APPENDIX A

Musquapsink Brook Watershed Restoration and Protection Plan Data Report

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

Musquapsink Brook Watershed Restoration and Protection Plan:
DATA REPORT

Developed by the Rutgers Cooperative Extension Water Resources Program

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RP 07–002

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This document has been produced by the Rutgers Cooperative Extension (RCE) Water Resources Program (more information at www.water.rutgers.edu). Data collection was carried out by staff from the RCE Water Resources Program and project partners including the Bergen County Health Department, the Bergen County Utilities Authority, and Marion McClary, Jr., Ph.D. of Fairleigh Dickinson University.

Table of Contents

List of Figures

List of Tables

Watershed Overview

The Musquapsink Brook Watershed, located above U.S. Geological Survey (USGS) streamflow gauge #01377499 at River Vale, is approximately nine square miles in size and is dominated by urban land uses (Figure 1). The New Jersey Department of Environmental Protection (NJDEP) 2002 land use data identifies the urban land uses as primarily consisting of residential (medium and low density), commercial, and roadways (Figure 2). The remainder of the land use consists of forest, wetlands, water bodies, agriculture, and barren land (NJDEP, 2007).

The Musquapsink Brook Watershed encompasses part of Woodcliff Lake Borough, Saddle River Borough, Hillsdale Borough, Washington Township, Westwood Borough, Emerson Borough, Paramus Borough, and Oradell Borough (Figure 3). The Musquapsink Brook is approximately 6.6 river miles from the headwaters to its confluence with the Pascack Brook. The largest surface water body in the drainage area is Schlegel Lake, which encompasses 26.5 acres.

Under certain conditions, United Water of New Jersey (UWNJ) diverts water from the Saddle River to the Oradell Reservoir through the Musquapsink Brook. UWNJ records show that during the period between June 1, 2007 and December 31, 2007 a total of 551 million gallons of river water was transferred.

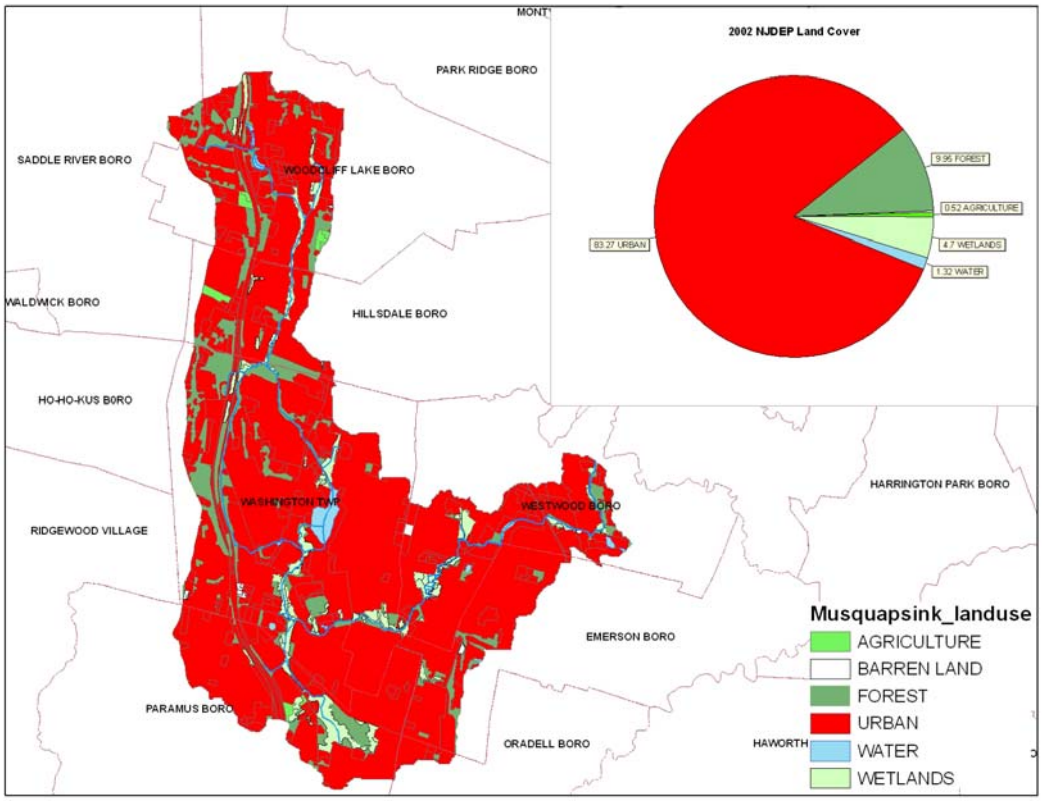

Figure 1: Land use/ land cover map

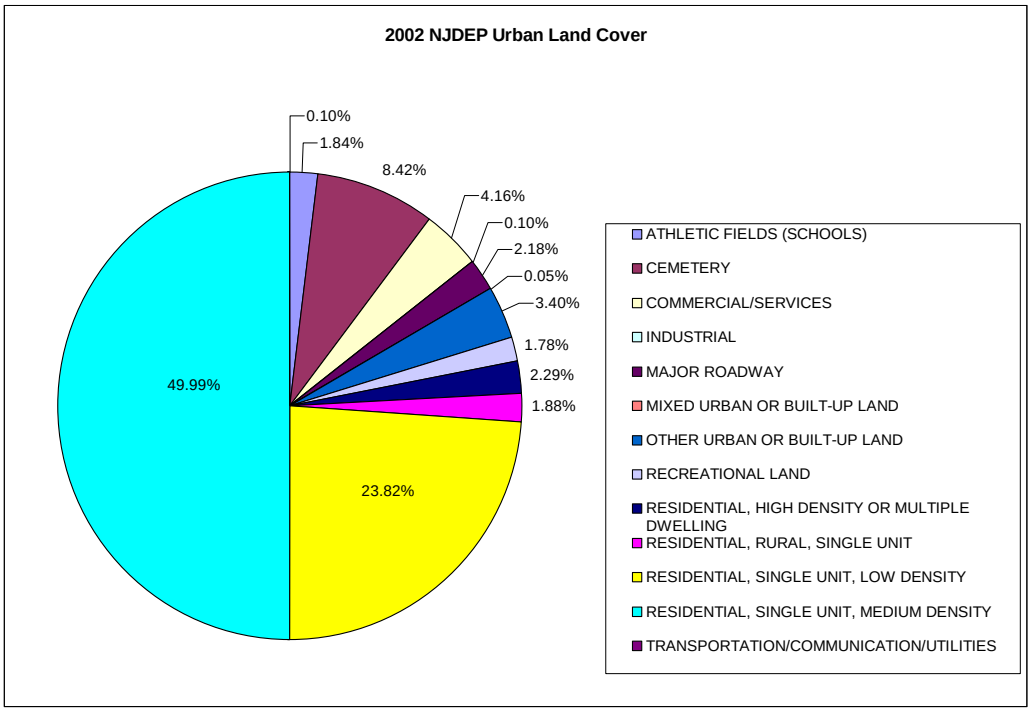

Figure 2: Land use/ land cover types and relative distribution

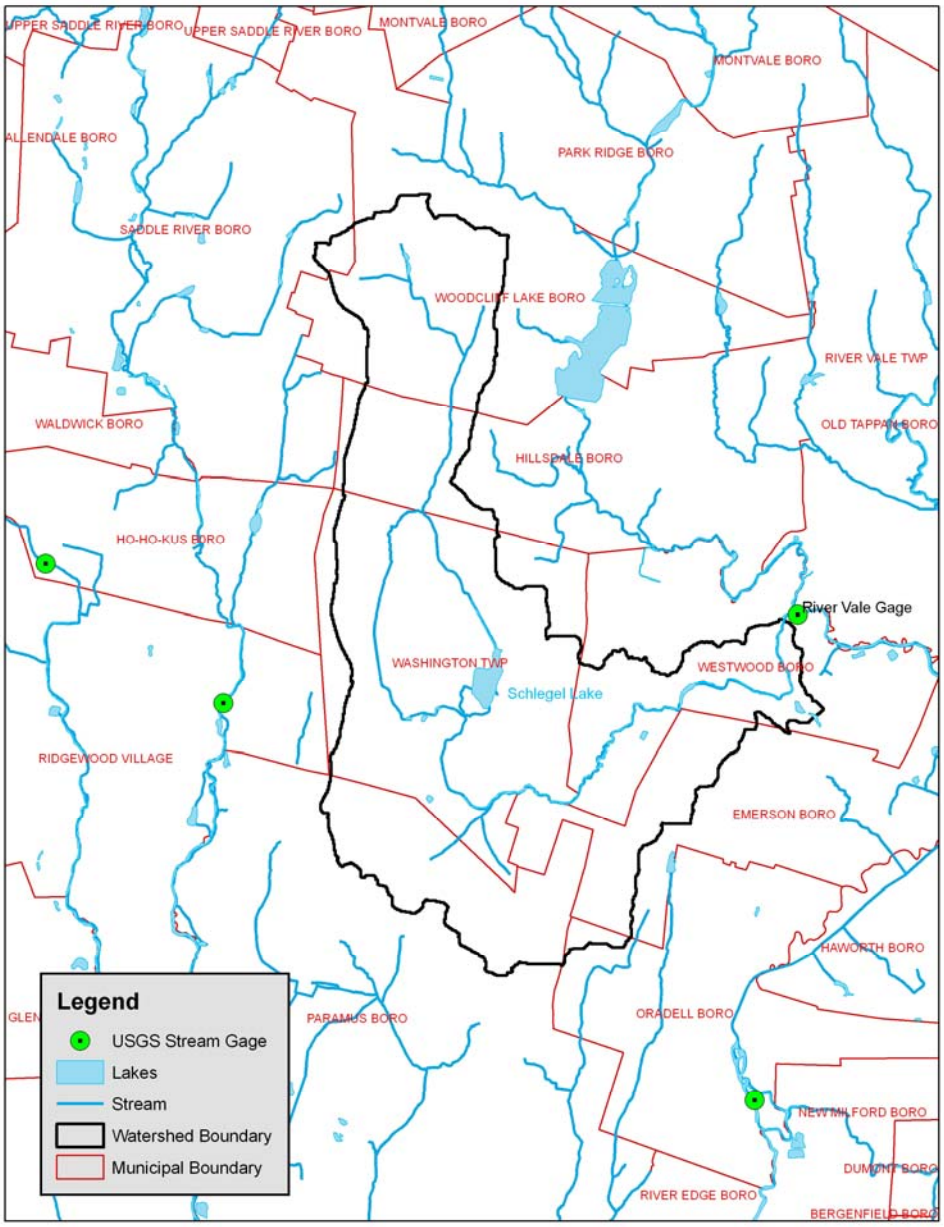

Figure 3: Municipalities and waterbodies located within the Musquapsink Brook Watershed

Project Background and the TMDL Development Process

The development of the Musquapsink Brook Watershed Restoration and Protection Plan was funded in 2007 by the NJDEP (RP 07-002). The project has been established to address a fecal coliform impairment that has been identified in the total maximum daily load (TMDL) developed based on data collected in the Musquapsink Brook at the US Geological Survey (USGS) monitoring station at River Vale (USGS 01377499).

TMDLs are developed by the NJDEP, and approval is given by the US Environmental Protection Agency (USEPA). In accordance with Section 305(b) of the Clean Water Act, New Jersey addresses the overall water quality of the State's waters and identifies impaired waterbodies through the development of a document referred to as the *Integrated List of Waterbodies* (NJDEP, 2006). Within this document are lists that indicate the presence and level of impairment for each waterbody monitored. The lists are defined as follows:

- **Sublist 1** suggests that the waterbody is meeting water quality standards.
- **Sublist 2** states that a waterbody is attaining some of the designated uses, and no use is threatened. Furthermore, Sublist 2 suggests that data are insufficient to declare if other uses are being met.
- **Sublist 3** maintains a list of waterbodies where no data or information are available to support an attainment determination.

- **Sublist 4** lists waterbodies where use attainment is threatened and/or a waterbody is impaired; however, a TMDL will not be required to restore the waterbody to meet its use designation.

  ➢**Sublist 4a** includes waterbodies that have a TMDL developed and approved by the USEPA, that when implemented, will result in the waterbody reaching its designated use.

  ➢**Sublist 4b** establishes that the impaired reach will require pollutant control measurements taken by local, state, or federal authorities that will result in full attainment of designated use.

  ➢**Sublist 4c** states that the impairment is not caused by a pollutant, but is due to factors such as instream channel condition and so forth. It is recommended by the USEPA that this list be a guideline for water quality management actions that will address the cause of impairment.

- **Sublist 5** clearly states that the water quality standard is not being attained and requires a TMDL.

Biological monitoring data is available for one location at the outlet of the Musquapsink Brook as part of the **Am**bient Biological Monitoring **Net**work (AMNET), which is administered by the NJDEP. Based upon AMNET and other monitoring sources, water quality impairments have been identified in the Musquapsink Brook. According to the *New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report,* the Musquapsink Brook has been cited with the following listings:

- Sublist 3 - No data or information are available to support attainment determination: cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc;

- Sublist 4 - Attainment is threatened or waterbody is impaired; a TMDL has been developed and/or approved or pollution control measures do not require a TMDL: fecal coliform;
- Sublist 5 - Water quality standard is not being attained and requires a TMDL: aquatic life, total phosphorus, and arsenic. **Arsenic will be addressed by the NJDEP and will not be a focus of this project.**

Based on the TMDL prepared for the Musquapsink Brook at River Vale, USGS 01377499, a 96% reduction in fecal coliform load for 6.6 miles of stream is needed (NJDEP, 2003). Additional aquatic life and total phosphorus surface water quality impairments will also need to be addressed through the TMDL process.

Biological Monitoring Data

Biological monitoring data is available for the Musquapsink Brook Watershed as part of the AMNET program administered by NJDEP. The NJDEP has been monitoring the biological communities of the State's waterways since the early 1970's, specifically the benthic macroinvertebrate communities. Benthic macroinvertebrates are primarily bottom-dwelling (benthic) organisms that are generally ubiquitous in freshwater and are macroscopic. Due to their important role in the food web, macroinvertebrate communities reflect current perturbations in the environment. There are several advantages to using macroinvertebrates to gauge the health of a stream. Macroinvertebrates have limited mobility, and thus, are good indicators of site-specific water conditions. Macroinvertebrates are sensitive to pollution, both point and nonpoint sources; they can be impacted by short-term environmental impacts such as intermittent discharges and contaminated spills. In addition to indicating chemical impacts to stream quality, macroinvertebrates can gauge non-chemical issues of a stream such as turbidity and siltation, eutrophication, and thermal stresses. Macroinvertebrate communities are a holistic overall indicator of water quality health, which is consistent with the goals of the

Clean Water Act (NJDEP, 2007a). Finally, these organisms are normally abundant in New Jersey freshwaters and are relatively inexpensive to sample.

New Jersey Impairment Score (NJIS)

The AMNET program began in 1992 and is currently comprised of more than 800 stream sites with approximately 200 monitoring locations in each of the five major drainage basins of New Jersey (i.e., Upper and Lower Delaware, Northeast, Raritan, and Atlantic). These sites are sampled once every five years using a modified version of the USEPA Rapid Bioassessment Protocol (RBP) II (NJDEP, 2007a). To evaluate the biological condition of the sampling locations, several community measures have been calculated by the NJDEP from the data collected and include the following:

1. Taxa Richness: Taxa richness is a measure of the total number of benthic macroinvertebrate families identified. A reduction in taxa richness typically indicates the presence of organic enrichment, toxics, sedimentation, or other factors.

2. EPT (Ephemeroptera, Plecoptera, Trichoptera) Index: The EPT Index is a measure of the total number of Ephemeroptera, Plecoptera, and Trichoptera families (i.e., mayflies, stoneflies, and caddisflies) in a sample. These organisms typically require clear moving water habitats.

3. % EPT: Percent EPT measures the numeric abundance of the mayflies, stoneflies, and caddisflies within a sample. A high percentage of EPT taxa is associated with good water quality.

4. % CDF (percent contribution of the dominant family): Percent CDF measures the relative balance within the benthic macroinvertebrate community. A healthy community is characterized by a diverse number of taxa that have abundances somewhat proportional to each other.

5. Family Biotic Index: The Family Biotic Index measures the relative tolerances of benthic macroinvertebrates to organic enrichment based on tolerance scores assigned to families ranging from 0 (intolerant) to 10 (tolerant).

This analysis integrates several community parameters into one easily comprehended evaluation of biological integrity referred to as the New Jersey

Impairment Score (NJIS). The NJIS was established for three categories of water quality bioassessment for New Jersey streams: non-impaired, moderately impaired, and severely impaired. A non-impaired site has a benthic community comparable to other high quality "reference" streams within the region. The community is characterized by maximum taxa richness, balanced taxa groups, and a good representation of intolerant individuals. A moderately impaired site is characterized by reduced macroinvertebrate taxa richness, in particular the EPT taxa. Changes in taxa composition result in reduced community balance and intolerant taxa become absent. A severely impaired site is one in which the benthic community is significantly different from that of the reference streams. The macroinvertebrates are dominated by a few taxa which are often very abundant. Tolerant taxa are typically the only taxa present. The scoring criteria used by the NJDEP are as follows:

- non-impaired sites have total scores ranging from 24 to 30,
- moderately impaired sites have total scores ranging from 9 to 21, and
- severely impaired sites have total scores ranging from 0 to 6.

It is important to note that the entire scoring system is based on comparisons with reference streams and a historical database consisting of 200 benthic macroinvertebrate samples collected from New Jersey streams. While a low score indicates "impairment," the score may actually be a consequence of habitat or other natural differences between the subject stream and the reference stream.

Starting with the second round of sampling under the AMNET program in 1998 for the Northeast Basin, habitat assessments were conducted in conjunction with the biological assessments. The first round of sampling under the AMNET program did not

include habitat assessments. The habitat assessment, which was designed to provide a measure of habitat quality, involves a visually based technique for assessing stream habitat structure. The habitat assessment is designed to provide an estimate of habitat quality based upon qualitative estimates of selected habitat attributes. The assessment involves the numerical scoring of ten habitat parameters to evaluate instream substrate, channel morphology, bank structural features, and riparian vegetation. Each parameter is scored and summed to produce a total score which is assigned a habitat quality category of optimal, sub-optimal, marginal, or poor. Sites with optimal/excellent habitat conditions have total scores ranging from 160 to 200; sites with suboptimal/good habitat conditions have total scores ranging from 110 to 159; sites with marginal/fair habitat conditions have total scores ranging from 60 to 109, and sites with poor habitat conditions have total scores less than 60. The findings from the habitat assessment are used to interpret survey results and identify obvious constraints on the attainable biological potential within the study area.

The NJDEP Bureau of Freshwater & Biological Monitoring maintains one AMNET station within the project area (i.e., Station AN0206 – Musquapsink Brook, Harrington Avenue, Westwood Borough, Bergen County). This station corresponds with the water quality monitoring station MB6. Station AN0206 was sampled by NJDEP in 1993, 1998, and 2003 under the AMNET program. Findings from the AMNET program are summarized in Table 1. The biological condition over the years has been assessed as being moderately impaired, and the habitat has ranged from marginal to sub-optimal within the Musquapsink Brook Watershed.

Table 1: Summary of NJDEP Ambient Biological Monitoring Network results (NJDEP, 1994; NJDEP, 2000; NJDEP, 2008)

Station	Date	Biological Condition (Score)	Habitat Assessment (Score)
AN0206	7/6/1993	Moderately Impaired (9)	~
AN0206	7/9/1998	Moderately Impaired (15)	Marginal (104)
AN0206	7/1/2003	Moderately Impaired (15)	Suboptimal (147)

The 2007 Biological Assessment by Marion McClary, Jr., Ph.D.

Given these aquatic life impairments, an additional biological assessment was proposed as part of the data collection needed to prepare a comprehensive watershed restoration and protection plan for the Musquapsink Brook. A biological assessment was conducted by Marion McClary, Jr., Ph.D., Associate Director of Biological Sciences at Fairleigh Dickinson University and project partner, in the late summer of 2007 at MB1 (Musquapsink Brook at Hillside Avenue, Hillsdale), MB3 (Musquapsink Brook at Ridgewood Avenue, Washington), MB4 (Musquapsink Brook at Forest Avenue, Westwood), and at MB6 (AMNET Station AN0206, Musquapsink Brook at Harrington Avenue, Westwood). The 2007 biological assessment conducted Dr. McClary is summarized in the Musquapsink Brook Benthic Data Report and Musquapsink Brook Benthic Species List provided in Appendix A of the Musquapsink Brook Watershed Restoration Plan Data Report. The 2007 assessment revealed that the biological condition within the Musquapsink Brook Watershed had degraded to a severely impaired condition. Marginal to sub-optimal habitat conditions were found within the watershed.

There was such a paucity of benthic organisms found that less than 100 specimens were collected from the four sampling locations combined, prohibiting the calculation of the various metrics needed for the NJIS score.

Stream Visual Assessment Protocol (SVAP) Data Collected in the Musquapsink Brook Watershed

Introduction to SVAP

Among the hierarchy of tools used to characterize watershed health, the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Stream Visual Assessment Protocol (SVAP) is one method that fills this need. SVAP was originally developed for use by the landowner (USDA, 1998), but it has proved to also be useful by those familiar with the river system and flooding occurrences. The protocol provides an outline on how to quantitatively score in-stream and riparian qualities that includes water appearance, channel condition, and riparian health. There are 10 primary SVAP elements:

- channel condition,
- hydrologic alternation,
- riparian zone,
- bank stability,
- water appearance,
- nutrient enrichment,
- barriers to fish movement,
- instream fish cover,
- presence of pools, and
- invertebrate habitat

In addition, there are elements that should only be scored if applicable. These are canopy cover, manure presence, salinity, riffle embeddedness, and observed macroinvertebrates. Elements are scored 1 to 10 (poor to excellent) with the exception of

observed macroinvertebrates, which uses a scale ranging from 1 to 15. The range of scores is qualitatively described as follows:

- < 6.0 is Poor;
- 6.1-7.4 is Fair;
- 7.5-8.9 is Good;
- 9.0 is Excellent.

The SVAP data sheet was modified to include other reach features that could aid pollution source trackdown in the Musquapsink Brook Watershed. These reach features include the identification of pipes and ditches, details as to erosion or impairment caused by the pipes or ditches, and access to stream reach for restoration. Additionally, all assessed reaches were photo-documented, and a sketch was made denoting important reach characteristics.

SVAP in the Musquapsink Brook Watershed

The visual assessment process in the Musquapsink Brook Watershed began in April 2007. In March 2006, all project partners were trained in using SVAP at the RCE Water Resources Program's SVAP Workshop. The training workshop consisted of a full day of SVAP introduction and use, and the workshop included presentations in a classroom setting and group and paired exercises in the field. Additional training included instructions on how to use the RCE online database entry system for the SVAP data. The Bergen County Department of GIS (geographic information systems) also developed an application to fill out SVAP data on a hand held ArcPad unit, which was used for this project. The Musquapsink Brook watershed was then divided into a grid; grids were assigned to the participating project partners.

Considerations were agreed upon at the onset of the assessment effort. Macroinvertebrates observed were not scored through this SVAP process, since macroinvertebrate data would be collected as part of the NJDEP-approved sampling plan for this project. Also, the manure presence element was expanded to include signs of waterfowl, pet, and wildlife waste. This category is only scored when the presence of manure or animal waste is visible within the reach, which includes the floodplain for that particular reach. As per the SVAP protocol and the agreed upon revisions, the following rules apply:

- A score of "1" indicates that extensive amount of manure is on the banks or in the stream, or, untreated human waste discharge pipes are present.
- A score of "3" indicates occasional manure in the stream, or there is a waste storage structure located on the floodplain.
- A score of "5" indicates evidence of waterfowl, wildlife, or domestic pet access to riparian zone.

Only one reach was scored for manure presence out of the 38 reaches assessed; this location is shown in Figure and had a manure presence score of 3 indicating occasional manure in the stream, or there is a waste storage structure located on the floodplain.

Figure 4: Manure presence at 3rd Street in the Musquapsink Brook Watershed

SVAP Data

Thirty eight stream reaches were evaluated in the Musquapsink Brook Watershed; the stream reaches and the average SVAP scores are identified in Figure . The average overall SVAP score was 6.7, a "fair" score (Table 2). Canopy cover was the highest scoring element (average of 8.4), and instream fish cover was the lowest scoring element (average of 5.2). No assessed stream reach received a score of "excellent," five reaches were rated as "good" and eighteen were rated as "fair" (Table 2). The remaining fifteen reaches were rated as "poor." The reaches that were rated as poor were located along the entire length of the Musquapsink Brook (Figure 5). Tabulated SVAP data are provided in Appendix B.

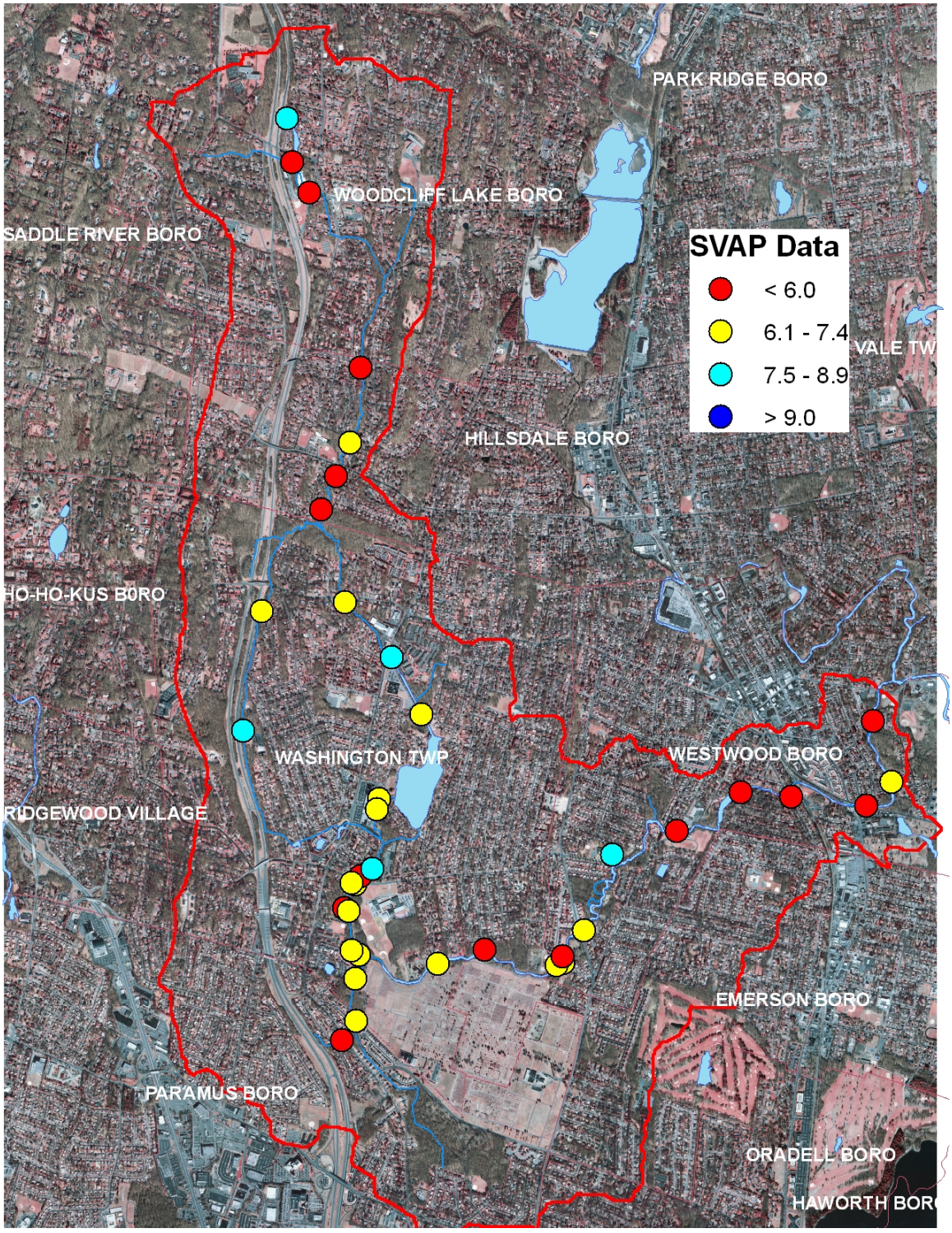

Figure 5: Stream visual assessment reaches with scores in the Musquapsink Brook Watershed

Table 2: SVAP assessment elements and data

	Channel Condition	**Hydrologic Alteration**	**Riparian Zone left bank**	**Riparian Zone right bank**	**Bank Stability left bank**	**Bank Stability right bank**	**Water Appearance**	**Nutrient Enrichment**	**Barriers to Fish Movement**
# of scores	38	20	38	38	38	38	38	38	38
minimum value	1	1	1	1	1	1	3	3	0
maximum value	10	10	10	10	10	10	10	10	10
average	6.4	6.7	7.3	6.3	5.8	5.8	7.6	7.4	5.5
	Instream Fish Cover	**Pools**	**Invertebrate Habitat**	**Canopy Cover**	**Manure Presence**	**Riffle Embeddedness**	**Water Appearance & Nutrient Enrichment Averages**		**Tiered Assessment Averages***
# of scores	38	38	38	38	NA	20	38		36
minimum value	0	1	3	1	NA	0	3		1.5
maximum value	8	8	10	10	NA	10	10		10
average	5.2	6.3	7.9	8.4	NA	6.0	7.5		6.7
	Overall Average - left bank		***Overall Average - right bank***		***Overall Site Average***				
# of scores	***35***		***35***		***35***				
minimum value	***1.3***		***1.3***		***1.3***				
maximum value	***9.7***		***9.7***		***9.7***				
average	***6.7***		***6.6***		***6.7***				

** "Tiered Assessment Averages" refers collectively to Hydrologic Alteration, Channel Condition, Riparian Zones left and right, Bank Stability left and right, Water Appearance, and Nutrient Enrichment.*

Using the SVAP Data

SVAP scores will be evaluated as individual assessment elements and combined with other data collected as part of this restoration planning effort. The SVAP results will be compared to land use, soil characteristics, slope and stream gradient, and water quality monitoring results to determine the quality of waters within the Musquapsink Brook Watershed. The SVAP scores, information on pipes, ditches, photos, and remediation notes will be used to identify sources of pollution and potential opportunities for improved management.

Water Quality Sampling Overview

Project partners, including NJDEP, the RCE Water Resources Program, and the Bergen County Department of Health Services, began water quality monitoring on May 25, 2007. As per the approved Quality Assurance Project Plan (QAPP) provided in Appendix C, *in situ* measurements of pH, dissolved oxygen (DO), and temperature were collected. Stream velocity and depth were measured across the transect of the stream at each sampling station. Using this information, flow rate was calculated for each event where access to the stream was deemed safe. Water samples were collected and analyzed by two separate laboratories. The Bergen County Utility Authority conducted analyses for total phosphorus (TP), dissolved orthophosphate phosphorus (PO_4^{3-}), ammonia-nitrogen (NH_3-N), total kjeldahl nitrogen (TKN), nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), total suspended solids (TSS), and fecal coliform. Garden State Laboratories analyzed samples for *Escherichia coli* (*E. coli*).

Water quality monitoring included two different types of sampling events, regular and bacteria only. Regular monitoring, which included analysis for all parameters,

occurred from May 25, 2007 through October 25, 2007. These events were monitored for total phosphorus, dissolved orthophosphate phosphorus, ammonia-nitrogen, TKN, nitrate-nitrogen, nitrite-nitrogen, total suspended solids, fecal coliform, and *E. coli* and had no specific weather conditions directing the sample collection. Bacteria-only monitoring was conducted in the summer months of June, July, and August 2007, again without conditions set by the weather. The bacteria-only sampling entailed collecting three additional samples in each of those months. Flow was measured, and *in situ* measurements were taken during these events. The dates and the types of monitoring events are summarized in Table 3.

Three storm events were supposed to be collected as part of this project. Due to the weather patterns and timing of storms during the six months of monitoring, only one storm event was encountered that would meet the requirements of the approved QAPP. Surface water samples collected during this storm were taken twice on October 10, 2007 and one the following morning on October 11, 2007. In addition to the one storm sampling event, several sampling events were representative of 'wet' conditions in the watershed.

To more accurately determine which monitoring events were collected under wet conditions when the stream velocities exceeded baseflow conditions, the HYSEP procedure was used. HYSEP is a data analysis program developed by the USGS to separate river flow into baseflow and storm-flow (Sloto and Crouse, 1996). Normally, this model would be applied to a daily discharge monitoring station within the watershed;

Table 3: Water quality monitoring events

Date	Weather	Regular Monitoring for all Parameters	Bacteria Only Monitoring
5/24/2007	Dry	X	
5/31/2007	Wet	X	
6/7/2007	Dry	X	
6/14/2007	Dry		X
6/19/2007	Dry		X
6/21/2007	Dry	X	
6/28/2007	Wet		X
7/5/2007	Wet	X	
7/12/2007	Wet		X
7/24/2007	Wet		X
7/26/2007	Dry		X
8/2/2007	Dry	X	
8/9/2007	Wet		X
8/16/2007	Wet	X	
8/23/2007	Wet		X
8/30/2007	Wet		X
9/13/2007	Wet		X
9/27/2007	Dry		X
10/10/2007	Storm	X	
10/11/2007	Storm	X	
10/25/2007	Wet	X	

however daily discharge is not recorded by the USGS in the Musquapsink Brook Watershed. Instead, USGS monitoring station 01377500, Pascack Brook at Westwood, which is just downstream of the confluence of the Musquapsink Brook and the Pascack Brook, was chosen. Although it would be preferable to use a flow gauge in the target watershed, the watershed does drain to the Pascack Brook, and the remainder of the drainage area is adjacent to the Musquapsink Brook watershed. The analysis was completed for the Pascack Brook over the length of the field sampling program. A 10% error bar was also applied to the baseflow since these data are collected in a watershed other than the Musquapsink Brook. When flow was more than 10% greater than

baseflow and rain occurred on the day of or the day preceding sampling, the event was considered as storm-related flow and assigned the term “wet” in Table 3.

Surface water samples from eight water quality monitoring stations were regularly collected over the six-month sampling time frame. These stations are depicted in Figure 6. Six stations were located on the Musquapsink Brook, and two were located adjacent to the UWNJ transfer intake located at the confluence of the Saddle River and the Ho Ho Kus Brook. The stations are identified in Table 4 .

A record of the water transfers to the Musquapsink Brook was obtained from UWNJ. It shows that transfers were made on 188 days out of the 214 day interval between June 1, 2007 and December 31, 2007. The total volume of water transferred was 551 million gallons. Figure 7 shows the water transfer record.

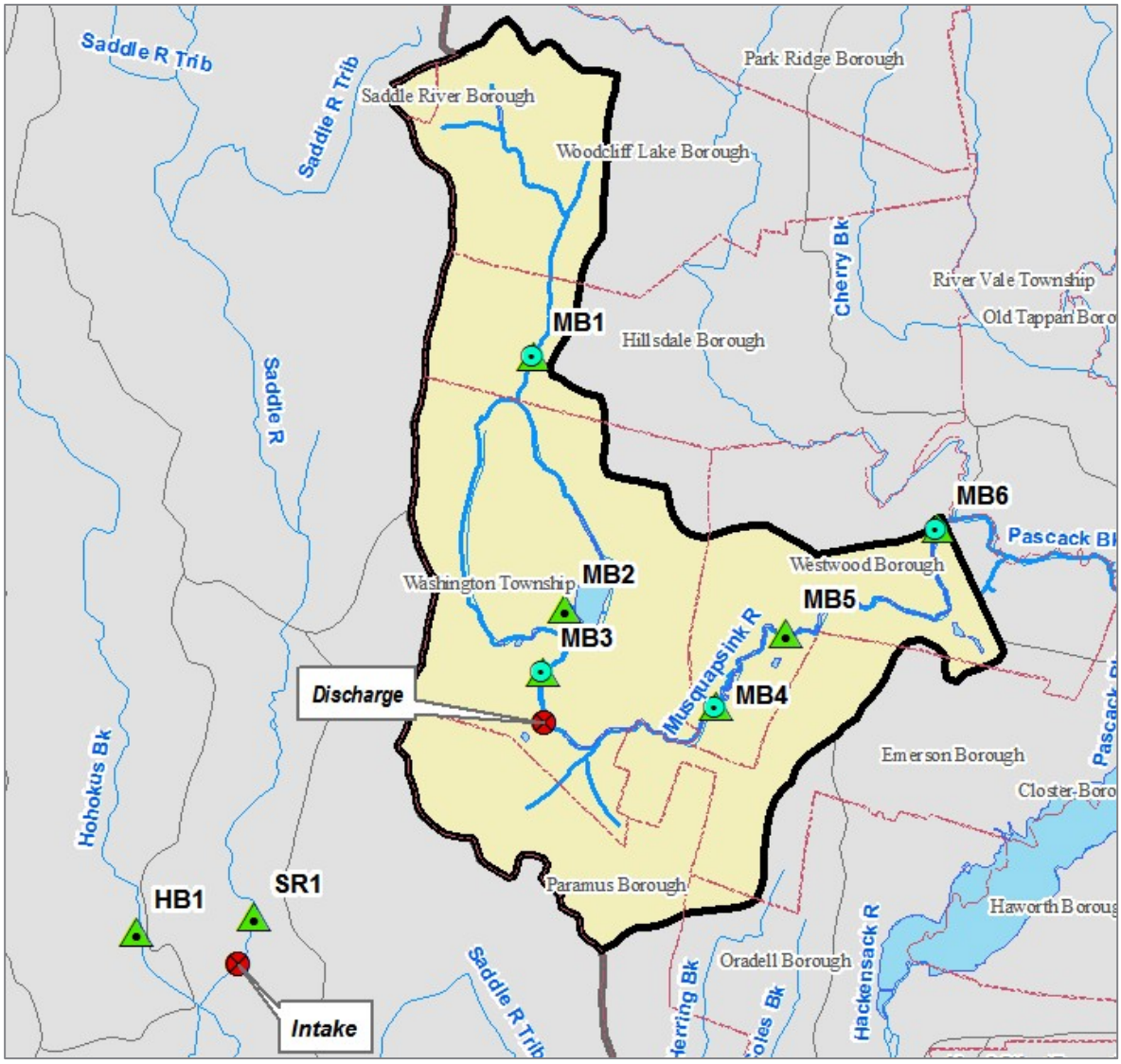

Figure 6: Water quality sampling location map

Table 4: Water quality monitoring location IDs and descriptions

Site ID	Site Description
MB1	Musquapsink Brook at Hillside Ave, Hillsdale
MB2	Musquapsink Brook at Woodfield Ave, Washington
MB3	Musquapsink Brook at Ridgewood Ave, Washington
MB4	Musquapsink Brook at Forest Ave, Westwood
MB5	Musquapsink Brook at Third Ave, Westwood
MB6	Musquapsink Brook at Harrington Ave, Westwood
SR1	Saddle River at Grove St, border of Paramus and Ridgewood
HB1	Ho Ho Kus Brook at Grove St, border of Paramus and Ridgewood

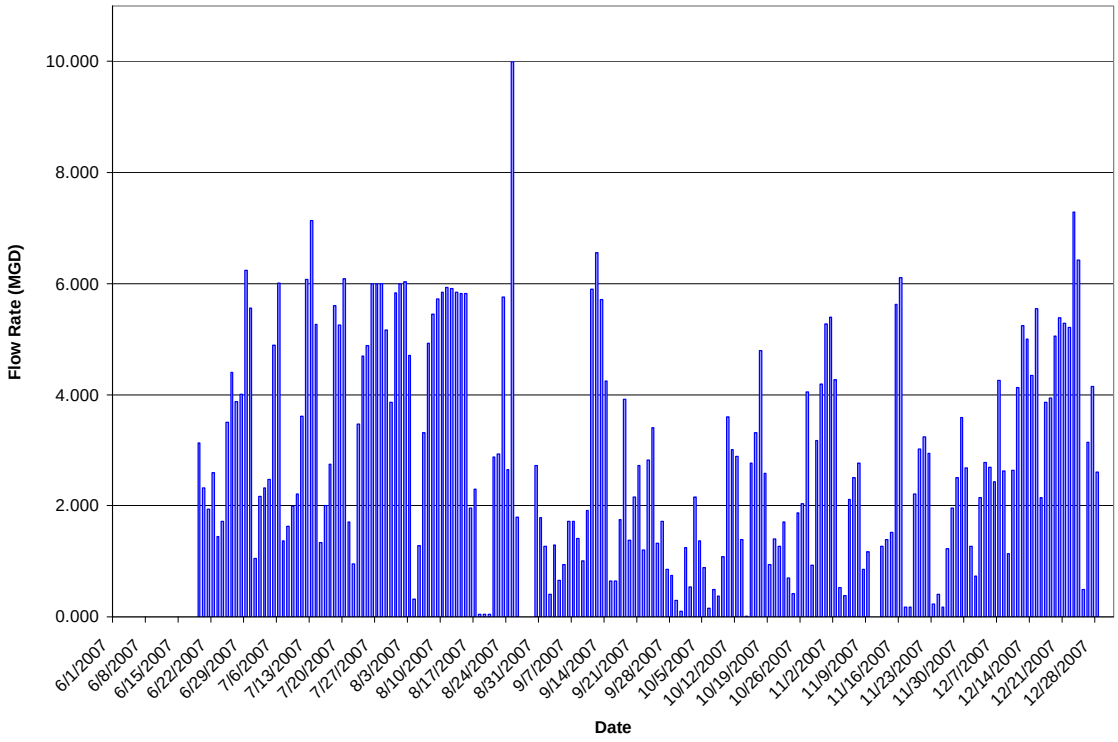

Figure 7: UWNJ transfer record

Data Results and Comparison to Water Quality Criteria

To evaluate the health of the Musquapsink Brook at all the stations, the monitoring results were compared to the designated water quality criteria. Water quality criteria are developed according to the designated uses of the waterbody. The Musquapsink Brook is classified as FW2-NT, or freshwater (FW) non trout (NT). "FW2" refers to waterbodies that are used for primary and secondary contact recreation; industrial and agricultural water supply; maintenance, migration, and propagation of natural and established biota; public potable water supply after conventional filtration treatment and disinfection; and any other reasonable uses. "NT" means those freshwaters that have not been designated as trout production or trout maintenance. NT waters are not suitable for trout due to physical, chemical, or biological characteristics, but NT

waters can support other fish species (NJDEP, 2006a). Furthermore, the Musquapsink Brook is a Category One antidegradation waterbody due to its discharge to the Oradell Reservoir, which is a potable water supply.

The USEPA Guidance for the Preparation of the Comprehensive State Water Quality Assessments (USEPA, 1997) advises that an acceptable frequency for water quality results to exceed criteria is 10% of samples. NJDEP has further stated that a minimum of eight samples collected quarterly over a two-year period are required to confirm quality of waters. Therefore, if a waterbody has a minimum of eight samples collected quarterly over a two-year period with more than 10% of the samples exceeding the water quality criteria for a certain parameter, the waterbody is considered "impaired" for that parameter. By applying this rule to the water quality data, it is possible to identify which stations are impaired for each parameter that has been identified as a concern to the project – total phosphorus, fecal coliform, and *E. coli*. The applicable water quality criteria for this project are detailed in Table 5, and the percent of samples that exceeded these standards are given in Table 6. At the time of this project's initiation, fecal coliform was the accepted measure indicating pathogen pollution for New Jersey freshwaters. Since then, the fecal coliform criterion has been replaced by an *E. coli* criterion. Since the TMDL refers to fecal coliform, both fecal and *E. coli* were measured.

Tabulated water quality monitoring results are provided in Appendix D. Water quality monitoring data have also been graphed with surface water quality criterion; these graphs are available in Appendix E.

Table 5: Water quality criteria according to N.J.A.C. 7:9B (NJDEP, 2006a)

Substance	Surface Water Classification	Criteria
TP (mg/L)	FW2 Streams	Except as necessary to satisfy the more stringent criteria in accordance with "Lakes" (above) or where watershed or site-specific criteria are developed pursuant to N.J.A.C. 7:9B-1.5(g)3, phosphorus as total P shall not exceed 0.1 in any stream, unless it can be demonstrated that total P is not a limiting nutrient and will not otherwise render the waters unsuitable for the designated uses.
	FW2 Lakes	Phosphorus as total P shall not exceed 0.05 in any lake, pond, or reservoir, or in a tributary at the point where it enters such bodies of water, except where watershed or site-specific criteria are developed pursuant to N.J.A.C. 7:9B-1.5(g)3.
Fecal Coliform (Col/100 mL)	FW2	Shall not exceed geometric average of 200/100 mL, nor should more than 10% of the total samples taken during any 30-day period exceed 400/100 mL.
E. coli (Col/100 mL)	FW2	Shall not exceed a geometric mean of 126/100 mL or a single sample maximum of 235/100 mL.

Table 6: Summary of water quality data collected and comparison to water quality criteria

Monitoring Station ID	TP (mg/L)					
	criterion	*count*	*minimum*	*maximum*	*average*	*% not satisfying criterion*
MB1	0.1	6	0.05	0.14	0.08	44
MB2	0.1	7	0.05	0.11	0.07	10
MB3	0.1	7	0.03	0.09	0.06	0
MB4	0.1	7	0.03	0.35	0.11	50
MB5	0.1	6	0.06	0.35	0.17	60
MB6	0.1	7	0.04	0.19	0.10	50
SR1	0.1	7	0.01	0.11	0.05	30
HB1	0.1	7	0.91	2.20	1.77	90
Fecal Coliform (col/100mL)						
MB1	200	23	200	28,000	3,479	*96*
MB2	200	23	60	12,000	1,481	*87*
MB3	200	23	120	44,000	3,706	*91*
MB4	200	23	410	49,000	5,530	*100*
MB5	200	23	106	58,000	6,627	*100*
MB6	200	22	500	70,000	8,117	*100*
SR1	200	23	110	39,000	5,550	*87*
HB1	200	23	200	41,000	7,270	*91*
***E. coli* (col/100mL)**						
MB1	235	23	170	16,000	2,639	*91*
MB2	235	23	60	2,200	480	*65*
MB3	235	23	160	7,800	1,897	*96*
MB4	235	23	160	25,000	4,809	*96*
MB5	235	23	120	33,000	6,090	*96*
MB6	235	23	210	38,000	5,202	*96*
SR1	235	22	380	23,000	2,860	*100*
HB1	235	22	410	22,000	3,150	*100*

MST Data in the Musquapsink Brook Watershed

Microbial source tracking (MST) techniques have recently been developed that have the ability to identify the origin of fecal pollution. MST is the concept of applying microbiological, genotypic (molecular), phenotypic (biochemical), and chemical methods to identify the origin of fecal pollution (USEPA, 2005). MST techniques typically report fecal contamination source as a percentage of targeted bacteria. One of the most

promising targets for MST is group *Bacteroides*, a genus of obligately anaerobic, gram-negative bacteria that are found in all mammals and birds. *Bacteroides* comprise up to 40% of the amount of bacteria in feces and 10% of the fecal mass. Due to the large quantity of *Bacteroides* in feces, they are an ideal target organism for identifying fecal contamination (Layton *et al.*, 2006). In addition, *Bacteroides* have been recognized as having broad geographic stability and distribution in target host animals and are a promising microbial species for differentiating fecal sources (USEPA, 2005; Dick *et al.*, 2005; Layton *et al.*, 2006).

Three sets of PCR primers (targets) were used to quantify *Bacteroides* from 1) all sources of *Bacteroides* ("AllBac"), 2) human sources ("HuBac"), and 3) bovine sources of *Bacteroides* ("BoBac"). This assay is based on published results from a study sponsored by the Tennessee Department of Environmental Conservation (Layton *et al*., 2006).

Methods

Samples were collected in sterile bottles at all six monitoring sites and held at 4˚C until processing. On one sampling occasion, additional samples were collected at stations HR1 and SR1. A 100 mL aliquot of each sample was filtered aseptically onto a membrane filter and DNA was extracted from total filtered biomass using a DNeasy® tissue kit (Qiagen). The protocol used is a modification of the procedure found in the DNeasy Tissue Handbook (Qiagen, 2004).

After extraction, all DNA samples were quantified by spectroscopy (Beckman DU 640) at 260 and 280 nm then diluted in sterile water to a concentration of 1 µg/mL.

This diluted DNA was used as the template for quantitative, real-time PCR reactions to measure the number of *Bacteroides* present.

