Missouri Department of Natural Resources

# Biological Assessment Report

## Mill Creek
## Washington County, Missouri

## September 2005- March 2006

Prepared for:
Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

Prepared by:
Missouri Department of Natural Resources
Field Services Division
Environmental Services Program
Water Quality Monitoring Section

## TABLE OF CONTENTS

## TABLES

**Page**



## FIGURES



## ATTACHMENTS

## 1.0 Introduction

Mill Creek flows northeasterly from Potosi, Missouri to its confluence with Big River near Blackwell, Missouri (Figure 1). The classified section of stream is approximately 12 miles long and is considered a class "P" stream (MDNR 2005b). A class "P" stream maintains flow during periods of drought. The stream has beneficial use designations for livestock and wildlife watering (**LWW**); protection of warm water aquatic life and human health-fish consumption (**AQL**); and whole body contact (**WBC**), category B (areas not specifically designated for swimming; MDNR 2005b).

## 1.1 Study Justification

The Mill Creek watershed contains a concentration of active and inactive barite strip mines. Damage to some aquatic habitats and the potential for serious damage to several streams existed due to past lead and barite mining activity (MDC 1997). The Mill Creek watershed has specifically been affected by mine waste in the past. Shibboleth Branch, a downstream tributary to Mill Creek, was placed on the 2002 303(d) list of impaired waters in Missouri for Non-volatile Suspended Solids (**NVSS**) or sediment (MDNR 2002; EPA 2007). A barite tailing dam breach in 1975 on Shibboleth Branch impacted Mill Creek and Big River with sediment for about nine months (Figure 2; Duchrow 1978). Fountain Farm Branch may contribute barite mining sediment to Mill Creek (MDNR 1994). Pond Creek, an upstream tributary to Mill Creek, is 303(d) listed for NVSS or sediment from barite mining sources (MDNR 2002; EPA 2007). Mine waste sedimentation has historically been responsible for smothering aquatic habitats within these and other streams, making them uninhabitable for some invertebrates (MDC 1997, Ryck 1974).

In 2002-2003, MDNR identified elevated dissolved barite levels in Big River with probable origins in the Mill Creek watershed (MDNR 2004). We recommended a bioassessment be conducted on Mill Creek to determine if the aquatic community in Mill Creek was impaired by mining or other influences.

This biological assessment study was conducted at the request of the Missouri Department of Natural Resources (**MDNR**), Water Protection Program (**WPP**), Water Pollution Control Branch (**WPCB**). The Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**), Aquatic Bioassessment Unit (**ABU**) coordinated and conducted the study.

## 1.2 Purpose

Determine if Mill Creek is biologically impaired.

## 1.3 Objectives

1) Assess the stream habitat quality of Mill Creek.

2) Assess the macroinvertebrate community integrity and water quality of Mill Creek.

### 1.4 Tasks

1) Conduct a stream habitat assessment for Mill Creek and compare results with Cub Creek (SHAPP Control).

2) Conduct a biological assessment, including macroinvertebrate and water physicochemical collection and analyses.

3) Compare biological assessment results to wadeable/perennial stream biological criteria and compare metrics between stations.

4) Compare physicochemical water quality between stations, controls, and with Water Quality Standards (MDNR 2005b).

### 1.5 Null Hypotheses

1) Stream habitat will be similar between test stations and the control station.

2) Biological metrics will be similar to wadeable/perennial stream biological criteria, as well as between stations.

3) Physicochemical water quality parameters will be similar at all stations and within acceptable criteria of the Missouri Water Quality Standards (MDNR 2005b).

## 2.0 Methods

Kenneth B. Lister, David Michaelson, and other members of ESP conducted this study. Randy Sarver (ESP) and Andy Austin, Missouri Department of Conservation (**MDC**), assisted with fieldwork. The study area, station descriptions, Ecological Drainage Units (**EDUs**), and land use are identified. The study timing is outlined. Methods are included for stream habitat assessments, biological assessments, and physicochemical water quality collection.

### 2.1 Study Area and Station Descriptions

The study area included approximately twelve miles of Mill Creek and the downstream reference station on Cub Creek, Washington County (Table 1; Figure 2). Two stations were allocated for Mill Creek and one for Cub Creek. Mill Creek #2 was located upstream of Missouri Highway 47. This sampling station included influence from Pond Creek. Mill Creek #1 was approximately ¼ mile downstream of County Road (**CR**) 408 near Tiff, Missouri and is immediately downstream of the confluence with Shibboleth Branch. The Cub Creek #1 reference or control station was downstream of Bethel Church near Courtois, Missouri, approximately 1.0 mile upstream of the confluence with Courtois Creek.

#### 2.1.1 Ecological Drainage Unit

Mill Creek is located within the Ozark/Meramec Ecological Drainage Unit (EDU; Figure 1). Ecological Drainage Units are delineated drainage units that are described by the physiographic and major riverine components. Within an EDU, similar

size streams are expected to contain similar aquatic communities and stream habitat conditions. Comparisons of biological and physicochemical results between test streams and similar size reference streams within the same EDU should then be appropriate.

Table 1
Location and Descriptive Information for Mill Creek and Cub Creek Stations, Washington County, 2005-2006

| Stream-Station Number | Location-Section, Township, Range | Description | County |
|---|---|---|---|
| Mill Creek #2 | NE ¼ sec. 35, T. 38 N., R. 03 E. | Upstream MO Hwy 47 | Washington |
| Mill Creek #1 | NE ¼ sec. 13, T. 38 N., R. 03 E. | 0.25 mile Downstream County Road 408 at Shibboleth Branch | Washington |
| Cub Creek (SHAPP Control) | SE ¼ sec. 32, T. 36 N., R. 01 W. | Downstream Bethel Church | Washington |

SHAPP=Stream Habitat Assessment Project Procedure

### 2.1.2 Land Use Description

Land cover of the Ozark/Meramec EDU was compared to land cover near the Mill Creek stations at the 14-digit Hydrological Unit scale (**HUC-14**; Table 2). Percent land cover data were derived from Thematic Mapper (TM) satellite data collected between 2000 and 2004 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**).

The dominant land cover in the immediate watershed of all Mill Creek stations was forest, followed by grassland, and then urban areas (Table 2). The percent land cover at Mill Creek stations was similar to the Ozark/Meramec EDU. The Cub Creek (SHAPP control) station had a higher percentage of forest, lower grassland, and no real urban areas. General land use should not be a factor in interpretation of the results.

Table 2
Percent Land Cover in the Mill Creek and Cub Creek, Washington County Stations and the Ozark/Meramec EDU

| Stations | HUC-14 | Urban | Crops | Grass | Forest | Wetland | Open-water |
|---|---|---|---|---|---|---|---|
| Mill Creek #2, #1 | 07140104080002 | 6 | 0 | 15 | 73 | 1 | 1 |
| Cub Creek #1 (SHAPP only) | 07140102040002 | 0 | 0 | 7 | 92 | 0 | 0 |
| Ozark/Meramec EDU | NA | 4 | 1 | 27 | 62 | -- | -- |

