# 2012-2013 ADF Discharge Minimization Progress Tracking Report

Prepared for:
Gerald R. Ford
International Airport

August 2013

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**Prepared for:**
**Gerald R. Ford International Airport**

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# 1 Introduction

Pursuant to Parts I.A.10 and I.A.12.e of NPDES Permit number MI0055735 (modified and effective August 1, 2013), this report describes the aspects of the Deicing Management Program implemented at the Gerald R. Ford International Airport (GFIA) in Kent County, Michigan to control aircraft deicing[1] fluid (ADF) discharges during the 2012-2013 winter season.

Part I.A.10 requires the following to be reported by September 1 of each year:

- A summary of aircraft deicing fluid (ADF) best management practices (BMPs), including information, measures, and data to demonstrate the extent to which the BMPs are reducing ADF discharges to the unnamed tributaries of the Thornapple River and Plaster Creek; and
- Data regarding the amount of ADF used, recycled, sent to the WWTP, and the percent of ADF used that was prevented from being discharged to the environment.

These elements are described in Section 2 of this report.

PartI.A.12.e requires the following to be reported by September 1 of each year:

- A summary of the nuisance biofilm growth results collected from the unnamed tributary to the Thornapple River during the previous year; and
- A summary of actions taken during the previous year to reduce or eliminate the discharge of ADF from Outfall 001.

These elements are described in Section 3 of this report.

## 1.1 Background

The Michigan Department of Environmental Quality (MDEQ) issued National Pollutant Discharge Elimination System (NPDES) Permit No. MI0055735 to GFIA on December 27, 2010. The permit took effect on January 1, 2011 and authorizes discharges of stormwater runoff to unnamed tributaries to the Thornapple River and Plaster Creek. Compliance with the NPDES permit is based on implementing BMPs and program enhancements to reduce the presence of ADF in stormwater from being discharged off-site. The permit also required GFIA to develop and submit for approval a long-term ADF runoff management program to eliminate the airport's contribution to nuisance biofilms in an unnamed tributary to the Thornapple River downstream of Outfall 001. The goal of GFIA's BMP implementation efforts and Program enhancements is to control ADF discharges and protect receiving waters.

[1] Unless otherwise noted, the term "deicing" in this document refers to both deicing and anti-icing products and activities.

The permit was modified August 1, 2013 to include the program improvements being constructed to comply with the requirement that the airport eliminate its contribution to nuisance biofilm growth in the unnamed tributary to the Thornapple River. Program improvements include consolidation of aircraft deicing runoff, seasonal diversion of deicing runoff away from the unnamed tributary, construction of a new stormwater conveyance and natural treatment system (NTS), and installation of a submerged diffuser and outfall 011 for discharge of treated stormwater to the Thornapple River. The program improvements are expected to be completed by October 1, 2015 to ensure compliance with terms of the permit.

# 2
# ADF BMP Summary

This section summarizes GFIA's ADF BMPs, as required by Part I.A.10 of the NPDES permit.

## 2.1 ADF BMPs Used During 2012-13

The BMPs used by GFIA to control the impacts of applied ADF on the environment fall into several categories that are described in the 2012-2013 Deicing Management and Monitoring Plan, and summarized in Table 1.

**Table 1. GFIA Deicing Management Program BMPs**

| BMP Category | Management Practice/Activity |
|---|---|
| General | Deicing materials storage |
| | Deicing materials spill management education |
| | Education and training of employees, contractors, and tenants |
| Aircraft Deicing | Forced Air Hybrid Deicing Vehicle |
| | Variable aircraft deicing mixtures |
| | Aircraft deicing equipment |
| | Heating aircraft deicing mixtures |
| | Application technique for aircraft deicing mixtures |
| | Proactive aircraft anti-icing |
| | Two-step aircraft application method |
| | Physical removal of accumulations |
| | Voluntary use of propylene glycol based products |
| | Materials use tracking |
| Deicing Runoff Collection, Storage and Disposal | Isolation and collection of aircraft deicing runoff |
| | Designated deicing areas |
| | Management of ADF impacted snow |
| | Cargo Ramp Plug and Pump Pilot Collection Program |
| | Pavement Maintenance |
| | Tankage and transfer |
| | Disposal of collected runoff |

### 2.1.1 General BMPs

#### Deicing Materials Storage

Deicing materials are stored and maintained in accordance with manufacturer guidance, as well as additional preventive measures and structural source control BMPs that are described in GFIA's Storm Water Pollution Prevention Plan.

#### Deicing Materials Spill Management Education

GFIA maintains a continuing program of employee, contractor and tenant orientation and education to help ensure awareness of the necessity of good facility control and quick and proper responses in the

event of a spill, accident, or equipment failure. To minimize the contamination of stormwater, airlines and FBOs utilize appropriate spill response techniques, per their company spill response plan, for spills or leaks of any deicing/anti-icing materials. Any spilled material is contained, cleaned up, and disposed of pursuant to such plans. Overspray and drips in the course of applying ADFs are not spills or leaks.

### Education and Training of Employees, Contractors and Tenants

Controlling potential deicing impacts on stormwater discharges requires that a number of different entities act in a cohesive and coordinated manner, including airlines, fixed base operators (FBOs), GFIA Operations, and others. GFIA has implemented specific efforts to help ensure that key individuals involved in aircraft and pavement deicing processes are aware of both the environmental issues surrounding these activities, as well as the Airport's program for controlling environmental impacts associated with those activities.

*Airlines and FBOs*

A major component of GFIA's Deicing Management Program is engaging the active participation of airlines and FBO representatives in developing the airport's deicing runoff control strategies and procedures. The airlines and FBOs operating at GFIA conduct annual training programs that include the following topics:

- Aircraft deicing and anti-icing procedures,
- Aircraft deicing and anti-icing locations,
- Materials handling and management

These annual training programs are conducted by each carrier and FBO to ensure awareness of how tenant deicing operations relate to the overall GFIA Deicing Management Program.

*GFIA Employees and Tenants*

GFIA conducts employee, contractor, and tenant education to inform and train personnel directly involved in deicing operations or deicing materials collection, treatment, and discharge. This educational program focuses on the environmental impacts of deicing materials and benefits from material handling techniques that minimize the amount of deicing materials being discharged.

GFIA's Deicing Management Program also guides the airport's Field Maintenance staff during training in the following areas:

- Operation of the mobile collection units (MCUs)
- Designation of glycol use areas
- Location and operational use of manhole inserts, covers, and containment devices
- Instruction on collection methods
- Instruction on collection efficiency
- Direction on storage of recovered product
- Use of pavement anti-icing product
- Glycol-impacted snow management
- Cargo ramp plug and pump pilot collection

Training sessions are conducted prior to each deicing season. Additional training sessions are conducted throughout the season on an as-needed basis when new equipment or materials are received. All new employees are trained as part of their orientation for appropriate field maintenance jobs.

### 2.1.2 Aircraft Deicing Practices

Aircraft deicing/anti-icing is first and foremost an issue of flight safety. The Federal Aviation Administration (FAA) strictly regulates deicing/anti-icing procedures and materials. Pertinent FAA regulations provide:

> *"...no person may takeoff an aircraft when frost, ice or snow is adhering to the wings, control surfaces, propellers, engine inlets or other critical surfaces of the aircraft."*
>
> *"...no person may dispatch, release or takeoff an aircraft anytime conditions are such that frost, ice or snow may reasonably be expected to adhere to the aircraft, unless the certificate holder has an approved ground De/Anti-icing program in its operations specifications and unless the dispatch, release, and takeoff complies with that program."*

(FAR 121.629)

Each airline at GFIA has an FAA approved deicing/anti-icing program, and is required to comply with that program. GFIA promotes the use of conservation practices by the air carriers.

Controls on the impacts of aircraft deicing activities are focused on protecting flight safety while minimizing use of deicing/anti-icing fluids through maximizing application efficiency, and on containment of runoff at the locations where aircraft are deiced.

Air carriers and operators are responsible for their aircraft deicing operations at GFIA. GFIA staff and contractors are responsible for collecting, handling, and disposing of, or otherwise managing deicing-related stormwater discharges. The responsibilities associated with aircraft deicing BMPs are consistent with these distinctions.

The following subsections provide details on the aircraft deicing controls and discharge reduction efforts considered and/or used at GFIA during the 2012-2013 deicing season. It must be noted that while GFIA may promote or encourage various practices or methods, the ultimate responsibility for flight safety and decision about deicing rests with the airline and pilot. GFIA's primary responsibility arises in designating appropriate deicing areas and then with regard to collection and management of spent deicing materials generated by the airlines.

#### *Forced Air Hybrid Deicing Vehicle*

This deicing technology combines warm air at near sonic speed with traditional deicing mixtures dispensed at relatively low flow rates. The goal is to deice effectively while reducing the amount of glycol used. FedEx has used Tempest® hybrid deicing vehicles at GFIA since the 2003-2004 season. A series of side-by-side comparisons between the hybrid and traditional deicing vehicles conducted during the 2004-2005 season indicated that glycol usage was reduced by approximately 50 percent. GFIA continues to promote the use of hybrid deicing vehicles by all of its tenants.

#### *Variable Aircraft Deicing Mixtures*

GFIA encourages each carrier to apply an efficient deicing mixture that complies with FAA regulations and requirements, and the particular airline's FAA-approved deicing plan. "Efficient" in this context means the ratio of deicing fluid concentrate to water (the ratio is determined by freeze-point depression tables for the fluid, allowing for the FAA required temperature buffer) that provides effective deicing performance for current and reasonably anticipated weather and operation conditions while minimizing BOD loading.

Airlines at GFIA have typically used a standard 50/50 mixture of concentrate/water for deicing purposes. In fact, FAA's requirements for ADF application mixtures to achieve a "clean aircraft" are based on the difference in temperature between the outside air temperature and the freeze point temperature of the

deicing mixture. For instance, a typical 50/50 mixture of a standard Type I deicing fluid has a freeze point of -18 °F and therefore can be used when the outside air temperature is as low as 0 °F. Under typical GFIA winter conditions, more moderate temperatures accompany conditions that require deicing/anti-icing. Under these moderate temperatures, a mixture with as little as 20 percent concentrate may be equally effective but better from an environmental perspective.

### *Aircraft Deicing Equipment*

Consistent with FAA regulations, standards, and requirements, GFIA encourages each carrier to use, and have available for use, deicing fluids and associated equipment which facilitate the use of efficient deicing mixtures, or otherwise reduce the total amount of glycol required to deice aircraft.

### *Heating Aircraft Deicing Mixtures*

GFIA also encourages each carrier to heat deicing mixtures to a minimum temperature of 140˚F prior to being applied to ensure maximum fluid effectiveness.

### *Application Technique for Aircraft Deicing Mixtures*

Consistent with FAA-approved deicing plans, each carrier is encouraged to apply deicing mixtures to aircraft surfaces in a manner and with equipment that maximizes the effectiveness of the deicing mixture, while using only the amount of mixture necessary to ensure safe aircraft operations.

### *Proactive Aircraft Anti-icing*

Because only glycol-based aircraft deicing fluids (ADFs) and aircraft anti-icing fluids (AAFs) are approved for use on aircraft, source reduction strategies necessarily focus on improving the efficiency of application techniques. Type IV AAFs provide for much longer protection from ice and snow accumulation after application (i.e., hold-over times) than Type I fluids. As a result, aircraft can be treated with a Type IV AAF upon arrival, when the aircraft is assumed to be clean, and in many cases remain effectively protected from snow and ice accumulation until takeoff. Thus, the need for conventional deicing prior to departure may be significantly reduced. In addition, because Type IV fluids are thicker and cling to the aircraft, they tend to be applied more efficiently, with reduced losses due to overspray and drippage.

GFIA encourages each carrier to apply Type IV aircraft anti-icing fluid to aircraft in order to help retard or prevent the formation of ice or frost on aircraft in a manner consistent with FAA approved deicing plans. GFIA also promotes application of Type IV anti-icing fluids for remaining overnight (RON) aircraft when snowfall is predicted during the overnight period.

### *Two-Step Aircraft Application Method*

To reduce the total volume of deicing and anti-icing materials required, GFIA encourages each carrier to utilize a “two-step” method of deicing and anti-icing whereby Type IV anti-icing solution is applied to an aircraft after deicing with Type I is complete, consistent with FAA regulations, standards, and requirements.

### *Physical Removal of Accumulations*

Two carriers at GFIA remove large accumulations of snow from their aircraft with brooms prior to applying ADF to further reduce the amount of deicing fluid necessary to achieve a clean aircraft condition. GFIA continues to promote this practice to its tenants when situations are appropriate for such practices.

### *Voluntary Use of Propylene Glycol Based Products*

Prior to the 2002-2003 season, all carriers and FBOs voluntarily switched to propylene glycol based products to facilitate recycling of glycol from collected runoff. The voluntary use of propylene glycol based products continued during the 2012-2013 season.

### *Materials Use Tracking*

Each airline and FBO was responsible for tracking and reporting the types and volumes of ADFs and AAFs used by location on a daily basis. The reported information included type (i.e. SAE Type I or IV), concentration or dilution (e.g., 50/50 Type I concentrate:water), and gallons used. These reports were submitted monthly and compiled in the project database.

## 2.1.3 Deicing Runoff Collection, Storage and Disposal

### *Isolation and Collection of Aircraft Deicing Runoff*

GFIA collects aircraft deicing runoff using NexGen (formerly V-Quip) tow-behind Mobile Collection Units (MCUs) in conjunction with catch basin inserts installed in the designated aircraft deicing areas.

*Designated Deicing Areas*

GFIA requires that all aircraft deicing operations be conducted in areas that facilitate the retention and collection of deicing runoff, as appropriate. Figure 1 shows the designated areas where aircraft deicing and anti-icing activities are conducted to facilitate the collection of spent deicing fluid.

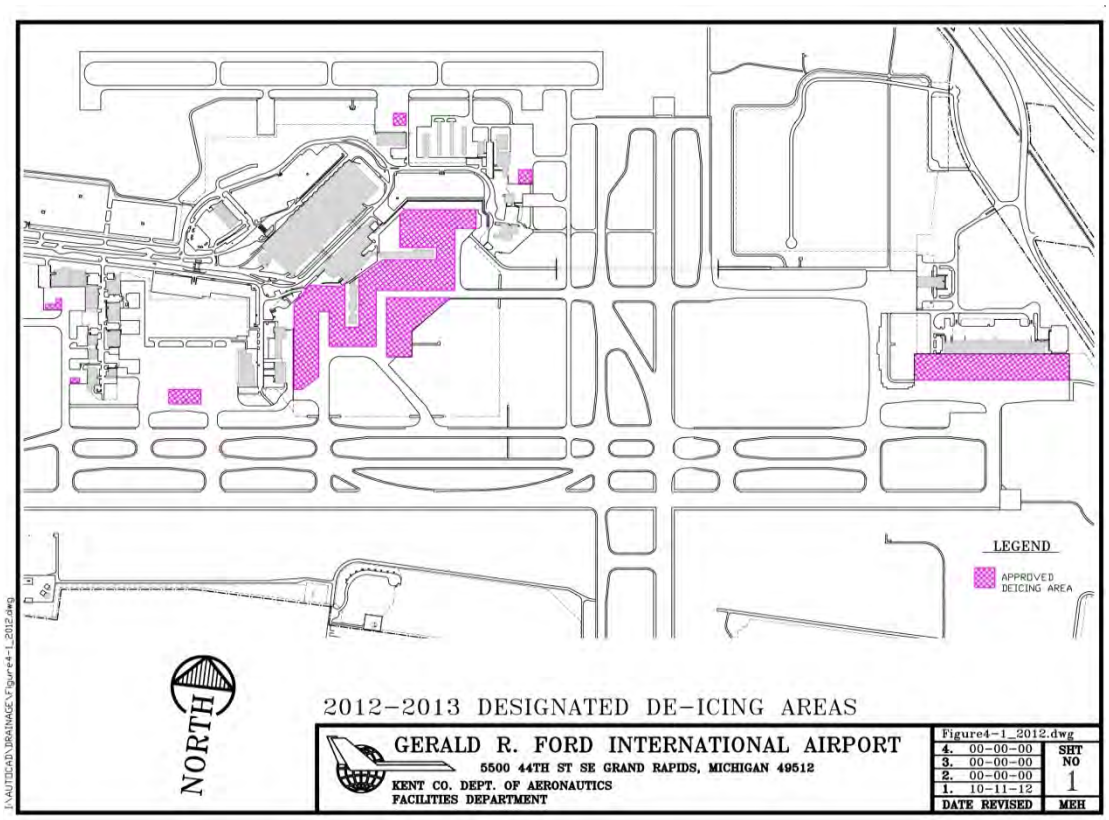


**Figure 1. Designated Locations for Aircraft Deicing/Anti-icing**

In the interest of continuing to promote the efficient use of aircraft deicing fluids and increase the recovery of those fluids, GFIA has also requested that airlines and FBOs perform deicing operations on the east portion of the terminal ramp whenever possible, and that deicing be conducted as close to departure time as possible. The goal of these requests is to minimize both the area where deicing fluids are applied and the time elapsed between deicing and access by the MCUs, thereby facilitating the collection of spent deicing fluid from pavement surfaces.