The number of *Bacteroides* was measured using a TaqMan® based assay using Applied Biosystems reagents and standard conditions on an Applied Biosystems 7300 Real-Time PCR system. Three target sequences were measured. These targets indicate the total number of *Bacteroides* (AllBac) as well as the number of specifically human-sourced (HuBac) and bovine-sourced (BoBac) *Bacteroides*. The copy number of each target was calculated by comparison to a standard curve made with plasmids containing human- or bovine-sourced target 16S RNA genes amplified with the primers Bac 32f and Bac 708r (Bernhard and Field, 2000). Dilutions of plasmid DNA provided standard curves which were linear from 10 to 100,000 copies per µL. Figure presents individual standard curves plotting log copy number vs. threshold cycle (Ct) for AllBac (a), Hubac (b), and BoBac (c) primer sets. All primers and probes were taken from Layton *et al.* (2006) or Bernhard and Field (2000) (Table 7).

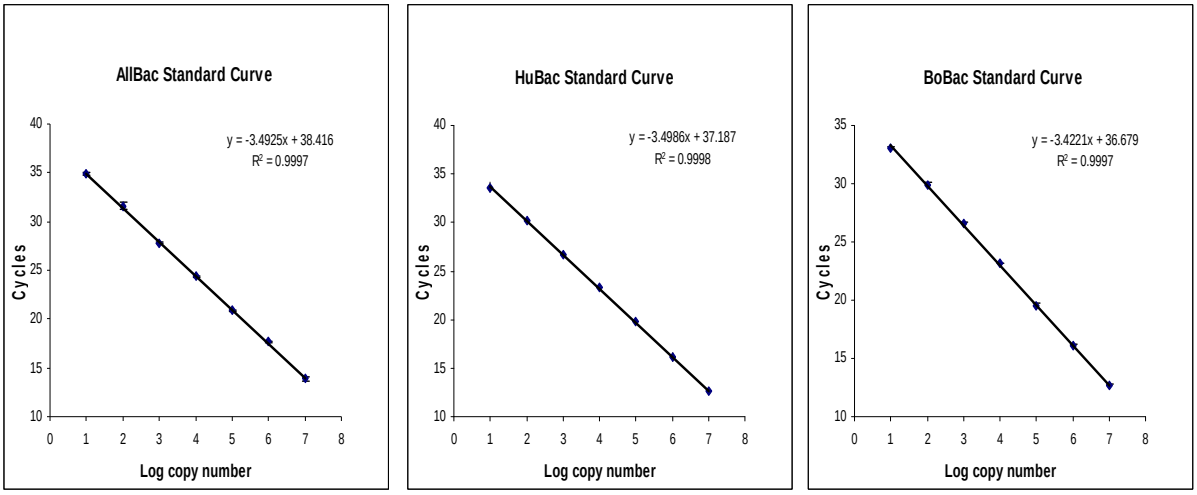

Figure 8: Standard curves for quantification of *Bacteroides*

Table 7: Primers and probes used for the MST effort

PCR Primers	
HuBac 566f	5' GGG TTT AAA GGG AGC GTA GG 3'
HuBac 692r	5' CTA CAC CAC GAA TTC CGC CT 3'
BoBac 367f	5' GAA GRC TGA ACC AGC CAA GTA 3'
BoBac 467r	5' GCT TAT TCA TAC GGT ACA TAC AAG 3'
AllBac 296f	5' GAG AGG AAG GTC CCC CAC 3'
AllBac 412r	5' CGC TAC TTG GCT GGT TCA G 3'
Bac 32f	5' AAC GCT AGC TAC AGG CTT 3'
Bac 708r	5' CAA TCG GAG TTC TTC GTG 3'
TaqMan Probes	
BoBac402Tman	5' 6FAM TGA AGG ATG AAG GTT CTA TGG ATT GTA AAC TT TAMRA 3'
HuBac594Tman	5' 6FAM TAA GTC AGT TGT GAA AGT TTG CGG CTC TAMRA 3'
AllBac375Tman	5' VIC CCA TTG ACC AAT ATT CCT CAC TGC TGC CT TAMRA 3'

Results of qPCR and Source Detection

The Musquapsink Brook Watershed is an urban watershed with no cattle within its boundaries, and the MST confirmed this with no detections of bovine-related *Bacteroides* in any sample. Human-related *Bacteroides* were detected in MB2, MB4, MB5, MB6, and HB1 on at least one sampling occasion (Figure 9). Pollution sources could be determined by the frequency of detection of specific markers at particular sampling locations (

Table 8). These data show that certain stations (MB2, MB4, MB5, MB6, and HB1) have a higher incidence of contamination with human feces.

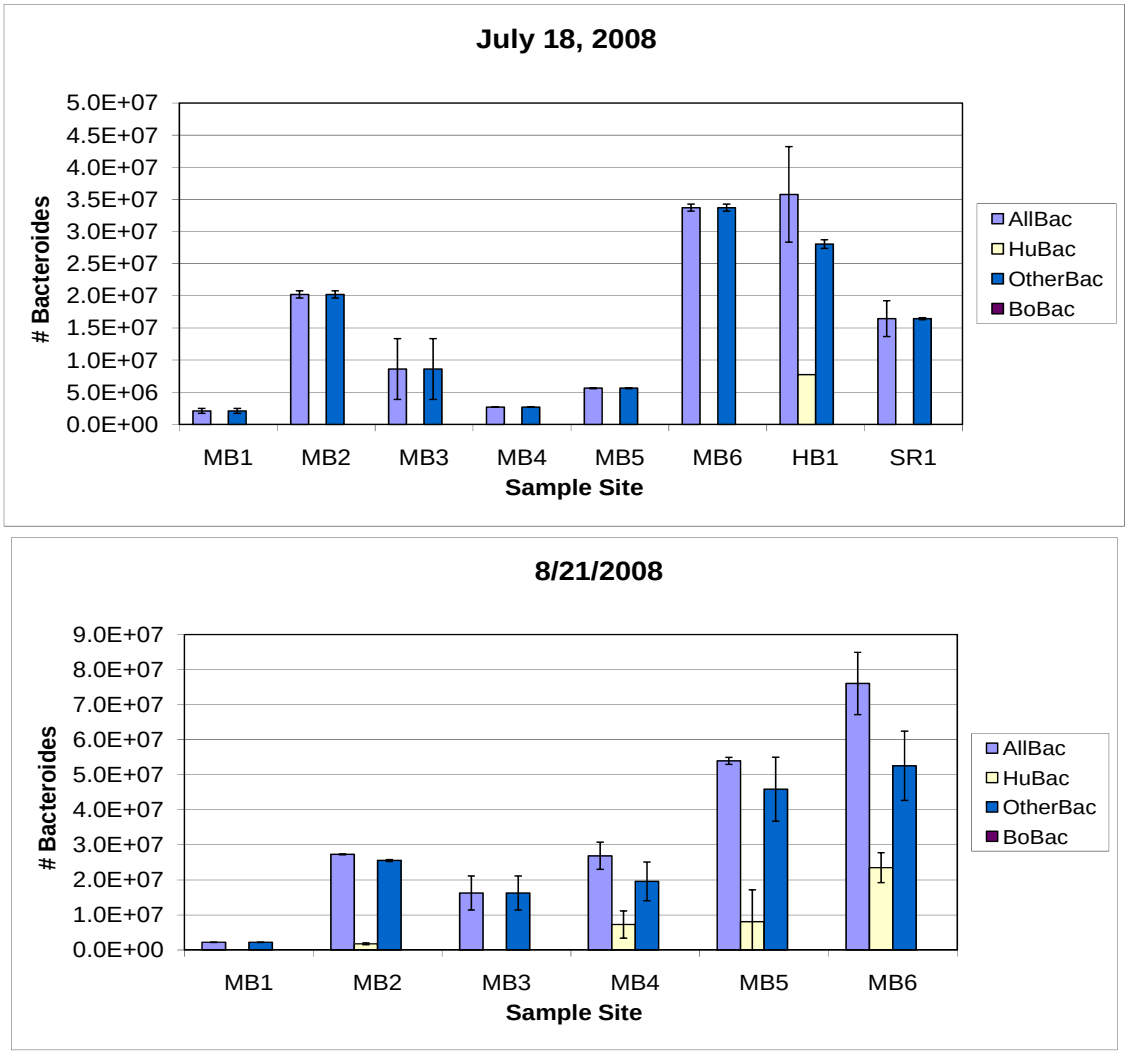

Figure 9: Sample data showing the numbers of *Bacteroides* detected by the three primer sets on two days of sampling

Table 8: Frequency of detection of AllBac, HuBac (human), or BoBac (bovine) target sequences

	% of Samples Containing Target Sequence							
	MB1	MB2	MB3	MB4	MB5	MB6	HB1	SR1
AllBac	100	100	100	100	100	100	100	100
HuBac	0	50	0	50	50	50	50	0

Data Summary

The data show a variety of water quality concerns in the Musquapsink Brook Watershed. The AMNET macroinvertebrate results show moderate impairments to the biological communities within the watershed (Table 1). The biological community may be impacted by environmental stressors or degraded habitat. Habitat quality may be low due to physical alterations as observed during SVAP assessments conducted throughout the watershed. Overall quality of the streams was assessed as "fair" but individual element scores ranged from "poor" to "good" (Table 2). Further analysis of this data may help to explain what physical factors (i.e., erosion, habitat structure, and water availability) may be responsible for the composition of the macroinvertebrate communities seen in the watershed.

While the biological monitoring and SVAP assessments shed light on watershed quality, surface water monitoring provides possible reasons for this quality. Results indicate that total phosphorus and fecal coliform concentrations, and pH levels are in violation of water quality criteria established by the NJDEP (Table 6). All eight (8) monitoring locations were in violation of both pH and total phosphorus water quality criteria in greater than 10% of the samples (Table 6). All eight (8) stations were also in violation of the fecal coliform water quality criterion (Table 6). Tracking of bacterial sources within the watershed indicate a higher human contribution to bacteria at stations MB2, MB4, MB5, MB6, and HB1 (Table 8).

Water quality data will be combined with land use data analyses to determine sources of pollutants. A full analysis of data will be conducted and presented in the Musquapsink Brook Watershed Restoration and Protection Plan.

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Appendix A: Musquapsink Brook Benthic Data Report & Species List, Marion McClary, Jr., Ph.D., Fairleigh Dickinson University

Musquapsink Brook Benthic Data Report

Prepared by:

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for

Rutgers Cooperative Extension Water Resources Program
as part of
RP07-002 Musquapsink Brook Watershed
Restoration and Protection Plan

June 2008

Biological Monitoring Materials and Methods

Upon arrival at the sampling location, the end of a tape measure was placed and held below any road or bridge crossing that was present and stretched 100 meters upstream to minimize the effect of the road or bridge on stream velocity, depth, and overall habitat quality as per the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. At this location, 100 meters upstream of the road or bridge crossing, the tape measure was again placed and held and stretched 100 meters upstream to include a 100 meter reach that was representative of the characteristics of the stream (the study area). Other road or bridge crossings were avoided. If this was not possible, the tape measure was placed and held below this road or bridge crossing and the aforementioned procedure was repeated until road and bridge crossing could be avoided. There were no major tributaries discharging to the stream in the study area as suggested by the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. The tape measure was left in the study area for sampling.

Before sampling the physical/chemical field sheet (Chapter 5; Appendix A-1, Form 1 of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition) was completed to document the site description, weather conditions, and land use. After sampling this information was reviewed for accuracy and completeness.

The straight-away portions of the sampling reach were photographed with a digital camera starting downstream and ending upstream (with the exception of MB6 which was done in the reverse direction) to include in-stream attributes (e.g. riffles, falls, fallen trees, pools, bends, etc.) and important structures, plants, and attributes of the bank and near stream areas. If the sampling reach had curves, the "straight-away portions of each curve" were photographed. This means more photographs were taken of sampling reaches that had more curves because each "straight-away segment of the curve" received a photograph, and fewer photographs were taken of sampling reaches that had less curves.

Two sampling procedures were used. One procedure was used depending upon if the habitat was a single habitat or a multihabitat. Habitats that had a very slow current or were greater than 1 ft deep, and lacked riffles were considered to be multihabitats and a multihabitat approach was used for them. Habitats that were 1 ft deep or less and had riffles and runs were considered single habitats. The second procedure was used for all habitats whether they were single or multihabitats. For single habitats with riffles and runs, all riffle and run areas within the 100-m reach were candidates for sampling macroinvertebrates. A composite sample was taken from individual sampling spots in the riffle and runs representing different velocities.

Field Sampling Procedures for Single Habitat

Sampling began at the downstream end of the reach and proceeded upstream. Sampling was done in triplicate. The first replicate (A) was done along the bank on the right. The second replicate (B) was done along the bank on the left. The third replicate

(C) was done in the middle of the channel. For sampling, a surber sampler (0.3 m x 0.3 m with a mesh size of 500 μ) was placed horizontally on cobble substrate and 2 or 3 kicks (use of the toe or heel of the boot to dislodge the upper layer of cobble or gravel and to scrape the underlying bed) were done at various velocities in the riffle or series or riffles. Larger substrate particles were picked up and rubbed by hand to remove attached organisms. The net on the vertical section of the frame captured the dislodged organisms from the sampling area.

The kicks collected from three different locations in the cobble substrate were composited to obtain a single homogenous sample for each replicate. After each kick, the collected material was washed by running clean stream water through the net 2 to 3 times until the water was clear. Large debris was removed after rinsing and inspecting for organisms. Any organisms found were placed into a sample container.

The sample in the net was transferred to a sample container and enough 95 percent ethanol was added to cover the sample. Forceps were used to remove organisms from the net. A label indicating the date, stream name and sampling location was placed on the sample container. This information was recorded in the "Sample log" (Appendix A-3, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition.

The top portion of the "Benthic Macroinvertebrate Field Data Sheet" (Appendix A-3, Form 1) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was completed.

The percentage of each habitat type in the reach was recorded, and the sampling gear used and the conditions of the sampling, e.g. high flows, treacherous rocks, difficult access to the stream, or anything that would indicate adverse sampling conditions were noted.

Observations of aquatic flora and fauna were documented and qualitative estimates of macroinvertebrate composition and relative abundance as a cursory estimate of ecosystem health and to check adequacy of sampling were made.

Habitat assessment (Appendix A-1, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was performed after sampling was completed by walking the reach.

The samples were returned to the laboratory and the log-in form (Appendix A-3, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was completed.

After sampling was completed at the site, all nets, pans, and etc. that came in contact with a sample was rinsed thoroughly, examined carefully, and picked free of organisms or debris. Any additional organisms found were placed in the sample containers. The equipment was examined again prior to use at the next sampling site.

Field Sampling Procedures for Multihabitat

Different types of habitat were sampled in approximate proportion to their representation of surface area of the total macroinvertebrate habitat in the reach. For example, if snags comprised 50% of the habitat in a reach and riffles comprised 20%,

then 10 kicks were done in snag material and 4 kicks were done in riffle areas. The remainder of the kicks (6) would be done in any remaining habitat type. Habitat types contributing less than 5% of the stable habitat in the stream were not sampled. In this case, the remaining kicks were allocated proportionately among the predominate substrates. The number of kicks done in each habitat was recorded on the field data sheet.

Sampling began at the downstream end of the reach and proceeded upstream. Sampling was done in triplicate. The first replicate (A) was done along the bank on the right. The second replicate (B) was done along the bank on the left. The third replicate (C) was done in the middle of the channel. A total of 20 kicks were done over the length of the reach. A kick was a stationary sampling accomplished by positioning a D-frame dip net (0.3 m width and 0.3 m height and shaped as a "D" with a mesh size of 500 μ) and disturbing the substrate for a distance of 0.5 m upstream of the net.

Kicks collected from the multiple habitats were composited to obtain a single homogenous sample for each replicate. After every 3 kicks or more if necessary, the collected material was washed by running clean stream water through the net two to three times. Large debris was removed after rinsing and inspecting for organisms. Any organisms found were placed into a sample container.

The sample in the net was transferred to a sample container and enough 95 percent ethanol was added to cover the sample. Forceps were used to remove organisms from the net. A label indicating the date, stream name and sampling location was placed on the sample container. This information was recorded in the "Sample log" (Appendix

A-3, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition.

The top portion of the "Benthic Macroinvertebrate Field Data Sheet" (Appendix A-3, Form 1) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was completed.

The percentage of each habitat type in the reach was recorded, and the sampling gear used and the conditions of the sampling, e.g. high flows, treacherous rocks, difficult access to the stream, or anything that would indicate adverse sampling conditions were noted.

Observations of aquatic flora and fauna were documented and qualitative estimates of macroinvertebrate composition and relative abundance as a cursory estimate of ecosystem health and to check adequacy of sampling were made.

Habitat assessment (Appendix A-1, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was performed after sampling was completed by walking the reach.

The samples were returned to the laboratory and the log-in form (Appendix A-3, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was completed.

After sampling was completed at the site, all nets, pans, and etc. that came in contact with a sample was rinsed thoroughly, examined carefully, and picked free of

organisms or debris. Any additional organisms found were placed in the sample containers. The equipment was examined again prior to use at the next sampling site.

Coarse Particulate Organic Matter (CPOM) Sampling Procedures

Sampling began at the downstream end of the reach and proceeded upstream. Sampling was done in triplicate. The first replicate (D) was done along the bank on the right. The second replicate (E) was done along the bank on the left. The third replicate (F) was done in the middle of the channel. Three grab type samples were collected for each replicate. These samples were sorted in the field, composited (i.e., the contents from the three grab samples from each site was combined into a single container) for each replicate, and preserved in 80% ethanol for later subsampling, identification and enumeration.

A composite collection of a variety of CPOM forms (e.g., leaves, needles, twigs, bark, or fragments of these) was collected for each replicate. The material was sampled in depositional areas, such as pools and along snags and undercut banks. The CPOM sample was processed using a U.S. Standard No. 30 sieve, and added to the composite of the replicate grab samples for each site.

A label indicating the date, stream name and sampling location was placed on the sample container. This information was recorded in the "Sample log" (Appendix A-3, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition.

The top portion of the "Benthic Macroinvertebrate Field Data Sheet" (Appendix A-3, Form 1) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable

Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was completed.

The percentage of each habitat type in the reach was recorded, and the sampling gear used and the conditions of the sampling, e.g. high flows, treacherous rocks, difficult access to the stream, or anything that would indicate adverse sampling conditions were noted.

The samples were returned to the laboratory and the log-in form (Appendix A-3, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition was completed.

After sampling was completed at the site, the sieve was rinsed thoroughly, examined carefully, and picked free of organisms or debris. Any additional organisms found were placed in the sample containers. The sieve was examined again prior to use at the next sampling site.

Laboratory Processing For Macroinvertebrate Samples

All samples were dated and recorded in the "Sample Log" notebook or on sample log form (Appendix A-3, Form 2) of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition in the laboratory. All information from the sample container label was included on the sample log sheet. All samples were sorted in a single laboratory to enhance quality control.

The identity and number of organisms were recorded on the Laboratory Bench Sheet (Appendix A-3, Form 3) of the Rapid Bioassessment Protocols for Use in Streams

and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. The life stage of the organisms, the taxonomist's initials and the Taxonomic Certainty Rating (TCR) was recorded as a measure of confidence.

The back of the bench sheet was used to explain certain TCR ratings or condition of organisms. Other comments were included to provide additional insights for data interpretation.

A 100-organism subsample of the benthic macroinvertebrate composite sample from each sampling site was to be taken into the laboratory according to the methods outlined in the Rapid Bioassessment Protocol used by the NJDEP Bureau of Freshwater and Biological Monitoring. With the exception of chironomids and oligochaetes, benthic macroinvertebrates were to be identified to genus. Chironomids were to be identified to subfamily as a minimum, and oligochaetes were to be identified to family as a minimum.

Each individual organism was to be assigned a number and 100 numbers were to be randomly selected out of a hat. The organisms assigned to these numbers were to be the randomly selected sub-sample. Taxa richness (total families) was to be determined by totaling each different family represented in the sub-sample. The EPT (*Ephemeroptera*, *Plecoptera*, and *Trichoptera* orders; mayflies, stoneflies, and caddisflies) Index was to be determined by adding each individual EPT family in the sub-sample. Percent dominance was to be determined by the family that has the greatest number of individuals in the sub-sample. Percent EPT was to be determined by adding the total number of individuals found in all EPT families in the sub-sample. A Modified Family Biotic Index (FBI) was to be determined by $FBI = \Sigma\, x_i\, t_i / n$ where x_i = number of individuals within a family, t_i = tolerance value of a family (in appendix B, Tables C-1

and C-2 of the NJDEP guide), and n = total number of organisms within the sub-sample (100). Taxa richness, EPT Index, percent dominance, percent EPT, and FBI were to be assigned a biometric score of 0, 3, or 6 (in Table 1 of the NJDEP guide) and totaled. A score of 24-30 means the Musquapsink Brook is not impaired, 9-21 means it is moderately impaired, and 0-6 means it is severely impaired. A good or bad land assessment moves a score between a range up or down.

The measurement of physicochemical parameters was also conducted concurrent with the benthic macroinvertebrate sampling. These parameters, pH, temperature, dissolved oxygen, and total dissolved solids (TDS) were conducted by Rutgers University.

For archiving samples, specimen vials, (grouped by station and date), were placed in jars with a small amount of denatured 70% ethanol and tightly capped. The ethanol levels in these jars was examined periodically and replenished as needed. A stick-on label was placed on the outside of the jar indicating sample identifier and date.

Biological Monitoring Results and Discussion

Physical characterization/water quality

The stations sampled in the Musquapsink Brook became deeper moving from an upstream to a downstream location. Station MB1, the most upstream sampling site, is composed of mainly bedrock and had the least amount of water of the other stations (Table 1). Station MB3, further downstream, has more water than MB1 and was composed of sediment and rocks (Table 2). Station MB6, even further downstream, has more water than MB3 and it too has sediment and rocks unlike station MB1 which lacks

sediment (Table 3). Station MB4, the most downstream sampling site, had the most water and was also the slowest moving of the other sites. It was the only site that lacked riffles (Table 4). Tables 1-4 also include information about the stream such as weather conditions during sampling, watershed features, riparian vegetation, instream features, large woody debris, aquatic vegetation, water quality, and sediment and substrate characteristics. The photographs of each station are immediately after the table. The table indicates the number of pages that contain the photographs.

Table 1. Physical characterization/water quality field data sheet for MB1.

Stream Name: Musquapsink Brook	
Station #: MB1	
Investigator: Dr. Marion McClary and students	
Form completed by: Dr. Marion McClary and students	Date: 8/30/07 Time: 8:28 am
Weather conditions:	Clear/sunny, no heavy rain in the last 7 days
Site location/photographs	See the next 3 pages
Watershed features	Predominant surrounding land use: forest and residential, no evidence of local watershed NPS pollution, moderate evidence of local watershed erosion
Riparian vegetation (18 meter buffer)	Trees are the dominant type
Instream features	Estimated reach length: 100 m, width: 2 m, stream depth: < 0.3 m, canopy cover: partly shaded, 40 riffle, 20% pool, 40% run, channelized, no dam present
Large woody debris	LWD: 0 m^2
Aquatic vegetation	0% of the reach with aquatic vegetation
Water quality	No water odors, no surface oils, clear
Sediment/substrate	No odors, no oils, no deposits
Inorganic substrate components % composition in reach (should add up to 100%)	Organic substrate components % composition in sampling area (does not necessarily add up to 100%)
Bedrock: 70%	Detritus: 5%
Boulder: 5%	
Cobble: 20%	Muck-Mud: 0%
Gravel: 5%	
Sand: 0%	Marl: 0%
Silt: 0%	
Clay: 0%	

Table 2. Physical characterization/water quality field data sheet for MB3.

Stream Name: Musquapsink Brook	
Station #: MB3	
Investigator: Dr. Marion McClary and students	
Form completed by: Dr. Marion McClary and students	Date: 8/30/07 Time: 11:07 am
Weather conditions:	70% cloud cover, clear/sunny, heavy rain in the last 7 days, air temperature: 22 ^{o} C
Site location/photographs	See the next 4 pages
Watershed features	Predominant surrounding land use: residential, no evidence of local watershed NPS pollution, moderate evidence of local watershed erosion
Riparian vegetation (18 meter buffer)	Trees and shrubs are the dominant type
Instream features	Estimated reach length: 100 m, width: 5 m, stream depth: < 0.3 m, canopy cover: partly shaded, 30% riffle, 30% pool, 30% run, channelized, no dam present
Large woody debris	LWD: 1 m^2
Aquatic vegetation	0% of the reach with aquatic vegetation
Water quality	No water odors, surface oils, slightly turbid
Sediment/substrate	No odors, no oils, trash
Inorganic substrate components % composition in reach (should add up to 100%)	Organic substrate components % composition in sampling area (does not necessarily add up to 100%)
Bedrock: 0%	Detritus: 60%
Boulder: 0%	
Cobble: 20%	Muck-Mud: 0%
Gravel: 20%	
Sand: 20%	Marl: 0%
Silt: 20%	
Clay: 20%	

Table 3. Physical characterization/water quality field data sheet for MB6.

Stream Name: Musquapsink Brook	
Station #: MB6	
Investigator: Dr. Marion McClary and students	
Form completed by: Dr. Marion McClary and students	Date: 9/13/07 Time: 9:30 am
Weather conditions:	Clear/sunny, heavy rain in the last 7 days, air temperature: 75 ^{o} F
Site location/photographs	See the next 3 pages
Watershed features	Predominant surrounding land use: residential, no evidence of local watershed NPS pollution, no evidence of local watershed erosion
Riparian vegetation (18 meter buffer)	Trees and shrubs are the dominant type
Instream features	Estimated reach length: 100 m, width: 7 m, stream depth: 0.3 m, canopy cover: partly shaded, 20% riffle, 40% pool, 20% run, not channelized, no dam present
Large woody debris	LWD: 1 m^2
Aquatic vegetation	0% of the reach with aquatic vegetation
Water quality	No water odors, no surface oils, slightly turbid to turbid
Sediment/substrate	No odors, no oils, trash
Inorganic substrate components % composition in reach (should add up to 100%)	Organic substrate components % composition in sampling area (does not necessarily add up to 100%)
Bedrock: 0%	Detritus: 20%
Boulder: 5%	
Cobble: 15%	Muck-Mud: 0%
Gravel: 20%	
Sand: 20%	Marl: 10%
Silt: 20%	
Clay: 20%	

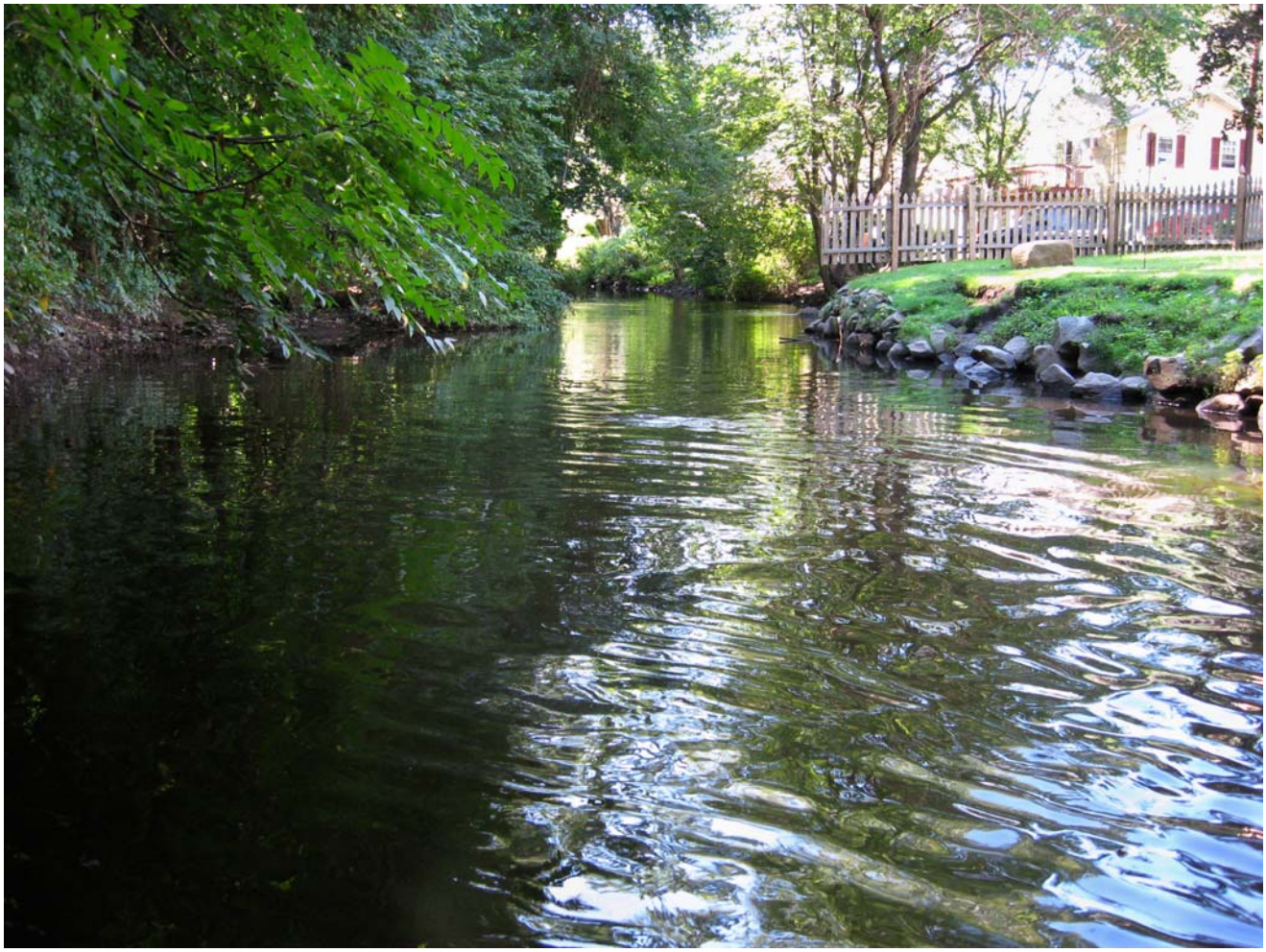
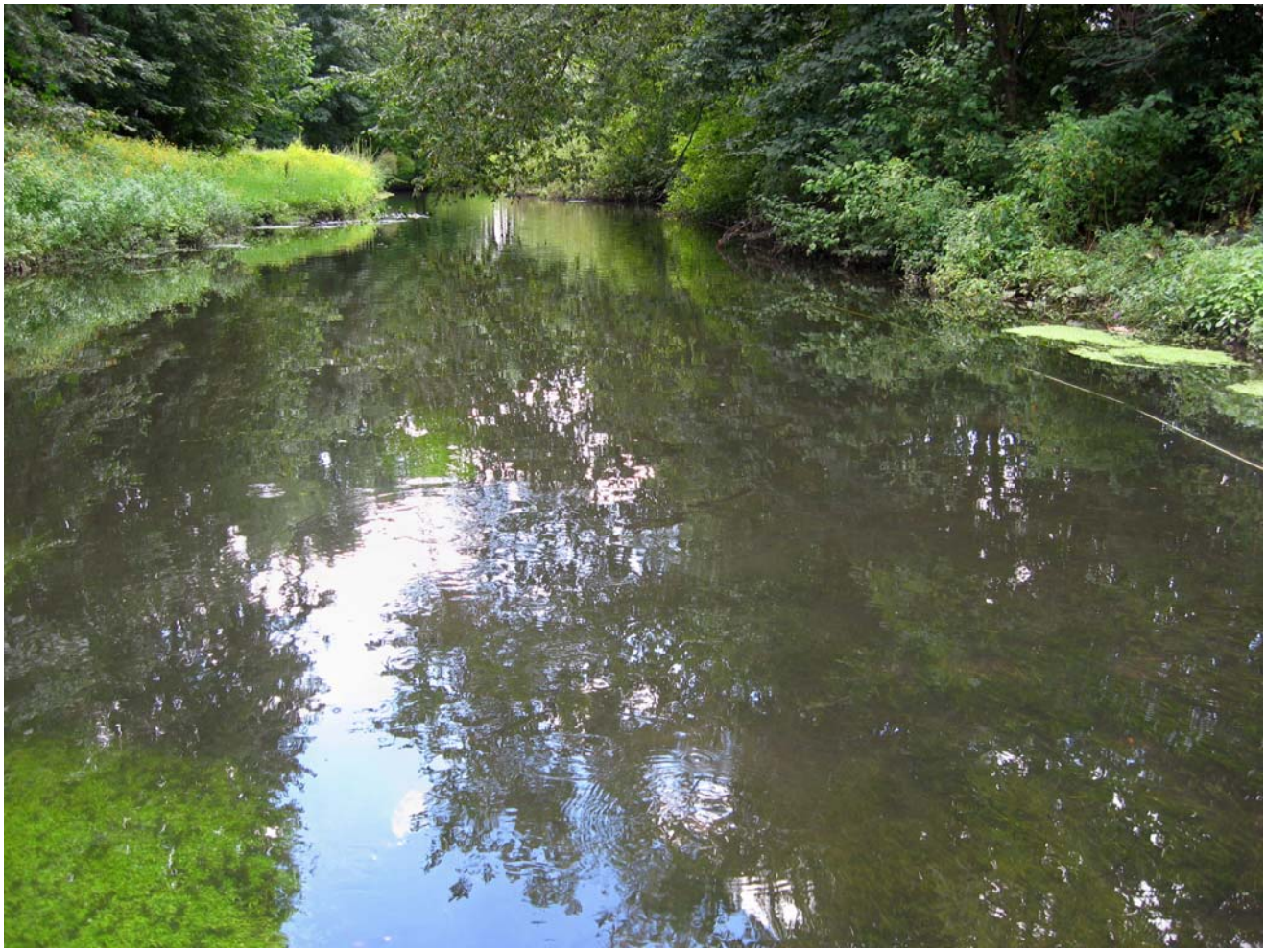


Table 4. Physical characterization/water quality field data sheet for MB4.

Stream Name: Musquapsink Brook	
Station #: MB4	
Investigator: Dr. Marion McClary and students	
Form completed by: Dr. Marion McClary and students	Date: 9/13/07 Time: 11:30 am
Weather conditions:	Clear/sunny, heavy rain in the last 7 days, air temperature: 78 ^{o} F
Site location/photographs	See the next 4 pages
Watershed features	Predominant surrounding land use: park, no evidence of local watershed NPS pollution, no evidence of local watershed erosion
Riparian vegetation (18 meter buffer)	Shrubs are the dominant type
Instream features	Estimated reach length: 100 m, width: 8 m, stream depth: > 1 m, canopy cover: partly shaded, 100% run, channelized, no dam present
Large woody debris	LWD: 1 m^2
Aquatic vegetation	Rooted emergent (70%), rooted submergent (30%) are dominant, 100% of the reach with aquatic vegetation
Water quality	No water odors, no surface oils, turbid
Sediment/substrate	No odors, no oils, no deposits
Inorganic substrate components % composition in reach (should add up to 100%)	Organic substrate components % composition in sampling area (does not necessarily add up to 100%)
Bedrock: 0%	Detritus: 10%
Boulder: 0%	
Cobble: 0%	Muck-Mud: 90%
Gravel: 0%	
Sand: 0%	Marl: 0%
Silt: 50%	
Clay: 50%	



Benthic Macroinvertebrates

Because station MB1 was shallow and had riffles (see Table 1), a surber was used to collect macroinvertebrates. An average of 0 (absent/not observed) were collected from MB1 using this technique and grab samples (Table 5).

Because MB3 was shallow and had riffles (see Table 2), a surber was used to collect macroinvertebrates. An average of 1 (rare) was collected from MB3 using this technique and grab samples (Table 6). Of the macroinvertebrates collected, the most abundant was an average of 1 (rare) which was found for Coleoptera and Trichoptera (Table 6).

Because MB6 was shallow and had riffles (see Table 3), a surber was used to collect macroinvertebrates. An average of 2 (common) was collected from MB6 using this technique and grab samples (Table 7). Of the macroinvertebrates collected, the most abundant was an average of 1 (rare) which was found for Amphipoda, Coleoptera and Chironomidae (Table 7).

Because station MB4 was deep and lacked riffles (see Table 4), a D frame dip was used to collect macroinvertebrates. An average of 1 (rare) was collected from MB4 using this technique and grab samples (Table 8). Of the macroinvertebrates collected, the most abundant was an average of 1 (rare) which was found for Anisoptera and Zygoptera (Table 8).

Table 5. Benthic macroinvertebrate field data sheet for MB1.

Stream Name: Musquapsink Brook								
Station #: MB1								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
Habitat types: % c = cobble, s = snags, vb = vegetated banks, s = sand, sm = submerged veg.				0s				0vb
Sample collection: d = d frame, s = surber, g = grab	s	s	s		g	g	g	
Qualitative listing of aquatic biota: 0 = absent/not observed, 1 = 1-3, 2 = 3-9, 3 = > 10, 4 = > 50 orgs.								
Periphyton	0	0	0	0	0	0	0	0
Filamentous algae	0	0	0	0	0	0	0	0
Macrophytes	0	0	0	0	0	0	0	0
Slimes	0	0	0	0	0	0	0	0
Macroinvertebrates	0	0	0	0	0	0	0	0
Fish	0	0	0	0	0	0	0	0
Field observations of macrobenthos: 0 = absent/not observed, 1 = rare (1-3), 2 = common (3-9), 3 = abundant (>10), 4 = dominant (>50 organisms)								
Porifera	0	0	0	0	0	0	0	0
Hydrozoa	0	0	0	0	0	0	0	0
Platyhelminthes	0	0	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0
Amphipoda	0	0	0	0	0	0	0	0
Decapoda	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0	0
Anisoptera	0	0	0	0	0	0	0	0
Zygoptera	0	0	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0	0	0
Coleoptera	0	0	0	0	0	0	0	0
Lepidoptera	0	0	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0
Empididae	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0
Tabanidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Chironomidae	0	0	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0	0	0
Trichoptera	0	0	0	0	0	0	0	0
Other (Nematocera)	0	0	0	0	0	0	0	0

Table 6. Benthic macroinvertebrate field data sheet for MB3.

Stream Name: Musquapsink Brook								
Station #: MB3								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
Habitat types: % c = cobble, s = snags, vb = vegetated banks, s = sand, sm = submerged veg.				30s				0vb
Sample collection: d = d frame, s = surber, g = grab	s	s	s		g	g	g	
Qualitative listing of aquatic biota: 0 = absent/not observed, 1 = 1-3, 2 = 3-9, 3 = > 10, 4 = > 50 orgs.								
Periphyton	0	0	0	0	0	0	0	0
Filamentous algae	0	0	0	0	0	0	0	0
Macrophytes	0	0	0	0	0	0	0	0
Slimes	0	0	0	0	0	0	0	0
Macroinvertebrates	0	1	3	1.3	1	1	2	1.3
Fish	0	0	0	0	0	0	0	0
Field observations of macrobenthos: 0 = absent/not observed, 1 = rare (1-3), 2 = common (3-9), 3 = abundant (>10), 4 = dominant (>50 organisms)								
Porifera	0	0	0	0	0	0	0	0
Hydrozoa	0	0	0	0	0	0	0	0
Platyhelminthes	0	0	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	1	0	0	0.3
Amphipoda	0	0	0	0	0	0	1	0.3
Decapoda	0	0	1	0.3	1	0	0	0.3
Gastropoda	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0	0
Anisoptera	0	0	0	0	0	0	0	0
Zygoptera	0	0	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0	0	0
Coleoptera	0	1	2	1	0	0	0	0
Lepidoptera	0	0	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0
Empididae	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0
Tabanidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Chironomidae	0	0	1	0.3	0	1	2	1
Ephemeroptera	0	0	0	0	0	0	0	0
Trichoptera	0	0	2	0.7	0	0	0	0
Other (Nematocera)	0	0	0	0	0	0	0	0

Table 7. Benthic macroinvertebrate field data sheet for MB6.

Stream Name: Musquapsink Brook								
Station #: MB6								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
Habitat types: % c = cobble, s = snags, vb = vegetated banks, s = sand, sm = submerged veg.				30s				50vb
Sample collection: d = d frame, s = surber, g = grab	s	s	s		g	g	g	
Qualitative listing of aquatic biota: 0 = absent/not observed, 1 = 1-3, 2 = 3-9, 3 = > 10, 4 = > 50 orgs.								
Periphyton	0	0	0	0	0	0	0	0
Filamentous algae	0	0	0	0	0	0	0	0
Macrophytes	0	0	0	0	0	0	0	0
Slimes	0	0	0	0	0	0	0	0
Macroinvertebrates	2	2	2	2	1	3	2	2
Fish	0	0	0	0	0	0	0	0
Field observations of macrobenthos: 0 = absent/not observed, 1 = rare (1-3), 2 = common (3-9), 3 = abundant (>10), 4 = dominant (>50 organisms)								
Porifera	0	0	0	0	0	0	0	0
Hydrozoa	0	0	0	0	0	0	0	0
Platyhelminthes	0	0	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0
Amphipoda	1	1	0	0.7	1	2	1	1.3
Decapoda	1	0	0	0.3	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0
Bivalvia	0	0	1	0.3	0	1	0	0.3
Anisoptera	0	0	0	0	0	1	0	0.3
Zygoptera	0	0	0	0	0	0	0	0
Hemiptera	0	0	0	0	0	0	0	0
Coleoptera	2	0	0	0.7	0	0	1	0.3
Lepidoptera	0	0	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0
Empididae	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0
Tabanidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Chironomidae	0	1	1	0.7	0	1	1	0.7
Ephemeroptera	0	1	0	0.3	0	0	0	0
Trichoptera	0	0	0	0	0	1	0	0.3
Other (Nematocera)	0	0	0	0	0	0	0	0

Table 8. Benthic macroinvertebrate field data sheet for MB4.

Stream Name: Musquapsink Brook								
Station #: MB4								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
Habitat types: % c = cobble, s = snags, vb = vegetated banks, s = sand, sm = submerged veg.				20s				100 Vb
Sample collection: d = d frame, s = surber, g = grab	d	d	d		g	g	g	
Qualitative listing of aquatic biota: 0 = absent/not observed, 1 = 1-3, 2 = 3-9, 3 = > 10, 4 = > 50 orgs.								
Periphyton	0	0	0	0	0	0	0	0
Filamentous algae	0	0	0	0	0	0	0	0
Macrophytes	0	0	0	0	0	0	0	0
Slimes	0	0	0	0	0	0	0	0
Macroinvertebrates	1	1	1	1	1	1	0	0.7
Fish	0	0	0	0	0	0	0	0
Field observations of macrobenthos: 0 = absent/not observed, 1 = rare (1-3), 2 = common (3-9), 3 = abundant (>10), 4 = dominant (>50 organisms)								
Porifera	0	0	0	0	0	0	0	0
Hydrozoa	0	0	0	0	0	0	0	0
Platyhelminthes	0	0	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0	0	0
Hirudinea	0	0	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0
Amphipoda	0	0	0	0	0	0	0	0
Decapoda	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0	0
Anisoptera	1	1	0	0.7	0	0	0	0
Zygoptera	0	0	1	0.3	1	1	0	0.7
Hemiptera	0	0	0	0	0	0	0	0
Coleoptera	1	0	0	0.3	0	0	0	0
Lepidoptera	0	0	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0
Empididae	0	0	0	0	0	0	0	0
Simuliidae	0	0	0	0	0	0	0	0
Tabanidae	0	0	0	0	0	0	0	0
Culicidae	0	0	0	0	0	0	0	0
Chironomidae	0	0	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0	0	0
Trichoptera	0	0	0	0	0	0	0	0
Other (Nematocera)	0	0	0	0	0	0	0	0

Habitat assessment

Station MB1 is poor for epifaunal substrate/available cover, optimal for embeddedness, marginal for velocity/depth regime, optimal for sediment deposition and marginal for channel flow status for an overall score of marginal (Table 9).

MB3 is suboptimal for epifaunal substrate/available cover, marginal for embeddedness, suboptimal for velocity/depth regime, optimal for sediment deposition and suboptimal for channel flow status for an overall score of suboptimal (Table 10).

MB6 is suboptimal for epifaunal substrate/available cover, poor for embeddedness, suboptimal for velocity/depth regime, optimal for sediment deposition and optimal for channel flow status for an overall score of suboptimal (Table 11)

Station MB4 is marginal for epifaunal substrate/available cover, poor for embeddedness, poor for velocity/depth regime, optimal for sediment deposition and optimal for channel flow status for an overall score of marginal (Table 12).

MB6 having an overall score of suboptimal (Table 11) may be the reason why it was the only station to have a macroinvertebrate collection average of 2 (the number of macroinvertebrates collected is common) (Table 7). When considering the type of macroinvertebrates present, all stations, including MB6, have a collection average of 1 (the number in the different types of macroinvertebrates is rare) or 0 (the macroinvertebrates are absent/not observed). This suggests a lack of diversity or a lack in general. Like MB6, MB3 also has an overall habitat assessment score of suboptimal (Table 10) but it does not have a macroinvertebrate collection average of 2 (Table 6) like MB6. This suggests that the problem is not entirely related to the habitat.

Table 9. Habitat assessment field data sheet for MB1.

Stream Name: Musquapsink Brook				
Habitat parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal substrate/ available cover Score:	Greater than 70% of substrate favorable for the epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. 0
2. Embeddedness Score:	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. 20	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
3. Velocity/depth regime Score:	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). 10	Dominated by 1 velocity/depth regime (usually slow-deep).
4. Sediment deposition Score:	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. 20	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constructions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5. Channel flow status Score:	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. 10	Very little water in channel and mostly present as standing pools.

Table 10. Habitat assessment field data sheet for MB3.

Stream Name: Musquapsink Brook				
Habitat parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal substrate/ available cover Score:	Greater than 70% of substrate favorable for the epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). 14	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2. Embeddedness Score:	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. 6	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
3. Velocity/depth regime Score:	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). 13	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
4. Sediment deposition Score:	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. 20	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constructions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5. Channel flow status Score:	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed. 11	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.

Table 11. Habitat assessment field data sheet for MB6.

Stream Name: Musquapsink Brook				
Habitat parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal substrate/ available cover Score:	Greater than 70% of substrate favorable for the epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). 13	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2. Embeddedness Score:	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. 5
3. Velocity/depth regime Score:	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). 15	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
4. Sediment deposition Score:	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. 20	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constructions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5. Channel flow status Score:	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. 20	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.

Table 12. Habitat assessment field data sheet for MB4.

Stream Name: Musquapsink Brook				
Habitat parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal substrate/ available cover Score:	Greater than 70% of substrate favorable for the epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. 10	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2. Embeddedness Score:	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. 0
3. Velocity/depth regime Score:	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep). 5
4. Sediment deposition Score:	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition. 20	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constructions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5. Channel flow status Score:	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. 20	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.

Benthic Macroinvertebrates

At MB1 no macroinvertebrates were found (Table 13).

At MB3, the Hydropsychidae, the Gammaridae and the Chironomidae averaged 1 individual followed by the Asellidae with 0.3 (Table 14).

At MB6, the Gammaridae averaged 3 individuals by grab samples and 1 individual with the surber followed by the Elmidae, the Chironomidae and the Gomphidae with 1 (Table 15).

At MB4, the Coenagrionidae averaged 1 individual followed by the Psephenidae with 0.3 (Table 16).

Due to the inability of obtaining a 100-organism subsample, even if combining replicates A-C with D-F which could not be done because different techniques were used in replicates A-C and D-F, taxa richness, EPT Index, percent dominance, percent EPT, and FBI were not calculated for a score. This suggests that Musquapsink Brook should receive the most severe level of biological impairment.

Table 13. Benthic macroinvertebrate field data sheet for MB1.

Stream Name: Musquapsink Brook								
Station #: MB1								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda	0	0	0	0	0	0	0	0
# of Amphipoda	0	0	0	0	0	0	0	0
# of Decapoda	0	0	0	0	0	0	0	0
# of Ephemeroptera	0	0	0	0	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera	0	0	0	0	0	0	0	0
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera	0	0	0	0	0	0	0	0
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda	0	0	0	0	0	0	0	0
# of Other	0	0	0	0	0	0	0	0

Table 14. Benthic macroinvertebrate field data sheet for MB3.

Stream Name: Musquapsink Brook								
Station #: MB3								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda, Asellidae	0	0	0	0	1	0	0	0.3
# of Amphipoda, Gammaridae	0	0	0	0	0	0	2	0.7
# of Decapoda, Cambaridae	0	0	1	0.3	1	0	0	0.3
# of Ephemeroptera	0	0	0	0	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera, Hydropsychidae	0	0	4	1.3	0	0	0	0
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera, beetle larva	0	1	3	1.3	0	0	0	0
Elmidae	0	0	1	0.3	0	0	0	0
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda	0	0	0	0	0	0	0	0
# of Other, Nematocera, Chironomidae	0	0	1	0.3	0	1	4	1.7

Table 15. Benthic macroinvertebrate field data sheet for MB6.

