Missouri Department of Natural Resources

Biological Assessment

Straight Fork
Morgan County, Missouri

2003-2004

Prepared for:
Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Protection Program
Water Pollution Branch

Prepared by:
Missouri Department of Natural Resources
Air and Land Protection Division
Environmental Services Program
Water Quality Monitoring Section

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1.0 Introduction

Straight Fork flows northeasterly for 18 miles from its headwaters near Versailles, Missouri to its confluence with the North Moreau Creek, approximately five miles east of Fortuna, Missouri. Six miles of its headwaters are listed as a class "C" stream with the remainder listed as class "P". A Class "C" stream section may cease flow during dry periods but a Class "P" stream section usually maintains flow (MDNR 2000). Straight Fork has designated uses of "Livestock and Wildlife Watering" (**LWW**) and "Protection of Aquatic Life and Human Health-Fish Consumption" (**AQL**).

Biological and stream habitat assessments were conducted on Straight Fork, Morgan County in the fall of 2003 and spring of 2004 to determine if it was impaired by the Versailles Wastewater Treatment Facility (**WWTF**). The Aquatic Bioassessment Unit of the Water Quality Monitoring Section (**WQMS**), Environmental Services Program (**ESP**), Missouri Department of Natural Resources (**MDNR**) coordinated and conducted this study. An evaluation of volatile suspended solids (**VSS**) and fine sediment in Straight Fork was conducted by the Water Quality Monitoring Unit of the WQMS and will be included in a later report.

1.1 Justification

Straight Fork, Morgan County receives effluent to its headwaters from the Versailles WWTF. Outfall #001 at the WWTF has a "design flow" of 550,000 gallons per day (**GPD**) and an "actual flow" of 300,000 GPD (MDNR Permit, MO-0094927). Outfall #002 is an infiltration basin with a design flow of 150,000 GPD, but is dependent on the amount of rainfall.

Approximately 1.1 miles of Straight Fork are on the Missouri Department of Natural Resources 2002 list of impaired waters under section 303(d) of the Federal Clean Water Act. The Versailles WWTF is suspected of being a source of potential impairment of aquatic life, due to VSS.
http://www.dnr.state.mo.us/wpscd/wpcp/waterquality/2002_303d_list.pdf
Volatile suspended solids represent the organic fraction of suspended solids that may be discharged by an improperly functioning WWTF. Volatile suspended solids and other effluent components are related to stream appearance and odor problems, along with excessive algae growth and decreased dissolved oxygen levels.
http://www.dnr.mo.gov/wpscd/wpcp/tmdl/info/straight-fork-info.pdf

The Total Maximum Daily Load (**TMDL**) section 303(d) listed reach of Straight Fork is considered to be a "High" priority for evaluation (2002 TMDL). In 2003, a study plan was submitted to the MDNR, Water Pollution Control Branch by the WQMS to conduct a biological assessment and stream habitat assessment of Straight Fork, Morgan County (Appendix A). The WQMS was responsible for coordinating and conducting the proposed project.

1.2 Purpose

Determine if Straight Fork, Morgan County was impaired downstream from the Versailles WWTF.

1.3 Objectives

1) Assess the macroinvertebrate community integrity and water quality in Straight Fork, Morgan County.

2) Assess the stream habitat quality of Straight Fork, Morgan County.

1.4 Tasks

1) Conduct a biological assessment, including macroinvertebrate and water physicochemical analyses, of Straight Fork, Morgan County and Bonne Femme Creek (control).

2) Conduct a stream habitat assessment of Straight Fork, Morgan County.

3) Compare wadeable/perennial stream biological criteria results between test stations on Straight Fork with control stations at a similar-size reference stream (stations).

1.5 Null Hypotheses

Straight Fork, Morgan County stations will be similar to wadeable/perennial stream biological criteria from upstream to downstream and between test and control stations.

Water quality at Straight Fork, Morgan County will be similar between all stations and acceptable with Water Quality Standards (MDNR 2000).

Stream habitat assessment will be similar between test stations, as well as with control stations at a similar-size reference stream (stations).

2.0 Methods and Analyses

The study area, station descriptions, Ecological Drainage Units (**EDUs**), and land use are identified. Study timing is outlined. A method for the stream habitat assessment is discussed. Biological assessments are introduced. Physicochemical water collection and analytical methods are defined.

2.1 Study Area and Station Descriptions

The study area includes a three-mile reach of Straight Fork, Morgan County and approximately one mile of Bonne Femme Creek, Boone County (Table 1, Figure 1). Bonne Femme Creek was used as a similar-size reference or control stream for comparisons with Straight Fork. Three test stations were allocated for Straight Fork (Figure 2) and two for Bonne Femme Creek (Table 1). Straight Fork #3 was situated

immediately downstream from the Versailles WWTF outfall #001. Stations #2 and #1 were positioned downstream from station #3 at approximately one-mile intervals. Stations #3 and #2 were within the 303(d) listed section of stream. Station #1 was located downstream from the listed section of Straight Fork.

Table 1
Location and Descriptive Information for Straight Fork and Bonne Femme Creek Stations, 2003-2004

Stream-Station Number	Location-Section or Survey, Township, Range	Description	County
Straight Fork #3	SE 1/4 sec. 36, T. 43 N., R. 18 W.	Test Station - Immediately Downstream WWTF	Morgan
Straight Fork #2	SE 1/4 sec. 25, T. 43 N., R. 18 W.	Test Station - 1.25 miles Downstream WWTF	Morgan
Straight Fork #1	SE 1/4 sec. 24, T. 43 N., R. 18 W.	Test Station - 2.25 miles Downstream WWTF	Morgan
Bonne Femme Creek #2	SW 1/4 sec. 30, T. 47 N., R. 12 W.	Similar-size control station in EDU	Boone
Bonne Femme Creek #1	SE 1/4 sec. 25, T. 47 N., R. 13 W.	Similar-size control station in EDU	Boone

2.1.1 Ecological Drainage Unit

Straight Fork and Bonne Femme Creek are within the Ozark/Moreau/Loutre Ecological Drainage Unit (**EDU**) (Figure 1). Ecological Drainage Units are delineated drainage units that include all streams and tributaries within a major river basin. Similar-size streams within an EDU are expected to contain similar aquatic communities and stream habitat conditions. Comparisons made between similar-size streams in the same EDU should then be appropriate.

2.1.2 Land Use Description

Land cover (land use) throughout the Ozark/Moreau/Loutre EDU was compared to the land cover of each station by 14-digit Hydrological Unit (**HU**) (Table 2). Percent land cover data were derived from Thematic Mapper (TM) satellite data collected between 1991 and 1993 and interpreted by the Missouri Resource Assessment Partnership (MoRAP). The implication of this comparison is that land use within the study area is similar to the control stations or reference stream and does not interfere with interpretation of the findings; such as may occur if a stream in an area dominated by cropland area was compared to a stream near forest.

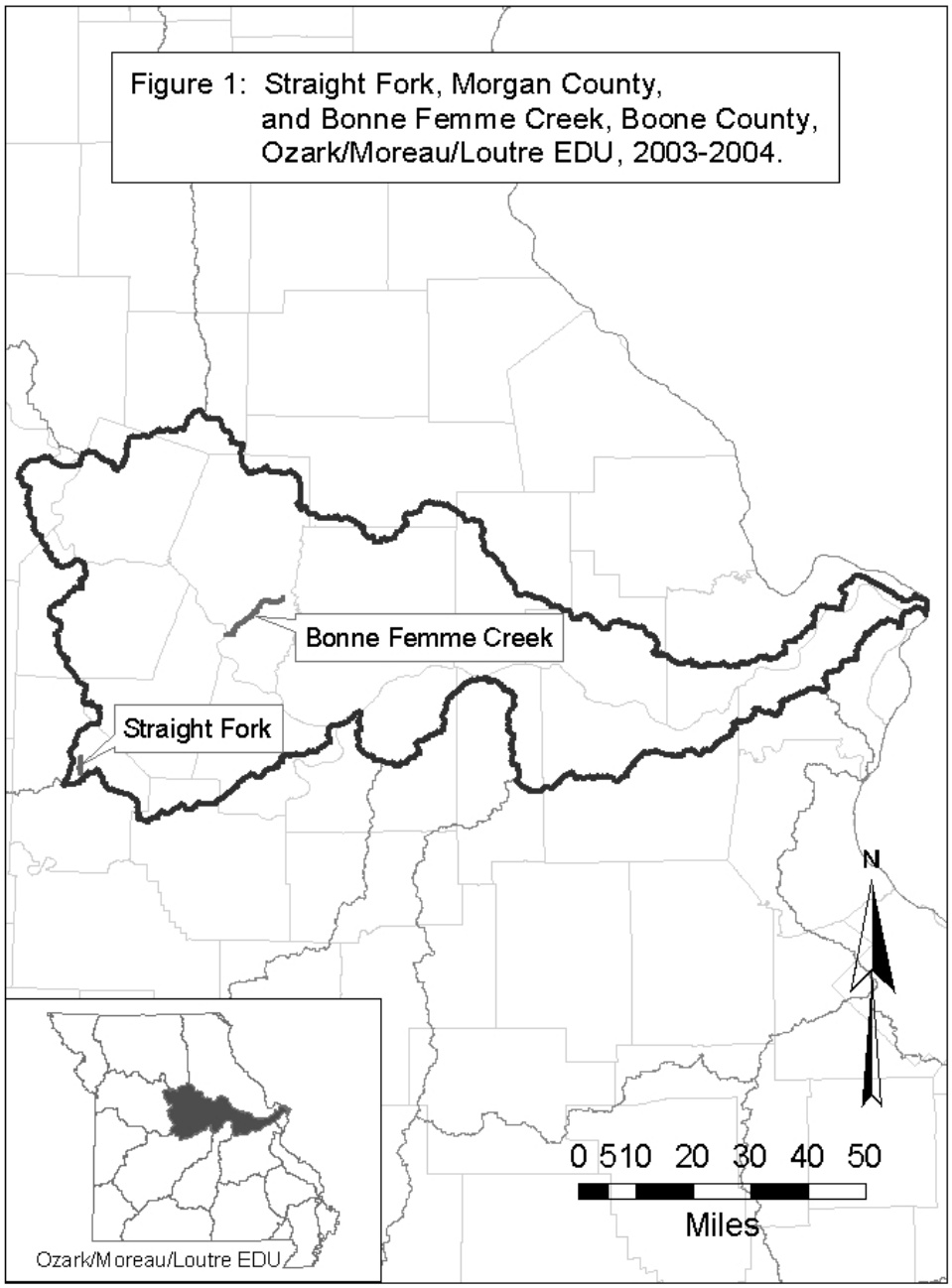

Figure 1: Straight Fork, Morgan County, and Bonne Femme Creek, Boone County, Ozark/Moreau/Loutre EDU, 2003-2004.

