Groundwater and Surface Water Monitoring Plan
Revision I

Bonney Disposal Pit Area
Homestead Township,
Benzie County, Michigan

April 2009
Project No. G06510

fTC&h
Fishbeck, Thompson, Carr & Huber
engineers • scientists • architects • constructors

fTC&h

GROUNDWATER AND SURFACE WATER MONITORING PLAN REVISION I

BONNEY DISPOSAL PIT AREA

HOMESTEAD TOWNSHIP, BENZIE COUNTY, MICHIGAN

PREPARED FOR:
GRACELAND FRUIT, INC.

APRIL 9, 2009
PROJECT NO. G06510

Fishbeck, Thompson, Carr & Huber, Inc. Engineers • Scientists • Architects • Constructors
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LIST OF ABBREVIATIONS/ACRONYMS

BOD	biochemical oxygen demand
COD	chemical oxygen demand
FTC&H	Fishbeck, Thompson, Carr & Huber, Inc.
GLEAS	Great Lakes and Environmental Assessment Section
MDEQ	Michigan Department of Environmental Quality
NTU	nephelometric turbidity units
RRD	Remediation and Redevelopment Division
Site	Bonney Disposal Pit Area, Homestead Township, Benzie County, Michigan
TOC	total organic carbon

1.0 INTRODUCTION

The proposed monitoring plan describes the locations, sample procedures, and analytical methods that will be used to evaluate groundwater and surface water quality at the Site. This monitoring will be completed to comply with Section 5.1.a of Consent Judgment in Case No. 08-8279-CE, filed on July 18, 2008. The project area is located in Sections 7 and 18 (26N/14W), Homestead Township, Michigan (Figure 1).

This is a revised version of the Groundwater and Surface Water Monitoring Plan prepared by FTC&H dated September 15, 2008, based on comments contained in the March 9, 2009, letter from the MDEQ. The original version was approved with specific modifications, and the MDEQ requested submittal of a revised work plan addressing their requested modifications.

2.0 GROUNDWATER MONITORING

The following wells will be monitored: MDEQ RL-1, MDEQ RL-2, MDEQ RL-3, MW-1R, MW-1DR, MW-2S/-2D, MW-3S/-3D, MW-4S/-MW-4D, MW-5, MW-6S/-6D

The locations of the wells are shown on Figure 1.

Groundwater monitoring will be performed on a quarterly basis in February, May, August, and November, weather and Site access permitting. Some of the monitoring locations present access challenges during winter conditions. Should accessing all monitoring locations present unreasonable obstacles because of weather or snow conditions, primarily during the February event, the MDEQ will be notified and an alternative schedule will be proposed. Any change to the planned quarterly events will be agreed upon in writing. In the interest of obtaining a timely approval of modifications an e-mail agreement will be sufficient.

Any additional permanent monitoring wells installed at the Site will be included into these routine sampling events.

2.1 STATIC WATER LEVEL MEASUREMENT

The static water level will be measured at each monitoring well and selected piezometers prior to sample collection. The measurements will be made to the nearest 0.01 foot using an electronic water level meter.

2.2 SAMPLING METHOD

The monitoring wells will be sampled using a minimal-drawdown (low-flow) sampling procedure in accordance with MDEQ-RRD Operational Memorandum 2, Sampling and Analysis Guidance (October 2004). The wells will be purged using a portable bladder pump. Determination of stabilization will be made through monitoring of the following water chemistry parameters: pH, Eh, specific conductance, dissolved oxygen, and temperature. A turbidity reading will also be collected prior to the sample collection. The MW-6S/-6D well cluster is characterized by artesian flow. These wells will be sampled as soon the stabilization occurs.

Field parameters will be recorded during purging to determine when stabilization has occurred. The groundwater will be considered acceptable for sampling after four of the parameters have stabilized for three successive readings. A copy of the sample documentation form is presented in Appendix 1. The stabilization criteria for each parameter are included on the form.

Samples collected for inorganic constituents will not be filtered. However, if the sample is turbid (>20 NTU), a filtered sample may also be collected using a 0.45-micron disposable filter. The purge water will not be containerized.

2.3 ANALYTICAL METHODS

The collected groundwater samples will be submitted for the following laboratory analyses:

- Alkalinity
- BOD
- COD
- Chloride
- Nitrogen series (ammonia, nitrate, nitrite)
- Phosphorus (total)
- Sulfate
- Total metals (arsenic, calcium, iron, lead, magnesium, manganese, and sodium)
- TOC

The analyses will be performed in accordance with approved test methods and target detection limits as listed in MDEQ-RRD Operational Memorandum 2, Attachment 1 (October 2004).

2.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control procedures will consist of:

- Collection and analysis of 1 duplicate sample for each 10 well samples
- Collection and analysis of 1 matrix spike/matrix spike duplicate for each 20 well samples
- Collection and analysis of an equipment blank to verify decontamination method

3.0 SURFACE WATER MONITORING

3.1 BIOLOGICAL MONITORING

The impacted stream, identified as Creek 1 on Figure 1 and Figure 2, will be monitored using the MDEQ GLEAS, Procedure 51, Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers, Revised May 2002 (Procedure 51), to biologically monitor the impacted stream north of the discharge area. This monitoring will be conducted annually during either July or August. Eight individual locations will be evaluated. These locations will roughly correspond to locations identified as Stations 2, 3, 4, 5, 6, 7, and 8 in the MDEQ Water Division Staff Report, *A Biological and Chemical Survey of An Unnamed Tributary of Platte Lake, Benzie County, February 26, 2003* (MI/DEQ/WD-03/048). A copy of this report is included as Appendix 2. One additional location will be selected for biological monitoring downstream of the confluence of Creek 1 and Creek 2.

All observations made as part of this procedure (raw data) shall be included with the report for this assessment.

3.2 CHEMICAL MONITORING

Semi-annual chemical monitoring of the impacted, unimpacted, and combined streams near US-31 has been ongoing since May 2003. These locations identified as Creek 1, Creek 2, and Combined, therefore, represent monitoring points with a history of several years of accumulated data. The locations used for collection of the Creek 1, Creek 2, and Combined surface water samples are shown on Figure 2. The stream identified as Creek 1 is the impacted stream.