Stream Name: Musquapsink Brook								
Station #: MB6								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda, Asellidae	0	1	0	0.3	0	0	0	0
# of Amphipoda, Gammaridae	1	3	0	1.3	2	5	1	2.7
# of Decapoda, Cambaridae	1	0	0	0.3	0	0	0	0
# of Ephemeroptera, Baetidae	0	2	0	0.7	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera, Hydropsychidae	0	0	0	0	0	1	0	0.3
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera, beetle larva	7	0	0	2.3	0	0	0	0
Elmidae	1	0	0	0.3	0	0	2	0.7
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda, Corbiculidae	0	0	3	1	0	1	0	0.3
# of Other, Nematocera, Chironomidae	0	2	1	1	0	1	1	0.7
Anisoptera, Gomphidae	0	0	0	0	0	2	0	0.7

Table 16. Benthic macroinvertebrate field data sheet for MB4.

Stream Name: Musquapsink Brook								
Station #: MB4								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda	0	0	0	0	0	0	0	0
# of Amphipoda	0	0	0	0	0	0	0	0
# of Decapoda	0	0	0	0	0	0	0	0
# of Ephemeroptera	0	0	0	0	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera	0	0	0	0	0	0	0	0
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera, Psephenidae	1	0	0	0.3	0	0	0	0
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda	0	0	0	0	0	0	0	0
# of Other, Anisoptera	1	1	0	0.7	0	0	0	0
Zygoptera, Coenagrionidae	0	2	1	1	2	2	0	1.3

References

NWCC Technical Note 99-1, Stream Visual Assessment Protocol, December 1998. 2 pgs.

Peckarsky, B.L., Fraissinet, P.R., Penton, M.A., and Conklin, Jr., D.J. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell University Press. Ithaca, N.Y. 442 pgs.

Rawlyk, W. 1998. The Common Benthic Macroinvertebrates of New Jersey Streams: A Field Guide to Family Level Identification. William Rawlyk. 101 pgs.

USEPA 1997. Volunteer Monitoring Guide for Macroinvertebrate Sampling and Data Analysis: New Jersey Impairment Score (NJIS) Bioassessment.

USEPA Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers (EPA 841-B-99-002 Nov. 1999).

Musquapsink Brook Benthic Species List

Prepared by:

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for

Rutgers Cooperative Extension Water Resources Program
as part of
RP07-002 Musquapsink Brook Watershed
Restoration and Protection Plan

June 2009

Table 1. Benthic macroinvertebrate field data sheet for MB1.

Stream Name: Musquapsink Brook								
Station #: MB1								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda	0	0	0	0	0	0	0	0
# of Amphipoda	0	0	0	0	0	0	0	0
# of Decapoda	0	0	0	0	0	0	0	0
# of Ephemeroptera	0	0	0	0	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera	0	0	0	0	0	0	0	0
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera	0	0	0	0	0	0	0	0
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda	0	0	0	0	0	0	0	0
# of Other	0	0	0	0	0	0	0	0

Table 2. Benthic macroinvertebrate field data sheet for MB3.

Stream Name: Musquapsink Brook								
Station #: MB3								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda, Asellidae, *Caecidotea* sp.	0	0	0	0	1	0	0	0.3
# of Amphipoda, Gammaridae,	0	0	0	0	0	0	2	0.7
Gammarua fasciatus								
# of Decapoda, Cambaridae	0	0	1	0.3	1	0	0	0.3
Orconectes virilis								
# of Ephemeroptera	0	0	0	0	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera, Hydropsychidae,	0	0	4	1.3	0	0	0	0
Hydropsyche sp.								
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera, beetle larva	0	1	3	1.3	0	0	0	0
Elmidae, *Dubiraphia* sp.	0	0	1	0.3	0	0	0	0
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda	0	0	0	0	0	0	0	0
# of Other, Nematocera, Chironomidae,	0	0	1	0.3	0	1	4	1.7
Axarus sp.								

Table 3. Benthic macroinvertebrate field data sheet for MB6.

Stream Name: Musquapsink Brook								
Station #: MB6								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda, Asellidae, *Caecidotea* sp.	0	1	0	0.3	0	0	0	0
# of Amphipoda, Gammaridae,	1	3	0	1.3	2	5	1	2.7
Gammarus fasciatus								
# of Decapoda, Cambaridae,	1	0	0	0.3	0	0	0	0
Orconectes virilis								
# of Ephemeroptera, Baetidae, *Callibaetis* sp.	0	2	0	0.7	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera, Hydropsychidae,	0	0	0	0	0	1	0	0.3
Hydropsyche sp.								
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera, *Optioservus* sp.	7	0	0	2.3	0	0	0	0
Elmidae, *Dubiraphia* sp.	1	0	0	0.3	0	0	2	0.7
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda, Corbiculidae,	0	0	3	1	0	1	0	0.3
Corbicula fluminea								
# of Other, Nematocera, Chironomidae,	0	2	1	1	0	1	1	0.7
Axarus sp.								
Anisoptera, Gomphidae, *Hagenius* sp.	0	0	0	0	0	2	0	0.7

Table 4. Benthic macroinvertebrate field data sheet for MB4.

Stream Name: Musquapsink Brook								
Station #: MB4								
Investigator: Dr. Marion McClary and students								
A-C are replicates, D-F are replicates	A	B	C	Ave.	D	E	F	Ave.
# of Oligochaeta	0	0	0	0	0	0	0	0
# of Hirudinea	0	0	0	0	0	0	0	0
# of Isopoda	0	0	0	0	0	0	0	0
# of Amphipoda	0	0	0	0	0	0	0	0
# of Decapoda	0	0	0	0	0	0	0	0
# of Ephemeroptera	0	0	0	0	0	0	0	0
# of Plecoptera	0	0	0	0	0	0	0	0
# of Trichoptera	0	0	0	0	0	0	0	0
# of Hemiptera	0	0	0	0	0	0	0	0
# of Megaloptera	0	0	0	0	0	0	0	0
# of Coleoptera, Psephenidae,	1	0	0	0.3	0	0	0	0
Psephenus herricki								
# of Diptera	0	0	0	0	0	0	0	0
# of Gastropoda	0	0	0	0	0	0	0	0
# of Pelecypoda	0	0	0	0	0	0	0	0
# of Other, Anisoptera, *Hagenius* sp.	1	1	0	0.7	0	0	0	0
Zygoptera, Coenagrionidae, *Argia* sp.	0	2	1	1	2	2	0	1.3

References

NWCC Technical Note 99-1, Stream Visual Assessment Protocol, December 1998. 2 pgs.

Peckarsky, B.L., Fraissinet, P.R., Penton, M.A., and Conklin, Jr., D.J. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell University Press. Ithaca, N.Y. 442 pgs.

Rawlyk, W. 1998. The Common Benthic Macroinvertebrates of New Jersey Streams: A Field Guide to Family Level Identification. William Rawlyk. 101 pgs.

Appendix B: Tabulated Stream Visual Assessment Protocol (SVAP) Data

REACH LOCATION	DATE	HYDROLOGIC ALTERATATION	CHANNEL CONDITION	RIPARIANZONE 1	RIPARIAN ZONE 2	BANKSTABILITY	BANKSTABILITY 2	WATER APPEARANCE	NUTRIENT ENRICHMENT	FISH BARRIER	INSTREAM FISHCOVER	POOLS	INVERTEBRATES	CANOPY COVER	MANURE PRESENCE	SALINITY	RIFFLE EMBEDEDNESS	MACROINVERTEBRATES	SITE AVERAGE
E3R005	6/29/07	NA	3	3	1	6	6	5	4	1	3	5	5	1	NA	NA	NA	NA	3.5
GB2R001	5/10/07	1	1	1	3	1	1	10	8	1	8	1	7	7	NA	NA	9	NA	4.7
E4R007	6/29/07	NA	3	5	3	5	7	7	7	7	5	3	7	1	NA	NA	NA	NA	5.0
GD2R001	5/10/07	5	3	5	1	3	5	10	8	1	3	1	7	7	NA	NA	10	NA	5.2
F2R005	7/3/07	NA	7	10	6	7	3	3	7	10	3	3	3	3	NA	NA	NA	NA	5.2
E3R004	6/29/07	NA	5	4	3	3	3	3	3	8	7	7	8	7	NA	NA	NA	NA	5.2
E4R006	6/29/07	NA	1	2	2	3	3	7	7	7	7	5	7	7	NA	NA	NA	NA	5.3
E4R009	6/29/07	NA	6	6	2	2	2	5	6	7	5	3	7	10	NA	NA	NA	NA	5.5
GD2R002	5/10/07	3	1	4	10	1	2	10	9	3	8	3	7	8	NA	NA	9	NA	5.6
GC2R001	4/30/07	5	8	4	8	3	3	10	9	1	3	1	7	8	NA	NA	8	NA	5.7
ge3r002	6/13/07	10	10	8	3	10	7	7	7	1	5	5	3	1	NA	NA	0	NA	5.7
G1R002	7/6/07	NA	1	3	3	7	7	8	7	6	5	5	6	10	NA	NA	NA	NA	5.8
F2R002	7/3/07	NA	6	10	6	8	6	8	7	8	3	5	3	3	NA	NA	NA	NA	5.8
GB2R002	5/10/07	7	7	1	1	5	5	10	10	1	8	1	10	1	NA	NA	10	NA	5.9
GF2R001	5/15/07	7	8	10	10	8	3	3	3	10	5	1	3	10	NA	NA	0	NA	6.0
G1R001	7/6/07	NA	3	8	6	3	5	8	8	5	5	7	7	7	NA	NA	NA	NA	6.1
F3R001	6/29/07	NA	6	5	6	4	4	7	3	7	8	7	7	7	NA	NA	NA	NA	6.2
ge2r002	6/13/07	7	7	9	8	8	9	7	7	4	5	5	7	3	NA	NA	5	NA	6.2
F3R002	6/29/07	NA	7	7	3	7	3	7	7	8	3	6	7	7	NA	NA	NA	NA	6.2
F2R003a	7/6/07	NA	8	10	10	5	2	5	5	7	5	3	7	10	NA	NA	NA	NA	6.4
gf2r004	6/13/07	8	9	10	10	10	9	7	7	3	3	3	3	8	NA	NA	0	NA	6.5

REACH LOCATION	DATE	HYDROLOGIC ALTERATATION	CHANNEL CONDITION	RIPARIANZONE 1	RIPARIAN ZONE 2	BANKSTABILITY	BANKSTABILITY 2	WATER APPEARANCE	NUTRIENT ENRICHMENT	FISH BARRIER	INSTREAM FISHCOVER	POOLS	INVERTEBRATES	CANOPY COVER	MANURE PRESENCE	SALINITY	RIFFLE EMBEDEDNESS	MACROINVERTEBRATES	SITE AVERAGE
GD2R002	5/15/07	8	7	8	10	10	10	10	9	1	5	1	3	10	NA	NA	0	NA	6.6
F2R003b	7/6/07	NA	8	10	7	5	5	9	8	8	5	1	7	7	NA	NA	NA	NA	6.7
ge3r001	6/13/07	10	10	8	5	10	10	7	8	10	5	3	3	1	NA	NA	0	NA	6.7
F2R001	7/3/07	NA	7	5	8	4	7	9	8	8	5	3	7	8	NA	NA	NA	NA	6.7
GC2R002	4/30/07	8	8	10	5	8	8	9	9	3	3	1	7	9	NA	NA	10	NA	6.9
E4R008	6/29/07	NA	7	9	5	5	5	5	7	8	7	5	8	10	NA	NA	NA	NA	6.9
F2R004	7/3/07	NA	9	8	3	5	7	3	7	10	6	7	7	9	NA	NA	NA	NA	7.0
F2R003	7/3/07	NA	5	9	9	9	8	3	7	10	7	8	7	6	NA	NA	NA	NA	7.1
ge2r003	6/13/07	5	8	8	10	6	6	10	8	1	8	7	7	7	NA	NA	10	NA	7.2
ge2r004	6/13/07	7	8	8	10	7	8	10	9	3	5	1	7	10	NA	NA	10	NA	7.2
gf2r003	6/13/07	3	8	9	10	5	5	10	9	3	5	8	7	10	NA	NA	10	NA	7.3
GD2R001	5/15/07	7	8	10	10	2	8	10	9	10	5	1	3	10	NA	NA	10	NA	7.4
GA2R001	5/10/07	8	7	10	10	4	8	10	8	1	8	3	10	10	NA	NA	10	NA	7.5
F3R003	6/29/07	NA	8	10	7	7	7	7	7	8	7	7	7	10	NA	NA	NA	NA	7.7
GE2R002	5/15/07	9	7	10	8	10	10	10	10	0	0	1	3	10	NA	NA	0	NA	7.7
GE2R001	5/15/07	8	8	10	7	10	8	10	9	10	3	1	7	10	NA	NA	8	NA	7.8
GF2R002	5/15/07	8	10	10	10	5	5	10	10	10	8	3	7	10	NA	NA	0	NA	8.3

Appendix C: Quality Assurance Project Plan, RP 07-002 Musquapsink Brook Watershed Restoration Plan, Rutgers Cooperative Extension Water Resources Program

QUALITY ASSURANCE PROJECT PLAN

RP07-002 MUSQUAPSINK BROOK WATERSHED RESTORATION PLAN

Rutgers Cooperative Extension Water Resources Program

January 8, 2007

Revised & Resubmitted April 12, 2007

Revised & Resubmitted May 15, 2007

QUALITY ASSURANCE PROJECT PLAN

RP07-002 MUSQUAPSINK BROOK WATERSHED RESTORATION PLAN

Rutgers Cooperative Extension Water Resources Program

Applicant/
Project Officer:

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Signature Date

QA Officers:

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Signature Date

NJDEP Main Point of Contact:

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Signature Date

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Signature Date

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_____

Signature Date

1. Project Name: Musquapsink Brook
Watershed Restoration Plan

Requested By: Michele Bakacs
New Jersey Department of Environmental Protection

2. This project has been initiated by the New Jersey Department of Environmental Protection to collect data needed to prepare a comprehensive watershed restoration plan for the Musquapsink Brook.

3. Date Project Requested: January 2007

4. Date Project Initiated: May 2007

5. Project Officer: Christopher C. Obropta, Ph.D., P.E.
Rutgers Cooperative Extension Water Resources Program

6. QA Officer: Lisa Galloway Evrard
Rutgers Cooperative Extension Water Resources Program

7. Project Description:

A. Objective and Scope

The proposed watershed study area is the Musquapsink Brook Watershed of Watershed Management Area 5 (WMA 5). The Musquapsink Brook Watershed, Hydrologic Unit Code 02030103170020, is approximately nine square miles in size. Based upon numerous monitoring sources, including the New Jersey Department of Environmental Protection (NJDEP) Ambient Biomonitoring Network (AMNET) program and the NJDEP/United States Geological Survey (USGS) water quality monitoring network, water quality impairments exist in the Musquapsink Brook Watershed.

According to the *New Jersey 2004 Integrated Water Quality Monitoring and Assessment Report*, the Musquapsink Brook maintains the following listings:

- Sublist 3 - No data or information are available to support attainment determination: cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc;
- Sublist 4 - Attainment is threatened or waterbody is impaired; a TMDL has been developed and/or approved or pollution control measures do not require a TMDL: fecal coliform;
- Sublist 5 - Water quality standard is not being attained and requires a TMDL: aquatic life, total phosphorus, and arsenic.

According to the recently adopted 2006 Integrated List, which uses a HUC-14 based water quality impairment listing methodology, the Musquapsink Brook Watershed (HUC 02030103170020), maintains the following listings:

- Sublist 4 for fecal coliform, phosphorus (primary recreation)

- Sublist 5 for drinking water, agricultural use, total dissolved solids (TDS), arsenic, aquatic life (general).

Based on the Total Maximum Daily Load (TMDL) prepared for the Musquapsink Brook at River Vale, USGS 01377499, a 96% reduction in fecal coliform load for 6.6 miles of stream is needed. Additional aquatic life and total phosphorus surface water quality impairments will also need to be addressed through the TMDL process.

B. Data Usage

The data collected in accordance with this Quality Assurance Project Plan (QAPP) will help describe both dry weather and wet weather water quality conditions. These data will provide the information needed to identify and quantify sources of pollution so that appropriate management practices can be implemented to minimize these sources.

C. Monitoring Network Design and Rationale

Sampling Locations:

A draft of this QAPP was forwarded to various stakeholders by Michele Bakacs on 2/16/07 for review and comment. In addition, an overview of the QAPP, in particular a review of all the sampling locations for the study, was presented by the Rutgers Cooperative Extension Water Resources Program at the Northeast NJ Watershed Alliance March meeting on 3/6/07 for review and comment. An additional presentation regarding addressing fecal contamination in the watershed was presented by the Rutgers Cooperative Extension Water Resources Program at the Northeast NJ Watershed Alliance April meeting on 4/10/07 for review and comment.

The sampling locations, following the above referenced presentations, are shown in Attachment A. The eight sampling stations throughout the watershed are as follows:

Musquapsink Brook Proposed Water Quality Stations			
Station ID	Station Name	Northing	Easting
SR1	Saddle River at Grove St., Ridgewood, NJ	604,246	775,678
HB1	Hohokus Brook at Saddle River County Park, Ridgewood, NJ	600,871	775,240
MB1	Musquapsink Brook at Hillsdale Ave, Hillsdale, NJ	612,208	791,635
MB2	Musquapsink Brook at Woodfield, below Schlegel Lake, Washington, NJ	613,070	784,469
MB3	Musquapsink Brook at Ridgewood Ave, Washington, NJ	612,454	782,650
MB4	Musquapsink Brook at Forest Ave, Westwood, NJ	617,409	781,658
MB5	Musquapsink Brook at Third Ave, Westwood, NJ	619,373	783,768
MB6	Musquapsink Brook at Harrington Avenue, Westwood, NJ	623,729	786,736

A WAAS-enable Garmin Rino 120 GPS (global positioning system) unit will be used to locate and identify the sampling locations. Sampling locations will be marked with stakes and surveying tape ***or flags***. Field personnel will take GPS readings in the field to aid in verifying the correct sampling locations during the first sampling event.

Basis for Sampling Locations:
Surface water quality sampling will be conducted to assess the loading inputs of nutrients, total suspended solids and bacteria to the Musquapsink Brook, as well as the movement of nutrients, total suspended solids and bacteria from basin to basin to identify and quantify the sources of pollution under dry weather and wet weather conditions. Biological sampling will be conducted so that the benthic macroinvertebrate community can be better characterized, compared, and evaluated for biological integrity within the study area.

- Location SR1 - Saddle River at Grove Street, Ridgewood was selected to monitor the Saddle River upstream of the United Water interbasin transfer site.
- Location HB1 – Hohokus Brook at Saddle River County Park, Ridgewood was selected to monitor the Hohokus Brook upstream of the United Water interbasin transfer location.
- Location MB1 – Musquapsink Brook at Hillsdale Avenue, Hillsdale was selected to yield water quality information on the headwaters of the Musquapsink Brook.
- Location MB2 – Musquapsink Brook at Woodfield Avenue, Washington was selected to yield water quality information on Musquapsink Brook just downstream of the spillway/discharge from Schlegel Lake and upstream from the interbasin discharge point.
- Location MB3 – Musquapsink Brook at Ridgewood Avenue, Westwood was selected to yield water quality information on the Musquapsink Brook below the interbasin transfer.
- Location MB4 – Musquapsink Brook at Forest Avenue, Westwood was selected to yield water quality information on the Musquapsink Brook downstream from the confluence with an unnamed tributary to the Musquapsink.
- Location MB5 – Musquapsink Brook at Third Avenue, Westwood was selected to yield water quality information on the Musquapsink Brook as the stream flows further downstream through the watershed and to monitor any inputs from the large duck and goose population in this area, as well as drainage from the Beth El and Cedar Park Cemeteries.
- Location MB6 – Musquapsink Brook at Harrington Avenue, Westwood was selected to yield water quality information on the Musquapsink Brook at the most downstream location within the study area prior to the confluence with Pascack Brook.

Temporal and Spatial Aspects:
Biweekly Surface Water Sampling
Surface water quality samples will be collected from all sampling locations in a downstream to upstream order to avoid disturbances to downstream water column samples twice a month, independent of weather, from May through October 2007 (12 events). Three additional surface water quality samples will be collected from all sampling locations in June, July, and August 2007 for fecal coliform and *Eschericia coli* (*E. coli*) analyses (nine additional sampling events). These nine additional sampling events will be independent of precipitation and will allow for a total of five fecal coliform, as well as five *E. coli* analyses at all sampling locations within a 30 day period during the warmer summer months. NJDEP considers the warm weather sampling months to fall between Memorial Day (i.e., May 28, 2007) and Labor Day (i.e., September 3, 2007).

All scheduling is subject to the natural occurrence of appropriate stream flow conditions (i.e., non-flooding conditions). In accordance with the Field Sampling Procedures Manual (See

Section 6.8.1.1, Chapter 6D – page 59 of 188), field personnel will not wade into flowing water when the product of depth (in feet) and velocity (in feet per second) equals ten or greater to ensure the health and safety of all field personnel. If the stream flow conditions preclude entry into the stream, samples will be collected from the closest bridge crossing to that location or from the stream bank.

Bacteriology samples will be collected directly into a bacteriological sample container in accordance with the methods outlined in section 6.8.2.2.7 of the Field Sampling Procedures Manual (See Chapter 6D - page 67 of 188). Composite samples will not be collected for bacteriology samples.

For the most part, the Musquapsink Brook and its tributaries are uniformly mixed, which warrants grab sampling (See Section 6.8.2.2.3, Chapter 6D-Page 66 of 188 of the Field Sampling Procedures Manual). A single grab sample will be collected at all locations where the stream width is six feet or less. At stream locations with a width greater than six feet, a minimum of three subsurface grab samples (i.e., quarter points) will be collected at equidistant points across the stream. The number of individual samples in a composite varies with the width of the stream being sampled. Horizontal intervals will be at least one foot wide (See Section 6.8.2.2.2, Chapter 6D – Page 64 of 188 of the Field Sampling Procedures Manual). These grab samples then will be composited in a larger volume container from which the desired volume will be transferred to the sample bottles. A dedicated large volume container will be assigned to each sample location.

Field equipment used for surface water quality sample collection (i.e., bottles and buckets) will be decontaminated/cleaned in the laboratory prior to each sampling event. A dedicated large volume container will be assigned to each sample location. Prior to each sampling event, the large volume containers will be decontaminated in the laboratory using the following procedures in accordance with the Field Sampling Procedures Manual (See Chapter 2A – Page 10 of 61): 1) laboratory grade glassware detergent plus tap water wash, 2) generous tap water rinse, 3) distilled/deionized water rinse, 4) 10% nitric acid rinse, 5) distilled/deionized water rinse. Note that the samples collected will not be analyzed for metals or organics. Also, field equipment decontamination water will be disposed of in accordance with the laboratory's Standard Operating Procedures and Quality Assurance Manual.

Wet Weather Surface Water Sampling

Three wet weather sampling events, at a minimum, will be conducted between May and October 2007 at each station. The wet weather samples for this plan will be in addition to the 12 biweekly surface water sampling events described above. Collection of stormwater samples will begin at the onset of the storm (i.e., a storm predicted to produce a minimum of ½ inch of precipitation), and an attempt will be made to span the course of the event. By using this method of sampling, the samples should accurately reflect loading for the entire event. A priority will be to acquire first flush samples. Flow will be measured along with concentrations to quantify loading for selected parameters. A total of three samples will be obtained between the onset of the storm and the time when the flow reaches the pre-storm level, unless impractical, at each station during each storm event. At each station, the samples obtained for the entire event will be flow-weight composited to provide one sample from each station, with the exception of fecal

coliform and *E. coli*, which will require analysis of each individual grab sample. Rainfall data will be collected from a rain gauge that will be installed in the watershed.

If three samples can not be collected between the onset of the storm and the time when the flow reaches the pre-storm level, then the sampling event will not count as a wet weather surface water sampling event. If three ½ inch storm events are not captured between May - October 2007, the Water Resources Program, after consultation with the Department, may have to defer the Wet Weather Surface Water Sampling portions of the study to May – October 2008. Attempts will be made to conduct this portion of the study as early on in the study period as possible. Regarding time for collection of the first flush samples, the Water Resources Program will attempt to capture the first flush using the expected or anticipated rising limb of the hydrograph. The actual point on the hydrograph will have to be confirmed after sample completion.

Biological Sampling

Samples of the benthic macroinvertebrate community will be collected in accordance with the Rapid Bioassessment Protocol (RBP) procedure used by the NJDEP Bureau of Freshwater and Biological Monitoring, which is based on USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (EPA 841-B-99-002 Nov. 1999). A multihabitat sampling approach, concentrating on the most productive habitat of the stream plus coarse particulate organic matter (CPOM) or leaf litter, will be used. Benthic macroinvertebrates will be collected from four locations (i.e., MB1, MB3, MB4, and MB6) once in either early summer or late summer as described in Attachment B. The biological sampling locations were selected to bracket the upstream and downstream boundaries of the study areas, as well as to characterize as much of the study area as possible since there are no AMNET monitoring locations on the Musquapsink Brook. In addition, locations with comparable substrate, canopy coverage, and flow conditions were selected within the study area for data comparability.

Summary of Monitoring Network Design and Rational – Temporal and Spatial Aspects

Type:	Biweekly Surface Water Sampling	Additional Bacteriology Sampling	Wet Weather Surface Water Sampling	Biological Sampling
Frequency:	Two (2) times a month from May - October 2007 (12 events)	Three (3) times, in addition to biweekly samples, in June, July, & August 2007 (9 events)	Three (3) times between May - October 2007 (3 events)	One (1) time in either early summer or late summer (1 event)
Parameters:	pH, temperature, dissolved oxygen, stream width, stream depth, stream velocity, ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen, total phosphorus, dissolved orthophosphate phosphorus, total suspended solids, fecal coliform, *E. coli*	Stream width, stream depth, stream velocity, fecal coliform, *E. coli*	pH, temperature, dissolved oxygen, stream width, stream depth, stream velocity, ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen, total phosphorus, dissolved orthophosphate phosphorus, total suspended solids, fecal coliform, *E. coli*	pH, temperature, dissolved oxygen, stream width, stream depth, stream velocity, total dissolved solids, benthic macroinvertebrate survey, habitat assessment
Sampling Locations:				
SR1	X	X	X	
HB1	X	X	X	
MB1	X	X	X	X
MB2	X	X	X	
MB3	X	X	X	X
MB4	X	X	X	X
MB5	X	X	X	
MB6	X	X	X	X

D. Monitoring Parameters

Surface water quality sample collection will be conducted by the Rutgers Cooperative Extension Water Resources Program (RCE WRP). Stream width, stream depth, and stream velocity will be measured in accordance with the methods outlined in Attachment C by the RCE WRP. *In situ* measurements of pH, temperature, and dissolved oxygen will be conducted by the Rutgers EcoComplex Laboratory (NJDEP Certified Laboratory #03019). Collected samples will be analyzed for fecal coliform, ammonia-nitrogen, total Kjeldahl nitrogen, total phosphorus, dissolved orthophosphate phosphorus, and total suspended solids by Bergen County Utilities Authority (NJDEP Certified Laboratory #02268). Collected samples will also be analyzed for nitrate-nitrogen, nitrite-nitrogen, and total dissolved solids by Hampton Clarke Veritech (NJDEP Certified Laboratory #14622) via the Bergen County Utilities Authority. In addition, collected samples will be analyzed for *E. coli* by Garden State Laboratories (NJDEP Certified Laboratory #20044).

Biological sampling will include benthic macroinvertebrate grab/jab type sampling, along with the collection of CPOM. Physicochemical measurements will include total dissolved solids and *in situ* pH, temperature, dissolved oxygen, stream width, stream depth, and stream velocity. Benthic macroinvertebrate sampling and identification will be conducted by Marion McClary, Jr., Ph.D., Associate Professor of Biological Sciences and Associate Director of Biological Sciences at Fairleigh Dickinson University, in accordance with the Rapid Bioassessment Protocol (RBP) procedure used by the NJDEP Bureau of Freshwater and Biological Monitoring, which is based on USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (EPA 841-B-99-002 Nov. 1999). The RCE WRP will make stream width, stream depth, and stream velocity determinations in accordance with the procedures specified in Attachment C. *In situ* measurements of pH, temperature, and dissolved oxygen will be conducted by the Rutgers EcoComplex Laboratory (NJDEP Certified Laboratory #03019). Total dissolved solids will be measured by Hampton Clarke Veritech (NJDEP Certified Laboratory #14622) via the Bergen County Utilities Authority.

E. Parameter Table

Measurements of the sampled parameters will be performed in accordance with Table 1A – List of Approved Biological Methods and Table 1B – List of Approved Inorganic Test Procedures (40 CFR Part 136.3) of Attachment D. Sample containers, preservation techniques, and holding times will be in accordance with Table II (40 CFR Part 136.3) of Attachment E. The Bergen County Utilities Authority, Hampton Clarke Veritech, and Garden State Laboratories will provide appropriate containers for all analyses. Any deviations from the test procedures and/or preservation methods and holding times will be reported to the NJDEP Office of Quality Assurance and will be noted in the final report from the laboratory.

8. Schedule:*

Task	Date
Submit QAPP	January 2007
Conduct biweekly surface water sampling	May – October 2007
Conduct additional bacteriology sampling	June, July, August 2007
Conduct wet weather surface water sampling	May - October 2007
Conduct biological sampling	Early Summer or Late Summer 2007
Submit data and summary report to NJDEP	January 2008

* All scheduling is subject to the natural occurrence of appropriate stream flow conditions (i.e., non-flooding conditions).

9. Project Organization and Responsibility:

Laboratory Operations:	(Bergen CUA)	John Dinice
	(Hampton Clarke V.)	Stanley E. Gilewicz
	(Garden State L.)	Harvey Klein
	(Rutgers EcoComplex)	Lisa Galloway Evrard
	(Fairleigh Dickinson U.)	Marion McClary, Jr.
	(NJDEP Representative)	Marc Ferko
Sampling Operations:	(QA Officer)	Lisa Galloway Evrard
	(NJDEP Representative)	Marc Ferko
Data Processing/	(QA Officer)	Lisa Galloway Evrard
Data Quality Review:	(NJDEP Representative)	Beth Torpey
		Michele Bakacs
Overall QA:	(QA Officer)	Lisa Galloway Evrard
Overall Coordination:	(Project Officer)	Christopher C. Obropta

10. Organizational Chart:

Overall Coordination: Christopher C. Obropta (RCE WRP) Overall QA: Lisa Galloway Evrard (RCE WRP)
Data Quality Review/Data Processing: Lisa Galloway Evrard (RCE WRP) Beth Torpey (NJDEP) Michele Bakacs (NJDEP)
Sampling QC/Sampling Operations: Lisa Galloway Evrard (RCE WRP) Marc Ferko (NJDEP)
Laboratory Operations: John Dinice (Bergen County Utilities Authority) Stanley E. Gilewicz (Hampton Clarke Veritech) Harvey Klein (Garden State Laboratories) Lisa Galloway Evrard (Rutgers EcoComplex) Marion McClary, Jr. (Fairleigh Dickinson University) Marc Ferko (NJDEP)

11. Sampling Procedures:

All sampling procedures will be in conformance with the NJDEP 2005 Field Sampling Procedures Manual, any applicable USEPA guidance, or with prior written approval.

- Bacteriology samples will be collected in accordance with the methods outlined in section 6.8.2.2.7 of the Field Sampling Procedures Manual (See Chapter 6D - page 67 of 188).
- Manual composite sampling for wider portions of the streams will be conducted in accordance with the methods outlined in section 6.8.2.2.2 of the Field Sampling Procedures Manual (See Chapter 6D – page 64 of 188).

- Grab sampling where the natural stream conditions make compositing unnecessary will be conducted in accordance with the methods outlined in section 6.8.2.2.3 of the Field Sampling Procedures Manual (See Chapter 6D – page 66 of 188).

  In addition, instrumentation used for the collection of field data will be properly calibrated, in conformance with the manufacturer's instructions, laboratory SOPs and QA Manuals, and the NJDEP Field Sampling Procedures Manual.

12. Chain of Custody Procedures:

    Chain of Custody procedures will be followed for all samples collected for this monitoring program. A sample chain of custody form is provided in Attachment F. A sample is in someone's "custody" if 1) it is in one's actual physical possession, 2) it is in one's view, after being in one's physical possession, 3) it is in one's physical possession and then locked up so that no one can tamper with it, and 4) it is kept in a secured area, restricted to authorized personnel only.

13. Calibration Procedures and Preventative Maintenance:

    Calibration and preventative maintenance of laboratory and field equipment will be in accordance with the manufacturer's instructions, NJDEP Field Sampling Procedures Manual, NJAC 7:18 and 40 CFR Part 136.

14. Documentation, Data Reduction, and Reporting:

    The QA Officer, for a minimum of five years, will keep all data on file, and all applicable data will be included in the summary report to NJDEP. An electronic version of all reports and data will be provided on a CD for the Department’s use.

15. Quality Assurance and Quality Control:

    NJAC 7:18 and 40 CFR Part 136 will be followed for all quality assurance and quality control (QA/QC) practices, including detection limits, quantitation limits, precision, and accuracy. Tables of parameter detection limits, quantitation limits, accuracy, and precision applicable to this study are provided in Attachment G. Bergen County Utilities Authority, Hampton Clarke Veritech, Garden State Laboratories, and Rutgers Cooperative Extension will perform data validation.

    Lisa Galloway Evrard of the Rutgers Cooperative Extension Water Resources Program will verify the reference/voucher collection prepared by Marion McClary, Jr., Ph.D. (Associate Professor of Biological Sciences and Associate Director of Biological Sciences at Fairleigh Dickinson University).

16. Performance and Systems Audits:

All NJDEP certified laboratories participate ***annually in a NJDEP mandated Performance Testing program.*** The NJDEP Office of Quality Assurance conducts a performance audit of each laboratory that is certified. The NJDEP Office of Quality Assurance also periodically conducts on-site technical systems audits of each certified laboratory. The findings of these audits, together with the ***NJDEP mandated Performance Testing program***, are used to update each laboratory's certification status.

The NJDEP Office of Quality Assurance periodically conducts field audits of project sampling operations. The Office of Quality Assurance will be contacted during the project to schedule a possible field audit.

17. Corrective Action:

All NJDEP certified laboratories must have a written corrective action procedure which they adhere to in the event that calibration standards, performance evaluation results, blanks, duplicates, spikes, etc. are out of the acceptable range or control limits. If the acceptable results cannot be obtained for the above-mentioned QA/QC samples during any given day, sample analysis must be repeated for that day with the acceptable QA/QC results. NJDEP will be notified if there are any deviations from the approved work plan.

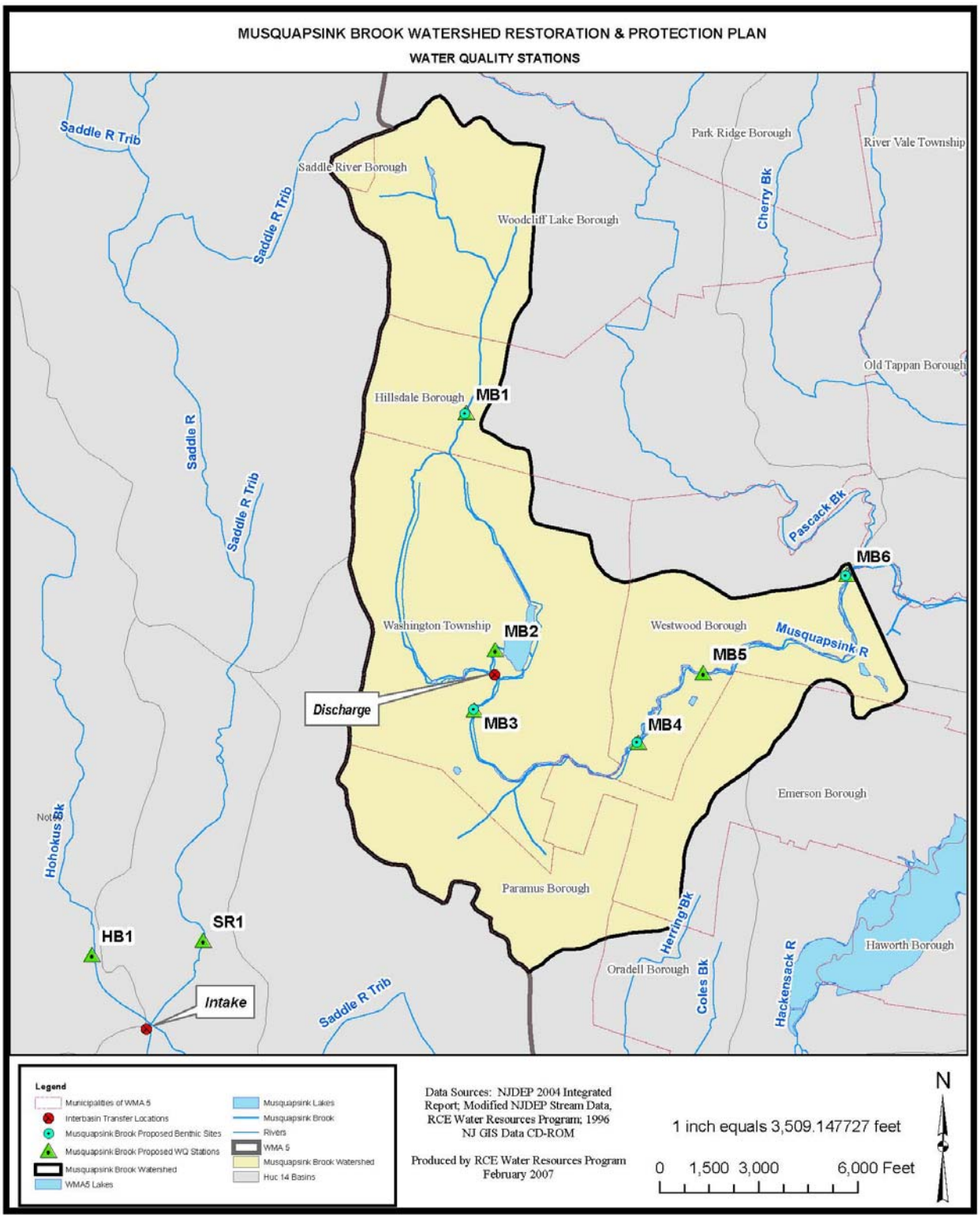
All signatories of this QAPP will be notified when deviations to the QAPP are made prior to their implementation.

18. Reports:

The summary report will include at a minimum an Introduction, Purpose and Scope, Results and Discussion, Conclusions and Recommendations, and an appendix with data tables. An electronic version of all reports and data will be provided on a CD for the Department’s use.

ATTACHMENT A

Sampling Locations
Musquapsink Brook Watershed


MUSQUAPSINK BROOK WATERSHED RESTORATION & PROTECTION PLAN
WATER QUALITY STATIONS
Saddle R Trib
Saddle River Borough
Park Ridge Borough
River Vale Township
Cherry Bk
Woodcliff Lake Borough
Old Tappan Borough
Hillsdale Borough
MB1
Saddle R
Pascack Bk
MB6
Washington Township
MB2
Westwood Borough
Musquapsink R
MB5
Discharge
MB3
MB4
Emerson Borough
Hohokus Bk
Paramus Borough
HB1
SR1
Herring Bk
Haworth Borough
Oradell Borough
Coles Bk
Hackensack R
Intake
Legend
Municipalities of WMA 5
Interbasin Transfer Locations
Musquapsink Brook Proposed Benthic Sites
Musquapsink Brook Proposed WQ Stations
Musquapsink Brook Watershed
WMA5 Lakes
Musquapsink Lakes
Musquapsink Brook
Rivers
WMA 5
Musquapsink Brook Watershed
Huc 14 Basins
Data Sources: NJDEP 2004 Integrated Report; Modified NJDEP Stream Data, RCE Water Resources Program; 1996 NJ GIS Data CD-ROM
Produced by RCE Water Resources Program February 2007
1 inch equals 3,509.147727 feet
0 1,500 3,000 6,000 Feet
N

ATTACHMENT B

Biological Sampling Procedures and Analysis

Biological Sampling Procedures and Analysis

These sampling and data analysis procedures are in accordance with the Rapid Bioassessment Protocol procedures used by the NJDEP Bureau of Freshwater and Biological Monitoring, which is based on USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (EPA 841-B-99-02 Nov. 1999).

Sampling Procedures:
Samples will be collected using a multi-habitat sampling approach, concentrating on the most productive habitat of the stream (i.e., the riffle/run areas), plus coarse particulate organic matter (CPOM) or leaf litter. This sampling method minimizes habitat or substrate variation between sampling sites, and includes all likely functional feeding groups of macroinvertebrates in the stream. Three grab type samples will be collected at each sampling site. These samples will be sorted in the field, composited (i.e., the contents from the three grab samples from each site will be combined into a single container), and preserved in 80% ethanol for later subsampling, identification and enumeration.

A composite collection of a variety of CPOM forms (e.g., leaves, needles, twigs, bark, or fragments of these) will be collected. It is difficult to quantify the amount of CPOM to be collected in terms of weight or volume, given the variability of its composition. Collection of several handfuls of material is usually adequate, and the material is typically found in depositional areas, such as in pools and along snags and undercut banks. The CPOM sample will be processed using a U.S. Standard No. 30 sieve, and added to the composite of the grab samples for each site.

A 100-organism subsample of the benthic macroinvertebrate composite sample from each sampling site will be taken in the laboratory according to the methods outlined in the Rapid Bioassessment Protocol used by the NJDEP Bureau of Freshwater and Biological Monitoring. With the exception of chironomids and oligochaetes, benthic macroinvertebrates will be identified to genus. Chironomids will be identified to subfamily as a minimum, and oligochaetes will be identified to family as a minimum.

A habitat assessment will be conducted concurrent with the benthic macroinvertebrate sampling in accordance with the methods used by the NJDEP Bureau of Freshwater and Biological Monitoring. The measurement of physicochemical parameters will also be conducted concurrent with the benthic macroinvertebrate sampling. Surface water sampling for the measurement of pH, temperature, and dissolved oxygen will be conducted on a representative cross section of the steam. At least four subsurface grab samples will be collected across an established transect. These grab samples will be composited, and an appropriate volume will be transferred to sample bottles for *in situ* measurements of pH, temperature, and dissolved oxygen. Stream width, stream depth, and stream velocity will be measured in accordance with the methods outlined in Attachment C. Total dissolved solids (TDS) will also be measured as part of the biological sampling.

Biological Sampling Procedures and Analysis (continued)

Data Analysis:

The NJDEP Bureau of Freshwater and Biological Monitoring uses several community measures of biometrics adapted from the Rapid Bioassessment Protocols to evaluate the biological condition of sampling sites within the Ambient Biomonitoring Network in New Jersey. These community measures include taxa richness, EPT index, %EPT, %CDF, and Modified Family Biotic Index. This analysis integrates several community parameters into one easily comprehended evaluation of biological integrity referred to as the New Jersey Impairment Score (NJIS). The NJIS has been established for three categories of water quality bioassessment for New Jersey streams: non-impaired, moderately impaired, and severely impaired, and is based on comparisons with reference streams and a historical database consisting of 200 benthic macroinvertebrate samples collected from New Jersey streams.

If the above metrics are not utilized, or if different metrics or indices are used, these changes will be discussed with NJDEP for approval. For example, to determine the similarity among the sampling sites with respect to species composition, the Percentage Similarity Index may be calculated for all pair wise comparisons of the sampling sites. Also, the benthic macroinvertebrates may be separated into the four broad functional feeding groups to evaluate community structure. In addition, the Shannon diversity index may be calculated to evaluate community structure. In addition, the findings from the habitat assessment will be used to interpret survey results and identify obvious constraints on the attainable biological potential of the site.

The final report will include a characterization of the aquatic biota, in particular the benthic macroinvertebrate community.

ATTACHMENT C

Stream Flow Measurement Procedure

Stream Flow Measurement Procedure

Stream width, depth, velocity, and flow determinations will be made in conformance with the following procedures:

1. A measuring tape is extended across the stream, from bank to bank, perpendicular to flow. Meter calibration is checked.

2. Using a Marsh-McBirney, Inc. Model 2000 Flo-Mate Portable Water Flow meter, velocity and depth measurements are made at points along the tape. Normally depth is measured using a rod calibrated in tenths of a foot. In shallow streams, a yardstick may be used to measure depth. Velocities are measured at approximately 0.6 depth (from the surface) where depths are less than 2.5 feet and at 0.2 and 0.8 depth (from the surface) in areas where the depth exceeds 2.5 feet.

3. The stream cross section is divided into segments with depth and velocity measurements made at equal intervals along the cross section. The number of measurements will vary with site conditions and uniformity of stream cross section. Each cross section is divided into equal parts depending upon the total width and uniformity of the section. At a minimum, velocities are taken at quarter points for very narrow sections. In general, velocity and depth measurements are taken every one to five feet. A minimum of ten velocity locations is used whenever possible. The velocity is determined by direct readout from the Marsh-McBirney meter set for 5 second velocity averaging.

4. Using the field data collected, total flow, average velocity, and average depth can be computed. Individual partial cross-sectional areas are computed for each depth and velocity measurement. The mean velocity of flow in each partial area is computed and multiplied by the partial cross-sectional area to produce an incremental flow. Incremental flows are summed to calculate the total flow. The average velocity for the stream can be computed by dividing the total flow by the sum of the partial cross-sectional areas. The average depth for the stream can be computed by dividing the sum of the partial cross-sectional areas by the total width of the stream. The accuracy of this method depends upon a number of factors, which include the uniformity of the steam bottom, total width, and the uniformity of the velocity profile.

- Flow measurements will be collected for all sampling events. However, in accordance with the Field Sampling Procedures Manual (See Section 6.8.1.1, Chapter 6D – page 59 of 188), field personnel will not wade into flowing water when the product of depth (in feet) and velocity (in feet per second) equals ten or greater. All scheduling is subject to the natural occurrence of appropriate stream flow conditions (i.e., non-flooding conditions) to ensure the health and safety of all field personnel. If the stream flow conditions preclude entry into the stream, flow will have to be estimated or calculated based on the recorded flow at the closest USGS gaging station and the drainage area.

ATTACHMENT D

Table 1A – List of Approved Biological Methods
&
Table 1B – List of Approved Inorganic Test Procedures
40 CFR Part 136.3
July 1, 2005

TABLE IA—LIST OF APPROVED BIOLOGICAL METHODS

Parameter and units	Method[1]	EPA	Standard methods 18th, 19th, 20th Ed.	ASTM	AOAC	USGS	Other
Bacteria:							
1. Coliform (fecal), number per 100 mL	Most Probable Number (MPN), 5 tube, 3 dilution, or	p. 132[3]	9221C,E[4]				
	Membrane filter (MF)[2], single step	p. 124[3]	9222D[4]			B–0050–85[5]	
2. Coliform (fecal) in presence of chlorine, number per 100 mL	MPN, 5 tube, 3 dilution, or	p. 132[3]	9221C,E[4]				
	MF, single step[6]	p. 124[3]	9222D[4]				
3. Coliform (total), number per 100 mL	MPN, 5 tube, 3 dilution, or	p. 114[3]	9221B[4]				
	MF[2], single step or two step	p. 108[3]	9222B[4]			B–0025–85[5]	
4. Coliform (total), in presence of chlorine, number per 100 mL	MPN, 5 tube, 3 dilution, or	p. 114[3]	9221B[4]				
	MF[2] with enrichment	p. 111[3]	9222[B+B.5c][4]				
5. *E. coli*, number per 100 mL[28]	MPN[7,9,15], multiple tube,		9221B.1/9221F[4,12,14]				
	multiple tube/multiple well,		9223B[4,13]		991.15[11]		Colilert®[13,17]
	MF[2,6,7,8,9] two step, or		9222B/9222G[4,19]				Colilert-18®[13,16,17]
	single step	1103.1[20] 1603[22] 1604[22]	9213D[4]	D5392–93[10]			
							mColiBlue 24[18]
6. Fecal streptococci, number per 100 mL	MPN, 5 tube, 3 dilution,	p. 139[3]	9230B[4], 9230C[4]				
	MF[2], or	p. 136[3]			B–0055–85[5]		
7. Enterococci, number per 100 mL	Plate count	p. 143[4]	9230B[4]				
	MPN[7,9] multiple tube			D6503–99[10]			Enterolert®[23]
	multiple tube/multiple well	1106.1[24]		D5259–92[10]			
	MF[2,6,7,8,9] two step		9230C[4]				
	single step, or	1600[25]					
	Plate count	p. 143[3]					
Protozoa:							
8. *Cryptosporidium*[28]	Filtration/IMS/FA	1622[26] 1623[27]					
9. *Giardia*[28]	Filtration/IMS/FA	1623[27]					
Aquatic Toxicity:							
10. Toxicity, acute, fresh water organisms, LC50, percent effluent	*Ceriodaphnia dubia* acute	2002.0[29]					

	Sea urchin, *Arbacia punctulata*, fertilization.	1008.0[31]					

Notes to Table IA:

[1] The method must be specified when results are reported.