HUC-14 = 14-digit Hydrologic Unit Code; EDU = Ecological Drainage Unit

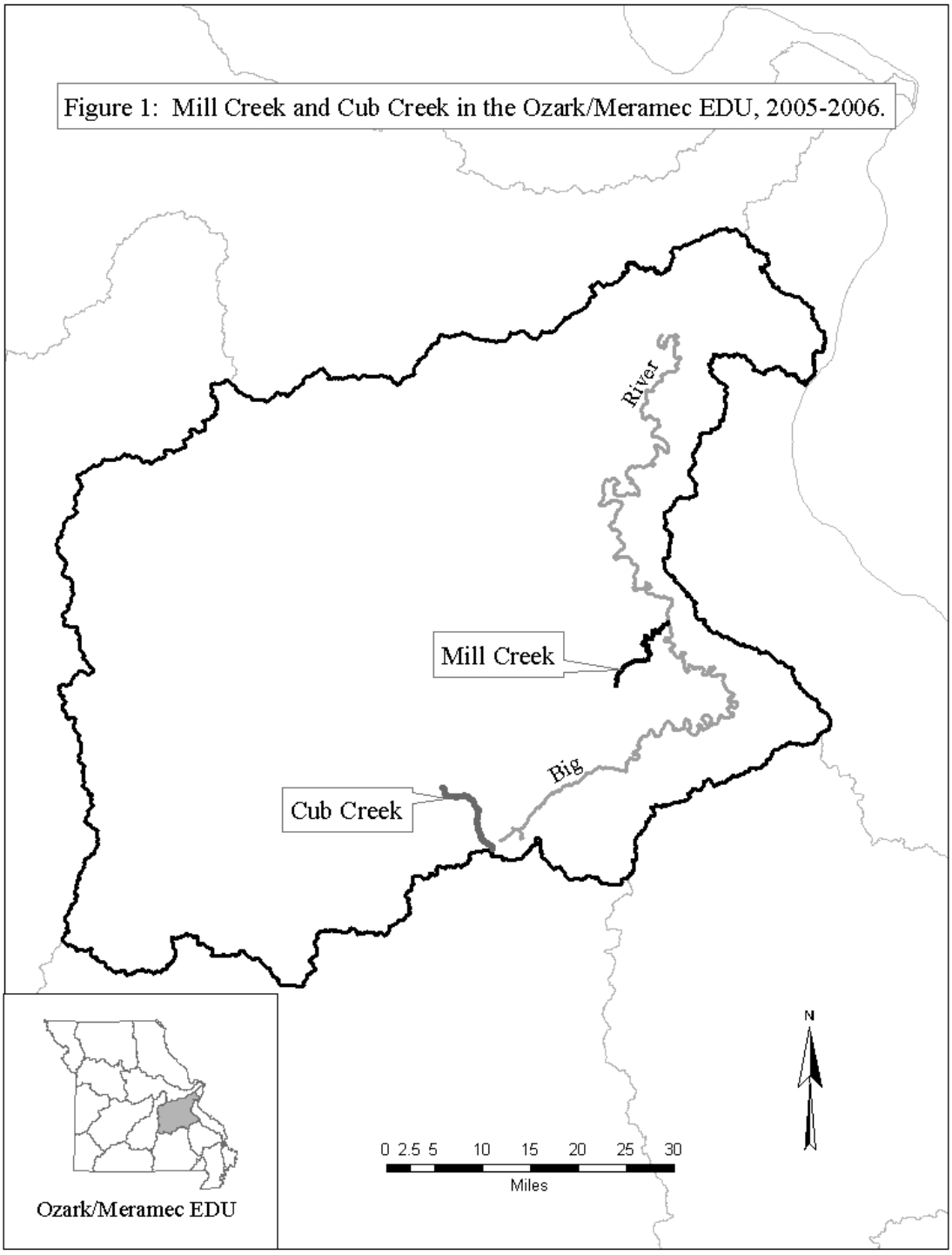
Figure 1: Mill Creek and Cub Creek in the Ozark/Meramec EDU, 2005-2006.
River
Mill Creek
Big
Cub Creek
Ozark/Meramec EDU
N
0 2.5 5 10 15 20 25 30
Miles

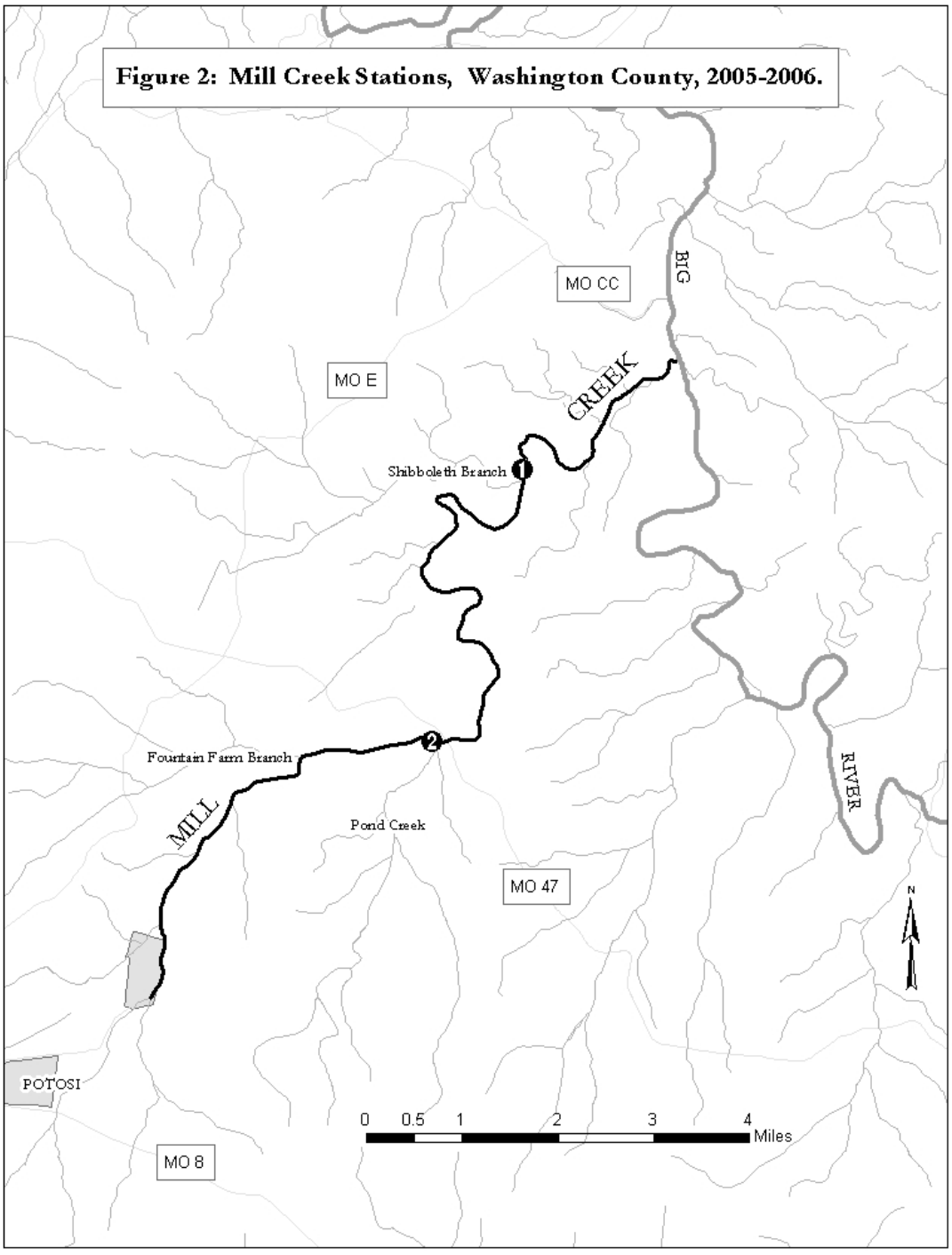
Figure 2: Mill Creek Stations, Washington County, 2005-2006.
MO CC
MO E
BIG
CREEK
Shibboleth Branch
1
2
Fountain Farm Branch
MILL
Pond Creek
MO 47
RIVER
N
POTOSI
MO 8
0 0.5 1 2 3 4
Miles

## 2.2 Study Timing

Sampling took place in the fall of 2005 and spring of 2006. Fall samples were collected September 28, 2005. Spring samples were collected March 28, 2006. Stream habitat assessments were conducted at Mill Creek stations on April 4, 2006.

## 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). According to the SHAPP, the integrity of an aquatic biological community is influenced by the quality of the stream habitat. Stream habitat quality is scored for each station and the scores are compared with SHAPP control (reference) station scores. If the SHAPP score at a test station is ≥75% of the mean SHAPP control scores, the stream habitat at the test station is considered to be comparable to the reference (control) stream. Cub Creek, Washington County (March 2004) was used as the SHAPP control (Table 1; Figure 1).

## 2.4 Biological Assessment

Sampling was conducted as described in the MDNR Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP,** MDNR 2003c). Biological assessments consist of macroinvertebrate community and physicochemical water collection and analyses. Macroinvertebrates and physicochemical water parameters were analyzed for two stations on Mill Creek, Washington County.

### 2.4.1 Macroinvertebrate Sampling and Analyses

According to the SMSBPP, macroinvertebrates were sampled from specified habitats based on stream type (MDNR 2003c). Mill Creek is considered a riffle/pool dominant stream in which flowing water over coarse substrate (**CS**), non-flowing water over depositional substrate (**NF**), and rootmat (**RM**) habitats were sampled. Macroinvertebrates are subsampled in the laboratory and identified to specific taxonomic levels (MNDR 2005a) in order to develop biological criteria metrics (MDNR 2003c)

Macroinvertebrate community data were analyzed using Macroinvertebrate Stream Condition Index (**MSCI**) scores, individual biological criteria metrics, and dominant macroinvertebrate families (**DMF**).