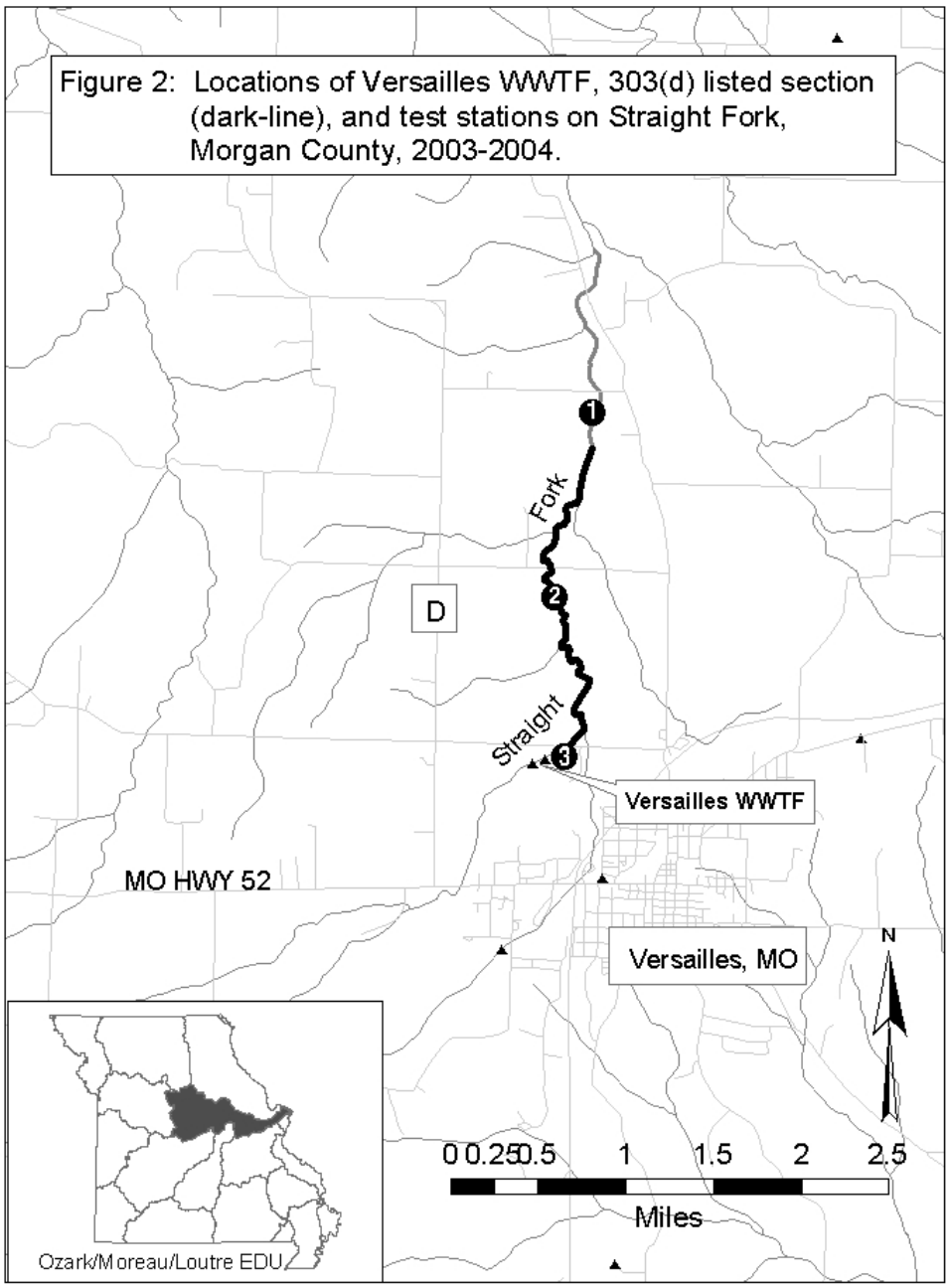

Figure 2: Locations of Versailles WWTF, 303(d) listed section (dark-line), and test stations on Straight Fork, Morgan County, 2003-2004.

Land use in Straight Fork's HU was similar to the HU of Bonne Femme Creek and the overall Ozark/Moreau/Loutre EDU with only a few exceptions (Table 2). Straight Fork HU had a slightly higher percentage of grassland (68) than at either Bonne Femme Creek (40.3) or the EDU (40.3). The percentage of forested land was less at Straight Fork (10.8) than at Bonne Femme Creek (41.9) or the EDU (35). However, differences in land use at the control and test stations should not interfere with interpretation of the results in this study.

Table 2
Percent Land Cover for Straight Fork Stations, Bonne Femme Creek Stations, and the Overall EDU

Stations	HUC-14	Urban	Crops	Grassland	Forest
Straight Fork #3, #2, #1	10300102200001	0.8	19.8	68	10.8
Bonne Femme #2, #1	10300102130003	0.0	17.3	40.3	41.9
Ozark/Moreau/Loutre EDU	--	1.9	20.9	40.3	35

2.2 Study Timing

Sampling was conducted in the fall (2003) and the spring (2004), as stated in MDNR's Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003c). Biological assessments were conducted twice and stream habitat assessments were conducted once.

Fall assessments were conducted at Straight Fork stations on September 24 and 25, 2003 and Bonne Femme Creek stations on September 24, 2003. Spring assessments were conducted at Straight Fork stations on March 31, 2004 and Bonne Femme Creek stations on April 2, 2004.

Stream habitat assessments were conducted at Straight Fork stations on April 1, 2004 and Bonne Femme Creek stations on April 5, 2004.

2.3 Stream Habitat Assessment Project Procedure

The standardized Stream Habitat Assessment Project Procedure (**SHAPP**) was followed as described for Riffle/Pool prevalent streams (MDNR 2003d). Comparisons were made between scores at the test stations (Straight Fork #3, #2, and #1) from upstream to downstream, as well as the mean score of the control stations (Bonne Femme Creek #2 and #1). According to the SHAPP, the quality of an aquatic community is based on the stream's ability to support the aquatic community. If SHAPP scores at test stations were $\geq$75% of the mean control scores, the stream habitat at the test station was considered to be comparable to the reference stream.

2.4 Biological Assessment

Biological assessments consist of macroinvertebrate community and physicochemical water collection and analyses.

2.4.1 Macroinvertebrate Collection and Analyses

A standardized macroinvertebrate sample collection procedure was followed as described in the SMSBPP (MDNR 2003c). Metric scores are normally derived based on taxa presence and community structure in multiple habitats of reference streams. Straight Fork and Bonne Femme Creek were considered to be Riffle/Pool predominant streams and were sampled accordingly. Subsequently, course substrate with flowing water (**CS**), non-flowing water with depositional substrates (**NF**), and rootmat (**RM**) habitats were sampled on Straight Fork and Bonne Femme Creek.

Macroinvertebrate community data were analyzed using Stream Condition Index (**SCI**) scores, individual biocriteria metrics, and dominant macroinvertebrate families (**DMF**). All results were examined by season and station, from upstream to downstream, and between control stations and test stations.

The first analysis was of SCI scores by station, grouped by season. An SCI is a qualitative rank measurement of a stream's aquatic biological integrity (Rabeni et al. 1997). The SCI was further refined for reference streams within each EDU in Biological Criteria for Perennial/Wadeable Streams (**BIOREF**) (MDNR 2002). Four primary metrics are used in calculating the SCI: 1) Taxa Richness (**TR**), 2) Ephemeroptera/ Plecoptera/Trichoptera Taxa (**EPTT**), 3) Biotic Index (**BI**), and 4) Shannon Diversity Index (**SDI**) per station. All metrics (TR, EPTT, BI, SDI) scores were compared to the scoring range (i.e. SCI Scoring Table, Tables 4 and 5) of the appropriate biological criteria and then rank scores (5, 3, 1) were assigned to each metric. Rank scores for each metric were compiled for each station and the total SCI was complete (Tables 4 and 5). A station's SCI score equates to the biological integrity of the aquatic community with 20-16 = fully biologically supporting, 14-10 = partially biologically supporting, and 8-4 = non-supporting of the biological community.

Secondly, the individual biocriteria metric (TR, EPTT, BI, SDI) scores were assessed to identify unusual responses or compare interesting trends from upstream to downstream and between test and control stations. Variations in certain metrics results may identify a source of impairment, if it exists.

The third analysis of the biological data was an evaluation of the DMF as a percentage of the total taxa. Presence or absence of certain families may identify why a stream is impaired and point to the source of impairment. The predominant families within each station were identified and trends were examined from upstream to downstream and between control and test stations. A taxa list is included for each station, grouped by season (Appendix B).

2.4.2 Physicochemical Water Collection and Analyses

Physicochemical water samples were handled according to appropriate MDNR, ESP Standard Operating Procedures (**SOPs**) and Project Procedures (**PPs**) for sampling and analyzing physical and chemical samples. Samples were collected according to the SOP MDNR-FSS-001 Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003b). Results are reported for physicochemical water variables in chronological order for each station. Samples were collected and analyses conducted in the fall of 2003 and spring of 2004.

Physicochemical water parameters measured in the field were pH, temperature (C^0), conductivity (uS/cm), dissolved oxygen, and discharge. Water samples for laboratory analyses were collected and kept on ice during transport to the ESP laboratory. Water samples were analyzed for turbidity, ammonia-nitrogen, nitrate/nitrite-nitrogen, Total Kjeldahl Nitrogen (**TKN**), chloride, and total phosphorus. Turbidity was measured and recorded in the WQMS Biology Laboratory. The ESP, Chemical Analysis Section (CAS) in Jefferson City, Missouri conducted all of the remaining analyses.

Physicochemical water data were compared from upstream to downstream stations and between the test and control stations. Results were also compared with acceptable limits according to Missouri's Water Quality Standards (**WQS**) (MDNR 2000). Interpretations of the acceptable levels for several physicochemical water variables are dependent on a stream's classification and beneficial-use designation. Straight Fork is classified as a class "C" stream with designated uses for "LWW and AQL". Furthermore, acceptable limits for some variables within the Water Quality Standards may be dependent on the rate of exposure. These toxicity limits are based on the lethality of a toxicant given long-term (chronic toxicity, **c**) or short-term (acute toxicity, **a)** exposure.

2.4.3 Discharge

Stream flow was measured using a Marsh-McBirney flow meter at each station. Velocity and depth measurements were recorded once per station and season. The discharge at each station is identified in units of cubic feet per second (**cfs**). Measurements were taken and discharge was derived in accordance with the SOP, MDNR-WQMS-113 Flow Measurement in Open Channels (MDNR 2003a).

2.5 Quality Control

Quality control was utilized in accordance with MDNR SOPs and Project Procedures.

3.0 Results and Analyses

The results for stream habitat and biological assessments are included here. Results are grouped by station (from upstream to downstream) and season (fall and spring), with the exception of the SHAPP, which was conducted once. Comparisons were made from upstream to downstream and between test and control stations.

3.1 Stream Habitat Assessment

Stream habitat assessment scores were similar between Straight Fork stations #3, #2, and #1 and were similar to the mean of the control stations on Bonne Femme Creek #2 and #1 (Table 3). Stream Habitat Assessment Project Procedure scores ranged from 128 to 135 at Straight Fork, while Bonne Femme ranged from 124 to 143. The average for all Straight Fork stations was 132, while Bonne Femme Creek was 134. As stated in the SHAPP, a score that is at least 75 percent of the SHAPP reference(s) (or controls) is considered to be comparable to that or those reference streams. Straight Fork stations scored from 96 to 100 percent of the mean score of Bonne Femme Creek stations and were considered comparable to the reference streams.