An expanded list of chemical monitoring locations has been requested by the MDEQ. This expanded list includes:

- Three additional samples upstream of the former Creek 1 sample. These locations are identified as Creek 1A, Creek 1B, and Creek 1C. The sampling location of the Creek 1 sample was requested to be relocated to the south side of US-31.
- The Creek 2 sample location was requested to be relocated to the south side of US-31.
- Three additional sampling locations have been requested by the MDEQ downstream of the current Combined sample. These locations are identified as locations Combined A, Combined B, Combined C.

The surface water chemical sampling locations are shown on Figure 3.

Unfiltered stream grab samples will be collected at each location for the analysis of the same list of parameters which the quarterly groundwater samples will be analyzed for as listed in Section 2.3 Analytical Methods. In addition the surface water samples will be analyzed for total suspended solids. Each location will be field monitored for temperature, dissolved oxygen, pH, and specific conductance. One of the surface water sampling locations will be collected and analyzed as a duplicate for quality assurance purposes. Chemical monitoring will be performed in May and November.

The analyses will be performed in accordance with approved test methods and target detection limits as listed in MDEQ-RRD Operational Memorandum 2, Attachment 1 (October 2004).

During each of the semi-annual chemical sampling events, a visual assessment shall be conducted at each of the sampling locations. The visual assessment shall be for bacterial slime, chemical precipitates, and black coatings on the streambed materials. These observations will be recorded on the sample collection forms during each event.

3.3 SURFACE WATER FLOW MONITORING

Routine surface water flow monitoring has also been requested by the MDEQ at six of the surface water chemical monitoring locations. Stream flow will be monitored at all locations along Creek 1 (1A, 1B, 1C, and 1), at the Creek 2 sampling location, and at the Combined location. Stream flow monitoring will not be performed at the Combined A, Combined B, or Combined C locations.

Reference cross sections at each of the flow monitoring locations will be established so that flow measurements are collected at the same locations during each monitoring event. Stream flow will be determined using a USGS Pygmy Meter (Model 6205). The Pygmy Meter Model 6205 is scaled two-fifths as large as the standard Type AA current meter for use in wadeable streams. It does not have a tailfin assembly and is used only for measuring shallow streams with a wading rod. Its range of operation is 0.1 to 4.9 feet per second. The 2-inch-diameter bucket wheel contains six cups; a single contact closure is made each revolution of the bucket wheel. Pygmy measurements shall be based on the USGS *Techniques of Water Resources Investigations, Chapter A8, Book 3* (Buchanan and Somers, 1969). Field notes, raw data, and stream flow calculations will be submitted to the MDEQ.

4.0 REPORTING

The MDEQ has requested periodic updates on the results of the groundwater and surface water monitoring events in addition to the annual report required in Section 6.4.c of the Consent Judgment. FTC&H will supply copies of the field sampling documentation forms, stream flow monitoring, and of the laboratory data within 30 days of each sampling event.

The required annual report provided by November 30 of each year will include a summary of the surface water and groundwater monitoring performed for the year. An updated analytical summary table and groundwater contour map will be prepared as part of the annual groundwater reporting. The table will include present and historical analytical results for each well. The surface water chemical monitoring results will be submitted similarly in a summary table containing both the newly collected data for the reporting year and the historical data for each site. The surface water biological monitoring data will be provided in a summary report. Any significant observations in either the groundwater or surface water data will be discussed in the annual reports along with any proposed modifications to the monitoring plan. Modifications to the approved monitoring plan can only be implemented with specific written agreement from the MDEQ.

fishbeck, thompson, carr & huber, inc.

engineers
scientists
architects
constructors

Hard copy is intended to be 8.5"x11" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

Bonney Pit Area

Homestead Township, Michigan

Groundwater Surface Water Monitoring Plan

0 500 1000

Scale: 1" = 500'

LEGEND

⊗ SURFACE WATER SAMPLING LOCATION

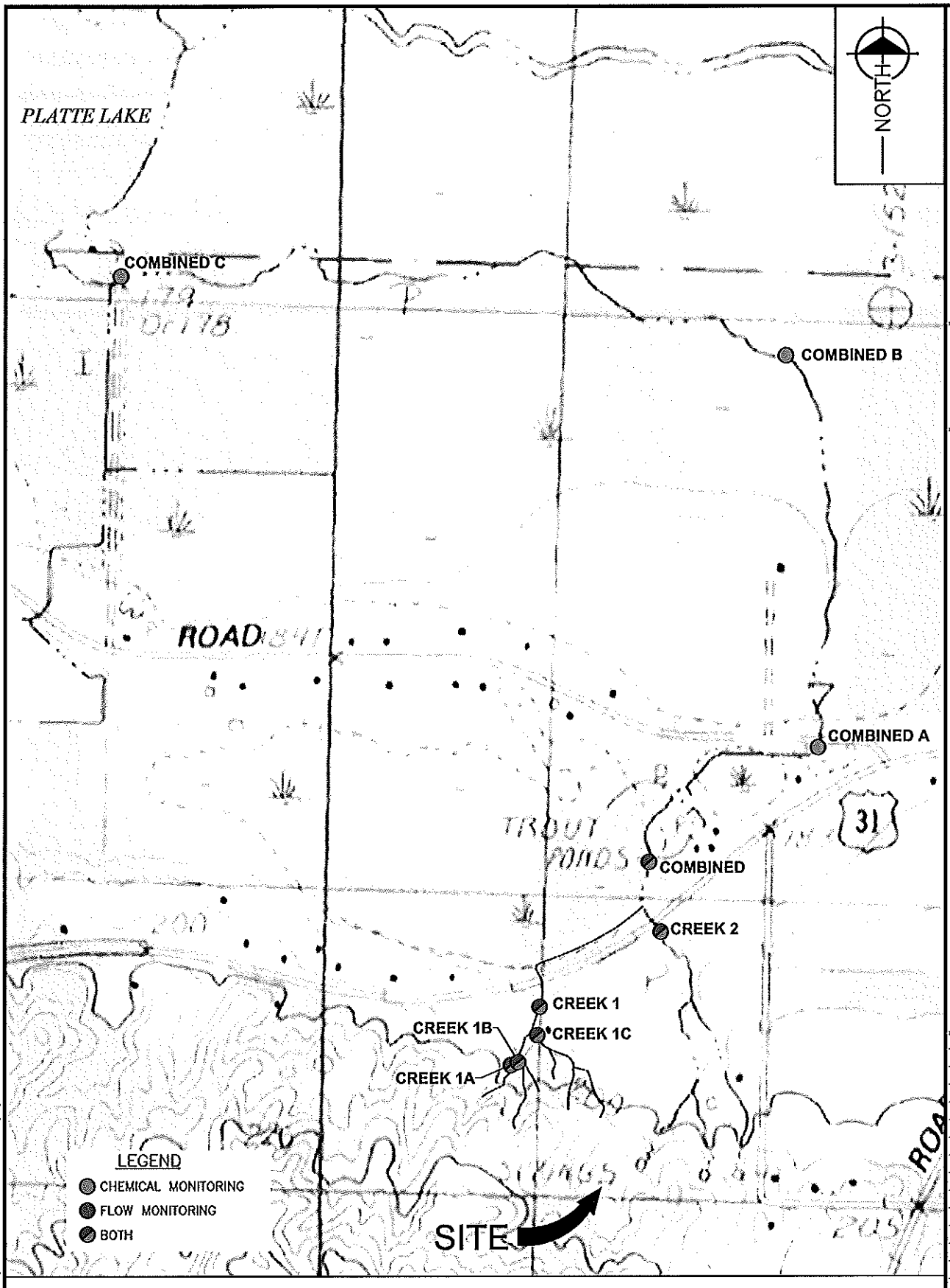
REFERENCE:
BEULAH SE
MICHIGAN CENTER FOR GEOGRAPHIC INFORMATION
PHOTO DATED: 1998