The first analysis is based on the MSCI. A Macroinvertebrate Stream Condition Index is a qualitative measurement of a stream's aquatic biological integrity (Rabeni et al. 1997). The MSCI was further refined for reference streams (**BIOREF**s) within each EDU in Biological Criteria for Perennial/Wadeable Streams (MDNR 2002; MDNR 2003c). A station's MSCI score is a compilation of rank scores that are assigned to the primary biological criteria metrics. These four primary biological criteria metrics are: 1) Taxa Richness (**TR**); 2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). An individual metric score is compared to its BIOREF scoring range (MSCI Scoring Table, Tables 4 and 5) and a rank score (5, 3, or 1) is assigned to that metric (Tables 4 and 5). This is repeated for each of the four metrics and then the four rank scores are compiled to complete the MSCI score.

Biological integrity, based on the MSCI scores, is interpreted as follows: 20-16 = full biological support; 14-10 = partial biological support; and 8-4 = non-support of the biological community. MSCI scores were grouped by season and compared between stations.

The second analysis of the macroinvertebrate community was to examine the individual metric scores. Each individual metric is compared to the BIOREF scoring range to identify the level of integrity for each station. Variations in the metrics may help identify how a community is affected and potentially identify a source of impairment.

The third biological analysis was an evaluation of the taxa that occur in each station. Dominant macroinvertebrate families (**DMF**) are compiled as a percentage of the total number of individuals in a sample. Dominance by certain families may illuminate the quality of the station and help identify a type and source of impairment. An individual taxa list grouped by season and station is attached as Appendix A.

### 2.4.2 Physicochemical Water Sampling and Analyses

Physicochemical water samples were handled according to the appropriate MDNR, ESP Standard Operating Procedure (**SOP**) and/or Project Procedure (**PP**). Results for physicochemical water parameters were examined by season and station.

Fall 2005 and spring 2006 physicochemical water parameters were sampled by field measurements or grab samples. Water samples were collected according to the SOP MDNR-FSS-001 Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003b). All samples were kept on ice during transport to ESP.

Water quality parameters were measured *in-situ* or collected and returned for analyses at the state environmental laboratory. Temperature ($C^o$), pH, conductivity (uS), dissolved oxygen (mg/L), and discharge (cubic feet per second-**cfs**) were measured in the field. Turbidity (NTU) was measured and recorded in the ESP, WQMS biology laboratory. The ESP, Chemical Analysis Section (**CAS**) in Jefferson City, Missouri conducted analyses for ammonia-nitrogen (mg/L), nitrate+nitrite-nitrogen (mg/L), total nitrogen (mg/L), chloride (mg/L), and total phosphorus (mg/L). Samples for dissolved metals (barium, cadmium, calcium, cobalt, copper, lead, magnesium, nickel, and zinc) were filtered in the field and analyzed by the CAS.

Physicochemical water parameters were compared between stations as well as with Missouri's Water Quality Standards (**WQS**, MDNR 2005b). Interpretation of acceptable limits in the WQS may be dependent on a stream's classification and its beneficial-use designation (MDNR 2005b). Mill Creek is a class "P" stream, with designated uses for LWW, AQL, and WBC-category B. Furthermore, acceptable limits for some parameters, such as dissolved metals, may be dependent on the rate of exposure. These exposure or toxicity limits are based on the lethality of a toxicant given long-term exposure (chronic toxicity, **c**) or short-term exposure (acute toxicity, **a**).

### 2.4.3 Discharge

Stream flow was measured using a Marsh-McBirney Flowmate™ flow meter at each station. Velocity and depth measurements were recorded at each station according to SOP MDNR-WQMS-113 Flow Measurement in Open Channels (MDNR 2003a).

## 2.5 Quality Control

Quality control measures were conducted in accordance with MDNR SOPs and Project Procedures. Quality control duplicates (Table 8) document consistency of *in situ* water collection techniques and laboratory analyses procedures.

## 3.0 Results

Results are shown for the stream habitat assessment and biological assessment. Components of the biological assessment are grouped by sample season and by station.

## 3.1 Stream Habitat Assessment

Stream habitat assessment scores were evaluated for both stations and a SHAPP control. The score was slightly lower at Mill Creek #2 than at the downstream #1. Both Mill Creek stations had scores above Cub Creek #1 (SHAPP control). Stations #2 and #1 were considered comparable to the SHAPP control.

Observations of the general Mill Creek watershed showed signs of disturbance. At station #1 the substrate of the stream contained red clay/sand size sediment that somewhat embedded larger substrate particles. Station #2 also had areas of fine sediment, but it did not appear to be the same type of material as that observed downstream in station #1.

Table 3
Stream Habitat Assessment Scores and Percentage Comparison for Mill Creek and Cub Creek (SHAPP Control), Washington County

| | Mill Creek #2 | Mill Creek #1 | Cub Creek #1 (SHAPP Control) |
|---|---|---|---|
| SHAPP Scores | 152 | 166 | 142 |
| Percent of Mean SHAPP Control | 107 | 117 | -- |

## 3.2 Biological Assessment

A biological assessment consists of macroinvertebrate community analyses and physicochemical water parameter analyses. Results are grouped by season and station. Trends or exceptional results in the tables are designated in bold type.

### 3.2.1 Macroinvertebrate Community Analyses

Evaluation of the macroinvertebrate communities in Mill Creek involved application of the MSCI, individual metrics, and examination of dominant macroinvertebrate families.

Results are grouped by season and station. Bench sheets are attached as Appendix A. They document a wide range of taxa that are relatively evenly distributed.

Mill Creek was considered to fully support the aquatic community in the fall of 2005 (Table 4). Stations #2a and #2b (quality control duplicates) had MSCI scores of 16. The downstream station #1 had an MSCI score of 18.

Individual metrics such as BI and SDI showed a slight response in the fall (Table 4). The BI was slightly elevated at #2 and #1 above the optimum BIOREF scoring range. The SDI was similar between stations and slightly below the optimum BIOREF scoring range at station #2. Metric scores were very similar at the quality control duplicates (#2a and #2b).

Table 4
Fall 2005 Biological Criteria (BIOREF) Metric Scores, Biological Support Category, and Stream Condition Index (MSCI) Scores for Mill Creek Stations, Washington County

| Stream and Station Number | Sample No. | TR | EPTT | BI | SDI | MSCI | Support |
|---|---|---|---|---|---|---|---|
| Mill Creek #2a | 0503086 | 92 | 24 | **6.09** | **2.94** | 16 | Full |
| Mill Creek #2b | 0503087 | 94 | 24 | **6.11** | **3.01** | 16 | Full |
| Mill Creek #1 | 0503088 | 89 | 27 | **5.81** | 3.10 | 18 | Full |
| BIOREF Score=5 | -- | >78 | >21 | <5.78 | >3.08 | 20-16 | Full |
| BIOREF Score=3 | -- | 78-39 | 21-10 | 5.78-7.89 | 3.08-1.54 | 14-10 | Partial |
| BIOREF Score=1 | -- | <39 | <10 | >7.89 | <1.54 | 8-4 | Non |

MSCI Scoring Table (in light gray) developed from BIOREF streams (n=7). TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index

Table 5
Spring 2006 Biological Criteria (BIOREF) Metric Scores, Biological Support Category, and Stream Condition Index (MSCI) Scores for Mill Creek Stations, Washington County

| Stream and Station Number | Sample No. | TR | EPTT | BI | SDI | MSCI | Support |
|---|---|---|---|---|---|---|---|
| Mill Creek #2 | 0602649 | 101 | 33 | **6.18** | 3.33 | 18 | Full |
| Mill Creek #1 | 0602650 | 105 | **26** | **5.94** | 3.79 | 16 | Full |
| BIOREF Score=5 | -- | >92 | >29 | <5.80 | >3.32 | 20-16 | Full |
| BIOREF Score=3 | -- | 92-46 | 29-14 | 5.80-7.90 | 3.32-1.66 | 14-10 | Partial |
| BIOREF Score=1 | -- | <46 | <14 | >7.90 | <1.66 | 8-4 | Non |

MSCI Scoring Table (in light gray) developed from BIOREF streams (n=6). TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index

The spring MSCI scores indicated that all stations were fully supporting the biological community (Table 5). Mill Creek #2 had a score of 18 and the downstream station #1 had a score of 16.

Individual metric scores were generally well within the optimum BIOREF scoring range (5), with a few exceptions in the spring of 2006 (Table 5). The BI was high or less than optimal at both #2 and #1. The EPTT was less than optimal at station #1.

The dominant macroinvertebrate families (DMFs) fluctuated slightly from upstream to downstream in the fall (Table 6). Caenidae comprised approximately 30 percent of the total number of individuals, but dropped to approximately 12 percent at station #1. Leptohyphid mayflies and Elmid beetles doubled in the downstream station. Isonychid, ephemerellid, and baetid mayflies were among the dominant families in station #1.