*Catch Basin Inserts*

Catch basin inserts are operated in conjunction with the MCUs to prevent spent ADF from entering the storm sewer system and to facilitate collecting runoff with glycol concentrations high enough to be suitable for practical recycling (i.e., >1 percent glycol). The inserts have valves that are closed when deicing activity begins, thus impounding runoff on the surface so it can be collected by the MCUs. A total of 51 inserts were used during the 2012-2013 season. Figure 2 shows the locations of the catch basin inserts.

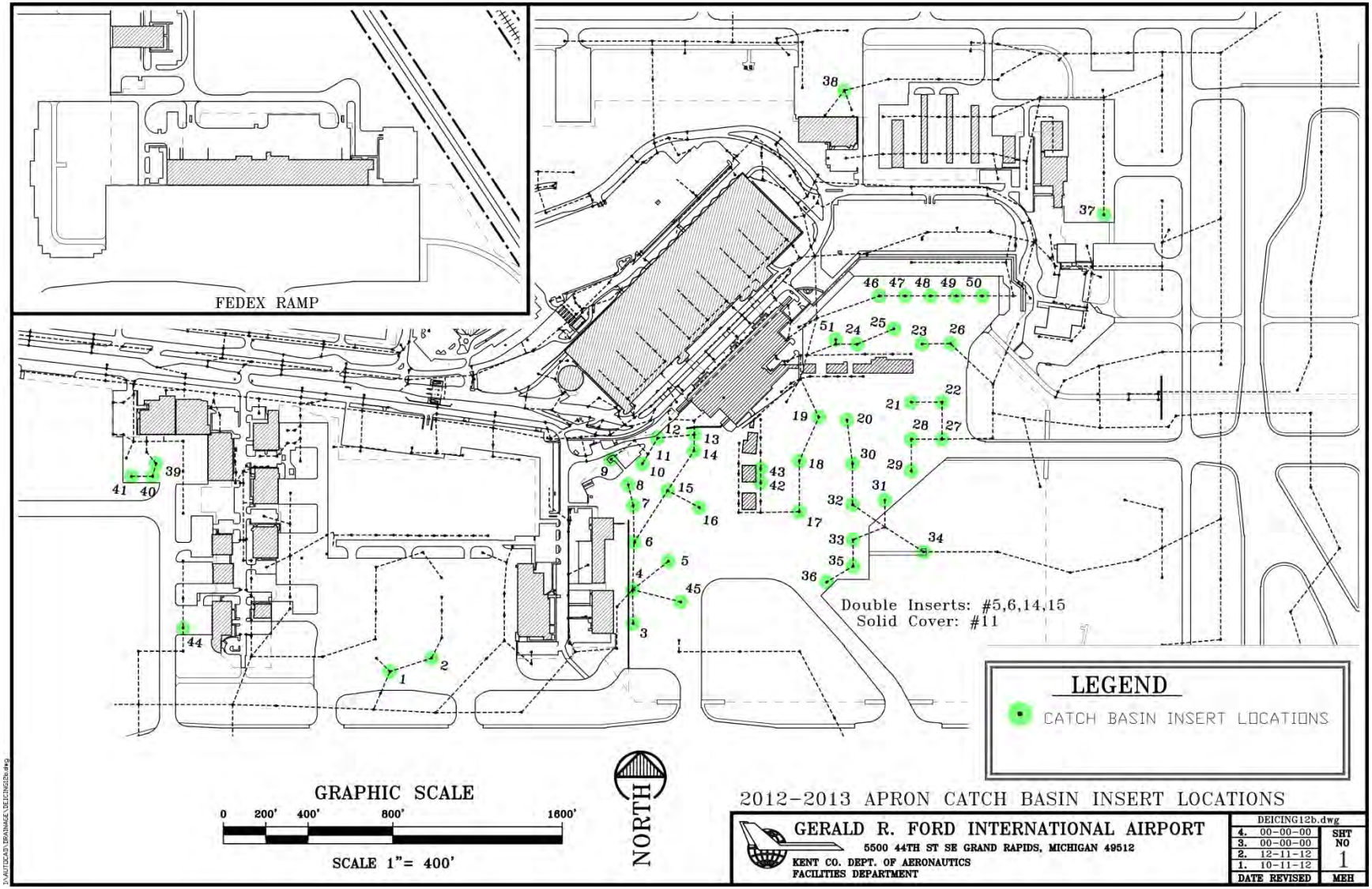


**Figure 2. Apron Catch Basin Insert Locations**

Six additional inserts (#s 46-51) were installed on the north side of the B Concourse prior to (#s 46-50) and during (#51) the 2012-2013 season. Inserts will continue to be installed in any additional locations that are identified as appropriate by GFIA Staff or if requested by a tenant.

*Mobile Collection Units*

The airport uses MCUs to collect spent deicing fluid from pavement surfaces. Collection activities are conducted whenever aircraft deicing operations are ongoing. ADF applicators and GFIA's deicing program staff coordinate closely to facilitate collection of deicing runoff as soon as possible after aircraft deicing is initiated. Runoff collected by the MCUs is off-loaded to recycle storage tanks located to the west of Concourse A (Figure 3).

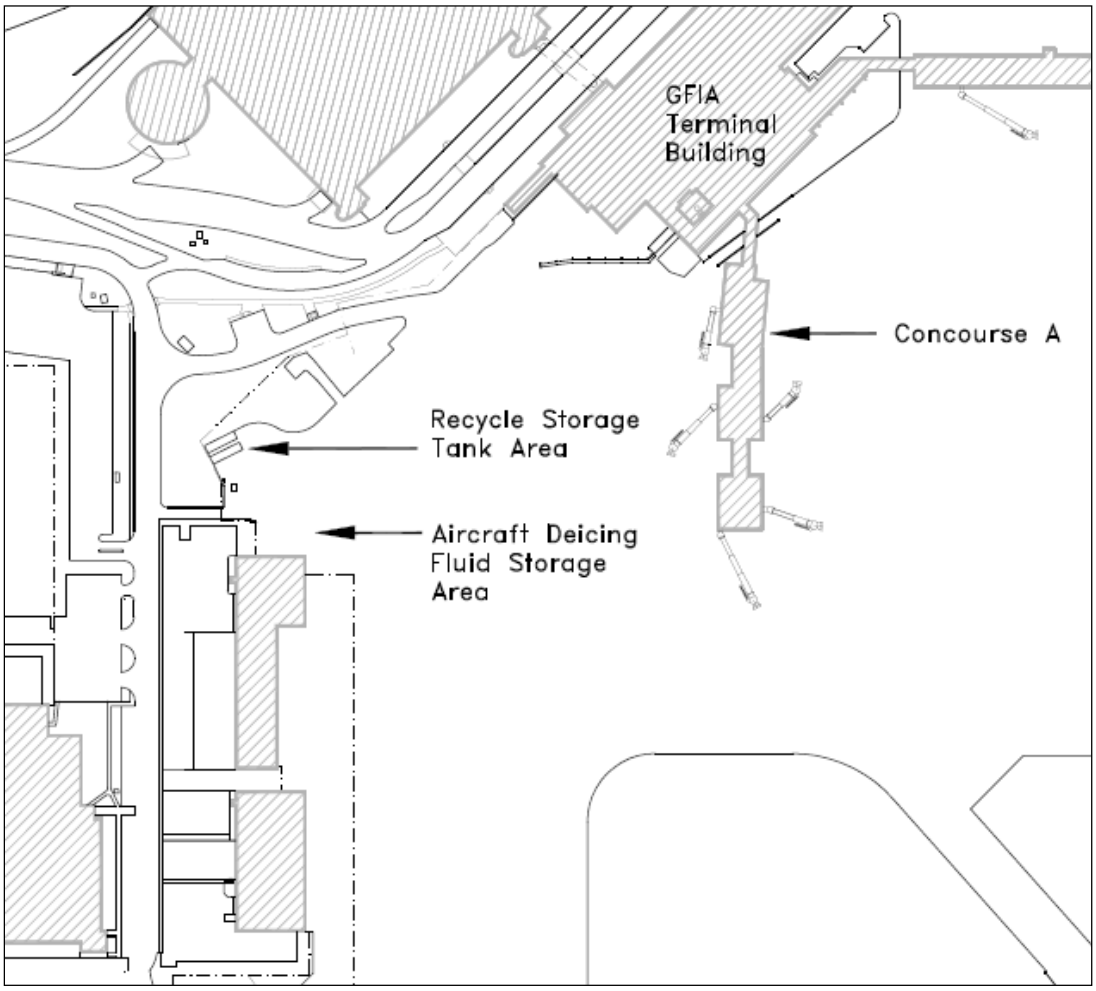


**Figure 3. Location of Recycle Storage Tanks for MCU Collection Operations**

### *Management of ADF Impacted Snow*

GFIA maintains a policy to manage ADF impacted snow piles. The goal of the policy is to enhance existing controls associated with such snow piles to prevent significant discharges of ADF to the unnamed tributary of the Thornapple River. GFIA's ability to contain runoff from ADF impacted snow is significantly constrained by space limitations near the terminal apron. Nevertheless, GFIA is using its available space, infrastructure, and equipment to enhance the control of ADF from snow piles in stormwater discharges.

ADF impacted snow management activities included alternative plowing practices, temporary storage of impacted snow, and the collection of snow pile runoff at the west terminal snow storage area.

Alternative plowing practices were used to minimize the amount of glycol removed from the terminal apron surface during snow removal operations. Snow was removed from the apron travel lanes prior to the departure of the first bank of morning flights, when possible, to allow aircraft to push-back from the gates and conduct deicing operations on pavement that is relatively free of snow. This practice reduces the potential for ADF to become entrained in plowed snow and facilitates the collection of spent ADF by the MCUs.

GFIA also stores ADF-impacted snow on Taxiways V, E, or M, depending on aircraft traffic routing. Snow is then removed to infield areas outside of the drainage area to Outfall 001, including the existing snow storage area west of the terminal.

***Cargo Ramp Plug and Pump Pilot Collection Program***

For the 2012-2013 season, GFIA initiated a pilot program at the cargo ramp using a plug and pump approach. An inflatable plug was installed in a manhole immediately downstream of the westernmost FedEx aircraft parking position and operated on a weekly basis during a range of conditions, attempting to capture runoff containing sufficient concentrations for glycol recycling (i.e. >1%).

***Pavement Maintenance***

To help minimize the amount of spent ADF getting into the drainage system, GFIA Maintenance uses a sealant around the perimeter of each catch basin insert. GFIA also continues to monitor pavement conditions and seal pavement joints and cracks as part of its pavement management program.

***Disposal of Collected Runoff***

All runoff collected during the 2012-2013 season with a PG concentration greater than 1 percent was transported via tanker truck to EQ's Romulus, Michigan recycling facility. On-site provisions were established to store collected runoff prior to hauling using frac tanks. For each load of runoff hauled off site, volume, percent glycol, and the quantity of glycol recovered were reported by EQ to provide an estimate of total glycol and BOD5 intercepted by the Deicing Management Program. These data were used to help estimate the total glycol and BOD5 that was sent off-site, as described in Section 2.2.2 of this report.

## 2.2 ADF Usage, Collection, and Recycling

### 2.2.1 ADF Usage

Table 2 contains a summary of aircraft deicing fluid usage by type at GFIA during the 2012-2013 season (October 1, 2012 through May 31, 2013). Volumes are expressed as gallons of pure propylene glycol (PG).

**Table 2. Summary of Glycol Usage at GFIA during the 2012-2013 Season**

| SAE Fluid Type | Total Used (Gals. Glycol) |
|---|---|
| Type I | 83,652 |
| Type IV | 19,896 |
| Totals | 103,548 |

A total of approximately 103,548 gallons of glycol in ADF was used on 158 days between October 2, 2012 and May 13, 2013.

### 2.2.2 ADF Collection, Recycling, and Conservation

***MCUs Operations and Cargo Ramp Plug and Pump Pilot Collection Program***

The MCUs collected approximately 260,000 gallons of aircraft deicing impacted runoff during the 2012-2013 season. This includes approximately 24,100 gallons that was collected as part of GFIA's new cargo ramp plug and pump pilot program.[2] The 260,000 gallons of runoff contained approximately 26,950 gallons worth of (pure) glycol, approximately 576 of which was collected as part of the cargo ramp plug and pump pilot program.

Table 3 presents a summary of glycol used and recycled, and calculated collection efficiency. Collection efficiency was estimated by comparing the amount of glycol in the runoff processed by EQ to the amount of glycol reported as being applied by the carriers and FBOs.

**Table 3. Summary of Recycled Glycol and MCU Collection Efficiencies at GFIA during the 2012-2013 Deicing Season**

| | Glycol Collected (gals.) | | |
|---|---|---|---|
| Glycol Used (gals.) | By MCU | Cargo Ramp | Total Efficiency (percent) |
| 103,548 | 26,374 | 576 | 26 |

The 26,950 gallons of glycol collected represent approximately 188,600 pounds of BOD5 that were prevented from being released to the environment.

The collection efficiency achieved by the MCUs during the 2012-2013 season is consistent with the range of performance achieved by airports using similar collection strategies. It should be noted that EPA, in its proposed Deicing ELG rulemaking, concluded that very well-operated MCUs could achieve a 20 percent collection standard. That proposal was not finalized in part because EPA identified significant cost-benefit concerns with its proposed standards. Nevertheless, GFIA's MCUs exceeded those proposed standards at 26 percent efficiency.

***Management of ADF Impacted Snow***

While it is not possible to accurately quantify the benefit of GFIA's snow management practices, they have served to reduce the amount of ADF lost to snow removal operations and reduce the amount of ADF-impacted snow in the 001 drainage area. These practices have also contributed to increased efficiency in glycol collection. GFIA continues to evaluate additional policies, strategies, and practices for managing glycol impacted snow in the context of its current operational environment.

***Source Reduction Practices***

The effects of source reduction efforts on ADF discharges to the environment are difficult to quantify because they require estimating the amount of deicing materials that would have been used in the absence of the source reduction practices. Nonetheless, estimates were developed for selected source reduction BMPs based on the available information, and are described below.