2003 - APRIL 2009 SURFACE WATER SAMPLING LOCATIONS

PROJECT NO.
G06510

FIGURE NO.
2

PLOT INFO: U:\CADD\06510\CD\Z005065510.DWG DATE: 4/7/2009 TIME: 1:58:13 PM USER: ACS



0 800 1600

Scale: 1" = 800'

REFERENCE:
BEULAH QUADRANGLE
7.5 MINUTE SERIES
DATED: 1983

Terrain Navigator Pro v. 6.01,
(c)2003, Maptech Inc.

SURFACE WATER SAMPLING LOCATIONS

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Bonney Pit Area
Homestead Township, Michigan

Groundwater and Surface Water Monitoring Plan

PROJECT NO.
G06510

FIGURE NO.
3

PLOT INFO: U:\CADD\06510\CD\Z01106510.DWG DATE: 4/7/2009 TIME: 1:04:53 PM USER: ACS

Appendix 1

GROUNDWATER SAMPLE COLLECTION FORM - LOW FLOW

CLIENT: _____ MONITORING LOCATION: _____

LOCATION: _____ SAMPLE ID: _____

PROJECT NO: _____ WELL TYPE: _____

EVENT: _____ KEY NO: _____

Weather/Temp.:

INSPECTION

Label on well?	YES / NO / REMEDIED	Is cement pad in good repair?	YES / NO / REMEDIED
Is reference mark visible?	YES / NO / REMEDIED	Is protective casing locked and in good repair?	YES / NO / REMEDIED
Standing water present?	YES / NO / REMEDIED	Is inner cap in place and properly sealing well?	YES / NO / REMEDIED
Indication of surface runoff in well?	YES / NO / REMEDIED	Is well casing in visibly good repair?	YES / NO / REMEDIED

Repair Notes:

STATIC WATER LEVEL DATE: TIME:

Top of Casing Elevation: _____ ft Measured with: Electronic tape / Chalked tape / Other:

Depth to Water: _____ ft Well depth verified? YES / NO

Elevation of Water: ft

WELL PURGING DATE: TIME:

Purge Method: FULTZ / PERISTALTIC / BLADDER / OTHER: Pump intake @ _____ ft (from TOC)

Equipment No.: _____

Measured well depth: Screen length: Depth to screen midpoint:

Time	Water Level (feet)	Drawdown (feet)	Pumping Rate (mL/min)	pH (S.U.)	Temp (°C)	Spec Cond (umhos/cm)	Turbidity (NTU)	Eh (mV)	D.O. (mg/L)
Volume:	(Gallons)		Stabilization Criteria:	±0.1	±3%	±3%	±10% for values >20	±10 mV	±10%

FIELD ANALYSES DATE: TIME:

Temperature: _____ °C

pH: _____ S.U.

Specific Conductance: _____ µmho/cm

Eh: _____ mV

Dissolved Oxygen: _____ mg/L

Turbidity: _____ NTU

Carbon Dioxide _____ mg/L

Sulfide mg/L

	CALIBRATION CHECK		Check if
	Standard	Reading	Recalibrated
pH:			
Specific Cond.:			
Eh:			
Dissolved Oxygen:			

SAMPLE COLLECTION DATE: TIME:

Sample appearance: _____ Duplicate sample collected? YES / NO

Collection method: FULTZ / PERISTALTIC / BLADDER / OTHER: MS/MSD sample collected? YES / NO

Equipment No.: Chain of Custody Number:

Filter used: 0.45 µm (8100) / 0.45 µm (8200) / NONE

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	125 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

SAMPLING PERSONNEL

Name (SIGNATURE): Name (SIGNATURE):

SURFACE WATER SAMPLE COLLECTION FORM

CLIENT: _____ MONITORING LOCATION: _____

LOCATION: _____ SAMPLE ID: _____

PROJECT #: _____ SAMPLE TYPE: _____

EVENT: _____

Weather/Temp.:

INSPECTION **DATE:** **TIME:**

Appearance of water: _____

Comments: _____

FIELD ANALYSES **DATE:** **TIME:**

Temperature: _____ °C

pH: _____ S.U.