Table 6
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, Fall 2005

| Station | Mill Creek #2a | Mill Creek #2b | Mill Creek #1 |
|---|---|---|---|
| Sample Number | 0503086 | 0503087 | 0503088 |
| Caenidae | 34.3 | 32.6 | 12.5 |
| Elmidae | 12.4 | 11.7 | 20.2 |
| Leptohyphidae | 11.9 | 12.3 | 24.9 |
| Heptageniidae | 8.9 | 7.7 | 6.2 |
| Chironomidae | 8.0 | 9.1 | 14.2 |
| Hyalellidae | 6.1 | 7.5 | -- |
| Arachnoidea | 2.8 | 3.6 | -- |
| Isonychiidae | 2.6 | 2.9 | 3.7 |
| Ephemerellidae | -- | -- | 2.2 |
| Baetidae | -- | -- | 1.6 |

The dominant macroinvertebrate families (DMFs) fluctuated somewhat but did not illustrate a major difference in the spring (Table 7). Chironomidae taxa made up approximately 20 to 30 percent of the total number of individuals, as would be expected in the spring sampling. Heptageniidae was consistently dominant from upstream to downstream. Caenidae mayflies decreased from approximately 36 percent at station #2 to 18 percent at station #1. Again, Leptohyphid mayflies increased by 2 fold in the downstream station. The dominant families illustrated a diverse assemblage from upstream to downstream.

### 3.2.2 Physicochemical Water Parameters Analyses

Results for fall 2005 and spring 2006 water samples are presented in Tables 8 and 9. Only trends or exceptional values are highlighted.

A few physicochemical water parameters should be noted from the fall sample (Table 8). Conductivity was elevated and nutrients were present. Dissolved barium was elevated at both stations and increased downstream of Shibboleth Branch. Dissolved metals concentrations did not exceed WQS (MDNR 2005b) at the observed hardness criteria in the fall.

Table 7
Dominant Macroinvertebrate Families (DMF) as a Percentage of the Total Number of Individuals per Station, Spring 2006

| Station | Mill Creek #2 | Mill Creek #1 |
|---|---|---|
| Sample Number | 0602649 | 0602650 |
| Caenidae | 36.4 | 18.0 |
| Chironomidae | 20.8 | 33.3 |
| Arachnoidea | 8.2 | 3.8 |
| Heptageniidae | 7.9 | 7.7 |
| Elmidae | 4.8 | 7.5 |
| Hyalellidae | 4.0 | -- |
| Ephemerellidae | 3.7 | -- |
| Empididae | 1.5 | 3.8 |
| Isonychiidae | -- | 4.5 |
| Leptohyphidae | -- | 3.3 |

Table 8
Physicochemical Water Parameters Per Station, Fall 2005

| Parameter | Mill Creek #2a | Mill Creek #2b | Mill Creek #1 |
|---|---|---|---|
| Sample Number | 0505652 | 0505653 | 0505654 |
| pH (Units) | 8.0 | -- | 8.2 |
| Temperature ($C^0$) | 17.5 | -- | 19.5 |
| Conductivity (uS/cm) | **501** | **--** | **468** |
| Dissolved $O_2$ | 8.01 | -- | 8.37 |
| Discharge (cfs) | 4.95 | -- | 3.14 |
| Turbidity (NTUs) | 1.0 | 1.0 | 3.0 |
| Nitrate+Nitrite-N | 0.17 | 0.29 | 0.11 |
| Total Nitrogen | 0.46 | 0.47 | 0.26 |
| Ammonia-N | <0.03 | <0.03 | <0.03 |
| Chloride | 10.8 | 10.7 | 7.09 |
| Total Phosphorus | 0.44 | 0.38 | 0.28 |
| Hardness as $CaCO_3$ | 254 | 257 | 244 |
| Barium (ug/L) - Dissolved | **684** | **665** | **750** |
| Cadmium (ug/L) - Dissolved | <0.25 | <0.25 | <0.25 |
| Calcium | 49.7 | 50.5 | 47.0 |
| Cobalt (ug/L) - Dissolved | <1.00 | <1.00 | <1.00 |
| Copper (ug/L) - Dissolved | 1.50 | 1.14 | 1.76 |
| Lead (ug/L) - Dissolved | <0.25 | <0.25 | 1.61 |
| Magnesium - Dissolved | 31.6 | 31.7 | 30.8 |
| Nickel (ug/L) - Dissolved | 0.75 | 0.75 | 0.68 |
| Zinc (ug/L) - Dissolved | 4.68 | 4.74 | 5.69 |

(Units mg/L unless otherwise noted; **Bold**=Ouside WQS limits or trend)

Spring physicochemical water parameters were generally unremarkable, with the exception of dissolved barium (Table 9). Barium levels were elevated at all stations and slightly increased at station #1 downstream from the Shibboleth Creek confluence. Dissolved metals concentrations did not exceed WQS (MDNR 2005b) at the observed hardness criteria in the spring.

Table 9
Physicochemical Water Parameters per Station, Spring 2006

| Parameter | Mill Creek #2 | Mill Creek #1 |
|---|---|---|
| Sample Number | 0603196 | 0603197 |
| pH (Units) | 8.3 | 8.3 |
| Temperature ($C^0$) | 8.0 | 8.0 |
| Conductivity (uS/cm) | 296 | 355 |
| Dissolved $O_2$ | 11.6 | 11.9 |
| Discharge (cfs) | 19.7 | 37.6 |
| Turbidity (NTUs) | 2.55 | 2.6 |
| Nitrate+Nitrite-N | 0.04 | 0.02 |
| Total Nitrogen | 0.24 | 0.15 |
| Ammonia-N | <0.03 | <0.03 |
| Chloride | 5.40 | 6.08 |
| Total Phosphorus | 0.02 | 0.01 |
| Hardness as $CaCO_3$ | 160 | 189 |
| Barium (ug/L) - Dissolved | **453** | **487** |
| Cadmium (ug/L) - Dissolved | <0.25 | <0.25 |
| Calcium | 32.1 | 38.2 |
| Cobalt (ug/L) - Dissolved | <1.00 | <1.00 |
| Copper (ug/L) - Dissolved | 1.00 | 1.73 |
| Lead (ug/L) - Dissolved | <0.25 | <0.25 |
| Magnesium - Dissolved | 19.4 | 22.8 |
| Nickel (ug/L) - Dissolved | 0.48 | 0.40 |
| Zinc (ug/L) - Dissolved | 7.42 | 6.34 |

(Units mg/L unless otherwise noted; **Bold**=Outside WQS limits or trend)

## 4.0 Discussion

The Mill Creek, Washington County biological community was not impaired during the fall 2005 and spring 2006 collection periods. Mill Creek stream habitat, macroinvertebrate community, and physicochemical water parameters were examined.

### 4.1 Stream Habitat Assessment

Using the MDNR Stream Habitat Assessment Project Procedure (MDNR 2003d), Mill Creek was found to have high quality stream habitat when compared to Cub Creek, Washington County (SHAPP control). The scores at both stations were consistent from upstream to downstream and were above the SHAPP control score. Earlier work done by

Czarnezki and Trial (1997) found high quality habitat in their Mill Creek stations. However, the general watershed of Mill Creek watershed shows evidence of past disturbance from strip mining activities.

### 4.1.1 General Stream Habitat Observations

The gravel and cobble substrates of stations #2 and #1 were somewhat embedded by a smaller sized different material. Station #2 had what seemed to be a more organic substrate light in color. Station #2 is the upstream control and was probably not as affected by historic barite strip mining as the lower station. Larger substrate particles at station #1 were moderately embedded by a red, clay-like fine sediment. This material is similar in appearance to the soil observed in tailing piles present in the watershed. It is likely that this is sediment from runoff through erosion of the surrounding watershed. A fine sediment study should be conducted on Mill Creek.

## 4.2 Macroinvertebrate Community Analyses

Macroinvertebrate community analyses indicated that Mill Creek stations were not impaired during either sample season. Mill Creek stations were considered to fully support the biological community during both seasons. Czarnezki and Trial (1997) found similar results in an investigation of Mill Creek in 1996. Biological criteria metrics at their sites (similar locations) identified little difference between upstream and downstream stations and good biological diversity.

While the overall MSCI scores illustrated that there was no impairment, several less-than-optimum individual metrics indicted a slightly altered macroinvertebrate community composition. The BI was elevated at both stations during both seasons, suggesting that there may be a continuous organic influence on the Mill Creek community. The lower than optimum diversity and uneven distribution (SDI) in the fall and the lower EPTT in the spring both contributed to the lower MSCI scores.