[2] A 0.45 µm membrane filter (MF) or other pore size certified by the manufacturer to fully retain organisms to be cultivated and to be free of extractables which could interfere with their growth.

[3] USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water, and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8–78/017.

[4] APHA. 1998, 1995, 1992. Standard Methods for the Examination of Water and Wastewater. American Public Health Association. 20th, 19th, and 18th Editions. Amer. Publ. Hlth. Assoc., Washington, D.C.

[5] USGS. 1989. U.S. Geological Survey Techniques of Water-Resource Investigations, Book 5, Laboratory Analysis, Chapter A4, Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples, U.S. Geological Survey, U.S. Department of Interior, Reston, Virginia.

[6] Because the MF technique usually yields low and variable recovery from chlorinated wastewaters, the Most Probable Number method will be required to resolve any controversies.

[7] Tests must be conducted to provide organism enumeration (density). Select the appropriate configuration of tubes/filtrations and dilutions/volumes to account for the quality, character, consistency, and anticipated organism density of the water sample.

[8] When the MF method has not been used previously to test ambient waters with high turbidity, large number of noncoliform bacteria, or samples that may contain organisms stressed by chlorine, a parallel test should be conducted with a multiple-tube technique to demonstrate applicability and comparability of results.

[9] To assess the comparability of results obtained with individual methods, it is suggested that side-by-side tests be conducted across seasons of the year with the water samples routinely tested in accordance with the most current Standard Methods for the Examination of Water and Wastewater or EPA alternate test procedure (ATP) guidelines.

[10] ASTM. 2000, 1999, 1996. Annual Book of ASTM Standards—Water and Environmental Technology. Section 11.02. American Society for Testing and Materials. 100 Barr Harbor Drive, West Conshohocken, PA 19428.

[11] AOAC. 1995. Official Methods of Analysis of AOAC International, 16th Edition, Volume I, Chapter 17. Association of Official Analytical Chemists International. 481 North Frederick Avenue, Suite 500, Gaithersburg, Maryland 20877–2417.

[12] The multiple-tube fermentation test is used in 9221B.1. Lactose broth may be used in lieu of lauryl tryptose broth (LTB), if at least 25 parallel tests are conducted between this broth and LTB using the water samples normally tested, and this comparison demonstrates that the false-positive rate and false-negative rate for total coliform using lactose broth is less than 10 percent. No requirement exists to run the completed phase on 10 percent of all total coliform-positive tubes on a seasonal basis.

[13] These tests are collectively known as defined enzyme substrate tests, where, for example, a substrate is used to detect the enzyme β–glucuronidase produced by *E. coli*.

[14] After prior enrichment in a presumptive medium for total coliform using 9221B.1, all presumptive tubes or bottles showing any amount of gas, growth or acidity within 48 h ± 3 h of incubation shall be submitted to 9221F. Commercially available EC-MUG media or EC media supplemented in the laboratory with 50 µg/mL of MUG may be used.

[15] Samples shall be enumerated by the multiple-tube or multiple-well procedure. Using multiple-tube procedures, employ an appropriate tube and dilution configuration of the sample as needed and report the Most Probable Number (MPN). Samples tested with Colilert® may be enumerated with the multiple-well procedures, Quanti-Tray® or Quanti-Tray® 2000, and the MPN calculated from the table provided by the manufacturer.

[16] Colilert-18® is an optimized formulation of the Colilert® for the determination of total coliforms and *E. coli* that provides results within 18 h of incubation at 35 °C rather than the 24 h required for the Colilert® test and is recommended for marine water samples.

[17] Descriptions of the Colilert®, Colilert-18®, Quanti-Tray®, and Quanti-Tray®/2000 may be obtained from IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092.

[18] A description of the mColiBlue24" test, Total Coliforms and *E. coli*, is available from Hach Company, 100 Dayton Ave., Ames, IA 50010.

[19] Subject total coliform positive samples determined by 9222B or other membrane filter procedure to 9222G using NA-MUG media.

[20] USEPA. 2002. Method 1103.1: *Escherichia coli* (*E. coli*) In Water By Membrane Filtration Using membrane-Thermotolerant *Escherichia coli* Agar (mTEC). U.S. Environmental Protection Agency, Office of Water, Washington D.C. EPA–821–R–02–020.

[21] USEPA. 2002. Method 1603: *Escherichia coli* (*E. coli*) In Water By Membrane Filtration Using Modified membrane-Thermotolerant *Escherichia coli* Agar (modified mTEC). U.S. Environmental Protection Agency, Office of Water, Washington D.C. EPA–821–R–02–023.

[22] Preparation and use of MI agar with a standard membrane filter procedure is set forth in the article, Brenner *et al.* 1993. "New Medium for the Simultaneous Detection of Total Coliform and *Escherichia coli* in Water." Appl. Environ. Microbiol. 59:3534–3544 and in USEPA. 2002. Method 1604: Total Coliforms and *Escherichia coli* (*E. coli*) in Water by Membrane Filtration by Using a Simultaneous Detection Technique (MI Medium). U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA 821–R–02–024.

[23] A description of the Enterolert® test may be obtained from IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092.

[24] USEPA. 2002. Method 1106.1: Enterococci In Water By Membrane Filtration Using membrane-Enterococcus-Esculin Iron Agar (mE-EIA). U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–02–021.

[25] USEPA. 2002. Method 1600: Enterococci in Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-β-D-Glucoside Agar (mEI). U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA–821–R–02–022.

[26] Method 1622 uses filtration, concentration, immunomagnetic separation of oocysts from captured material, immunofluorescence assay to determine concentrations, and confirmation through vital dye staining and differential interference contrast microscopy for the detection of *Cryptosporidium*. USEPA. 2001. Method 1622: Cryptosporidium in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–01–026.

[27] Method 1623 uses filtration, concentration, immunomagnetic separation of oocysts and cysts from captured material, immunofluorescence assay to determine concentrations, and confirmation through vital dye staining and differential interference contrast microscopy for the simultaneous detection of *Cryptosporidium* and *Giardia* oocysts and cysts. USEPA. 2001. Method 1623. Cryptosporidium and Giardia in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–01–025.

[28] Recommended for enumeration of target organism in ambient water only.

[29] USEPA. October 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fifth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R–02/012.
[30] USEPA. October 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R–02/013.
[31] USEPA. October 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. Third Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R–02/014.

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES

Parameter, units and method	Reference (method number or page)				
	EPA[1,31]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
1. Acidity, as $CaCO_3$, mg/L:					
Electrometric endpoint or phenolphthalein endpoint.	305.1	2310 B(4a) [18th, 19th, 20th]	D1067–92	I–1020–85	
				I–2030–85	
2. Alkalinity, as $CaCO_3$, mg/L:					
Electrometric or Colorimetric titration to pH 4.5, manual or automatic.	310.1	2320 B [18th, 19th, 20th]	D1067–92	I–1030–85	973.43[3]
	310.2.			I–2030–85	
3. Aluminium—Total,[4] mg/L.: Digestion[4] followed by:					
AA direct aspiration[36]	202.1	3111 D [18th, 19th]		I–3051–85	
AA furnace	202.2	3113 B [18th, 19th]			
Inductively Coupled Plasma/Atomic Emission Spectrometry (ICP/AES)[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[59]	
Direct Current Plasma (DCP)[36]			D4190–94		Note 34.
Colorimetric (Eriochrome cyanine R).		3500–Al B [20th] and 3500–Al D [18th, 19th].			
4. Ammonia (as N), mg/L:					
Manual, distillation (at pH 9.5)[6] followed by:	350.2	4500–NH_3 B [18th, 19th, 20th]			973.49[3]
Nesslerization	350.2	4500–NH_3 C [18th]	D1426–98(A)	I–3520–85	973.49[3]
Titration	350.2	4500–NH_3 C [19th, 20th] and 4500–NH_3 E [18th]			
Electrode	350.3	4500–NH_3 D or E [19th, 20th] and 4500–NH_3 F or G [18th]	D1426–98(B).		
Automated phenate, or	350.1	4500–NH_3 G [19th, 20th] and 4500–NH_3 H [18th].		I–4523–85	
Automated electrode					Note 7.
5. Antimony-Total,[4] mg/L.: Digestion[4] followed by:					
AA direct aspiration[36]	204.1	3111 B [18th, 19th]			
AA furnace	204.2	3113 B [18th, 19th]			
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]			
6. Arsenic-Total[4] mg/L:					

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	Reference (method number or page)				
	EPA[1,33]	*Standard Methods* (Edition[s])	ASTM	USGS[2]	Other
Titrimetric (EDTA), or Ca plus Mg as their carbonates, by inductively coupled plasma or AA direct aspiration. (See Parameters 13 and 33)	130.2	2340 B or C [18th, 19th, 20th]	D1126–86(92)	I–1338–85	973.52B[3]
28. Hydrogen ion (pH), pH units: Electrometric measurement, or	150.1	4500–H+ B [18th, 19th, 20th]	D1293–84 (90)(A or B)	I–1586–85	973.41[3]
Automated electrode				I–2587–85	Note 21.
29. Indium—Total[4] mg/L, Digestion[4] followed by:					
AA direct aspiration or	235.1	3111 B [18th, 19th]			
AA furnace	235.2				
30. Iron—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration[36]	236.1	3111 B or C [18th, 19th]	D1068–96(A or B)	I–3381–85	974.27[3]
AA furnace	236.2	3113 B [18th, 19th]	D1068–96(C)		
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[39]	
DCP[34] or			D4190–94		Note 34.
Colorimetric (Phenanthroline)		3500–Fe B [20th] and 3500–Fe D [18th, 19th]	D1068–96(D)		Note 22.
31. Kjeldahl Nitrogen—Total, (as N), mg/L:					
Digestion and distillation followed by	351.3	4500–N_{org} B or C and 4500–NH_3 B [18th, 19th, 20th]	D3590–89(A)		973.48[3]
Titration	351.3		D3590–89(A)		
Nesslerization	351.3	4500–NH_3 C [18th]	D3590–89(A)		
Electrode	351.3	4500–NH_3 C [19th, 20th] and 4500–NH_3 E [18th]		I–4551–78[38]	
Automated phenate colorimetric	351.1			I–4515–91[45]	
Semi-automated block digestor colorimetric.	351.2		D3590–89(B)		
Manual or block digestor potentiometric.	351.4		D3590–89(A)		
Block digester, followed by Auto distillation and Titration, or:					Note 39.
Nesslerization, or					Note 40.
Flow injection gas diffusion					Note 41.
32. Lead—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration[36]	239.1	3111 B or C [18th, 19th]	D3559–96(A or B)	I–3399–85	974.27[3]

AA furnace	239.2	3113 B [18th, 19th]	D3559–96(D)	I–4403–89[51]	
ICP/AES [36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[59]	
DCP [34]			D4190–94		Note 34.
Voltametry[11] or			D3559–96(C)		
Colorimetric (Dithizone)		3500–Pb B [20th] and 3500–Pb D [18th, 19th].			
33. Magnesium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	242.1	3111 B [18th, 19th]	D511–93(B)	I–3447–85	974.27[3]
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[59]	
DCP or					Note 34.
Gravimetric		3500–Mg D [18th, 19th]			
34. Manganese–Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	243.1	3111 B [18th, 19th]	D858–95(A or B)	I–3454–85	974.27[3]
AA furnace	243.2	3113 B [18th, 19th]	D858–95(C)		
ICP/AES [36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[59]	
DCP [36], or			D4190–94		Note 34.
Colorimetric (Persulfate), or		3500–Mn B [20th] and 3500–Mn D [18th, 19th]			920.203[3]
(Periodate)					Note 23.
35. Mercury—Total,[4] mg/L:					
Cold vapor, manual or	245.1	3112 B [18th, 19th]	D3223–91	I–3462–85	977.22[3]
Automated	245.2				
Oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry (ng/L).	1631E[43]				
36. Molybdenum—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	246.1	3111 D [18th, 19th]		I–3490–85	
AA furnace	246.2	3113 B [18th, 19th]		I–3492–96[47]	
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[59]	Note 34.
DCP					
37. Nickel—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	249.1	3111 B or C [18th, 19th]	D1886–90(A or B)	I–3499–85	
AA furnace	249.2	3113 B [18th, 19th]	D1886–90(C)	I–4503–89[51]	
ICP/AES [36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[59]	
DCP [36], or			D4190–94		Note 34.
Colorimetric (Heptoxime)		3500–Ni D [17th]			
38. Nitrate (as N), mg/L:					973.50,[3] 419D,[17] p. 28[9]
Colorimetric (Brucine sulfate), or Nitrate-nitrite N minus Nitrite N (See parameters 39 and 40).	352.1				
39. Nitrate-nitrite (as N), mg/L:					
Cadmium reduction, Manual or:	353.3	4500–NO_3–E [18th, 19th, 20th]	D3867–99(B).		

Nitrate: EPA 300.0; Ion Chromatography

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	Reference (method number or page)				
	EPA[1,35]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
Automated, or	353.2	4500-NO_3^- F [18th, 19th, 20th]	D3867–99(A)	I–4545–85	
Automated hydrazine	353.1	4500-NO_3^- H [18th, 19th, 20th]			
40. Nitrite (as N), mg/L: Spectrophotometric: Manual or	354.1	4500-NO_2^- B [18th, 19th, 20th]		I–4540–85	Note 25.
Automated (Diazotization)					
41. Oil and grease—Total recoverable, mg/L: Gravimetric (extraction)	413.1	5520B [18th, 19th, 20th][38]			
Oil and grease and nonpolar material, mg/L: Hexane extractable material (HEM): n-Hexane extraction and gravimetry.	1664A[42]	5520B [18th, 19th, 20th][38]			
Silica gel treated HEM (SGT-HEM): Silica gel treatment and gravimetry.	1664A[42]				
42. Organic carbon—Total (TOC), mg/L: Combustion or oxidation	415.1	5310 B, C, or D [18th, 19th, 20th]	D2579–93 (A or B)		973.47,[3] p. 14[24]
43. Organic nitrogen (as N), mg/L: Total Kjeldahl N (Parameter 31) minus ammonia N (Parameter 4).					
44. Orthophosphate (as P), mg/L: Ascorbic acid method: Automated, or	365.1	4500–P F [18th, 19th, 20th]		I–4601–85	973.56[3]
Manual single reagent	365.2	4500–P E [18th, 19th, 20th]	D515–88(A)		973.55[3]
Manual two reagent	365.3				
45. Osmium—Total[4], mg/L: Digestion[4] followed by: AA direct aspiration, or	252.1	3111 D [18th, 19th]			
AA furnace	252.2				
46. Oxygen, dissolved, mg/L: Winkler (Azide modification), or	360.2	4500–O C [18th, 19th, 20th]	D888–92(A)	I–1575–78[8]	973.45B[3]
Electrode	360.1	4500–O G [18th, 19th, 20th]	D888–92(B)	I–1576–78[8]	

Nitrite: EPA 300.0, Ion Chromatography

47. Palladium—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration, or	253.1	3111 B [18th, 19th].			p. S27[10]
AA furnace	253.2				p. S28[10]
DCP					Note 34.
48. Phenols, mg/L:					
Manual distillation[26]	420.1				Note 27.
Followed by:					
Colorimetric (4AAP) manual, or	420.1				Note 27.
Automated[19]	420.2.				
49. Phosphorus (elemental), mg/L:					Note 28.
50. Phosphorus—Total, mg/L:					
Persulfate digestion followed by:	365.2	4500–P B, 5 [18th, 19th, 20th].			973.55[3]
Manual or	365.2 or 365.3	4500–P E [18th, 19th, 20th].	D515–88(A)	I–4600–85	973.56[3]
Automated ascorbic acid reduction.	365.1	4500–P F [18th, 19th, 20th].			
Semi-automated block digestor.	365.4		D515–88(B)	I–4610–91[48]	
51. Platinum—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration	255.1	3111 B [18th, 19th].			
AA furnace	255.2.				
DCP					Note 34.
52. Potassium—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration	258.1	3111 B [18th, 19th].			
ICP/AES	200.7[6]	3120 B [18th, 19th, 20th].		I–3630–85	973.53[3]
Flame photometric, or		3500–K B [20th] and 3500–K D [18th, 19th].			
Colorimetric					Note 34.
53. Residue—Total, mg/L:					317 B[17]
Gravimetric, 103–105°	160.3	2540 B [18th, 19th, 20th].		I–3750–85.	
54. Residue—filterable, mg/L:					
Gravimetric, 180°	160.1	2540 C [18th, 19th, 20th].		I–1750–85.	
55. Residue—nonfilterable (TSS), mg/L:					
Gravimetric, 103–105° post washing of residue.	160.2	2540 D [18th, 19th, 20th].		I–3765–85.	
56. Residue—settleable, mg/L:					
Volumetric, (Imhoff cone), or gravimetric.	160.5	2540 F [18th, 18th, 20th].			
57. Residue—Volatile, mg/L:					
Gravimetric, 550°	160.4			I–3753–85.	
58. Rhodium-Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration, or	265.1	3111 B [18th, 19th].			

Colorimetric (methylene blue)	376.2		4500–S^{-2}D [18th, 19th, 20th]			
67. Sulfite (as SO_3), mg/L: Titrimetric (iodine-iodate)	377.1		4500–SO_3^{-2}B [18th, 19th, 20th]			
68. Surfactants, mg/L: Colorimetric (methylene blue)	425.1		5540 C [18th, 19th, 20th]	D2330–88		
69. Temperature, °C: Thermometric	170.1		2550 B [18th, 19th, 20th]			Note 32.
70. Thallium—Total,[4] mg/L; Digestion[4] followed by:						
AA direct aspiration	279.1		3111 B [18th, 19th].			
AA furnace	279.2					
ICP/AES	200.7[5]		3120 B [18th, 19th, 20th].			
71. Tin—Total,[4] mg/L; Digestion[4] followed by:						
AA direct aspiration	282.1		3111 B [18th, 19th]		I–3850–78[8]	
AA furnace, or	282.2		3113 B [18th, 19th]			
ICP/AES	200.7[5]					
72. Titanium—Total,[4] mg/L; Digestion[4] followed by:						
AA direct aspiration	283.1		3111 D [18th, 19th].			
AA furnace	283.2.					
DCP						Note 34.
73. Turbidity, NTU: Nephelometric	180.1		2130 B [18th, 19th, 20th]	D1889–94(A)	I–3860–85.	
74. Vanadium—Total,[4] mg/L; Digestion[4] followed by:						
AA direct aspiration	286.1		3111 D [18th, 19th].			
AA furnace	286.2			D3373–93.		
ICP/AES	200.7[5]		3120 B [18th, 19th, 20th]		I–4471–97[59]	
DCP, or				D4190–94		Note 34.
Colorimetric (Gallic Acid)			3500–V B [20th] and 3500–V D [18th, 19th]			
75. Zinc—Total,[4] mg/L; Digestion[4] followed by:						
AA direct aspiration[36]	289.1		3111 B or C [18th, 19th]	D1691–95(A or B)	I–3900–85	974.27,3 p. 37[9]
AA furnace	289.2.					
ICP/AES[36]	200.7[5]		3120 B [18th, 19th, 20th]		I–4471–97[59]	
DCP[36] or				D4190–94		Note 34.
Colorimetric (Dithizone) or			3500–Zn E [18th, 19th]			
(Zincon)			3500–Zn B [20th] and 3500–Zn F [18th, 19th].			Note 33.

Table 1B Notes:

[1] "Methods for Chemical Analysis of Water and Wastes," Environmental Protection Agency, Environmental Monitoring Systems Laboratory—Cincinnati (EMSL-CI), EPA–600/4–79–020, Revised March 1983 and 1979 where applicable.

[2] Fishman, M.J., *et al.* "Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments," U.S. Department of the Interior, Techniques of Water-Resource Investigations of the U.S. Geological Survey, Denver, CO, Revised 1989, unless otherwise stated.

[3] "Official Methods of Analysis of the Association of Official Analytical Chemists," methods manual, 15th ed. (1990).

[4] For the determination of total metals the sample is not filtered before processing. A digestion procedure is required to solubilize suspended material and to destroy possible organic-metal complexes. Two digestion procedures are given in "Methods for Chemical Analysis of Water and Wastes, 1979 and 1983". One (Section 4.1.3), is a vigorous digestion using nitric acid. A less vigorous digestion using nitric and hydrochloric acids (Section 4.1.4) is preferred; however, the analyst should be cautioned that this mild digestion may not suffice for all samples types. Particularly, if a colorimetric procedure is to be employed, it is necessary to ensure that all organo-metallic bonds be broken so that the metal is in a reactive state. In those situations, the vigorous digestion is to be preferred making certain that at no time does the sample go to dryness. Samples containing large amounts of organic materials may also benefit by this vigorous digestion, however, vigorous digestion with concentrated nitric acid will convert antimony and tin to insoluble oxides and render them unavailable for analysis. Use of ICP/AES as well as determinations for certain elements such as antimony, arsenic, the noble metals, mercury, selenium, silver, tin, and titanium require a modified sample digestion procedure and in all cases the method write-up should be consulted for specific instructions and/or cautions.

NOTE TO TABLE 1B NOTE 4: If the digestion procedure for direct aspiration AA included in one of the other approved references is different than the above, the EPA procedure must be used. Dissolved metals are defined as those constituents which will pass through a 0.45 micron membrane filter. Following filtration of the sample, the referenced procedure for total metals must be followed. Sample digestion of the filtrate for dissolved metals (or digestion of the original sample solution for total metals) may be omitted for AA (direct aspiration or graphite furnace) and ICP analyses, provided the sample solution to be analyzed meets the following criteria:

a. has a low COD (<20)

b. is visibly transparent with a turbidity measurement of 1 NTU or less

c. is colorless with no perceptible odor, and

d. is of one liquid phase and free of particulate or suspended matter following acidification.

[5] The full text of Method 200.7, "Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," is given at Appendix C of this Part 136.

[6] Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary: however, manual distillation will be required to resolve any controversies.

[7] Ammonia, Automated Electrode Method, Industrial Method Number 379–75 WE, dated February 19, 1976, Bran & Luebbe (Technicon) Auto Analyzer II, Bran & Luebbe Analyzing Technologies, Inc., Elmsford, NY 10523.

[8] The approved method is that cited in "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments", USGS TWRI, Book 5, Chapter A1 (1979).

[9] American National Standard on Photographic Processing Effluents, Apr. 2, 1975. Available from ANSI, 25 West 43rd Street, New York, NY 10036.

[10] "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency", Supplement to the Fifteenth Edition of Standard Methods for the Examination of Water and Wastewater (1981).

[11] The use of normal and differential pulse voltage ramps to increase sensitivity and resolution is acceptable.

[12] Carbonaceous biochemical oxygen demand ($CBOD_5$) must not be confused with the traditional BOD_5 test method which measures "total BOD". The addition of the nitrification inhibitor is not a procedural option, but must be included to report the $CBOD_5$ parameter. A discharger whose permit requires reporting the traditional BOD_5 may not use a nitrification inhibitor in the procedure for reporting the results. Only when a discharger's permit specifically states $CBOD_5$ is required can the permittee report data using a nitrification inhibitor.

[13] OIC Chemical Oxygen Demand Method, Oceanography International Corporation, 1978, 512 West Loop, PO Box 2980, College Station, TX 77840.

[14] Chemical Oxygen Demand, Method 8000, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[15] The back titration method will be used to resolve controversy.

[16] Orion Research Instruction Manual, Residual Chlorine Electrode Model 97–70, 1977, Orion Research Incorporated, 840 Memorial Drive, Cambridge, MA 02138. The calibration graph for the Orion residual chlorine method must be derived using a reagent blank and three standard solutions, containing 0.2, 1.0, and 5.0 mL 0.00281 N potassium iodate/100 mL solution, respectively.

[17] The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1976.

[18] National Council of the Paper Industry for Air and Stream Improvement, Inc. Technical Bulletin 253, December 1971.

[19] Copper, Biocinchoinate Method, Method 8506, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[20] After the manual distillation is completed, the autoanalyzer manifolds in EPA Methods 335.3 (cyanide) or 420.2 (phenols) are simplified by connecting the re-sample line directly to the sampler. When using the manifold setup shown in Method 335.3, the buffer 6.2 should be replaced with the buffer 7.6 found in Method 335.2.

[21] Hydrogen ion (pH) Automated Electrode Method, Industrial Method Number 378–75WA, October 1976, Bran & Luebbe (Technicon) Autoanalyzer II. Bran & Luebbe Analyzing Technologies, Inc., Elmsford, NY 10523.

[22] Iron, 1,10-Phenanthroline Method, Method 8008, 1980, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[23] Manganese, Periodate Oxidation Method, Method 8034, Hach Handbook of Wastewater Analysis, 1979, pages 2–113 and 2–117, Hach Chemical Company, Loveland, CO 80537.

[24] Wershaw, R.L., *et al*, "Methods for Analysis of Organic Substances in Water," Techniques of Water-Resources Investigation of the U.S. Geological Survey, Book 5, Chapter A3, (1972 Revised 1987) p. 14.

[25] Nitrogen, Nitrite, Method 8507, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[26] Just prior to distillation, adjust the sulfuric-acid-preserved sample to pH 4 with 1 + 9 NaOH.

[27] The approved method is cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition. The colorimetric reaction is conducted at a pH of 10.0±0.2. The approved methods are given on pp 576–81 of the 14th Edition: Method 510A for distillation, Method 510B for the manual colorimetric procedure, or Method 510C for the manual spectrometric procedure.

[28] R.F. Addison and R.G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," Journal of Chromatography, Vol. 47, No. 3, pp. 421–426, 1970.

[29] Approved methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/L and above are inadequate where silver exists as an inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to pH of 12. Therefore, for levels of silver above 1 mg/L, 20 mL of sample should be diluted to 100 mL by adding 40 mL each of 2 M $Na_2S_2O_3$ and NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/L the approved method is satisfactory.

[30] The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 15th Edition.

[31] EPA Methods 335.2 and 335.3 require the NaOH absorber solution final concentration to be adjusted to 0.25 N before colorimetric determination of total cyanide.
[32] Stevens, H.H., Ficke, J.F., and Smoot, G.F. "Water Temperature—Influential Factors, Field Measurement and Data Presentation," Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 1, Chapter D1, 1975.
[33] Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2–231 and 2–333, Hach Chemical Company, Loveland, CO 80537.
[34] Trace Direct Current Plasma (DCP) Optical Emission Spectrometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029, 1986—Revised 1991, Thermo Jarrell Ash Corporation, 27 Forge Parkway, Franklin, MA 02038.
[35] Precision and recovery statements for the atomic absorption direct aspiration and graphite furnace methods, and for the spectrophotometric SDDC method for arsenic are provided in Appendix D of this part titled, "Precision and Recovery Statements for Methods for Measuring Metals".
[36] "Closed Vessel Microwave Digestion of Wastewater Samples for Determination of Metals", CEM Corporation, P.O. Box 200, Matthews, NC 28106–0200, April 16, 1992. Available from the CEM Corporation.
[37] When determining boron and silica, only plastic, PTFE, or quartz laboratory ware may be used from start until completion of analysis.
[38] Only use Trichlorotrifluoroethane (1,1,2-trichloro-1,2,2-trifluoroethane); CFC–113) extraction solvent when determining Total Recoverable Oil and Grease (analogous to EPA Method 413.1) Only use *n*-hexane extraction solvent when determining Hexane Extractable Material (analogous to EPA Method 1664A). Use of other extraction solvents is strictly prohibited.
[39] Nitrogen, Total Kjeldahl, Method PAI-DK01 (Block Digestion, Steam Distillation, Titrimetric Detection), revised 12/22/94, OI Analytical/ALPKEM, P.O. Box 9010, College Station, TX 77842.
[40] Nitrogen, Total Kjeldahl, Method PAI-DK02 (Block Digestion, Steam Distillation, Colorimetric Detection), revised 12/22/94, OI Analytical/ALPKEM, P.O. Box 9010, College Station, TX 77842.
[41] Nitrogen, Total Kjeldahl, Method PAI-DK03 (Block Digestion, Automated FIA Gas Diffusion), revised 12/22/94, OI Analytical/ALPKEM, P.O. Box 9010, College Station, TX 77842.
[42] Method 1664, Revision A, "N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry" EPA–821–R–98–002, February 1999. Available at NTIS, PB–121949, U.S. Department of Commerce, 5285 Port Royal, Springfield, Virginia 22161.
[43] USEPA. 2002. Method 1631, Revision E. "Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry." September 2002. Office of Water, U.S. Environmental Protection Agency (EPA–821–R–02–019). The application of clean techniques described in EPA's draft Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (EPA–821–R–96–011) are recommended to preclude contamination at low-level, trace metal determinations.
[44] Available Cyanide, Method OIA–1677 (Available Cyanide by Flow Injection, Ligand Exchange, and Amperometry). ALPKEM, A Division of OI Analytical, P.O. Box 9010, College Station, TX 77842–9010.
[45] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Ammonia Plus Organic Nitrogen by a Kjeldahl Digestion Method", Open File Report (OFR) 00–170.
[46] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Chromium in Water by Graphite Furnace Atomic Absorption Spectrophotometry", Open File Report (OFR) 93–449.
[47] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Molybdenum by Graphite Furnace Atomic Absorption Spectrophotometry", Open File Report (OFR) 97–198.
[48] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Total Phosphorus by Kjeldahl Digestion Method and an Automated Colorimetric Finish That Includes Dialysis" Open File Report (OFR) 92–146.
[49] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Arsenic and Selenium in Water and Sediment by Graphite Furnace-Atomic Absorption Spectrometry," Open File Report (OFR) 98–639.
[50] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Elements in Whole-Water Digests Using Inductively Coupled Plasma-Optical Emission Spectrometry and Inductively Coupled Plasma-Mass Spectrometry", Open File Report (OFR) 98–165.
[51] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Inorganic and Organic Constituents in Water and Fluvial Sediment", Open File Report (OFR) 93–125.

TABLE IC—LIST OF APPROVED TEST PROCEDURES FOR NON-PESTICIDE ORGANIC COMPOUNDS

Parameter[1]	EPA method number[2,7]			Other approved methods		
	GC	GC/MS	HPLC	*Standard Methods* [Edition(s)]	ASTM	Other
1. Acenaphthene	610	625, 1625B	610	6440 B [18th, 19th, 20th]	D4657–92	Note 9, p. 27.
2. Acenaphthylene	610	625, 1625B	610	6440 B, 6410 B [18th, 19th, 20th]	D4657–92	Note 9, p. 27.
3. Acrolein	603	624[4], 1624B				
4. Acrylonitrile	603	624[4], 1624B				
5. Anthracene	610	625, 1625B	610	6410 B, 6440 B [18th, 19th, 20th]	D4657–92	Note 9, p. 27.

ATTACHMENT E

Table II - Required Containers, Preservation Techniques, and Holding Times
40 CFR Part 136.3
July 1, 2005

3544. Available from the American Society for Microbiology, 1752 N Street NW., Washington, DC 20036. Table IA, Note 22.

(58) USEPA. 2002. Method 1604: Total Coliforms and *Escherichia coli (E. coli)* in Water by Membrane Filtration using a Simultaneous Detection Technique (MI Medium). U.S. Environmental Protection Agency, Office of Water, Washington D.C. September 2002, EPA 821–R–02–024. Available from NTIS, PB2003–100129. Table IA, Note 22.

(59) USEPA. 2002. Method 1600: Enterococci in Water by Membrane Filtration using membrane-Enterococcus Indoxyl-β-D-Glucoside Agar (mEI). U.S. Environmental Protection Agency, Office of Water, Washington D.C. September 2002, EPA–821–R–02–022. Available from NTIS, PB2003–100127. Table IA, Note 25.

(60) USEPA. 2001. Method 1622: *Cryptosporidium* in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington, DC April 2001, EPA–821–R–01–026.

Available from NTIS, PB2002–108709. Table IA, Note 26.

(61) USEPA. 2001. Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington, DC April 2001, EPA–821–R–01–025. Available from NTIS, PB2002–108710. Table IA, Note 27.

(62) AOAC. 1995. Official Methods of Analysis of AOAC International, 16th Edition, Volume I, Chapter 17. AOAC International. 481 North Frederick Avenue, Suite 500, Gaithersburg, Maryland 20877–2417. Table IA, Note 11.

(c) Under certain circumstances the Regional Administrator or the Director in the Region or State where the discharge will occur may determine for a particular discharge that additional parameters or pollutants must be reported. Under such circumstances, additional test procedures for analysis of pollutants may be specified by the Regional Administrator, or the Director upon the recommendation of the Director of the Environmental Monitoring Systems Laboratory—Cincinnati.

(d) Under certain circumstances, the Administrator may approve, upon recommendation by the Director, Environmental Monitoring Systems Laboratory—Cincinnati, additional alternate test procedures for nationwide use.

(e) Sample preservation procedures, container materials, and maximum allowable holding times for parameters cited in Tables IA, IB, IC, ID, and IE are prescribed in Table II. Any person may apply for a variance from the prescribed preservation techniques, container materials, and maximum holding times applicable to samples taken from a specific discharge. Applications for variances may be made by letters to the Regional Administrator in the Region in which the discharge will occur. Sufficient data should be provided to assure such variance does not adversely affect the integrity of the sample. Such data will be forwarded, by the Regional Administrator, to the Director of the Environmental Monitoring Systems Laboratory—Cincinnati, Ohio for technical review and recommendations for action on the variance application. Upon receipt of the recommendations from the Director of the Environmental Monitoring Systems Laboratory, the Regional Administrator may grant a variance applicable to the specific charge to the applicant. A decision to approve or deny a variance will be made within 90 days of receipt of the application by the Regional Administrator.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
Table IA—Bacteria Tests:			
1–5 Coliform, total, fecal, and *E. coli*	PP, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$[5]	6 hours.
6 Fecal *streptococci*	PP, G	Cool, <10° 0.0008% $Na_2S_2O_3$[5]	6 hours.
7 *Enterococci*	PP, G	Cool, <10° 0.0008% $Na_2S_2O_3$[5]	6 hours.
Table IA—Protozoa Tests:			
8 *Cryptosporidium*	LDPE	0–8 °C	96 hours.[17]
9 *Giardia*	LDPE	0–8 °C	96 hours.[17]
Table IA—Aquatic Toxicity Tests:			
6–10 Toxicity, acute and chronic	P,G	Cool, 4 °C[16]	36 hours.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES—Continued

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
Table IB—Inorganic Tests:			
1. Acidity	P, G	Cool, 4°C	14 days.
2. Alkalinity	P, G	do	Do.
4. Ammonia	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
5. Biochemical oxygen demand	P, G	Cool, 4°C	48 hours.
10. Boron	P, PFTE, or Quartz.	HNO_3 TO pH<2	6 months.
11. Bromide	P, G	None required	28 days.
14. Biochemical oxygen demand, carbonaceous	P, G	Cool, 4°C	48 hours.
15. Chemical oxygen demand	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
16. Chloride	P, G	None required	Do.
17. Chlorine, total residual	P, G	do	Analyze immediately.
21. Color	P, G	Cool, 4°C	48 hours.
23–24. Cyanide, total and amenable to chlorination.	P, G	Cool, 4°C, NaOH to pH>12, 0.6g ascorbic acid[5].	14 days.[6]
25. Fluoride	P	None required	28 days.
27. Hardness	P, G	HNO_3 to pH<2, H_2SO_4 to pH<2	6 months.
28. Hydrogen ion (pH)	P, G	None required	Analyze immediately.
31, 43. Kjeldahl and organic nitrogen	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
Metals:[7]			
18. Chromium VI[7]	P, G	Cool, 4 °C	24 hours.
35. Mercury[17]	P, G	HNO_3 to pH<2	28 days.
3, 5–8, 12,13, 19, 20, 22, 26, 29, 30, 32–34, 36, 37, 45, 47, 51, 52, 58–60, 62, 63, 70–72, 74, 75. Metals except boron, chromium VI and mercury[7].	P, G	do	6 months.
38. Nitrate	P, G	Cool, 4°C	48 hours.
39. Nitrate-nitrite	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
40. Nitrite	P, G	Cool, 4°C	48 hours.
41. Oil and grease	G	Cool to 4°C, HCl or H_2SO_4 to pH<2.	28 days.
42. Organic Carbon	P, G	Cool to 4 °C HC1 or H_2SO4 or H_3PO4, to pH<2.	28 days.
44. Orthophosphate	P, G	Filter immediately, Cool, 4°C	48 hours.
46. Oxygen, Dissolved Probe	G Bottle and top.	None required	Analyze immediately.
47. Winkler	do	Fix on site and store in dark	8 hours.
48. Phenols	G only	Cool, 4°C, H_2SO_4 to pH<2	28 days.
49. Phosphorus (elemental)	G	Cool, 4°C	48 hours.
50. Phosphorus, total	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
53. Residue, total	P, G	Cool, 4°C	7 days.
54. Residue, Filterable	P, G	do	7 days.
55. Residue, Nonfilterable (TSS)	P, G	do	7 days.
56. Residue, Settleable	P, G	do	48 hours.
57. Residue, volatile	P, G	do	7 days.
61. Silica	P, PFTE, or Quartz.	Cool, 4 °C	28 days.
64. Specific conductance	P, G	do	Do.
65. Sulfate	P, G	do	Do.
66. Sulfide	P, G	Cool, 4°C add zinc acetate plus sodium hydroxide to pH>9.	7 days.
67. Sulfite	P, G	None required	Analyze immediately.
68. Surfactants	P, G	Cool, 4°C	48 hours.
69. Temperature	P, G	None required	Analyze.
73. Turbidity	P, G	Cool, 4°C	48 hours.
Table IC—Organic Tests[8]			
13, 18–20, 22, 24–28, 34–37, 39–43, 45–47, 56, 76, 104, 105, 108–111, 113. Purgeable Halocarbons.	G, Teflon-lined septum.	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5].	14 days.
6, 57, 106. Purgeable aromatic hydrocarbons	do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] HCl to pH2[9].	Do.
3, 4. Acrolein and acrylonitrile	do	Cool, 4 °C; 0.008% $Na_2S_2O_3$,[5] adjust pH to 4–5[10].	Do.
23, 30, 44, 49, 53, 77, 80, 81, 98, 100, 112. Phenols[11].	G, Teflon-lined cap..	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction.
7, 38. Benzidines[11]	do	do	7 days until extraction.[13]
14, 17, 48, 50–52. Phthalate esters[11]	do	Cool, 4 °C	7 days until extraction; 40 days after extraction.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES—Continued

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
82–84. Nitrosamines[11,14]	....do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] store in dark.	Do.
88–94. PCBs[11]	....do	Cool, 4 °C	Do.
54, 55, 75, 79. Nitroaromatics and isophorone[11].	....do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] store in dark.	Do.
1, 2, 5, 8–12, 32, 33, 56, 59, 74, 78, 99, 101. Polynuclear aromatic hydrocarbons[11].	....do	....do	Do.
15, 16, 21, 31, 87. Haloethers[11]	....do	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5]	Do.
29, 35–37, 63–65, 73, 107. Chlorinated hydrocarbons[11].	....do	Cool, 4 °C	Do.
60–62, 66–72, 85, 86, 95–97, 102, 103. CDDs/CDFs[11]			
aqueous: field and lab preservation.	G	Cool, 0–4 °C, pH<9, 0.008% $Na_2S_2O_3$[5].	1 year.
Solids, mixed phase, and tissue: field preservation.	....do	Cool, <4 °C	7 days.
Solids, mixed phase, and tissue: lab preservation.	....do	Freeze, < 10 °C	1 year.
Table ID—Pesticides Tests:			
1–70. Pesticides[11]	....do	Cool, 4 °C, pH 5–9[13]	Do.
Table IE—Radiological Tests:			
1–5. Alpha, beta and radium	P, G	HNO_3 to pH<2	6 months.

Table II Notes

[1] Polyethylene (P) or glass (G). For microbiology, plastic sample containers must be made of sterilizable materials (polypropylene or other autoclavable plastic).

[2] Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4 °C until compositing and sample splitting is completed.

[3] When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

[4] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that for the specific types of samples under study, the analytes are stable for the longer time, and has received a variance from the Regional Administrator under § 136.3(e). Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show that this is necessary to maintain sample stability. See § 136.3(e) for details. The term "analyze immediately" usually means within 15 minutes or less of sample collection.

[5] Should only be used in the presence of residual chlorine.

[6] Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

[7] Samples should be filtered immediately on-site before adding preservative for dissolved metals.

[8] Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

[9] Sample receiving no pH adjustment must be analyzed within seven days of sampling.

[10] The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

[11] When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4 °C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6–9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine), and footnotes 12, 13 (re the analysis of benzidine).

[12] If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

[13] Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

[14] For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7–10 with NaOH within 24 hours of sampling.

[15] The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

[16] Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, it is necessary to immediately measure the temperature of the samples and confirm that the 4C temperature maximum has not been exceeded. In the isolated cases where it can be documented that this holding temperature can not be met, the permittee can be given the option of on-site testing or can request a variance. The request for a variance should include supportive data which show that the toxicity of the effluent samples is not reduced because of the increased holding temperature.

[17] Samples collected for the determination of trace level mercury (100 ng/L) using EPA Method 1631 must be collected in tightly-capped fluoropolymer or glass bottles and preserved with BrCl or HCl solution within 48 hours of sample collection. The time to preservation may be extended to 28 days if a sample is oxidized in the sample bottle. Samples collected for dissolved trace level mercury should be filtered in the laboratory. However, if circumstances prevent overnight shipment, samples should be filtered in a designated clean area in the field in accordance with procedures given in Method 1669. Samples that have been collected for determination of total or dissolved trace level mercury must be analyzed within 90 days of sample collection.

ATTACHMENT F

Sample Chain of Custody Form

Bergen County Utilities Authority
PO Box 9
Little Ferry NJ 07643

ORDER ID:

CHAIN OF CUSTODY RECORD

	Permit / Site Number	Sampler's Initials	Received Date/Time

I/we certify that the samples below have not been out of our custody until relinquished. **RELINQUISHER(S) SIGNATURE:**	**Work Order Comments:**

Bottle Type	Preservation	pH	pH Check			
Sample ID	**Sample Type**	**Analysis**	**BCUA Bottle Type**	**Received by: (Initial)**	**Date**	**Time**
Start Collect Date/Time:		**End Collect Date/Time:**				

Sample Comments:

ATTACHMENT G

Tables of Parameter Detection Limits, Accuracy, and Precision

Parameter Detection Limits, Quantitation Limits, Accuracy, and Precision

Parameter:	(Dissolved) Ortho-Phosphate (as P)	Total Phosphorous (as P)	Ammonia-Nitrogen	Nitrate-Nitrogen†	Nitrite - Nitrogen†	Total Kjeldahl Nitrogen	Total Suspended Solids	Total Dissolved Solids†
Referenced Methodology –(NJDEP Certified Methodology)	EPA 365.2	EPA 365.2	EPA 350.2	EPA 300.0	EPA 300.0	EPA 351.3	EPA 160.2	EPA 160.1
Technique Description	Ascorbic Acid, Manual Single Reagent	Persulfate Digestion + Manual	Distillation, Titration	Ion Chroma-tography	Ion Chroma-tography	Digestion, Distillation, Titration	Gravi-metric, 103-105˚C, Post Washing	Gravi-metric, 180˚C
Method Detection Limit (ppm) – Calculated	0.005	0.01	0.164	0.027	0.08	0.579	4	8.9
Instrument Detection Limit (ppm)	NA	NA	NA	NA	NA	NA	NA	NA
Project Detection Limit (ppm)	***0.015***	***0.03***	***0.5***	***0.27***	***0.8***	***1.8***	***12***	***10***
Quantitation Limit (ppm)	***0.015***	***0.03***	***0.5***	***0.27***	***0.8***	***1.8***	***12***	***10***
Accuracy (mean % recovery	98.2	99.6	103.4	90-110	90-110	101.6	NA	NA
Precision -% (mean – RPD	2.23	1.6	2.7	20	20	2.8	9.4	20
Accuracy Protocol (% recovery for LCL/UCL)	75.00 / 123.20	75.00 / 123.20	86.636 / 103.981	---	---	80.8 / 116.8	NA	---
Precision Protocol - % (maximum RPD)	4.7	4.9	4.6	---	---	5.13	28.6	---

RPD- Relative % Difference; NA-Not Applicable

Laboratory: Bergen County Utilities Authority – (NJDEP #02268)

†Laboratory: Hampton Clarke Veritech – (NJDEP #14622)

Parameter:	pH (SU)	Temperature (°C)	Dissolved Oxygen (mg/L)	†Fecal Coliform	‡*Eschericia coli* (*E. coli*)
Referenced Methodology – (NJDEP Certified Methodology)	Standard Methods 4500-H^+ B	Standard Methods 2550 B	Standard Methods 4500-O G	Standard Methods 9222D	EPA 1603
Technique Description	Electrometric	Thermometric	Electrode	Membrane Filter (MF), Single Step	Membrane Filter (modified mTEC)
Method Detection Limit (ppm)	NA	NA	NA	2 (col/ 100 ml)	<10 organisms per 100 ml
Instrument Detection Limit (ppm)	0.00-14.00 S.U.	0.0 to 100.0 °C	0 – 20 mg/L	NA	NA
Project Detection Limit (ppm)	0.00-14.00 S.U.	0.0 to 100.0 °C	0 - 20 mg/L	2 (col/ 100 ml)	<10 organisms per 100 ml
Quantitation Limit (ppm)	NA	NA	NA	2 (col/ 100 ml)	60,000 organisms per 100 ml
Accuracy (mean % recovery)	NA	NA	NA	NA	NA
Precision (mean – RPD)	± 0.01 S.U.	± 0.3 °C	± 0.3 mg/l	5.7	NA
Accuracy Protocol (% recovery for LCL/UCL)	NA	NA	NA	NA	Detect – 144%
Precision Protocol (maximum RPD)	± 0.01 S.U.	± 0.3 °C	± 0.3 mg/l	20.55	61%

RPD – Relative % Difference; NA – Not Applicable

Laboratory: Rutgers EcoComplex Laboratory (NJDEP #03019)
†Laboratory: Bergen County Utilities Authority (NJDEP #02268)
‡Laboratory: Garden State Laboratories, Inc. (NJDEP #20044)

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June 29, 2007

VIA E-MAIL
Michele Bakacs
Watershed Management Area 5 Manager
Division of Watershed Management
New Jersey Department of Environmental Protection
401 East State Street
P.O. Box 418
Trenton, NJ 08625

Re: Addendum to Quality Assurance Project Plans (QAPPs)
RP07-001 Tenakill Brook Watershed Restoration Plan
RP07-002 Musquapsink Brook Watershed Restoration Plan

Michele:

For both the Tenakill Brook and Musquapsink Brook Watershed Restoration Plans, the Bergen County Utilities Authority (BCUA) has requested that surface water samples be delivered to the BCUA laboratory (NJDEP Certified Laboratory #02268) by noon for analysis. To date, this has not been a problem for the biweekly surface water sampling and additional bacteriology sampling. However, it will be extremely difficult, if not impossible, to meet this sample drop-off requirement for the wet weather surface water sampling portion of these studies.

We would like to amend the QAPPs to reflect that for the wet weather surface water sampling portion of these studies Garden State Laboratories (NJDEP Certified Laboratory #20044) will be conducting the necessary water quality analyses. Garden State Laboratories is currently conducting the *E. coli* analyses for these studies, and they have more reasonable sample drop-off requirements, which will be suitable for the wet weather surface water sampling portion of these studies.

I have attached the following for you to review and for you to forward to the Office of Quality Assurance:

- Wet Weather Surface Water Sampling - Parameter Detection Limits, Quantitation Limits, Accuracy, and Precision
- Wet Weather Surface Water Sampling – Table 1A: List of Approved Biological Methods & Table 1B: List of Approved Inorganic Test Procedures, 40 CRF Part 136.3, July 1, 2005
- Wet Weather Surface Water Sampling – Table II: Required Containers, Preservation Techniques, and Holding Times, 40 CFR Part 136.3, July 1, 2005.