Table 3
Stream Habitat Assessment Scores for Straight Fork and Bonne Femme Creek
Spring (April) 2004

	Straight Fork #3	Straight Fork #2	Straight Fork #1	Bonne Femme #2 (control)	Bonne Femme #1 (control)
SHAPP Scores	128	135	135	143	124
Percent of mean controls (134)	96	101	101	107	92

3.2 Biological Assessment

Biological assessments consisted of macroinvertebrate community composition analyses and physicochemical water analyses at test and control stations. Trends were observed from upstream to downstream, as well as between test and control stations. Results are shown in chronological order (e.g. fall 2003, spring 2004)

3.2.1 Macroinvertebrate Community Analyses

Three macroinvertebrate community analyses were used to identify the integrity of the biological community in Straight Fork: 1) SCI scores; 2) individual metric scores; and 3) dominant macroinvertebrate families per station. Trends and outstanding results were grouped by sample season before examination from upstream to downstream and between test and control stations.

3.2.1.1 Stream Condition Index Scores and Individual Biocriteria Metrics

A trend was observed in the SCI scores for the fall 2003 samples (Table 4). The SCI score was lowest (10) at Straight Fork #3. The scores were again low at the remaining downstream stations (#2-14 and #1-12, respectively). Stream Condition Index scores indicated that Straight Fork stations #3, #2, and #1 were partially supporting of the biological community in the fall. Control stations on Bonne Femme Creek #2 and #1 were both fully supporting of the biological community.

Individual biocriteria metrics illustrated a trend from upstream to downstream, as well as between test and control stations in the fall of 2003 (Table 4). Station #3 had the lowest TR, EPTT, and SDI and the highest BI of all test stations. Metrics generally improved (increased TR, EPT, SDI and decreased BI) at downstream stations #2 and #1. With the exception of the BI at Straight Fork #2, all individual metrics at Straight Fork stations were different from the control stations.

Table 4
Fall 2003 Biocriteria Metric and Stream Condition Index Scores for Straight Fork and Bonne Femme Stations. SCI Scoring Table (in gray) Developed from BIOREF Streams (n=11)

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	SCI	Supporting
Straight Fork #3	0318729	44	5	7.42	2.54	10	Partially
Straight Fork #2	0318728	54	7	6.78	2.87	14	Partially
Straight Fork #1	0318727	58	10	7.23	2.72	12	Partially
Bonne Femme #2	0318726	75	11	6.59	3.14	18	Fully
Bonne Femme #1	0318725	79	11	6.79	3.05	16	Fully
Score=5	--	>68	>13	<7.05	>3.08	20-16	Fully
Score=3	--	68-34	13-6	7.05-8.52	3.08-1.54	14-10	Partially
Score=1	--	<34	<6	>8.52	<1.54	8-4	Non

A trend was identified in the SCI scores for the spring 2004 season (Table 5). Stream Condition Index scores at Straight Fork #3 (10) and #2 (10) were the lowest of all stations. Station #1 scored slightly higher (12) than the upstream stations; however, all test stations were considered partially supporting of the biological community. Control stations (Bonne Femme #2 and #1) scored 20 and 18, respectively, which identified them as fully supporting of the biological community.

All individual biocriteria metrics were different from control metrics in the spring of 2004 (Table 5). The TR was lower at test stations than the control stations. The EPTT was as much as three times lower at the test stations than at the controls and appeared to be very influential in developing the overall SCI score at stations #3 and #2. The BI was highest at station #3 (8.06). The BIs remained higher at stations #2 (6.68) and #1 (6.89), yet were only slightly higher than the similar size controls (6.40 and 6.50). The SDI was lower at test stations than the control stations.

Table 5
Spring 2004 Biocriteria Metric and Stream Condition Index Scores for Straight Fork and Bonne Femme Stations. SCI Scoring Table (in gray) Developed from BIOREF Streams (n=13)

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	SCI	Supporting
Straight Fork #3	0418668	54	5	8.06	2.44	10	Partially
Straight Fork #2	0418667	39	4	6.68	2.44	10	Partially
Straight Fork #1	0418666	60	9	6.89	2.76	12	Partially
Bonne Femme #2	0418716	74	14	6.40	3.06	20	Fully
Bonne Femme #1	0418670	78	14	6.50	3.17	18	Fully
Score=5	--	>71	>13	<6.45	>2.80	20-16	Fully
Score=3	--	71-36	13-6	6.45-8.22	2.80-1.40	14-10	Partially
Score=1	--	<36	<6	>8.22	<1.40	8-4	Non

3.2.1.2 Dominant Macroinvertebrate Families

The composition of DMFs illustrated the impairment in the fall of 2003 (Table 6). Straight Fork #3 had larger percentages of Chironomidae (33.6), Tubificidae (22.6), Hydropyschidae (11.9), and Lumbriculidae (5.2) than the controls. Elmid beetles were found at Straight Fork #3 in a relatively low percentage (3.4) compared to all stations downstream and the controls. Baetid mayflies were found in Straight Fork #2 and #1. Conversely, Heptageniidae (mayflies) were found in the Bonne Femme #2 and #1 controls and were not among the dominant taxa in Straight Fork in the fall.

Dominant macroinvertebrate family percentages were not similar from upstream to downstream, nor between test and control stations in the spring of 2004 (Table 7). Straight Fork #3 was dominated by tubificid (27.8) and lumbriculid (27.1) worms. Elmid beetles were not found in station #3, yet they were sampled in substantial numbers at downstream stations #2 and #1(16.4 and 10.7) and in the control stations #2 and #1 (6.6 and 12.1). However, Chironomidae still dominated stations #2 (55.6) and #1 (52.7). Bonne Femme #2 and #1 (controls) contained heptageniid mayflies (11.1 and 9.5), where they were not among the dominant taxa in Straight Fork. Perlodid stoneflies were among the dominant taxa at stations #2 and #1 (10.5 and 7.6) but were rarely found in any of the Straight Fork stations (#3 and #1, Appendix B).

An individual taxa list (bench sheet) is found in Appendix B, grouped by season, station, and order. This identifies the taxa and the number of each taxa observed/counted in the subsamples by habitat (i.e. CS, NF, RM). This illustrates not only that intolerant taxa, (*Acerpenna sp*. and *Chimarra sp*.) were present in the controls and not Straight Fork, but that the diversity is much greater at Bonne Femme as well.

Table 6
Dominant Macroinvertebrate Families as a Percentage of the Total Number of Individuals Per Station for Fall 2003

Station	Straight Fork #3	Straight Fork #2	Straight Fork #1	Bonne Femme #2	Bonne Femme #1
Sample Number	0318729	0318728	0318727	0318726	0318725
Chironomidae	**33.6**	13.6	6.1	17.8	14.1
Tubificidae	**22.6**	7.2	10.5	12.2	16.7
Hydropsychidae	11.9	7.3	--	2.7	--
Physidae	6.8	--	18.2	--	--
Coenagrionidae	6.0	12.4	5.6	3.8	5.6
Lumbriculidae	**5.2**	--	--	--	--
Hyalellidae	3.8	--	--	--	5.0
Elmidae	**3.4**	19.8	14.1	25.5	25.4
Caenidae	--	15.6	4.2	8.4	5.1
Baetidae	--	**9.2**	**11.1**	--	--
Philopotamidae	--	5.7	--	4.9	4.3
Tricorythidae	--	--	13.4	--	--
Heptageniidae	--	--	--	**6.9**	**7.1**

Table 7
Dominant Macroinvertebrate Families as a Percentage of the Total Number of Individuals Per Station for Spring 2004

Station	Straight Fork #3	Straight Fork #2	Straight Fork #1	Bonne Femme #2	Bonne Femme #1
Sample Number	0418668	0418667	0418666	0418716	0418670
Tubificidae	**27.8**	3.5	4.0	7.7	9.6
Lumbriculidae	**27.1**	--	--	--	--
Chironomidae	22.7	**55.6**	**52.7**	18.8	22.9
Coenagrionidae	5.7	6.1	8.0	--	--
Hydropsychidae	2.8	3.5	2.6	--	--
Physidae	2.3	--	3.4	--	--
Lumbricidae	2.2	--	--	--	--
Veliidae	1.6	--	--	--	--
Elmidae	--	16.4	10.7	6.6	12.1
Caenidae	--	10.0	7.9	8.2	6.3
Planariidae	--	1.0	--	--	--
Ceratopogonidae	--	0.8	--	--	--
Tricorythidae	--	--	1.8	--	--
Crangonyctidae	--	--	--	14.9	12.2
Heptageniidae	--	--	--	**11.1**	**9.5**
Perlodidae	--	--	--	**10.5**	**7.6**
Asellidae	--	--	--	9.7	8.5

3.2.2 Physicochemical Water Variables

Several relevant trends were detected in the physicochemical water variables in the fall 2003 and the spring 2004 seasons. Trends were observed from upstream to downstream, as well as between test and control stations. Trends were found in conductivity, chloride, nutrients (nitrogen and total phosphorus), and dissolved oxygen concentrations. Other variables were unremarkable, yet they may be examined in Tables 8 and 9.

Conductivity decreased from station #3 to station #1, and was much higher than the controls in the fall of 2003 (Table 8). Conductivity was highest at station #3 (1780uS). Conductivity decreased at station #2 (1380uS) and again at station #1 (1160uS). The conductivity levels on Straight Fork were as much as five times higher than the Bonne Femme Creek controls (306 mg/L) during the fall sampling.

Chloride levels on Straight Fork decreased from upstream to downstream stations and were considerably higher than levels in Bonne Femme Creek in the fall of 2003 (Table 8). The chloride level was highest at station #3 (382 mg/L), which was also above the WQS chronic toxicity level for "the protection of aquatic life (230 mg/L)". At station #2 (249 mg/L), the level was still above the WQS chronic level for "the protection of aquatic life (230 mg/L)". The chloride level at station #1 (206 mg/L) decreased to below WQSs. Straight Fork levels were considerable and were not similar to the Bonne Femme Creek #2 (<0.50 mg/L) and #1 (5.97 mg/L) control stations in the fall.

Nutrients such as nitrogen and Total Kjeldahl Nitrogen (TKN) were found in Straight Fork in the fall of 2003 (Table 8). Nitrate+nitrite-N concentrations followed a decreasing trend from upstream to downstream Straight Fork and were higher than Bonne Femme Creek #2 and #1. The nitrate+nitrite-N concentration was highest (12.5 mg/L) at station #3, decreased at station #2 (7.76 mg/L), and yet again at station #1 (5.50 mg/L). All of the test stations were much higher than the controls (Bonne Femme #2-0.32mg/L, #1-0.32 mg/L). Total Kjeldahl Nitrogen (TKN) generally followed a similar pattern and was slightly higher than the control stations. Ammonia was not detected (<0.03 mg/L).