Examination of the composition of dominant macroinvertebrate families and the individual taxa list identified a diverse and intolerant community. The dominant macroinvertebrate families fluctuated slightly from upstream to downstream in the fall and the spring. Caenids and Chironomids were more dominant in the spring. However, the presence of relatively intolerant isonychid, ephemerellid, and baetid mayflies downstream illustrates the high quality of the stream. Although macroinvertebrate community analyses suggested that Mill Creek was not impaired during the study period, further sampling should be conducted on tributaries such as Shibboleth Branch, Fountain Farm Branch, and Pond Creek, Washington County.

## 4.3 Physicochemical Water Analyses

Physicochemical water parameters were generally unremarkable with a few exceptions. Nutrients and the dissolved metal barium were present or elevated during the sample periods.

### 4.3.1 Conductivity and Nutrients

Conductivity was elevated in the fall and nutrient levels were apparent but not excessive. These parameters may identify a slight organic input that may help explain a slightly altered macroinvertebrate community. At least one nutrient related pollution event has been documented on a tributary to Mill Creek. In 1991, a chicken manure release killed an undisclosed number of fish (MDC 1997). Higher conductivity values may be a result of mine waste runoff. Water quality should be periodically monitored in Mill Creek.

### 4.3.2 Dissolved Metals

Dissolved barium concentrations ranged from approximately 450 to 750 ug/L and identified a continuous influence to Mill Creek. The levels at which dissolved barium were found indicate that past barite mining or other disturbance in the Mill Creek watershed probably contributed to the concentrations found in the stream. Dissolved metals concentrations should be included in the water quality monitoring of Mill Creek.

Dissolved barium levels found at Mill Creek appear to be higher than background. Concentrations found in an earlier biological assessment in upper Big River (MDNR 2004) rarely exceeded 125 ug/L. Downstream from the confluence of Big River and Mill Creek barium concentrations increased two-fold, suggesting that 1) the background was probably closer to the upstream reading of 125 ug/L; and 2) a barium influence was probably located in the Mill Creek drainage. It appears that runoff from the Mill Creek watershed is contributing barium to Mill Creek and then to Big River. Widespread historic strip mining for barite in the Mill Creek watershed could explain a diffuse source of barium and explain the higher concentrations in the stream. The dissolved barium concentrations found in Mill Creek, Washington County did not exceed Water Quality Standards (MDNR 2005b) for either drinking water supply (DWS; 2000 ug/L) or groundwater (GRW; 2000 ug/L). Further sampling should be conducted on Mill Creek tributaries such as Shibboleth Branch, Fountain Farm Branch, and Pond Creek, Washington County.

### 4.3.3 Total Metals

Czarnezki and Trial (1997) found cadmium and mercury levels in fish of Mill Creek were typical of unimpacted Ozark streams. Lead levels in fish were elevated, however, not to a level of concern. We did not find elevated levels of these metals (excluding mercury) in the water samples, which suggests the availability of lead is either intermittent or found elsewhere, such as in the Mill Creek sediment. Alternatively, the fish found with elevated levels of lead may have migrated upstream from Big River. Regardless, the sediment is a probable source of metals. Fine sediment contaminant studies should be conducted on Mill Creek, Fountain Farm Branch, Pond Creek, and Shibboleth Branch.

## 4.4 Quality Control

The quality control duplicates for field collection and analyses were collected at station #2 (2a and 2b). Results were consistent for macroinvertebrate and water physicochemical parameters, indicating that sample collection and analyses techniques were equally effective.

## 5.0 Conclusion

The objective of the study was to determine if Mill Creek was biologically impaired. Using macroinvertebrate indicators, Mill Creek was not found to be impaired during the 2005-2006 sample periods. The objectives were met. The macroinvertebrate community, physicochemical water parameters, and stream habitat indicated that the stream was not impaired during the sample periods.

All hypotheses were accepted. Stream habitat was similar between test stations and the control station; biological metrics were similar to wadeable/perennial stream biological criteria, as well as between stations; and physicochemical water quality was similar at all stations and parameters were within acceptable criteria of Missouri Water Quality Standards (MDNR 2005b).

## 6.0 Recommendations

1) Stabilize fine sediment influences in the watershed using land use best management practices.

2) Identify sources for organic influences.

3) Periodically monitor water quality, including dissolved metals concentrations.

4) Conduct biological assessments on tributaries such as Fountain Farm Branch, Pond Creek, and Shibboleth Branch.

5) Conduct fine sediment studies on Mill Creek, Fountain Farm Branch, Pond Creek, and Shibboleth Branch.

## 7.0 Literature Cited

Czarnezki, J. and L. Trial. 1997. Water quality investigation of Mill Creek, Washington County, Missouri 1996. Missouri Department of Conservation. Fish and Wildlife Research Center, 1110 South College Avenue, Columbia, Missouri. 11pp.

Duchrow, R.M. 1978. The effects of barite tailings pond dam failure upon the water quality of Mill Creek and Big River, Washington County, Missouri. D-J Project F-19-R, Missouri Department of Conservation, Columbia, Missouri. 48 pp.

Missouri Department of Natural Resources. 1994. Missouri water quality basin plans. Volume 5, unpublished data. Missouri Department of Natural Resources, Division of Environmental Quality, Water Protection Program, Water Pollution Control Branch. Jefferson City, Missouri.

Missouri Department of Natural Resources. 2002. Biological Criteria for Wadeable/Perennial Streams of Missouri. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 32 pp.

Missouri Department of Natural Resources. 2003a. Flow measurements in open channels. Water Quality Monitoring Section-113. Environmental Services Program, P.O. Box 176, Jefferson City, Missouri. 9 pp.

Missouri Department of Natural Resources. 2003b. Required/recommended containers, volumes, preservatives, holding times, and special sampling considerations. Field Services Section-001. Environmental Services Program, P.O. Box 176, Jefferson City, Missouri. 25 pp.

Missouri Department of Natural Resources. 2003c. Semi-quantitative macroinvertebrate stream bioassessment project procedure. Field Services Section-030. Environmental Services Program, P.O. Box 176, Jefferson City, Missouri. 24 pp.

Missouri Department of Natural Resources. 2003d. Stream habitat assessment project procedure. Field Services Section-032. Environmental Services Program, P.O. Box 176, Jefferson City, Missouri. 40 pp.

Missouri Department of Natural Resources. 2004. Biological and fine sediment study. Big River (lower): Irondale to Washington State Park St. Francois, Washington, and Jefferson Counties, Missouri, 2002-2003. Missouri Department of Natural Resources, Field Services Division, Environmental Services Program, Water Quality Monitoring Section. 40 pp + app.

Missouri Department of Natural Resources. 2005a. Taxonomic levels for macroinvertebrate identifications. Water Quality Monitoring Section-209. Environmental Services Program, P.O. Box 176, Jefferson City, Missouri. 30 pp.

Missouri Department of Natural Resources. 2005b. Title 10. Rules of Department of Natural Resources Division 20-Clean Water Commission, Chapter 7-Water Quality. 10 CSR 20-7.031 Water Quality Standards. pp. 10-136.

Missouri Department of Conservation. 1997. Big River basin inventory and management plan. Missouri Department of Conservation, Fisheries Division. 106 pp.

Missouri Department of Conservation. 2006. Big River watershed basin information: Online. Prepared by Kevin Meneau. 1997. St. Louis Region. Missouri Department of Conservation, Jefferson City, Missouri. http://www.mdc.mo.gov/fish/watershed/big/habitat/

Rabeni, C.F., R.J. Sarver, N. Wang, G.S. Wallace, M. Weiland, and J.T. Peterson. 1997. Biological criteria for streams of Missouri. Missouri Cooperative Fish and Wildlife Research Unit, University of Missouri-Columbia, Columbia, Missouri. 261 pp.

Ryck, F.M. Jr. 1974. Missouri stream pollution survey. Aquatic Series #8. Missouri Department of Conservation. Jefferson City, Missouri.

