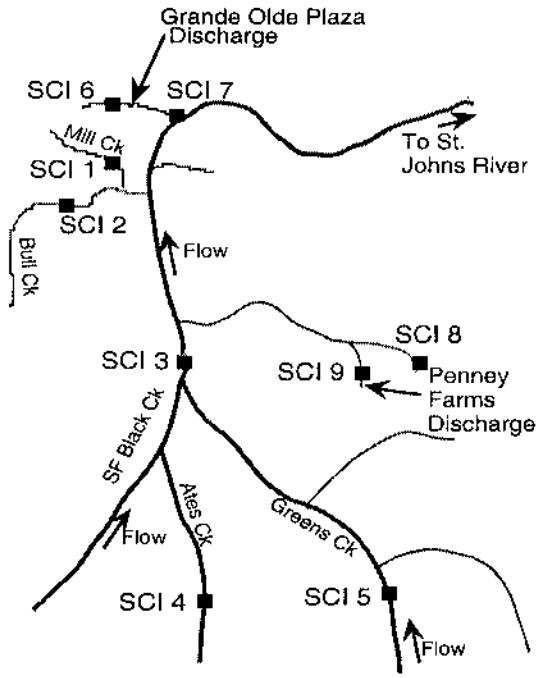
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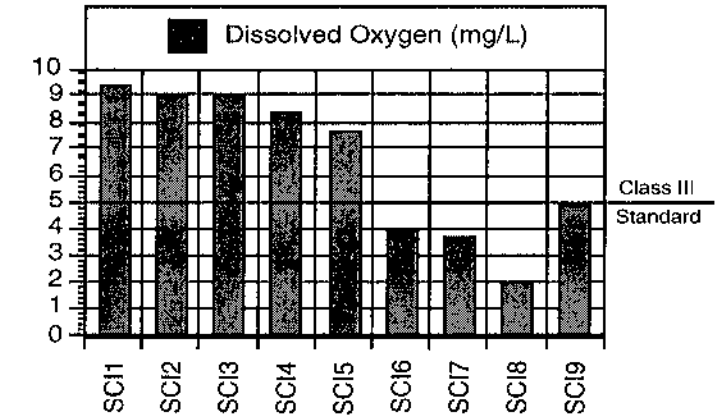
B - Results based on colony counts outside the acceptable range

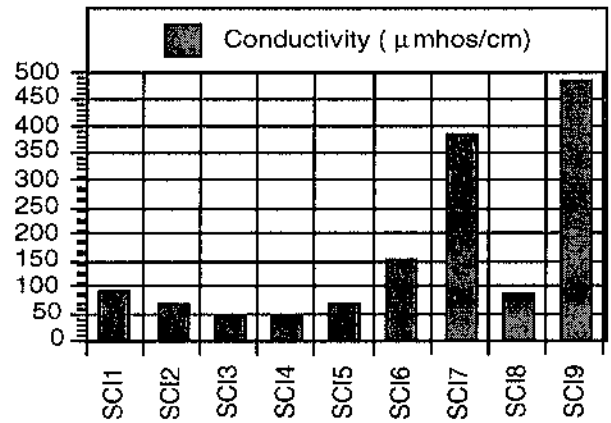
I - Value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit

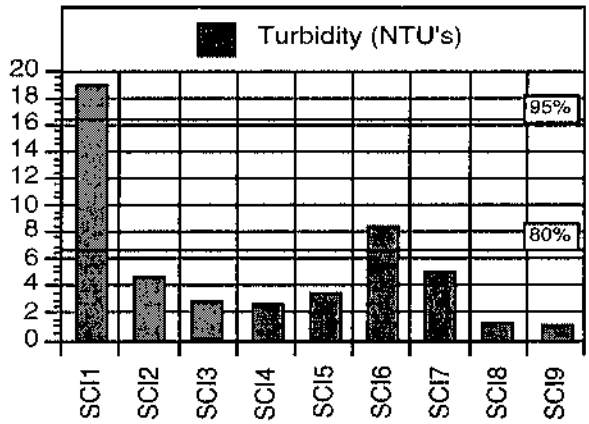
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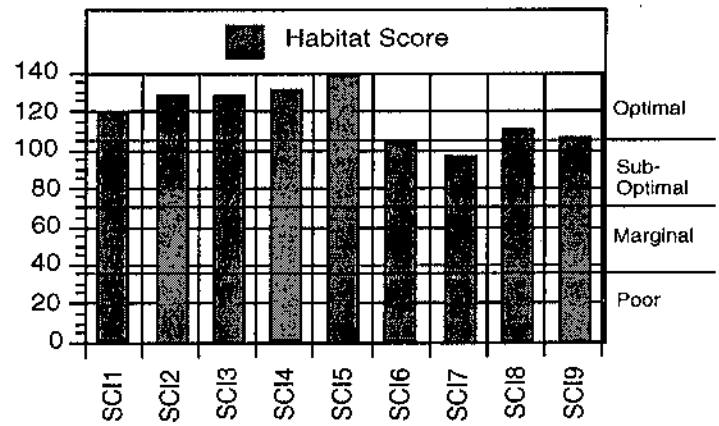
Figure 1. Basinwide Physical/Chemical Measurements.











wetlands (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). Mill Creek is a second order stream. SCI 2 was located on Bull Creek, 100 m downstream of the bridge on County Road 215. Bull Creek is a third order stream which drains silvicultural lands, natural forest, wetlands, low density residential areas, and rural open and pasture land. SCI 3 was on the main stem of South Fork Black Creek at SR 16, west of Penney Farms. This site is downstream of the confluence of Ates Creek and Green's Creek with South Fork Black Creek. South Fork Black Creek is a third order stream at this point, and drains primarily silvicultural land and natural forest along with some wetlands and pasture. SCI 4 was located on Ates Creek, 100 m upstream of the bridge on County Road 315, east of SR 21. Ates Creek is a third order stream which drains primarily (48%) silvicultural land, as well as natural forest, wetlands, and rural open and pasture land. SCI 5 was situated on the middle tributary of Green's Creek, 50 m downstream of the bridge on County Road 315, west of Saunders Road. This is a second order stream draining primarily (67%) silvicul-

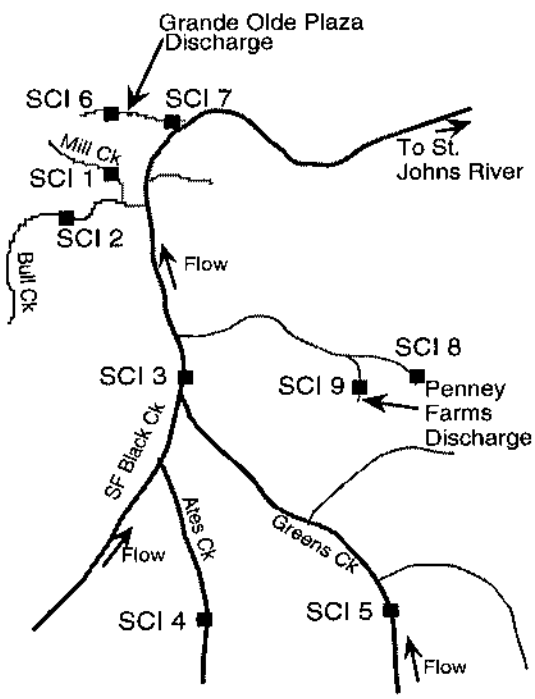
tural land and some wetlands and natural forest. There may also be some influence from mining at SCI 5.

SCI sites 6 and 7 served as reference and test sites, respectively, for the Grande Olde Plaza WWTP. SCI sites 8 and 9 served as reference and test sites, respectively, for the Penney Farms WWTP. These stations are located on unnamed, first order tributaries to South Fork Black (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). SCI 6, located approximately 100 m upstream of the Grande Olde Plaza discharge. The land use in this watershed is primarily medium density residential, accompanied by light commercial, natural forest, and a small amount of silviculture. SCI 7 was located in the same unnamed tributary, 30 m downstream of the Grande Olde Plaza discharge. SC 8 was located 1.5 miles east of the Penney Farms WWTP on a tributary that is similar to the one that receives the Penney Farms effluent. The tributary originates in an area of open pasture and planted pine and is influenced by grazing animals and medium density residential areas. Penney Farms WWTP is the primary source for the receiving stream and no suitable upstream site could be identified for use as a reference site. SCI 9 was located on the receiving water stream, 30 m downstream of the Penney Farms discharge.

Additional macroinvertebrate collections were taken at SCI sites 6, 7, 8, and 9, using Hester-Dendy multiplate samplers which were incubated for 28 days (Ross 1990). Periphyton was sampled at SCI sites 6, 7, 8, and 9 by incubating glass microscope slides in a standard periphytometer for 28 days (Ross 1990). Phytoplankton was sampled at all SCI sites by subsurface grabs. Chlorophyll *a* was also determined for periphyton and phytoplankton communities (Ross 1990). Bacterial populations were analyzed for total and fecal coliforms following the methods of APHA (1989). Algal Growth Potential tests, using *Selenastrum capricornutum* as the test organism, followed Miller *et al.* (1978).

For the seven remaining stations, benthic macroinvertebrate communities were evaluated by performing biological reconnaissance (Bio-Recon) at each site (FDEP 1996a, #BA-29). These sites are designated Recon sites 1 through 7 (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). For the Bio-Recon sites, invertebrates were collected from multiple substrates (*e.g.*, snags, leaf packs, vegetation) using four discrete dip net sweeps. The resulting samples

Figure 1a. Basinwide Bacteria.