Total phosphorus concentrations decreased from upstream to downstream in the fall of 2003 (Table 8). Straight Fork #3 had the highest concentration (1.32 mg/L). Stations #2 (1.02 mg/L) and #1 (0.75 mg/L) followed the decreasing trend. Straight Fork #3 was also approximately 10 fold higher than the Bonne Femme Creek controls #2 and #1 (0.13 mg/L).

Dissolved oxygen levels decreased downstream during the fall of 2003 (Table 8). Dissolved oxygen dropped from a high at station #3 (12.8 mg/L) to lows at stations #2 and #1 (5.30 mg/L). Bonne Femme #2 and #1 controls were slightly higher at 7.0 mg/L. Dissolved oxygen levels were near, but did not exceed, the acceptable minimum for dissolved oxygen (5.0 mg/L, WQS MDNR 2000) in the fall.

Table 8
Physicochemical Water Variables Per Station,
Straight Fork and Bonne Femme Creek for Fall 2003
(Units mg/L Unless Otherwise Noted. **Bold**=Above WQS or Trend)

Station Variable/ Date	Straight Fork #3 9-24-2003	Straight Fork #2 9-25-2003	Straight Fork #1 9-25-2003	Bonne Femme Creek #2 9-24-2003	Bonne Femme Creek #1 9-24-2003
Phys/Chem Sample No.	0337557	0337556	0337555	0337554	0337553
pH (Units)	8.4	7.5	8.1	7.7	7.7
Temperature (C^0)	23.0	16.0	16.0	18.0	18.0
Conductivity (uS)	1780	1380	1160	306	306
Dissolved O_2	12.8	**5.30**	**5.30**	7.0	7.0
Discharge (cfs)	0.80	0.29	0.46	6.60	6.60
Turbidity (NTUs)	1.68	4.85	2.77	15.0	15.1
Nitrate+Nitrite-N	**12.5**	7.76	5.50	0.32	0.32
TKN	0.88	0.69	0.77	0.48	0.45
Ammonia-N	<0.03	<0.03	<0.03	<0.03	<0.03
Chloride	**382c**	**249c**	206	<0.50	5.97
Total Phosphorus	1.32	1.02	0.75	0.13	0.13

Several relevant trends were detected in the physicochemical water variables in the spring of 2004 (Table 9). Conductivity, chloride, nutrients (nitrogen and total phosphorus), and dissolved oxygen levels were examined. Other less notable spring 2004 variables that were not included here may be found in Table 9.

Conductivity levels decreased from upstream to downstream on Straight Fork in the spring of 2004 (Table 9). Conductivity measurements decreased from a high at station #3 (724 uS) to station #2 (519 uS) and station #1 (407 uS). Conductivity at station #3 was nearly twice as high as Bonne Femme Creek control stations (382 uS).

Chloride levels followed a decreasing trend from station #3 to station #1 in the spring of 2004 (Table 9). The level of chloride was highest at station #3 (113 mg/L) on Straight Fork. Station #2 (72.7 mg/L) and station #1 (53.1 mg/L) decreased downstream. Straight Fork stations were well above Bonne Femme controls #2 (10.4 mg/L) and #1 (10.4 mg/L). Chloride levels did not reach or exceed WQSs (MDNR 2000).

Nitrogen levels followed a decreasing trend in Straight Fork (upstream to downstream) and were much higher than the control stations during the spring of 2004 (Table 9). Nitrate+nitrite-N was highest at station #3 (3.84 mg/L) and decreased downstream at station #2 (2.04mg/L) and #1 (1.4 mg/L). Total Kjeldahl Nitrogen (TKN)

also decreased from upstream to downstream. It reached a high of 1.53 mg/L at station #3 and decreased to 0.92 mg/L at station #1 on Straight Fork. Ammonia was not detected (<0.03 mg/L). All of the nitrogenous variables were low in the control stations.

Total phosphorus decreased from upstream to downstream in Straight Fork and was slightly higher than the control stations on Bonne Femme Creek in the spring of 2004 (Table 9). The total phosphorus level was highest at station #3 (0.46 mg/L). Phosphorus declined downstream at station #2 (0.40 mg/L) and again at station #1 (0.29 mg/L). Concentrations of total phosphorus were found at lower levels in the control stations on Bonne Femme Creek #2 (0.10 mg/L) and #1 (0.09 mg/L) in the spring.

Dissolved oxygen levels were similar from upstream to downstream and between test stations and control stations in the spring of 2004 (Table 9). The highest dissolved oxygen reading was in station #3 (11.2 mg/L), which declined slightly at station #2 (10.7 mg/L) and then increased at station #1 (11.3 mg/L). All levels were at or above those found at the control stations on Bonne Femme Creek (9.4 mg/L) in the spring.

Table 9
Physicochemical Water Variables Per Station,
Straight Fork and Bonne Femme Creek for Spring 2004
(Units mg/L Unless Otherwise Noted. **Bold**=Above WQS or Trend)

Station Variable/ Date	Straight Fork #3 3-31-2004	Straight Fork #2 3-31-2004	Straight Fork #1 3-31-2004	Bonne Femme Creek #2 4-2-2004	Bonne Femme Creek #1 4-2-2004
Phys/Chem Sample No.	0411031	0411030	0411029	0411034	0411033
pH (Units)	8.2	7.8	7.7	7.7	7.7
Temperature (C^0)	10.0	8.5	6.5	9.0	9.0
Conductivity (uS)	724	519	407	382	382
Dissolved O_2	11.2	10.7	11.3	9.4	9.4
Discharge (cfs)	2.6	3.80	5.60	14.5	14.5
Turbidity (NTUs)	9.81	20.2	21.6	8.59	5.25
Nitrate+Nitrite-N	**3.84**	2.04	1.40	0.39	0.39
TKN	**1.53**	1.30	0.92	0.19	0.18
Ammonia-N	<0.03	<0.03	<0.03	<0.03	<0.03
Chloride	**113**	72.7	53.1	10.4	10.4
Total Phosphorus	0.46	0.40	0.29	0.10	0.09

3.2.2.1 Stream Classification and Discharge

Straight Fork is a class "C" stream, which means that flow may be intermittent during periods of drought, but permanent pools will remain (MDNR 2000). The Versailles WWTF discharges effluent into the stream in its headwaters, contributing to the discharge.

The discharge measurement at station #3 in the fall was 520,000 GPD (0.80 cfs). Versailles WWTF monitoring for discharge on September 24, 2003 was 312,000 GPD. Flow from the outfall made up approximately 60 percent of the total daily discharge in the Straight Fork study area in the fall.

The discharge measurement at station #3 in the spring was 1,710,000 GPD (2.60 cfs). On March 30, 2004, city personnel recorded a discharge at the outfall of 802,000 GPD. Flow from the outfall made up approximately 47 percent of the total daily discharge in Straight Fork in the spring.

4.0 Discussion

The goal of this project was to determine if Straight Fork, Morgan County was impaired by the Versailles WWTF. In doing so, the stream habitat quality, biological integrity, and water quality were examined.

4.1 Stream Habitat Assessment

The stream habitat within the Straight Fork study area was not impaired relative to the controls (Table 3). Stream habitat at all of Straight Fork's test stations was considered to be comparable to the stream habitat references or controls.

4.2 Macroinvertebrate Community Analyses

Macroinvertebrate analyses included examination of overall SCI scores, individual metric scores, and the DMF composition. These were compared from upstream to downstream, as well as between Straight Fork test stations and the Bonne Femme Creek controls. These examinations may identify and illustrate impairment, as well as potentially identify a source.

4.2.1 Stream Condition Index Scores and Individual Biocriteria Metrics

Stream Condition Index scores and individual metric scores suggested that the community composition in Straight Fork was not similar from upstream to downstream, or to the control stations (Tables 4 and 5). Stream Condition Index scores illustrated that all Straight Fork stations were partially supporting of the biological community during both seasons. Station #3 scored consistently low between seasons and appeared to be more impaired than the two remaining test stations. The Bonne Femme Creek control stations were considered to be fully supporting of the biological community.

The individual metrics (TR, EPTT, SDI) suggested that the community composition in Straight Fork was more tolerant to organic pollution and less diverse than the Bonne

Femme controls when compared to the BIOREF scoring range. The BI illustrated that the macroinvertebrate community was composed of taxa that had a higher tolerance to organic pollution in all three stations, with station #3 being the most tolerant during both seasons. The source of that organic pollution may have been the Versailles WWTF, as was illustrated by decreasing impairment with increasing distance from the WWTF. Compliance monitoring of the WWTF should continue.

Stations #3, #2, and #1 had fewer taxa, fewer EPT taxa, lower diversity and evenness than the control stations in both seasons (Tables 4 and 5). All test stations had higher BIs than the controls during both seasons, except station #2 in the fall of 2003. Interestingly, station #3 had much higher BIs than the downstream stations or controls during both seasons. This indicated that the biological community was much more tolerant to organic pollution than the downstream stations. The stream recovered downstream at stations #2 and #1, as the metrics were slightly better than #3. The lower BI downstream indicated that the organic influence was less downstream, which suggested that the effects came from an upstream source. Despite some recovery downstream, it appears that communities in the entire study area were impaired due to upstream organic sources.

4.2.2 Dominant Macroinvertebrate Families

The assemblage of DMFs illustrated the impairment during both seasons (Tables 6 and 7). The taxa observed in Straight Fork were generally more tolerant to organic pollution than those found in the Bonne Femme Creek stations. The presence or absence of certain DMFs per station illustrated the potential intensity and extent of impairment.

The composition of DMFs suggested there was a difference upstream to downstream, as well as between Straight Fork stations and the control stations during both seasons. The dominance of tolerant families such as tubificid worms, chironomid midges, and lumbriculid worms illustrated a substantial impairment at Straight Fork #3. The percentage of the worms decreased downstream in stations #2 and #1, suggesting that these two stations may not be as impaired as station #3. Elmid beetles were not among the dominant families at station #3, however, elmids made up a significant percentage of the total number of individuals at Straight Fork #2 and #1 and the controls. This also suggested that impairment was greater at station #3. The presence of Heptageniidae as the dominant family at the control stations, but not in Straight Fork, illustrated the impairment. Intolerant perlodid stoneflies were among the dominant families found in Bonne Femme Creek, but not in Straight Fork. Generally, families intolerant of organic pollution were not dominant in Straight Fork, even fewer near the WWTF. The DMFs supported a difference between Straight Fork stations as well as with the controls in the both seasons. The impairment is greatest near the outfall and extends for at least two miles to the end of the study area.

The presence or absence of certain taxa indicated that Straight Fork was impaired during both seasons (Appendix B). *Cheumatopsyche sp.* (Hydropsychidae) and *Hydroptila sp*. (Hydroptilidae), which are relatively tolerant caddisflies, were found in station #3 in both seasons. Other more intolerant caddisfly taxa (*Chimarra sp*. and *Hydropyche sp*.) were found in #2 and #1 in both seasons, indicating there may be less impairment downstream. These intolerant taxa were also found in the controls. *Acerpenna sp*. (Baetidae), an intolerant mayfly, was found only in Bonne Femme stations. Taxa illustrated that Straight Fork was impaired, more so near the WWTF. The tolerance and diversity of species clearly shows a difference between Straight Fork and Bonne Femme Creek.