(EPA) United States Environmental Protection Agency. 2007. Consolidated 2002 Missouri 303(d) list. http://epa.gov/region7/water/MO-303d_consolidated_list.pdf

Submitted by: _____

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

Date: _____

Approved by: _____

Alan Reinkemeyer
Director
Environmental Services Program

AR:klt

c: John Ford, WPP
Gary Gaines, SERO

Appendix A

Invertebrate Database Bench Sheet Report: Mill Creek
Washington County

Grouped by Season and Station

(Quality Control Duplicates = 2a and 2b)

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503086], Station #2a, Sample Date: 9/28/2005 9:20:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| "HYDRACARINA" | | | |
| Acarina | 37 | 12 | 3 |
| AMPHIPODA | | | |
| Gammarus | | | 1 |
| Hyalella azteca | 3 | 6 | 101 |
| COLEOPTERA | | | |
| Berosus | | 1 | |
| Dubiraphia | 1 | 33 | 78 |
| Ectopria nervosa | | -99 | 1 |
| Macronychus glabratus | | | 5 |
| Microcylloepus pusillus | 7 | | 4 |
| Optioservus sandersoni | 78 | 2 | |
| Psephenus herricki | 3 | -99 | |
| Scirtidae | | | 2 |
| Stenelmis | 6 | 3 | 7 |
| DECAPODA | | | |
| Orconectes hylas | | 1 | 1 |
| Orconectes luteus | 2 | -99 | 1 |
| Orconectes medius | -99 | -99 | |
| DIPTERA | | | |
| Ablabesmyia | 1 | 3 | 2 |
| Atherix | -99 | | |
| Ceratopogoninae | | 22 | |
| Chrysops | | 1 | |
| Cladotanytarsus | | 2 | |
| Cricotopus/Orthocladius | 7 | 3 | 5 |
| Dicrotendipes | | 3 | 1 |
| Dixella | | | 1 |
| Epoicocladius | | 1 | |
| Hemerodromia | 2 | | |
| Labrundinia | | 1 | 2 |
| Microtendipes | 1 | | |
| Natarsia | | 1 | |
| Parakiefferiella | | 3 | |
| Paratanytarsus | | 2 | 3 |
| Phaenopsectra | | 2 | |
| Polypedilum illinoense grp | 1 | | 1 |
| Pseudochironomus | 1 | 25 | |
| Rheocricotopus | 2 | | |
| Rheotanytarsus | 2 | | 4 |
| Simulium | 5 | | |
| Stempellinella | 3 | 12 | 1 |
| Stictochironomus | 1 | | |
| Synorthocladius | 1 | | |
| Tabanus | -99 | | |
| Tanytarsus | 9 | 15 | |
| Thienemannimyia grp. | 3 | | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503086], Station #2a, Sample Date: 9/28/2005 9:20:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Tipula | -99 | | |
| Tribelos | | 20 | |
| EPHEMEROPTERA | | | |
| Baetis | 8 | | |
| Caenis anceps | 74 | 367 | 49 |
| Caenis latipennis | 31 | 64 | 32 |
| Centroptilum | | | 1 |
| Ephemera simulans | -99 | 1 | |
| Ephemerella | | | 1 |
| Eurylophella | 14 | 1 | 1 |
| Heptageniidae | 15 | 2 | |
| Hexagenia limbata | | 1 | |
| Isonychia bicolor | 47 | | |
| Leptophlebiidae | | | 1 |
| Stenacron | 5 | 7 | 1 |
| Stenonema femoratum | | 3 | 3 |
| Stenonema mediopunctatum | 36 | | |
| Stenonema pulchellum | 88 | | |
| Tricorythodes | 210 | 4 | 1 |
| ISOPODA | | | |
| Caecidotea | | | 1 |
| LIMNOPHILA | | | |
| Ancylidae | 13 | 5 | 9 |
| Helisoma | | -99 | 2 |
| Physella | 1 | -99 | 1 |
| LUMBRICINA | | | |
| Lumbricidae | 2 | -99 | |
| MEGALOPTERA | | | |
| Corydalus | 2 | | |
| Nigronia serricornis | -99 | -99 | |
| Sialis | | -99 | |
| MESOGASTROPODA | | | |
| Elimia | | -99 | 2 |
| ODONATA | | | |
| Argia | | 1 | 1 |
| Basiaeschna janata | | | -99 |
| Boyeria | | | 1 |
| Calopteryx | | | 6 |
| Didymops | | -99 | |
| Enallagma | | | 15 |
| Gomphidae | 2 | | |
| Hagenius brevistylus | | | -99 |
| Hetaerina | | | 1 |
| Ophiogomphus | -99 | | |
| Stylogomphus albistylus | | -99 | -99 |
| RHYNCHOBDELLIDA | | | |
| Glossiphoniidae | | | -99 |
| TRICHOPTERA | | | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503086], Station #2a, Sample Date: 9/28/2005 9:20:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Ceratopsyche morosa grp | 9 | | |
| Cernotina | | | 1 |
| Cheumatopsyche | 27 | | |
| Helicopsyche | 1 | | 1 |
| Nectopsyche | | 1 | |
| Oecetis | | 1 | 3 |
| Psychomyia | 1 | | |
| Triaenodes | | | 17 |
| TUBIFICIDA | | | |
| Tubificidae | | 9 | |
| VENEROIDEA | | | |
| Corbicula | -99 | -99 | |
| Sphaeriidae | 11 | 7 | 1 |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503087], Station #2b, Sample Date: 9/28/2005 9:20:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| "HYDRACARINA" | | | |
| Acarina | 38 | 11 | 17 |
| AMPHIPODA | | | |
| Gammarus | | -99 | |
| Hyalella azteca | 2 | 5 | 127 |
| BRANCHIOBDELLIDA | | | |
| Branchiobdellida | 1 | | |
| COLEOPTERA | | | |
| Ancyronyx variegatus | | | 1 |
| Berosus | | 2 | |
| Dubiraphia | 1 | 29 | 94 |
| Ectopria nervosa | | -99 | |
| Macronychus glabratus | | | 4 |
| Microcylloepus pusillus | 4 | | 9 |
| Optioservus sandersoni | 59 | 1 | |
| Psephenus herricki | 7 | -99 | 2 |
| Stenelmis | 3 | 3 | 2 |
| DECAPODA | | | |
| Orconectes hylas | | | -99 |
| Orconectes luteus | -99 | | 2 |
| Orconectes medius | 4 | -99 | |
| DIPTERA | | | |
| Ablabesmyia | | 6 | 1 |
| Atherix | 1 | | |
| Ceratopogoninae | | 7 | |
| Chironomus | | 3 | |
| Chrysops | | -99 | |
| Cladotanytarsus | | 3 | |
| Cricotopus bicinctus | | 1 | |
| Cricotopus/Orthocladius | 6 | 2 | 4 |
| Cryptochironomus | | 1 | |
| Dicrotendipes | | 8 | |
| Hemerodromia | 2 | | 1 |
| Labrundinia | | | 2 |
| Microtendipes | | 1 | 1 |
| Nanocladius | | 1 | |
| Parakiefferiella | 1 | 5 | |
| Parametriocnemus | 1 | | |
| Paratanytarsus | | | 4 |
| Polypedilum convictum grp | 4 | 1 | |
| Polypedilum illinoense grp | | 1 | 2 |
| Polypedilum scalaenum grp | | 1 | |
| Pseudochironomus | | 17 | 3 |
| Rheotanytarsus | 1 | 1 | 14 |
| Simuliidae | 1 | | |
| Stempellinella | 1 | 10 | |
| Stictochironomus | | 2 | |
| Synorthocladius | 1 | 1 | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503087], Station #2b, Sample Date: 9/28/2005 9:20:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Tabanus | 1 | | |
| Tanytarsus | | 27 | 4 |
| Thienemanniella | 4 | | |
| Thienemannimyia grp. | 2 | | 2 |
| Tribelos | | 14 | |
| EPHEMEROPTERA | | | |
| Baetis | 6 | | 1 |
| Caenis anceps | 59 | 319 | 30 |
| Caenis latipennis | 12 | 139 | 23 |
| Ephemera simulans | | -99 | |
| Ephemerella | 2 | | |
| Eurylophella | 5 | 2 | 4 |
| Heptageniidae | 47 | | |
| Isonychia bicolor | 52 | | |
| Leptophlebiidae | | | 1 |
| Procloeon | | | 1 |
| Stenacron | 2 | | |
| Stenonema femoratum | | 6 | 1 |
| Stenonema mediopunctatum | 65 | | |
| Stenonema pulchellum | 17 | | 1 |
| Tricorythodes | 210 | 7 | 4 |
| ISOPODA | | | |
| Caecidotea | 1 | | |
| LEPIDOPTERA | | | |
| Petrophila | 1 | | |
| LIMNOPHILA | | | |
| Ancylidae | 6 | 6 | 8 |
| Helisoma | | | -99 |
| Menetus | | | 8 |
| Physella | | | 1 |
| LUMBRICINA | | | |
| Lumbricina | 1 | 1 | |
| MEGALOPTERA | | | |
| Corydalus | 8 | | |
| Sialis | | -99 | |
| MESOGASTROPODA | | | |
| Elimia | 1 | -99 | 2 |
| ODONATA | | | |
| Basiaeschna janata | | | -99 |
| Boyeria | | | -99 |
| Enallagma | | | 8 |
| Gomphidae | | | 1 |
| Hagenius brevistylus | | | -99 |
| Hetaerina | | | 1 |
| Macromia | | | -99 |
| Stylogomphus albistylus | 2 | -99 | -99 |
| TRICHOPTERA | | | |
| Ceratopsyche morosa grp | 6 | | 2 |
| Cheumatopsyche | 36 | | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503087], Station #2b, Sample Date: 9/28/2005 9:20:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Chimarra | 2 | | |
| Helicopsyche | 4 | | |
| Hydropsyche | 1 | | |
| Hydroptila | | | 1 |
| Oecetis | | | 2 |
| Polycentropus | | | 1 |
| Triaenodes | | | 10 |
| TRICLADIDA | | | |
| Planariidae | 3 | | |
| TUBIFICIDA | | | |
| Aulodrilus | | 1 | |
| Tubificidae | | 2 | |
| VENEROIDEA | | | |
| Corbicula | 16 | 13 | 2 |
| Sphaeriidae | | 5 | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503088], Station #1, Sample Date: 9/28/2005 12:20:00 PM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| "HYDRACARINA" | | | |
| Acarina | 15 | 1 | 2 |
| AMPHIPODA | | | |
| Crangonyx | | | 1 |
| Hyalella azteca | | | 19 |
| BRANCHIOBDELLIDA | | | |
| Branchiobdellida | 4 | | |
| COLEOPTERA | | | |
| Dubiraphia | | 125 | 67 |
| Ectopria nervosa | | | 1 |
| Helichus basalis | | | 1 |
| Macronychus glabratus | | | 2 |
| Microcylloepus pusillus | 2 | | 9 |
| Optioservus sandersoni | 6 | | 3 |
| Psephenus herricki | 2 | 5 | |
| Stenelmis | 8 | 28 | 18 |
| DECAPODA | | | |
| Orconectes harrisonii | -99 | | -99 |
| Orconectes hylas | | | -99 |
| Orconectes luteus | 2 | | |
| Orconectes medius | -99 | -99 | |
| DIPTERA | | | |
| Ablabesmyia | | 6 | 4 |
| Cardiocladius | 1 | | |
| Clinotanypus | | | 1 |
| Corynoneura | | | 5 |
| Cricotopus bicinctus | | 4 | |
| Cricotopus/Orthocladius | 8 | 3 | 2 |
| Cryptochironomus | | 1 | |
| Cryptotendipes | | 1 | |
| Dicrotendipes | 1 | 2 | 1 |
| Dixella | | | 2 |
| Epoicocladius | | 1 | |
| Hemerodromia | 7 | | 6 |
| Labrundinia | | 6 | 10 |
| Microtendipes | | | 1 |
| Parakiefferiella | | 4 | |
| Paratanytarsus | | | 6 |
| Polypedilum convictum grp | 2 | | |
| Polypedilum illinoense grp | 2 | 2 | 4 |
| Pseudochironomus | | 1 | |
| Rheocricotopus | 2 | | |