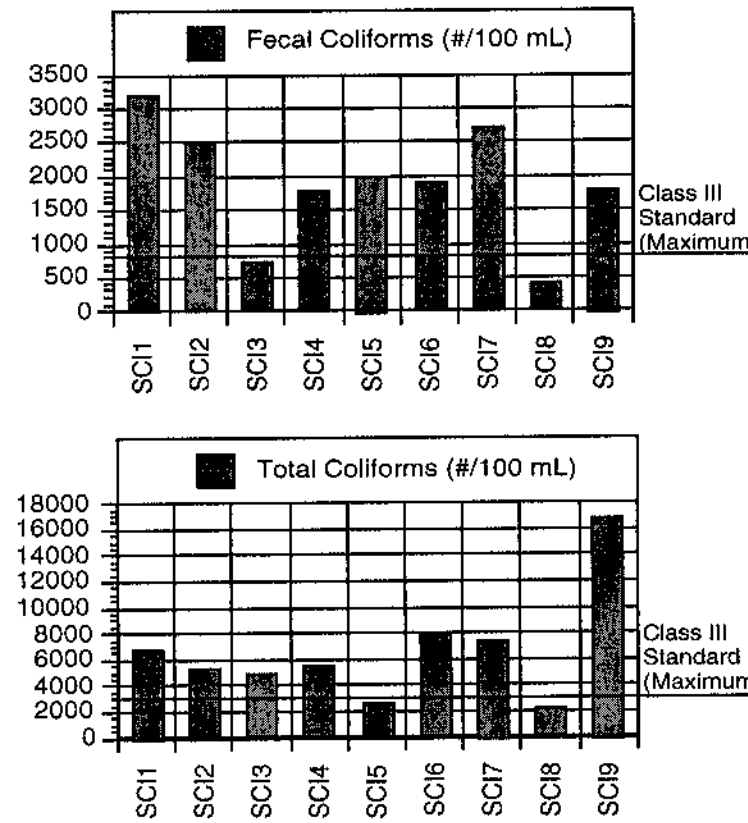
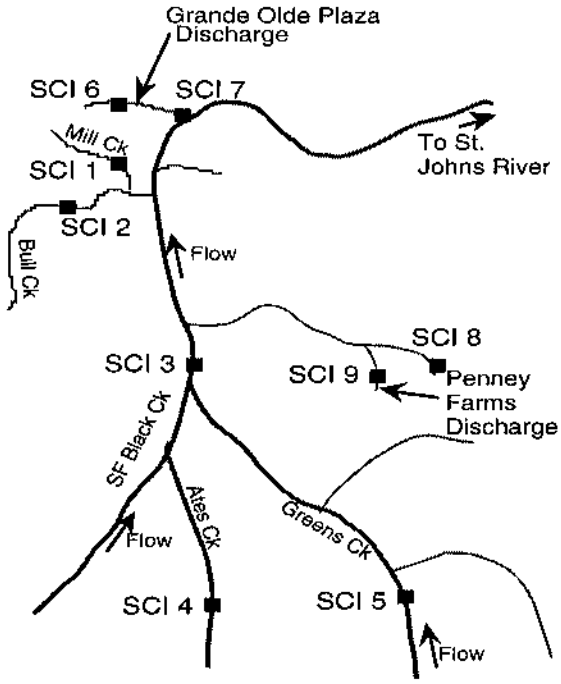
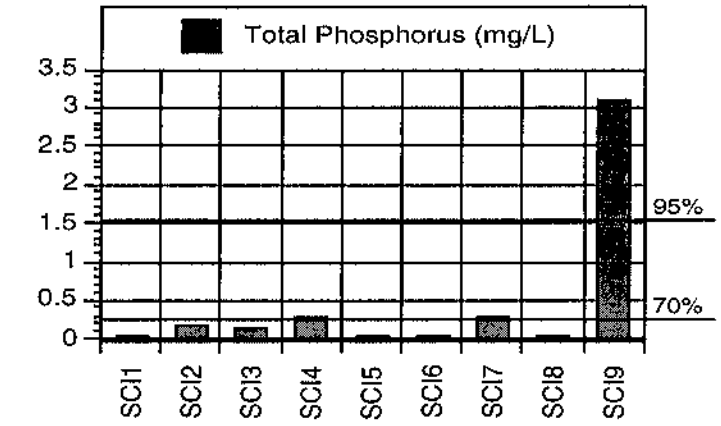
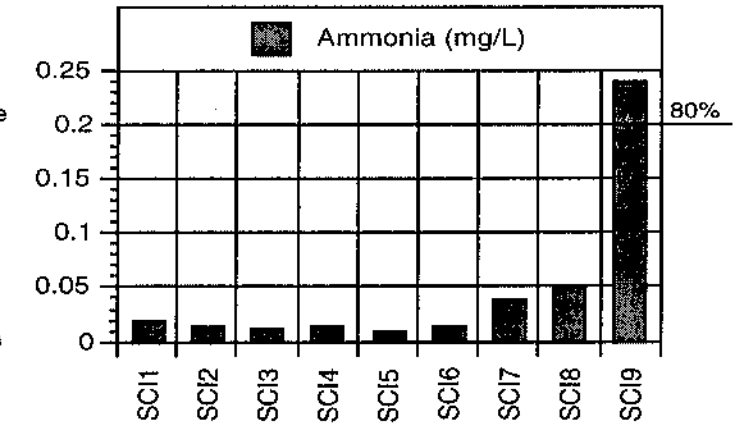
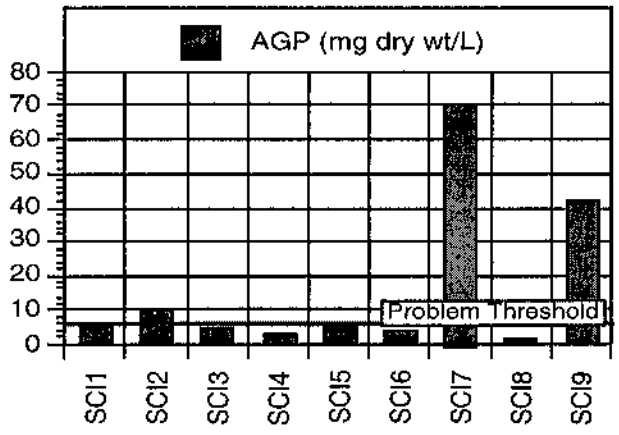


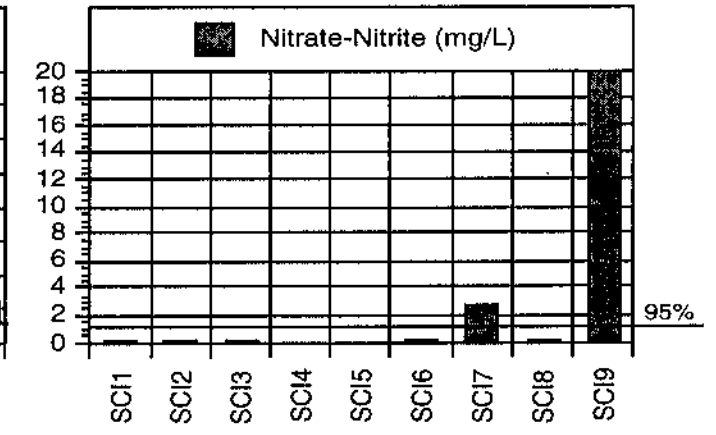
Figure 2. Basinwide Nutrients and Algal Growth Potential.











were field sorted and brought back to the laboratory for identification under the dissecting microscope. Recon 1 was located on the southeastern tributary of Green's Creek, 100 m upstream of the bridge on County Road 315. This is a second order stream which drains wetlands, silvicultural land, natural forest, open pasture land, and mining operations. Stormwater run-off from mining operations is a potential source of impairment for this site (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). Recon 2 is on the northeastern tributary of Green's Creek, 100 m downstream of the bridge at Saunders Road. This is a second order stream which drains primarily (75%) silvicultural land and some wetlands and natural forest. Possible sources of impairment at Recon 2 include effects from the bridge construction, channelization, and silvicultural operations. Recon 3 is located on an unnamed, second order tributary to South Fork Black Creek, 50

m upstream of the bridge on County Road 218. This site is downstream of the reference site for the Penney Farms WWTP (SCI 8) and is surrounded by silvicultural areas. The effects of recent clearcutting on the macroinvertebrate community could be evaluated at this site.

Recon 4 is downstream of Recon 3 on the same unnamed tributary to South Fork Black Creek. The sample site is 50 m upstream of the bridge on Thunder Road. There is a domestic waste sludge spreading operation upstream of this site as well as silvicultural operations. This tributary is a third order stream at Recon site 4. Recon 5 was located on Polander Branch, 100 m south of Sandy Run Drive. Polander Branch is a second order stream which drains natural forest, low and medium residential areas, wetlands, rural pasture, and some light commercial areas. It is the most northeastern tributary of South Fork Black Creek. Residential and commercial development represent potential sources of impairment at this site. Recon 6 is located on the southern stem of Bull Creek, 100 m upstream of the bridge on County Road 215. Bull Creek is a third order stream which drains silvicultural activities, natural forest, wetlands, low density residential, rural pasture land, and a small amount of heavy commercial land. Recon 6 is upstream of SCI 2 and upstream of higher density residential development. Recon 7 is located on South Fork Black Creek at the bridge on SR 21. At this location, South Fork Black Creek is a second order stream which drains primarily natural forest (51%) as well as some silvicultural land, wetlands, open pasture, light commercial, and residential areas.

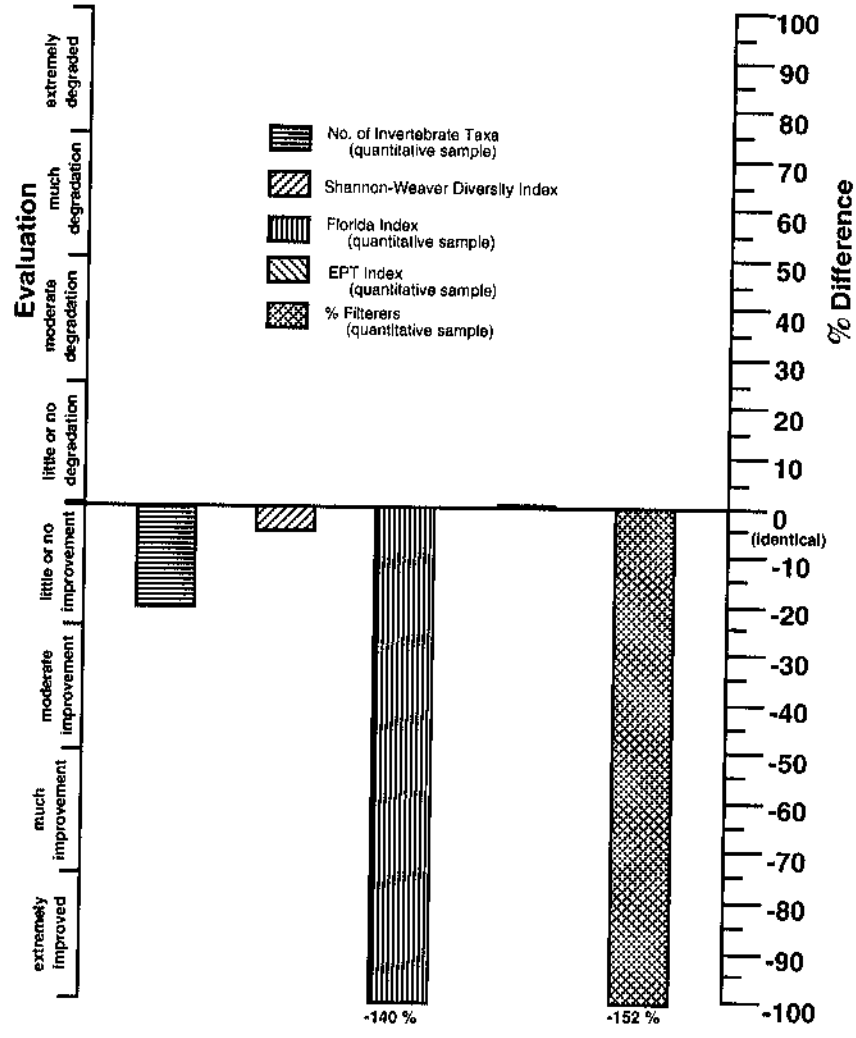
Habitat quality was determined for each station during an *in situ* assessment. Supplemental physical/chemical data were also collected on the effluents and study sites. Acute screening toxicity bioassays, using *Ceriodaphnia dubia* and *Cyprinella leedsi* as test organisms, were performed on the effluent samples (Weber 1991). The effluents were analyzed for metals and for organic constituents (base neutral and acid extractables, and pesticide extractables). Additionally, nutrient analyses were performed on the effluents and the receiving water at the SCI sites. Methods used for all chemical analyses are on file at the DEP Central Laboratory in Tallahassee.