Specific Conductance: _____ µmho/cm

Eh: _____ mV

Dissolved O_2: _____ mg/L

Turbidity _____ NTU

Carbon Dioxide _____ mg/L

Sulfide mg/L

CALIBRATION CHECK		Check if
Standard	Reading	Recalibrated
pH			
Spec Cond.			
Eh			
Dissolved O_2			

SAMPLE COLLECTION **DATE:** **TIME:**

Sample appearance: _____

Collection method: _____

Equipment #: _____

Filter used: 0.45 µm (8100) / 0.45 µm (8200) / NONE

Duplicate sample collected? YES / NO

MS/MSD sample collected? YES / NO

Chain of Custody Number:

Quantity	Size	Type	Filtered	Preservative	Parameters
	40 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	125 mL	Plastic	Yes No	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Plastic	NO	None HCl HNO_3 H_2SO_4 NaOH	
	250 mL	Glass	NO	None HCl HNO_3 H_2SO_4 NaOH	
	500 mL	Plastic	NO	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Glass	NO	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Plastic	NO	None HCl HNO_3 H_2SO_4 NaOH	
	1000 mL	Glass	Yes No	None HCl HNO_3 H_2SO_4 NaOH	

SAMPLING PERSONNEL

Name (SIGNATURE): Name (SIGNATURE):

Stream Flow Measurement Data Collection Form

Site: _____

Project Name: _____

Project Number: _____

Date: _____

Time: _____

Weather Conditions: _____

Stream Width (m): _____

Recorders: _____

Instrument ID: _____

Flow Measurements				
Section	Tape measurement (ft)	Actual measurement (ft)	Stream depth (in)	Velocity (ft/s)
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Notes:

Appendix 2

MI/DEQ/WD-03/048

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER DIVISION
MAY 2003

STAFF REPORT

A BIOLOGICAL AND CHEMICAL SURVEY OF AN UNNAMED TRIBUTARY OF PLATTE LAKE
BENZIE COUNTY
FEBRUARY 26, 2003

INTRODUCTION

In response to a water quality complaint filed with the Cadillac District Office of the Michigan Department of Environmental Quality (MDEQ), staff from the Surface Water Quality Assessment Section (SWQAS) and the Cadillac District Office conducted a chemical and qualitative biological survey of an unnamed tributary stream of Platte Lake, in Benzie County. The complaint noted strong odors from the western portion of the stream and a change in the color of the stream appearance. The stream headwaters consist of an east and west branch that arise from groundwater springs erupting from the northern sides of a high moraine ridge. These two branches converge just downstream of US 31. The east branch is formed from springs that appear on the more eastern end on the moraine ridge while the west branch is formed from several springs that erupt farther to the west on the moraine ridge. The west half of the stream, being comprised of the main spring fed channel and three spring fed, side tributaries which converge to form the west branch, was the portion of the stream system that was noted in the complaint.

The biological survey was conducted according to SWQAS Procedure 51 (P-51, available upon request). Water samples were collected, preserved as required, and transported to the MDEQ Environmental Laboratory, or to a local wastewater treatment plant for the biochemical oxygen demand (BOD) samples, for analyses. The survey objectives were to: evaluate and document the existing fish and macroinvertebrate communities along with the habitat conditions; generate selected water chemistry data for the system; and determine if the requirements of the Michigan Water Quality Standards were being met. The first site visit, on February 21, 2003, was for a preliminary site reconnaissance and collection of BOD samples. The February 26, 2003 site visit was conducted to more fully assess the instream habitat and the biological community structure and to collect additional water chemistry samples. A companion report, MI/DEQ/SWQ-03/053, contains a discussion of the data and modeling related to BOD and carbonaceous (hereafter called organic) wastes. P-51 is typically conducted between June and September. Winter sampling may miss the presence of some insect taxa as they may be present in egg or small instar forms and comparisons to summer time community-based scoring metrics may be less accurate. However, the macroinvertebrate community sampling conducted in this survey was very appropriate for comparisons between stations on the two stream branches.

The unnamed tributary evaluated in this survey is a designated coldwater stream in the North Central Hardwood Forest (NCHF) ecoregion. The stream flows into the southeast corner of Platte Lake.

SUMMARY

1 The locations of the 13 sampling stations are shown in Figure 1. The fish community data for one station are presented in Tables 1A and 1B. The macroinvertebrate community data are presented in Tables 2A, 2B (east branch) and 3A, 3B (west branch). The analytical results for the water samples collected on February 21 and 26, 2003 are presented in Table 4. The type of sampling effort by station is summarized in Table 5.

2. Overall, the survey results indicate that the east branch of the unnamed stream supports a coldwater fishery (brook trout), it contains an acceptable macroinvertebrate community, it has high quality water, and is meeting the applicable requirements of the Michigan Water Quality Standards (WQS). The survey results also indicate that the west branch of the unnamed stream is severely degraded and is not meeting the applicable requirements of the WQS. The west branch exhibited an impaired macroinvertebrate community, very degraded instream habitat conditions, dramatically altered water quality characteristics, and it contained bacterial slime growths. Based on analytical results and field observations, groundwater venting through the springs that formed the west branch of the unnamed stream contained high concentrations of organic matter, metals, and nutrients. The effects from the discharge of the contaminated groundwater were estimated to extend for at least 1,400' downstream from the primary groundwater spring site at the head of the west branch.

3 To determine whether the unnamed tributary system was supporting a coldwater fishery, at least where water quality was not sharply degraded, a short segment of the east branch of the unnamed tributary was sampled using electrofishing equipment. The fish community data (Tables 1A, 1B) indicated that the east branch of the unnamed tributary has high quality water and is supporting its coldwater designation with good numbers of brook trout being collected. The presence of a fish community comprised of only one or two species is not uncommon in the headwater reaches of coldwater streams. The majority of the brook trout captured in the east branch were approximately 3" long which suggests that these headwater areas serve an important function as a nursery, and possible spawning, area for the system. Absent the degraded water quality conditions currently existing in the west branch, one would expect a similar brook trout community in that stream segment. The complainant stated that brook trout also had been present in the west branch prior to it being degraded.

4. The macroinvertebrate community at the two east branch stations (Tables 2A and 2B) was rated acceptable. Station 2 (community score of +3) rated in the upper end of the acceptable score range (-4 to +4) with 15 taxa being found. One mayfly, six caddisfly, and one stonefly taxa were present. The community composition and the rating indicates the presence of high quality water in this headwater segment. The presence of stoneflies, along with some families of mayflies and caddisflies, is typically associated with high quality water. Scuds were the dominant organism which is not uncommon in some small coldwater locations having stable sand as a large component of the substrate. Downstream at Station 3, the community contained 11 taxa and rated acceptable with a score (-4) at the low end of the acceptable range. The lower score reflected that scuds were more dominant at Station 3, mayfly or stonefly specimens not were found, and low numbers of snails and isopoda were present. The majority of the difference between the community scores for Stations 2 and 3 is most likely due to the differences in habitat characteristics between the two stations (see # 6 below). According to the P-51 protocol, the abundance numbers assigned to the taxa at these two stations were estimated relative to summing at or close to a 100 specimen sample

size. The macroinvertebrate communities were abundant enough to easily allow the collection of at least 100 specimens from the substrates at these two stations.