If you have any questions, please do not hesitate to contact me at evrard@rci.rutgers.edu or call me at 732-932-9800 x 6130. If for some reason we are not allowed to use Garden State Laboratories for the wet weather surface water sampling portion of the Musquapsink and Tenakill studies, please contact me, Katie Buckley at kbuckley@envsci.rutgers.edu, or Rob Miskewitz at rmiskewitz@aesop.rutgers.edu as soon as possible.

Thank you for your attention to this matter.

Sincerely,

Lisa Galloway Evrard
QAPP QA Officer

C: P. Rector
C. Obropta
K. Buckley
R. Miskewitz

Wet Weather Surface Water Sampling

Parameter Detection Limits, Quantitation Limits, Accuracy, and Precision

RP07-002 MUSQUAPSINK BROOK WATERSHED RESTORATION PLAN
&
RP07-001 TENAKILL BROOK WATERSHED RESTORATION PLAN

Wet Weather Surface Water Sampling
Parameter Detection Limits, Quantitation Limits, Accuracy, and Precision

Parameter:	(Dissolved) Ortho-Phosphate (as P)	Total Phosphorous (as P)	Ammonia-Nitrogen	Nitrate-Nitrogen	Nitrite - Nitrogen	Total Kjeldahl Nitrogen	Total Suspended Solids
Referenced Methodology –(NJDEP Certified Methodology)	Standard Methods 4500-P E	Standard Methods 4500-P E	Standard Methods 4500-NH_3 D	EPA 353.2	Standard Methods 4500-NO_2 B	LACHAT 10-107-06-2-D	Standard Methods 2540 D
Technique Description	Colorimetric	Persulfate Digestion + Manual	Electrode	Automated Cadmium Reduction	Spectro-photometric	Digestion, Distillation, Semiautomated Digestor	Gravi-metric, 103-105˚C, Post Washing
Method Detection Limit (ppm) – Calculated	0.008	0.010	0.018	0.010	0.0002	0.059	NA
Instrument Detection Limit (ppm)	0.01	0.01	0.05	0.20	0.005	0.50	NA
Project Detection Limit (ppm)	0.015	0.03	0.5	0.27	0.8	1.8	12
Quantitation Limit (ppm)	0.015	0.03	0.5	0.27	0.8	1.8	12
Accuracy (mean % recovery	100.8	93.7	99.2	103.9	98.6	89.9	NA
Precision -% (mean – RPD	1.20	0.56	1.75	0.72	1.32	1.50	3.85
Accuracy Protocol (% recovery for LCL/UCL)	90 / 110	90 / 110	90 / 110	90 / 110	90 / 110	90 / 110	90 / 110
Precision Protocol - % (maximum RPD)	10%	10%	10%	10%	10%	10%	10%

RPD- Relative % Difference; NA-Not Applicable

Laboratory: Garden State Laboratories, Inc. (NJDEP #20044)

Parameter:	†pH (SU)	†Temperature (°C)	†Dissolved Oxygen (mg/L)	Fecal Coliform	*Eschericia coli* (*E. coli*)
Referenced Methodology – (NJDEP Certified Methodology)	Standard Methods 4500-H^+ B	Standard Methods 2550 B	Standard Methods 4500-O G	Standard Methods 9222D	EPA 1603
Technique Description	Electrometric	Thermometric	Electrode	Membrane Filter (MF), Single Step	Membrane Filter (modified mTEC)
Method Detection Limit (ppm)	NA	NA	NA	<10 organisms per 100 ml	<10 organisms per 100 ml
Instrument Detection Limit (ppm)	0.00-14.00 S.U.	0.0 to 100.0 °C	0 – 20 mg/L	NA	NA
Project Detection Limit (ppm)	0.00-14.00 S.U.	0.0 to 100.0 °C	0 - 20 mg/L	--	<10 organisms per 100 ml
Quantitation Limit (ppm)	NA	NA	NA	--	60,000 organisms per 100 ml
Accuracy (mean % recovery)	NA	NA	NA	NA	NA
Precision (mean – RPD)	± 0.01 S.U.	± 0.3 °C	± 0.3 mg/l	NA	NA
Accuracy Protocol (% recovery for LCL/UCL)	NA	NA	NA	NA	Detect – 144%
Precision Protocol (maximum RPD)	± 0.01 S.U.	± 0.3 °C	± 0.3 mg/l	NA	61%

RPD – Relative % Difference; NA – Not Applicable

Laboratory: Garden State Laboratories, Inc. (NJDEP #20044)

†Laboratory: Rutgers EcoComplex Laboratory (NJDEP #03019)

Wet Weather Surface Water Sampling

Table 1A – List of Approved Biological Methods
&
Table 1B – List of Approved Inorganic Test Procedures
40 CFR Part 136.3
July 1, 2005

RP07-002 MUSQUAPSINK BROOK WATERSHED RESTORATION PLAN
&
RP07-001 TENAKILL BROOK WATERSHED RESTORATION PLAN

TABLE IA—LIST OF APPROVED BIOLOGICAL METHODS

Parameter and units	Method[1]	EPA	Standard methods 18th, 19th, 20th Ed	ASTM	AOAC	USGS	Other
Bacteria:							
1. Coliform (fecal), number per 100 mL	Most Probable Number (MPN), 5 tube, 3 dilution, or	p. 132[3]	9221C E[4]				
	Membrane filter (MF)[2], single step	p. 124[3]	9222D[4]			B–0050–85[5]	
2. Coliform (fecal) in presence of chlorine, number per 100 mL	MPN, 5 tube, 3 dilution, or	p. 132[3]	9221C E[4]				
	MF, single step[6]	p. 124[3]	9222D[4]			B–0025–85[5]	
3. Coliform (total), number per 100 mL	MPN, 5 tube, 3 dilution, or	p. 114[3]	9221B[4]				
	MF[2], single step or two step	p. 108[3]	9222B[4]				
4. Coliform (total), in presence of chlorine, number per 100 mL	MPN, 5 tube, 3 dilution, or	p. 114[3]	9221B[4]				
	MF[2] with enrichment	p. 111[3]	9222(B+B.5c)[4] 9221B.1/9221F[4,12,14]				
5. *E. coli*, number per 100 mL[26]	MPN[7,9,15], multiple tube,		9223B[4,13]		991.15[11]		Colilert®[13,17] Colilert-18®[13,16,17]
	multiple tube/multiple well,						
	MF[2,6,7,8,9] two step, or		9222B/9222G[4,19]	D5392–93[10]			
	single step	1103.1[20] 1603[21]	9213D[4]				
		1604[22]					mColiBue 24[18]
6. Fecal streptococci, number per 100 mL	MPN, 5 tube, 3 dilution,	p. 139[3]	9230B[4], 9230C[4]				
	MF[2], or	p. 136[3]			B–0055–85[5]		
	Plate count	p. 143[4]					
7. Enterococci, number per 100 mL	MPN[7,9] multiple tube		9230B[4]				
	multiple tube/multiple well			D6503–99[10]			Enterolert®[3,23]
	MF[2,6,7,8,9] two step	1106.1[24]	9230C[4]	D5259–92[10]			
	single step, or	1600[25]					
	Plate count	p. 143[3]					
Protozoa:							
8. *Cryptosporidium*[26]	Filtration/IMS/FA	1622[26] 1623[27]					
9. *Giardia*[26]	Filtration/IMS/FA	1623[27]					
Aquatic Toxicity:							
10. Toxicity, acute, fresh water organisms, LC50, percent effluent	*Ceriodaphnia dubia* acute	2002.0[29]					

Sea urchin, *Arbacia punctulata*, fertilization	1008.0[31]					

Notes to Table IA:
[1] The method must be specified when results are reported.
[2] A 0.45 µm membrane filter (MF) or other pore size certified by the manufacturer to fully retain organisms to be cultivated and to be free of extractables which could interfere with their growth.
[3] USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water, and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8–78/017.
[4] APHA. 1998, 1995, 1992. Standard Methods for the Examination of Water and Wastewater. American Public Health Association. 20th, 19th, and 18th Editions. Amer. Publ. Hlth. Assoc., Washington, D.C.
[5] USGS. 1989. U.S. Geological Survey Techniques of Water-Resource Investigations, Book 5, Laboratory Analysis, Chapter A4, Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples, U.S. Geological Survey, U.S. Department of Interior, Reston, Virginia.
[6] Because the MF technique usually yields low and variable recovery from chlorinated wastewaters, the Most Probable Number method will be required to resolve any controversies.
[7] Tests must be conducted to provide organism enumeration (density). Select the appropriate configuration of tubes/filtrations and dilutions/volumes to account for the quality, character, consistency, and anticipated organism density of the water sample.
[8] When the MF method has not been used previously to test ambient waters with high turbidity, large number of noncoliform bacteria, or samples that may contain organisms stressed by chlorine, a parallel test should be conducted with a multiple-tube technique to demonstrate applicability and comparability of results.
[9] To assess the comparability of results obtained with individual methods, it is suggested that side-by-side tests be conducted across seasons of the year with the water samples routinely tested in accordance with the most current Standard Methods for the Examination of Water and Wastewater or EPA alternate test procedure (ATP) guidelines.
[10] ASTM. 2000, 1998, 1996. Annual Book of ASTM Standards—Water and Environmental Technology. Section 11.02. American Society for Testing and Materials. 100 Barr Harbor Drive, West Conshohocken, PA 19428.
[11] AOAC. 1995. Official Methods of Analysis of AOAC International, 16th Edition, Volume I, Chapter 17. Association of Official Analytical Chemists International. 481 North Frederick Avenue, Suite 500, Gaithersburg, Maryland 20877–2417.
[12] The multiple-tube fermentation test is used in 9221B.1. Lactose broth may be used in lieu of lauryl tryptose broth (LTB), if at least 25 parallel tests are conducted between this broth and LTB using the water samples normally tested, and this comparison demonstrates that the false-positive rate and false-negative rate for total coliform using lactose broth is less than 10 percent. No requirement exists to run the completed phase on 10 percent of all total coliform-positive tubes on a seasonal basis.
[13] These tests are collectively known as defined enzyme substrate tests, where, for example, a substrate is used to detect the enzyme β–glucuronidase produced by *E. coli*.
[14] After prior enrichment in a presumptive medium for total coliform using 9221B.1, all presumptive tubes or bottles showing any amount of gas, growth or acidity within 48 h ± 3 h of incubation shall be submitted to 9221F. Commercially available EC-MUG media or EC media supplemented in the laboratory with 50 µg/mL of MUG may be used.
[15] Samples shall be enumerated by the multiple-tube or multiple-well procedure. Using multiple-tube procedures, employ an appropriate tube and dilution configuration of the sample as needed and report the Most Probable Number (MPN). Samples tested with Colilert® may be enumerated with the multiple-well procedures, Quanti-Tray® or Quanti-Tray® 2000, and the MPN calculated from the table provided by the manufacturer.
[16] Colilert-18® is an optimized formulation of the Colilert® for the determination of total coliforms and *E. coli* that provides results within 18 h of incubation at 35 °C rather than the 24 h required for the Colilert® test and is recommended for marine water samples.
[17] Descriptions of the Colilert®, Colilert-18®, Quanti-Tray®, and Quanti-Tray®/2000 may be obtained from IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092.
[18] A description of the mColiBlue24® test, Total Coliforms and *E. coli*, is available from Hach Company, 100 Dayton Ave., Ames, IA 50010.
[19] Subject total coliform positive samples determined by 9222B or other membrane filter procedure to 9222G using NA-MUG media.
[20] USEPA. 2002. Method 1103.1: *Escherichia coli* (*E. coli*) In Water By Membrane Filtration Using membrane-Thermotolerant *Escherichia coli* Agar (mTEC). U.S. Environmental Protection Agency, Office of Water, Washington D.C. EPA–821–R–02–020.
[21] USEPA. 2002. Method 1603: *Escherichia coli* (*E. coli*) In Water By Membrane Filtration Using Modified membrane-Thermotolerant *Escherichia coli* Agar (modified mTEC). U.S. Environmental Protection Agency, Office of Water, Washington D.C. EPA–821–R–02–023.
[22] Preparation and use of MI agar with a standard membrane filter procedure is set forth in the article, Brenner et al. 1993. "New Medium for the Simultaneous Detection of Total Coliform and *Escherichia coli* in Water." Appl. Environ. Microbiol. 59:3534–3544 and in USEPA. 2002. Method 1604: Total Coliforms and *Escherichia coli* (*E. coli*) in Water by Membrane Filtration by Using a Simultaneous Detection Technique (MI Medium). U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA 821–R–02–024.
[23] A description of the Enterolert® test may be obtained from IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092.
[24] USEPA. 2001. Method 1106.1: Enterococci In Water By Membrane Filtration Using membrane-Enterococcus-Esculin Iron Agar (mE-EIA). U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–02–021.
[25] USEPA. 2002. Method 1600: Enterococci In Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-β-D-Glucoside Agar (mEI). U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA–821–R–02–022.
[26] Method 1622 uses filtration, concentration, immunomagnetic separation of oocysts from captured material, immunofluorescence assay to determine concentrations, and confirmation through vital dye staining and differential interference contrast microscopy for the detection of *Cryptosporidium*. USEPA. 2001. Method 1622: Cryptosporidium in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–01–026.
[27] Method 1623 uses filtration, concentration, immunomagnetic separation of oocysts and cysts from captured material, immunofluorescence assay to determine concentrations, and confirmation through vital dye staining and differential interference contrast microscopy for the simultaneous detection of *Cryptosporidium* and *Giardia* oocysts and cysts. USEPA. 2001. Method 1623: Cryptosporidium and Giardia in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–01–025.
[28] Recommended for enumeration of target organism in ambient water only.

[29] USEPA. October 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fifth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821R–02/012.
[30] USEPA. October 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821R–02/013.
[31] USEPA. October 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. Third Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821R–02/014.

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES

Parameter, units and method	Reference (method number or page)				
	EPA[1, 35]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
1. Acidity, as $CaCO_3$, mg/L:					
Electrometric endpoint or phenolphthalein endpoint.	305.1	2310 B[4a] [18th, 19th, 20th]	D1067–92	I–1020–85	
				I–2030–85	
2. Alkalinity, as $CaCO_3$, mg/L:					
Electrometric or Colorimetric titration to pH 4.5, manual or automatic.	310.1	2320 B [18th, 19th, 20th]	D1067–92	I–1030–85	973.43[3]
	310.2			I–2030–85	
3. Aluminium—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration[36]	202.1	3111 D [18th, 19th]		I–3051–85	
AA furnace	202.2	3113 B [18th, 19th]			
Inductively Coupled Plasma/ Atomic Emission Spectrometry (ICP/AES).[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
Direct Current Plasma (DCP).[36]			D4190–94		Note 34.
Colorimetric (Eriochrome cyanine R).		3500–Al B [20th] and 3500–Al D [18th, 19th]			
Ammonia (as N), mg/L:					
Manual, distillation (at pH 9.5)[6] followed by:	350.2	4500–NH_3 B [18th, 19th, 20th]			973.49[3]
Nesslerization	350.2	4500–NH_3 C [18th]	D1426–98(A)	I–3520–85	973.49[3]
Titration	350.2	4500–NH_3 C [19th, 20th] and 4500–NH_3 E [18th]			
Electrode	350.3	4500–NH_3 D [19th, 20th] and 4500–NH_3 F or G [18th]	D1426–98(B)		
Automated phenate, or	350.1	4500–NH_3 G [19th, 20th] and 4500–NH_3 H [18th]		I–4523–85	Note 7.
Automated electrode					
5. Antimony-Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration[36]	204.1	3111 B [18th, 19th]			
AA furnace	204.2	3113 B [18th, 19th]			
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]			
6. Arsenic-Total[4] mg/L:					

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	Reference (method number or page)				
	EPA[1, 35]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
Titrimetric (EDTA), or Ca plus Mg as their carbonates, by inductively coupled plasma or AA direct aspiration (See Parameters 13 and 33)	130.2	2340 B or C [18th, 19th, 20th]	D1126–86(92)	I–1338–85	973.52B[3]
28. Hydrogen ion (pH), pH Units, Electrometric measurement, or	150.1	4500–H+ B [18th, 19th, 20th]	D1293–84 (90)(A or B)	I–1586–85	973.41[3]
Automated electrode				I–2587–85	Note 21.
29. Indium—Total,[4] mg/L, Digestion[4] followed by:					
AA direct aspiration or	235.1	3111 B [18th, 19th]			
AA furnace	235.2				
30. Iron—Total,[4] mg/L, Digestion[4] followed by:					
AA direct aspiration[36]	236.1	3111 B or C [18th, 19th]	D1068–96(A or B)	I–3381–85	974.27[3]
AA furnace	236.2	3113 B [18th, 19th]	D1068–96(C)		
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[39]	
DCP[36] or			D4190–94		Note 34.
Colorimetric (Phenanthroline)		3500–Fe B [20th] and 3500–Fe D [18th, 19th]	D1068–96(D)		Note 22.
31. Kjeldahl Nitrogen—Total, (as N), mg/L:					
Digestion and distillation followed by	351.3	4500–N_{org} B or C and 4500–NH_3 B [18th, 19th, 20th]	D3590–89(A)		973.48[3]
Titration	351.3	4500–NH_3 C [18th]	D3590–89(A)		
Nesslerization	351.3	4500–NH_3 C [19th, 20th]	D3590–89(A)		
Electrode	351.3	4500–NH_3 C [19th, 20th] and 4500–NH_3 E [18th]			
Automated phenate, colorimetric	351.1			I–4551–78[38]	
Semi-automated block digestor colorimetric	351.2		D3590–89(B)	I–4515–91[45]	
Manual or block digestor potentiometric	351.4		D3590–89(A)		
Block digester, followed by Auto distillation and Titration, or					Note 39.
Nesslerization, or					Note 40.
Flow injection gas diffusion					Note 41.
32. Lead—Total,[4] mg/L, Digestion[4] followed by					
AA direct aspiration[36]	239.1	3111 B or C [18th, 19th]	D3559–96(A or B)	I–3399–85	974.27[3]

TKN: Lachat 10-107--06-2-D; Digestion, Distillation, Semiautomatic Digestor

AA furnace	239.2	3113 B [18th, 19th]	D3559–96(D)	I–4403–89[51]	
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP[36]			D4190–94		Note 34.
Voltametry[11] or			D3559–96(C)		
Colorimetric (Dithizone)		3500–Pb B [20th] and 3500–Pb D [18th, 19th]			
33. Magnesium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	242.1	3111 B [18th, 19th]	D511–93(B)	I–3447–85	974.27[3]
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP or					Note 34.
Gravimetric		3500–Mg D [18th, 19th]			
34. Manganese-Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	243.1	3111 B [18th, 19th]	D858–95(A or B)	I–3454–85	974.27[3]
AA furnace	243.2	3113 B [18th, 19th]	D858–95(C)		
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP[36], or			D4190–94		Note 34
Colorimetric (Persulfate), or		3500–Mn B [20th] and 3500–Mn D [18th, 19th]			920.203[3]
(Periodate)					Note 23.
35. Mercury—Total,[4] mg/L:					
Cold vapor, manual or	245.1	3112 B [18th, 19th]	D3223–91	I–3462–85	977.22[3]
Automated	245.2				
Oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry (ng/L).	1631E[43]				
36. Molybdenum—Total[4], mg/L; Digestion[4] followed by:					
AA direct aspiration	246.1	3111 D [18th, 19th]		I–3490–85	
AA furnace	246.2	3113 B [18th, 19th]		I–3492–96[47]	
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP					Note 34.
37. Nickel—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	249.1	3111 B or C [18th, 19th]	D1886–90(A or B)	I–3499–85	
AA furnace	249.2	3113 B [18th, 19th]	D1886–90(C)	I–4503–89[51]	
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP[36], or			D4190–94		Note 34.
Colorimetric (Heptoxime)		3500–Ni D [17th]			
38. Nitrate (as N), mg/L:					
Colorimetric (Brucine sulfate), or Nitrate-nitrite N minus Nitrite N (See parameters 39 and 40)	352.1				973.50,[3] 419D,[17] p. 28[9]
39. Nitrate-nitrite (as N), mg/L:					
Cadmium reduction, Manual or	353.3	4500–NO_3–E [18th, 19th, 20th]	D3867–99(B)		

Nitrate (as N), EPA 353.2; Automated Cadmium Reduction

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	Reference (method number or page)				
	EPA[1,31]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
Automated, or	353.2	4500–NO_3–F [18th, 19th, 20th]	D3867–99(A)	I–4545–85	
Automated hydrazine	353.1	4500–NO_3–H [18th, 19th, 20th]			
40. Nitrite (as N), mg/L: Spectrophotometric: Manual or	354.1	4500–NO_2–B [18th, 19th, 20th]			Note 25.
Automated (Diazotization)				I–4540–85	
41. Oil and grease—Total recoverable, mg/L: Gravimetric (extraction)	413.1	5520B [18th, 19th, 20th][38]			
Oil and grease and nonpolar material, mg/L: Hexane extractable material (HEM): n-Hexane extraction and gravimetry	1664A[42]	5520B [18th, 19th, 20th][38]			
Silica gel treated HEM (SGT-HEM): Silica gel treatment and gravimetry	1664A[42]				
42. Organic carbon—Total (TOC), mg/L: Combustion or oxidation	415.1	5310 B, C, or D [18th, 19th, 20th]	D2579–93 (A or B)		973.47[3] p. 14[24]
43. Organic nitrogen (as N), mg/L: Total Kjeldahl N (Parameter 31) minus ammonia N (Parameter 4)					
44. Orthophosphate (as P), mg/L: Ascorbic acid method: Automated, or	365.1	4500–P F [18th, 19th, 20th]		I–4601–85	973.56[3]
Manual single reagent	365.2	4500–P F [18th, 19th, 20th]	D515–88(A)		973.55[3]
Manual two reagent	365.3				
45. Osmium—Total[4], mg/L: Digestion[4] followed by: AA direct aspiration, or	252.1	3111 D [18th, 19th]			
AA furnace	252.2				
46. Oxygen, dissolved, mg/L: Winkler (Azide modification), or	360.2	4500–O C [18th, 19th, 20th]	D888–92(A)	I–1575–78[8]	973.45B[3]
Electrode	360.1	4500–O G [18th, 19th, 20th]	D888–92(B)	I–1576–78[8]	

47. Palladium—Total,[4] mg/L: Digestion[4] followed by:						p. S2710
AA direct aspiration, or	253.1	3111 B [18th, 19th]				p. S2810
AA furnace	253.2					Note 34.
DCP						
48. Phenols, mg/L:						
Manual distillation[26]	420.1					Note 27.
Followed by:						
Colorimetric (4AAP) manual, or	420.1					Note 27.
Automated[19]	420.2					
49. Phosphorus (elemental), mg/L:						Note 28.
Gas-liquid chromatography						
50. Phosphorus—Total, mg/L:						
Persulfate digestion followed by	365.2	4500–P B. 5 [18th, 19th, 20th]				973.55[3]
Manual or	365.2 or 365.3	4500–P E [18th, 19th, 20th]	D515–88(A)			
Automated ascorbic acid reduction	365.1	4500–P F [18th, 19th, 20th]		I–4600–85		973.56[3]
Semi-automated block digestor	365.4		D515–88(B)	I–4610–91[48]		
51. Platinum—Total,[4] mg/L: Digestion[4] followed by:						
AA direct aspiration	255.1	3111 B [18th, 19th]				Note 34
AA furnace	255.2					
DCP						
52. Potassium—Total,[4] mg/L: Digestion[4] followed by:						
AA direct aspiration	258.1	3111 B [18th, 19th]		I–3630–85		973.53[3]
ICP/AES	200.7[6]	3120 B [18th, 19th, 20th]				
Flame photometric, or		3500–K B [20th] and 3500–K D [18th, 19th]				
Colorimetric						3.17 B[17]
53. Residue—Total, mg/L:						
Gravimetric, 103–105[9]	160.3	2540 B [18th, 19th, 20th]		I–3750–85		
54. Residue—filterable, mg/L:						
Gravimetric, 180[9]	160.1	2540 C [18th, 19th, 20th]		I–1750–85		
55. Residue—nonfilterable (TSS), mg/L:						
Gravimetric, 103–105[9] post washing of residue	160.2	2540 D [18th, 19th, 20th]		I–3765–85		
56. Residue—settleable, mg/L:						
Volumetric, (Imhoff cone), or gravimetric	160.5	2540 F [18th, 19th, 20th]				
57. Residue—Volatile, mg/L:						
Gravimetric, 550[9]	160.4			I–3753–85		
58. Rhodium-Total,[4] mg/L: Digestion[4] followed by:						
AA direct aspiration, or	265.1	3111 B [18th, 19th]				

Colorimetric (methylene blue)	376.2	4500–S^{-2}D [18th, 19th, 20th].			
67. Sulfite (as SO_3), mg/L: Titrimetric (iodine-iodate)	377.1	4500–SO_3^{-2}B [18th, 19th, 20th].			
68. Surfactants, mg/L: Colorimetric (methylene blue)	425.1	5540 C [18th, 19th, 20th]	D2330–88.		
69. Temperature, °C: Thermometric	170.1	2550 B [18th, 19th, 20th].		Note 32.	
70. Thallium—Total[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	279.1	3111 B [18th, 19th]			
AA furnace	279.2				
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th].			
71. Tin—Total[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	282.1	3111 B [18th, 19th]		I–3850–78[8].	
AA furnace, or	282.2	3113 B [18th, 19th]			
ICP/AES	200.7[5].				
72. Titanium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	283.1	3111 D [18th, 19th]			
AA furnace	283.2				
DCP				Note 34.	
73. Turbidity, NTU: Nephelometric	180.1	2130 B [18th, 19th, 20th]	D1889–94(A)	I–3860–85.	
74. Vanadium—Total[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	286.1	3111 D [18th, 19th]	D3373–93.		
AA furnace	286.2			I–4471–97[50].	
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]			
DCP, or			D4190–94		Note 34.
Colorimetric (Gallic Acid)		3500–V B [20th] and 3500–V D [18th, 19th]			
75. Zinc—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	289.1	3111 B or C [18th, 19th]	D1691–95(A or B)	I–3900–85	974.27[3] p. 37[9]
AA furnace	289.2				
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50].	
DCP[36] or			D4190–94		Note 34.
Colorimetric (Dithizone) or		3500–Zn E [18th, 19th].			
(Zincon)		3500–Zn B [20th] and 3500–Zn F [18th, 19th].			Note 33.

Table 1B Notes:

[1] "Methods for Chemical Analysis of Water and Wastes," Environmental Protection Agency, Environmental Monitoring Systems Laboratory—Cincinnati (EMSL-CI), EPA–600/4–79–020, Revised March 1983 and 1979 where applicable.

[2] Fishman, M.J., *et al.* "Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments," U.S. Department of the Interior, Techniques of Water-Resource Investigations of the U.S. Geological Survey, Denver, CO, Revised 1985, unless otherwise stated.

[3] "Official Methods of Analysis of the Association of Official Analytical Chemists," methods manual, 15th ed. (1990)

[4] For the determination of total metals the sample is not filtered before processing. A digestion procedure is required to solubilize suspended material and to destroy possible organic-metal complexes. Two digestion procedures are given in "Methods for Chemical Analysis of Water and Wastes, 1979 and 1983". One (Section 4.1.3), is a vigorous digestion using nitric acid. A less vigorous digestion using nitric and hydrochloric acids (Section 4.1.4) is preferred, however, the analyst should be cautioned that this mild digestion may not suffice for all samples types. Particularly, if a colorimetric procedure is to be employed, it is necessary to ensure that all organo-metallic bonds be broken so that the metal is in a reactive state. In those situations, the vigorous digestion is to be preferred making certain that at no time does the sample go to dryness. Samples containing large amounts of organic materials may also benefit by this vigorous digestion, however, vigorous digestion with concentrated nitric acid will convert antimony and tin to insoluble oxides and render them unavailable for analysis. Use of ICP/AES as well as determinations for certain elements such as antimony, arsenic, the noble metals, mercury, selenium, silver, tin, and titanium require a modified sample digestion procedure and in all cases the method write-up should be consulted for specific instructions and/or cautions.

NOTE TO TABLE 1B NOTE 4. If the digestion procedure for direct aspiration AA included in one of the other approved references is different than the above, the EPA procedure must be used. Dissolved metals are those constituents which will pass through a 0.45 micron membrane filter. Following filtration of the sample, the referenced procedure for total metals must be followed. Sample digestion of the filtrate for dissolved metals (or digestion of the original sample solution for total metals) may be omitted for AA (direct aspiration or graphite furnace) and ICP analyses, provided the sample solution to be analyzed meets the following criteria:

a. has a low COD (<20),

b. is visibly transparent with a turbidity measurement of 1 NTU or less

c. is colorless with no perceptible odor, and

d. is of one liquid phase and free of particulate or suspended matter following acidification.

[5] The full text of Method 200.7, "Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," is given at Appendix C of this Part 136.

[6] Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary; however, manual distillation will be required to resolve any controversies.

[7] Ammonia, Automated Electrode Method, Industrial Method Number 379–75 WE, dated February 19, 1976, Bran & Luebbe (Technicon) Auto Analyzer II, Bran & Luebbe Analyzing Technologies, Inc., Elmsford, NY 10523.

[8] The approved method is that cited in "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments," USGS TWRI, Book 5, Chapter A1 (1979).

[9] American National Standard on Photographic Processing Effluents, Apr. 2, 1975. Available from ANSI, 25 West 43rd Street, New York, NY 10036.

[10] "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency", Supplement to the Fifteenth Edition of Standard Methods for the Examination of Water and Wastewater (1981).

[11] The use of normal and differential pulse voltage ramps to increase sensitivity and resolution is acceptable.

[12] Carbonaceous biochemical oxygen demand ($CBOD_5$) must not be confused with the traditional BOD_5 test method which measures "Total BOD_5". The addition of the nitrification inhibitor is not a procedural option, but must be included to report the $CBOD_5$ parameter. A discharger whose permit requires reporting the traditional BOD_5 may not use a nitrification inhibitor in the procedure for reporting the results. Only when a discharger's permit specifically states $CBOD_5$ is required can the permittee report data using a nitrification inhibitor.

[13] OIC Chemical Oxygen Demand Method, Oceanography International Corporation, 1978, 512 West Loop, P.O. Box 2980, College Station, TX 77840.

[14] Chemical Oxygen Demand, Method 8000, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

[15] The back titration method will be used to resolve controversy.

[16] Orion Research Instruction Manual, Residual Chlorine Electrode Model 97–70, 1977, Orion Research Incorporated, 840 Memorial Drive, Cambridge, MA 02138. The calibration graph for the Orion residual chlorine method must be derived using a reagent blank and three standard solutions, containing 0.2, 1.0, and 5.0 mL 0.00281 N potassium iodate/100 mL solution, respectively.

[17] The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1976.

[18] National Council of the Paper Industry for Air and Stream Improvement, Inc. Technical Bulletin 253, December 1971.

[19] Copper, Bicinchoninate Method, Method 8506, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

[20] After the manual distillation is completed, the autoanalyzer manifolds in EPA Methods 335.3 (cyanide) or 420.2 (phenols) are simplified by connecting the re-sample line directly to the sampler. When using the manifold setup shown in Method 335.3, the buffer 6.2 should be replaced with the buffer 7.6 found in Method 335.2.

[21] Hydrogen ion (pH) Automated Electrode Method, Industrial Method Number 378–75WA, October 1976, Bran & Luebbe (Technicon) Autoanalyzer II, Bran & Luebbe Analyzing Technologies, Inc., Elmsford, NY 10523.

[22] Iron, 1,10-Phenanthroline Method, Method 8008, 1980, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

[23] Manganese, Periodate Oxidation Method, Method 8034, Hach Handbook of Wastewater Analysis, 1979, pages 2–113 and 2–117, Hach Chemical Company, Loveland, CO 80537.

[24] Warshaw, R. L., *et al*, "Methods for Analysis of Organic Substances in Water," Techniques of Water-Resources Investigation of the U.S. Geological Survey, Book 5, Chapter A3, (1972 Revised 1987), p. 14.

[25] Nitrogen, Nitrite, Method 8507, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

[26] Just prior to distillation, adjust the sulfuric-acid-preserved sample to pH 4 with 1 + 9 NaOH.

[27] The approved method is cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition. The colorimetric reaction is conducted at a pH of 10.0±0.2. The approved methods are given on pp 576–81 of the 14th Edition: Method 510A for distillation, Method 510B for the manual colorimetric procedure, or Method 510C for the manual spectrometric procedure.

[28] F. Addison and R.G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," Journal of Chromatography, Vol. 47, No. 3, pp. 421–426, 1970.

[29] Approved methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/L and above are inadequate where silver exists as an inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to pH of 12. Therefore, for levels of silver above 1 mg/L, 20 mL of sample should be diluted to 100 mL by adding 40 mL each of 2 M $Na_2S_2O_3$ and NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/L the approved method is satisfactory.

[30] The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 15th Edition.

[31] EPA Methods 335.2 and 335.3 require the NaOH absorber solution final concentration to be adjusted to 0.25 N before colorimetric determination of total cyanide.
[32] Stevens, H.H., Ficke, J.F., and Smoot, G.F., "Water Temperature—Influential Factors, Field Measurement and Data Presentation," Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 1, Chapter D1, 1975.
[33] Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2–231 and 2–333, Hach Chemical Company, Loveland, CO, 80537.
[34] "Direct Current Plasma (DCP) Optical Emission Spectrometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029," 1986—Revised 1991, Thermo Jarrell Ash Corporation, 27 Forge Parkway, Franklin, MA 02038.
[35] Precision and recovery statements for the atomic absorption direct aspiration and graphite furnace methods, and for the spectrophotometric SDDC method for arsenic are provided in Appendix D of this part titled, "Precision and Recovery Statements for Methods for Measuring Metals."
[36] "Closed Vessel Microwave Digestion of Wastewater Samples for Determination of Metals", CEM Corporation, PO Box 200, Matthews, NC 28106–0200, April 16, 1992. Available from the CEM Corporation.
[37] When determining boron and silica, only plastic, PTFE, or quartz laboratory ware may be used from start until completion of analysis.
[38] Only use Trichlorotrifluoroethane (1,1,2-trichloro-1,2,2-trifluoroethane, CFC–113) extraction solvent when determining Total Recoverable Oil and Grease (analogous to EPA Method 413.1). Only use n-Hexane extraction solvent when determining Hexane Extractable Material (analogous to EPA Method 1664A). Use of other extraction solvents is strictly prohibited.
[39] Nitrogen, Total Kjeldahl, Method PAI-DK01 (Block Digestion, Steam Distillation, Titrimetric Detection), revised 12/22/94, OI Analytical/ALPHEM, PO Box 9010, College Station, TX 77842.
[40] Nitrogen, Total Kjeldahl, Method PAI-DK02 (Block Digestion, Steam Distillation, Colorimetric Detection), revised 12/22/94, OI Analytical/ALPHEM, PO Box 9010, College Station, TX 77842.
[41] Nitrogen, Total Kjeldahl, Method PAI-DK03 (Block Digestion, Automated FIA Gas Diffusion), revised 12/22/94, OI Analytical/ALPHEM, PO Box 9010, College Station, TX 77842.
[42] Method 1664, Revision A: "n-Hexane Extractable Material (-HEM; Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry" EPA–821–R–98–002, February 1999. Available at NTIS, PB–121949, U.S. Department of Commerce, 5285 Port Royal, Springfield, Virginia 22161.
[43] USEPA. 2002. Method 1631, Revision E: "Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry." September 2002. Office of Water, U.S. Environmental Protection Agency. EPA–821–R–02–019). The application of clean techniques described in EPA's draft Method 1669 "Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (EPA–821–R–96–011) are recommended to preclude contamination at low-level, trace metal determinations.
[44] Available Cyanide, Method OIA–1677 (Available Cyanide by Flow Injection, Ligand Exchange, and Amperometry), ALPHEM, A Division of OI Analytical, PO Box 9010, College Station, TX 77842–9010.
[45] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Ammonia Plus Organic Nitrogen by a Kjeldahl Digestion Method", Open File Report (OFR) 00–170.
[46] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Chromium in Water by Graphite Furnace Atomic Absorption Spectrophotometry", Open File Report (OFR) 93–449.
[47] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Molybdenum by Graphite Furnace Atomic Absorption Spectrophotometry", Open File Report (OFR) 97–198.
[48] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Total Phosphorus by Kjeldahl Digestion Method and an Automated Colorimetric Finish That Includes Dialysis," Open File Report (OFR) 92–146.
[49] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Arsenic and Selenium in Water and Sediment by Graphite Furnace-Atomic Absorption Spectrometry," Open File Report (OFR) 98–639.
[50] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Elements in Whole-water Digests Using Inductively Coupled Plasma-Optical Emission Spectrometry and Inductively Coupled Plasma-Mass Spectrometry", Open File Report (OFR) 98–165.
[51] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Inorganic and Organic Constituents in Water and Fluvial Sediment", Open File Report (OFR) 93–125.

TABLE IC—LIST OF APPROVED TEST PROCEDURES FOR NON-PESTICIDE ORGANIC COMPOUNDS

Parameter[1]	EPA method number[2,7]			Other approved methods		
	GC	GC/MS	HPLC	*Standard Methods* [Edition(s)]	ASTM	Other
1. Acenaphthene	610	625, 1625B	610	6440 B [18th, 19th, 20th]	D4657–92	Note 9, p. 27.
2. Acenaphthylene	610	625, 1625B	610	6440 B, 6410 B [18th, 19th, 20th]	D4657–92	Note 9, p.27.
3. Acrolein	603	624[4], 1624B				
4. Acrylonitrile	603	624[4], 1624B				
5. Anthracene	610	625, 1625B	610	6410 B, 6440 B [18th, 19th, 20th]	D4657–92	Note 9, p. 27.

Wet Weather Surface Water Sampling

Table II - Required Containers, Preservation Techniques, and Holding Times
40 CFR Part 136.3
July 1, 2005

RP07-002 MUSQUAPSINK BROOK WATERSHED RESTORATION PLAN
&
RP07-001 TENAKILL BROOK WATERSHED RESTORATION PLAN

3544. Available from the American Society for Microbiology, 1752 N Street NW., Washington, DC 20036. Table IA, Note 22.

(58) USEPA. 2002. Method 1604: Total Coliforms and *Escherichia coli (E. coli)* in Water by Membrane Filtration using a Simultaneous Detection Technique (MI Medium). U.S. Environmental Protection Agency, Office of Water, Washington D.C. September 2002, EPA 821–R–02–024. Available from NTIS, PB2003–100129. Table IA, Note 22.

(59) USEPA. 2002. Method 1600: Enterococci in Water by Membrane Filtration using membrane-Enterococcus Indoxyl-β-D-Glucoside Agar (mEI). U.S. Environmental Protection Agency, Office of Water, Washington D.C. September 2002, EPA–821–R–02–022. Available from NTIS, PB2003–100127. Table IA, Note 25.

(60) USEPA. 2001. Method 1622: *Cryptosporidium* in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington, DC April 2001, EPA–821–R–01–026.

Available from NTIS, PB2002–108709. Table IA, Note 26.

(61) USEPA. 2001. Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington, DC April 2001, EPA–821–R–01–025. Available from NTIS, PB2002–108710. Table IA, Note 27.

(62) AOAC. 1995. Official Methods of Analysis of AOAC International, 16th Edition, Volume I, Chapter 17. AOAC International. 481 North Frederick Avenue, Suite 500, Gaithersburg, Maryland 20877–2417. Table IA, Note 11.

(c) Under certain circumstances the Regional Administrator or the Director in the Region or State where the discharge will occur may determine for a particular discharge that additional parameters or pollutants must be reported. Under such circumstances, additional test procedures for analysis of pollutants may be specified by the Regional Administrator, or the Director upon the recommendation of the Director of the Environmental Monitoring Systems Laboratory—Cincinnati.

(d) Under certain circumstances, the Administrator may approve, upon recommendation by the Director, Environmental Monitoring Systems Laboratory—Cincinnati, additional alternate test procedures for nationwide use.

(e) Sample preservation procedures, container materials, and maximum allowable holding times for parameters cited in Tables IA, IB, IC, ID, and IE are prescribed in Table II. Any person may apply for a variance from the prescribed preservation techniques, container materials, and maximum holding times applicable to samples taken from a specific discharge. Applications for variances may be made by letters to the Regional Administrator in the Region in which the discharge will occur. Sufficient data should be provided to assure such variance does not adversely affect the integrity of the sample. Such data will be forwarded, by the Regional Administrator, to the Director of the Environmental Monitoring Systems Laboratory—Cincinnati, Ohio for technical review and recommendations for action on the variance application. Upon receipt of the recommendations from the Director of the Environmental Monitoring Systems Laboratory, the Regional Administrator may grant a variance applicable to the specific charge to the applicant. A decision to approve or deny a variance will be made within 90 days of receipt of the application by the Regional Administrator.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
Table IA—Bacteria Tests:			
1–5 Coliform, total, fecal, and *E. coli*	PP, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$[5]	6 hours.
6 Fecal *streptococci*	PP, G	Cool, <10° 0.0008% $Na_2S_2O_3$[5]	6 hours.
7 *Enterococci*	PP, G	Cool, <10° 0.0008% $Na_2S_2O_3$[5]	6 hours.
Table IA—Protozoa Tests:			
8 *Cryptosporidium*	LDPE	0–8 °C	96 hours.[17]
9 *Giardia*	LDPE	0–8 °C	96 hours.[17]
Table IA—Aquatic Toxicity Tests:			
8–10 Toxicity, acute and chronic	P,G	Cool, 4 °C[16]	36 hours.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES—Continued

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
Table IB—Inorganic Tests:			
1. Acidity	P, G	Cool, 4°C	14 days.
2. Alkalinity	P, G	do	Do.
4. Ammonia	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
9. Biochemical oxygen demand	P, G	Cool, 4°C	48 hours.
10. Boron	P, PFTE, or Quartz.	HNO_3 TO pH<2	6 months.
11. Bromide	P, G	None required	28 days.
14. Biochemical oxygen demand, carbonaceous	P, G	Cool, 4°C	48 hours.
15. Chemical oxygen demand	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
16. Chloride	P, G	None required	Do.
17. Chlorine, total residual	P, G	do	Analyze immediately.
21. Color	P, G	Cool, 4°C	48 hours.
23–24. Cyanide, total and amenable to chlorination.	P, G	Cool, 4°C, NaOH to pH>12, 0.6g ascorbic acid[5].	14 days[6]
25. Fluoride	P	None required	28 days.
27. Hardness	P, G	HNO_3 to pH<2, H_2SO_4 to pH<2	6 months.
28. Hydrogen ion (pH)	P, G	None required	Analyze immediately.
31, 33. Kjeldahl and organic nitrogen	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
Metals:[7]			
18. Chromium VI[7]	P, G	Cool, 4 °C	24 hours.
35. Mercury[17]	P, G	HNO_3 to pH<2	28 days.
3, 5–8, 12,13, 19, 20, 22, 26, 29, 30, 32–34, 36, 37, 45, 47, 51, 52, 58–60, 62, 63, 70–72, 74, 75. Metals except boron, chromium VI and mercury[7].	P, G	do	6 months.
38. Nitrate	P, G	Cool, 4°C	48 hours.
39. Nitrate-nitrite	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
40. Nitrite	P, G	Cool, 4°C	48 hours.
41. Oil and grease	G	Cool to 4°C, HCl or H_2SO_4 to pH<2.	28 days.
42. Organic Carbon	P, G	Cool to 4 °C HC1 or H_2SO4 or H_3PO4, to pH<2.	28 days.
44. Orthophosphate	P, G	Filter immediately, Cool, 4°C	48 hours.
46. Oxygen, Dissolved Probe	G Bottle and top.	None required	Analyze immediately.
47. Winkler	do	Fix on site and store in dark	8 hours.
48. Phenols	G only	Cool, 4°C, H_2SO_4 to pH<2	28 days.
49. Phosphorus (elemental)	G	Cool, 4°C	48 hours.
50. Phosphorus, total	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
53. Residue, total	P, G	Cool, 4°C	7 days.
54. Residue, Filterable	P, G	do	7 days.
55. Residue, Nonfilterable (TSS)	P, G	do	7 days.
56. Residue, Settleable	P, G	do	48 hours.
57. Residue, volatile	P, G	do	7 days.
61. Silica	P, PFTE, or Quartz.	Cool, 4 °C	28 days.
64. Specific conductance	P, G	do	Do.
65. Sulfate	P, G	do	Do.
66. Sulfide	P, G	Cool, 4°C add zinc acetate plus sodium hydroxide to pH>9.	7 days.
67. Sulfite	P, G	None required	Analyze immediately.
68. Surfactants	P, G	Cool, 4°C	48 hours.
69. Temperature	P, G	None required	Analyze.
73. Turbidity	P, G	Cool, 4°C	48 hours.
Table IC—Organic Tests[8]			
13, 18–20, 22, 24–28, 34–37, 39–43, 45–47, 56, 76, 104, 105, 108–111, 113. Purgeable Halocarbons.	G, Teflon-lined septum.	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5].	14 days.
6, 57, 106. Purgeable aromatic hydrocarbons	do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] HCl to pH2[9].	Do.
3, 4. Acrolein and acrylonitrile	do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] adjust pH to 4–5[10].	Do.
23, 30, 44, 49, 53, 77, 80, 81, 98, 100, 112. Phenols[11].	G, Teflon-lined cap.	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction.
7, 38. Benzidines[11]	do	do	7 days until extraction.[13]
14, 17, 48, 50–52. Phthalate esters[11]	do	Cool, 4 °C	7 days until extraction; 40 days after extraction.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES—Continued

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
82–84. Nitrosamines[11,14]	....do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] store in dark.	Do.
88–94. PCBs[11]	....do	Cool, 4 °C	Do.
54, 55, 75, 79. Nitroaromatics and isophorone[11].	....do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] store in dark.	Do.
1, 2, 5, 8–12, 32, 33, 58, 59, 74, 78, 99, 101. Polynuclear aromatic hydrocarbons[11].	....do	....do	Do.
15, 16, 21, 31, 87. Haloethers[11]	....do	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5]	Do.
29, 35–37, 63–65, 73, 107. Chlorinated hydrocarbons[11].	....do	Cool, 4 °C	Do.
60–62, 66–72, 85, 86, 95–97, 102, 103. CDDs/CDFs[11].			
aqueous: field and lab preservation.	G	Cool, 0–4 °C, pH<9, 0.008% $Na_2S_2O_3$[5].	1 year.
Solids, mixed phase, and tissue: field preservation.	....do	Cool, <4 °C	7 days.
Solids, mixed phase, and tissue: lab preservation.	....do	Freeze, < 10 °C	1 year.
Table ID—Pesticides Tests:			
1–70. Pesticides[11]	....do	Cool, 4°C, pH 5–9[13]	Do.
Table IE—Radiological Tests:			
1–5. Alpha, beta and radium	P, G	HNO_3 to pH<2	6 months.

Table II Notes

[1] Polyethylene (P) or glass (G). For microbiology, plastic sample containers must be made of sterilizable materials (polypropylene or other autoclavable plastic).

[2] Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

[3] When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

[4] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that for the specific types of samples under study, the analytes are stable for the longer time, and has received a variance from the Regional Administrator under § 136.3(e). Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show that this is necessary to maintain sample stability. See § 136.3(e) for details. The term "analyze immediately" usually means within 15 minutes or less of sample collection.

[5] Should only be used in the presence of residual chlorine.

[6] Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

[7] Samples should be filtered immediately on-site before adding preservative for dissolved metals.

[8] Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

[9] Sample receiving no pH adjustment must be analyzed within seven days of sampling.

[10] The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

[11] When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6–9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine), and footnotes 12, 13 (re the analysis of benzidine).

[12] If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

[13] Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

[14] For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7–10 with NaOH within 24 hours of sampling.

[15] The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

[16] Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, it is necessary to immediately measure the temperature of the samples and confirm that the 4C temperature maximum has not been exceeded. In the isolated cases where it can be documented that this holding temperature can not be met, the permittee can be given the option of on-site testing or can request a variance. The request for a variance should include supportive data which show that the toxicity of the effluent samples is not reduced because of the increased holding temperature.

[17] Samples collected for the determination of trace level mercury (100 ng/L) using EPA Method 1631 must be collected in tightly-capped fluoropolymer or glass bottles and preserved with BrCl or HCl solution within 48 hours of sample collection. The time to preservation may be extended to 28 days if a sample is oxidized in the sample bottle. Samples collected for dissolved trace level mercury should be filtered in the laboratory. However, if circumstances prevent overnight shipment, samples should be filtered in a designated clean area in the field in accordance with procedures given in Method 1669. Samples that have been collected for determination of total or dissolved trace level mercury must be analyzed within 90 days of sample collection.