*Variable Aircraft Deicing Mixtures*

Delta Airlines used variable mixtures of Type I ADF during the course of the 2012-2013 season based on ambient outside air temperatures. The amount of glycol conserved through this practice was estimated by

[2] The cargo ramp plug and pump pilot collection program was operated fifteen times during the season. The majority of collection events result in runoff below the 1% percent recycle threshold. Nonetheless, approximately 24,100 gallons of runoff containing approximately 576 gallons of glycol were collected and sent to recycling. This represents approximately 4,000 pounds of BOD5 that were prevented from being released to the environment.

comparing the amount of glycol in Type I ADF reported to that which would have been applied had Delta used a standard 50/50 Type I concentrate/water mixture under all weather conditions. Table 4 contains a summary of the analysis.

**Table 4. Summary of Type I Glycol Conservation Achieved by Delta at GRR during the 2012-2013 Season**

| Range of Type I Mixture Ratios Reported (concentrate/water) | Type I Used (gals of glycol) | Estimated Type I that would have been used if all @ 50/50 (gals of glycol) | Glycol Conserved (gals) |
|---|---|---|---|
| 40/60 to 50/50 | 25,520 | 25,736 | 216 |

By varying mixture ratios, Delta was able to reduce Type I ADF usage by 216 gallons of glycol as compared to the volume that would have been applied had they used a standard 50/50 mixture throughout the season. This represents a reduction of approximately 1,500 pounds of BOD5.

*Forced Air Hybrid Deicing Vehicle*

FedEx used Tempest® hybrid deicing trucks exclusively for deicing operations at the GFIA station during the 2012-2013 season. Previous side-by-side comparisons with a conventional deicing truck during the 2004-2005 season indicated an annual savings in Type I usage of nearly 50 percent. Based on the previous analysis and an examination of usage data, it is assumed that approximately 50 percent less glycol was used with the Tempest® hybrid deicing trucks than if conventional trucks had been employed.

FedEx reported using a total of 14,865 gallons of glycol in Type I ADF during the season. It is estimated that a total of approximately 29,700 gallons would have been used if FedEx deicing operations were conducted using conventional deicing vehicles. This represents a reduction of approximately 104,100 pounds of CBOD5.

### 2.2.3 Summary of ADF Discharge Reductions

The quantifiable cumulative benefits of the 2012-2013 GFIA Deicing Management Program are summarized in Table 5 to demonstrate the extent to which GFIA's BMPs are reducing actual and potential ADF discharges to the environment

**Table 5. Summary of Quantifiable Environmental Benefits Achieved during the 2012-2013 Deicing Season**

| Best Management Practice | Reduced ADF Loading (gals glycol) | Reduced $BOD_5$ Loading (lbs) |
|---|---|---|
| Isolation and collection of aircraft deicing runoff (MCUs and Plug&Pump) | 26,950 | 188,600 |
| FedEx hybrid deicing | 14,865 | 104,100 |
| Delta variable ADF mixtures | 216 | 1,500 |
| Total | 42,031 | 294,200 |

The BMPs implemented as part of GFIA's 2012-2013 Deicing Management Program prevented at least 42,031 gallons of glycol in ADF, containing approximately 294,200 pounds of BOD5 from being released to the environment compared to if they not been in place.

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# 3 Nuisance Biofilm Results and Summary of ADF Discharge Reduction Actions

This section contains information required by Part I.A.12.E of the NPDES permit summarizing the nuisance biofilm monitoring results collected from the unnamed tributary to the Thornapple River and actions taken to reduce or eliminate the discharge of ADF from Outfall 001.

## 3.1 Nuisance Biofilm Monitoring Summary

GFIA continued to investigate attached bacterial growth (i.e., biofilms) during the 2012-2013 season. In addition, GFIA continued its involvement as a monitoring location as part of the U.S. Transportation Research Board's Airport Cooperative Research Program (ACRP) research into biofilms associated with airport storm water discharges.

GFIA continued the biofilm monitoring program at three locations on the unnamed tributary to the Thornapple River downstream of outfall 001 as required by the permit. The three locations are at the 36th Street, Thornapple River Drive, and Tricklewood Drive road crossings and surveys are conducted every other month. Very little biofilm growth was observed at the monitoring locations during the September, November 2012 and July 2013 monitoring events. The greatest magnitude and extent of biofilm at all three locations was observed during the May 2013 sampling event. The Biofilm Monitoring Survey Reports are included in Appendix A.

Biofilm monitoring will continue to be conducted every other month in accordance with GFIA's revised permit. GFIA notes that presence of or level of biofilm growth is not necessarily a reflection on the Airport's activities and may exist regardless of any Airport-related contributions. Nevertheless, the Airport has committed to eliminating its contribution to biofilm growth in the unnamed tributary to the Thornapple River.

## 3.2 Summary of Actions Taken to Reduce or Eliminate the Discharge of ADF From Outfall 001

The activities undertaken and results achieved in reducing ADF discharges during the 2012-2013 season are described above in Section 2.

# Appendix A

# Biofilm Monitoring Reports

LimnoTech
Water | Environment | Scientists | Engineers

# MEMORANDUM

DATE: September 21, 2012

FROM: Doug Bradley
Derek Schlea
Chris Cieciek

PROJECT: GRR12

TO: Mr. Thomas R. Ecklund, P.E.
Facilities Management Director
Gerald R. Ford International Airport

CC:

SUBJECT: Gerald R. Ford International Airport (GFIA) September 2012 Biofilm Monitoring Results

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## Summary

The purpose of this memo is to summarize the observations collected during the September 2012 biofilm monitoring survey in the unnamed tributary to the Thornapple River. This is the eighth of the biofilm monitoring events being conducted as required by Part I.A.7.d. of GFIA's NPDES Permit (MI0055735). The monitoring results and metric calculations are described below.


## General Observations

Heterotrophic biofilm was not observed at any of the monitoring locations.

## Monitoring Approach

On September 19, 2012, biofilm monitoring was conducted at three locations (sample stations) in the unnamed tributary of the Thornapple River. Stream assessment reaches were established at each of the locations during the first survey (July 2011) using a hand-held global position system (GPS) device. The monitoring locations are at 36$^{th}$ Street, Thornapple River Drive, and Tricklewood Drive and are shown in Figure 1. Consistent with previous surveys, monitoring was conducted using the Stevenson and Rollins 2007 procedure described in the Proposed Biofilm Monitoring Procedure memo submitted to and approved by MDEQ in June 2011 (LimnoTech, June 3, 2011).

At each of the three sample stations, five transects were designated and marked. The transects were selected based on substrate type. Riffles and/or run segments with coarse substrate materials were specifically targeted because they are most appropriate for periphyton and biofilm attachment and provide repeatable and reliable long-term monitoring locations (Stevenson and Rollins, 2007 in *Methods in Stream Ecology*, 2007). Sampling was conducted at 10 equally spaced points on each transect using the rapid periphyton survey method, Basic Method 1 (Stevenson and Rollins, 2007). Measurements were recorded on the field data sheet (Table 1). Physical habitat characterization forms from the EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* were used to record field observations and measurements at each monitoring reach (EPA, 1999).

**Figure 1. Unnamed Tributary Biofilm/Macroinvertebrate Monitoring Locations.**

Community metric calculations include density and distribution estimates for functional categories of moss, macro, and micro (biofilm) algal species. As noted previously, slight modifications necessary to differentiate between microalgae and heterotrophic biofilm were added to the data collection procedure as described below.

1) The Sz column in the Field Data Sheet (Table 1) is intended for inventory of substrate particles >2 cm in size. Since a primary purpose of this monitoring effort is to characterize the presence of biofilm (which is associated with larger size substrates), the Sz column has been modified to instead identify substratum of < 2 cm (where it is not possible to collect community information). The sum of the Sz column observations is transferred to the NA row in Table 3 for extent and magnitude calculations. This modification was discussed with Stevenson and Rollins (personal communication with Doug Bradley, LimnoTech) and the authors stated that this modification is appropriate for the purpose of this monitoring effort.

2) The Algal Cover and Thickness Class Description (Table 2) include estimated cover classes for moss and macroalgae but not microalgae. The purpose of the monitoring was discussed with the procedure authors and it was suggested by Stevenson that including cover class for microalgae would provide estimated cover and thickness values that will improve the applicability of the procedure for tracking the status of the heterotrophic biofilm community. This component of the protocol was expanded for this monitoring event by adding a column (Table 2) to quantify the number of grid points counted over microalgae at 10 equally spaced points on each transect using a viewing bucket (EPA, 1999) with a 50-dot grid. The grid is used as a quantifiable and repeatable means for measuring distribution and density of biofilm across transects.

3) The calculations for the extent and magnitude of moss, and benthic algal cover (Table 3) include a row named NA. Following clarification from the authors, NA includes the points not sampled because no substrate particle >2 cm was present.

4) The microalgae functional class includes heterotrophic biofilm. The dominance of non-nuisance biofilm microalgae observed during the July and September field visits highlights the need to identify and calculate heterotrophic-specific biofilm observations as well as the other forms of microalgae. The calculation table (Table 3) used for the biofilm monitoring events beginning with the September 2011 event was expanded to quantify the extent and magnitude of biofilm-specific observations, and to estimate the cover of all microalgae as measured with the viewing bucket.

5) The microalgae thickness Class 2 of 0.5 to 1 mm appears is a transition category between non-visible (thin slimy layer) and visible microalgae (Stevenson and Bahls 1999). The category may be misrepresenting the presence of heterotrophic biofilm because our approach had previously (prior to July 2012) grouped natural occurring microalgae (diatoms and bluegreens) with heterotrophic biofilm evidence within Class 2. Beginning with this sampling event (September 2012), we modified the Class 2 calculations to differentiate 'natural' or autotrophic/photosynthetic microalgae from heterotrophic biofilm in the extent and magnitude microalgae metrics (Table 3). Other calculations remain unchanged.

The information being collected and calculations being performed are consistent with the procedures described in the monitoring plan. The additional calculations will provide added information on the biofilm community. The metrics will continue to be calculated consistently to support the evaluation of relative changes in the biofilm community.

Monitoring Summary

Site 1 36th Street – The site is approximately 75 meters long with an average channel width of 2.4 meters. Maximum stream velocity was measured at 0.24 m/sec. The site includes a mix of natural and re-establishing riparian vegetation, and channel re-alignment from the 36th Street road work conducted in 2006. The substrate is generally coarse with patches of fine sediment deposits. Filamentous green algae were observed throughout this reach. Heterotrophic biofilm was not present at any of the transects sampled. All microalgae thickness Class 2 observations recorded were naturally occurring microalgae.

Site 2 Thornapple River Drive – The site is approximately 350 meters long with an average channel width of 2.5 meters. Maximum stream velocity was measured at 0.13 m/sec. This reach is longer than Sites 1 and 3 because of the limited amount of suitable coarse substrate upon which to locate survey transects. The site is densely vegetated along the banks and in the riparian area. Evidence of recent bed material movement, bank erosion and deposition remains present throughout the reach. Other indicators of active channel activity included an increased abundance of newly fallen trees. Heterotrophic biofilm was not present at any of the transects sampled. All microalgae thickness Class 2 observations recorded were naturally occurring microalgae. Several fish were observed in a shaded pool upstream of transect 4.

Site 3 Tricklewood Drive– The site is approximately 135 meters long with an average channel width of 3.7 meters. Maximum stream velocity was measured at 0.26 m/sec. The northern banks of the site are more closely bound by residences than the other sites yet retain thick overhead cover but thin understory. The reach is characterized by a slightly higher gradient than Site 2 and contains a greater dominance of coarser substrates along with an outcrop of exposed hardpan clay. Heterotrophic biofilm was not present at any of the transects sampled. All microalgae thickness Class 2 observations recorded were naturally occurring microalgae.

The field sheets and metric calculations are included as Attachment 1.

## References

D. Bradley, LimnoTech. July 2011. Personal communication with J. Stevenson and S. Rollins.

MDEQ (Michigan Department of Environmental Quality). 2008. Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers. Water Bureau Policy and Procedures, WB-SWAS-051 (SWAS Procedure 51), revised December 2008.

Stevenson, R. J., and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in M. T. Barbour,J. Gerritsen, and B. D. Snyder (Eds.) Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. U. S. Environmental Protection Agency, Washington, D.C.

Stevenson, R.J. and S.L. Rollins. 2007. Ecological assessments with benthic algae. Pages 785-803 in F.R. Hauer and G.A. Lamberti (Eds.) Methods in Stream Ecology. Second edition, Academic Press, Burlington, MA.

**Attachment 1**
GFIA Biofilm Monitoring Field Sheets
September 19, 2012

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib at 36th St. | LOCATION Upstream 36th St. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |
| FORM COMPLETED BY D. Schlea | DATE 9-19-12 TIME 09:45 AM PM -11:00 / REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| % ☐ | % cloud cover | ☒ % |
| ☒ | Clear/sunny | ☒ |

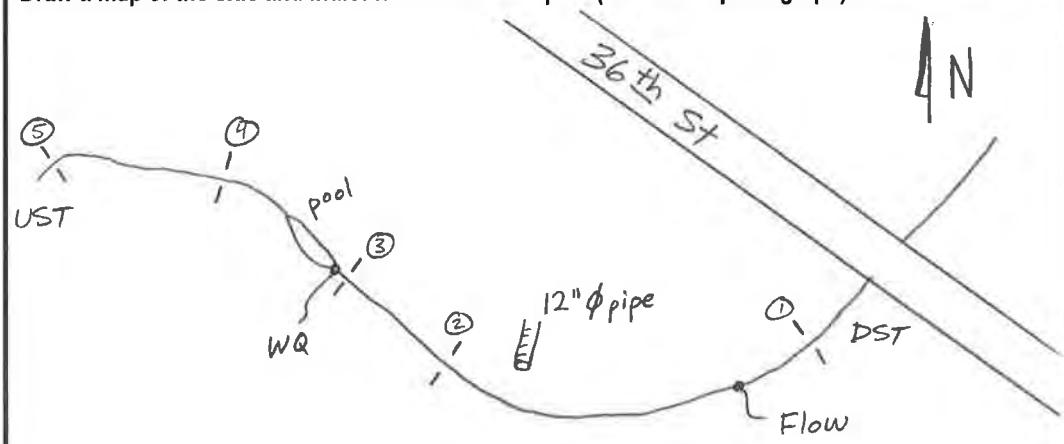
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 12.0 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~ 9.1 km²

1

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | | |
|---|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☒ Other Road<br>☐ Residential | **Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☐ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☐ Trees ☒ Shrubs ☐ Grasses ☒ Herbaceous<br>**Dominant species present** | |
| **INSTREAM FEATURES** | **Estimated Reach Length** 75 m<br>**Estimated Stream Width** 2.4 m<br>**Sampling Reach Area** 180 m²<br>**Area in km² (m²x1000)** ____ m²<br>**Estimated Stream Depth** 0.11 m<br>**Surface Velocity (at thalwag)** 0.24 m/sec | **Canopy Cover**<br>☒ Partly open ☐ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 20 % ☐ Run 70 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 12 ~~m²~~ pieces<br>**Density of LWD** 0.067 ~~m²/km²~~ (LWD/reach area) | |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 85 % | |
| **WATER QUALITY** | **Temperature** 10.4 °C<br>**Specific Conductance** 0.609 mS/cm<br>**Dissolved Oxygen** 11.22 mg/L<br>**pH** 8.20<br>**Turbidity** 2.1 NTU<br>**WQ Instrument Used** YSI 6920 | **Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other ____<br>**Water Surface Oils**<br>☐ Slick ☒ Sheen ☐ Gloss ☐ Flecks<br>☐ None ☐ Other at stormwater outfall from 36th street<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other ____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other ____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse | **Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:

- Apparent petroleum sheen observed at 12 inch diameter outfall from 36th st. road drainage
- Filamentous green algae present throughout reach
- Riparian vegetation planted during the channel reconstruction was beginning to cover the stream
- Evidence of crayfish (claws) was observed
- Orange/rust colored biofilm observed at confluence of outfall from 36th st. road drainage and unnamed trib, just downstream of transect 2

## PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 30 | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 40 | | | |
| Sand | 0.06 – 2mm (gritty) | 20 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | – | | | |

1

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib at 36th St. Date: 9-19-12 Sampler: D. Bradley Recorder: D. Schlea

Air temp 12.0°C

| Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | 4 | – | | 0 | 26 | 3 | | – | 1 | | 5 |
| 2 | | | 4 | – | | 12 | 27 | | | 4 | – | | 7 |
| 3 | | | 4 | – | | 0 | 28 | | | | | ✓ | 10 |
| 4 | | | 4 | – | | 0 | 29 | | | 1 | 1 | | 6 |
| 5 | | | 3 | 1 | | 1 | 30 | | | 4 | ~~4~~ – | | 8 |
| 6 | | | 4 | 2 | | 0 | 31 | 4 | | – | 1 | | 7 |
| 7 | | | 3 | 1 | | 4 | 32 | | | | | ✓ | 9 |
| 8 | | | 4 | 1 | | 0 | 33 | | | | | ✓ | 5 |
| 9 | | | 4 | – | | 1 | 34 | | | 4 | 1 | | 9 |
| 10 | | | 2 | 2 | | 1 | 35 | | | 2 | 2 | | 4 |
| 11 | 2 | | 3 | 2 | | 29 | 36 | | | 4 | – | | 2 |
| 12 | | | – | 2 | | 12 | 37 | | | 4 | – | | 6 |
| 13 | | | 3 | 1 | | 12 | 38 | | | 4 | – | | 0 |
| 14 | | | 2 | 1 | | 6 | 39 | | | 3 | 2 | | 4 |
| 15 | | | 4 | 1 | | 18 | 40 | | | 4 | – | | 0 |
| 16 | | | 1 | 2 | | 16 | 41 | 5 | | | | ✓ | 21 |
| 17 | | | 4 | 1 | | 26 | 42 | | | – | 2 | | 12 |
| 18 | | | 4 | 2 | | 11 | 43 | | | | | ✓ | 7 |
| 19 | | | 4 | 1 | | 14 | 44 | | | | | ✓ | 4 |
| 20 | | | – | – | ✓ | 9 | 45 | | | | | ✓ | 19 |
| 21 | 3 | | | | ✓ | 0 | 46 | | | 2 | 2 | | 8 |
| 22 | | | 2 | 2 | | 1 | 47 | | | | | ✓ | 2 |
| 23 | | | 2 | 2 | | 3 | 48 | | | 4 | 1 | | 11 |
| 24 | | | 1 | 1 | | 12 | 49 | | | 4 | – | | 9 |
| 25 | | | 2 | 1 | | 18 | 50 | | | 4 | – | | 19 |

width 6'0" depth 4" crayfish claw (1,3)

width 5'1" depth 4"

width 6'10" depth 5"

width 5'2" depth 4" crayfish claw

width 16'10" depth 5"

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 39.9 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

1 Unnamed Trib at 36th St.

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 3 | 1 × 3 = 3 | 15 | 1 × 15 = 15 | 7 | 1 × 7 = 7 |
| 2 | 0 | 0 | 7 | 2 × 7 = 14 | 12 | 2 × 12 = 24 | 26 | 2 × 26 = 52 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 5 | 3 × 5 = 15 | 0 | 0 | 7 | 3 × 7 = 21 |
| 4 | 0 | 0 | 21 | 4 × 21 = 84 | 0 | 0 | 2 | 4 × 2 = 8 |
| 5 | | | | | 0 | 0 | 0 | 0 |
| NA | 10 | | 10 | | 10 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.90 | | 0.68 | | | |
| Sum ÷ (50 – NA) | | 0 | | 2.90 | | 0.98 | | 1.76 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{390}{2500} = 0.16$ |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

2

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below TRD | LOCATION Downstream Thornapple River Dr. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |

| | | |
|---|---|---|
| FORM COMPLETED BY D. Schlea | DATE 9-19-12<br>TIME 11:25 AM<br>PM -12:30 | REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 50% ☒ | % cloud cover | ☒ ___% |
| ☒ | Clear/sunny | ☒ |

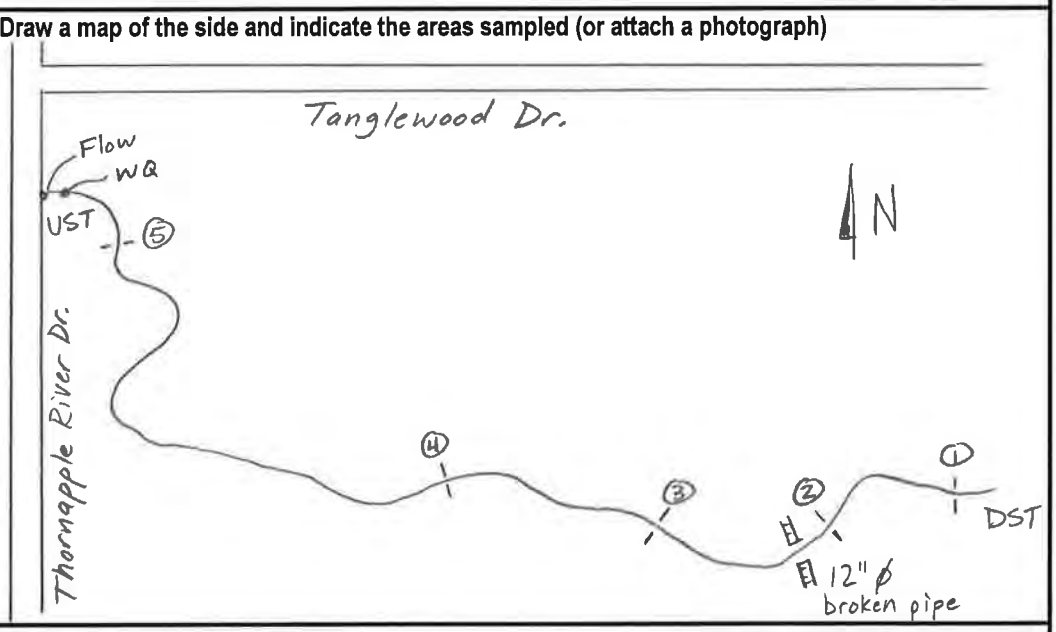
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 17.0 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

2

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 350 m<br>**Estimated Stream Width** 2.5 m<br>**Sampling Reach Area** 875 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.13 m<br>**Surface Velocity (at thalwag)** 0.28 m/sec<br>**Canopy Cover**<br>☐ Partly open ☐ Partly shaded ☒ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 10 % ☐ Run 50 %<br>☐ Pool 40 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 190 m² pieces<br>**Density of LWD** 0.217 m²/km² (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 5 % |
| **WATER QUALITY** | **Temperature** 11.77 °C<br>**Specific Conductance** 0.867 mS/cm<br>**Dissolved Oxygen** 9.59 mg/L<br>**pH** 7.83<br>**Turbidity** 2.9 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☒ Sheen ☐ Gloss ☐ Flecks<br>☐ None ☐ Other sheen in standing water<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Several 2 to 6 inch long fish were observed in a shaded pool upstream of transect 4
- Active channel conditions noted at transect 1 with new sand bar formation on left side (facing downstream). Coarse substrate was completely covered or deeply embedded in sand.
- Orange/rust colored biofilm noted in standing water just upstream of transect 1
- More sand was present at transects 3 and 4 as compared to previous surveys
- Additional riparian structure (newly fallen trees) observed throughout reach
- Filamentous green algae sparse within the reach

2

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 25 |
| Boulder | >256mm (10") | — | | | |
| Cobble | 64-256mm (2.5" – 10") | 5 | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 5 | | | |
| Sand | 0.06 – 2mm (gritty) | 70 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 15 | | | |
| Clay | <0.004mm (slick) | 5 | | | |

2

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below TRD Date: 9-19-12 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 7'10" depth 6" | 1 | 1 | | | | ✓ | 0 | | 26 | 3 | | | | ✓ | 9 | |
| | 2 | ↓ | | | | ✓ | 3 | | 27 | ↓ | | | 1 | | 7 | |
| | 3 | | | | | ✓ | 0 | | 28 | | | | | ✓ | 7 | |
| | 4 | | | | | ✓ | 2 | | 29 | | | | | ✓ | 2 | |
| | 5 | | | | | ✓ | 0 | | 30 | | | | 1 | | 6 | |
| | 6 | | | | | ✓ | 0 | | 31 | 4 | | | | ✓ | 0 | width 8'0" |
| | 7 | | – | – | – | | 4 | | 32 | ↓ | | | | ✓ | 0 | |
| | 8 | | | | | ✓ | 0 | | 33 | | | | | ✓ | 0 | depth 6" |
| | 9 | | | | | ✓ | 0 | | 34 | | | | | ✓ | 0 | |
| | 10 | | | | 1 | | 0 | | 35 | | | | | ✓ | 0 | |
| width 10'10" depth 4" | 11 | 2 | | | 1 | | 29 | | 36 | | | | | ✓ | 0 | |
| | 12 | ↓ | | | 1 | | 38 | | 37 | | | | | ✓ | 9 | |
| | 13 | | | | 2 | | 31 | | 38 | | | | 1 | | 6 | |
| | 14 | | | | 1 | | 28 | | 39 | | | | 1 | | 16 | |
| | 15 | | | | 2 | | 26 | | 40 | | | | 1 | | 21 | |
| | 16 | | | | 2 | | 12 | | 41 | 5 | | | | ✓ | 6 | width 6'8" |
| | 17 | | | | 2 | | 19 | | 42 | ↓ | | | | ✓ | 3 | |
| | 18 | | | | | ✓ | 12 | | 43 | | | 1 | 2 | | 5 | depth 5" |
| | 19 | | | | 1 | | 7 | | 44 | | | 3 | 1 | | 11 | |
| | 20 | | | | | ✓ | 4 | | 45 | | | | 1 | | 11 | |
| width 8'5" depth 4" | 21 | 3 | | | | ✓ | 0 | | 46 | | | | 1 | | 7 | |
| | 22 | ↓ | | | | ✓ | 6 | | 47 | | – | – | – | | 3 | |
| | 23 | | | | 1 | | 8 | | 48 | | – | – | – | | 5 | |
| | 24 | | | | 1 | | 11 | | 49 | | | | 1 | | 3 | |
| | 25 | | | | 1 | | 11 | | 50 | | | | 1 | | 3 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 41.8 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

2 Unnamed Trib at TRD

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 1 | 1 x 1 = 1 | 18 | 1 x 18 = 18 | 2 | 1 x 2 = 2 |
| 2 | 0 | 0 | 0 | 0 | 5 | 2 x 5 = 10 | 26 | 2 x 26 = 52 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 1 | 3 x 1 = 3 | 0 | 0 | 3 | 3 x 3 = 9 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 x 4 = 16 |
| 5 | | | | | 0 | 0 | 1 | 5 x 1 = 5 |
| NA | 24 | | 24 | | 24 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.08 | | 0.88 | | | |
| Sum ÷ (50 – NA) | | 0 | | 0.15 | | 1.08 | | 1.68 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{391}{2500} = 0.16$ |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

3

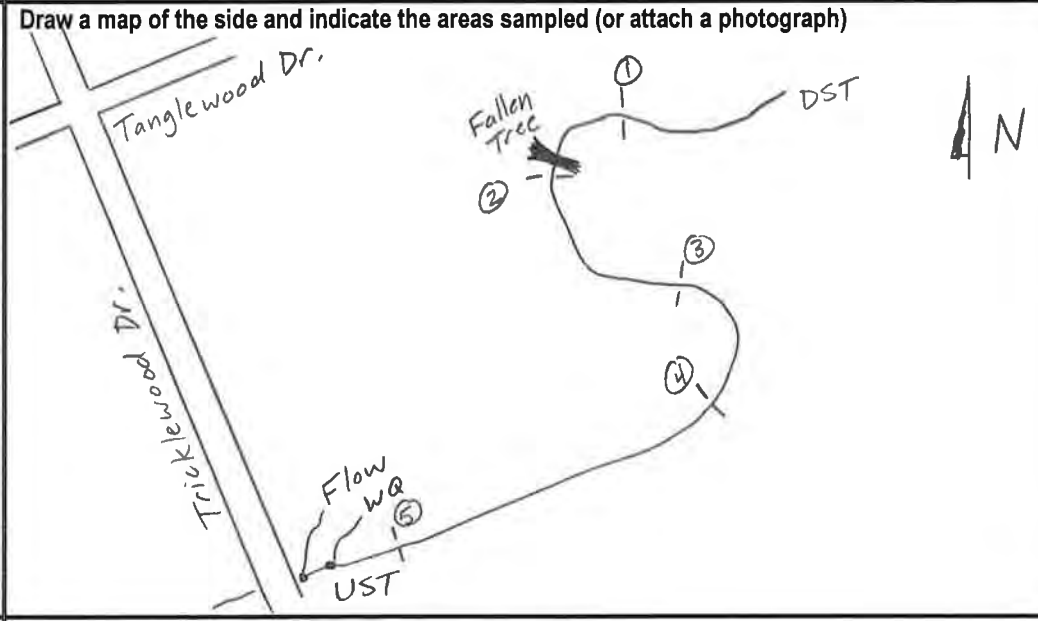
# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below Tricklewood | LOCATION Downstream Tricklewood Drive |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET #~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |
| FORM COMPLETED BY D. Schlea | DATE 9-19-12 TIME 13:15 AM PM -14:00 / REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement. |

| | | | | |
|---|---|---|---|---|
| **WEATHER CONDITIONS** | **Now** | | **Past 24 Hours** | **Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No |
| | ☐ | Storm (heavy rain) | ☐ | |
| | ☐ | Rain (steady rain) | ☐ | |
| | ☐ | Showers (intermittent) | ☐ | **Air Temperature** 18.0 °C |
| | 70% ☒ | % cloud cover | ☒ % | |
| | ☐ | Clear/sunny | ☒ | **Other** _____ |

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

3

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 135 m<br>**Estimated Stream Width** 3.7 m<br>**Sampling Reach Area** 500 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.12 m<br>**Surface Velocity (at thalwag)** 0.26 m/sec<br>**Canopy Cover**<br>☐ Partly open ☒ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 50 % ☐ Run 40 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 38 ~~m²~~ pieces<br>**Density of LWD** 0.076 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 10 % |
| **WATER QUALITY** | **Temperature** 11.95 °C<br>**Specific Conductance** 1.042 mS/cm<br>**Dissolved Oxygen** 10.41 mg/L<br>**pH** 7.96<br>**Turbidity** 2.6 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

3

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 10 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 15 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 20 | | | |
| Sand | 0.06 – 2mm (gritty) | 30 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 10 | | | |
| Clay | <0.004mm (slick) | 20 | | | |