5. The macroinvertebrate community in the west branch (Tables 3A and 3B) was sharply degraded from that observed in the east branch. The macroinvertebrate community was rated poor (Stations 5, 7, and 8; scores -8, -5, and -5, respectively) at three of the four west branch stations while Station 6 (score -3) was rated acceptable. A poor rating indicates that the stream is not meeting the applicable requirements of the WQS. The total number of specimens noted in Table 3A represent the actual number of organisms observed in the samples from each west branch station. The P-51 macroinvertebrate sampling directions recommend that at least 100 organisms be collected per station. Although Station 6 was rated acceptable based on the total score for the P-51 macroinvertebrate community metrics, the community was clearly impaired if one also considered its depressed macroinvertebrate density; a total of only 66 organisms were found in the samples from Station 6.

   The west branch macroinvertebrate community at all four stations showed a dramatic shift in the type and abundance of the taxa present. All west branch stations had sharply reduced numbers of taxa, no stonefly or mayfly taxa were found at any of the four stations, and caddisflies were only marginally present at only two of the four stations. Only 2 individuals of one caddisfly family were found among all four stations. The family Chironomidae (midges), which includes a number of species that can tolerate more degraded conditions than many other insect taxa, were the dominant taxon at all four west branch stations. West branch Station 5 (only 5 taxa, no caddisflies, more tolerant taxa) was within 100' of east branch Station 3 and one would expect that the two stations should support similar communities. Station 6 had even fewer taxa and was 80% midges. At Station 7, the only west branch station where the 100 organism target was met, the community was 97% midges. Loss of diversity and sensitive species and dominance by one or two tolerant species is a response commonly observed in macroinvertebrate communities subjected to stress (such as pollution). At Station 8, a total of only 21 organisms were found in the samples from what should have been a productive riffle area. The poor quality macroinvertebrate communities observed in the west branch reflect at least the severely degraded habitat conditions present in that branch (see #7 below) and also may reflect effects from degraded water quality.

6. Procedure 51 (P-51) includes the assessment of a stream's overall habitat quality through the evaluation and scoring of 10 individual metrics that describe specific instream and riparian characteristics. Habitat metric data are not tabulated and included in this report as overall P-51 habitat score comparisons between the east and west branches are inappropriate given the nature of the adverse instream habitat effects observed in the west branch. Consequently, specific instream habitat features are discussed in items # 6 and #7 below rather than simply presenting a total habitat score and rating.

   Based on best professional judgment, instream habitat in the east branch was estimated to be high fair to low good quality at Station 2. Instream habitat included fair amounts of embedded gravel, limited amounts of cobble and large woody debris (LWD), and some cress and Cladophora were present in the small channel (approximately 3' wide, 1.5" deep) that was primarily a firm sand bottom where it flowed near a farmhouse. The hard substrate allowed colonization by a number of different taxa. Station 3, just downstream of US31 and largely in the highway right-of-way, was different from Station 2 in that it essentially lacked the gravel/cobble substrate and instream vegetation and it had very little LWD. The channel bottom was dominated by firm sand. Cover was

largely limited to undercut banks, roots and a few overhanging dried grasses, and a few sticks and one small log. Although the lack of instream hard substrate at this station limited its colonization potential, 11 taxa were present including five caddisfly taxa. The east branch instream habitat and hard substrates were free from silt or other coatings which would limit colonization by macroinvertebrates.

7 Instream habitat in the west branch was very suitable to support a diverse and acceptable to excellent macroinvertebrate community had it not been degraded by a moderate to heavy layer of a slippery orange precipitate coating on the hard substrate and leaf packs at Stations 6, 7, and 8. Fair to good amounts of gravel, cobble, some undercuts, and some limited LWD were present in portions of the west branch and the gravel/cobble was not excessively embedded in the riffle and fast water stretches. Much of the west branch upstream of US 31 was high gradient, and absent the orange coating, would provide better quality instream habitat conditions than in the east branch. While the west branch had larger quantities of hard substrate (primarily gravel/cobble) than the east branch, the west branch substrates were not available for colonization due to the accumulations of the orange coating. A silt or soft precipitate coating reduces or prevents the utilization of that substrate by preventing the growth of an algal food layer and it severely limits the potential for macroinvertebrate colonization by impeding attachment to the substrate. These unstable, fine coatings also can impede the respiration of many organisms by physically obstructing respiratory structures. Additionally, much of the west branch cobble was black on the bottom surface which suggested that reducing (typically anaerobic) conditions were present under the hard substrates.

The orange coating appeared to be primarily an iron precipitate which was similar in appearance to what is sometimes observed in small, very localized bank or instream areas near groundwater seeps that contain elevated levels of iron. The author has observed similar precipitates where acid mine drainages containing high iron concentrations flowed into oxygenated river waters. The west branch hard substrates had orange precipitate coatings starting from the primary spring source at Station 10 all the way downstream to US 31. Station 8 was located in a wider area of the main flow channel of the west branch where there was a riffle with abundant gravel. The gravel/cobble in this area, and upstream, had the heaviest coatings of the orange precipitate and the samples from this area yielded the lowest total number of organisms. Station 13 was in a side tributary that did not appear to be receiving the same loadings of iron and the substrate visible (most of the channel was iced over) did not show the precipitate coating. The side tributary where Station 11 was located had some areas with a noticeable orange precipitate on some of the embedded gravel but the coating was not as heavy or extensive as in the main west branch channel. The side tributary where Station 12 was located did not exhibit noticeable amounts of the precipitates. This tributary was just east of the main channel and was formed from a broader flow through a wide, cress filled area that eventually coalesced to form a defined channel close to its confluence with the main west branch channel.