| Rheotanytarsus | 5 | 1 | 5 |
| Simulium | 3 | | |
| Stempellinella | 2 | 6 | 1 |
| Stenochironomus | | 1 | |
| Tanytarsus | 15 | 26 | 21 |
| Thienemanniella | 2 | 7 | 5 |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503088], Station #1, Sample Date: 9/28/2005 12:20:00 PM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Thienemannimyia grp. | 2 | | 1 |
| Tribelos | 2 | 5 | |
| EPHEMEROPTERA | | | |
| Baetidae | | 1 | |
| Baetis | 13 | 1 | 1 |
| Baetiscidae | | 6 | |
| Caenis anceps | 27 | 31 | 4 |
| Caenis latipennis | 10 | 29 | 65 |
| Centroptilum | | | 2 |
| Ephemera | | -99 | -99 |
| Eurylophella | 29 | | 1 |
| Heptageniidae | 15 | | |
| Hexagenia limbata | | 1 | 3 |
| Isonychia bicolor | 49 | | |
| Leptophlebiidae | 1 | | |
| Pseudocloeon | | | 4 |
| Stenacron | 5 | 11 | 1 |
| Stenonema femoratum | | 10 | |
| Stenonema mediopunctatum | 35 | | 1 |
| Stenonema pulchellum | 4 | | |
| Tricorythodes | 319 | 3 | 8 |
| ISOPODA | | | |
| Caecidotea | | 1 | |
| LIMNOPHILA | | | |
| Ancylidae | 2 | 6 | |
| LUMBRICINA | | | |
| Lumbricina | 1 | 1 | |
| MEGALOPTERA | | | |
| Corydalus | -99 | | |
| MESOGASTROPODA | | | |
| Elimia | | 1 | 3 |
| ODONATA | | | |
| Argia | 4 | 8 | 4 |
| Boyeria | | | -99 |
| Calopteryx | | | 2 |
| Enallagma | | | 6 |
| Gomphidae | 5 | | 1 |
| Hetaerina | | | 1 |
| Macromia | | | 1 |
| Stylogomphus albistylus | -99 | | |
| PLECOPTERA | | | |
| Acroneuria | -99 | | |
| TRICHOPTERA | | | |
| Ceratopsyche morosa grp | | | 1 |
| Cheumatopsyche | 6 | | 2 |
| Helicopsyche | 1 | 2 | 1 |
| Hydropsyche | 1 | | |
| Nectopsyche | | 2 | 1 |
| Oecetis | 1 | 1 | 6 |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0503088], Station #1, Sample Date: 9/28/2005 12:20:00 PM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Polycentropodidae | | 1 | |
| Triaenodes | | | 2 |
| TRICLADIDA | | | |
| Planariidae | 6 | 1 | |
| TUBIFICIDA | | | |
| Branchiura sowerbyi | | 4 | |
| Tubificidae | | 4 | |
| VENEROIDEA | | | |
| Corbicula | | -99 | -99 |
| Sphaeriidae | 1 | 12 | 2 |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0602649], Station #2, Sample Date: 3/28/2006 11:00:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| "HYDRACARINA" | | | |
| Acarina | 77 | 22 | 9 |
| AMPHIPODA | | | |
| Hyalella azteca | | 4 | 49 |
| BRANCHIOBDELLIDA | | | |
| Branchiobdellida | 3 | | |
| COLEOPTERA | | | |
| Berosus | 2 | | 1 |
| Dubiraphia | 2 | 10 | 18 |
| Ectopria nervosa | 1 | | |
| Helichus lithophilus | | | 1 |
| Hydraena | | 1 | |
| Lutrochus | 2 | | |
| Microcylloepus pusillus | | | 4 |
| Optioservus sandersoni | 16 | 5 | |
| Psephenus herricki | 6 | | |
| Stenelmis | 7 | 1 | |
| DECAPODA | | | |
| Orconectes luteus | -99 | | -99 |
| Orconectes medius | 1 | | |
| Orconectes punctimanus | | | -99 |
| DIPTERA | | | |
| Ablabesmyia | | 6 | 1 |
| Ceratopogoninae | | 3 | |
| Cladotanytarsus | 5 | 12 | |
| Clinocera | 10 | 1 | |
| Corynoneura | | | 3 |
| Cricotopus/Orthocladius | 7 | 3 | 10 |
| Cryptochironomus | | 2 | |
| Dicrotendipes | 2 | 7 | 2 |
| Diptera | | 1 | |
| Eukiefferiella | 4 | | |
| Hemerodromia | 4 | 3 | 2 |
| Hydrobaenus | | 1 | |
| Labrundinia | | | 7 |
| Microtendipes | 1 | 2 | |
| Nilotanypus | 4 | | |
| Orthocladius (Euorthocladius) | 3 | | |
| Parakiefferiella | 4 | 21 | 1 |
| Parametriocnemus | 4 | | |
| Paratanytarsus | | | 16 |
| Paratendipes | | 1 | |
| Phaenopsectra | | | 1 |
| Polypedilum convictum grp | 7 | 2 | 1 |
| Polypedilum illinoense grp | | 1 | 7 |
| Polypedilum scalaenum grp | | 1 | |
| Procladius | | 1 | |
| Prosimulium | 4 | | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0602649], Station #2, Sample Date: 3/28/2006 11:00:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Pseudochironomus | 1 | 4 | 1 |
| Rheocricotopus | 16 | | 6 |
| Rheotanytarsus | 1 | | 7 |
| Simulium | 2 | | |
| Stempellinella | 3 | 15 | |
| Sympotthastia | | | 1 |
| Synorthocladius | | | 1 |
| Tanytarsus | 7 | 28 | 2 |
| Thienemanniella | | | 2 |
| Thienemannimyia grp. | 8 | 7 | 8 |
| Tipula | | | -99 |
| Tvetenia bavarica grp | 2 | | 2 |
| EPHEMEROPTERA | | | |
| Acentrella | 1 | | 1 |
| Baetidae | 1 | | |
| Caenis anceps | 132 | 67 | 32 |
| Caenis latipennis | 140 | 52 | 52 |
| Centroptilum | | | 2 |
| Ephemera | | -99 | |
| Ephemerella | 2 | | 1 |
| Eurylophella bicolor | 13 | 3 | 1 |
| Eurylophella enoensis | | 1 | 28 |
| Heptageniidae | 21 | 4 | 1 |
| Isonychia bicolor | 19 | | 1 |
| Leptophlebia | | | 1 |
| Stenacron | 7 | 4 | |
| Stenonema femoratum | 7 | 9 | 3 |
| Stenonema mediopunctatum | 28 | | |
| Stenonema pulchellum | 20 | | |
| Tricorythodes | 13 | 2 | 3 |
| ISOPODA | | | |
| Caecidotea | | 1 | 1 |
| LIMNOPHILA | | | |
| Lymnaeidae | | 1 | |
| LUMBRICINA | | | |
| Lumbricina | | -99 | |
| MEGALOPTERA | | | |
| Corydalus | 1 | | |
| MESOGASTROPODA | | | |
| Elimia | 4 | 1 | 5 |
| ODONATA | | | |
| Argia | 1 | 1 | |
| Enallagma | | | 4 |
| Gomphus | | -99 | |
| Stylogomphus albistylus | 9 | 1 | 2 |
| PLECOPTERA | | | |
| Acroneuria | 1 | | |
| Amphinemura | 1 | | 4 |
| Leuctridae | 5 | | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0602649], Station #2, Sample Date: 3/28/2006 11:00:00 AM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Perlesta | 6 | | 2 |
| TRICHOPTERA | | | |
| Ceratopsyche | 2 | | |
| Cheumatopsyche | 5 | -99 | 1 |
| Chimarra | 1 | | |
| Helicopsyche | 7 | | |
| Hydroptila | 2 | | |
| Mystacides | | 1 | |
| Nectopsyche | | 1 | |
| Oecetis | | | 1 |
| Polycentropus | | | 2 |
| Pycnopsyche | | | -99 |
| Rhyacophila | 2 | | |
| Triaenodes | | | 2 |
| TRICLADIDA | | | |
| Planariidae | | 1 | |
| TUBIFICIDA | | | |
| Limnodrilus hoffmeisteri | | | 1 |
| Tubificidae | 1 | | |
| VENEROIDEA | | | |
| Corbicula | | 1 | 1 |
| Sphaeriidae | 1 | 4 | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0602650], Station #1, Sample Date: 3/28/2006 1:20:00 PM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| "HYDRACARINA" | | | |
| Acarina | 34 | 2 | 3 |
| AMPHIPODA | | | |
| Gammarus | | 3 | 3 |
| Hyalella azteca | | | 10 |
| Stygobromus | | 3 | |
| BRANCHIOBDELLIDA | | | |
| Branchiobdellida | 3 | | |
| COLEOPTERA | | | |
| Ancyronyx variegatus | | | 1 |
| Berosus | | 1 | |
| Dubiraphia | 12 | 29 | 5 |
| Ectopria nervosa | 1 | 2 | |
| Hydroporus | | 3 | 2 |
| Lutrochus | 1 | 2 | |
| Microcylloepus pusillus | 8 | | |
| Optioservus sandersoni | 3 | 1 | |
| Psephenus herricki | 1 | 1 | |
| Stenelmis | 14 | 4 | |
| DECAPODA | | | |
| Orconectes luteus | 5 | | -99 |
| Orconectes medius | | -99 | -99 |
| Orconectes punctimanus | | -99 | |
| DIPTERA | | | |
| Ablabesmyia | 1 | 7 | |
| Antocha | 2 | | |
| Cardiocladius | 1 | | |
| Ceratopogoninae | | 2 | |
| Cladotanytarsus | | 2 | |
| Clinocera | 14 | 6 | |
| Corynoneura | | 2 | 7 |
| Cricotopus bicinctus | | 1 | 8 |
| Cricotopus/Orthocladius | 18 | 2 | 9 |
| Cryptochironomus | | 2 | 2 |
| Dicrotendipes | | 1 | |
| Diptera | 1 | 6 | |
| Eukiefferiella | 3 | | 1 |
| Gymnometriocnemus | | 1 | |
| Hemerodromia | 16 | 3 | |
| Labrundinia | | | 14 |
| Microtendipes | 2 | 1 | 1 |
| Nanocladius | | 1 | 1 |
| Nilotanypus | 2 | | |
| Orthocladius (Euorthocladius) | | 1 | |
| Parakiefferiella | 4 | 28 | 1 |
| Paramerina | | | 1 |
| Parametriocnemus | 6 | | 1 |
| Paratanytarsus | | 2 | 10 |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0602650], Station #1, Sample Date: 3/28/2006 1:20:00 PM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Paratendipes | | 2 | |
| Phaenopsectra | | 6 | 1 |
| Polypedilum convictum grp | 27 | | 1 |
| Polypedilum illinoense grp | 1 | | 4 |
| Polypedilum scalaenum grp | | 1 | |
| Prosimulium | 8 | | |
| Pseudochironomus | | 2 | |
| Rheocricotopus | 7 | | |
| Rheotanytarsus | 3 | | 8 |
| Simulium | 3 | | 1 |
| Stempellinella | 9 | 14 | 6 |
| Stratiomyidae | | 1 | |
| Tanytarsus | 13 | 18 | 23 |
| Thienemanniella | 3 | | 22 |
| Thienemannimyia grp. | 6 | 5 | 6 |
| Tipula | 1 | -99 | |
| Tribelos | | 7 | |
| Tvetenia | 3 | | |
| EPHEMEROPTERA | | | |
| Acentrella | 1 | | 1 |
| Caenis anceps | 17 | 8 | 4 |
| Caenis latipennis | 78 | 42 | 36 |
| Centroptilum | | | 2 |
| Eurylophella bicolor | 4 | 13 | 4 |
| Eurylophella enoensis | | | 2 |
| Isonychia bicolor | 47 | | |
| Leptophlebia | | | 1 |
| Stenacron | 10 | 11 | 2 |
| Stenonema femoratum | 8 | 9 | 1 |
| Stenonema mediopunctatum | 18 | 1 | |
| Stenonema pulchellum | 18 | 1 | |
| Tricorythodes | 27 | 6 | 1 |
| ISOPODA | | | |
| Caecidotea | 2 | 2 | 7 |
| LIMNOPHILA | | | |
| Helisoma | | | -99 |
| Physella | | | 1 |
| LUMBRICINA | | | |
| Lumbricina | 8 | | |
| MEGALOPTERA | | | |
| Corydalus | -99 | | |
| Nigronia serricornis | | 1 | |
| MESOGASTROPODA | | | |
| Elimia | 1 | | 5 |
| ODONATA | | | |
| Argia | 2 | 2 | |
| Calopteryx | | | -99 |
| Enallagma | | | 5 |
| Gomphidae | | 1 | |