Appendix D: Tabulated Water Quality Monitoring Data

		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 - N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	MB6	10.7	6.62	6.09	16.80	615	360	0.50	ND	0.50	ND	0.005	ND	1.300		0.03		0.06		19.00	
5/31/2007	MB6	3.9	7.04	6.60	18.70	2600	660	0.50	ND	0.50	ND	0.005	ND	1.100		0.03		0.05		9.00	
6/7/2007	MB6	7.6	7.20	6.30	16.40	720	570	1.10		0.50	ND	0.005	ND	1.000		0.06		0.15		2.00	ND
6/14/2007	MB6	9.3	7.35	NS	16.70	760	1200	Bacteria Sampling Only													
6/19/2007	MB6	7.8	7.02	6.57	20.40	1040	580														
6/21/2007	MB6	7.7	7.10	6.20	18.40	3900	610	0.50	ND	0.50	ND	0.005	ND	1.400		0.07		0.04		2.00	ND
6/28/2007	MB6	31.4	7.00	6.80	22.30	650	38000	Bacteria Sampling Only													
7/5/2007	MB6	33.4	7.11	8.14	19.00	4300	3700	0.50	ND	0.50	ND	0.005	ND	1.400		0.05		0.11		18.00	
7/12/2007	MB6	25.8	6.90	NS	23.10	60000	10000	Bacteria Sampling Only													
7/19/2007	MB6	27.4	4.77	7.24	22.30	11000	5300														
7/24/2007	MB6	20.3	6.76	7.57	19.60	11000	2600														
7/26/2007	MB6	20.8	7.10	7.68	21.00	627	380														
8/2/2007	MB6	19.1	7.27	7.61	21.30	587	410	0.50	ND	0.50	ND	0.005	ND	2.000		0.08		0.10		2.00	ND
8/9/2007	MB6	25.1	7.20	7.20	24.10	900	480	Bacteria Sampling Only													
8/16/2007	MB6	14.1	7.39	7.41	20.70	2500	760	0.50	ND	0.50	ND	0.005	ND	2.300		0.15		0.19		6.00	
8/23/2007	MB6	19.5	7.11	8.10	18.10	4300	560	Bacteria Sampling Only													
8/30/2007	MB6	4.3	6.75	7.77	19.50	660	380														
9/13/2007	MB6	17.1	6.90	6.09	18.20	720	490														
9/27/2007	MB6	4.4	6.85	5.70	20.10	500	210														
10/10/2007	MB6	17.4	6.49	5.66	17.70	31000	20000	0.82		0.21		0.027		1.350		0.09		0.16		11.00	
10/10/2007	MB6	5.9	7.01	7.56	17.30	27000	28000	0.99		0.21		0.024		1.350		0.09		0.16		5.00	
10/11/2007	MB6	5.9	6.36	6.35	17.90	3200	3400	0.71		0.11		0.005	ND	0.005	ND	0.06		0.01	ND	1.00	
10/25/2007	MB6	6.1	6.79	6.32	15.00	70000	1000	2.00		0.50	ND	0.005	ND	0.62		0.22		0.29		NS	
n		23	23	21	23	23	23	11		11		11		11		11		11		10	
min		3.9	4.77	5.66	15.00	500	210	0.50		0.11		0.01		0.01		0.03		0.01		1.00	
mean*		15.0	6.87	6.90	19.33	10373	5202	0.78		0.41		0.01		1.26		0.08		0.12		7.50	
max		33.4	7.39	8.14	24.10	70000	38000	2.00		0.50		0.03		2.30		0.22		0.29		19.00	
std. dev.		9.3	0.5	0.78	2.32	19115	9935	0.46		0.15		0.01		0.614		0.06		0.082		6.65	

ND indicates value is one half of the detection limit
*For fecal coliform and *E. coli*, geometric means were calculated

		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 - N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	MB5	11.9	7.04	4.98	16.70	880	400	0.50	ND	0.50	ND	0.005	ND	1.200		0.03		0.07		5.00	
5/31/2007	MB5	3.5	6.48	2.86	17.80	580	570	0.50	ND	0.50	ND	0.005	ND	1.000		0.03		0.06		2.00	ND
6/7/2007	MB5	4.7	6.70	4.30	15.80	220	550	0.50	ND	0.50	ND	0.005	ND	0.900		0.04		0.12		2.00	ND
6/14/2007	MB5	6.1	6.97	NS	16.20	800	1900	Bacteria Sampling Only													
6/19/2007	MB5	8.5	6.96	3.34	19.50	980	680														
6/21/2007	MB5	5.2	6.90	4.30	18.40	5900	2600	0.50	ND	0.50	ND	0.005	ND	1.100		0.05		0.01	ND	5.00	
6/28/2007	MB5	20.5	6.80	4.90	23.10	680	33000	Bacteria Sampling Only													
7/5/2007	MB5	29.6	6.74	4.88	20.30	5100	6000	1.00		0.50	ND	0.005	ND	0.005	ND	0.04		0.10		16.00	
7/12/2007	MB5	16.9	6.90	NS	23.10	58000	20000	Bacteria Sampling Only													
7/19/2007	MB5	16.9	6.30	5.13	21.10	3900	5700														
7/24/2007	MB5	20.2	6.35	6.13	20.00	3900	2900														
7/26/2007	MB5	20.0	6.71	6.07	21.60	1060	540														
8/2/2007	MB5	19.4	7.12	5.91	22.40	600	420	0.50	ND	0.50	ND	0.005	ND	0.005	ND	0.29		0.35		2.00	ND
8/9/2007	MB5	22.2	7.00	7.00	23.00	1680	120	Bacteria Sampling Only													
8/16/2007	MB5	15.8	7.32	6.02	20.90	740	590	0.50	ND	0.50	ND	0.005	ND	2.800		0.27		0.30		2.00	ND
8/23/2007	MB5	16.8	6.92	6.86	17.05	1220	760	Bacteria Sampling Only													
8/30/2007	MB5	2.4	6.67	5.36	19.90	124	460														
9/13/2007	MB5	16.7	6.77	5.05	17.50	660	1300														
9/27/2007	MB5	3.4	6.40	4.00	18.70	106	780														
10/10/2007	MB5	12.6	7.03	3.25	18.50	33000	33000	0.99		0.15		0.020		0.700		0.05		0.12		3.00	
10/10/2007	MB5	5.2	6.85	3.86	18.30	26000	21000	1.16		0.21		0.018		0.630		NS		0.14		NS	
10/11/2007	MB5	2.0	6.88	4.64	17.30	5200	5100	0.71		0.10		0.005	ND	1.110		0.05		0.01	ND	6.00	
10/25/2007	MB5	5.4	6.63	3.21	14.80	1100	1700	0.50	ND	0.50	ND	0.005	ND	0.01	ND	0.01		0.10		2.00	ND
n		23	23	21	23	23	23	11		11		11		11		10		11		10	
min		2.0	6.30	2.86	14.80	106	120	0.50		0.10		0.01		0.01		0.01		0.01		2.00	
mean*		12.4	6.80	4.86	19.22	6627	6090	0.67		0.41		0.01		0.86		0.09		0.12		4.50	
max		29.6	7.32	7.00	23.10	58000	33000	1.16		0.50		0.02		2.80		0.29		0.35		16.00	
std. dev.		7.8	0.25	1.19	2.44	13896	10197	0.26		0.16		0.01		0.793		0.10		0.11		4.33	

ND indicates value is one half of the detection limit
*For fecal coliform and *E. coli*, geometric means were calculated

		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 - N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	MB4	8.7	7.17	5.63	16.90	1060	410	1.01		0.50	ND	0.005	ND	1.300		0.03		0.07		8.00	
5/31/2007	MB4	2.6	6.64	3.20	18.10	620	560	0.50	ND	0.50	ND	0.005	ND	1.200		0.03		0.06		6.00	
6/7/2007	MB4	5.5	7.20	4.30	15.80	3200	760	0.50	ND	0.50	ND	0.005	ND	1.100		0.04		0.11		5.00	
6/14/2007	MB4	5.7	7.15	NS	16.10	640	890	Bacteria Sampling Only													
6/19/2007	MB4	5.8	7.03	4.80	19.60	660	630														
6/21/2007	MB4	7.8	7.20	4.50	17.80	4000	2500	0.50	ND	0.50	ND	0.005	ND	1.300		0.01		0.07		2.00	ND
6/28/2007	MB4	16.5	6.90	5.30	23.10	580	11000	Bacteria Sampling Only													
7/5/2007	MB4	24.9	6.87	6.50	20.70	3800	3800	0.50	ND	0.50	ND	0.005	ND	0.660		0.03		0.11		22.00	
7/12/2007	MB4	12.1	6.90	NS	23.20	49000	24000	Bacteria Sampling Only													
7/19/2007	MB4	12.1	6.28	6.01	22.20	3400	8000														
7/24/2007	MB4	18.5	6.93	6.15	20.10	3400	2800														
7/26/2007	MB4	18.9	6.85	6.50	21.00	1160	610														
8/2/2007	MB4	17.4	7.26	6.36	22.60	780	460	0.50	ND	0.50	ND	0.005	ND	0.660		0.29		0.35		2.00	ND
8/9/2007	MB4	22.6	7.20	5.60	23.40	1670	160	Bacteria Sampling Only													
8/16/2007	MB4	15.8	7.38	6.35	21.00	420	460	0.50	ND	0.50	ND	0.005	ND	2.900		0.26		0.03		4.00	
8/23/2007	MB4	17.8	6.91	6.96	17.40	900	680	Bacteria Sampling Only													
8/30/2007	MB4	5.6	6.58	5.12	18.60	720	310														
9/13/2007	MB4	15.3	6.92	5.30	17.90	4400	2100														
9/27/2007	MB4	2.7	6.67	4.74	18.50	410	270														
10/10/2007	MB4	9.8	5.84	4.62	18.70	20000	25000	0.87		0.14		0.019		0.800		0.05		0.11		3.00	
10/10/2007	MB4	3.4	6.98	6.35	18.60	21000	19000	0.95		0.17		0.017		0.790		0.08		0.11		19.00	
10/11/2007	MB4	1.8	6.72	4.25	17.30	4200	4000	0.76		0.11		0.005	ND	1.350		0.05		0.01	ND	11.00	
10/25/2007	MB4	5.2	6.61	3.01	14.30	1160	2200	0.50	ND	0.50	ND	0.005	ND	0.52		0.01		0.08		2.00	ND
n		23	23	21	23	23	23	11		11		11		11		11		11		11	
min		1.8	5.84	3.01	14.30	410	160	0.50		0.11		0.01		0.52		0.01		0.01		2.00	
mean*		11.1	6.88	5.31	19.26	5530	4809	0.64		0.40		0.01		1.14		0.08		0.10		7.64	
max		24.9	7.38	6.96	23.40	49000	25000	1.01		0.50		0.02		2.90		0.29		0.35		22.00	
std. dev.		6.9	0.35	1.09	2.55	10975	7606	0.21		0.17		0.01		0.654		0.10		0.09		6.98	

ND indicates value is one half of the detection limit
*For fecal coliform and *E. coli*, geometric means were calculated

		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 - N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	MB3	4.4	7.36	7.30	19.20	433	260	0.50	ND	0.50	ND	0.005	ND	1.100		0.03		0.05		2.00	
5/31/2007	MB3	1.2	7.06	4.85	21.10	840	530	0.50	ND	0.50	ND	0.005	ND	0.960		0.02		0.04		7.00	
6/7/2007	MB3	3.3	7.20	4.20	17.40	1000	540	0.50	ND	0.50	ND	0.005	ND	0.910		0.04		0.09		4.00	
6/14/2007	MB3	3.8	7.48	NS	17.40	580	740	Bacteria Sampling Only													
6/19/2007	MB3	2.3	7.28	6.70	22.30	700	660														
6/21/2007	MB3	2.5	7.50	6.40	19.40	3400	930	0.50	ND	0.50	ND	0.005	ND	0.730		0.03		0.09		13.00	
6/28/2007	MB3	7.2	7.60	7.00	25.20	120	5400	Bacteria Sampling Only													
7/5/2007	MB3	8.9	7.44	7.71	22.40	3600	4600	0.50	ND	0.50	ND	0.005	ND	0.005	ND	0.02		0.07		13.00	
7/12/2007	MB3	4.8	7.40	NS	23.20	44000	5100	Bacteria Sampling Only													
7/19/2007	MB3	4.8	6.52	6.54	23.90	2000	2000														
7/24/2007	MB3	6.5	7.21	7.71	20.80	2000	2200														
7/26/2007	MB3	1.9	6.99	6.75	22.40	760	340														
8/2/2007	MB3	1.5	7.45	6.64	23.30	310	160	0.50	ND	0.50	ND	0.005	ND	2.900		0.04		0.08		4.00	
8/9/2007	MB3	3.7	7.50	7.00	24.60	706	460	Bacteria Sampling Only													
8/16/2007	MB3	1.2	7.48	6.43	21.80	260	270	0.50	ND	0.50	ND	0.005	ND	0.560		0.01	ND	0.03		22.00	
8/23/2007	MB3	2.3	7.13	6.91	18.80	1300	860	Bacteria Sampling Only													
8/30/2007	MB3	1.3	6.80	7.87	20.30	627	580														
9/13/2007	MB3	1.9	6.87	4.63	17.50	4100	2000														
9/27/2007	MB3	0.8	6.72	4.98	19.50	420	260														
10/10/2007	MB3	3.2	6.94	5.72	20.00	7700	6600	0.74		0.09		0.008		0.260		0.01		0.06		3.00	
10/10/2007	MB3	1.3	6.99	5.22	19.90	9400	7800	0.75		0.11		0.008		0.270		0.01		0.05		2.00	
10/11/2007	MB3	0.4	6.52	6.09	17.90	870	790	0.54		0.08		0.005	ND	0.560		0.02		0.01	ND	1.00	
10/25/2007	MB3	2.2	6.67	6.32	14.40	120	560	0.50	ND	0.50	ND	0.005	ND	0.94		0.05		0.13		2.00	ND
n		23	23	21	23	23	23	11		11		11		11		11		11		11	
min		0.4	6.52	4.20	14.40	120	160	0.50		0.08		0.01		0.01		0.01		0.01		1.00	
mean*		3.1	7.14	6.33	20.55	3706	1897	0.55		0.39		0.01		0.84		0.03		0.06		6.64	
max		8.9	7.60	7.87	25.20	44000	7800	0.75		0.50		0.01		2.90		0.05		0.13		22.00	
std. dev.		2.2	0.336	1.05	2.68	9106	2294	0.10		0.19		0.00		0.766		0.01		0.034		6.64	

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*For fecal coliform and *E. coli*, geometric means were calculated

		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 - N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	MB2	1.5	7.28	6.95	20.50	280	170	0.50	ND	0.50	ND	0.005	ND	1.100		0.03		0.06		7.00	
5/31/2007	MB2	0.8	7.42	4.90	23.50	2000	680	0.50	ND	0.50	ND	0.005	ND	1.000		0.02		0.05		16.00	
6/7/2007	MB2	0.9	6.60	6.30	19.60	2100	190	0.50	ND	0.50	ND	0.005	ND	0.800		0.03		0.11		11.00	
6/14/2007	MB2	3.0	8.20	NS	19.50	4400	460	Bacteria Sampling Only													
6/19/2007	MB2	1.6	7.89	7.43	24.60	480	620														
6/21/2007	MB2	1.0	7.90	6.80	6.80	1600	730	0.50	ND	0.50	ND	0.005	ND	0.480		0.04		0.07		9.00	
6/28/2007	MB2	1.9	7.80	7.90	25.20	60	1300	Bacteria Sampling Only													
7/5/2007	MB2	4.5	7.75	8.12	23.30	230	280	2.50		0.50	ND	0.005	ND	0.005	ND	0.01		0.06		11.00	
7/12/2007	MB2	2.3	7.80	NS	24.90	12000	2200	Bacteria Sampling Only													
7/19/2007	MB2	2.3	6.15	6.04	25.20	493	230														
7/24/2007	MB2	2.5	7.58	8.11	21.80	493	390														
7/26/2007	MB2	0.8	8.13	8.15	24.90	156	60														
8/2/2007	MB2	0.8	7.56	5.90	26.50	106	120	0.50	ND	0.50	ND	0.005	ND	2.800		0.04		0.09		9.00	
8/9/2007	MB2	1.4	7.90	7.30	26.20	538	420	Bacteria Sampling Only													
8/16/2007	MB2	0.4	8.44	6.93	24.50	800	370	0.50	ND	0.50	ND	0.005	ND	0.005	ND	0.01		0.05		10.00	
8/23/2007	MB2	1.1	6.89	6.60	20.00	230	190	Bacteria Sampling Only													
8/30/2007	MB2	0.3	8.11	7.78	23.50	680	140														
9/13/2007	MB2	0.6	7.05	4.79	20.60	3200	540														
9/27/2007	MB2	0.3	6.98	4.63	21.70	1600	150														
10/10/2007	MB2	2.2	7.90	0.21	21.20	420	470	0.81		0.09		0.005	ND	0.005	ND	0.01		0.05		4.00	
10/10/2007	MB2	2.0	7.90	0.19	21.20	340	350	0.82		0.09		0.005	ND	0.005	ND	0.02		0.05		4.00	
10/11/2007	MB2	0.1	8.19	0.24	19.70	350	370	0.92		0.08		0.006		0.270		0.02		0.08		15.00	
10/25/2007	MB2	2.1	6.82	6.11	16.30	1500	600	0.50	ND	0.50	ND	0.005	ND	1.10		0.06		0.13		2.00	ND
n		23	23	21	23	23	23	11		11		11		11		11		11		11	
min		0.1	6.15	0.19	6.80	60	60	0.50		0.08		0.01		0.01		0.01		0.05		2.00	
mean*		1.5	7.58	5.78	21.79	1481	480	0.78		0.39		0.01		0.69		0.03		0.07		8.91	
max		4.5	8.44	8.15	26.50	12000	2200	2.50		0.50		0.01		2.80		0.06		0.13		16.00	
std. dev.		1.0	0.58	2.56	4.18	2538	463	0.59		0.19		0.00		0.836		0.02		0.027		4.44	

ND indicates value is one half of the detection limit
*For fecal coliform and *E. coli*, geometric means were calculated

		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 – N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	MB1	1.1	7.44	7.60	16.3	250	180	0.50	ND	0.50	ND	0.005	ND	1.800		0.04		0.05		2.00	
5/31/2007	MB1	0.3	7.08	7.85	17.9	200	170	0.50	ND	0.50	ND	0.005	ND	1.700		0.05		0.05		2.00	ND
6/7/2007	MB1	0.5	9.00	7.20	14.8	660	490	0.50	ND	0.50	ND	0.005	ND	1.800		0.05		0.14		2.00	ND
6/14/2007	MB1	0.2	8.20	NS	19.5	5400	560	Bacteria Sampling Only													
6/19/2007	MB1	0.8	7.69	8.88	18.3	980	460														
6/21/2007	MB1	0.4	7.90	9.30	15.6	460	360	0.50	ND	0.50	ND	0.005	ND	2.000		0.04		0.01	ND	2.00	ND
6/28/2007	MB1	0.6	7.40	7.90	21.2	210	4800	Bacteria Sampling Only													
7/5/2007	MB1	1.4	6.78	7.94	19.8	4200	4000	0.50	ND	0.50	ND	0.005	ND	1.000	ND	0.06		0.12		17.00	
7/12/2007	MB1	1.0	7.60	NS	19.5	28000	5300	Bacteria Sampling Only													
7/19/2007	MB1	27.4	5.74	8.79	20.7	3500	3300														
7/24/2007	MB1	0.9	7.74	9.55	17.6	3500	1600														
7/26/2007	MB1	0.4	7.62	9.09	19.6	860	570														
8/2/2007	MB1	0.3	7.87	9.47	19.5	1040	480	0.50	ND	0.50	ND	0.005	ND	1.700		0.06		0.07		2.00	ND
8/9/2007	MB1	0.6	7.80	8.80	21.4	763	410	Bacteria Sampling Only													
8/16/2007	MB1	0.2	7.88	8.43	19.8	780	440	0.50	ND	0.50	ND	0.005	ND	1.900	ND	0.05		0.06		2.00	ND
8/23/2007	MB1	0.4	7.55	8.78	16.9	1060	480	Bacteria Sampling Only													
8/30/2007	MB1	0.1	7.09	9.37	18.4	1270	560														
9/13/2007	MB1	0.1	7.23	7.01	15.6	720	610														
9/27/2007	MB1	0.0	7.34	6.24	19.4	370	16000														
10/10/2007	MB1	0.6	8.05	0.28	17.1	16000	11000	0.96		0.05		0.011		1.410		0.12		0.16		5.00	
10/10/2007	MB1	0.6	7.88	0.26	16.7	7000	780	0.67		0.06		0.012		1.420		0.12		0.15		3.00	
10/11/2007	MB1	0.0	8.43	1.35	16.7	1100	7800	0.50	ND	0.50	ND	0.005		1.530		0.08		0.09		1.00	
10/25/2007	MB1	0.1	6.70	6.30	12.9	1700	490	0.50	ND	0.50	ND	0.005	ND	1.00		0.06		0.12		2.00	ND
n		23	23	21	23	23	23	11		11		11		11		11		11		11	
min		0.0	5.74	0.26	12.90	200	170	0.50		0.05		0.01		1.00		0.04		0.01		1.00	
mean*		1.7	7.57	7.16	18.05	3479	2645	0.56		0.42		0.01		1.57		0.07		0.09		3.64	
max		27.4	9.00	9.55	21.40	28000	16000	0.96		0.50		0.01		2.00		0.12		0.16		17.00	
std. dev.		5.6	0.65	2.91	2.17	6375	4052	0.14		0.18		0.00		0.337		0.03		0.049		4.54	

ND indicates value is one half of the detection limit
*For fecal coliform and *E. coli*, geometric means were calculated

		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 – N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	HB1	45.3	7.22	7.60	19.10	3300	2600	0.50	ND	0.50	ND	0.005	ND	7.200		1.20		1.34		6.00	
5/31/2007	HB1	10.6	7.08	6.49	20.60	2100	780	2.20		1.40		0.005	ND	8.200		1.81		1.85		8.00	
6/7/2007	HB1	30.9	6.60	6.40	17.40	2200	660	2.30		0.50	ND	0.005	ND	9.400		1.70		2.10		2.00	ND
6/14/2007	HB1	54.4	7.62	NS	16.10	900	1800	Bacteria Sampling Only													
6/19/2007	HB1	29.0	NS	NS	NS	5900	1400														
6/21/2007	HB1	22.7	7.30	5.80	19.30	780	820	0.50	ND	0.50	ND	0.005	ND	13.000		2.00		2.20		2.00	ND
6/28/2007	HB1	45.7	7.60	7.20	23.20	200	5200	Bacteria Sampling Only													
7/5/2007	HB1	43.2	7.01	8.79	21.70	1160	2700	0.50	ND	0.50	ND	0.005	ND	0.005	ND	0.80		0.91		10.00	
7/12/2007	HB1	75.8	7.30	NS	22.10	41000	NS	Bacteria Sampling Only													
7/19/2007	HB1	75.2	6.74	6.37	22.50	5900	3700														
7/24/2007	HB1	69.3	7.38	9.08	20.00	5900	2800														
7/26/2007	HB1	28.9	7.24	7.77	22.20	1200	1700														
8/2/2007	HB1	22.5	7.22	7.54	23.30	800	430	1.20		0.50	ND	0.005	ND	12.000		2.10		1.80		2.00	ND
8/9/2007	HB1	43.0	7.50	7.50	24.00	1420	430	Bacteria Sampling Only													
8/16/2007	HB1	19.7	7.55	7.25	22.60	860	410	0.50	ND	0.50	ND	0.005	ND	11.000	ND	1.90		2.20		10.00	
8/23/2007	HB1	19.7	7.16	7.74	19.60	880	640	Bacteria Sampling Only													
8/30/2007	HB1	20.0	7.00	6.96	21.80	1030	1800														
9/13/2007	HB1	22.3	6.98	6.23	19.40	2700	840														
9/27/2007	HB1	15.9	7.29	4.91	22.10	880	560														
10/10/2007	HB1	NS	7.61	0.23	19.10	26000	22000	1.30		0.13		0.061		5.410		0.94		1.05		5.00	
10/10/2007	HB1	NS	7.56	0.23	19.00	21000	16000	0.93		0.13		0.064		5.640		0.98		1.03		4.00	
10/11/2007	HB1	NS	8.38	2.10	19.20	1100	1600	NS		NS		NS		NS		NS		NS		NS	
10/25/2007	HB1	19.5	7.11	6.67	16.70	40000	440	1.40		0.50	ND	0.005	ND	14.00		2.20		1.80		2.00	ND
n		20	22	20	22	23	22	10		10		10		10		10		10		10	
min		10.6	6.60	0.23	16.10	200	410	0.50		0.13		0.01		0.01		0.80		0.91		2.00	
mean*		35.7	7.29	6.14	20.50	7270	3150	1.13		0.52		0.02		8.59		1.56		1.63		5.10	
max		75.8	8.38	9.08	24.00	41000	22000	2.30		1.40		0.06		14.00		2.20		2.20		10.00	
std. dev.		20.0	0.37	2.49	2.20	12295	5354	0.69		0.35		0.02		4.235		0.53		0.5029		3.28	

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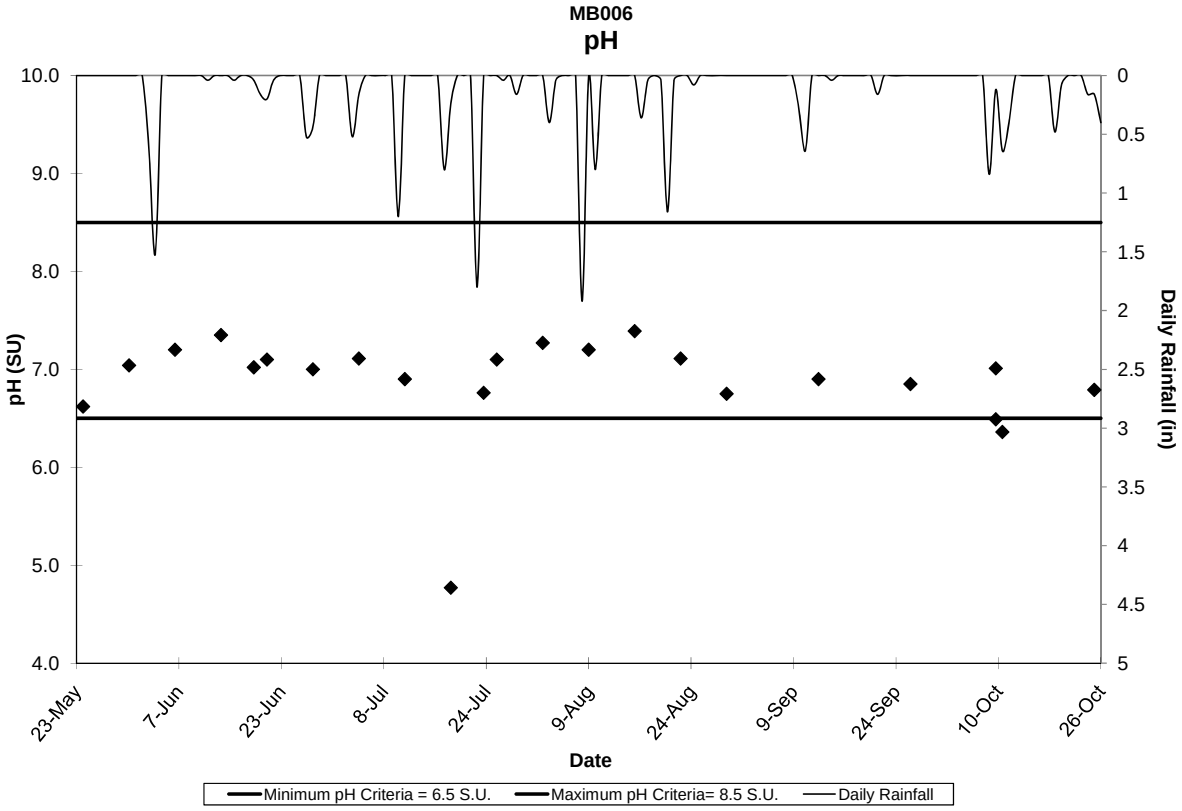
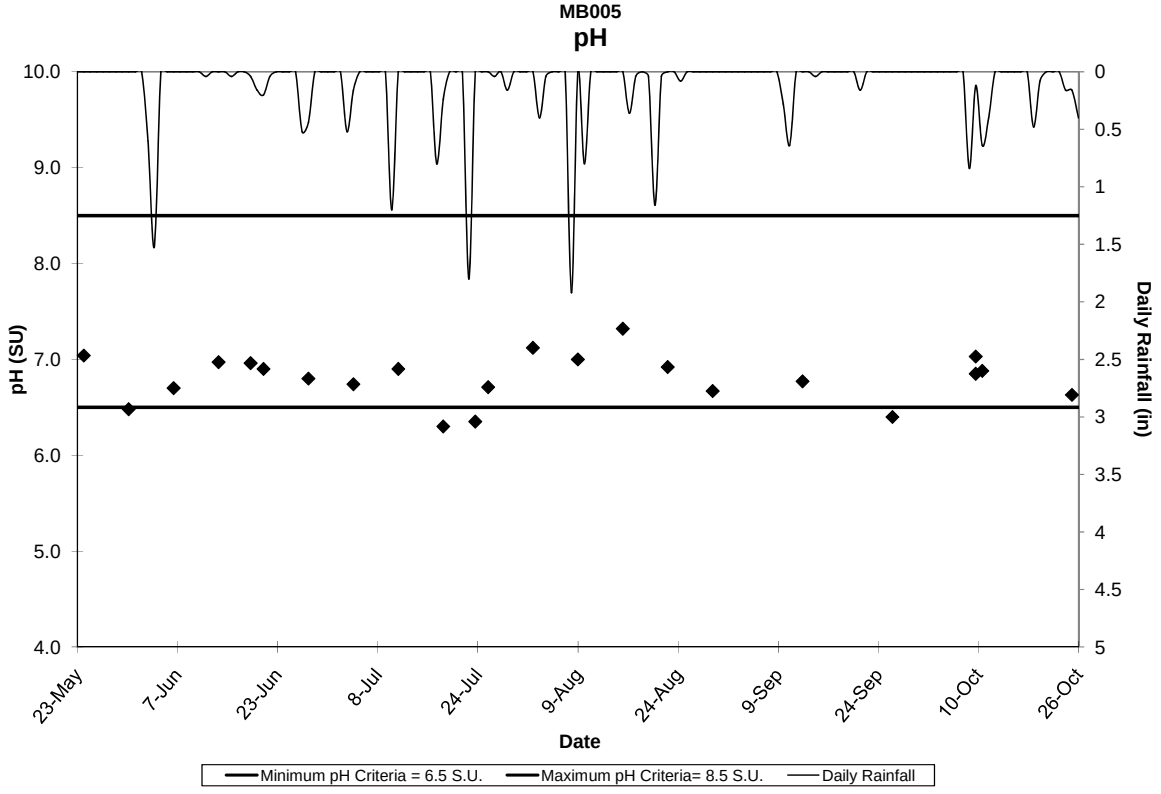
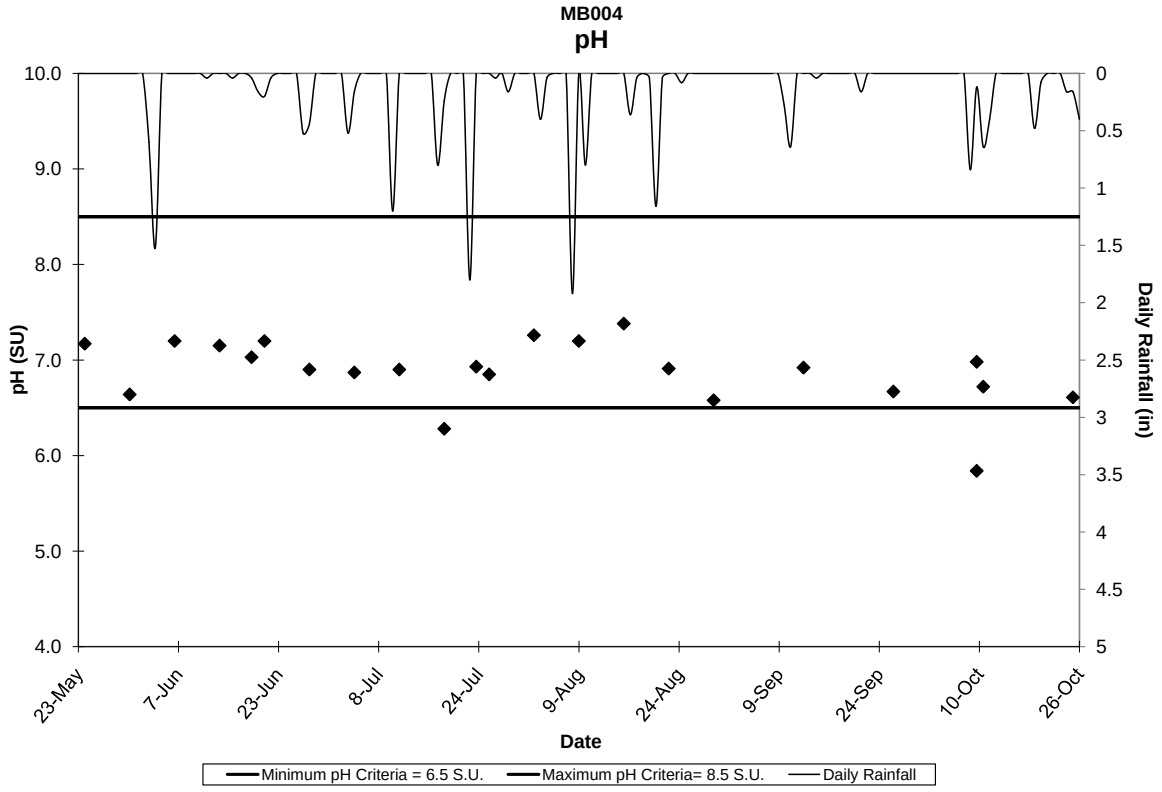
		Flow Rate	pH	DO	Temperature	Fecal Coliform	*E. coli*	TKN		NH_3 - N		NO_2- N		NO_3- N		PO_4^{3-} Dissolved		TP		TSS	
Date	*Station ID*	*cfs*	*S.U.*	*(mg/L)*	*deg C*	*col/100 ml*	*col/100 ml*	*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*		*(mg/L)*	
5/24/2007	SR1	25.1	7.49	8.34	17.90	820	440	0.50	ND	0.50	ND	0.005	ND	1.800		0.02		0.03		4.00	
5/31/2007	SR1	5.8	6.98	7.21	18.70	700	380	0.50	ND	0.50	ND	0.005	ND	1.800		0.03		0.04		2.00	ND
6/7/2007	SR1	12.0	6.20	7.90	16.00	2200	590	0.50	ND	0.50	ND	0.005	ND	1.600		0.03		0.11		2.00	ND
6/14/2007	SR1	17.0	7.35	NS	17.60	1060	1100	Bacteria Sampling Only													
6/19/2007	SR1	12.8	7.45	7.40	22.80	4900	1800														
6/21/2007	SR1	13.1	7.50	7.00	17.80	3900	790	0.50	ND	0.50	ND	0.005	ND	1.800		0.03		0.04		2.00	ND
6/28/2007	SR1	27.2	7.50	7.70	21.80	170	6100	Bacteria Sampling Only													
7/5/2007	SR1	34.2	7.55	8.50	19.30	3700	3700	0.50	ND	0.50	ND	0.005	ND	1.400		0.03		0.07		7.00	
7/12/2007	SR1	41.0	7.20	NS	21.40	39000	NS	Bacteria Sampling Only													
7/19/2007	SR1	41.0	6.38	8.42	21.80	5800	4100														
7/24/2007	SR1	43.6	7.27	8.76	18.50	5800	3500														
7/26/2007	SR1	12.2	7.09	8.04	20.60	1020	520														
8/2/2007	SR1	11.5	7.50	8.52	21.90	110	390	0.50	ND	0.50	ND	0.005	ND	1.400		0.01	ND	0.01		2.00	ND
8/9/2007	SR1	23.5	7.40	7.40	22.70	1270	390	Bacteria Sampling Only													
8/16/2007	SR1	9.3	7.52	8.29	20.40	553	430	0.50	ND	0.50	ND	0.005	ND	1.600		0.02		0.06		2.00	ND
8/23/2007	SR1	9.3	6.85	8.64	17.10	900	460	Bacteria Sampling Only													
8/30/2007	SR1	6.8	6.75	8.11	19.20	420	430														
9/13/2007	SR1	8.5	7.02	4.99	16.90	2000	630														
9/27/2007	SR1	4.6	6.90	6.02	19.20	820	480														
10/10/2007	SR1	NS	8.11	0.28	17.50	33000	23000	0.91		0.09		0.018		1.490		0.07		0.12		10.00	
10/10/2007	SR1	NS	7.41	0.26	17.10	12000	9400	0.94		0.13		0.018		1.500		0.08		0.13		10.00	
10/11/2007	SR1	NS	8.41	2.15	16.90	3000	2600	0.52		0.07		0.008		1.560		0.04		0.07		2.00	
10/25/2007	SR1	7.6	6.88	6.54	13.80	4500	1700	0.50	ND	0.50	ND	0.005	ND	1.30		0.02		0.08		2.00	ND
n		20	23	21	23	23	22	11		11		11		11		11		11		11	
min		4.6	6.20	0.26	13.80	110	380	0.50		0.07		0.01		1.30		0.01		0.01		2.00	
mean*		18.3	7.25	6.69	19.00	5550	2860	0.58		0.39		0.01		1.57		0.03		0.07		4.09	
max		43.6	8.41	8.76	22.80	39000	23000	0.94		0.50		0.02		1.80		0.08		0.13		10.00	
std. dev.		12.8	0.49	2.62	2.35	10025	5045	0.17		0.19		0.01		0.174		0.02		0.0386		3.30	

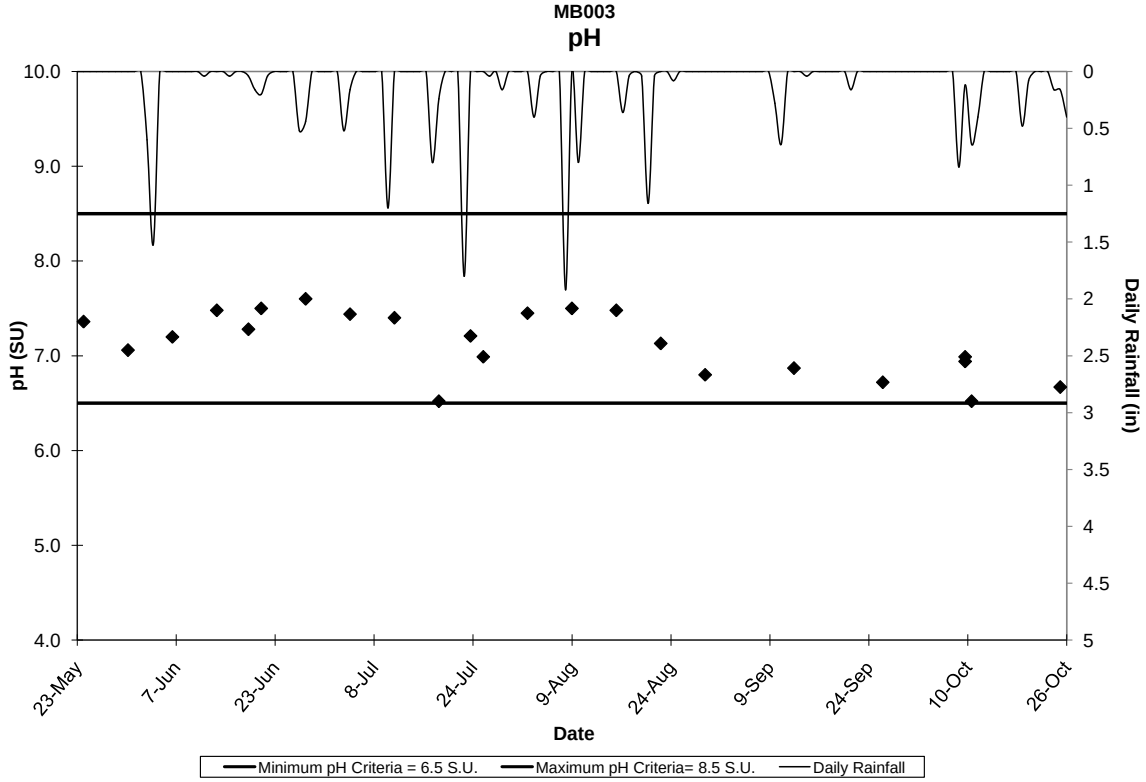
ND indicates value is one half of the detection limit
*For fecal coliform and *E. coli*, geometric means were calculated

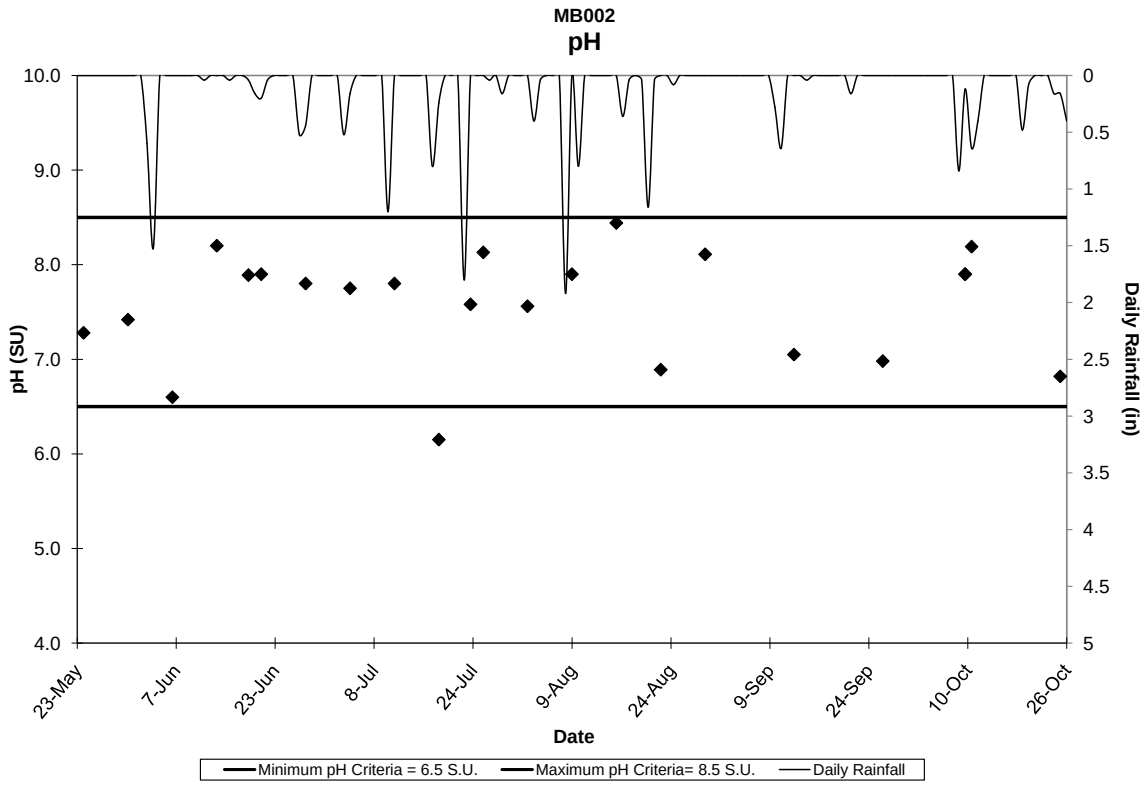
Appendix E: Presentation of Graphed Instream Water Quality Data