3

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection.**
**Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae;
Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below Tricklewood Date: 9-19-12 Sampler: D.Bradley Recorder: D.Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 9'10" | 1 | 1 | | | 1 | | 38 | | 26 | 3 | | | 1 | | 22 | |
| | 2 | 1 | – | – | – | | 21 | | 27 | 1 | | | 1 | | 14 | |
| depth 3" | 3 | | | | 1 | | 26 | | 28 | | – | – | – | | 11 | |
| | 4 | | | | 1 | | 18 | | 29 | | | 3 | 1 | | 14 | |
| | 5 | | | | 2 | | 34 | | 30 | | | | 2 | | 8 | |
| | 6 | | | | 1 | | 33 | | 31 | 4 | | 2 | 1 | | 16 | width 16'2" |
| | 7 | | | 2 | 1 | | 36 | | 32 | 1 | – | – | – | | 6 | |
| | 8 | | | | 1 | | 12 | | 33 | | – | – | – | | 13 | depth 5" |
| | 9 | | | | 1 | | 15 | | 34 | | | 1 | | | 17 | |
| | 10 | | | | 1 | | 32 | | 35 | | | | | ✓ | 6 | |
| width 12'8" | 11 | 2 | | | | ✓ | 16 | | 36 | | | | | ✓ | 0 | |
| | 12 | | | | 1 | | 11 | | 37 | | | | | ✓ | 2 | |
| depth 6" | 13 | | | | 1 | | 11 | | 38 | | | | | ✓ | 5 | |
| | 14 | | | | 1 | | 10 | | 39 | | | | 1 | | 8 | |
| | 15 | | | | 1 | | 6 | | 40 | | | | 1 | | 9 | |
| | 16 | | | | | ✓ | 3 | | 41 | 5 | | | 2 | | 39 | width 11'0" |
| | 17 | | – | – | – | | 18 | | 42 | 1 | | | 1 | | 26 | |
| | 18 | | | | 2 | | 12 | | 43 | | | 3 | 2 | | 34 | depth 6" |
| | 19 | | | | 1 | | 18 | | 44 | | | | 2 | | 36 | |
| | 20 | | | | 2 | | 29 | | 45 | | | | 2 | | 22 | |
| width 10'7" | 21 | 3 | – | – | – | | 14 | | 46 | | | | 2 | | 29 | |
| | 22 | 1 | | | 1 | | 11 | | 47 | | | | 1 | | 21 | |
| depth 4" | 23 | | | | 2 | | 16 | | 48 | | | | 1 | | 31 | |
| | 24 | | | 1 | 1 | | 14 | | 49 | | | | 1 | | 39 | |
| | 25 | | | 2 | 1 | | 23 | | 50 | | | | 1 | | 21 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 60.3 ft²
Substrata Sampled: rock/wood/plant
(circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

3 Unnamed Trib at Tricklewood

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 2 | 1×2= 2 | 27 | 1×27 = 27 | 1 | 1×1 = 1 |
| 2 | 0 | 0 | 3 | 2×3= 6 | 10 | 2×10 = 20 | 15 | 2×15= 30 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 2 | 3×2= 6 | 0 | 0 | 19 | 3×19= 57 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 4×11= 44 |
| 5 | | | | | 0 | 0 | 3 | 5×3 = 15 |
| NA | 6 | | 6 | | 6 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.16 | | 0.84 | | | |
| Sum ÷ (50 – NA) | | 0 | | 0.32 | | 1.07 | | 2.94 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{926}{2500} = 0.37$ |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

LimnoTech
Water | Environment | Scientists | Engineers

# MEMORANDUM

DATE: November 29, 2012

FROM: Doug Bradley
Derek Schlea
Chris Cieciek

PROJECT: GRR12

TO: Mr. Thomas R. Ecklund, P.E.
Facilities Management Director
Gerald R. Ford International Airport

CC:

SUBJECT: Gerald R. Ford International Airport (GFIA) November 2012 Biofilm Monitoring Results

---


## Summary

The purpose of this memo is to summarize the observations collected during the November 2012 biofilm monitoring survey in the unnamed tributary to the Thornapple River. This is the eighth of the biofilm monitoring events being conducted as required by Part I.A.7.d. of GFIA's NPDES Permit (MI0055735). The monitoring results and metric calculations are described below.


## General Observations

Heterotrophic biofilm was observed at one transect at the Tricklewood Drive monitoring location during this survey. No heterotrophic biofilm was observed at the 36th Street and Thornapple river Drive monitoring locations.

## Monitoring Approach

On November 27, 2012, biofilm monitoring was conducted at three locations (sample stations) in the unnamed tributary of the Thornapple River. Stream assessment reaches were established at each of the locations during the first survey (July 2011) using a hand-held global position system (GPS) device. The monitoring locations are at 36th Street, Thornapple River Drive, and Tricklewood Drive and are shown in Figure 1. Consistent with previous surveys, monitoring was conducted using the Stevenson and Rollins 2007 procedure described in the Proposed Biofilm Monitoring Procedure memo submitted to and approved by MDEQ in June 2011 (LimnoTech, June 3, 2011).

At each of the three sample stations, five transects were designated and marked. The transects were selected based on substrate type. Riffles and/or run segments with coarse substrate materials were specifically targeted because they are most appropriate for periphyton and biofilm attachment and provide repeatable and reliable long-term monitoring locations (Stevenson and Rollins, 2007 in *Methods in Stream Ecology*, 2007). Sampling was conducted at 10 equally spaced points on each transect using the rapid periphyton survey method, Basic Method 1 (Stevenson and Rollins, 2007). Measurements were recorded on the field data sheet (Table 1). Physical habitat characterization forms from the EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* were used to record field observations and measurements at each monitoring reach (EPA, 1999).

**Figure 1. Unnamed Tributary Biofilm/Macroinvertebrate Monitoring Locations.**

Community metric calculations include density and distribution estimates for functional categories of moss, macro, and micro (biofilm) algal species. As noted previously, slight modifications necessary to differentiate between microalgae and heterotrophic biofilm were added to the data collection procedure as described below.

1) The Sz column in the Field Data Sheet (Table 1) is intended for inventory of substrate particles >2 cm in size. Since a primary purpose of this monitoring effort is to characterize the presence of biofilm (which is associated with larger size substrates), the Sz column has been modified to instead identify substratum of < 2 cm (where it is not possible to collect community information). The sum of the Sz column observations is transferred to the NA row in Table 3 for extent and magnitude calculations. This modification was discussed with Stevenson and Rollins (personal communication with Doug Bradley, LimnoTech) and the authors stated that this modification is appropriate for the purpose of this monitoring effort.

2) The Algal Cover and Thickness Class Description (Table 2) include estimated cover classes for moss and macroalgae but not microalgae. The purpose of the monitoring was discussed with the procedure authors and it was suggested by Stevenson that including cover class for microalgae would provide estimated cover and thickness values that will improve the applicability of the procedure for tracking the status of the heterotrophic biofilm community. This component of the protocol was expanded for this monitoring event by adding a column (Table 2) to quantify the number of grid points counted over microalgae at 10 equally spaced points on each transect using a viewing bucket (EPA, 1999) with a 50-dot grid. The grid is used as a quantifiable and repeatable means for measuring distribution and density of biofilm across transects.

3) The calculations for the extent and magnitude of moss, and benthic algal cover (Table 3) include a row named NA. Following clarification from the authors, NA includes the points not sampled because no substrate particle >2 cm was present.

4) The microalgae functional class includes heterotrophic biofilm. The dominance of non-nuisance biofilm microalgae observed during the July and September field visits highlights the need to identify and calculate heterotrophic-specific biofilm observations as well as the other forms of microalgae. The calculation table (Table 3) used for the biofilm monitoring events beginning with the September 2011 event was expanded to quantify the extent and magnitude of biofilm-specific observations, and to estimate the cover of all microalgae as measured with the viewing bucket.

5) The microalgae thickness Class 2 of 0.5 to 1 mm is a transition category between non-visible (thin slimy layer) and visible microalgae (Stevenson and Bahls 1999). The category may misrepresent the presence of heterotrophic biofilm because the study approach prior to July 2012 grouped naturally occurring microalgae (diatoms and bluegreens) with heterotrophic biofilm in Class 2. Beginning with the September 2012 sampling event, we modified the Class 2 calculations to differentiate autotrophic/photosynthetic microalgae from heterotrophic biofilm in the extent and magnitude microalgae metrics (Table 3). Other calculations remain unchanged.

The information being collected and calculations being performed are consistent with the procedures described in the monitoring plan. The additional calculations provide added information on the biofilm community. The metrics will continue to be calculated consistently to support the evaluation of relative changes in the biofilm community.

Monitoring Summary

Site 1 36$^{th}$ Street – The site is approximately 75 meters long with an average channel width of 2.3 meters. Maximum stream velocity was measured at 0.04 m/sec. The site includes a mix of natural and re-establishing riparian vegetation, and channel re-alignment from the 36$^{th}$ Street road work conducted in 2006. The channel substrate is generally coarse with patches of fine sediment deposits. Filamentous green algae were observed throughout this reach. Heterotrophic biofilm was not present at any of the transects sampled. All microalgae thickness Class 2 observations recorded were naturally occurring microalgae.

Site 2 Thornapple River Drive – The site is approximately 350 meters long with an average channel width of 2.8 meters. Maximum stream velocity was measured at 0.17 m/sec. This reach is longer than Sites 1 and 3 because of the limited amount of suitable coarse substrate upon which to locate survey transects. The site is densely vegetated along the banks and in the immediate riparian area. Evidence of bed material movement, bank erosion and deposition remains present throughout the reach. Heterotrophic biofilm was not present at any of the transects sampled. All microalgae thickness Class 2 observations recorded were naturally occurring microalgae.

Site 3 Tricklewood Drive – The site is approximately 135 meters long with an average channel width of 3.6 meters. Maximum stream velocity was measured at 0.11 m/sec. The northern banks of the site are more closely bound by residences than the other sites yet retain thick overhead cover but thin understory. The reach is characterized by a slightly higher gradient than Site 2 and contains a greater dominance of coarser substrates along with an outcrop of exposed hardpan clay. All microalgae thickness Class 2 observations recorded were naturally occurring microalgae. Although heterotrophic biofilm was not observed during thickness measurement collection, a small amount of white biofilm attached to a rock was observed at transect 2 during distribution (cover) measurement using the viewing bucket.

The field sheets and metric calculations are included as Attachment 1.

## References

D. Bradley, LimnoTech. July 2011. Personal communication with J. Stevenson and S. Rollins.

MDEQ (Michigan Department of Environmental Quality). 2008. Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers. Water Bureau Policy and Procedures, WB-SWAS-051 (SWAS Procedure 51), revised December 2008.

Stevenson, R. J., and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in M. T. Barbour,J. Gerritsen, and B. D. Snyder (Eds.) Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. U. S. Environmental Protection Agency, Washington, D.C.

Stevenson, R.J. and S.L. Rollins. 2007. Ecological assessments with benthic algae. Pages 785-803 in F.R. Hauer and G.A. Lamberti (Eds.) Methods in Stream Ecology. Second edition, Academic Press, Burlington, MA.

**Attachment 1**
GFIA Biofilm Monitoring Field Sheets
November 27, 2012

1

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib at 36th St. | LOCATION Upstream 36th St. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET #~~ AUID 04050070408-02 | AGENCY Limno Tech |
| INVESTIGATORS Doug Bradley, Derek Schlea / Limno Tech | |

| FORM COMPLETED BY | DATE | REASON FOR SURVEY |
|---|---|---|
| D. Schlea | DATE 11-27-12<br>TIME 9:30 AM<br>PM - 11:00 | GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 20 % ☒ | % cloud cover | ☒ ___ % |
| ☒ | Clear/sunny | ☐ |

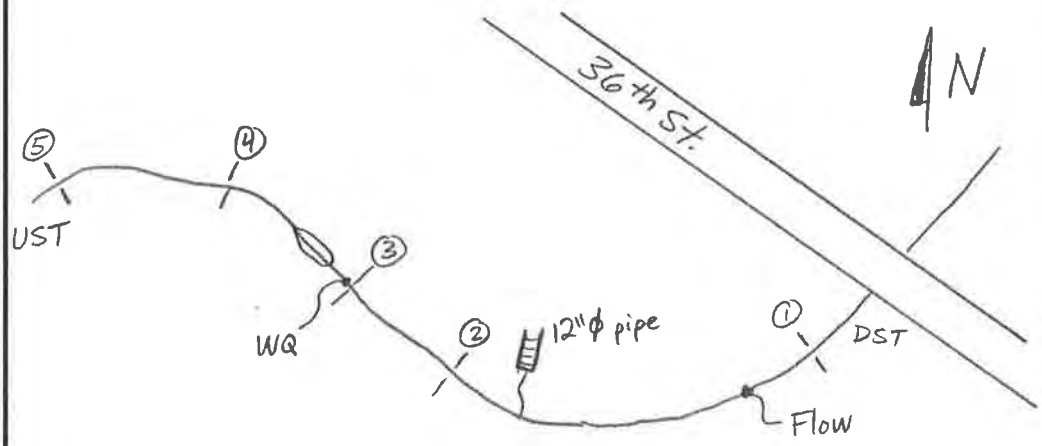
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** -1.0 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~ 9.1 km²

1

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | | |
|---|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☒ Other Road<br>☐ Residential | **Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☐ Trees ☒ Shrubs ☐ Grasses ☒ Herbaceous<br>**Dominant species present** | |
| **INSTREAM FEATURES** | **Estimated Reach Length** 75 m<br>**Estimated Stream Width** 2.3 m<br>**Sampling Reach Area** 173 m²<br>**Area in km² (m²x1000)** – m²<br>**Estimated Stream Depth** 0.10 m<br>**Surface Velocity (at thalwag)** 0.04 m/sec | **Canopy Cover**<br>☒ Partly open ☐ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 20 % ☐ Run 70 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 12 ~~m²~~ pieces<br>**Density of LWD** 0.07 ~~m²/km²~~ (LWD/reach area) | |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 70 % | |
| **WATER QUALITY** | **Temperature** 0.95 °C<br>**Specific Conductance** 590 µS/cm<br>**Dissolved Oxygen** 13.49 mg/L<br>**pH** 8.25<br>**Turbidity** 0.9 NTU<br>**WQ Instrument Used** YSI 6920 | **Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other see note<br>**Water Surface Oils**<br>☐ Slick ☒ Sheen ☐ Gloss ☐ Flecks<br>☐ None ☐ Other<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse | **Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand<br>☐ Relict Shells ☒ Other<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Slight organic decomposition odor noted
- Apparent petroleum sheen observed near 12-inch diameter outfall from 36th St. road drainage
- Dense filamentous green algae throughout reach

## PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 30 | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 40 | | | |
| Sand | 0.06 – 2mm (gritty) | 20 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | — | | | |

1

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib at 36th St. Date: 11-27-12 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width | 1 | 1 | | 2 | | | 0 | | 26 | 3 | | 4 | | | 7 | |
| 6.0 ft | 2 | | | 4 | | | 0 | | 27 | | | 4 | | | 8 | |
| depth | 3 | | | 4 | 1 | | 0 | | 28 | | | | 2 | | 12 | |
| 0.3 ft | 4 | | | 4 | 1 | | 0 | | 29 | | | | | ✓ | 7 | |
| | 5 | | | 4 | 2 | | 3 | | 30 | | | | 2 | | 3 | |
| | 6 | | | 4 | 1 | | 2 | | 31 | 4 | | 1 | 2 | | 5 | width |
| | 7 | | | 3 | 2 | | 3 | | 32 | | | | | ✓ | 4 | 5.0 ft |
| | 8 | | | 4 | 2 | | 9 | | 33 | | | | 1 | | 6 | depth |
| | 9 | | | 2 | | | 7 | | 34 | | | 4 | 2 | | 8 | 0.3 ft |
| | 10 | | | 4 | 1 | | 11 | | 35 | | | 4 | | | 4 | |
| width | 11 | 2 | | 3 | 1 | | 11 | | 36 | | | 2 | 1 | | 9 | |
| 4.5 ft | 12 | | | | 2 | | 7 | | 37 | | | | 1 | | 2 | |
| depth | 13 | | | 3 | 2 | | 14 | | 38 | | | 4 | | | 6 | |
| 0.3 ft | 14 | | | 2 | 2 | | 4 | | 39 | | | | 1 | | 3 | |
| | 15 | | | | 2 | | 6 | | 40 | | | 4 | | | 3 | |
| | 16 | | | | 1 | | 11 | | 41 | 5 | | | | ✓ | 2 | width |
| | 17 | | | | 1 | | 12 | | 42 | | | | | ✓ | 4 | 15.3 ft |
| | 18 | | | 2 | 2 | | 12 | | 43 | | | | | ✓ | 3 | depth |
| | 19 | | | | | ✓ | 16 | | 44 | | | | 1 | | 5 | 0.4 ft |
| | 20 | | | | | ✓ | 11 | | 45 | | | | 1 | | 11 | |
| width | 21 | 3 | | | | ✓ | 11 | | 46 | | | 1 | 2 | | 7 | |
| 6.7 ft. | 22 | | | | 1 | | 13 | | 47 | | | | 2 | | 3 | |
| depth | 23 | | | | 1 | | 8 | | 48 | | | | 1 | | 9 | |
| 0.4 ft | 24 | | | 3 | 1 | | 8 | | 49 | | | | 2 | | 12 | |
| | 25 | | | 4 | 2 | | 13 | | 50 | | | | | ✓ | 4 | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 37.5 $ft^2$
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