**Aquid Invertebrate Database Bench Sheet Report**
**Mill Ck [0602650], Station #1, Sample Date: 3/28/2006 1:20:00 PM**
**CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

| ORDER: TAXA | CS | NF | RM |
|---|---|---|---|
| Hagenius brevistylus | | -99 | |
| Macromia | | 1 | |
| PLECOPTERA | | | |
| Leuctridae | 1 | 2 | |
| Perlidae | 1 | | 3 |
| TRICHOPTERA | | | |
| Cheumatopsyche | 2 | | 1 |
| Cyrnellus fraternus | | 1 | |
| Helicopsyche | 2 | | |
| Hydropsyche | 1 | | |
| Nectopsyche | 1 | 1 | 1 |
| Neophylax | 1 | | |
| Oecetis | | 2 | |
| Polycentropus | 2 | | |
| Pycnopsyche | | 3 | 3 |
| Rhyacophila | 6 | | |
| Triaenodes | | | 5 |
| TRICLADIDA | | | |
| Planariidae | 1 | | |
| TUBIFICIDA | | | |
| Branchiura sowerbyi | | 1 | |
| Enchytraeidae | | 2 | |
| Limnodrilus hoffmeisteri | | 1 | |
| Tubificidae | | 3 | |
| VENEROIDEA | | | |
| Sphaeriidae | 1 | 2 | |