Explanation of Measurements of Community Health

Several different measurements of macroinvertebrate and algal community health have been employed to determine the effects of a discharge. These are briefly discussed here.

Habitat: Seven attributes known to have potential effects on the stream biota were evaluated and scored, with 20 possible points

Figure 3. Effect of Grande Olde Plaza discharge on the benthic macroinvertebrate community.



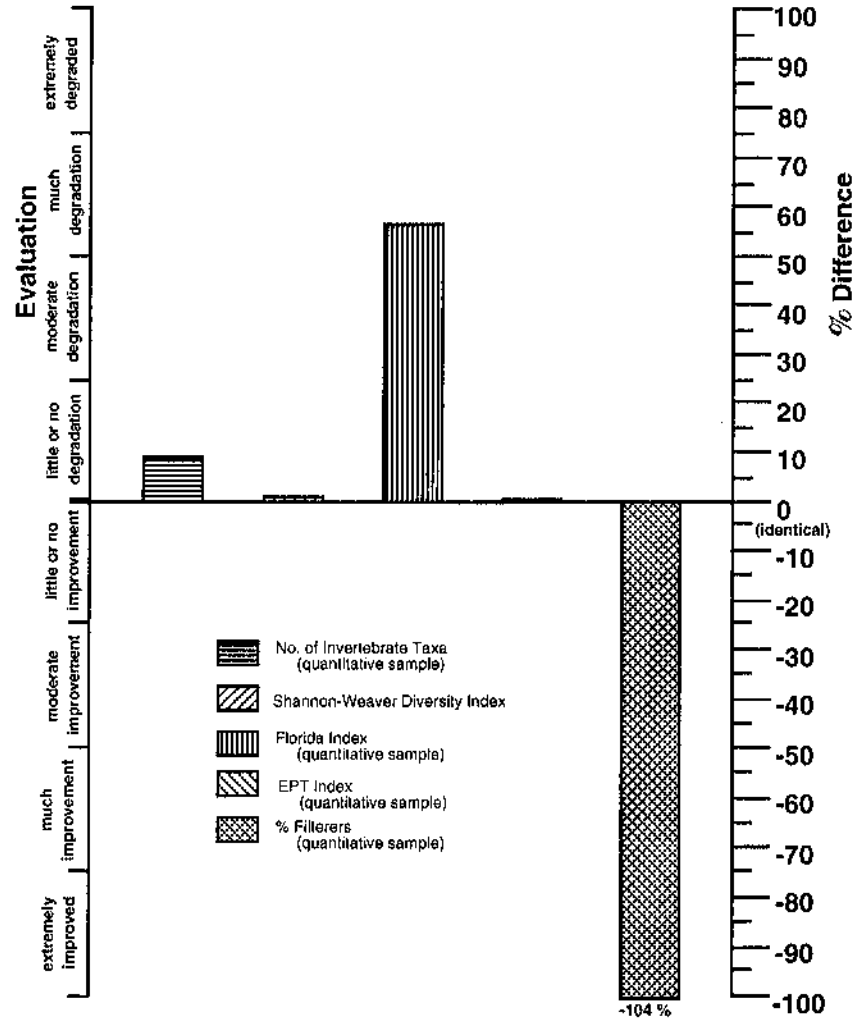
for each factor. Based on the sum of these individual scores, overall habitat quality is assigned to one of four categories: Optimal (105-140 points); Suboptimal (70-104 points); Marginal (35-69 points); and Poor (0-34 points) (see habitat assessment field sheets in Appendix B).

Taxa richness: Stress tends to reduce the number of different types of organisms present in a system, although moderate nutrient enrichment may sometimes be correlated with increased algal taxa richness.

Shannon-Weaver diversity: This index is specified in the Florida Administrative Code as a measure of biological integrity. Low diversity scores are undesirable. They represent conditions where only a few organisms are abundant, to the exclusion of other taxa. Excessive numerical dominance of a single type of organism (a high % contribution of the dominant tax-

Table 3. Summary of Benthic Macroinvertebrate Data for the Black Creek Basin SCI Sites	Mill Creek SCI 1	Bull Creek SCI 2	S. Fork Black Creek SCI 3	Ates Creek SCI 4	Greens Creek SCI 5	Grande Olde Plaza Ref Site SCI 6	Grande Olde Plaza Test Site SCI 7	Penney Farms Ref Site SCI 8	Penney Farms Test Site SCI 9
Macroinvertebrate Qualitative									
Number of Taxa	38	29	40	28	47	39	40	36	30
Florida Index	15	17	25	21	26	8	12	19	14
SCI	29	27	29	29	29	25	27	27	25
EPT Index	3	3	15	6	13	1	2	3	0
% Contribution of Dominant Taxon	18.1	25.0	14.6	15.7	12.5	8.8	29.2	10.8	17.3
% Oligochaeta	3.8	1.2	0.8	0	3.4	0	3.4	2.7	3.8
% Diptera	37.1	61.0	41.5	36.6	37.0	58.4	56.7	47.7	63.5
% Ephemeroptera	0	1.2	8.9	9.1	12.0	0	0	0	0
% Trichoptera	9.5	11.0	13.8	26.1	11.1	1.6	0.7	5.4	0
% Plecoptera	0	0.6	5.7	5.2	0	0	0	0	0
% Odonata	2.8	0.6	0.8	0.6	0.5	6.4	1.4	0.9	9.6
% Coleoptera	35.2	17.7	26.8	15.7	22.1	12.8	6.5	16.2	7.7
% Pelecypoda	0.9	5.5	0	0	2.9	0.8	0.3	6.3	1.9
% Gastropoda	5.7	0	0.8	2.0	5.8	15.2	29.2	2.7	11.5
% Amphipoda	0.9	0	0	3.9	2.9	0.8	0	5.4	0
% Isopoda	0	0	0	0	1.0	0.8	0.7	10.8	0
% Other	3.8	1.2	0.8	0.6	1.4	3.2	1.0	1.8	1.9
% Predators	12.4	4.0	11.0	9.1	13.7	27.6	6.2	26.6	32.7
% Above Surface Deposit Feeders	28.6	24.7	34.5	30.4	26.9	35.6	32.8	26.6	24.0
% Below Surface Deposit Feeders	3.8	1.2	0.8	0	1.0	0	2.7	2.7	3.8
% Suspension Feeders	24.3	47.3	18.7	37.9	28.1	9.6	21.6	20.3	21.1
% Scrapers	23.3	9.4	17.9	14.0	22.8	22.0	33.3	5.9	13.5
% Shredders	4.8	12.2	13.0	7.8	4.6	4.4	1.9	5.4	4.8
Macroinvertebrate Hester-Dendy									
Number of Taxa						24	29	22	20
Florida Index						5	12	7	3
Shannon-Weaver Diversity						3.5	3.7	3.4	3.3
EPT Index						0	0	0	0
% Oligochaeta						1.2	2.7	8.3	3.7
% Diptera						91.0	76.2	88.9	90.8
% Coleoptera						1.4	0.2	0.2	0.4
% Isopoda						0	0	2.0	0
% Gastropoda						6.2	20.2	0.5	5.0
% Other						0.2	0.7	0	0.4
% Predators						11.6	7.5	7.2	5.4
% Above Surface Deposit Feeders						56.5	35.4	57.6	44.0
% Below Surface Deposit Feeders						1.2	2.7	8.3	3.7
% Suspension Feeders						12.4	31.3	15.9	32.5
% Scrapers						6.2	20.7	0.6	5.2
% Shredders						4.7	0.7	6.6	9.2

Figure 4. Effect of Penney Farms discharge on the benthic macroinvertebrate community.



on) is a related measure which is also associated with disturbance.

Numbers of pollution sensitive taxa: Some organisms become rare or absent as the intensity or duration of disturbance increases. For example, the Florida Index assigns points to stream-dwelling macroinvertebrates based on their sensitivity to pollution (Ross 1990). A site with a high Florida Index score is considered healthy. Species sensitivity data from other sources, such as Hulbert (1990), Hudson *et al.* (1990), Lenat (1993), Farrell (1992), Chang *et al.* (1992), and Whitmore (1989), are used as appropriate.

Ephemeroptera/Plecoptera/Trichoptera Index: This index is the sum of the number of EPT taxa present. Higher EPT values are associated with healthier systems.

Community structure: Substantial shifts in the proportions of major groups of organisms, compared to reference conditions, may indicate degradation. In marine systems, an increase in the % tubificid oligochaetes, a decrease in the % pelecypods, and a decrease in the number of polychaete taxa are all considered indicators of disturbance (Engel *et al.* 1994).

Algal biomass: High algal biomass (algal density or chlorophyll *a*) implies nutrient stress. A decreased diatom to blue-green algae ratio (calculated by dividing the number of individuals in the Bacillariophyta by the number of individuals in the Bacillariophyta + Cyanophyta) is often indicative of nutrient enriched conditions in flowing streams.