4.3 Physicochemical Water Variables (Water Quality) per Station

The macroinvertebrate community composition in Straight Fork illustrated that the stream was impaired, possibly due to effluent discharged by the Versailles WWTF. Notable physicochemical water variables also illustrated that the WWTF was the source of impairment. One variable (chloride) was found above WQSs in the fall (Table 8) at stations #3 and #2. Notable variables were conductivity, chloride, nutrients, and dissolved oxygen.

4.3.1 Conductivity

Conductivity was higher nearest the WWTF and decreased downstream during both seasons. The test stations were also much higher than the controls, which suggested that the results were probably not a function of geology or land-use. The differences suggested the WWTF was the source for elements that would be expected in water discharged from a WWTF.

4.3.2 Chloride

The chloride trends suggested that the WWTF was the contributor during both seasons and exceeded the WQSs. Chloride was highest near the WWTF and decreased downstream. In the fall, the chloride level at station #3 (382 mg/L) exceeded chronic WQSs for the Protection of Aquatic Life (230 mg/L, MDNR 2000). The concentration at station #2 (249 mg/L) was also above chronic levels for the Protection of Aquatic Life (230 mg/L). The level of chloride was not above the WQS during the spring at any station, however, it was again highest of all stations at #3 (113 mg/L). Levels decreased downstream as distance increased. The chloride levels in Straight Fork were much higher than the control stations in Bonne Femme Creek, which suggested that chloride influence was not similar at both streams. The Versailles WWTF was the likely contributor of chloride to the stream. Chloride levels should be periodically monitored from the outfall effluent and at each station on Straight Fork.

4.3.3 Nutrients

Nutrient (nitrate+nitrite-N, TKN, total phosphorus) levels were found in higher concentrations than the controls and illustrated that they may have originated from the Versailles WWTF. Nutrients such as nitrogen and phosphorus are important constituents of organic effluent. Nutrients were found in higher concentrations at station #3 and

decreased at stations #2 and #1 during both seasons. Nitrate+nitrite-N and TKN concentrations were highest at station #3 near the WWTF outfall and followed a similar trend from upstream to downstream. Total phosphorus likewise decreased from station #3 to #1. Nitrogen compounds did not exceed WQSs (MDNR 2000) in either sample season. However, the trends suggested that the effluent was probably the source for nutrients. Nutrient levels should be monitored at Straight Fork stations.

4.3.4 Dissolved Oxygen

Dissolved oxygen levels may be affected by the effluent discharged from the Versailles WWTF. In the fall of 2003, dissolved oxygen levels were high at station #3 near the WWTF and rapidly decreased to near minimum acceptable levels for the Protection of Aquatic Life (5.0 mg/L, WQS 2000) at stations #2 and #1. The levels may very well have dropped below acceptable standards during the evening or early morning hours when oxygen levels are normally lower, but measurements were not taken during these times. The higher dissolved oxygen levels at station #3 may have been due to an aeration system used by the WWTF. The lower dissolved oxygen levels at stations #2 and #1 may have been due to increased BOD.

The dissolved oxygen level at #3, #2, and #1 was consistently high in the spring and slightly higher than the controls. This suggested that the oxygen demand was not persistent. Analysis of the BOD should be conducted periodically in compliance monitoring by the ESP/WQMS.

4.3.5 Bias

Since no station was positioned upstream of the WWTF on Straight Fork, it is not possible to say with certainty that the WWTF was the source for these notable variables. For example, it is possible that the chloride and nutrients originated upstream of the WWTF. However, the variables are indicators of wastewater effluent. They were found during both seasons, which suggested there was a continuous influence. This illustrated that there was a strong possibility that the Versailles WWTF was the source of the variables.

4.4 Stream Classification and Discharge

Discharge from the Versailles WWTF outfall made up approximately 60 percent of the daily total discharge of Straight Fork in the fall and approximately 47 percent in the spring. Straight Fork is considered a class “C” stream (MDNR 2000), which suggests that flow may be intermittent during dry periods. However, with as much as 60 percent of the discharge originating from the continuous WWTF output, it is not likely that Straight Fork actually ceases flow during dry periods. Bonne Femme Creek is a class “P” stream, which maintains permanent flow, even in dry periods. The comparison between a class “C” and class “P” flowing stream was adequate.

5.0 Summary

The goal of this study was to determine if Straight Fork, Morgan County was impaired by the Versailles WWTF. It appears that Straight Fork was impaired by the WWTF. The objectives to assess the macroinvertebrate community integrity, water quality, and stream habitat quality were completed.

The macroinvertebrate community appeared to be impaired in the Straight Fork study area during both sample seasons, probably due to components or secondary effects of effluent discharged into the stream from the Versailles WWTF. The SCI score indicated that all Straight Fork stations were only partially supporting of the biological community. Biological criteria metrics indicated that there were fewer taxa, fewer EPT taxa, as well as less diversity and evenness than the controls and BIOREFs. The biological community in Straight Fork was also more tolerant to organic pollution than the controls and BIOREFs.

The biological community composition illustrated that the greatest impairment was nearest to the WWTF, with some improvement in the biological integrity in the downstream test stations. The substantial presence of tubificid, lumbriculid, and lumbricid worms near the WWTF illustrated the impairment and potentially identified the contributor. The low percentage or absence of relatively intolerant elmid beetles at station #3, with a significant presence at all other stations, again indicated that #3 was more impaired than the downstream stations. The percentage of worms decreased and elmids increased downstream; however, the presence and diversity of intolerant mayfly, caddisfly, and stonefly taxa was much greater in the control stations than all Straight Fork stations. This illustrated impairment downstream as well. The absence of taxa intolerant to organic pollution and presence of taxa tolerant to organic pollution nearest to the Versailles WWTF suggested that it was the source and that all test stations were impaired.

Physicochemical water quality variables identified a potential contributor to the impairment. Two stations (#3 and #2) on Straight Fork exceeded WQSs (MDNR 2000) for chloride in the fall of 2004 and followed a decreasing trend from upstream to downstream during both seasons. Conductivity and nutrient levels were higher upstream and also followed a decreasing pattern from upstream to downstream. Nutrient levels followed a similar pattern in both seasons, suggesting that organic contaminants are present. The dissolved oxygen level was near the WQS minimum of 5.0 mg/L at downstream stations #2 (5.30 mg/L) and #1 (5.30 mg/L) in the fall of 2003, possibly due to excessive BOD. However, levels were high in the spring, which suggested that the condition was not persistent. These indicators of sewage discharge followed trends from upstream to downstream during both seasons, which illustrated that Versailles WWTF was the probable source.

Finally, the stream habitat quality at Straight Fork was fully supporting of the biological community and even comparable to the reference, according to the SHAPP

(MNDR 2003d). Cows grazed around Straight Fork stations #2 and #1, which had some effect on bank stability in those areas, however, the habitat was similar to the stream habitat control stations.

Several null hypotheses were rejected, while one was not. The null hypothesis stating that macroinvertebrate communities were similar to the wadeable/perennial biological criteria from upstream to downstream and between test and control stations was rejected. The null hypothesis that physicochemical water quality was similar between all stations and acceptable with Water Quality Standards (MDNR 2000) was rejected. The null hypothesis that stream habitat was similar from upstream to downstream and between test and control stations was not rejected.

6.0 Recommendations

- Continue WQMS compliance monitoring of the effluent at Versailles WWTF, as outlined in MDNR Missouri State Operating Permit No. MO0094927.

- Monitor chloride concentrations at outfall #001 and Straight Fork stations.

- Periodically conduct BOD analyses at all stations.

- Periodically conduct biological assessments on Straight Fork stations.

- The biological potential of effluent dominated streams should be studied to determine if any of them, especially the best-operated and designed WWTFs, could rate well against biological criteria.

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Submitted by: _____

Kenneth B. Lister
Environmental Specialist
Environmental Services Program
Water Quality Monitoring Section

Date: _____

Approved by: _____

Earl W. Pabst
Director
Environmental Services Program

EP:klt

c: John Ford, WPP
Bruce Martin, SWRO

Appendix A

Missouri Department of Natural Resources Bioassessment Study Plan
Straight Fork, Morgan County
August 28, 2003
(Revised Title)

Missouri Department of Natural Resources
Bioassessment Study Plan
Straight Fork, Morgan County
(Revised Title)

August 28, 2003

Background

Straight Fork, Morgan County is located in the Ozark/Moreau/Loutre Ecological Drainage Unit (**EDU**). The stream originates near Versailles, Missouri and reaches a confluence with North Moreau Creek, in Moniteau County approximately 18 miles downstream. The headwaters of Straight Fork (approximately six miles) are classified as a class "C" stream. As such, it may cease flow but maintain pools in dry weather (MDNR 2000).

Two miles of Straight Fork headwaters are 303(d) listed for excessive non-filterable residue (**NFR**). The apparent source of NFR is the Versailles Wastewater Treatment Facility (**WWTF**). All effluent from the WWTF flows through the listed segment of Straight Fork. The extent of impairment, if it exists, on the aquatic community has not been determined. The Water Quality Monitoring Section (**WQMS**), Environmental Services Program (**ESP**) intends to identify impairment due to the WWTF, if any exists. Biological assessments, which include macroinvertebrate community assessments and water quality assessments, along with stream habitat assessments will be conducted at control and test stations on Straight Fork, Morgan County.

Objectives

1) Assess the condition of the macroinvertebrate community and water quality of Straight Fork, Morgan County downstream from the Versailles WWTF.

2) Define the habitat quality of Straight Fork, Morgan County.

Tasks

1) Conduct a biological assessment, including macroinvertebrate and water physicochemical analyses, on Straight Fork, Morgan County.

2) Conduct a habitat assessment of Straight Fork, Morgan County.

Null Hypotheses

Straight Fork, Morgan County stations will be similar to wadeable/perennial biological criteria.

Water quality at Straight Fork, Morgan County will be similar between all stations and acceptable with Water Quality Standards (MDNR 2000).

Habitat assessment total scores on Straight Fork, Morgan County will be similar between study stations, and to the reference stations.

Study Methods

General: The boundaries for this study on Straight Fork, Morgan County include the two miles of listed stream. The upstream boundary is approximately 0.5 miles north of Missouri State Highway 52, immediately downstream of the Versailles WWTF (Figure 1). The downstream boundary is approximately three miles north (downstream) of Highway 52.

Three stations will be used to assess the 303(d) listed segment of stream. One station (#3) will be immediately downstream of the WWTF and the two remaining stations (#2 and #1) are located downstream at one mile intervals (Table 1; Figure 1). Biological assessments and habitat assessments will be conducted on all stations by the Water Quality Monitoring Section (**WQMS**), Environmental Services Program (**ESP**), Air and Land Protection Division (**ALPD**), Missouri Department of Natural Resources (**MDNR**).