Slime bacterial growths were noted near and upstream of Station 11 in one of the side tributaries that form the west branch. Growths of slime bacteria were also noted up to 375' downstream of the confluence of the east and west branches of this unnamed stream. The presence of slime growths reflects the longer term presence of excessive organic carbon loadings to a waterbody and indicates that the water quality does not meet the applicable requirement of the WQS. Slime bacteria growths were not observed in areas that had heavy accumulations of the orange precipitate. Degraded habitat and water quality conditions, as indicated by the presence of orange precipitates

or bacterial slime growths were estimated to extend downstream from Station 10 for at least 1,400 feet along the main west branch channel and into the combined stream channel below the east and west branch confluence.

Abundant leaf packs were also present in the west branch where the leaf litter was trapped by cobble or other substrate features. Leaf litter inputs are a major energy source for headwater and mid-reach segments of streams. However, unlike in the east branch, the leaf packs in the west branch were not being processed (i.e. eaten) which indicates a severe suppression of the bacterial and macroinvertebrate community assemblages that typically utilize this energy source. The leaf packs were thick, but coated by the orange precipitate, and were anaerobic (black) just a few leaves deep into the leaf packs. These leaf pack observations, considered with the observed precipitate and anaerobic conditions (as well as potential water quality issues), strongly suggest there is an inhibition of normal stream function processes in the west branch. Although some probable leaf processing insect larvae (Tipulidae) were found at Station 6 in a small cobble riffle area, very few of the leaves observed there showed typical signs of biological processing; only small portions of a few leaf margins indicated any utilization of this resource.

Station 5 was the most downstream station in the west branch. The west branch downstream of US 31 had been recently dredged for most of the distance between the road and the confluence with the east branch. Station 5 was located in the undredged reach below the dredged segment and upstream of the confluence with the east branch. Habitat conditions at this location should have been similar to those at Station 3. Station 5 had numerous vegetation (tall grasses) stems in the current which should have provided a substrate feature suitable to some macroinvertebrates. However, all the stems were surrounded by a thick gelatinous layer that rendered the stem masses unsuitable for most macroinvertebrates. It was not clear if the gelatinous material on the stems was related to the slime growths noted upstream or was the result of other processes or bacterial growths. The orange precipitate was not obvious at Station 5 and may have settled out of the water column in the ice covered, wide, deep, and slow dredged area upstream of Station 5. The channel bottom at Station 5 also was covered with several inches of a soft mass of unprocessed leaves, some silts, and some undefined organic matter which may have been related to the previously mentioned gelatinous coating on the grass stems.

8. The water chemistry and physical measurement data are presented in Table 4. The water was too shallow for physical measurements at Stations 10 and 12 and measurements were not made at Station 3. The data for Station 1 are representative of background groundwater conditions for that area and reflect high quality water characteristics. At Station 1, COD (chemical oxygen demand) was less that 5 mg/l, the TOC (total organic carbon) concentration was low at 1.3 mg/l, and iron was present at 85 ug/l. Comparing the data for Stations 4 – 10, there is a downstream to upstream pattern of increasing concentrations for alkalinity, hardness, manganese, iron, COD, and TOC, and total phosphorus (TP). Conductivity, an indirect measure of the amount of dissolved solids, also increased going upstream in the west branch which also exhibited lower pH measurements than in the east branch. The west branch COD, TOC, and iron concentrations peak at 220 mg/l, 74 mg/l and 18,000 ug/l, respectfully, in the most upstream sample (Station 10) at the spring area which is the main flow source of the west branch. This iron concentration is over 200 times greater than what was present at Station 1. The iron concentration data support the field observation that the orange coating which makes the substrate unavailable is an iron precipitate. These data strongly point to the conclusion that the source springs, and the associated

groundwater flows, are very contaminated. It is known from other sites of groundwater contamination that organic contamination of a groundwater aquifer can cause reducing conditions which result in the leaching and mobilization of metals from the soil column. This is a likely basis for at least some of the high metals concentrations observed in the west branch water samples.

The analytical results also indicate that the three other side tributaries that help form the west branch are also affected by the contaminated groundwater flows, although not as severely in some respects as in the main channel which is fed by the spring at Station 10. Indications of contamination by various constituents vary between the side tributaries which suggests that they are influenced by different portions of the groundwater plume. Compared to Station 1, Stations 11, 12, and 13 have increased concentrations of the same constituents discussed above for Stations 5-10. Barium is also elevated at Station 11, Station 12 had the highest BOD and TP concentrations of the side tributaries, and TP was also elevated at Station 13.

The initial BOD sample results indicated that west branch stations 5-12 had high BOD concentrations that were greater than could be handled by standard analyses. The Station 5-12 samples were rerun for BOD analyses using additional dilutions after it became apparent that they were high concentration samples. The fact that the samples were archived past the normal sample holding time may mean that there is some inaccuracy in the values from the re-analyses due to uncertainty of how the extra holding time may have affected some of the higher strength samples. This may explain some of the variations seen in the BOD results for Stations 10, 11, and 12. However, the BOD rerun results clearly indicate that BOD is higher in the upstream reaches and that the groundwaters are discharging a high BOD load to the west branch of the unnamed tributary. Although the physical measurements did not indicate a dissolved oxygen problem in the water column at the time of the February sampling, the substantial BOD loading could cause problems with downstream dissolved oxygen concentrations during the warmer times of the year. The BOD concentration in the combined flow (Station 4) of the two stream branches was above that of the east branch at Station 1. The Station 13 side tributary does not appear to be receiving a high BOD load although COD and other analytes were elevated in the sample.