1 Unnamed Trib at 36th st.

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 2 | 1×2 = 2 | 17 | 1×17 = 17 | 3 | 1×3 = 3 |
| 2 | 0 | 0 | 5 | 2×5 = 10 | 16 | 2×16 = 32 | 39 | 2×39 = 78 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 4 | 3×4 = 12 | 0 | 0 | 4 | 3×4 = 12 |
| 4 | 0 | 0 | 14 | 4×14 = 56 | 0 | 0 | 0 | 0 |
| 5 | | | | | 0 | 0 | 0 | 0 |
| NA | 9 | | 9 | | 9 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.61 | | 0.80 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{80}{41}$ = 1.95 | | $\frac{49}{41}$ = 1.20 | | $\frac{93}{50}$ = 1.86 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{339}{2500}$ = 0.14 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

2

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME *Unnamed Trib below TRD* | LOCATION *Downstream Thornapple River Dr.* |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN *Thornapple River* |
| ~~STORET#~~ *AUID 040500704008-02* | AGENCY *LimnoTech* |
| INVESTIGATORS *Doug Bradley, Derek Schlea / LimnoTech* | |
| FORM COMPLETED BY *D. Schlea* | DATE *11-27-12* TIME *11:20* AM PM *-12:30* / REASON FOR SURVEY *GFIA BioFilm Elimination / NPDES Requirement* |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 50 % ☒ | % cloud cover | ☒ ___ % |
| ☐ | Clear/sunny | ☐ |

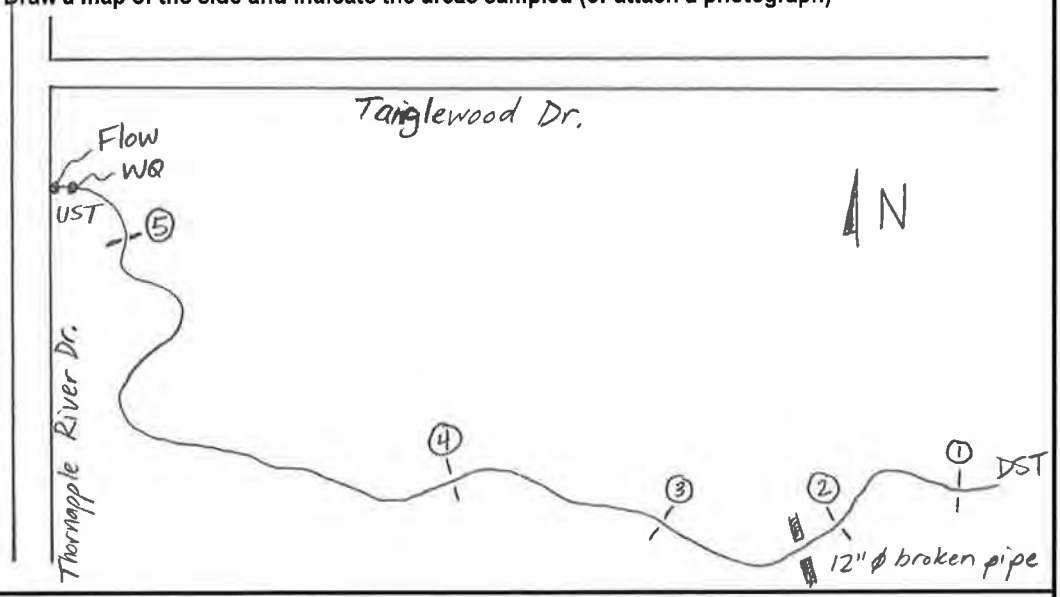
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 2.0 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~ 9.1 km²

2

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☐ Moderate ☒ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 350 m<br>**Estimated Stream Width** 2.8 m<br>**Sampling Reach Area** 980 m²<br>**Area in km² (m²x1000)** – m²<br>**Estimated Stream Depth** 0.13 m<br>**Surface Velocity (at thalwag)** 0.17 m/sec<br>**Canopy Cover**<br>☐ Partly open ☐ Partly shaded ☒ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 10 % ☐ Run 50 %<br>☐ Pool 40 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 204 ~~m²~~ pieces<br>**Density of LWD** 0.208 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 5 % |
| **WATER QUALITY** | **Temperature** 5.25 °C<br>**Specific Conductance** 842 µS/cm<br>**Dissolved Oxygen** 11.83 mg/L<br>**pH** 8.28<br>**Turbidity** 1.0 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other Silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:

- Gravel and rocks at transect 1 were almost completely embedded in a layer of sand
- Minnows observed in several pools throughout reach

2

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 30 |
| Boulder | >256mm (10") | – | | | |
| Cobble | 64-256mm (2.5" – 10") | 5 | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 5 | | | |
| Sand | 0.06 – 2mm (gritty) | 70 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 15 | | | |
| Clay | <0.004mm (slick) | 5 | | | |

2

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below TRD Date: 11-27-12 Sampler: D.Bradley Recorder: D.Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width | 1 | 1 | | | | ✓ | 0 | | 26 | 3 | | | 1 | | 6 | |
| 10.6 ft. | 2 | | | | | ✓ | 1 | | 27 | | | | 1 | | 3 | |
| depth | 3 | | | | | ✓ | 0 | | 28 | | | | 1 | | 6 | |
| 0.3 ft. | 4 | | | | | ✓ | 0 | | 29 | | | | 1 | | 9 | |
| | 5 | | | | | ✓ | 0 | | 30 | | | | 1 | | 8 | |
| | 6 | | | | | ✓ | 0 | | 31 | 4 | | | | ✓ | 3 | width |
| | 7 | | | | | ✓ | 0 | | 32 | | | | | ✓ | 0 | 8.5 ft. |
| | 8 | | | | | ✓ | 3 | | 33 | | | | | ✓ | 0 | depth |
| | 9 | | | | | ✓ | 0 | | 34 | | | | | ✓ | 11 | 0.6 ft. |
| | 10 | | | | | ✓ | 2 | | 35 | | | 4 | 2 | | 14 | |
| width | 11 | 2 | | | | ✓ | 13 | | 36 | | | 4 | 2 | | 17 | |
| 10.5 ft. | 12 | | | 3 | 2 | | 7 | | 37 | | | | 2 | | 12 | |
| depth | 13 | | | 2 | 2 | | 4 | | 38 | | | | 2 | | 10 | |
| 0.5 ft. | 14 | | | | | ✓ | 8 | | 39 | | | | 2 | | 13 | |
| | 15 | | | 3 | 2 | | 18 | | 40 | | | 3 | 2 | | 17 | |
| | 16 | | | 2 | 2 | | 3 | | 41 | 5 | | | | ✓ | 9 | width |
| | 17 | | | | | ✓ | 10 | | 42 | | | 2 | 1 | | 16 | 7.2 ft. |
| | 18 | | | 3 | 2 | | 2 | | 43 | | | | 2 | | 7 | depth |
| | 19 | | | 4 | 2 | | 9 | | 44 | | | | 1 | | 2 | 0.3 ft. |
| | 20 | | | | | ✓ | 2 | | 45 | | | 4 | | | 12 | |
| width | 21 | 3 | | | | ✓ | 6 | | 46 | | | | | ✓ | 10 | |
| 9.8 ft. | 22 | | | | 2 | | 2 | | 47 | | | | 1 | | 8 | |
| depth | 23 | | | | | ✓ | 2 | | 48 | | | 4 | | | 8 | |
| 0.5 ft. | 24 | | | | 2 | | 15 | | 49 | | | | 2 | | 14 | |
| | 25 | | | | 2 | | 11 | | 50 | | | | 1 | | 11 | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 46.1 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid.

2 Unnamed Trib below TRD

**Table 2. Algae and Moss Cover and Thickness Class Descriptions. Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover. Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 9 | 1×9 = 9 | 7 | 1×7 = 7 |
| 2 | 0 | 0 | 3 | 2×3 = 6 | 17 | 2×17 = 34 | | 2×25 = 50 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 4 | 3×4 = 12 | 0 | 0 | 9 | 3 9 = 27 |
| 4 | 0 | 0 | 5 | 4×5 = 20 | 0 | 0 | 0 | 0 |
| 5 | | | | | 0 | 0 | 0 | 0 |
| NA | 22 | | 22 | | 22 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.43 | | 0.93 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{38}{28}$ = 1.36 | | $\frac{43}{28}$ = 1.54 | | $\frac{84}{50}$ = 1.68 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{344}{2500}$ = 0.14 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

3

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | | |
|---|---|---|
| STREAM NAME *Unnamed Trib below Tricklewood* | LOCATION *Downstream Tricklewood Dr.* | |
| STATION # _____ RIVERMILE _____ | STREAM CLASS | |
| LAT _____ LONG _____ | RIVER BASIN *Thornapple River* | |
| STORET # *AUID 04050070408-02* | AGENCY *LimnoTech* | |
| INVESTIGATORS *Doug Bradley, Derek Schlea / LimnoTech* | | |
| FORM COMPLETED BY *D. Schlea* | DATE *11-27-12* TIME *13:10* AM PM *-14:10* | REASON FOR SURVEY *GFIA Biofilm Elimination / NPDES Requirement* |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 50% ☒ | % cloud cover | ☒ ___% |
| ☒ | Clear/sunny | ☐ |

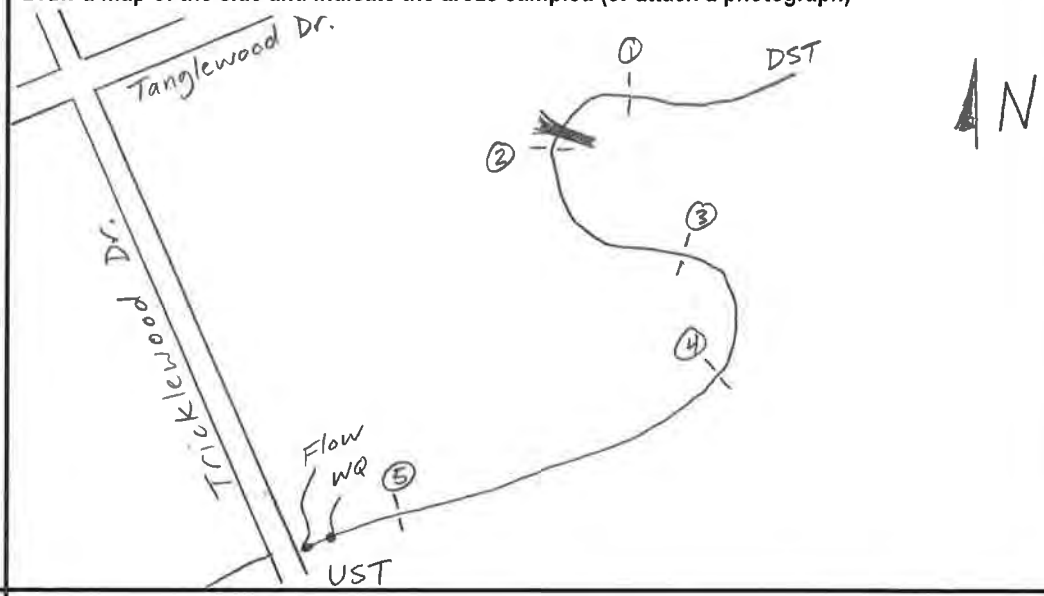
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 2.5 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~ 9.1 km²

3

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | | |
|---|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential | **Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ | |
| **INSTREAM FEATURES** | **Estimated Reach Length** 135 m<br>**Estimated Stream Width** 3.6 m<br>**Sampling Reach Area** 486 m²<br>**Area in km² (m²x1000)** – m²<br>**Estimated Stream Depth** 0.13 m<br>**Surface Velocity (at thalwag)** 0.11 m/sec | **Canopy Cover**<br>☐ Partly open ☒ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 50 % ☐ Run 40 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 43 ~~m²~~ pieces<br>**Density of LWD** 0.088 ~~m²/km²~~ (LWD/reach area) | |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 40 % | |
| **WATER QUALITY** | **Temperature** 5.71 °C<br>**Specific Conductance** 1009 µS/cm<br>**Dissolved Oxygen** 13.60 mg/L<br>**pH** 8.09<br>**Turbidity** 0.1 NTU<br>**WQ Instrument Used** YSI 6920 | **Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse | **Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other Silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:

- Yard waste observed on bank and in channel at transect 1.
- Small patch of biofilm observed at transect 2.
- Fine layer of silt observed throughout reach.

3

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 15 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 20 | | | |
| Sand | 0.06 – 2mm (gritty) | 30 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 10 | | | |
| Clay | <0.004mm (slick) | 20 | | | |

3

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below Tricklewood Date: 11-27-12 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 8.8 ft. depth 0.4 ft | 1 | 1 | | 2 | 2 | | 6 | | 26 | 3 | | 2 | 2 | | 6 | |
| | 2 | 1 | | | 2 | | 7 | | 27 | 1 | | | 2 | | 19 | |
| | 3 | 1 | | | | ✓ | 2 | | 28 | 1 | | 4 | 2 | | 11 | |
| | 4 | 1 | | 4 | | | 21 | | 29 | 1 | | 3 | 2 | | 8 | |
| | 5 | 1 | | 2 | 2 | | 11 | | 30 | 1 | | | | ✓ | 6 | |
| | 6 | 1 | | 4 | 2 | | 16 | | 31 | 4 | | 2 | 1 | | 7 | width 16.2 ft depth 0.4 ft |
| | 7 | 1 | | 2 | 1 | | 22 | | 32 | 1 | | 4 | | | 5 | |
| | 8 | 1 | | 3 | 2 | | 4 | | 33 | 1 | | 3 | 2 | | 3 | |
| | 9 | 1 | | 3 | 2 | | 7 | | 34 | 1 | | 2 | 2 | | 8 | |
| | 10 | 1 | | 2 | 2 | | 3 | | 35 | 1 | | | | ✓ | 6 | |
| width 13.4 ft. depth 0.4 ft. | 11 | 2 | | | | ✓ | 3 | | 36 | 1 | | 2 | 1 | | 4 | |
| | 12 | 1 | | | | ✓ | 4 | | 37 | 1 | | 3 | 2 | | 2 | |
| | 13 | 1 | | 3 | | | 6 | | 38 | 1 | | | | ✓ | 6 | |
| | 14 | 1 | | 4 | | | 4 | | 39 | 1 | | 4 | 2 | | 5 | |
| | 15 | 1 | | 3 | 2 | | 11 | | 40 | 1 | – | – | – | | 8 | |
| | 16 | 1 | | 2 | 2 | | 2 | | 41 | 5 | | 3 | 2 | | 19 | width 10.6 ft depth 0.5 ft |
| | 17 | 1 | | 3 | 2 | | 8 | | 42 | 1 | | 4 | 2 | | 12 | |
| | 18 | 1 | | 2 | 2 | | 0 | | 43 | 1 | | | | ✓ | 12 | |
| | 19 | 1 | | | | ✓ | 4 | | 44 | 1 | | 4 | 2 | | 9 | |
| | 20 | 1 | | 3 | 2 | | 11 | | 45 | 1 | | 4 | 2 | | 9 | |
| width 10.6 ft. depth 0.4 ft | 21 | 3 | | 2 | | | 16 | | 46 | 1 | | 4 | | | 12 | |
| | 22 | 1 | | | 2 | | 12 | | 47 | 1 | | 4 | 2 | | 6 | |
| | 23 | 1 | | 3 | 2 | | 6 | | 48 | 1 | | | | ✓ | 7 | |
| | 24 | 1 | | 4 | 2 | | 4 | | 49 | 1 | | | 2 | | 8 | |
| | 25 | 1 | | 4 | 1 | | 11 | | 50 | 1 | | | 2 | | 17 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 59.6 ft²
Substrata Sampled (circle): rock/wood/plant, sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