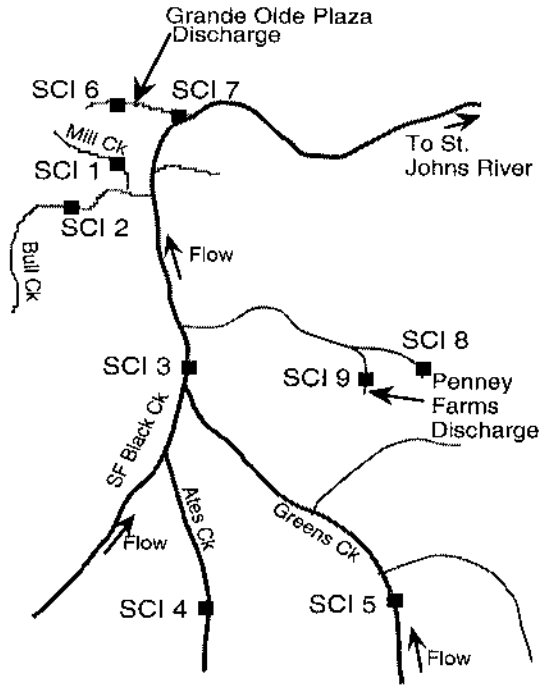
Trophic composition/feeding guilds: Disturbance can shift the feeding strategies of invertebrates. In Florida, for example, pollution may be responsible for reducing the numbers of filter-feeders (FDEP 1994) and shredders (EA Engineering 1994).

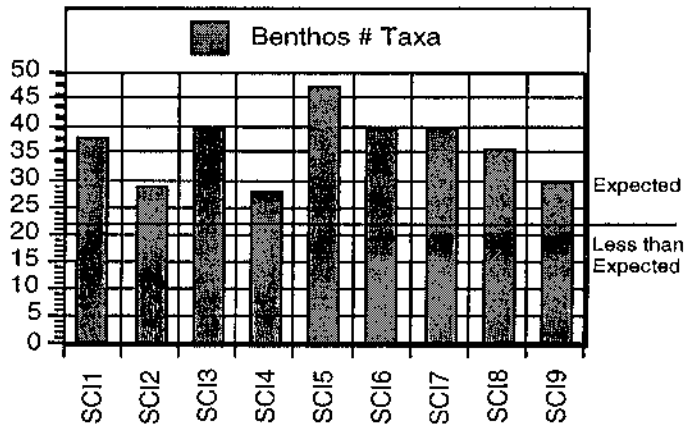
The Stream condition Index for Florida (SCI) is a composite macroinvertebrate metric (Barbour *et al.* 1996). The SCI assigns points to a variety of parameters, depending on how closely each parameter approaches an expected reference condition.

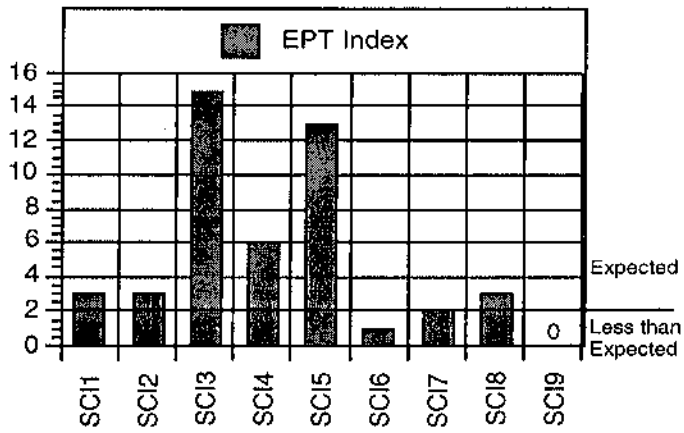
For graphical purposes, the percent differences between the reference and test sites involving the number of taxa, the diversity index, the Florida Index, the EPT Index, the diatom to blue-green algae ratio, and the % filter-feeders are measured as the reference site minus test site divided by the reference site. The percent differences between sites involving algal density, chlorophyll *a*, and algal growth potential are measured as the test site minus reference site divided by the reference site.

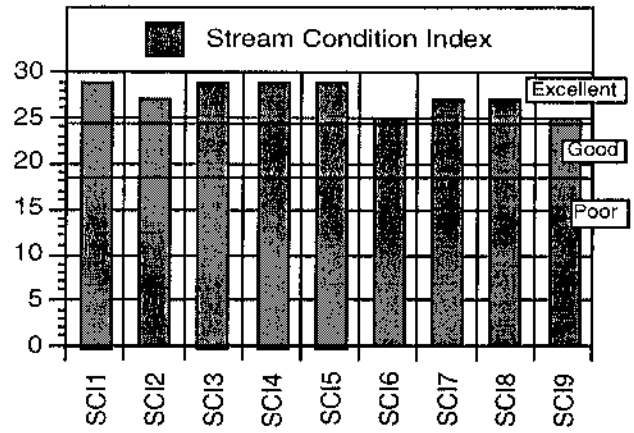
The following personnel were involved in this investigation: (Lee Banks, Dana Denson, John Dinges, Laurence Donelan, Ed Hernandez, Mike Hollingsworth, Brent Johnson, Steve Kent, Lou Ley, Tim McKelvey, Peggy Morgan, Pat O'Connor, Randy Payne, Eric Pluchino, Donald Ray, Bob Rutter, Stefan Schulze, and Ford Walton

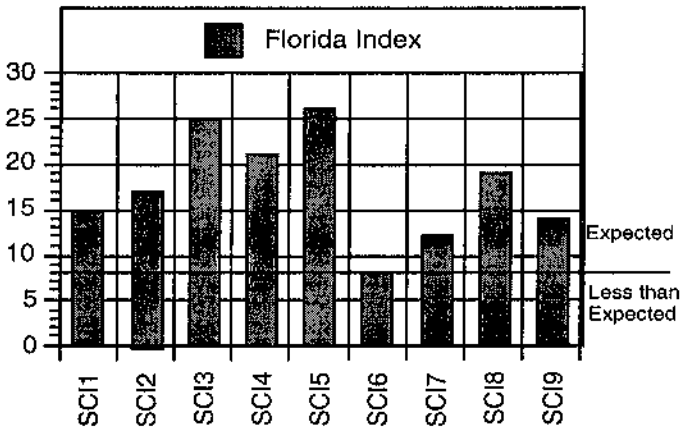
Figure 5. Basinwide Benthic SCI Measurements.











(DEP District Offices) Bill Beers and Kim Schildt (Tallahassee Division of Water Facilities), and Lynn Burton-Hupp, Jennifer Eichelberger, Ken Espy, Marshall Faircloth, Russel Frydenborg, Joy Jackson, Scott Lashbrook, Elizabeth Miller, Urania Quintana, Johnny Richardson, Lisa Tamburello, David Whiting, and Vicki Whiting (Tallahassee Biology Laboratory). The report was reviewed by the Point Source Studies Review Committee, consisting of Wayne Magley, Jan Mandrup-Poulsen, and Michael Tanski, as well as District representatives.

Results and Discussion

SCI Sites

Habitat quality did not vary greatly among the SCI sites in the Black Creek South Fork Basin (Tables 1 and 2, Figure 1). Habitat

scores at stations 6 (103 points) and 7 (96 points) were in the suboptimal range. These sites received low scores in the categories of habitat smothering, bank stability, and water velocity (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix B). SCI 7 lost additional points in the category of riparian buffer zone width. The remaining SCI sites had habitat scores of 106 points or more, placing them in the optimal range for habitat quality (Figure 1).

Dissolved oxygen throughout the basin ranged from 2.0 mg/L at SCI 8 to 9.3 mg/L at SCI 1 (Tables 1 and 2). Sites 1 through 5 complied with the 5.0 mg/L minimum Class III dissolved oxygen standard, while SCI stations 6 (4.0 mg/L), 7 (3.7 mg/L), 8 (2.0 mg/L) and 9 (4.9 mg/L) fell below the Class III standard (Rule 62-302.560(31)FAC) (Figure 1). Sites 6 through 9 were located on first order streams and were generally smaller and had less flow than the other SCI sites (see "Black Creek Basin Study Appendices"). The effluent dissolved oxygen level of 4.6 mg/L at the Penney Farms WWTP fell below the facility permit limit (minimum of 7.0 mg/L), as well as the Class III standard cited above. The pH values ranged from 4.5 SU at SCI 4 to 7.0 SU at SCI 7, while the temperature ranged from 16.1 °C at SCI 2 to 22.4 °C at SCI 9 (Tables 1 and 2).

Conductivity values fell between 50 µmhos/cm to 155 µmhos/cm at all stations except for SCI 7 (389 µmhos/cm) and SCI 9 (484 µmhos/cm), which had higher conductivity values (Tables 1 and 2, Figure 1). Stations 7 and 9 are the test sites for the Grande Olde Plaza WWTP and the Penney Farms WWTP, respectively. The somewhat elevated conductivity in these effluents (613 µmhos/cm at Grand Old Plaza and 534 µmhos/cm at Penney Farms), as well as the apparent lack of dilution in the streams, were the factors responsible for the higher conductivity observed there.

The turbidity at SCI station 1 (19.0 NTU's) was higher than the turbidity found in 95% of other Florida streams (see Table of Typical Water Quality Values in "Black Creek Basin Study Appendices"). Field observations suggested the elevated turbidity at SCI 1 may be

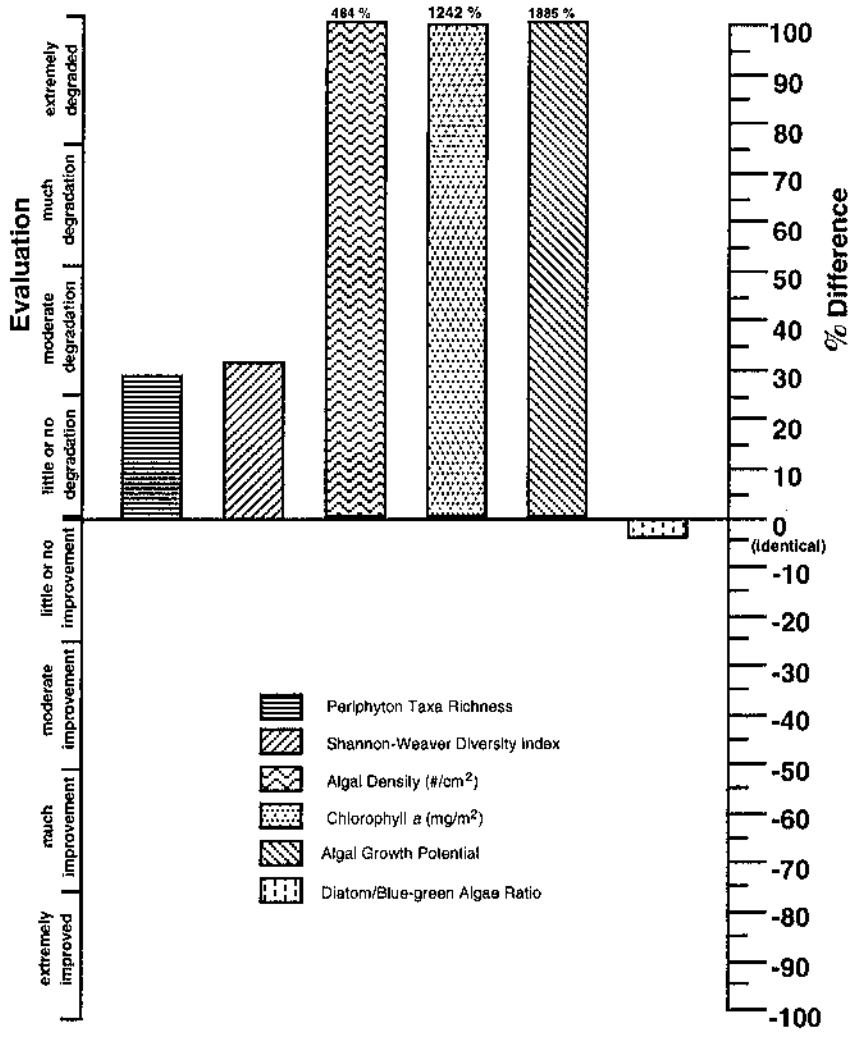
Table 4. Summary of Periphyton and Phytoplankton Data for the Black Creek Basin SCI Sites