Biological Assessment: Macroinvertebrates will be sampled according to the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**; MDNR 2003a). Straight Fork, Morgan County is considered a "Riffle/Pool" predominant stream and habitats will be sampled accordingly. Habitats included in these streams are coarse-substrate, non-flow, and rootmat. Each station consists of a length of twenty-times the stream's average width, which includes at least two riffle sequences. Biological samples will be processed and identified according to MDNR-WQMS-209, Taxonomic Levels for Macroinvertebrate Identifications (MDNR 2001).

Macroinvertebrate data will be compared in two ways. Firstly, Straight Fork, Morgan County metrics will be compared with MDNR's wadeable/perennial stream biological criteria for reference streams in the EDU. Macroinvertebrate data will be entered in a Microsoft Access database according to the MDNR, Standard Operating Procedure WQMS-214, Quality Control Procedures for Data Processing (MDNR 2003a). Data analysis is automated within the Microsoft Access database to calculate four standard metrics: Total Taxa (**TT**); Ephemeroptera, Plecoptera, Trichoptera Taxa (**EPTT**); Biotic Index (**BI**); and the Shannon Diversity Index (**SDI**). Macroinvertebrate data from reference streams within the Ozark/Moniteau/Loutre EDU will allow for the calculation of a 25th percentile for the four metrics in the SMSBPP, which are then compared to the Straight Fork, Morgan County station. Secondly, a Stream Condition Index (**SCI**) is calculated for each Straight Fork station. An SCI is derived from the composite score from all four metrics for each station. Each of the four metrics receives a score (i.e. 5, 3, 1) based on the similarity of the metrics to the wadeable/perennial biological criteria. The Straight Fork, Morgan County will be scored against these calculations and a composite score (SCI) of 16 or greater will determine "non-impairment" or "full sustainability". The SCIs will be compared between stations at Straight Fork, Morgan County to identify the extent of impairment.

Other comparisons may be conducted to identify impairment. Additional metrics, such as Percent Taxon Similarity or Dominant Macroinvertebrate Families may be employed to discern differences in taxa between control and test stations.

Biological assessments will be conducted on Straight Fork, Morgan County during the fall 2003 and spring 2004 seasons.

Water Quality Sampling: Water will be sampled in Straight Fork, Morgan County. Physicochemical variables determined in the field will include: pH, temperature (C^0), conductivity, dissolved oxygen, and discharge. Water samples collected for analyses include: turbidity, ammonia-nitrogen, nitrate+nitrite-nitrogen, Total Kjeldahl Nitrogen (**TKN**), chloride, and total phosphorus. Samples will be handled according to the Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2002). Water samples will be collected during the fall 2003 and spring 2004 seasons.

Water sample analyses will be conducted by the Environmental Services Program, Environmental Laboratory in Jefferson City, Missouri. The Water Quality Monitoring Section will conduct analysis of turbidity. The Chemical Analysis Section (**CAS**) will conduct the remaining analyses.

Water quality (physicochemical water variables) data will be analyzed using two methods. Water quality data for Straight Fork, Morgan County will be compared between stations. Secondly, results will be compared to Missouri Water Quality Standards (MDNR 2000) and parameters not within acceptable limits will be identified.

Habitat Assessments: A standardized Stream Habitat Assessment Project Procedure (**SHAPP**) will be conducted (MDNR 2003c) and total scores will be compared using two methods. The first comparison will be for total scores between stations. In the second, total scores will be compared with a habitat assessment score from a reference stream within the EDU. All habitats to be compared will be assessed during the same sample period, by the same investigators. Habitat assessments will be conducted at the three stations on Straight Fork, Morgan County in the spring of 2004.

Additional Data Analyses: Ordination of communities with multiple linear regression and correlation may be used in conjunction with habitat assessment, water quality values.

Data Reporting: A report will be written by the Water Quality Monitoring Section, ESP for the Water Pollution Control Program (**WPCP**).

Quality Controls: All analyses will be done according to recommended Standard Operating Procedures (**SOP**s), Project Procedures (**PP**s), and Quality Assurance Project Plans (**QAPP**s).

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Attachments:

Table 1: Location and descriptive information for Straight Fork, Morgan County stations, 2003

Figure 1: Straight Fork, Morgan County, 2003

Table 1
Location and descriptive information for Straight Fork, Morgan County stations, 2003

Stream-Station Number	Location-Section or Survey, Township, Range	Description	County
Straight Fork #3	SE 1/4 sec. 36; T.43N., R.18W.	Test Station - Immediately Downstream WWTF	Morgan
Straight Fork #2	SE 1/4 sec. 25; T.43N., R.18 W.	Test Station - 1.0 miles Downstream WWTF	Morgan
Straight Fork #1	SE 1/4 sec. 24; T.43N., R,18 W.	Test Station - 2.0 miles Downstream WWTF	Morgan

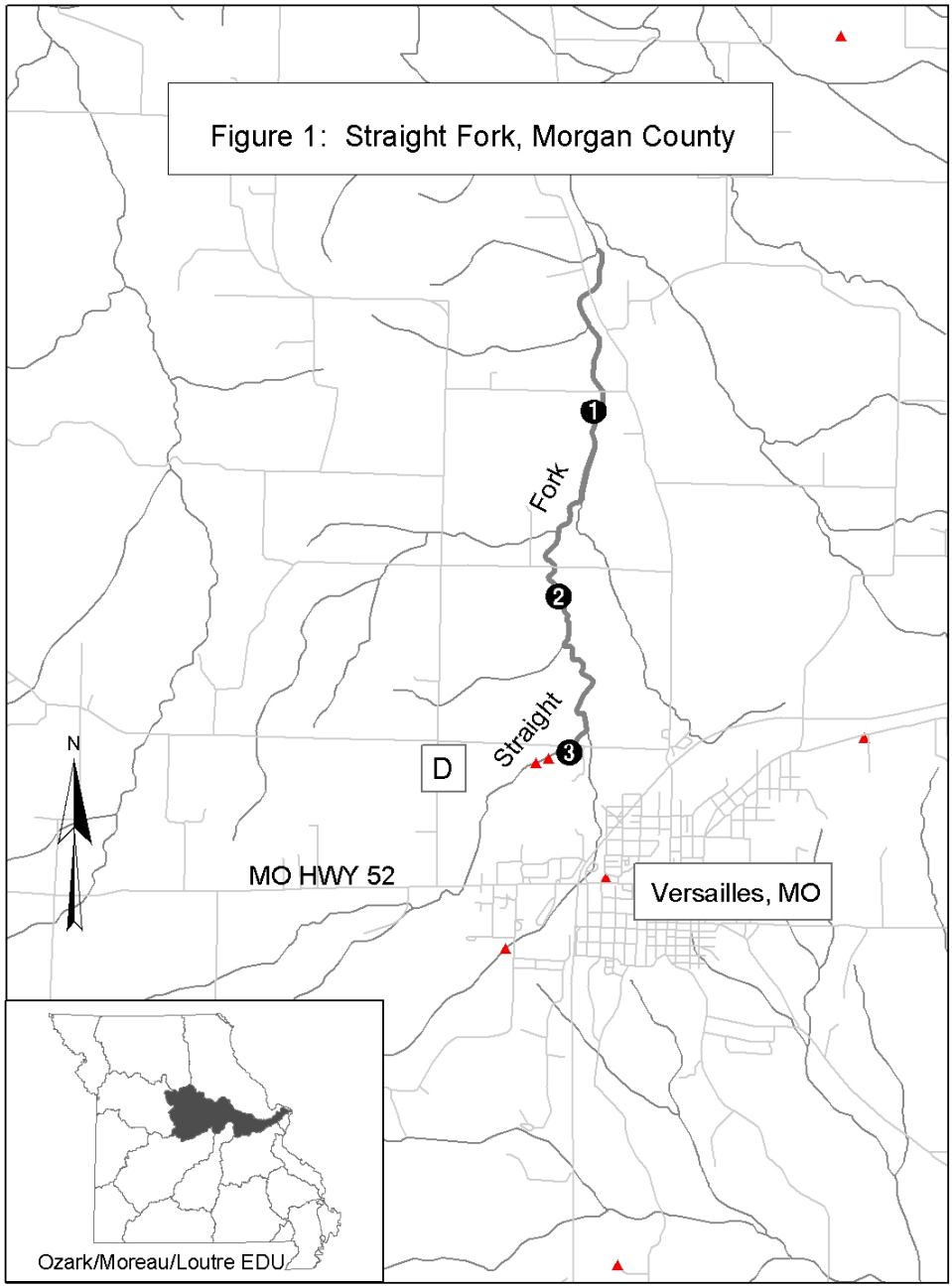
Figure 1: Straight Fork, Morgan County
Straight
Fork
1
2
3
D
N
MO HWY 52
Versailles, MO
Ozark/Moreau/Loutre EDU

Appendix B

Macroinvertebrate Bench Sheets for Straight Fork and Bonne Femme Creek Stations
Fall 2003 and Spring 2004
(CS=course substrate, NF=nonflow, SG= snag, RM=rootmat habitats; -99=Present)

Aquid Invertebrate Database Bench Sheet Report
Straight Fk [0318729], Station #3, Fall 2003

ORDER: TAXA	CS	NF	SG	RM
AMPHIPODA				
Hyalella azteca				64
ARHYNCHOBDELLIDA				
Erpobdellidae	-99	-99		
COLEOPTERA				
Berosus	4	1		
Stenelmis	55	1		1
DIPTERA				
Ablabesmyia	1	1		2
Chironomus	1	21		1
Corynoneura	1			
Cricotopus bicinctus	31			3
Cricotopus/Orthocladius	21	1		
Dicrotendipes		1		
Forcipomyiinae	1			
Goeldichironomus		1		
Labrundinia				1
Paratanytarsus		1		23
Paratendipes		1		
Polypedilum	12			
Polypedilum convictum grp	387			3
Polypedilum illinoense grp		1		3
Stictochironomus		19		
Tanytarsus	1			
Thienemanniella	5			1
Thienemannimyia grp.	18			
Tipula	1			
EPHEMEROPTERA				
Baetis	35			
Caenis latipennis	10	10		
Fallceon	20			
HEMIPTERA				
Rheumatobates				1
LIMNOPHILA				
Fossaria				2
Helisoma		-99		-99
Physella		1		114
LUMBRICINA				
Lumbricidae	6	4		
LUMBRICULIDA				
Lumbriculidae	49	31		7
ODONATA				

ORDER: TAXA	CS	NF	SG	RM
Argia	2			
Enallagma				48
Epitheca (Epicordulia)		-99		-99
Ischnura		3		48
RHYNCHOBDELLIDA				
Glossiphoniidae		-99		2
TRICHOPTERA				
Cheumatopsyche	195			4
Hydroptila	3			
TRICLADIDA				
Planariidae	2			3
TUBIFICIDA				
Branchiura sowerbyi		1		
Enchytraeidae		1		
Limnodrilus hoffmeisteri		19		
Tubificidae	63	291		3

Aquid Invertebrate Database Bench Sheet Report
Straight Fk [0318728], Station #2, Fall 2003