REFERENCES

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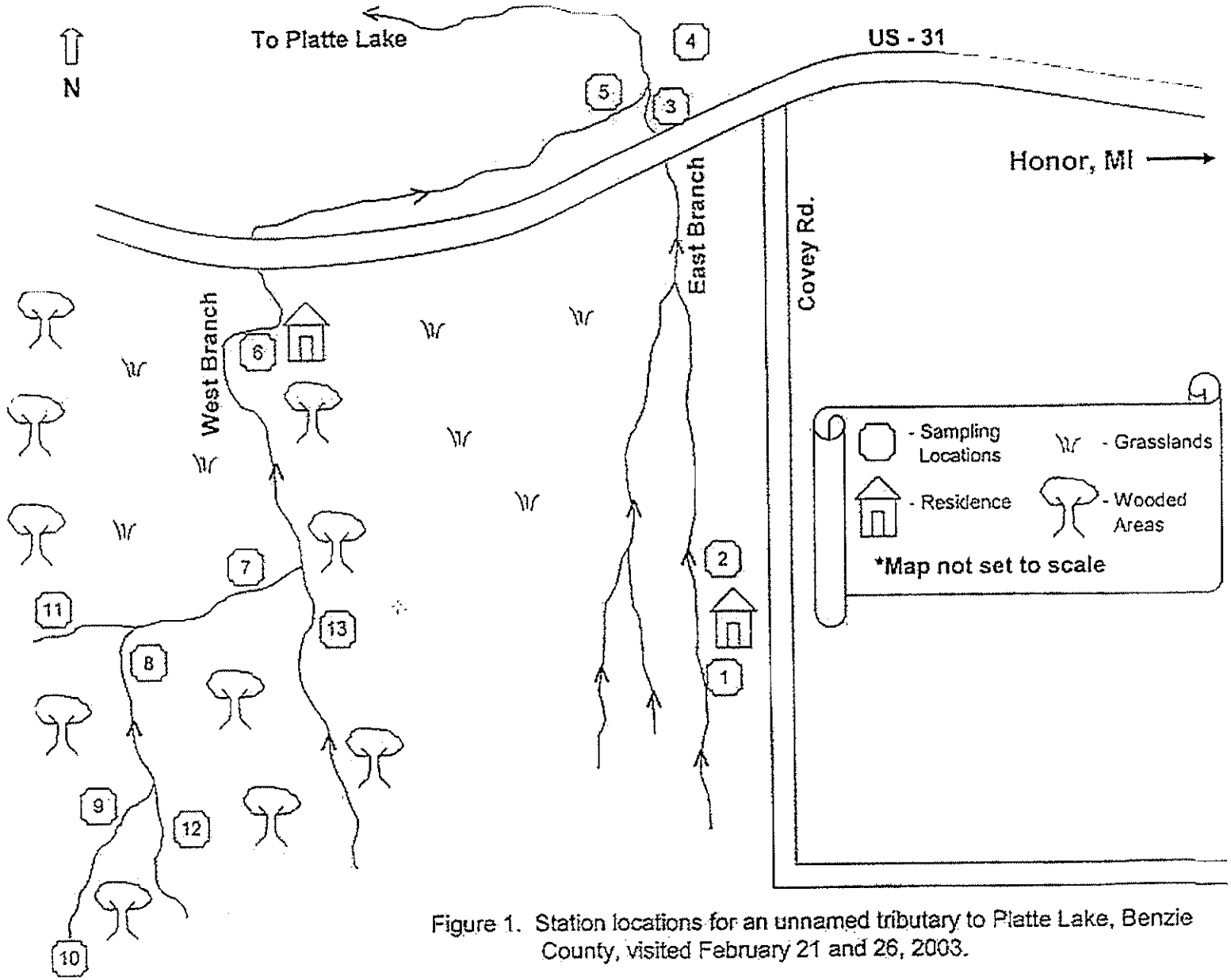

Figure 1. Station locations for an unnamed tributary to Platte Lake, Benzie County, visited February 21 and 26, 2003.

Table 1A. Qualitative fish sampling results for an unnamed tributary of Platte Lake, Benzie County, on February 26, 2003.

TAXA	Unnamed Ck - East Branch u/s US-31 2/26/2003 STATION 2
Salmonidae (trouts)	
Salvelinus fontinalis (Brook trout)	
TOTAL INDIVIDUALS	17
Number of hybrid sunfish	0
Number of anomalies	0
Percent anomalies	0.000
Percent salmonids	100.000
Reach sampled (ft)	75
Area sampled (sq ft)	225
Density (# fish/sq ft)	0.076
Gear	bps

Table 1B. Fish metric evaluation of an unnamed tributary of Platte Lake, Benzie County, on February 26, 2003.

METRIC	Unnamed Ck - East Branch u/s US-31 2/26/2003 STATION 2 Value
TOTAL NUMBER OF TAXA	1
NO. OF DARTER, SCULPIN, MADTOM T	0
NUMBER OF SUNFISH TAXA	0
NUMBER OF SUCKER TAXA	0
NUMBER OF INTOLERANT TAXA	1
PERCENT TOLERANT	0.00
PERCENT OMNIVOROUS TAXA	0.00
PERCENT INSECTIVOROUS TAXA	0.00
PERCENT PISCIVOROUS TAXA	0.00
% SIMPLE LITHOPHILIC SPAWNER TA	0.00
SUPPORTS COLDWATER DESIGNATION	YES

Table 2A. Qualitative macroinvertebrate sampling results for an unnamed tributary to Platte Lake, Benzie County, on February 26, 2003.

TAXA	East Branch u/s US-31 2/26/2003 STATION 2	East Branch d/s US-31 2/26/2003 STATION 3
ANNELIDA (segmented worms)		
Oligochaeta (worms)	1	
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	35	50
Isopoda (sowbugs)		1
Arachnoidea		
Hydracarina	1	
Insecta		
Ephemeroptera (mayflies)		
Baetidae	8	
Plecoptera (stoneflies)		
Perlodidae	5	
Trichoptera (caddisflies)		
Brachycentridae	15	
Glossosomatidae	6	
Hydropsychidae		7
Lepidostomatidae	3	
Limnephilidae	3	5
Philopotamidae	6	
Phryganeidae		1
Rhyacophilidae		1
Uenoidae	3	3
Diptera (flies)		
Chironomidae	8	13
Ptychopteridae		3
Simuliidae	2	
Tipulidae	4	6
MOLLUSCA		
Gastropoda (snails)		
Physidae	1	2
TOTAL INDIVIDUALS	101	92

Table 2B. Macroinvertebrate metric evaluation of an unnamed tributary to Platte Lake, Benzie County, on February 26, 2003.