	Mill Creek SCI 1	Bull Creek SCI 2	S. Fork Black Creek SCI 3	Ates Creek SCI 4	Greens Creek SCI 5	Grande Olde Plaza Ref Site SCI 6	Grande Olde Plaza Test Site SCI 7	Penney Farms Ref Site SCI 8	Penney Farms Test Site SCI 9
Periphyton Algae									
Number of Taxa						31	22	17	20
Shannon-Weaver Diversity						4.1	2.8	2.3	3.9
Algal Density (#/sq. cm)						6537	38166	32227	1899
Chlorophyll a (mg/sq. m)						1.8 Q	24.7	5.0 Q	0.1 UQ
Diatom/Diatom + B-G Abundance Ratio						0.947	0.988	1.00	0.926
% Blue-green						4.3	1.2	0	6.1
% Green						16.5	1.2	10.4	15.1
% Diatoms						78.3	97.7	89.0	75.8
% Other						0.9	0	0.6	3.0
Phytoplankton Algae									
Number of Taxa	9	15	13	10	13	9	11	11	8
Shannon-Weaver Diversity	3.0	3.4	3.2	3.1	3.4	2.8	2.8	2.5	2.9
Algal Density (#/mL)	210	217	311	168	72	88	172	496	72
Chlorophyll a (µg/L)	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.1 U
% Blue-green	32.0	37.0	25.0	32.0	51.9	23.8	4.7	25.4	50.0
% Green	48.0	38.9	44.4	20.0	33.3	57.1	23.8	11.9	27.8
% Diatoms	8.0	16.7	25.0	40.0	7.4	9.5	69.0	55.9	11.1
% Cryptophytes	8.0	5.5	2.8	8.0	7.4	9.5	0	3.4	11.1
% Other	4.0	1.8	2.8	0	0	0	2.4	3.4	0
Algal Growth Potential (mg dry wt/l)	5.8	10.1	4.5	2.6	6.1	3.6	71.1	1.9	41.5

Q - Sample held beyond normal holding time

U - Material analyzed for but not detected; value reported is the minimum detection limit

Figure 6. Effect of the Grande Olde Plaza discharge on the periphyton community.



attributable to poor land management practices in the Mill Creek drainage area (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix A). Turbidity was also elevated at SCI 6 (8.5 NTU's), where it was higher than the turbidity observed in 80% of other Florida streams (Tables 1 and 2, Figure 1). Home construction was observed in this watershed, which may have contributed to the turbidity.

The Grande Olde Plaza WWTP dechlorinated effluent was not acutely toxic to the fish, *Cyprinella leedsi*, or to the invertebrate, *Ceriodaphnia dubia* (see "Black Creek Basin Study Appendices" – Appendix C). Similarly, the Penney Farms WWTP dechlorinated effluent demonstrated no toxicity to either test organism (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix C).

Of the pesticides and organic compounds analyzed for, only a non-problem level of atrazine (0.091 µg/L) was detected in the Grande Olde Plaza WWTP effluent grab sample. No organic compounds were detected in the Penney Farms WWTP effluent sample.

Iron (28 µg/L) and zinc (26 µg/L) were detected in the Penney Farms WWTP effluent at levels which complied with Class III water quality standards (Table 2).

The following metals were detected in the Grande Olde Plaza effluent: aluminum (155 µg/L), cadmium (0.22 µg/L) copper (25 µg/L), iron (853 µg/L), silver (1.09 µg/L), and zinc (199 µg/L). At an effluent hardness of 87.2, the respective Class III water quality standards are 1.0 for cadmium, 10.5 µg/L for copper, and 94.4 µg/L for zinc. Therefore, the copper and zinc concentrations were in violation of Rules 62-302.530(24) and 62-302.530(71)FAC, respectively. The Class III standard for silver (0.07 µg/L) is not hardness based, and was exceeded by the level found in the Grande Olde Plaza WWTP effluent (Rule 62-302.530(60)FAC).

Widespread violations of Class III fecal coliform standards (Rule 62-302.530(6) FAC) occurred throughout the basin. Fecal coliform levels at SCI sites, 1, 2, 4, 5, 6, 7, and 9 exceeded the allowed maximum of 800 organism/100 mL (Tables 1 and 2, Figure 1A). Fecal coliforms in the Penney Farms WWTP effluent (1,170 organisms/100 mL) also exceeded this standard, as well as the facility's permit limit. Fecal coliform samples from SCI 3, SCI 8, and the Grand Olde Plaza WWTP effluent did not exceed the standard.

Total coliforms at SCI sites 1, 2, 3, 4, 5, 6, 7, and 9, as well as in the Penney Farms effluent, exceeded the Class III water quality standard of 2,400 organisms/100 mL (Rule 62-302.530(7) FAC) (Tables 1 and 2, Figure 1a). Total coliform bacteria complied with the Class III

water quality standard at SCI 8 and in the Grande Olde Plaza WWTP effluent sample.

Nitrate-nitrite enrichment was observed at SCI 7 (2.8 mg/L) and at SCI 9 (20.0 mg/L) was attributable to discharges from the Grande Olde Plaza WWTP and Penney Farms WWTP, respectively (Table 2, Figure 2). The nitrate-nitrite concentrations at these sites were higher than those found in 95% of other Florida streams, with the SCI 9 (20.0 mg/L) value being extremely elevated (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix B). Nitrate-nitrite concentrations in the Grande Olde Plaza and Penney Farms WWTP effluent samples were 12 mg/L and 23 mg/L, respectively.

Ammonia at SCI 9, the Penney Farms test site (0.24 mg/L), was higher than the concentrations found in 80% of other Florida streams. The high ammonia concentration at SCI 9 corresponds to elevated ammonia levels in the Penney Farms WWTP effluent (0.25 mg/L). Ammonia concentrations were not elevated at any of the other SCI sites (Tables 1 and 2, Figure 2).

Total phosphorus levels at SCI 9 (3.1 mg/L) and at SCI 7 (0.29 mg/L) were higher than the concentrations found in 95% and 70%, respectively, of other Florida streams. The concentrations of total phosphorus in the Penney Farms WWTP effluent (3.4 mg/L) and in the Grande Olde Plaza WWTP effluent (1.9 mg/L) appeared to be responsible for the elevated receiving water values. A moderately elevated total phosphorus value (0.26 mg/L) was also observed at SCI 4.

Algal growth potential (AGP) exceeded the 5 mg dry wt/L "problem threshold" (Raschke and Schultz 1987) at several sites in the Black Creek South Fork Basin (Tables 1 and 2, Figure 2). SCI 1 (5.8 mg dry wt/L), SCI 2 (10.1 mg dry wt/L), and SCI 5 (6.1 mg dry wt/L) had slightly to moderately elevated AGP levels. As expected from the nutrient results, the Grande Olde Plaza test site (SCI 7) and the Penney Farms test site (SCI 9) had extremely elevated AGP's (71.1 mg dry wt/L and 41.5 mg dry wt/L, respectively). AGP was also elevated in the Grande Olde Plaza WWTP effluent sample (438.8 mg dry wt/L) and the Penney Farms WWTP effluent sample (32.1 mg dry wt/L).

Hester-Dendy samplers were deployed upstream and downstream of the Grande Olde Plaza discharge. Figure 3 indicates the degree of difference between the invertebrate populations collected from Hester-Dendy samplers at the Grande Olde Plaza reference (SCI 6) and test (SCI 7) sites. Larger differences (that is, higher percentages) correspond with greater degrees of degradation. Negative values mean the test site is better than the reference. The number of taxa at the test site (29) was higher than the number found at the reference

Figure 7. Effect of the Penney Farms discharge on the periphyton community.