ORDER: TAXA	CS	NF	SG	RM
AMPHIPODA				
Hyalella azteca				8
ARHYNCHOBDELLIDA				
Erpobdellidae	-99	4		
COLEOPTERA				
Berosus	6	6		21
Dubiraphia		3		6
Ectopria nervosa	2			
Hydroporus		1		
Psephenus herricki	1			
Stenelmis	255	11		16
DIPTERA				
Ablabesmyia		1		2
Bryophaenocladius				1
Ceratopogoninae		3		
Chironomus		3		
Cladotanytarsus		12		
Cricotopus/Orthocladius	4			1
Dicrotendipes	3	2		11
Ephydridae		1		
Glyptotendipes		1		
Labrundinia				12
Microtendipes	2			7
Nanocladius				3
Paratanytarsus		2		14
Paratendipes		7		
Phaenopsectra		1		
Polypedilum convictum grp	30			
Rheotanytarsus	15			2
Stictochironomus		23		
Tanytarsus	7	1		18
Thienemanniella	1			
Thienemannimyia grp.	9			5
Tipula	-99			
EPHEMEROPTERA				
Baetis	17			
Caenis latipennis	53	168		8
Fallceon	118			
LIMNOPHILA				
Ancylidae				8
Menetus				13
Physella		3		14

ORDER: TAXA	CS	NF	SG	RM
Planorbella				1
LUMBRICULIDA				
Lumbriculidae	1	2		
ODONATA				
Argia	3	2		48
Enallagma		1		122
Epitheca (Epicordulia)				-99
Ischnura				6
Pachydiplax longipennis				-99
RHYNCHOBDELLIDA				
Glossiphoniidae	1			
TRICHOPTERA				
Cheumatopsyche	96			
Chimarra	84			
Hydropsyche	12			
Hydroptila	2			
TRICLADIDA				
Planariidae	18	2		10
TUBIFICIDA				
Aulodrilus		2		
Limnodrilus hoffmeisteri		4		
Tubificidae	53	44		3
VENEROIDEA				
Pisidium		2		
Sphaerium		1		

Aquid Invertebrate Database Bench Sheet Report
Straight Fk [0318727], Station #1, Fall 2003

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina				1
AMPHIPODA				
Hyalella azteca	2	3		38
ARHYNCHOBDELLIDA				
Erpobdellidae	3	4		-99
COLEOPTERA				
Berosus	26	21		11
Dubiraphia		2		7
Ectopria nervosa	4			
Peltodytes		1		
Psephenus herricki	2	-99		-99
Stenelmis	179	8		7
DIPTERA				
Ablabesmyia	2	1		
Chironomus		2		
Corynoneura	4			
Cricotopus bicinctus	2			
Cricotopus/Orthocladius	21			
Dicrotendipes	2	1		
Ephydridae	2			
Labrundinia				1
Paratanytarsus		1		
Paratendipes	2	4		
Polypedilum	3			
Polypedilum convictum grp	19			
Polypedilum illinoense grp	2			
Procladius		1		1
Rheotanytarsus	4	1		1
Stictochironomus		5		
Tanytarsus	4	1		1
Thienemannimyia grp.	1			
Tribelos		1		
EPHEMEROPTERA				
Baetis	1			
Caenis latipennis	31	30		
Fallceon	159			
Stenonema femoratum		1		
Tricorythodes	191			2
HEMIPTERA				
Microvelia	1			
Ranatra fusca				-99

ORDER: TAXA	CS	NF	SG	RM
Rhagovelia	5			
LIMNOPHILA				
Fossaria	2			1
Gyraulus		1		
Helisoma	2	2		4
Physella	67	40		155
Planorbella		4		4
LUMBRICINA				
Lumbricidae		-99		-99
LUMBRICULIDA				
Lumbriculidae	2	5		
ODONATA				
Argia	20	2		10
Enallagma	1	4		44
Epitheca (Epicordulia)		-99		-99
Pachydiplax longipennis		3		-99
RHYNCHOBDELLIDA				
Glossiphoniidae	2	2		
TRICHOPTERA				
Cheumatopsyche	54			
Helicopsyche	2			
Hydropsyche	2			
Hydroptila	10			
Hydroptilidae		1		
TRICLADIDA				
Planariidae	3			4
TUBIFICIDA				
Aulodrilus	1			
Limnodrilus hoffmeisteri		7		
Tubificidae	29	114		1
VENEROIDEA				
Sphaerium				1

Aquid Invertebrate Database Bench Sheet Report
Bonne Femme Ck [0318726], Station #2, Fall 2003

ORDER: TAXA	CS	NF	SG	RM
N/A				
Branchiobdellida		3		
"HYDRACARINA"				
Acarina	2	3		4
AMPHIPODA				
Crangonyx	10			
Hyalella azteca				23
COLEOPTERA				
Berosus	1			
Dubiraphia		2		22
Helichus basalis	1			6
Helichus lithophilus	2			5
Paracymus				2
Scirtes				6
Stenelmis	178	22		44
DECAPODA				
Orconectes virilis	2			-99
Palaemonetes kadiakensis				-99
DIPTERA				
Ablabesmyia		4		
Ceratopogoninae	1	2		2
Chironomus		4		
Cladotanytarsus	2	9		
Cricotopus/Orthocladius	3			
Cryptochironomus	1	7		
Diptera	1			1
Endochironomus				1
Glyptotendipes				6
Hemerodromia	1			
Hexatoma	15	3		
Labrundinia		1		4
Microtendipes	2	3		1
Nanocladius				2
Parametriocnemus	1			
Paratanytarsus				8
Polypedilum convictum grp	52	1		
Polypedilum halterale grp		1		
Polypedilum scalaenum grp	3	5		
Rheotanytarsus	2			1
Simulium	1			
Stempellinella		3		
Stictochironomus		2		

ORDER: TAXA	CS	NF	SG	RM
Tabanus	3			
Tanytarsus	6	14		15
Thienemanniella	2			
Thienemannimyia grp.	13			8
Tipula	1			1
Tipulidae				1
undescribed Empididae	2			
EPHEMEROPTERA				
Acerpenna	8			
Baetis	5			
Caenis latipennis	29	35		25
Stenacron	25	9		1
Stenonema femoratum	4	30		4
HEMIPTERA				
Microvelia				1
ISOPODA				
Caecidotea				1
LIMNOPHILA				
Menetus				16
Physella	1			2
LUMBRICINA				
Lumbricidae	1			
LUMBRICULIDA				
Lumbriculidae		2		1
ODONATA				
Argia	1			1
Calopteryx				1
Enallagma				38
Epitheca (Epicordulia)				1
Erythemis				-99
Gomphus				-99
Libellula				1
Macromia				-99
Nasiaeschna pentacantha				-99
TRICHOPTERA				
Agrypnia				2
Cheumatopsyche	28			1
Chimarra	52			
Helicopsyche	2	1		
Pycnopsyche				-99
Triaenodes				2
TRICLADIDA				
Planariidae	1			15

ORDER: TAXA	CS	NF	SG	RM
TUBIFICIDA				
Aulodrilus		1		
Branchiura sowerbyi		18		
Enchytraeidae	2			
Tubificidae	33	71		6
VENEROIDEA				
Sphaerium	10			1

Aquid Invertebrate Database Bench Sheet Report
Bonne Femme Ck [0318725], Station #1, Fall 2003

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina	1	1		
AMPHIPODA				
Crangonyx	13			3
Hyalella azteca				62
COLEOPTERA				
Berosus		1		
Dubiraphia	1	2		32
Gyretes				5
Helichus basalis				3
Helichus lithophilus	1			1
Macronychus glabratus				2
Paracymus				1
Peltodytes				7
Scirtes				24
Sperchopsis				2
Stenelmis	258	8		12
DECAPODA				
Orconectes virilis	1			
Palaemonetes kadiakensis		1		1
DIPTERA				
Ablabesmyia		3		5
Ceratopogoninae		8		
Chaoborus		1		
Chironomus		7		
Cladotanytarsus	5	6		
Corynoneura	1			
Cryptochironomus	1			
Eukiefferiella	1			
Glyptotendipes	1	1		
Hexatoma	22			
Kiefferulus		1		
Labrundinia		1		3
Microtendipes	1			1
Nanocladius	1			1
Nemotelus		1		
Parametriocnemus	3			
Paratanytarsus				5
Paratendipes		4		
Pentaneura	1			
Polypedilum convictum grp	44			
Polypedilum illinoense grp				3

ORDER: TAXA	CS	NF	SG	RM
Polypedilum scalaenum grp	2			
Procladius		5		1
Pseudochironomus	1			
Rheotanytarsus	1			
Tabanus	-99			
Tanypus		1		
Tanytarsus	10	17		6
Thienemanniella	2			
Thienemannimyia grp.	8			21
Tipula	1			
Tipulidae	1			
undescribed Empididae	1			
EPHEMEROPTERA				
Acerpenna	22			
Baetis	1			
Caenis latipennis	27	15		22
Callibaetis				1
Centroptilum				1
Hexagenia limbata		1		
Stenacron	12	1		
Stenonema femoratum	62	9		4
HEMIPTERA				
Corixidae		3		
Microvelia				2
ISOPODA				
Caecidotea	19	1		5
LIMNOPHILA				
Physella		1		3
LUMBRICULIDA				
Lumbriculidae		7		
ODONATA				
Argia				2
Basiaeschna janata				2
Enallagma		1		67
Macromia				-99
Nasiaeschna pentacantha				-99
RHYNCHOBDELLIDA				
Glossiphoniidae		-99		
TRICHOPTERA				
Cheumatopsyche	26			
Chimarra	54			
Pycnopsyche				-99
TRICLADIDA				

ORDER: TAXA	CS	NF	SG	RM
Planariidae				1
TUBIFICIDA				
Aulodrilus		1		
Branchiura sowerbyi	2	20		
Enchytraeidae	4			
Limnodrilus cervix		6		
Limnodrilus hoffmeisteri		3		
Tubificidae	5	169		1
VENEROIDEA				
Sphaerium		-99		1

Aquid Invertebrate Database Bench Sheet Report
Straight Fk [0418668], Station #3, Spring 2004

ORDER: TAXA	CS	NF	SG	RM
AMPHIPODA				
Hyalella azteca				1
ARHYNCHOBDELLIDA				
Erpobdellidae		-99		
COLEOPTERA				
Coptotomus				1
Cybister				-99
Dytiscidae	1			2
Hydroporus				1
Laccophilus				1
Scirtes				3
Stenelmis	13	1		
Tropisternus				2
DECAPODA				
Orconectes immunis	-99			
Orconectes virilis				1
DIPTERA				
Ablabesmyia				3
Ceratopogoninae				1
Chironomus	2	1		
Cricotopus bicinctus	4			9
Cricotopus/Orthocladius	70	6		28
Dicrotendipes				1
Glyptotendipes		2		3
Hydrobaenus	8	2		3
Larsia	1			
Natarsia		1		
Paratanytarsus				13
Paratendipes		3		
Polypedilum convictum grp	23			1
Polypedilum illinoense grp				15
Smittia		1		
Stictochironomus	1	8		
Thienemannimyia grp.	42			18
Tipula				-99
Tvetenia				1
EPHEMEROPTERA				
Caenis latipennis	4	1		12
Stenonema femoratum	6			2
HEMIPTERA				
Corisella		1		
Microvelia				20