METRIC	East Branch u/s US-31 2/26/2003 STATION 2 Value	Score	East Branch d/s US-31 2/26/2003 STATION 3 Value	Score
TOTAL NUMBER OF TAXA	15	1	11	1
NUMBER OF MAYFLY TAXA	1	0	0	-1
NUMBER OF CADDISFLY TAXA	6	1	5	1
NUMBER OF STONEFLY TAXA	1	0	0	-1
PERCENT MAYFLY COMP.	7.92	-1	0.00	-1
PERCENT CADDISFLY COMP.	35.64	0	18.48	0
PERCENT CONTR. DOM. TAXON	34.65	0	54.35	-1
PERCENT ISOPOD, SNAIL, LEECH	0.99	1	3.26	-1
PERCENT SURF. AIR BREATHERS	0.00	1	3.26	-1
TOTAL SCORE				-4
MACROINV. COMMUNITY RATING		ACCEPT.		ACCEPT.

Table 3A. Qualitative macroinvertebrate sampling results for an unnamed tributary to Platte Lake, Benzie County, on February 26, 2003.

TAXA	West Branch d/s US-31 2/26/2003 STATION 5	West Branch u/s US-31 2/26/2003 STATION 6	West Branch u/s US-31 2/20/2003 STATION 7	West Branch u/s US-31 2/26/2003 STATION 8
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	17	1	3	
Isopoda (sowbugs)	7			
Insecta				
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	1			
Trichoptera (caddisflies)				
Limnephilidae		1		1
Coleoptera (beetles)				
Dytiscidae (total)	2			
Diptera (flies)				
Chironomidae	33	53	114	19
Stratiomyidae			1	
Tipulidae		11		1
TOTAL INDIVIDUALS	60	66	118	21

Table 2B. Macroinvertebrate metric evaluation of an unnamed tributary to Platte Lake, Benzie County, on February 26, 2003.

METRIC	West Branch d/s US-31 2/26/2003 STATION 5 Value	Score	West Branch u/s US-31 2/26/2003 STATION 6 Value	Score	West Branch u/s US-31 2/20/2003 STATION 7 Value	Score	West Branch u/s US-31 2/26/2003 STATION 8 Value	Score
TOTAL NUMBER OF TAXA	5	0	4	0	3	-1	3	-1
NUMBER OF MAYFLY TAXA	0	-1	0	-1	0	-1	0	-1
NUMBER OF CADDISFLY TAXA	0	-1	1	0	0	-1	1	-1
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMP.	0.00	-1	0.00	-1	0.00	-1	0.00	-1
PERCENT CADDISFLY COMP.	0.00	-1	1.52	-1	0.00	-1	4.76	-1
PERCENT CONTR. DOM. TAXON	55.00	-1	80.30	-1	96.61	-1	90.48	-1
PERCENT ISOPOD, SNAIL, LEECH	11.67	-1	0.00	1	0.00	1	0.00	1
PERCENT SURF. AIR BREATHERS	3.33	-1	0.00	1	0.85	1	0.00	1
TOTAL SCORE		-8		-3		-5		-5
MACROINV. COMMUNITY RATING	POOR		ACCEPT.		POOR		POOR	

Table 4 Analytical results for samples collected from an unnamed tributary to Platte Lake, Benzie County, on February 21 and 26, 2003. Metal values [illegible]

Analyte	Units	Site 1	Site 2	Site 4	Site 5	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13
Alkalinity	mg/L	186		251	313		418	448	486	310	374	292
Hardness	mg/L	211		265	311		437	476	532	310	369	224
Calcium	mg/L	53.6		69.6	83.4		130	145	168	70.9	92	56.9
Magnesium	mg/L	[illegible]		22.2	[illegible]		27.2	[illegible]	[illegible]	32.2	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Potassium	mg/L	0.7		0.8	0.8		1.1	1	1	0.6	1.8	0.9
Sodium	mg/L	2.5		3.0	3.1		3.1	1.9	2.3	1.6	5.3	2.7
Aluminum	ug/L	<50		53	59		114	303	174	<50	941	601
Arsenic	ug/L	<1		<1	1.1		2	3	4.7	[illegible]	<1	<1
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chromium	ug/L	<1		<1	<1		<1	1.5	<1	<1	2	1.6
Cobalt	ug/L	<15		<15	<15		<15	<15	<15	<15	<15	<15
Copper	ug/L	<1		<1	<1		<1	1.2	<1	<1	4.4	1.8
Lead	ug/L	<1		<1	<1		<1	<1	<1	<1	1.2	1.1
Manganese	ug/L	[illegible]		220	420		[illegible]	[illegible]	[illegible]	[illegible]	12	42
Molybdenum	ug/L	<25		<25	<25		<25	<25	<25	<25	<25	<25
Silver	ug/L	<0.5		<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc	ug/L	<10		<10	<10		<10	<10	<10	<10	<10	10
Iron	ug/L	85		1,000	2,000		6,900	10,000	18,000	1,600	730	720
Lithium	ug/L	<8		<8	<8		<8	<8	<8	<8	<8	<8
Conductance	umho/cm	422	NM	462	[illegible]	[illegible]	760	632	[illegible] (lab)	550	[illegible] (lab)	729
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ammonia N	mg/L	<0.01		<0.01	<0.01		0.01	0.02	0.02	<0.01	<0.01	<0.01
Nitrite & Nirtrate N	mg/L	1.09		0.97	0.89		1.04	0.77	0.87	0.32	2.6	1.21
Total Phosphorus	mg/L	<0.010		0.01	0.01		0.02	0.03	0.03	<0.010	0.07	0.06
COD	mg/L	<5		42	79		140	220	220	140	17	40
[illegible]	mg/L	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD rerun results	mg/L	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

conductance - field data unless noted otherwise

NM - not measured

NR - not rerun

Table 5. Summary of sampling and data collection per station during the February 21 and 26, 2003 site visits to an unnamed tributary of Platte Lake, Benzie County. Water chemistry samples were not collected at Stations 2, 3, 6, and 7.

Station	B	W	M	H	P	F
1		X		X	X	
2			X	X		X
3	X		X	X		
4	X	X		X	X	
5	X	X	X	X	X	
6			X	X		
7	X		X	X	X	
8	X	X	X	X	X	
9	X	X		X	X	
10	X	X		X		
11	X	X		X	X	
12	X	X		X		
13	X	X		X	X	

B - BOD sample
W - Water chemistry sample
M - Macroinvertebrate sample
H - Habitat metric notes or general observations
P - Physical measurements (temperature, pH, etc)
F - Fish sample