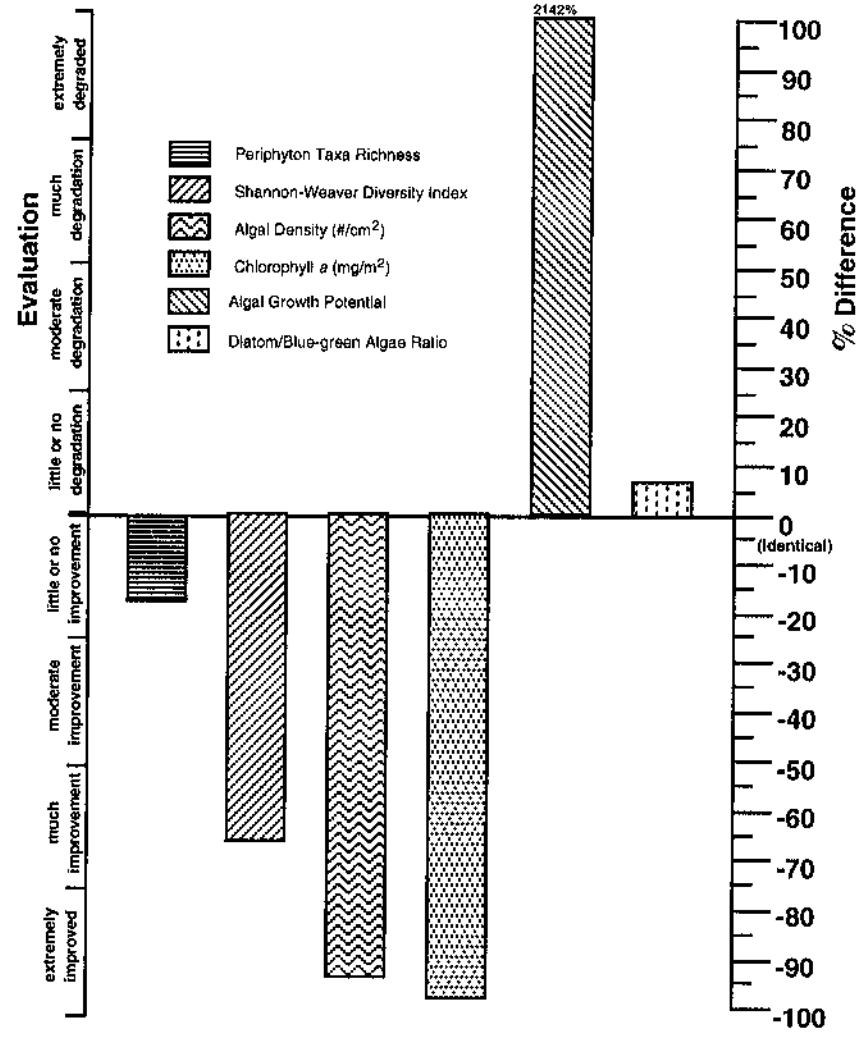
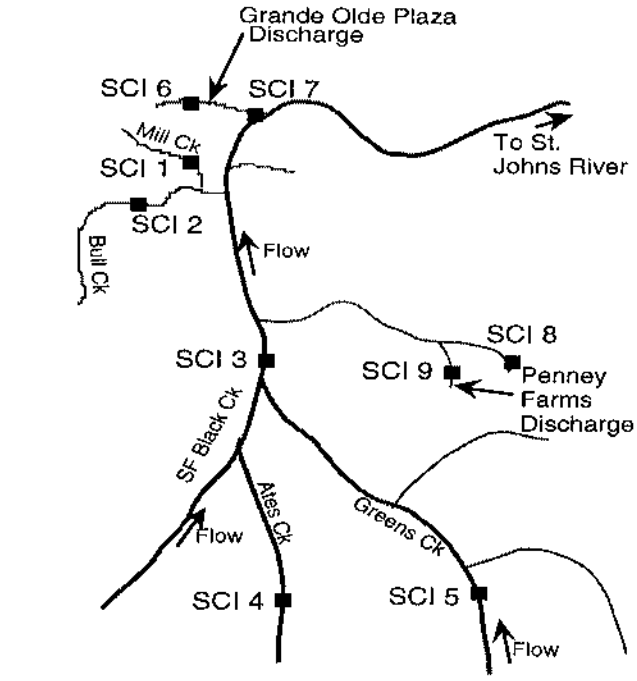
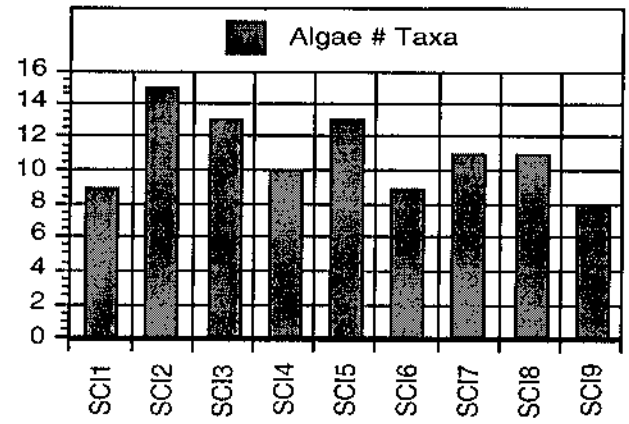
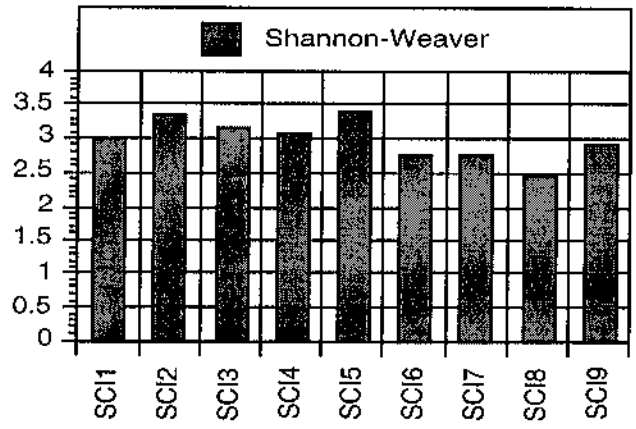
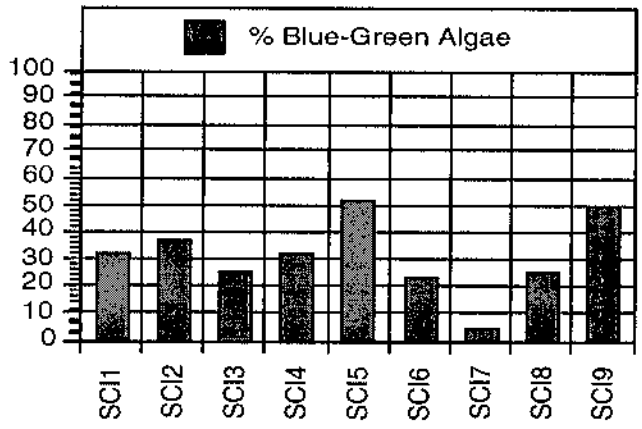


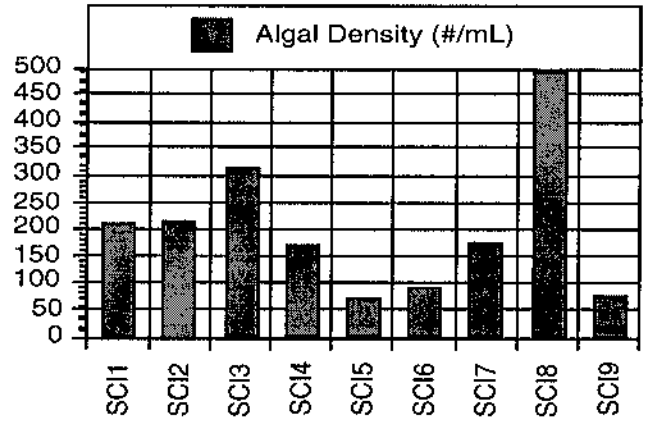
Figure 8. Basinwide Phytoplankton Measurements.











site (24) (Table 3, Figure 3). The Florida Index also increased at the test site (12) when compared to the reference site (5). There was also a greater percentage of filter-feeders at the test site (31.3%) when compared to the reference site (12.4%). No EPT taxa were found at either site. The Shannon-Weaver Diversity Index at the test site (3.7) was similar to the reference site (3.5). The Hester-Dendy data show no indications of degradation in the macroinvertebrate community due to the Grande Olde Plaza WWTP effluent.

Hester-Dendy samplers were also deployed at the Penney Farms reference site (SCI 8) and downstream of the Penney Farms discharge (SCI 9). The number of taxa was slightly lower at the test site (20) when compared to the reference site (22) (Table 3, Figure 4). No EPT taxa were found at either site. The Shannon-Weaver diversity index, with 3.4 at SCI 8 (reference site) and 3.3 at SCI 9 (test site), was similar. A higher percentage of filter-feeders was observed at the test site (32.5%) compared to the reference site (15.9%). The only indication of disturbance

at the Penney Farms test site was a decrease in the Florida Index from 7 at the reference site to 3 at the test site.

Macroinvertebrate sampling using the 20 dip net sweep method was performed at all 9 SCI stations throughout the watershed. Macroinvertebrate taxa richness ranged from a high of 47 taxa at station 5, to a low of 28 taxa at station 4 (Table 3, Figure 5). Based upon the current SCI thresholds, one expects to find a minimum of 22 taxa at an unimpaired site in northeastern Florida. All of the SCI sites in the Black Creek South Fork Basin met or exceeded this threshold. The EPT Index fluctuated from 15 EPT taxa at station 3, to a low of zero EPT taxa at station 9. An EPT Index of 2 or higher is usually found in a typical northeastern Florida stream. SCI station 6 (with 1 EPT) and SCI station 9 (with 0 EPT) fell below this threshold. A minimum Florida Index score of 8 points is expected for an unimpaired stream in northeast Florida. All of the SCI sites met this threshold with scores ranging from a high of 26 at SCI 5 to a low of 8 at SCI station 6.

The Stream Condition Index is a composite of seven different measures of macroinvertebrate community structure and function, including the parameters mentioned in the preceding paragraph (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix C). The SCI ranged from a low of 25 points at SCI stations 6 and 9, to a high of 29 at SCI stations 1, 3, 4 and 5 (Figure 5). In the Northeast portion of the state, a minimum score of 25 is needed for a site to receive an "excellent" rating, which was achieved at all stations. Although the SCI provides a good overview of a site's biological community health, some information is lost when individual measures are composited. An examination of our most robust measures of degradation, the Florida Index and the EPT Index, suggest that stations 6 and 9 showed signs of stress. By compiling points from other invertebrate measures which are used in the SCI calculation (the percent suspension feeders, percent dominance, and the number of chironomid taxa), the total scores were sufficient to bring the SCI values of these sites into the "excellent" category. However, the low Florida Index and/or EPT Index values at SCI sites 6, 7, and 9, coupled with the habitat observations or water quality results, suggest anthropogenic effects at those particular sites.

Based upon the habitat evaluation, potential problems at SCI 6 include low dissolved oxygen, bank erosion, and moderate habitat smothering by sand and silt. This station also had higher turbidity than all but one site in the basin. SCI station 7, downstream of the Grand Olde Plaza WWTP. Several problems with this discharge were documented during the present study, including low dissolved oxygen, elevated nutrients, and water quality violations of copper, silver, and zinc. The exceptionally low EPT score at SCI site 9 (with 0 EPT), may have been caused by the Penney Farms WWTP discharge. This site had elevated levels of conductivity, nitrate-nitrite, ammonia, and total phosphorus, suggesting the stream flow there was dominated by the domestic wastewater effluent. It is possible that the biota at SCI site 9 were responding to chronic or episodic pollution events caused by the facility.