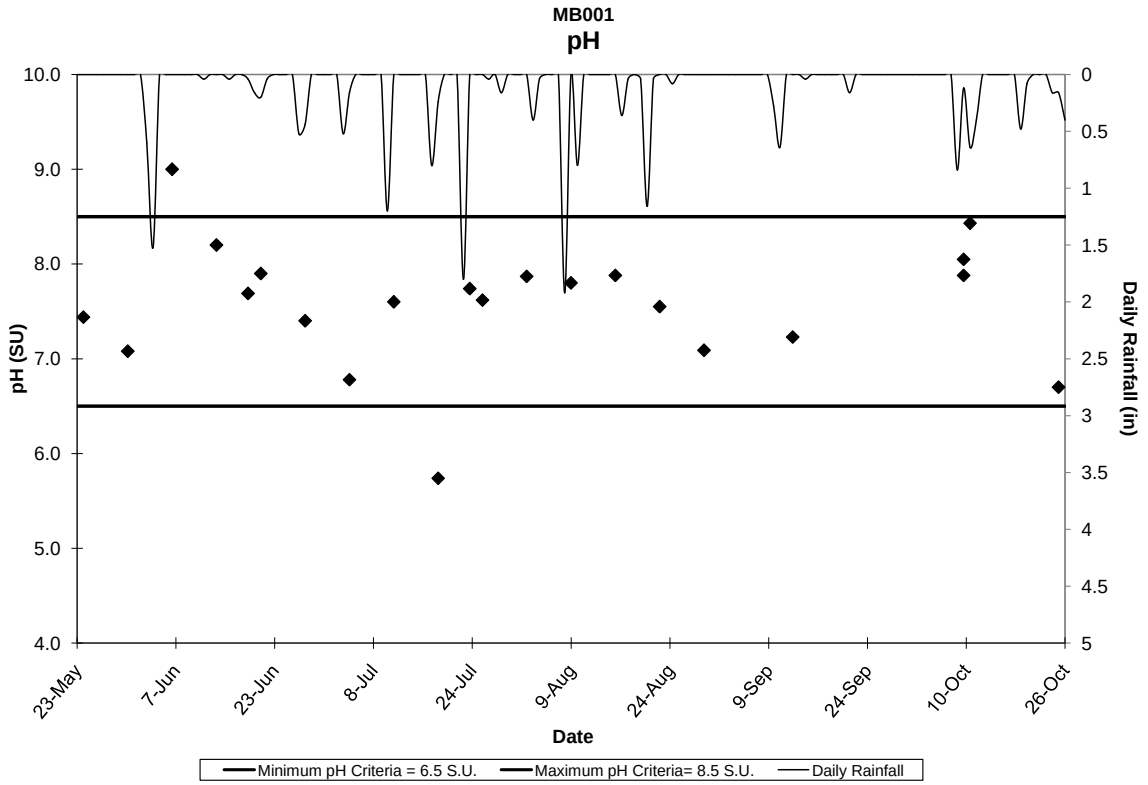

MB006
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

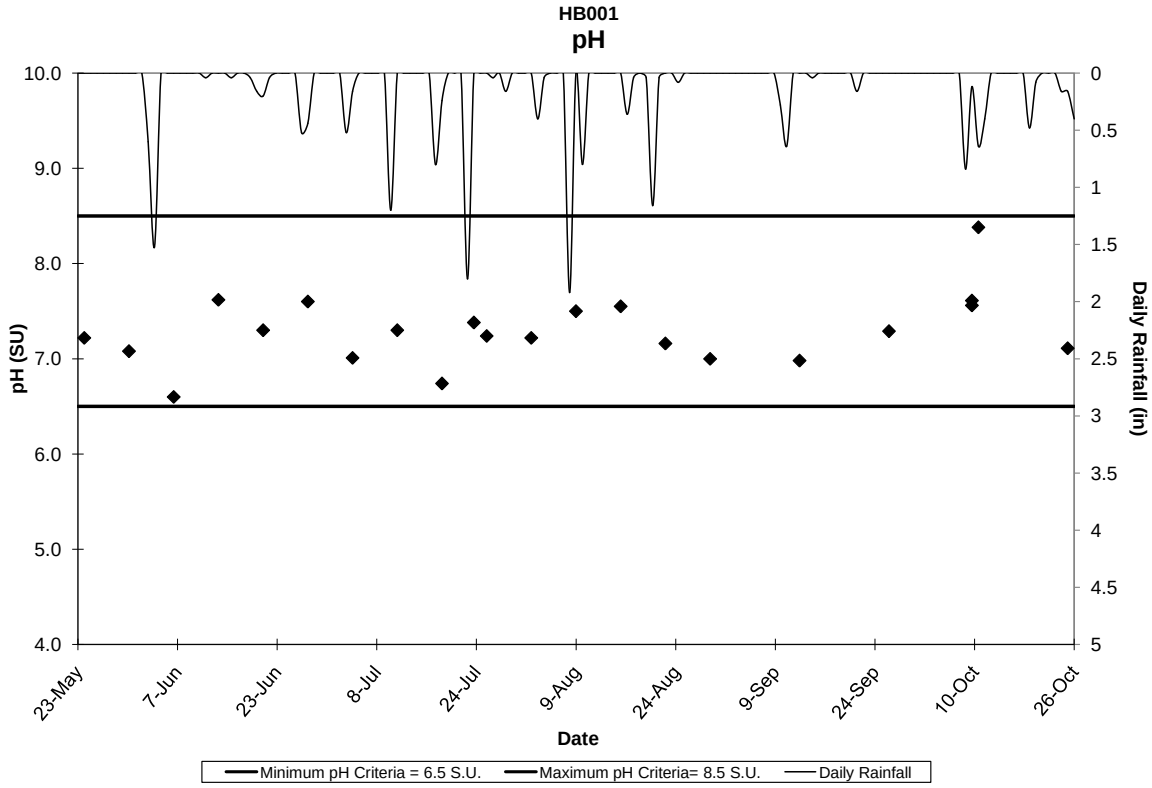

MB005
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

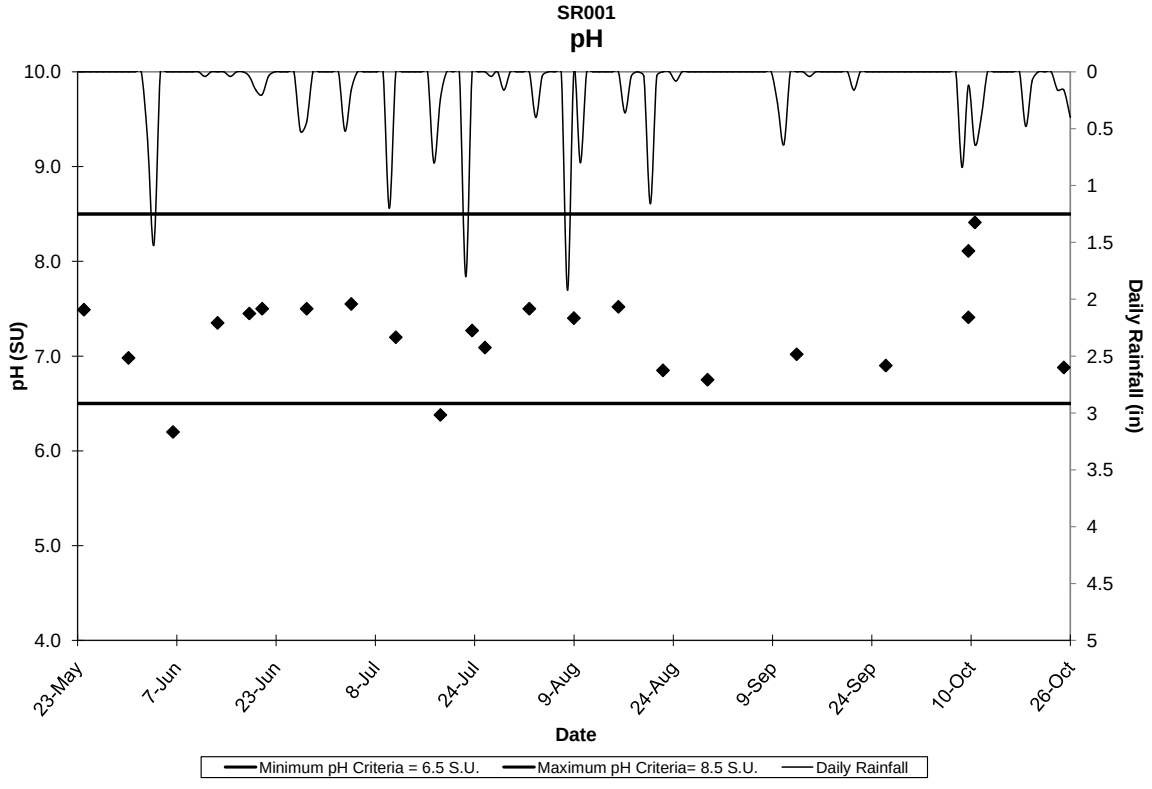

MB004
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

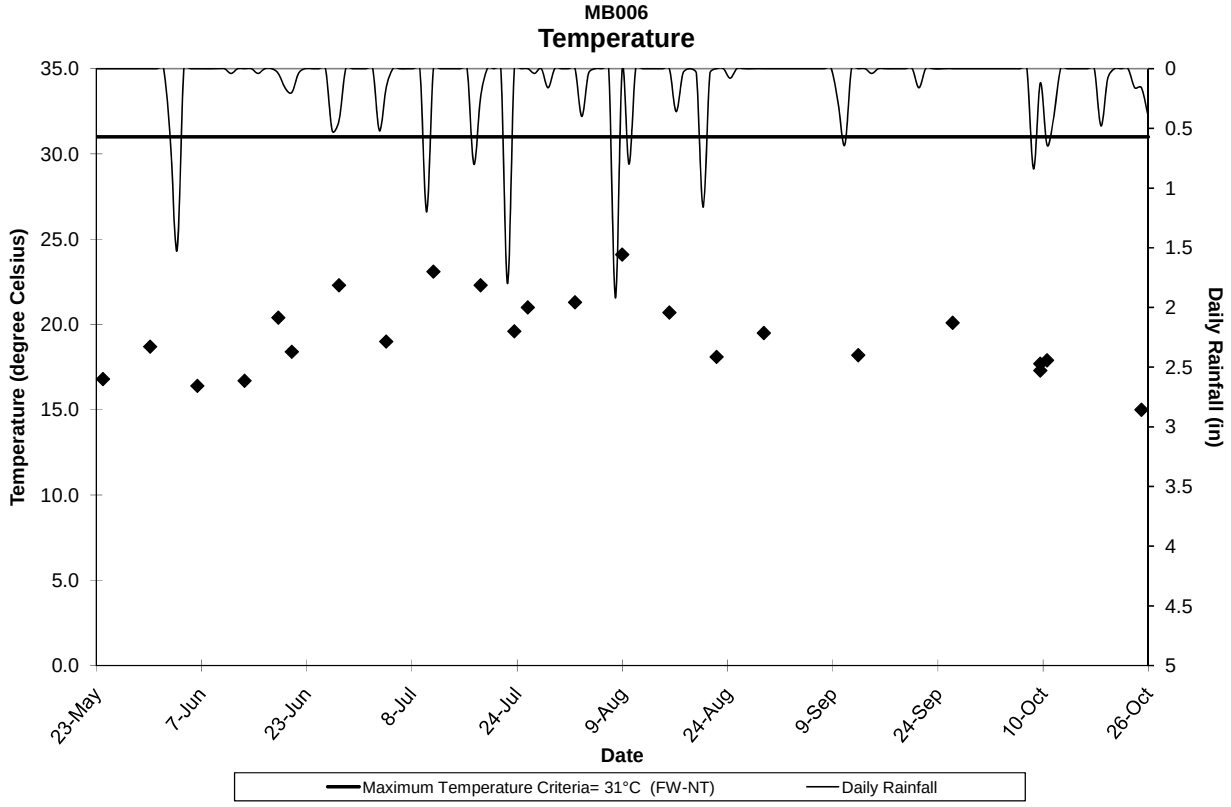

MB003
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

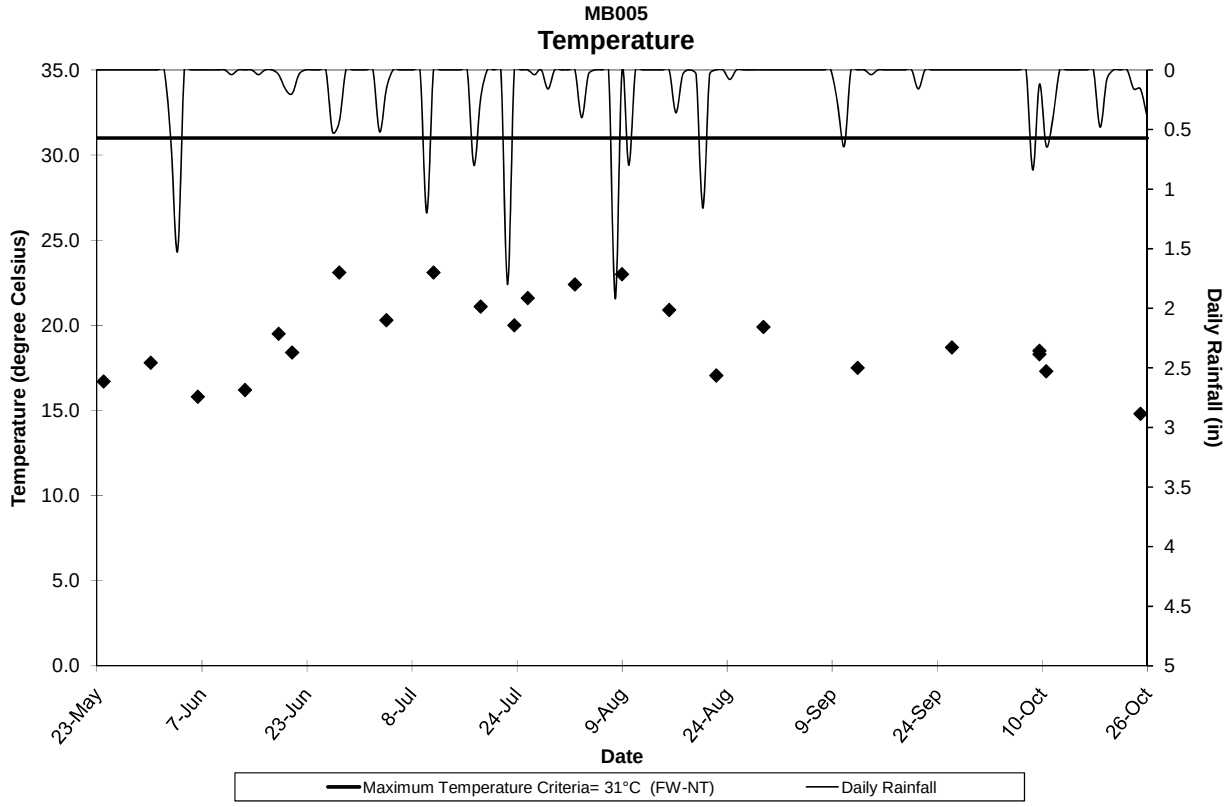

MB002
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

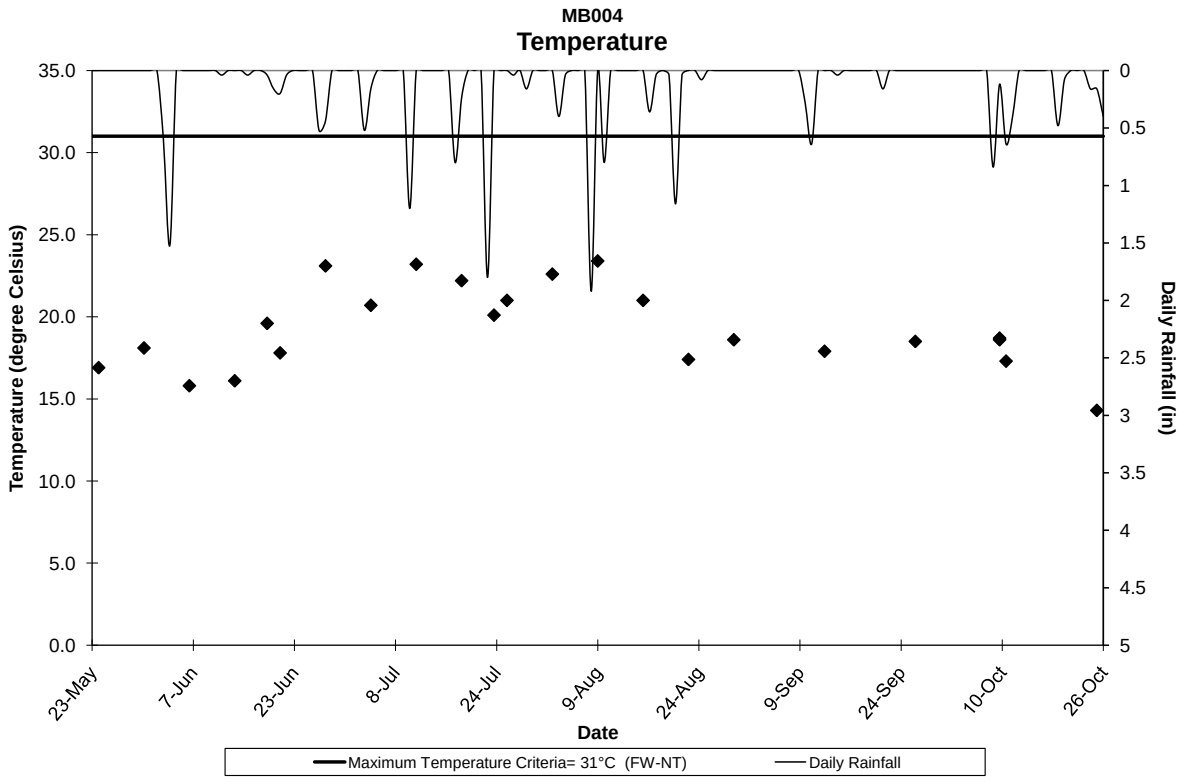

MB001
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

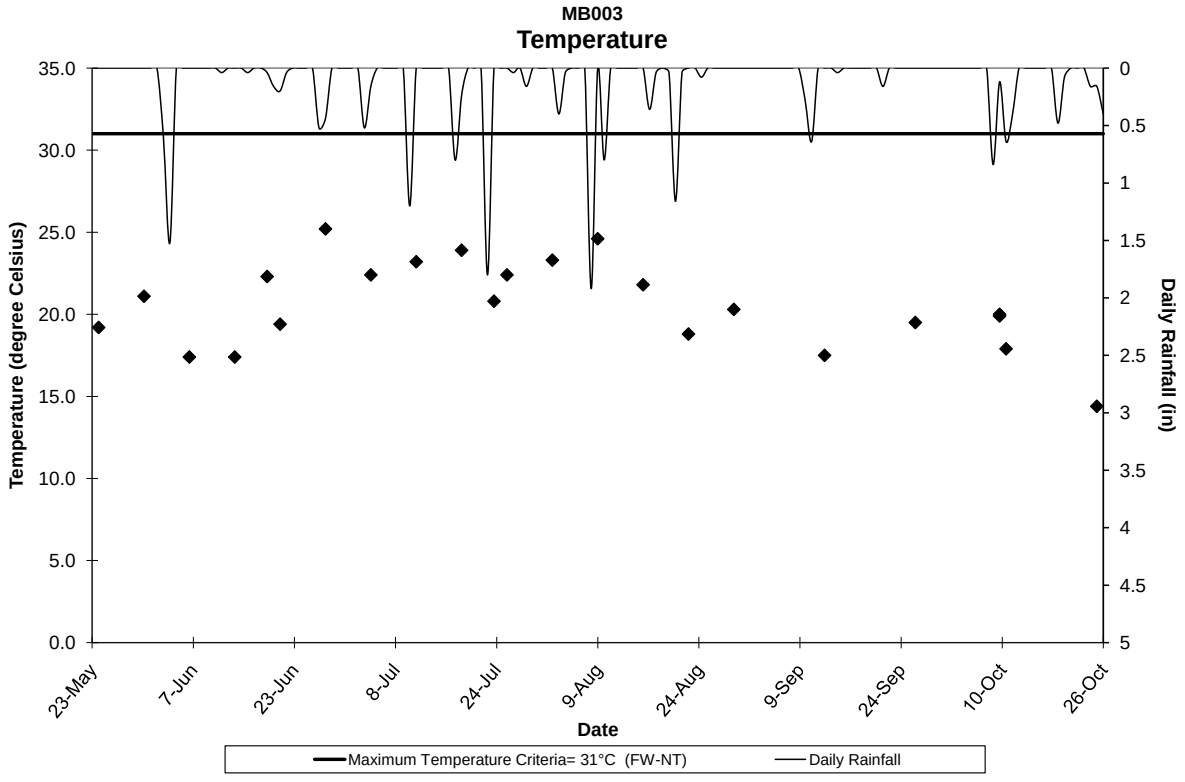

HB001
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

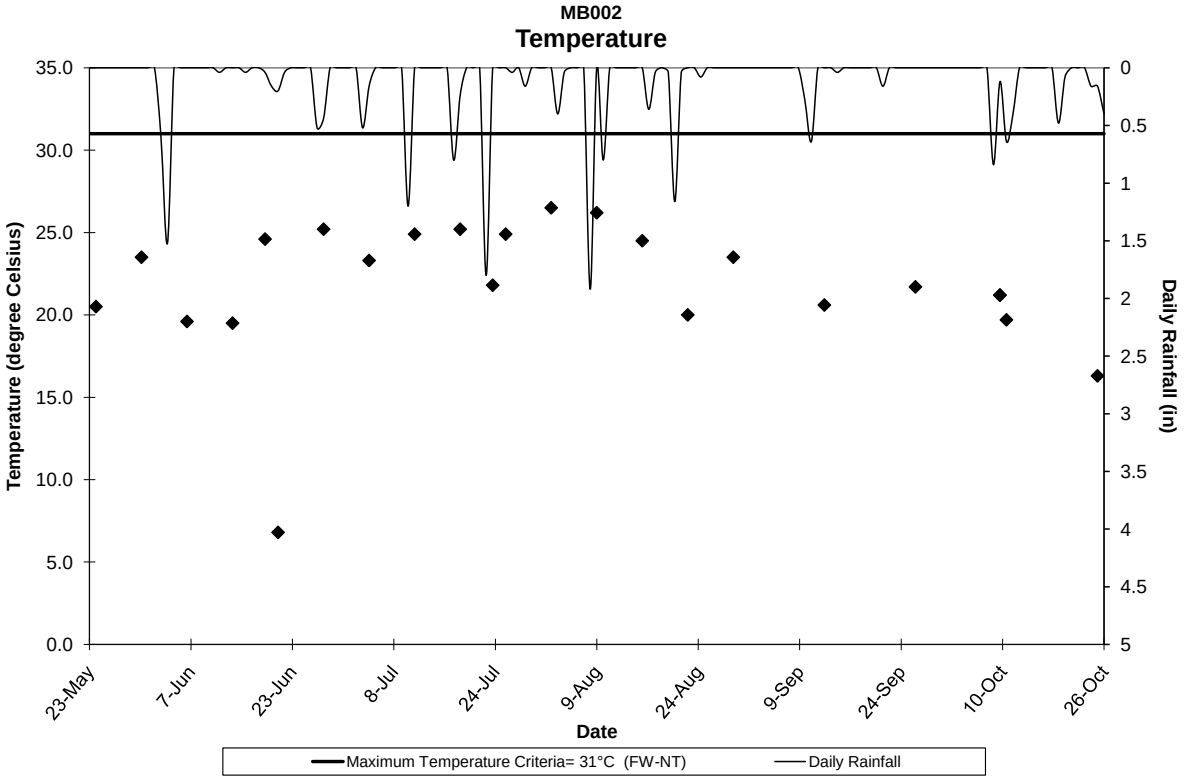

SR001
pH
10.0
9.0
8.0
7.0
6.0
5.0
4.0
pH (SU)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Minimum pH Criteria = 6.5 S.U.
Maximum pH Criteria= 8.5 S.U.
Daily Rainfall

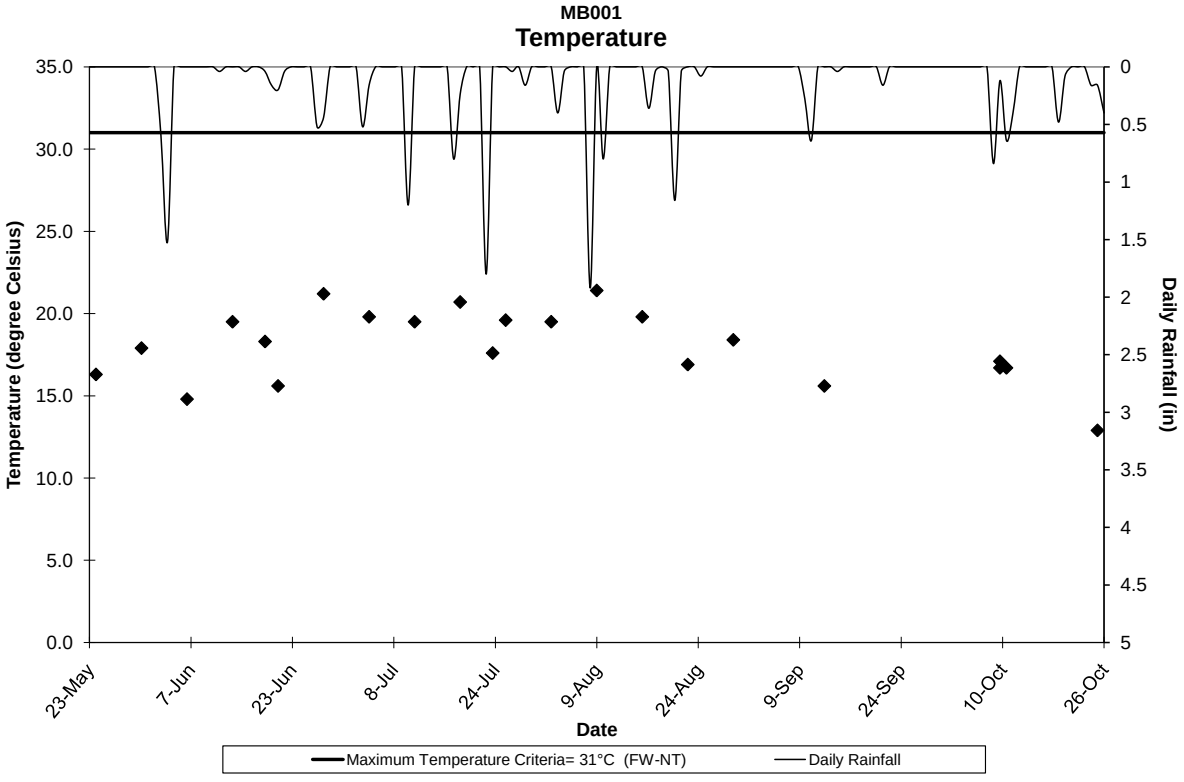

MB006
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

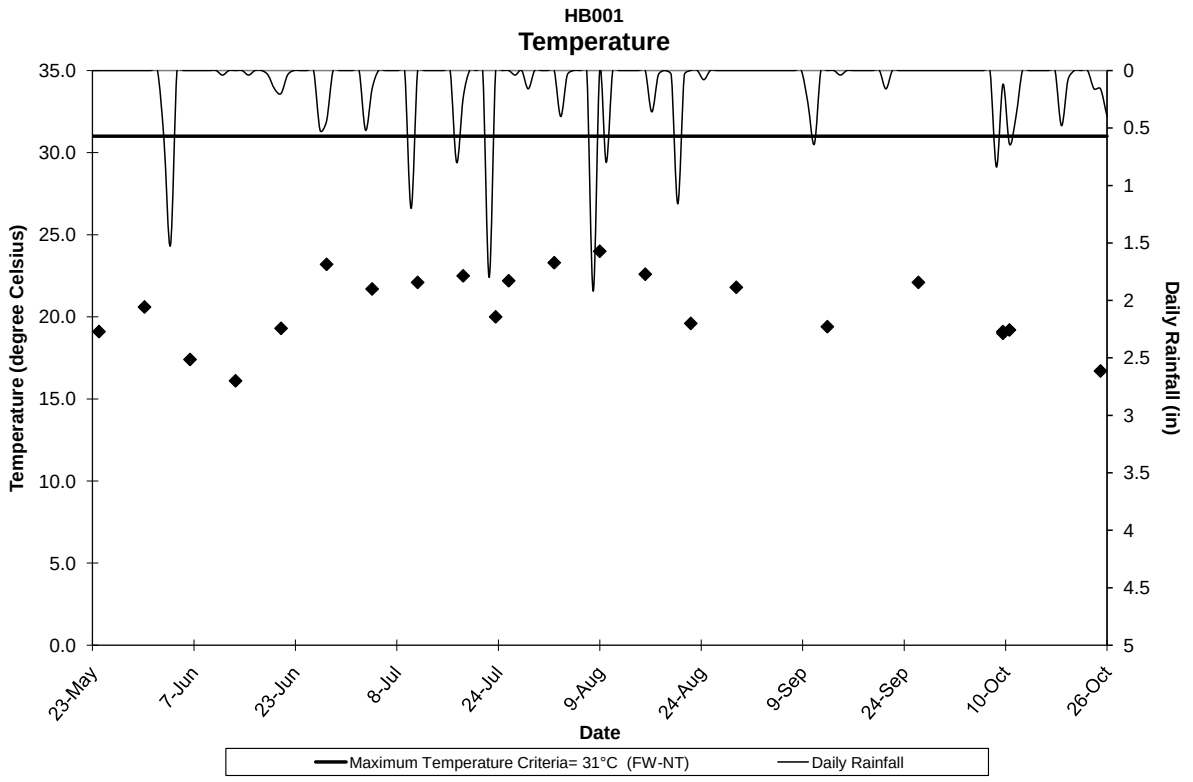

MB005
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

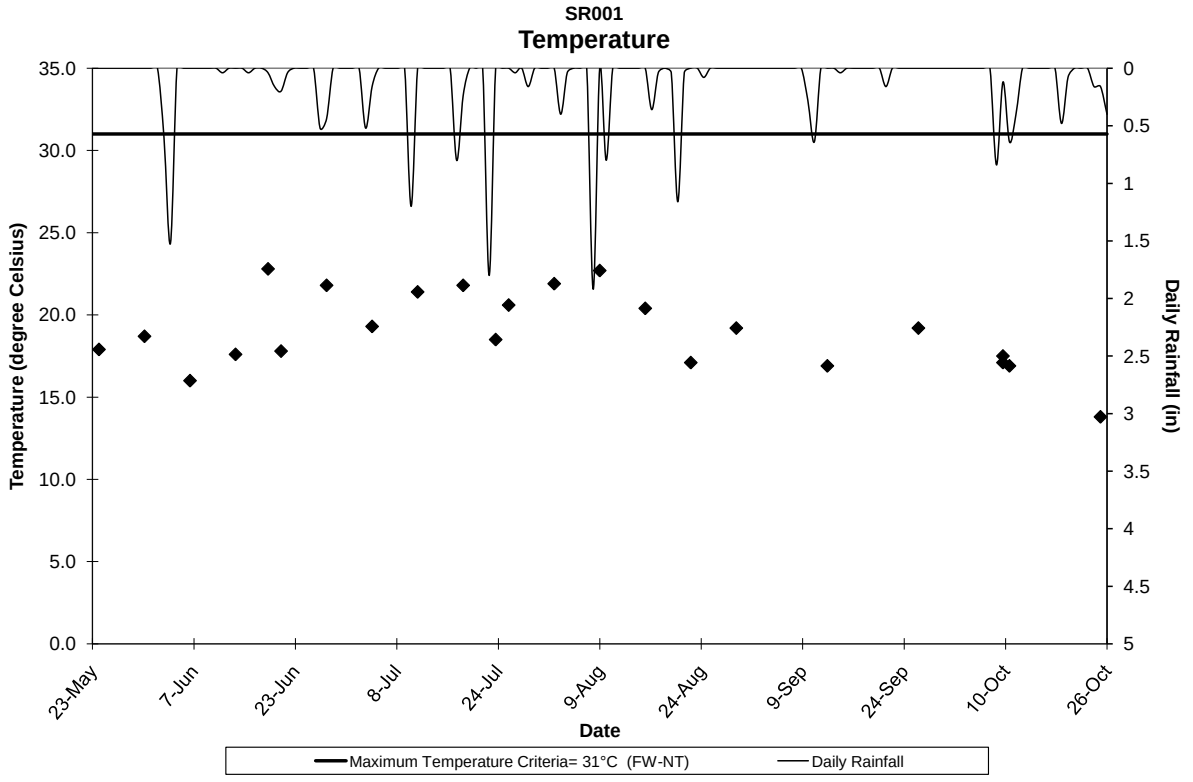

MB004
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

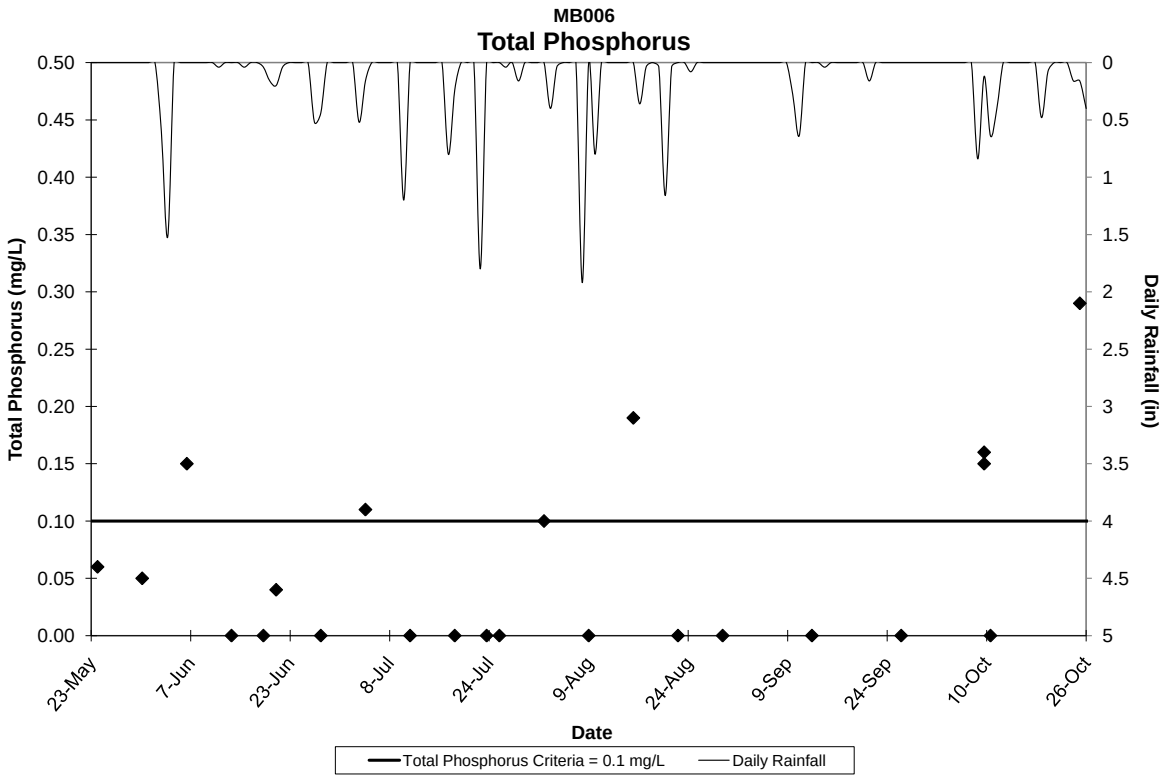

MB003
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

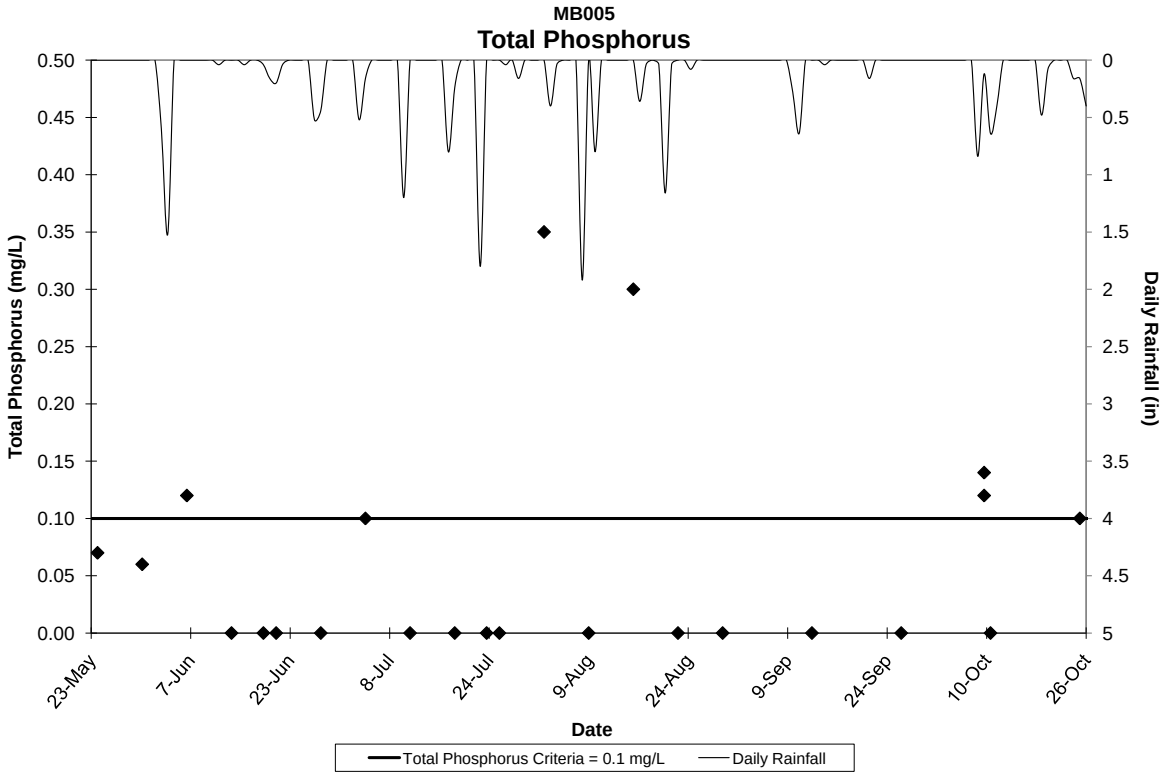

MB002
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
Date
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

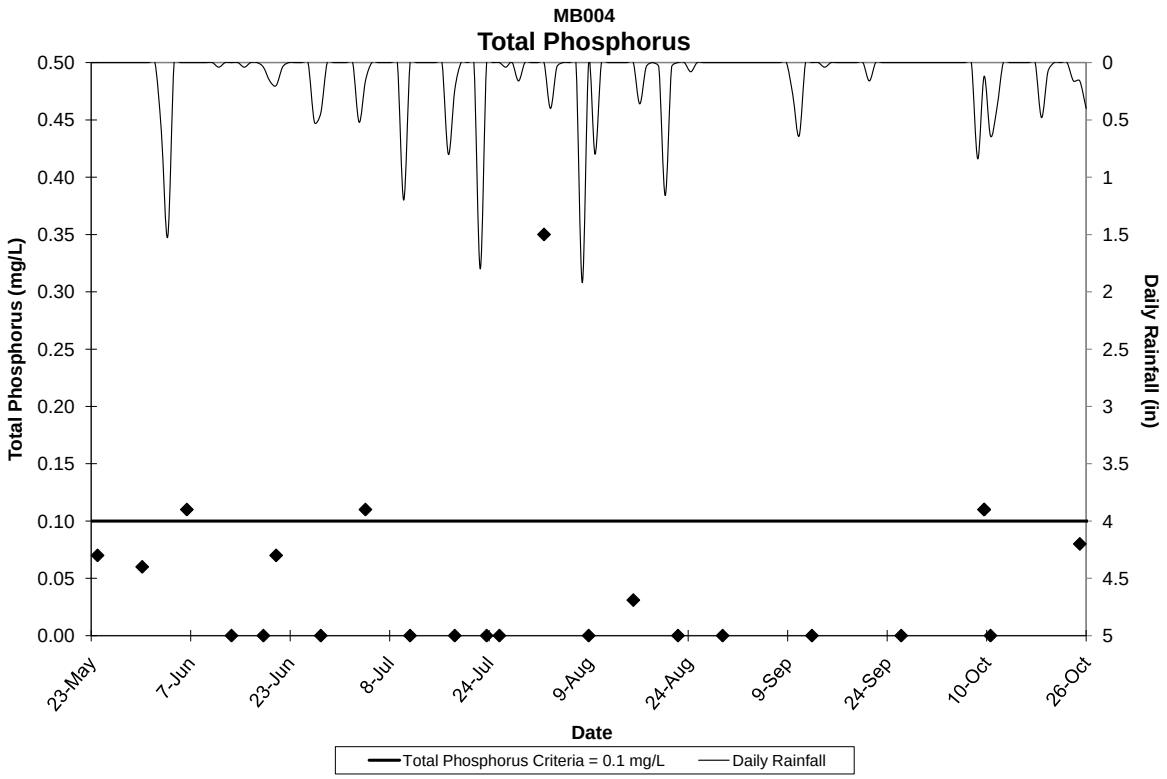

MB001
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
Date
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

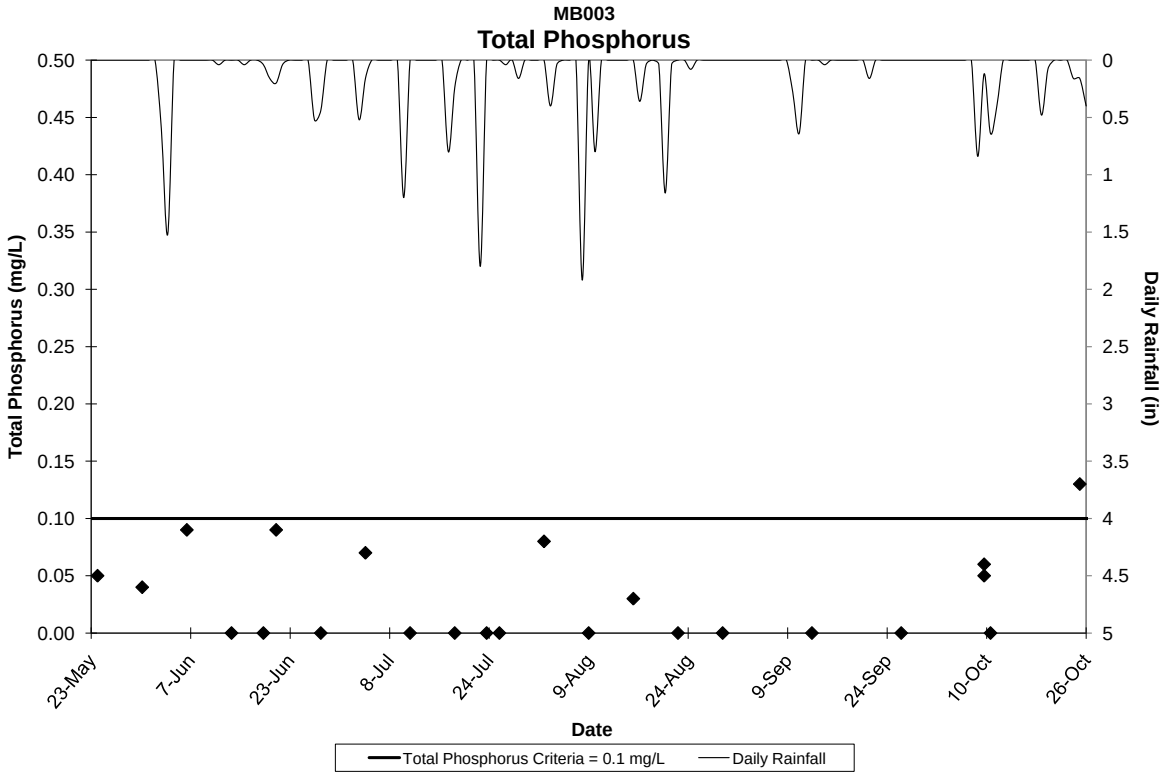

HB001
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

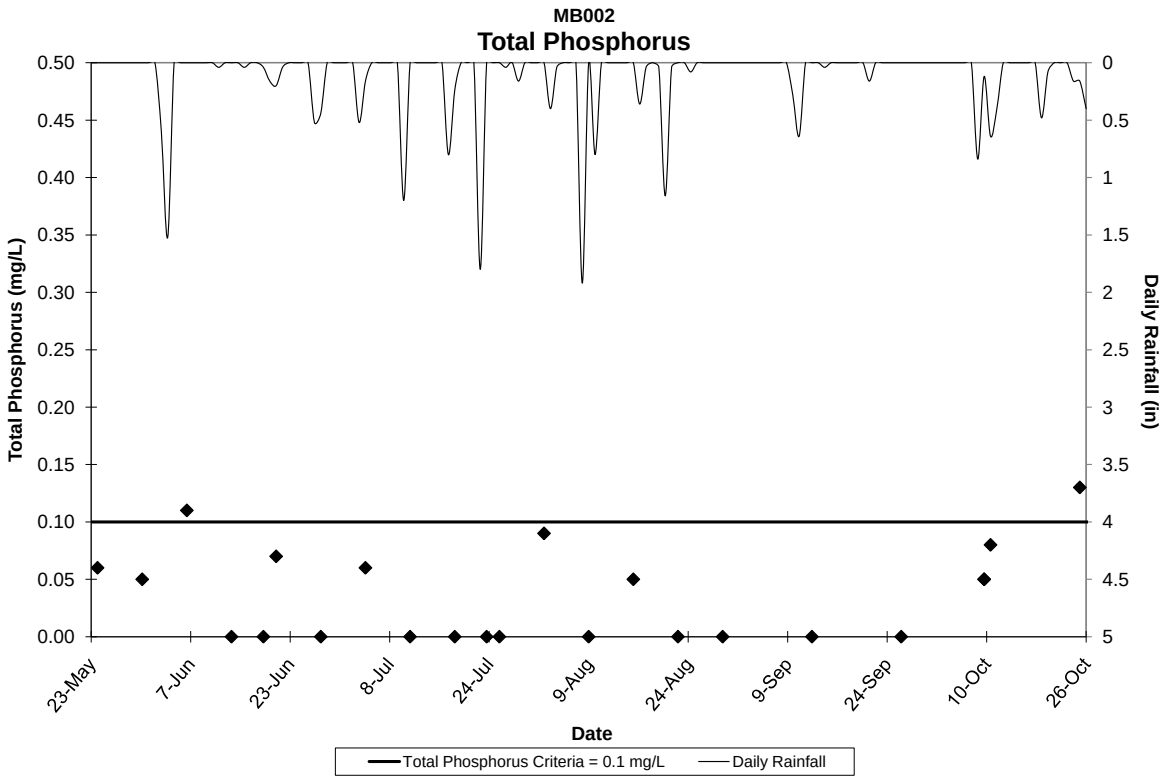

SR001
Temperature
Temperature (degree Celsius)
Daily Rainfall (in)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Maximum Temperature Criteria= 31°C (FW-NT)
Daily Rainfall