ORDER: TAXA	CS	NF	SG	RM
LIMNOPHILA				
Ancylidae				1
Physella	2			26
LUMBRICINA				
Lumbricidae	15	1		11
LUMBRICULIDA				
Lumbriculidae	215	78		29
ODONATA				
Enallagma				40
Epitheca (Epicordulia)				1
Ischnura				28
Libellula		2		
Somatochlora				1
PLECOPTERA				
Isoperla	1			
Perlidae	1			
RHYNCHOBDELLIDA				
Glossiphoniidae		-99		
TRICHOPTERA				
Cheumatopsyche	28			6
TRICLADIDA				
Planariidae	4			4
TUBIFICIDA				
Enchytraeidae	4	4		5
Ilyodrilus templetoni		1		
Limnodrilus hoffmeisteri		5		
Tubificidae	77	239		9
VENEROIDEA				
Sphaerium	3			3

Aquid Invertebrate Database Bench Sheet Report
Straight Fk [0418667], Station #2, Spring 2004

ORDER: TAXA	CS	NF	SG	RM
AMPHIPODA				
Hyalella azteca				1
ARHYNCHOBDELLIDA				
Erpobdellidae	-99	1		-99
COLEOPTERA				
Berosus	5	3		2
Dubiraphia				1
Ectopria nervosa		1		
Stenelmis	175	9		11
DIPTERA				
Ablabesmyia		2		1
Ceratopogoninae		10		
Cladotanytarsus		3		
Cricotopus bicinctus	9	1		26
Cricotopus/Orthocladius	256	34		90
Dicrotendipes	6	3		2
Diptera		2		
Hydrobaenus		4		4
Nanocladius				1
Nilotanypus	1			
Paratanytarsus		1		10
Paratendipes	9	56		1
Polypedilum convictum grp	80			1
Polypedilum illinoense grp	1			1
Rheotanytarsus	2			13
Stictochironomus		8		
Tanytarsus	19	1		8
Thienemanniella		1		
Thienemannimyia grp.	5	3		2
EPHEMEROPTERA				
Caenis latipennis	11	69		40
LIMNOPHILA				
Menetus				1
Physella				7
LUMBRICULIDA				
Lumbriculidae		2		1
ODONATA				
Argia		4		17
Enallagma		1		52
Epitheca (Tetragoneuria)				-99
TRICHOPTERA				
Cheumatopsyche	40			2

ORDER: TAXA	CS	NF	SG	RM
Chimarra	4			
Hydroptila	1			
TRICLADIDA				
Planariidae	13			
TUBIFICIDA				
Enchytraeidae		2		
Limnodrilus hoffmeisteri		5		
Tubificidae	11	26		

Aquid Invertebrate Database Bench Sheet Report
Straight Fk [0418666], Station #1, Spring 2004

ORDER: TAXA	CS	NF	SG	RM
AMPHIPODA				
Hyalella azteca				15
ARHYNCHOBDELLIDA				
Erpobdellidae	2	-99		-99
COLEOPTERA				
Berosus	8	4		4
Dubiraphia		1		5
Ectopria nervosa	1	1		
Psephenus herricki	1	1		
Stenelmis	95	30		18
DIPTERA				
Ablabesmyia	2			
Ceratopogoninae	1	2		
Chironomus	1			
Cladotanytarsus	1	4		
Cricotopus bicinctus	5			15
Cricotopus/Orthocladius	384	20		18
Dicrotendipes	5	2		
Diptera		1		
Glyptotendipes	1			
Hydrobaenus	28	17		5
Nanocladius	1			2
Nilotanypus	2			1
Paraphaenocladius		1		
Paratanytarsus		3		2
Paratendipes	5	57		2
Polypedilum convictum grp	85	1		
Polypedilum illinoense grp	2			2
Polypedilum scalaenum grp	1			
Procladius		1		
Psychoda		1		
Rheotanytarsus	6			3
Simulium	2			
Stictochironomus	1	7		
Tanytarsus	15	3		6
Thienemannimyia grp.	8			4
Tipula				-99
Tvetenia	2			
EPHEMEROPTERA				
Caenis latipennis	27	58		25
Fallceon	2			
Tricorythodes	14	4		7

ORDER: TAXA	CS	NF	SG	RM
LIMNOPHILA				
Fossaria		2		4
Gyraulus				4
Physella		4		44
LUMBRICINA				
Lumbricidae		2		1
LUMBRICULIDA				
Lumbriculidae	1	1		1
ODONATA				
Anax				-99
Argia	1	1		24
Enallagma		3		82
Epitheca (Epicordulia)		-99		-99
Libellula		-99		-99
Plathemis				-99
PLECOPTERA				
Isoperla	3			
RHYNCHOBDELLIDA				
Glossiphoniidae				-99
TRICHOPTERA				
Cheumatopsyche	29	1		5
Chimarra	1			
Helicopsyche	6			9
Hydropsyche	1			1
Hydroptila	4	3		4
TRICLADIDA				
Planariidae	3	2		
TUBIFICIDA				
Enchytraeidae	15	6		
Limnodrilus hoffmeisteri		7		
Tubificidae	14	33		2
VENEROIDEA				
Sphaerium		1		

Aquid Invertebrate Database Bench Sheet Report
Bonne Femme Ck [0418716], Station #2, Spring 2004

ORDER: TAXA	CS	NF	SG	RM
N/A				
Branchiobdellida		2		5
"HYDRACARINA"				
Acarina	1	8		
AMPHIPODA				
Crangonyx	58	29		98
COLEOPTERA				
Dubiraphia		3		4
Helichus basalis	1			
Helichus lithophilus				2
Peltodytes		1		
Stenelmis	60	10		6
DECAPODA				
Orconectes virilis		1		-99
Palaemonetes kadiakensis				1
DIPTERA				
Ablabesmyia		3		
Bryophaenocladius		1		
Caloparyphus	1			
Ceratopogoninae	2			
Chironomus		1		
Cladotanytarsus		8		1
Corynoneura				1
Cricotopus/Orthocladius	22	1		25
Cryptochironomus		5		
Dicrotendipes	1	4		
Diptera	1			1
Eukiefferiella	1			
Glyptotendipes				1
Gonomyia	11			
Hexatoma	2	2		
Hydrobaenus	25	5		4
Microtendipes	1	1		
Ormosia		1		
Parametriocnemus	1			
Paratanytarsus				1
Paratendipes	3	19		
Phaenopsectra		2		
Polypedilum convictum grp	19			4
Polypedilum halterale grp		1		
Polypedilum illinoense grp	1			
Polypedilum scalaenum grp	6	5		

ORDER: TAXA	CS	NF	SG	RM
Prosimulium	1			
Rheocricotopus	2			3
Simulium	3			1
Stictochironomus	2	13		
Tabanus	1			
Tanytarsus	6	3		11
Thienemanniella	1			
Thienemannimyia grp.	6	6		7
Tipula	2			
Tvetenia	1			
EPHEMEROPTERA				
Acerpenna				1
Caenis latipennis	18	25		59
Stenacron	5	6		
Stenonema femoratum	90	34		3
ISOPODA				
Caecidotea	10	9		102
LIMNOPHILA				
Ancylidae				1
LUMBRICINA				
Lumbricidae		1		
MEGALOPTERA				
Sialis		-99		
ODONATA				
Argia	1			
Basiaeschna janata				-99
Enallagma				1
Ischnura				1
PLECOPTERA				
Alloperla	2			
Amphinemura	11			2
Isoperla	125			6
Perlesta	61			
Perlinella drymo				1
TRICHOPTERA				
Cheumatopsyche	1			1
Chimarra	1			
Ironoquia				1
Pycnopsyche				-99
Rhyacophila	3			
TUBIFICIDA				
Branchiura sowerbyi		17		
Enchytraeidae	2	6		1

ORDER: TAXA	CS	NF	SG	RM
Limnodrilus claparedianus		11		
Limnodrilus hoffmeisteri	3	8		
Tubificidae	1	55		1
VENEROIDEA				
Sphaerium		1		-99

Aquid Invertebrate Database Bench Sheet Report
Bonne Femme Ck [0418670], Station #1, Spring 2004

ORDER: TAXA	CS	NF	SG	RM
"HYDRACARINA"				
Acarina	1	13		
AMPHIPODA				
Crangonyx	30	12		118
Hyalella azteca				1
COLEOPTERA				
Dubiraphia	1	2		6
Dytiscus	1			
Helichus lithophilus				2
Hydroporus				1
Stenelmis	130	9		10
DECAPODA				
Orconectes virilis				2
Palaemonetes kadiakensis		1		
DIPTERA				
Ablabesmyia		4		2
Ceratopogoninae	1	10		
Chironomus	1	4		
Cladotanytarsus	8	15		
Clinocera	1			
Corynoneura				1
Cricotopus/Orthocladius	49	6		12
Cryptochironomus	1	5		
Demicryptochironomus	1			
Dicrotendipes	1	2		1
Diptera		1		
Dolichopodidae	1	1		
Empididae	4			
Gonomyia	1			
Hexatoma	17			
Hydrobaenus	14			1
Labrundinia				1
Larsia	1			
Microtendipes	1	2		1
Nilotanypus	1			
Parakiefferiella	1			
Parametriocnemus	6			
Paratendipes	4	52		
Pilaria		1		
Polypedilum convictum grp	34			
Polypedilum halterale grp		3		
Polypedilum illinoense grp				1

ORDER: TAXA	CS	NF	SG	RM
Polypedilum scalaenum grp	9	7		
Rheocricotopus		1		3
Rheotanytarsus	1			
Simulium	2			
Stempellinella		4		
Stictochironomus		6		
Sympotthastia	1			
Tabanus	2			
Tanytarsus	9	9		1
Thienemannimyia grp.	6	2		4
Tipula	3			
EPHEMEROPTERA				
Acerpenna	1			
Caenis latipennis	16	23		44
Stenacron	1			2
Stenonema femoratum	82	7		32
ISOPODA				
Caecidotea	13	14		83
Caecidotea (Blind & Unpigmented)		1		
LIMNOPHILA				
Physella				1
LUMBRICINA				
Lumbricidae	1	3		1
ODONATA				
Basiaeschna janata				-99
Enallagma				2
Libellula				1
PLECOPTERA				
Alloperla	7			
Amphinemura	13			
Isoperla	100			-99
Perlesta	23			
Perlinella drymo	-99			1
TRICHOPTERA				
Cheumatopsyche	5			
Chimarra	1			
Ironoquia				1
Pycnopsyche				5
Rhyacophila	3			
TRICLADIDA				
Planariidae		1		
TUBIFICIDA				

ORDER: TAXA	CS	NF	SG	RM
Branchiura sowerbyi		2		
Enchytraeidae	2			1
Limnodrilus cervix		10		
Limnodrilus claparedianus		2		
Limnodrilus hoffmeisteri	12	17		1
Tasserkidrilus superiorensis		1		
Tubificidae	11	69		1
VENEROIDEA				
Sphaeriidae	1	1		