Although the overall invertebrate health throughout the Black Creek South Fork Basin is currently excellent, observations regarding land use and subtle changes in the biological populations deserve mention. Stations in the more south-

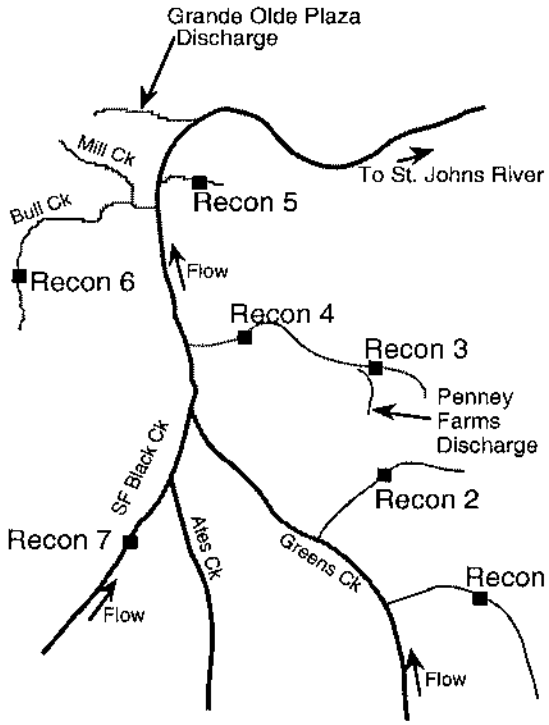
Table 5. Results of Physical/Chemical and Bio-Recon Analyses for the Black Creek Basin

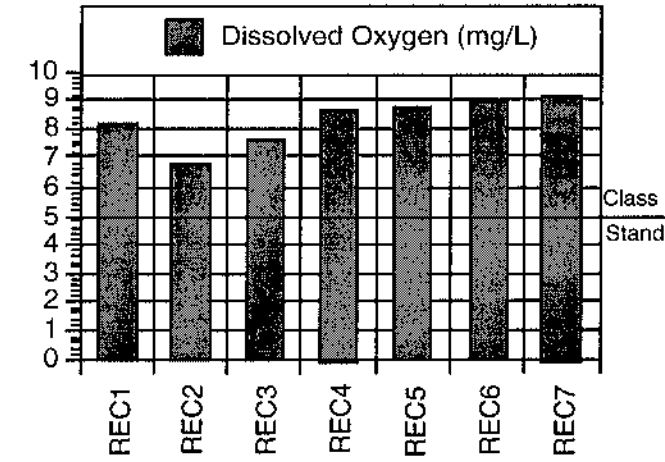
	REC 1	REC 2	REC 3	REC 4	REC 5	REC 6	REC 7
General Phys-Chem Parameters							
Habitat Assessment	140	122	118	138	125	131	108
Flow (m/s)	0.25	0.15	0.25	0.20	0.20	0.20	0.25
D.O. (mg/L)	8.2	6.8	7.7	8.7	8.8	8.9	9.2
pH (SU)	5.5	5.3	5.7	6.1	6.5	5.9	5.9
Conductivity (µmhos/cm)	73	61	88	79	126	62	50
Temperature (°C)	17.4	16.9	16.9	16.7	15.1	15.8	16.2
Macroinvertebrate Qualitative							
Number of Taxa	23	33	31	26	20	23	30
Florida Index	17	20	17	17	8	19	19
EPT Index	8	11	7	7	3	9	10

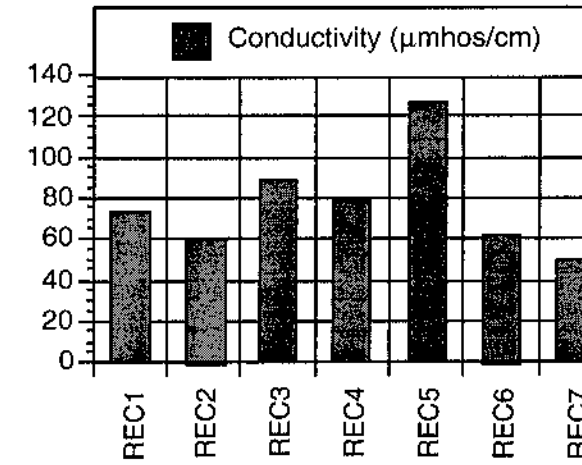
ern (upstream) portions of the basin (stations 3, 4 and 5) scored higher on most measures of macroinvertebrate community health than did the more northern sites (Figure 5). These southern stations are located in areas with lower proportions of residential and commercial land use. It is possible that in areas experiencing more rapid development (the northern part of the basin), construction disturbance (resulting in habitat degradation) will become an increasingly negative source of stress to the stream biota.

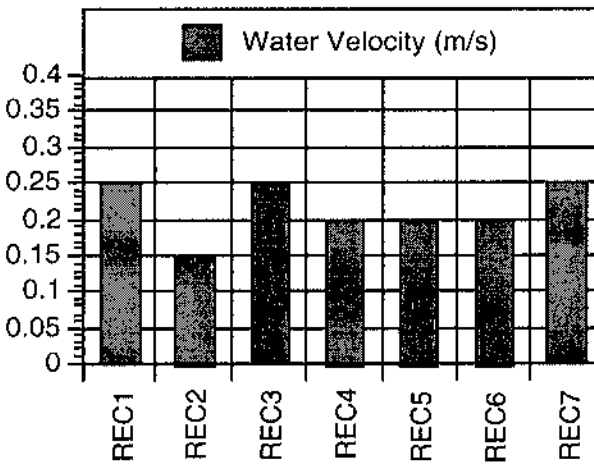
Periphyton racks were placed upstream (SCI 6, or reference site) and downstream (SCI 7, or test site) of the Grande Olde Plaza WWTP. Periphyton taxa richness was higher at the reference site (31 taxa) than at the test site (with 22 taxa) (Table 4, Figure 6). The Shannon-

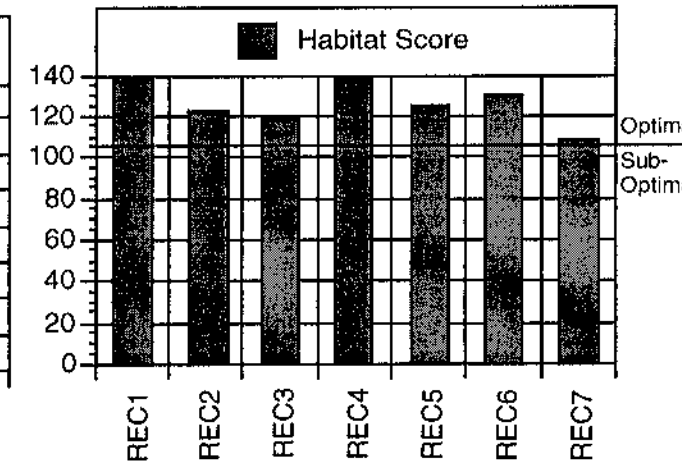
Figure 9. Bio-Recon Physical/Chemical and Habitat Measurements.











Weaver Diversity Index also decreased at the test site (2.8) when compared to the reference site (4.1), a 31.7% decline. Conversely, algal density was much greater at the test site (38,166 cells/cm^2) compared to the reference site (6,537 cells/cm^2). Similarly, chlorophyll *a* increased from 1.8 mg/m^2 at the reference site to 24.7 mg/m^2 at the test site, a 1,242% augmentation. Although the chlorophyll *a* sample collected at the reference site was held beyond normal holding time, the substantial difference in biomass corresponds to that observed with algal density. The combination of elevated algal density, chlorophyll *a*, and AGP, coupled with the observed decreases in diversity and taxa richness, indicate substantial degradation in the Grand Olde Plaza test site periphyton. This imbalance in the periphyton community may be attributable to the nutrient enrichment caused by the Grande Olde Plaza WWTP effluent, and represents a violation of Rule 62-302.530(48)(b) FAC.

Periphyton racks were incubated at the Penney Farms reference site (SCI station 8) and downstream of the Penney Farms WWTP discharge (SCI station 9). A total of 17 periphyton taxa were observed at the reference site, while 20 periphyton taxa were found at the test site (Table 4, Figure 7). The Shannon-Weaver diversity index was lower at the reference site (2.3) than the test site (3.9). Algal density at the reference site (32,227 cells/cm^2) was higher than at the test site (1,898 cells/cm^2). Normal concentrations of chlorophyll *a* were observed at the reference site (5.0 mg/m^2) while chlorophyll *a* was undetected at the test site (see separate document, "Appendices of the Biological Assessment of the Black Creek South Fork Watershed" – Appendix B). Despite extremely elevated nutrient levels and AGP at the Penney Farms test site, the periphyton community did not appear to be degraded when compared to the reference site. Light attenuation, caused by the moderately dense riparian zone vegetation canopy, would be one potential explanation for this unexpected phenomenon.

Phytoplankton communities throughout the Black Creek South Fork Basin appeared to be typical for stream systems, where flowing conditions prohibit accumulation of free-water algae. Algal densities ranged from a low of 72 cells/mL at station 5 to a high of 496 cells/mL at station 8 (Table 4, Figure 8). Chlorophyll *a* was undetected in the phytoplankton samples taken at all 9 SCI sites. The number of taxa ranged from 8 taxa at SCI 9 to 15 taxa at SCI 2. The Shannon-Weaver diversity index ranged from 2.5 at station 8 to 3.4 at stations 2 and 5. Conditions such as flow, temperature, and sunlight attenuation appeared to prevent phytoplankton blooms at the sites (SCI 7 and 9) where significant nutrient enrichment from the Grande Olde Plaza and Penney Farms effluents was observed.

Bio-Recon Sites (Recon 1 through Recon 7)

Habitat quality was optimal at all seven of the Bio-Recon sites, ranging from 108 at Recon 7 to a high of 140 at Recon 1 (Table 5, Figure 9). Dissolved oxygen was above the Class III water quality standard at all of the Bio-Recon sites, with values ranging from 6.8 mg/L at Recon 2 to 9.2 mg/L at Recon site 7. Conductivity was highest at Recon 5 (126 µmhos/cm) while the rest of the stations fell between 88 µmhos/cm (station 3) and 50 µmhos/cm (station 7). Water velocity was similar throughout the basin, ranging from 0.15 m/s at Recon station 2 to 0.25 m/s at stations 1, 3 and 7.