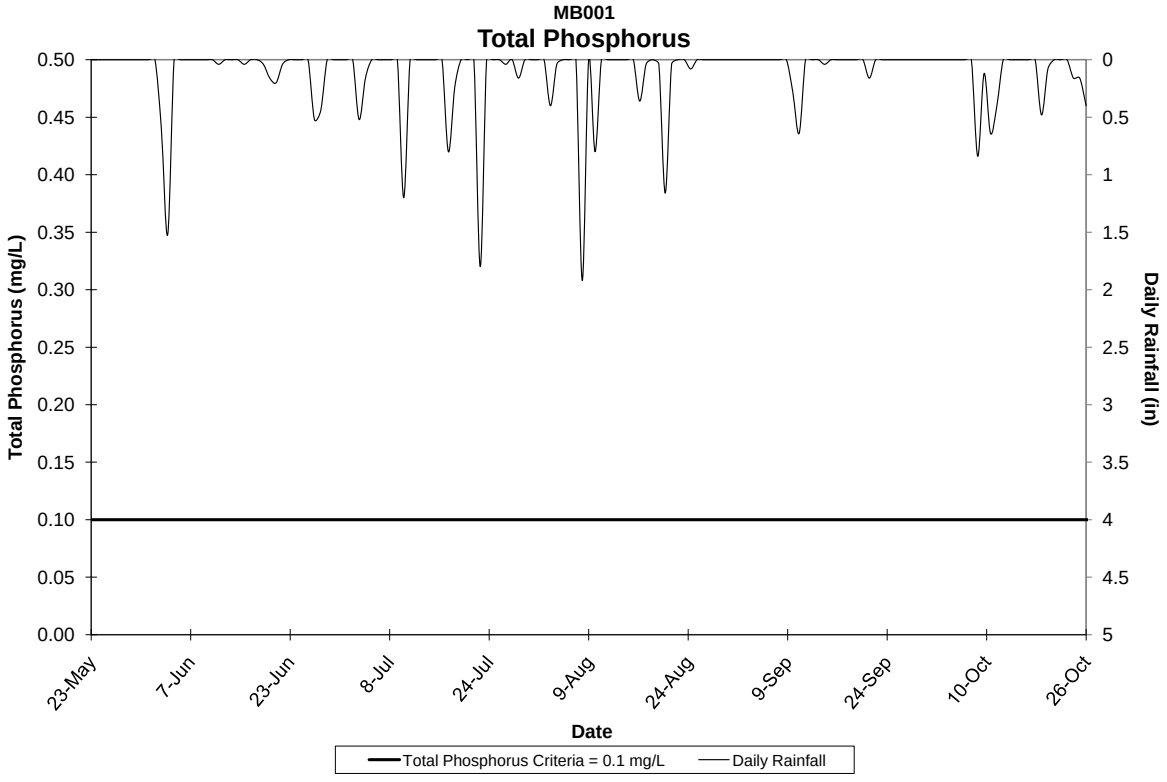

MB006
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

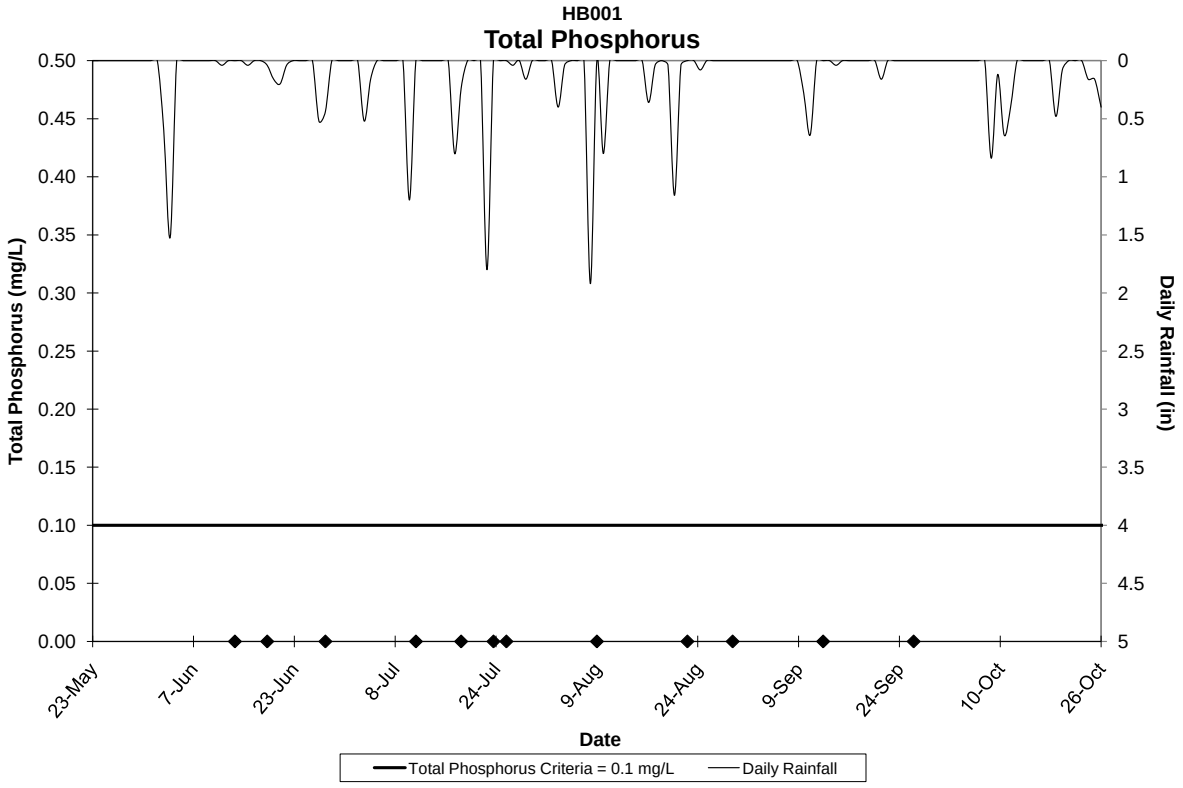

MB005
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

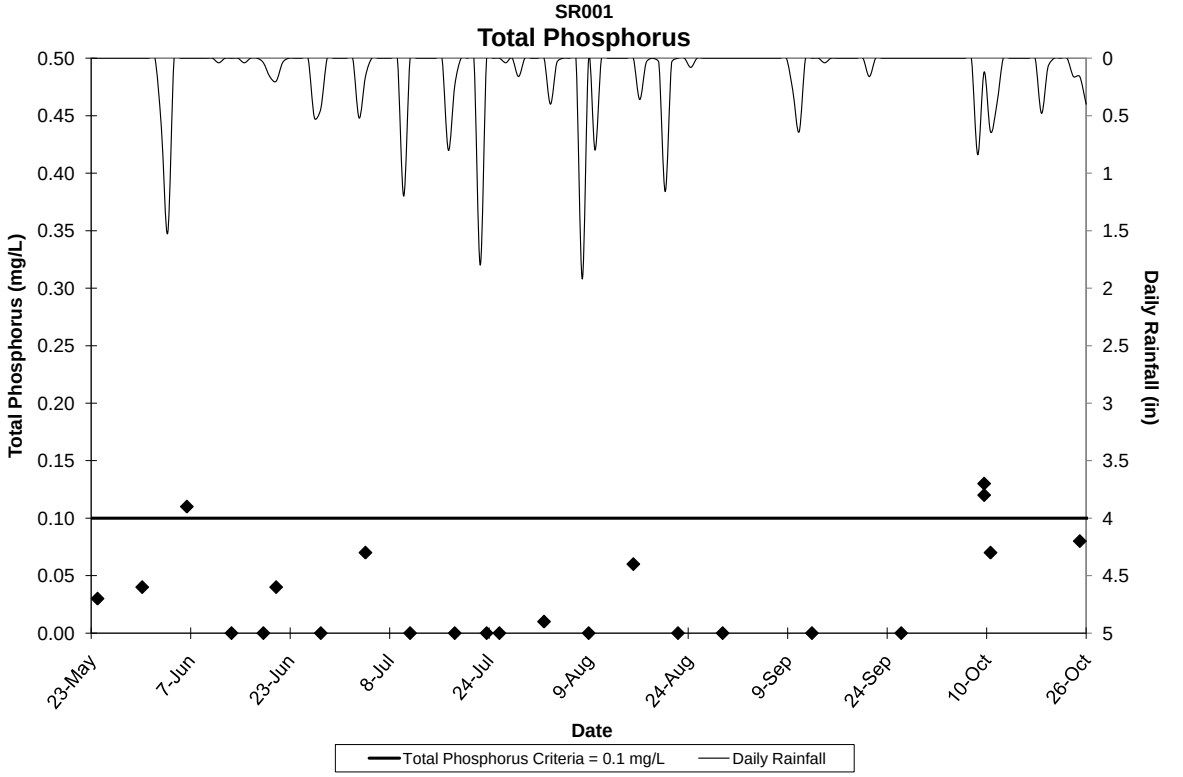

MB004
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

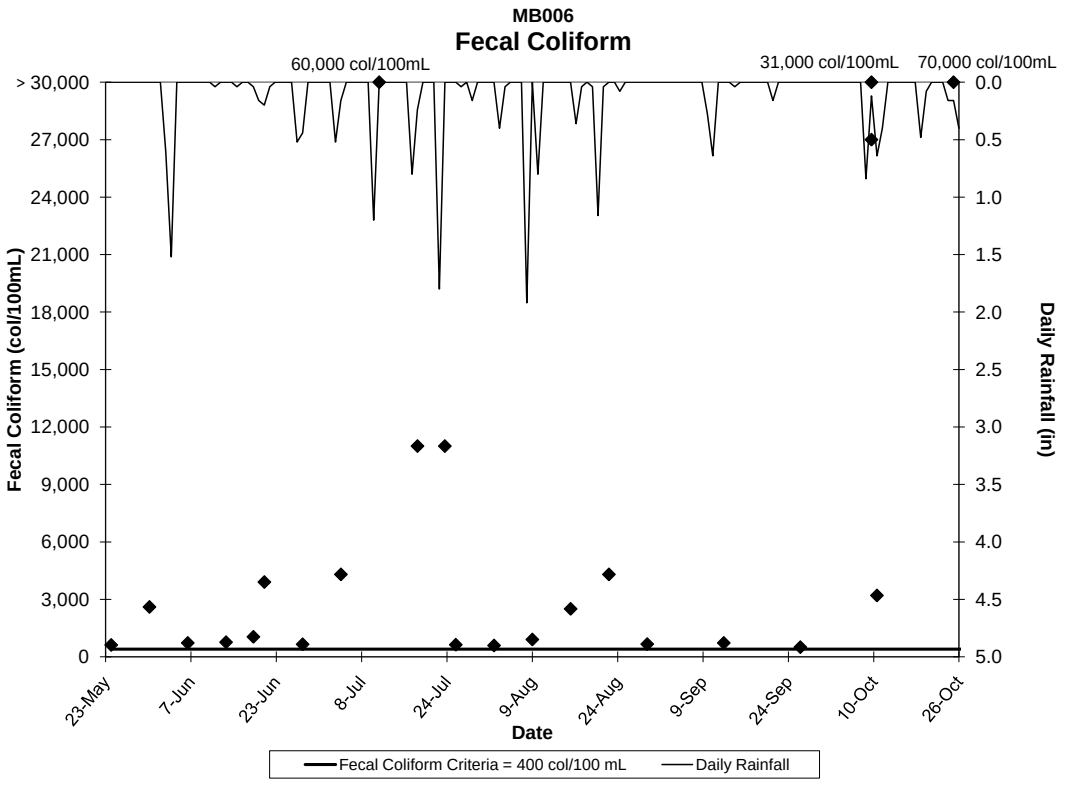

MB003
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

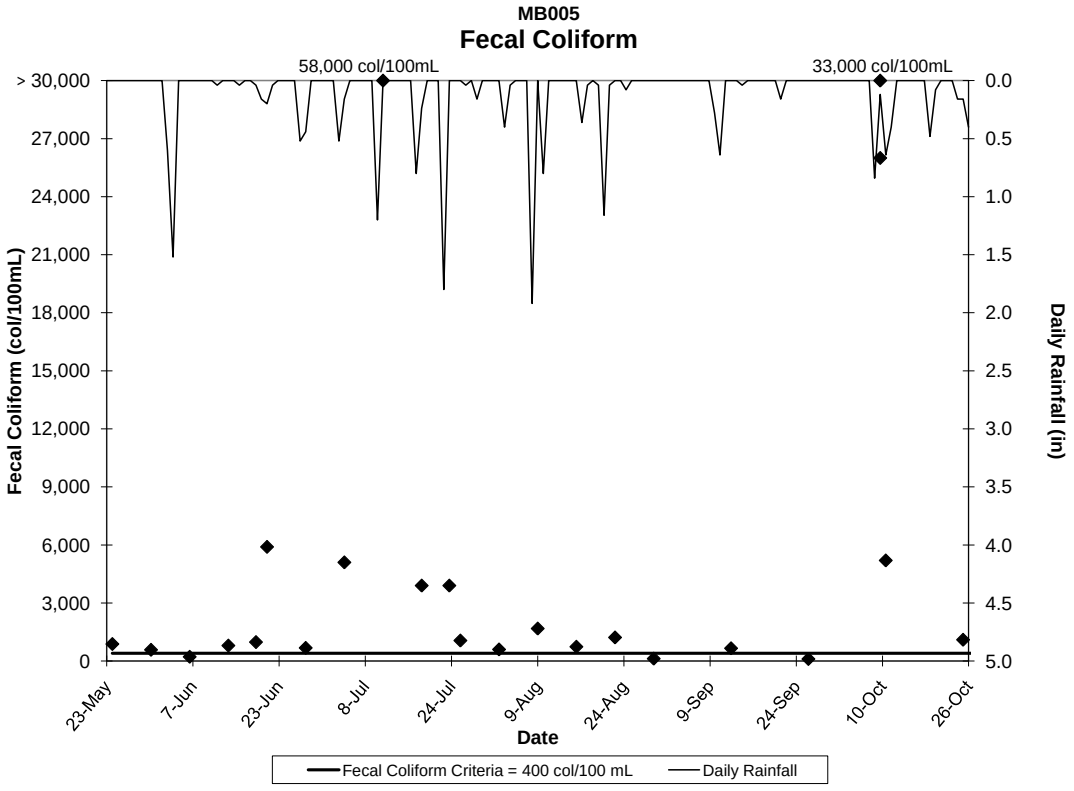

MB002
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

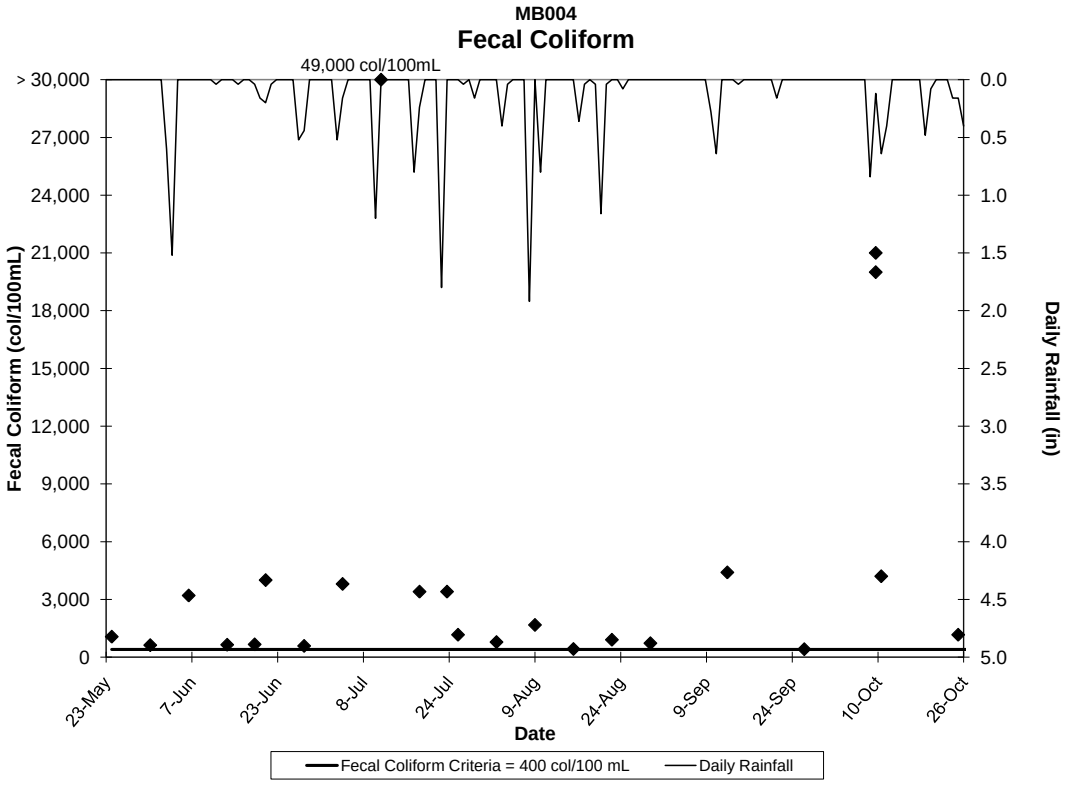

MB001
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

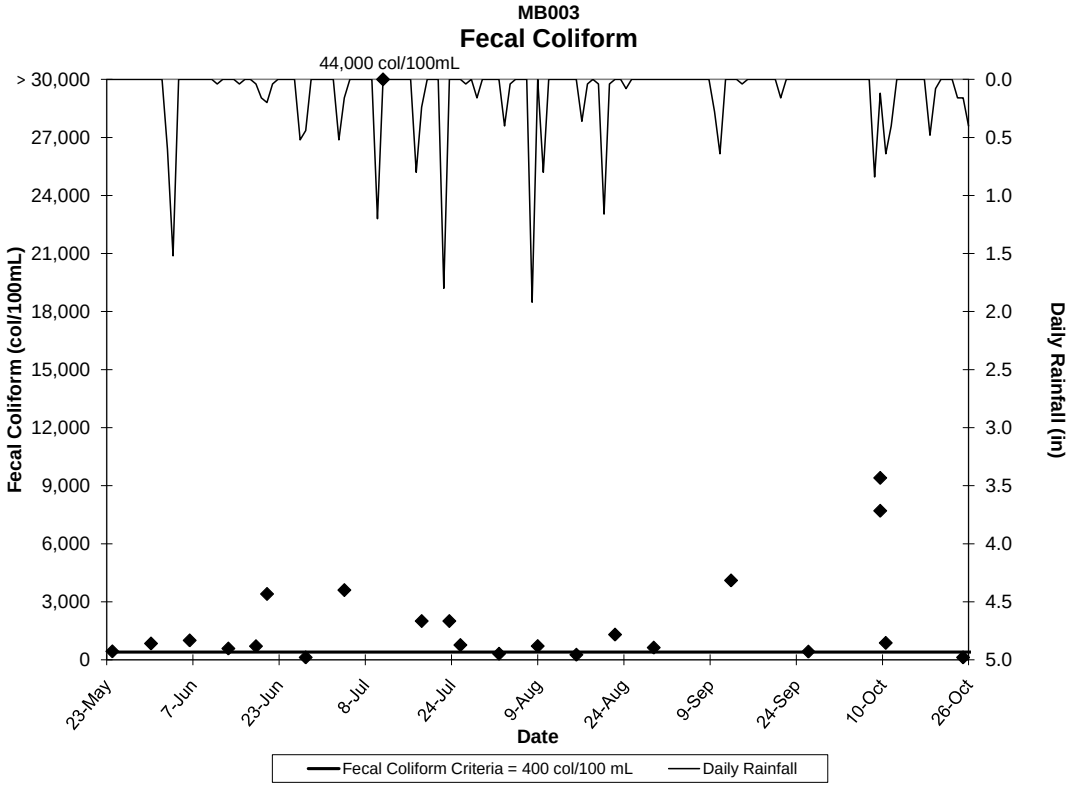

HB001
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

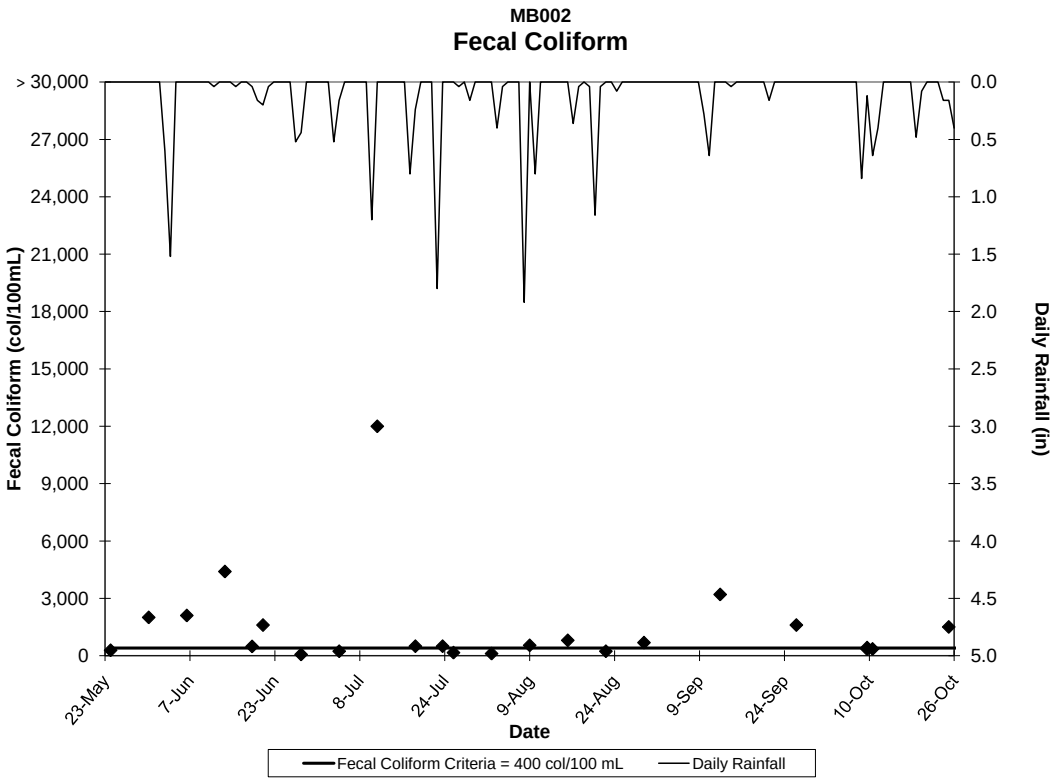

SR001
Total Phosphorus
Total Phosphorus (mg/L)
Daily Rainfall (in)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Total Phosphorus Criteria = 0.1 mg/L
Daily Rainfall

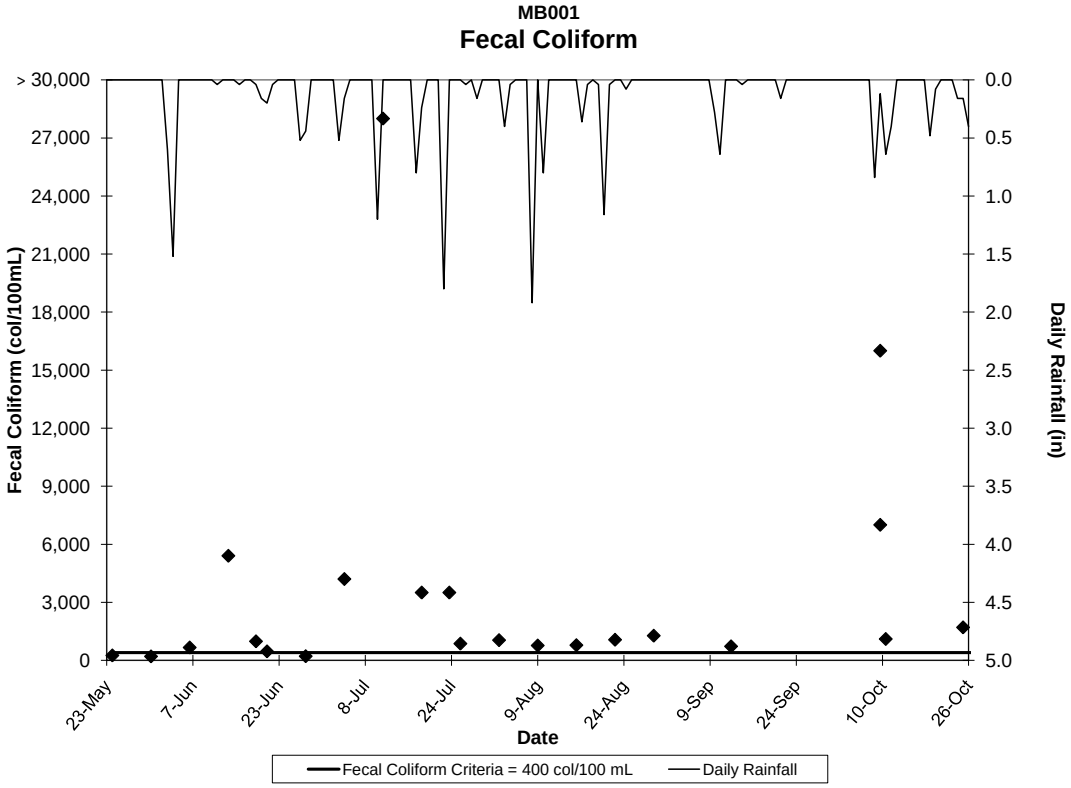

MB006
Fecal Coliform
60,000 col/100mL
31,000 col/100mL
70,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Fecal Coliform (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

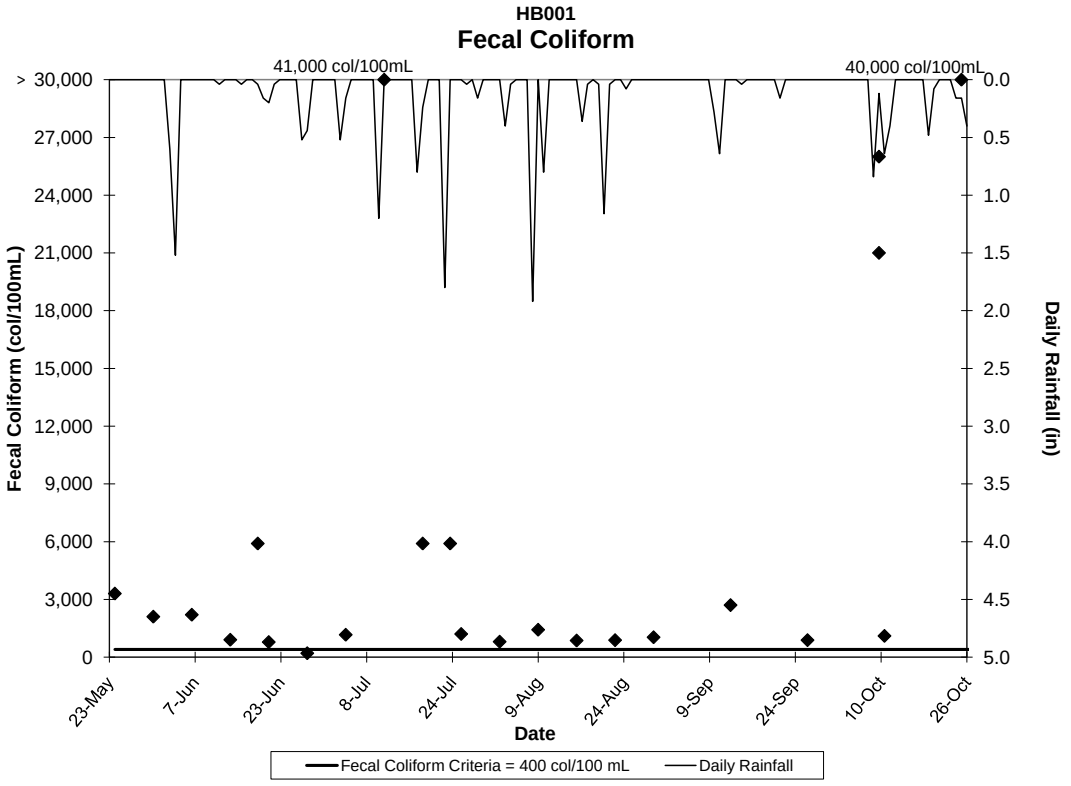

MB005
Fecal Coliform
58,000 col/100mL
33,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Fecal Coliform (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

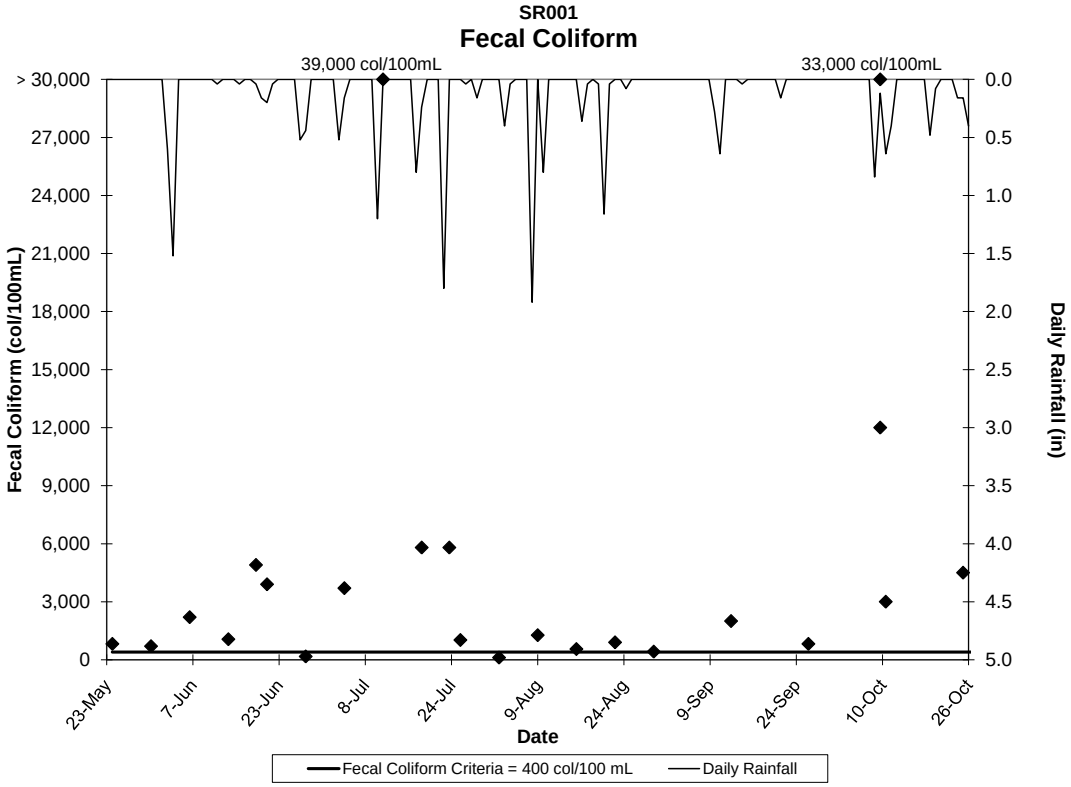

MB004
Fecal Coliform
49,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Fecal Coliform (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

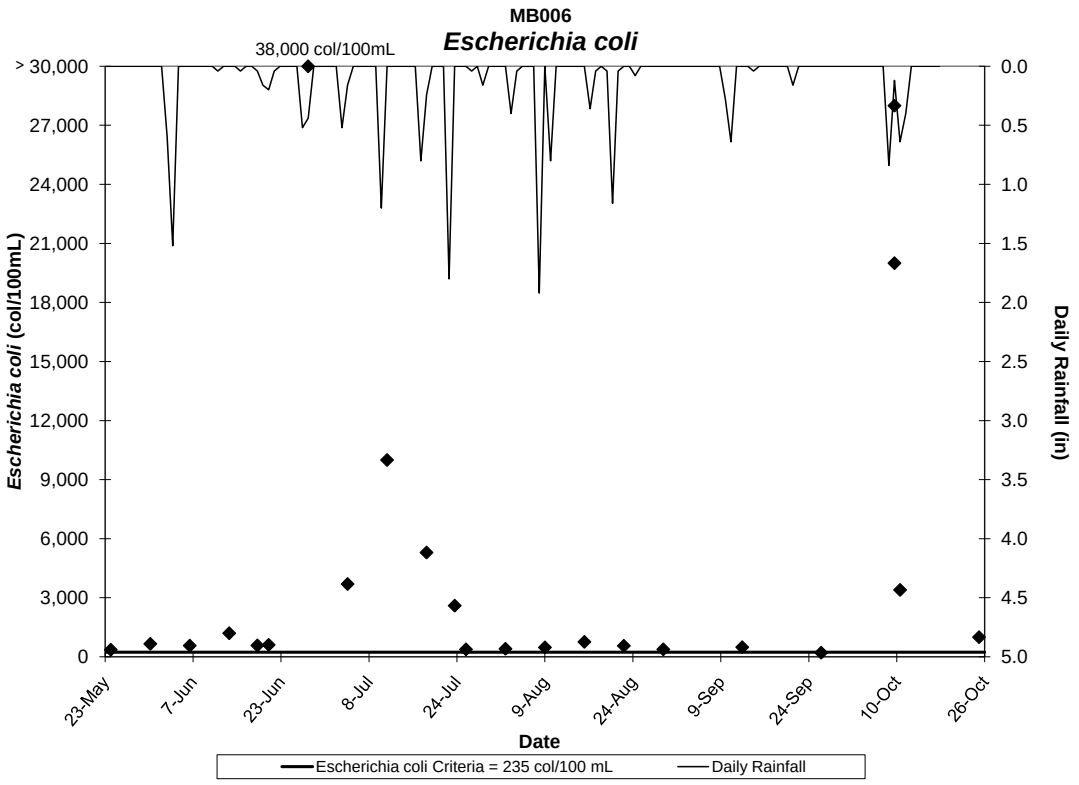

MB003
Fecal Coliform
44,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Fecal Coliform (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

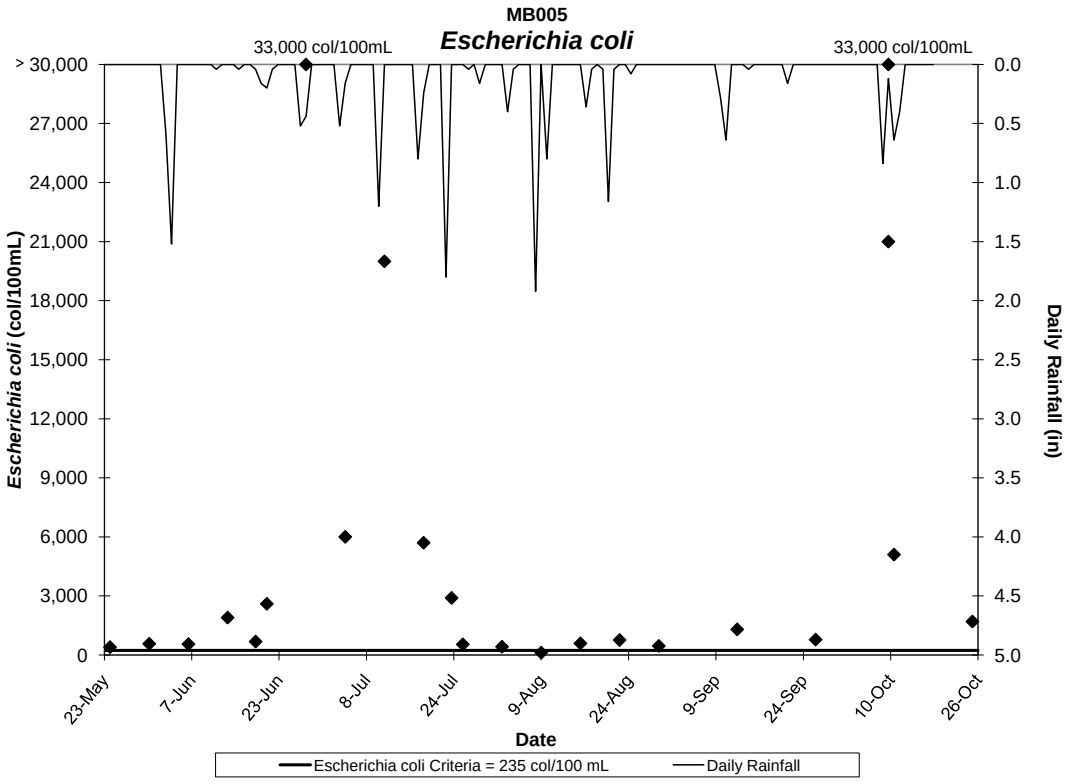

MB002
Fecal Coliform
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Fecal Coliform (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

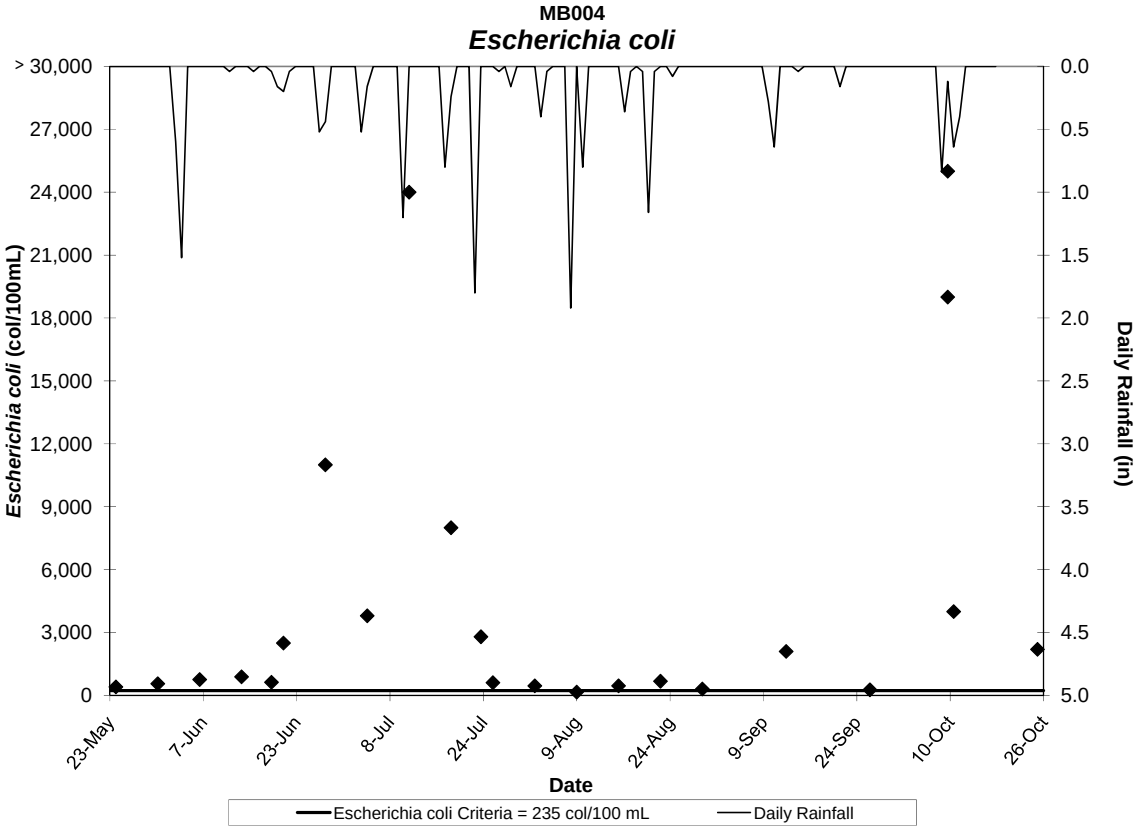

MB001
Fecal Coliform
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Fecal Coliform (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

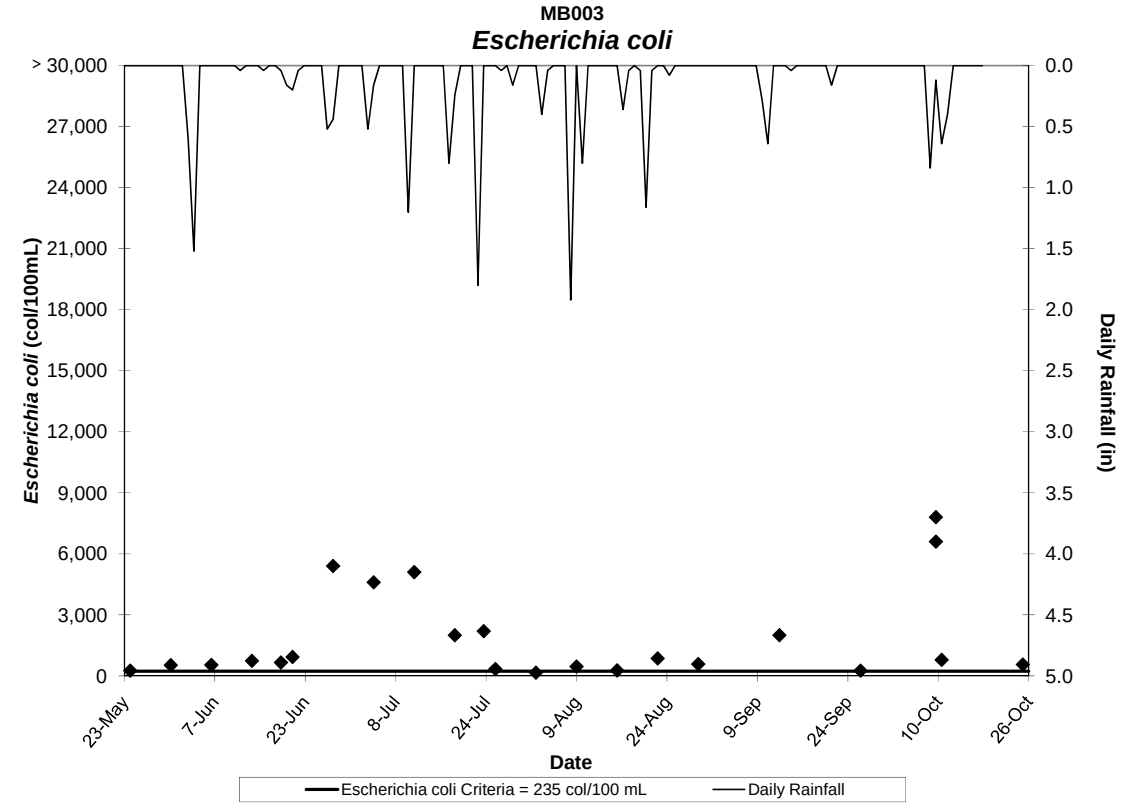

HB001
Fecal Coliform
41,000 col/100mL
40,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Fecal Coliform (col/100mL)
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

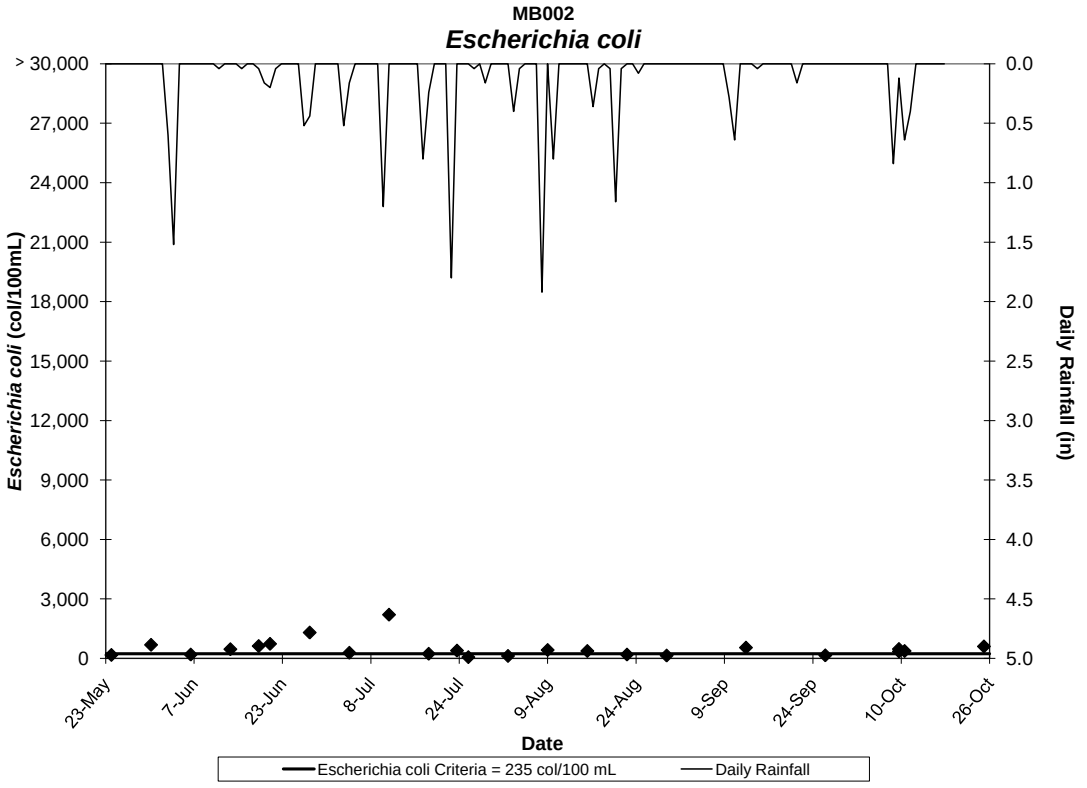

SR001
Fecal Coliform
39,000 col/100mL
33,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Fecal Coliform (col/100mL)
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Fecal Coliform Criteria = 400 col/100 mL
Daily Rainfall

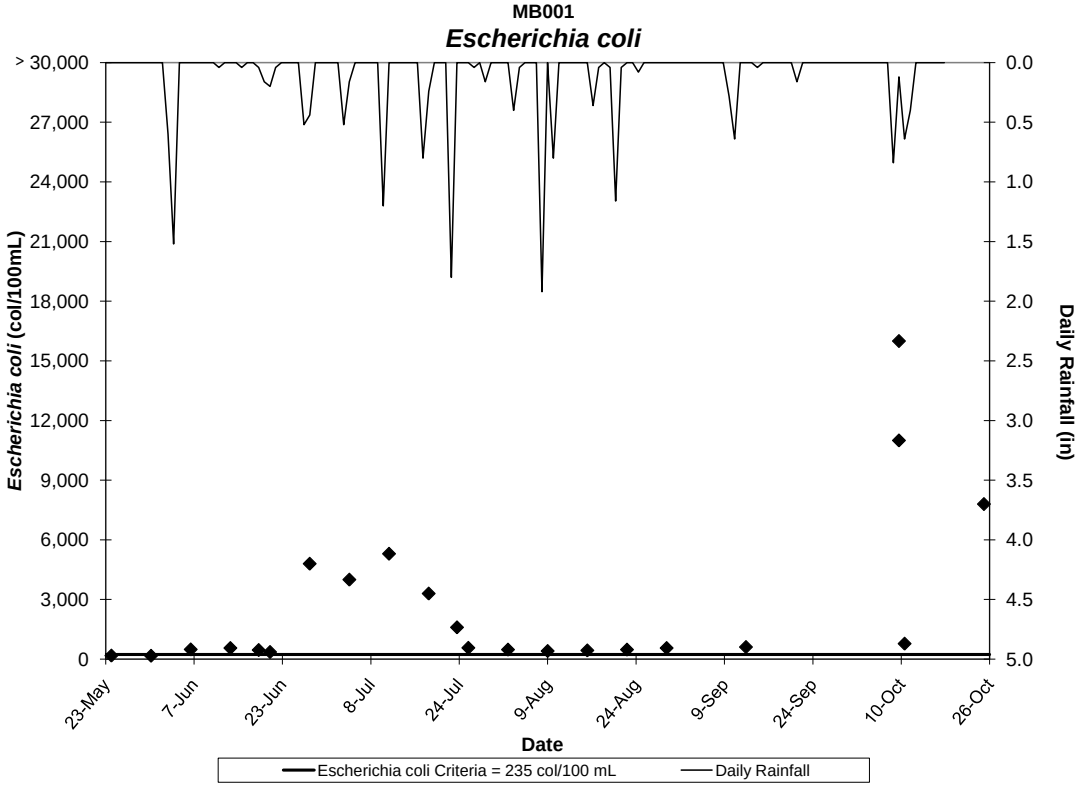

MB006
Escherichia coli
38,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall

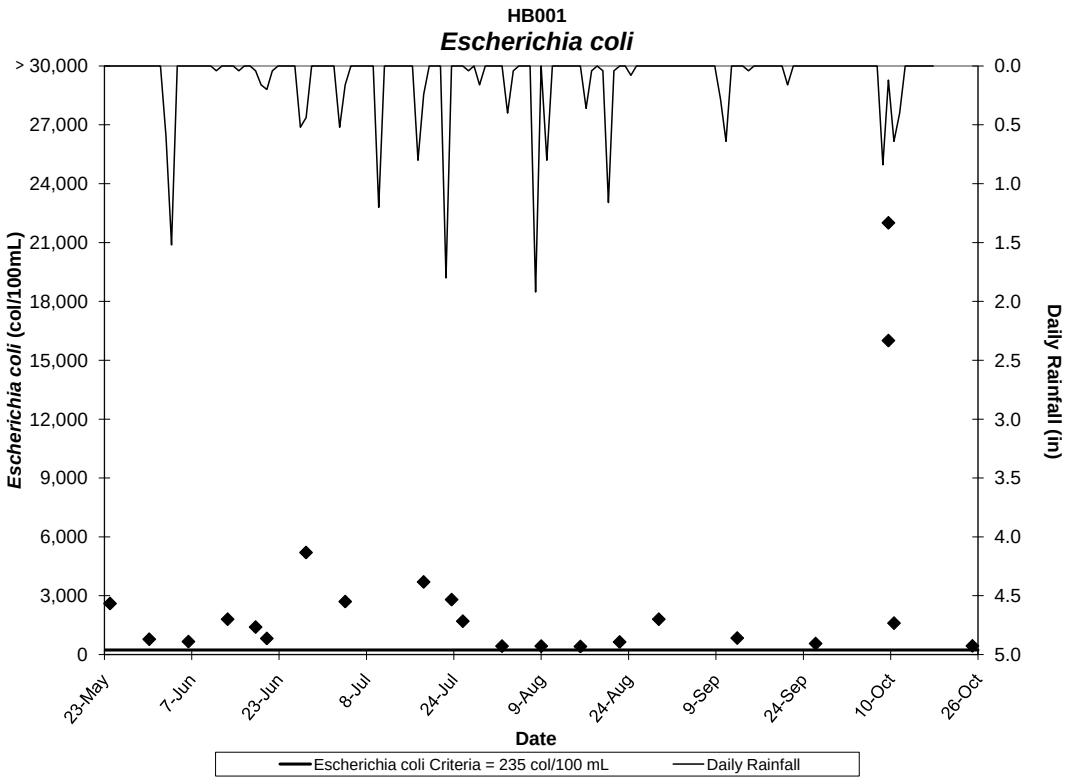

MB005
Escherichia coli
33,000 col/100mL
33,000 col/100mL
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall

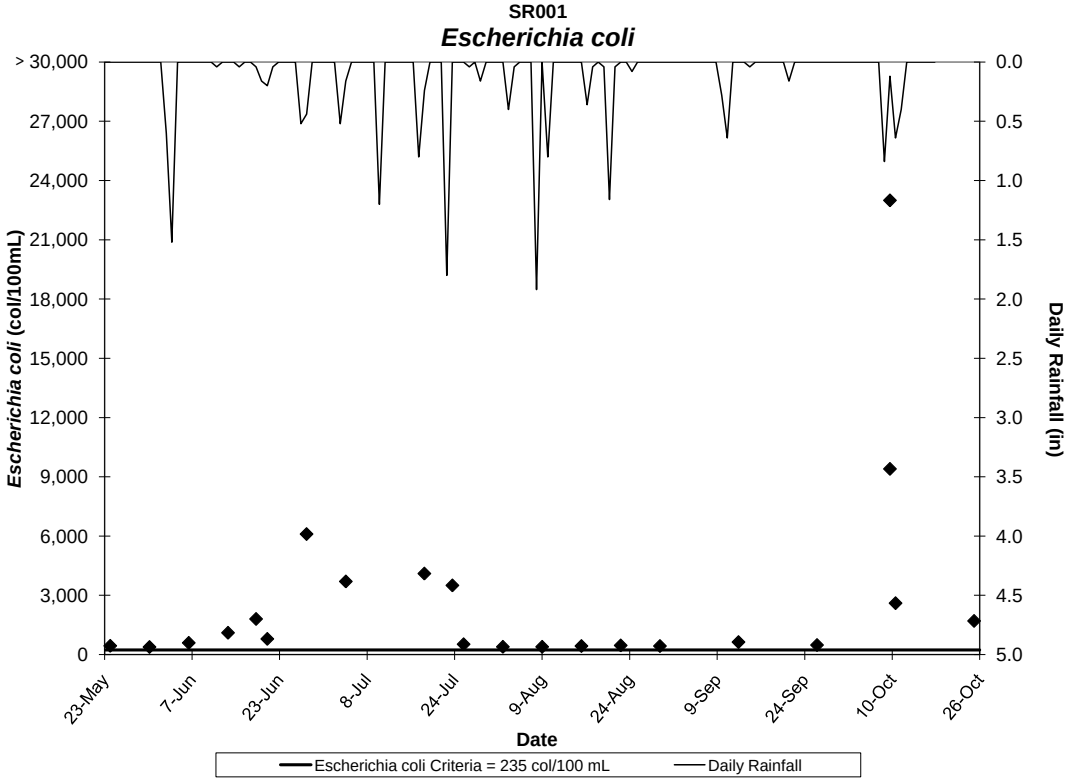

MB004
Escherichia coli
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall


MB003
Escherichia coli
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall


MB002
Escherichia coli
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall


MB001
Escherichia coli
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall


HB001
Escherichia coli
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall


SR001
Escherichia coli
> 30,000
27,000
24,000
21,000
18,000
15,000
12,000
9,000
6,000
3,000
0
Escherichia coli (col/100mL)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Daily Rainfall (in)
23-May
7-Jun
23-Jun
8-Jul
24-Jul
9-Aug
24-Aug
9-Sep
24-Sep
10-Oct
26-Oct
Date
Escherichia coli Criteria = 235 col/100 mL
Daily Rainfall