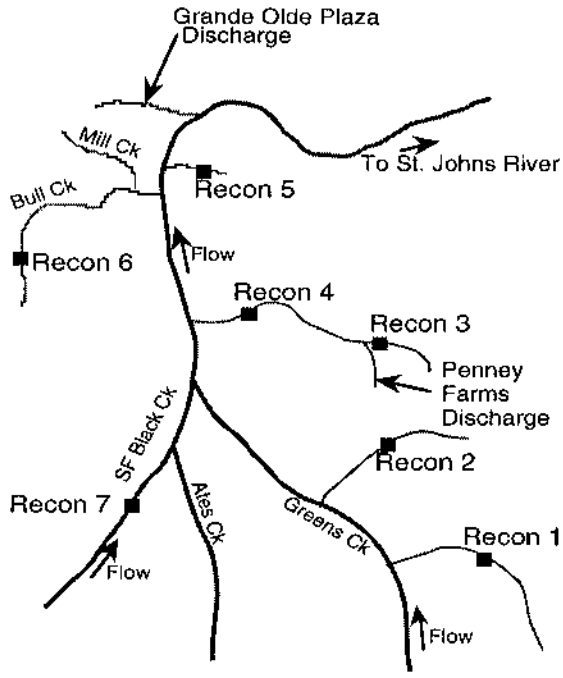
Bio-Recon is a screening tool, utilizing an abbreviated sampling strategy and a purposely limited taxonomic evaluation of the study system. EPT taxa and non-chironomid taxa which receive Florida Index points are emphasized. Bio-Recon appears to be useful in differentiating streams where biological health is very good from those where the biota are suspected to be impaired. More rigorous, follow-up sampling would be necessary to confirm the evaluation and determine the degree of impairment.

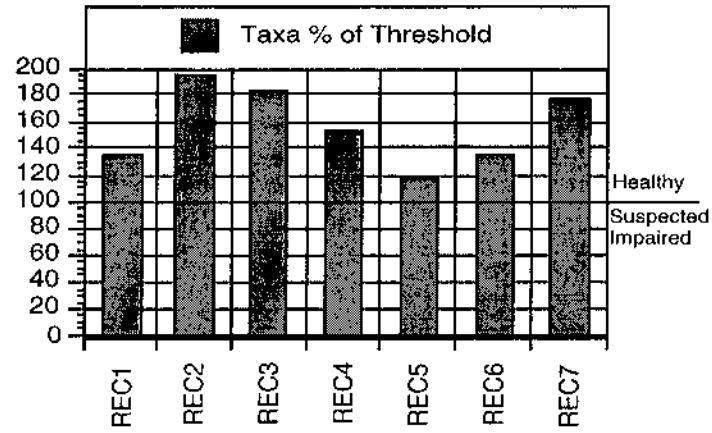
Three measures of community health are calculated from Bio-Recon results (with minimum expected values for northeastern Florida streams in parentheses): Recon taxa richness (17), Recon Florida Index (6), and Recon EPT Index (3). Note that the minimum threshold values for these metrics are considered interim, and may be modified as more data are gathered. If two out of three metrics achieve the minimum thresholds, the site is considered healthy (FDEP 1996a, #BA-29). If not, the site is suspected to be impaired.

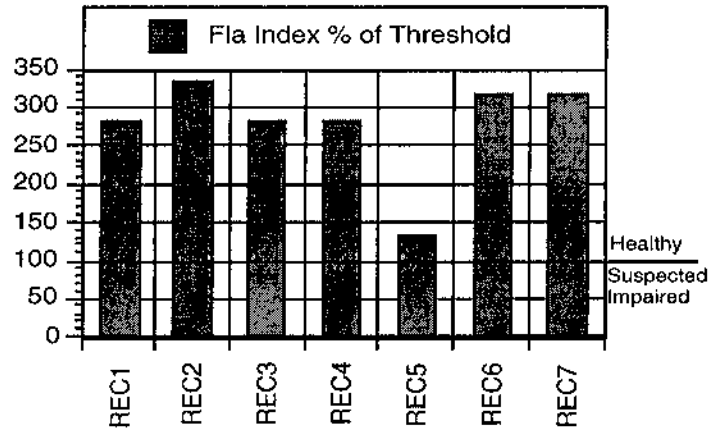
For each of the seven streams evaluated by the Bio-Recon method in the Black Creek South Fork Basin, these three metrics were calculated, and then normalized based on the percentage attainment of the minimum thresholds (Figure 10). The resulting (percentage) normalized values were then averaged for each site and plotted on additional graph (Figure 10).

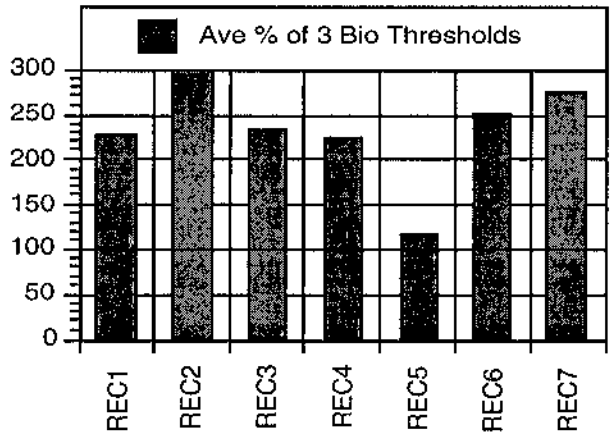
All of the Bio-Recon sites passed all three of the biological thresholds, indicating healthy mac-

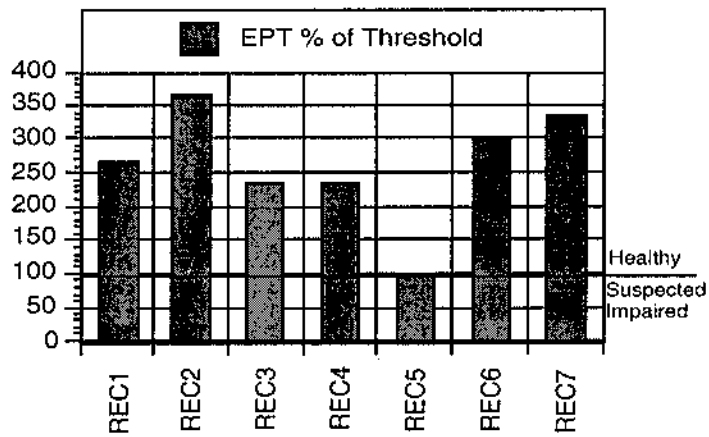
Figure 10. Bio-Recon Benthic Macroinvertebrate Measurements.











roinvertebrate communities throughout the basin. However, it should be noted that despite passing all of the threshold values, Recon 5 scored the lowest on all three measures of macroinvertebrate community health when compared to the other sites in this study (Figure 10). Residential and commercial development in the Polander Branch drainage may be having a negative impact on the biological communities of this stream. Further evaluation of the this site may be warranted, especially considering that the thresholds established for the Bio-Recon method are interim values and may need to be modified to accurately identify potentially impaired streams.

Conclusions

Habitat quality was suboptimal at SCI stations 6 and 7 (due to habitat smothering, bank instability, and low water velocity), but optimal at the remaining sites. Habitat quality was optimal at all the Bio-Recon sites.

Dissolved oxygen at SCI stations 6, 7, 8, and 9 was less than the 5.0 mg/L minimum Class III dissolved oxygen standard. Effluent from the Penney Farms WWTP had a dissolved oxygen level of 4.6 mg/L, in excess of the facility's permit as well as the Class III standard. Elevated turbidity was observed at SCI stations 1 (19.0 NTU's) and 6 (8.5 NTU's). Other physical/chemical parameters were normal.

Neither the Grande Olde Plaza WWTP effluent or the Penney Farms WWTP effluent was acutely toxic to the fish, *Cyprinella leedsi*, or to the invertebrate, *Ceriodaphnia dubia*.

No organic compounds were detected in the Grande Olde Plaza nor Penney Farms effluents at levels which exceeded Class III water quality standards.

Copper (25 µg/L), silver (1.09 µg/L), and zinc (199 µg/L) were present in the Grand Olde Plaza effluent at levels which exceeded the Class III water quality standards, violating Rules 62-302.530 (24), 62-302.530 (60), and 62-302.530 (71) FAC, respectively.

Widespread violations of Class III fecal coliform and total coliform standards (Rules 62-302.530(6) and 62-302.530(7) FAC) occurred throughout the basin. Fecal coliform levels in the Penney Farms WWTP effluent and at SCI sites 1, 2, 4, 5, 6, 7, and 9 exceeded the allowed maximum of 800 organism/100 mL. Total coliforms in the Penney Farms effluent and at SCI sites 1, 2, 3, 4, 6, 7, and 9 exceeded the Class III water quality standard of 2,400 organisms/100 mL.

Nitrate-nitrite and total phosphorus enrichment was observed at SCI 7 and at SCI 9, attributable to discharges from the Grande Olde Plaza WWTP and Penney Farms WWTP, respectively. Similarly, ammonia at SCI 9, the Penney Farms test site, was higher than the concentrations found in 80% of other Florida streams. A moderately elevated total phosphorus value was also observed at SCI 4.

Algal growth potential (AGP) exceeded the 5 mg dry wt/L "problem threshold" at some sites throughout the Black Creek South Fork Basin. Sites with the most elevated AGP values were those downstream of the Grande Olde Plaza and Penney Farms effluents, with AGP values of 71.1 mg dry wt/L and 41.5 mg dry wt/L, respectively.

Based on the Stream Condition Index (SCI), all sites received an "excellent" rating. However, the low Florida Index and/or EPT Index values at SCI sites 6, 7, and 9, coupled with the habitat observations or water quality results, suggest moderate anthropogenic effects at those particular sites. Potential problems at SCI site 6 include low dissolved oxygen, bank erosion, and moderate habitat smothering by sand and silt. SCI station 7, downstream of the Grand Olde Plaza WWTP, had low dissolved oxygen and elevated nutrients. Additionally, water quality violations of copper, silver, and zinc were found in the effluent. The exceptionally low EPT score at SCI site 9 (with 0 EPT), may have been caused by the Penney Farms WWTP discharge. This site had elevated levels of conductivity, nitrate-nitrite, ammonia, and total phosphorus. It is likely that the biota at SCI site 9 were responding to chronic or episodic pollution events caused by the facility. It was hypothesized that in areas experiencing more rapid development (the northern part of the basin), construction disturbance, resulting in habitat degradation, will become an increasingly negative source of stress to the stream biota.

Imbalances in the periphyton community at SCI station 7 were attributed to the Grande Olde Plaza WWTP. Decreases in periphyton taxa richness and diversity, as well as increases in density and chlorophyll *a*, indicated a violation of Rule 62-302.530 (48) (b) FAC. Despite extremely elevated nutrient levels and AGP at the Penney Farms test site, the periphyton community at SCI 9 did not appear to be degraded when compared to the reference site.

Phytoplankton communities throughout the Black Creek South Fork Basin appeared to be typical for stream systems.

The Bio-Recon survey did not indicate any sites where the macroinvertebrate community was suspected to be impaired. However, Bio-Recon station 5 (Polander Branch) scored lower on measures of macroinvertebrate community health than the remaining Bio-Recon sites, suggesting further evaluation of this site may be warranted.

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