3 Unnamed Trib below Tricklewood

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 4 | 1×4 = 4 | 3 | 1×3 = 3 |
| 2 | 0 | 0 | 11 | 2×11 = 22 | 30 | 2×30 = 60 | 39 | 2×39 = 78 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 11 | 3×11 = 33 | 0 | 0 | 7 | 3×7 = 21 |
| 4 | 0 | 0 | 13 | 4×13 = 52 | 0 | 0 | 0 | 0 |
| 5 | | | | | 0 | 0 | 0 | 0 |
| NA | 9 | | 9 | | 9 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.85 | | 0.83 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{107}{41}$ = 2.61 | | $\frac{64}{41}$ = 1.56 | | $\frac{102}{50}$ = 2.04 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{416}{2500}$ = 0.17 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

LimnoTech
Water | Environment | Scientists | Engineers

# MEMORANDUM

**DATE:** **February 14, 2013**

**FROM:** **Doug Bradley**
**Derek Schlea**
**Chris Cieciek**

**PROJECT:** **GRR12**

**TO:** Mr. Thomas R. Ecklund, P.E.
Facilities Management Director
Gerald R. Ford International Airport

**CC:**

**SUBJECT**: Gerald R. Ford International Airport (GFIA) February 2013 Biofilm Monitoring Results

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## Summary

The purpose of this memo is to summarize the observations collected during the February 2013 biofilm monitoring survey in the unnamed tributary to the Thornapple River. Monitoring could not be completed in January due to conditions that prevented stream access on the days when surveys were scheduled. The stream channel was frozen on January 22 and was near-flood stage on January 29. The delay was communicated to DEQ staff on January 29 and acknowledgement was received. This is the tenth biofilm monitoring event conducted as required by Part I.A.7.d. of GFIA's NPDES Permit (MI0055735). The monitoring results and metric calculations are described below.


## General Observations

Heterotrophic biofilm was observed on substrate surfaces sampled during this survey.

## Monitoring Approach

On February 12, 2013, biofilm monitoring was conducted at three locations (sample stations) in the unnamed tributary of the Thornapple River. Stream assessment reaches were established at each of the locations during the first survey (July 2011) using a hand-held global position system (GPS) device. The monitoring locations are at 36th Street, Thornapple River Drive, and Tricklewood Drive and are shown in Figure 1. Consistent with previous surveys, monitoring was conducted using the Stevenson and Rollins 2007 procedure described in the Proposed Biofilm Monitoring Procedure memo submitted to and approved by MDEQ in June 2011 (LimnoTech, June 3, 2011).

At each of the three sample stations, five transects were designated and marked. The transects were selected based on substrate type. Riffles and/or run segments with coarse substrate materials were specifically targeted because they are most appropriate for periphyton and biofilm attachment and provide repeatable and reliable long-term monitoring locations (Stevenson and Rollins, 2007 in *Methods in Stream Ecology*, 2007). Sampling was conducted at 10 equally spaced points on each transect using the rapid periphyton survey method, Basic Method 1 (Stevenson and Rollins, 2007). Measurements were recorded on the field data sheet (Table 1). Physical habitat characterization forms from the EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* were used to record field observations and measurements at each monitoring reach (EPA, 1999).

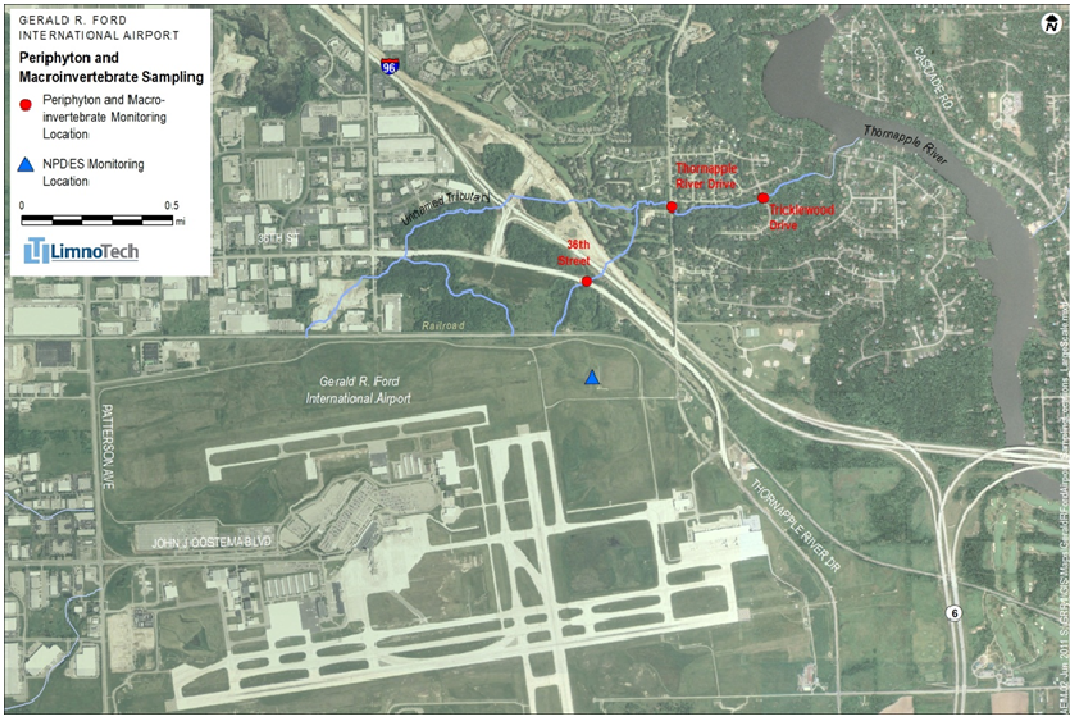



**Figure 1. Unnamed Tributary Biofilm/Macroinvertebrate Monitoring Locations.**

Community metric calculations include density and distribution estimates for functional categories of moss, macro, and micro (biofilm) algal species. As noted previously, slight modifications necessary to differentiate between microalgae and heterotrophic biofilm were added to the data collection procedure as described below.

1) The Sz column in the Field Data Sheet (Table 1) is intended for inventory of substrate particles >2 cm in size. Since a primary purpose of this monitoring effort is to characterize the presence of biofilm (which is associated with larger size substrates), the Sz column has been modified to instead identify substratum of < 2 cm (where it is not possible to collect community information). The sum of the Sz column observations is transferred to the NA row in Table 3 for extent and magnitude calculations. This modification was discussed with Stevenson and Rollins (personal communication with Doug Bradley, LimnoTech) and the authors stated that this modification is appropriate for the purpose of this monitoring effort.

2) The Algal Cover and Thickness Class Description (Table 2) include estimated cover classes for moss and macroalgae but not microalgae. The purpose of the monitoring was discussed with the procedure authors and it was suggested by Stevenson that including cover class for microalgae would provide estimated cover and thickness values that will improve the applicability of the procedure for tracking the status of the heterotrophic biofilm community. This component of the protocol was expanded for this monitoring event by adding a column (Table 2) to quantify the number of grid points counted over microalgae at 10 equally spaced points on each transect using a viewing bucket (EPA, 1999) with a 50-dot grid. The grid is used as a quantifiable and repeatable means for measuring distribution and density of biofilm across transects.

3) The calculations for the extent and magnitude of moss, and benthic algal cover (Table 3) include a row named NA. Following clarification from the authors, NA includes the points not sampled because no substrate particle >2 cm was present.
4) The microalgae functional class includes heterotrophic biofilm. The dominance of non-nuisance biofilm microalgae observed during the July and September field visits highlights the need to identify and calculate heterotrophic-specific biofilm observations as well as the other forms of microalgae. The calculation table (Table 3) used for the biofilm monitoring events beginning with the September 2011 event was expanded to quantify the extent and magnitude of biofilm-specific observations, and to estimate the cover of all microalgae as measured with the viewing bucket.
5) The microalgae thickness Class 2 of 0.5 to 1 mm is a transition category between non-visible (thin slimy layer) and visible microalgae (Stevenson and Bahls 1999). The category may misrepresent the presence of heterotrophic biofilm because the study approach prior to July 2012 grouped naturally occurring microalgae (diatoms and bluegreens) with heterotrophic biofilm in Class 2. Beginning with the September 2012 sampling event, we modified the Class 2 calculations to differentiate autotrophic/photosynthetic microalgae from heterotrophic biofilm in the extent and magnitude microalgae metrics (Table 3). Other calculations remain unchanged.

The information being collected and calculations being performed are consistent with the procedures described in the monitoring plan. The additional calculations provide added information on the biofilm community. The metrics will continue to be calculated consistently to support the evaluation of relative changes in the biofilm community.

Monitoring Summary

Site 1 36th Street – The site is approximately 75 meters long and average channel width was approximately 2.7 meters. Maximum stream velocity was measured at 0.54 m/sec. The site includes a mix of natural and re-establishing riparian vegetation, and channel re-alignment from the 36th Street road work conducted in 2006. The channel substrate is generally coarse with patches of fine sediment deposits. Heterotrophic biofilm was present at all transects sampled.

Site 2 Thornapple River Drive – The site is approximately 350 meters long and average channel width was approximately 3.4 meters. Maximum stream velocity was measured at 0.47 m/sec. This reach is longer than Sites 1 and 3 because of the limited amount of suitable coarse substrate upon which to locate survey transects. The site is densely vegetated along the banks and in the immediate riparian area. Evidence of bed material movement, bank erosion and deposition is present throughout the reach. Heterotrophic biofilm was present at all transects sampled. Biofilm thickness was not measured at all locations because of the lack of coarse substrate (greater than 50% of substrate particles were <2 cm). Localized biofilm was present at transects 1 and 3 but not quantified because it did not coincide with any of the random sampling points.

Site 3 Tricklewood Drive – The site is approximately 135 meters long and average channel width was approximately 4.0 meters. Maximum stream velocity was measured at 0.41 m/sec. The northern banks of the site are more closely bound by residences than the other sites yet retain thick overhead cover but thin understory. The reach is characterized by a slightly higher gradient than Site 2 and contains a greater dominance of coarser substrates along with an outcrop of exposed hardpan clay. Heterotrophic biofilm was present at all transects sampled. .

The field sheets and metric calculations are included as Attachment 1.

## References

D. Bradley, LimnoTech. July 2011. Personal communication with J. Stevenson and S. Rollins.

MDEQ (Michigan Department of Environmental Quality). 2008. Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers. Water Bureau Policy and Procedures, WB-SWAS-051 (SWAS Procedure 51), revised December 2008.

Stevenson, R. J., and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in M. T. Barbour,J. Gerritsen, and B. D. Snyder (Eds.) Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. U. S. Environmental Protection Agency, Washington, D.C.

Stevenson, R.J. and S.L. Rollins. 2007. Ecological assessments with benthic algae. Pages 785-803 in F.R. Hauer and G.A. Lamberti (Eds.) Methods in Stream Ecology. Second edition, Academic Press, Burlington, MA.

**Attachment 1**
GFIA Biofilm Monitoring Field Sheets
February 12, 2013

①

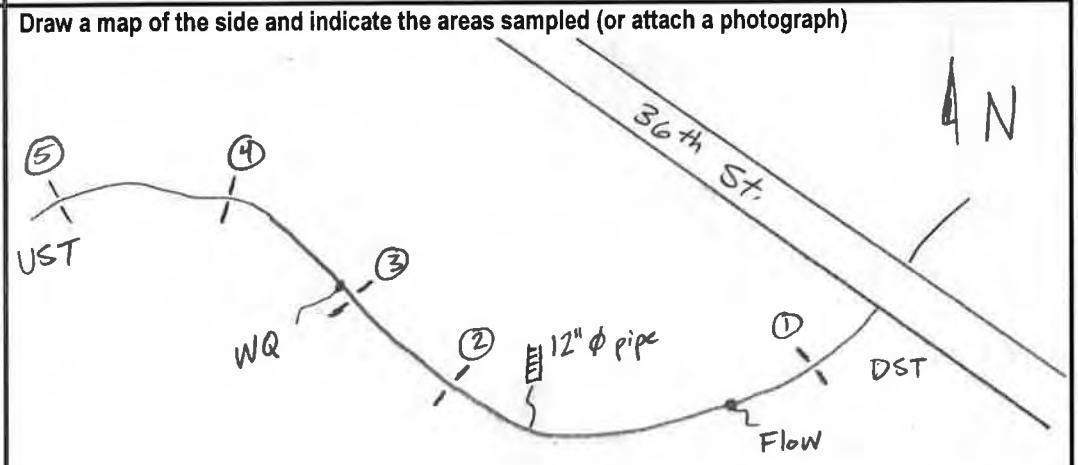
# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib at 36th St. | LOCATION Upstream 36th St. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET~~# AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |
| FORM COMPLETED BY D. Schlea | DATE 2-12-2013 TIME 9:50 AM PM – 11:15 / REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement |

| | | | | |
|---|---|---|---|---|
| **WEATHER CONDITIONS** | **Now** | | **Past 24 Hours** | **Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No |
| | ☐ | Storm (heavy rain) | ☐ | |
| | ☐ | Rain (steady rain) | ☐ | |
| | ☐ | Showers (intermittent) | ☒ | **Air Temperature** -1.0 °C |
| | 100% ☒ | % cloud cover | ☒ ___% | |
| | ☐ | Clear/sunny | ☐ | **Other** 4-6" snow pack |

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

(1)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☒ Other Road<br>☐ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☐ Trees ☒ Shrubs ☐ Grasses ☒ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 75 m<br>**Estimated Stream Width** 2.70 m<br>**Sampling Reach Area** 203 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.15 m<br>**Surface Velocity (at thalwag)** 0.54 m/sec<br>**Canopy Cover**<br>☒ Partly open ☐ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 25 % ☐ Run 60 %<br>☐ Pool 15 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 12 ~~m²~~ pieces<br>**Density of LWD** 0.059 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 30 % |
| **WATER QUALITY** | **Temperature** 2.46 °C<br>**Specific Conductance** 542 µS/cm<br>**Dissolved Oxygen** 12.66 mg/L<br>**pH** 8.13<br>**Turbidity** -1.1 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other see note<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☒ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand<br>☐ Relict Shells ☒ Other Silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- organic odor noted
- Turbidity instrument recorded a negative value; likely instrument error

1

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 30 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 40 | | | |
| Sand | 0.06 – 2mm (gritty) | 20 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | — | | | |

①

BFD 9:50 - 11:05

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib at 36th St. Date: 2-12-13 Sampler: D. Bradley Recorder: D. Bradley / D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 6.2 ft depth 0.5 ft | 1 | 1 | | 4 | 2 | | 9 | | 26 | 3 | | 0 | 1 | | 7 | |
| | 2 | 1 | | 4 | 3 | | 14 | | 27 | 3 | | 3 | 2 | | 9 | |
| | 3 | 1 | | 4 | 3 | | 8 | | 28 | 3 | | 2 | 2 | | 12 | |
| | 4 | 1 | | 4 | 3 | | 14 | | 29 | 3 | | 3 | 3 | | 22 | |
| | 5 | 1 | | 3 | 2 * | | 14 | | 30 | 3 | | – | – | ✓ | 17 | |
| | 6 | 1 | | 3 | 3 | | 21 | | 31 | 4 | | – | – | ✓ | 3 | width 6.6 ft depth 0.4 ft |
| | 7 | 1 | | 2 | 3 | | 6 | | 32 | 4 | | 0 | 1 | | 0 | |
| | 8 | 1 | | 2 | 1 | | 2 | | 33 | 4 | | 0 | 1 | | 2 | |
| | 9 | 1 | | 2 | 1 | | 4 | | 34 | 4 | | 3 | 3 | | 0 | |
| | 10 | 1 | | 1 | 1 | | 2 | | 35 | 4 | | 0 | 2 * | | 3 | |
| width 5.8 ft depth 0.4 ft | 11 | 2 | | 3 | 4 | | 14 | | 36 | 4 | | 2 | 3 | | 14 | |
| | 12 | 2 | | 4 | 3 | | 11 | | 37 | 4 | | 0 | 2 | | 16 | |
| | 13 | 2 | | 4 | 3 | | 26 | | 38 | 4 | | 3 | 3 | | 11 | |
| | 14 | 2 | | 4 | 3 | | 16 | | 39 | 4 | | 3 | 2 | | 6 | |
| | 15 | 2 | | 2 | 2 | | 7 | | 40 | 4 | | 3 | 2 | | 19 | |
| | 16 | 2 | | 1 | 1 | | 6 | | 41 | 5 | | – | – | ✓ | 9 | width 17.5 ft depth 0.7 ft |
| | 17 | 2 | | 1 | 0 | | 3 | | 42 | 5 | | – | – | ✓ | 7 | |
| | 18 | 2 | | – | – | ✓ | 6 | | 43 | 5 | | 0 | 1 | | 4 | |
| | 19 | 2 | | 1 | 1 | | 8 | | 44 | 5 | | 0 | 1 | | 13 | |
| | 20 | 2 | | – | – | ✓ | 16 | | 45 | 5 | | 0 | 1 | | 0 | |
| width 7.4 ft depth 0.5 ft | 21 | 3 | | 2 | 2 * | | 6 | | 46 | 5 | | 2 | 2 | | 4 | |
| | 22 | 3 | | 3 | 2 * | | 7 | | 47 | 5 | | 0 | 1 | | 3 | |
| | 23 | 3 | | 1 | 1 | | 5 | | 48 | 5 | | 4 | 3 | | 0 | |
| | 24 | 3 | | 0 | 1 | | 8 | | 49 | 5 | | 3 | 3 | | 2 | |
| | 25 | 3 | | 0 | 1 | | 3 | | 50 | 5 | | | | ✓ | 2 | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

2 * yes biofilm

Surface Area Sampled = 43.5 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

① Unnamed Trib at 36th Street

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 5 | 1×5 = 5 | 15 | 1×15 = 15 | 5 | 1×5 = 5 |
| 2 | 0 | 0 | 8 | 2×8 = 16 | 8 | 2×8 = 16 | 27 | 2×27 = 54 |
| 2* (heterotrophic biofilm)[1] | | | | | 4 | 2×4 = 8 | | |
| 3 | 0 | 0 | 11 | 3×11 = 33 | 14 | 3×14 = 42 | 13 | 3×13 = 39 |
| 4 | 0 | 0 | 8 | 4×8 = 32 | 1 | 4×1 = 4 | 1 | 4×1 = 4 |
| 5 | | | | | 0 | 5×0 = 0 | 0 | 5×0 0 |
| NA | 7 | | 7 | | 7 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.74 | | 0.98 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{86}{43}$ = 2.0 | | $\frac{85}{43}$ = 1.98 | | $\frac{102}{50}$ = 2.04 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0.44 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{54}{43}$ = 1.26 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{42}{2500}$ = 0.17 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below TRD | LOCATION Downstream Thornapple River Dr. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |
| FORM COMPLETED BY D. Schlea | DATE 2-12-13 TIME 11:50 AM PM -13:15 — REASON FOR SURVEY GFIA BioFilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☒ |
| 100% ☒ | % cloud cover | ☒ ___% |
| ☐ | Clear/sunny | ☐ |

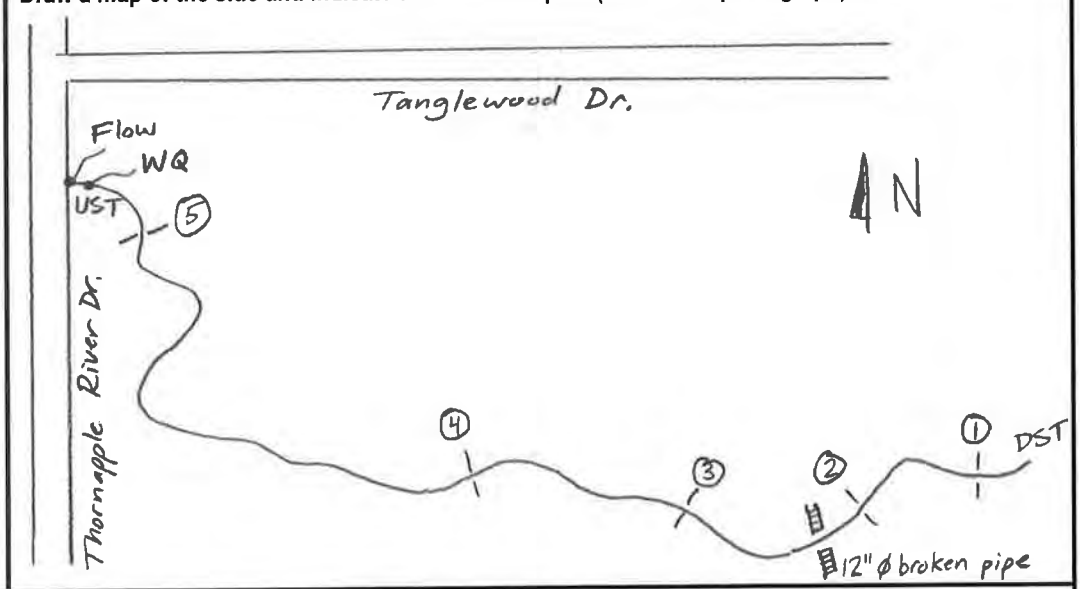
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** -1.0 °C

**Other** 4-6" snowpack

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | | |
|---|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential | **Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☐ Moderate ☒ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ | |
| **INSTREAM FEATURES** | **Estimated Reach Length** 350 m<br>**Estimated Stream Width** 3.4 m<br>**Sampling Reach Area** 1190 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.18 m<br>**Surface Velocity (at thalwag)** 0.47 m/sec | **Canopy Cover**<br>☐ Partly open ☐ Partly shaded ☒ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 10 % ☐ Run 50 %<br>☐ Pool 40 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 213 m² pieces<br>**Density of LWD** 0.179 m²/km² (LWD/reach area) | |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 20 % | |
| **WATER QUALITY** | **Temperature** 2.74 °C<br>**Specific Conductance** 923 mS/cm<br>**Dissolved Oxygen** 11.67 mg/L<br>**pH** 7.83<br>**Turbidity** 1.1 NTU<br>**WQ Instrument Used** YSI 6920 | **Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other see note<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse | **Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other Silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Slight organic odor noted
- All gravel and rocks at transect 1 were almost completely embedded in a layer of sand
- New sand deposition observed at transect 2
- Evidence of new woody debris throughout reach

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 30 |
| Boulder | >256mm (10") | – | | | |
| Cobble | 64-256mm (2.5" – 10") | 5 | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 5 | | | |
| Sand | 0.06 – 2mm (gritty) | 80 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 10 | | | |
| Clay | <0.004mm (slick) | – | | | |

②

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below TRD Date: 2-12-13 Sampler: D. Bradley Recorder: D. Schlea

| Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | ✓ | 3 | 26 | 3 | 0 | 0 | 0 | | 3 |
| 2 | | | | | ✓ | 10 | 27 | | 0 | 0 | 0 | | 8 |
| 3 | | | | | ✓ | 4 | 28 | | | 0 | 1 | | 6 |
| 4 | | | | | ✓ | 3 | 29 | | | 0 | 1 | | 0 |
| 5 | | | | | ✓ | 0 | 30 | | | | | ✓ | 17 |
| 6 | | | | | ✓ | 0 | 31 | 4 | | | | ✓ | 8 |
| 7 | | | | | ✓ | 0 | 32 | | | | | ✓ | 7 |
| 8 | | | | | ✓ | 0 | 33 | | | 4 | 4 | | 0 |
| 9 | | | | | ✓ | 16 | 34 | | | | | ✓ | 9 |
| 10 | | | | | ✓ | 20 | 35 | | 0 | 0 | 0 | | 31 |
| 11 | 2 | | | | ✓ | 32 | 36 | | | | | ✓ | 33 |
| 12 | | | 4 | 4 | | 32 | 37 | | | 4 | 3 | | 23 |
| 13 | | | 3 | 4 | | 15 | 38 | | | 4 | 5 | | 39 |
| 14 | | | 4 | 4 | | 27 | 39 | | | | | ✓ | 37 |
| 15 | | | 3 | 4 | | 18 | 40 | | | 4 | 5 | | 18 |
| 16 | | | | | ✓ | 17 | 41 | 5 | | | | ✓ | 19 |
| 17 | | | 3 | 4 | | 15 | 42 | | | 4 | 5 | | 24 |
| 18 | | | | | ✓ | 2 | 43 | | | 4 | 4 | | 38 |
| 19 | | | 3 | 4 | | 13 | 44 | | | | | ✓ | 6 |
| 20 | | | | | ✓ | 0 | 45 | | | 4 | 3 | | 8 |
| 21 | 3 | | | | ✓ | 27 | 46 | | | 4 | 3 | | 3 |
| 22 | | | | | ✓ | 15 | 47 | | | 3 | 2 | | 7 |
| 23 | | | | | ✓ | 12 | 48 | | | 0 | 2 | | 9 |
| 24 | | | | | ✓ | 0 | 49 | | | | | ✓ | 31 |
| 25 | | | | | ✓ | 5 | 50 | | | 0 | 3 | | 34 |

width 13.7 ft depth 0.5 ft

width 11.3 ft depth 0.5 ft

width 13.0 ft depth 0.7 ft

width 9.9 ft depth 0.5 ft

width 7.5 ft depth 0.7 ft

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 55.4 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

② Unnamed Trib below TRD

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 2 | 1 x 2 = 2 | 1 | 1 x 1 = 1 |
| 2 | 0 | 0 | 0 | 0 | 2 | 2 x 2 = 4 | 17 | 2 x 17 = 34 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 5 | 3 x 5 = 15 | 4 | 3 x 4 = 12 | 13 | 3 x 13 = 39 |
| 4 | 0 | 0 | 10 | 4 x 10 = 40 | 8 | 4 x 8 = 32 | 9 | 4 x 9 = 36 |
| 5 | | | | | 3 | 5 x 3 = 15 | 2 | 5 x 2 = 10 |
| NA | 28 | | 28 | | 28 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.68 | | 0.86 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{55}{22}$ = 2.50 | | $\frac{65}{22}$ = 2.95 | | $\frac{120}{50}$ = 2.40 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0.68 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{59}{22}$ = 2.68 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{704}{2500}$ = 0.28 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below Tricklewood | LOCATION Downstream Tricklewood Dr. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |
| FORM COMPLETED BY D. Schlea | DATE 2-12-13 TIME 13:45 AM PM - 15:00 / REASON FOR SURVEY GFIA BioFilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☒ |
| 100% ☒ | % cloud cover | ☒ % |
| ☐ | Clear/sunny | ☐ |

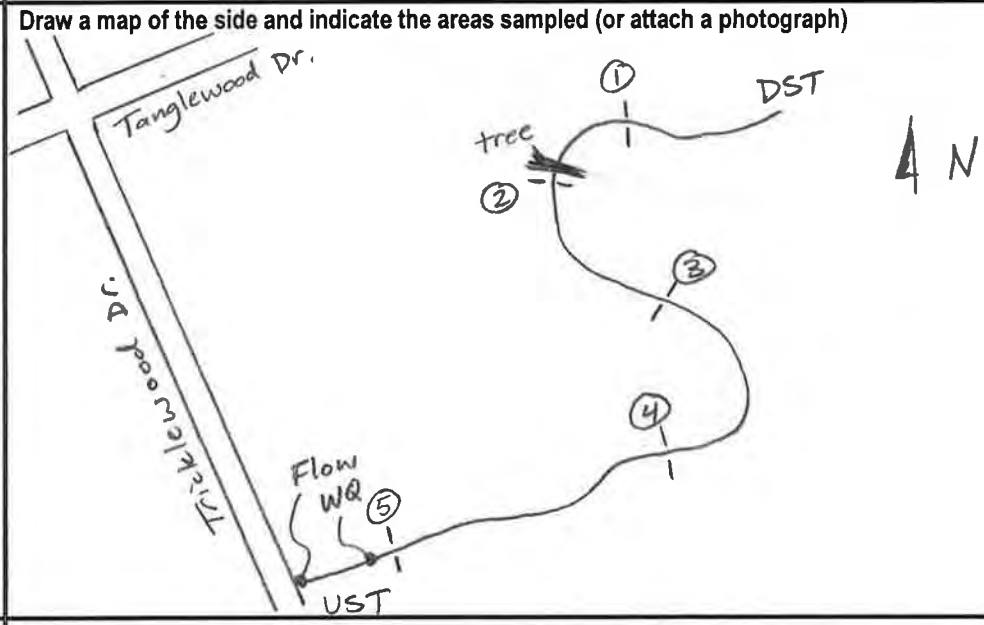
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** -1.0 °C

**Other** 4-6" snowpack

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 135 m<br>**Estimated Stream Width** 4.0 m<br>**Sampling Reach Area** 540 $m^2$<br>**Area in $km^2$ ($m^2$x1000)** _____ $m^2$<br>**Estimated Stream Depth** 0.12 m<br>**Surface Velocity (at thalwag)** 0.41 m/sec<br>**Canopy Cover**<br>☐ Partly open ☒ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 50 % ☐ Run 40 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 38 ~~$m^2$~~ pieces<br>**Density of LWD** 0.070 ~~$m^2/km^2$~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 25 % |
| **WATER QUALITY** | **Temperature** 3.3 °C<br>**Specific Conductance** 999 µS/cm<br>**Dissolved Oxygen** 11.45 mg/L<br>**pH** 7.85<br>**Turbidity** 0.9 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other see note<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other Silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- slight organic odor noted

3

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 15 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 20 | | | |
| Sand | 0.06 – 2mm (gritty) | 30 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 10 | | | |
| Clay | <0.004mm (slick) | 20 | | | |

③

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below Tricklewood Date: 2-12-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 11.0 ft | 1 | 1 | | | | ✓ | 6 | | 26 | 3 | | 3 | 4 | | 30 | |
| | 2 | | | 0 | 2 | | 11 | | 27 | | | 3 | 5 | | 33 | |
| depth 0.45 ft | 3 | | | 0 | 2 | | 14 | | 28 | | | 3 | 4 | | 20 | |
| | 4 | | | | | ✓ | 28 | | 29 | | | 4 | 4 | | 12 | |
| | 5 | | | 4 | 4 | | 21 | | 30 | | | 3 | 4 | | 9 | |
| | 6 | | | 4 | 4 | | 21 | | 31 | 4 | | 3 | 3 | | 16 | width 16.4 ft |
| | 7 | | | 4 | 4 | | 15 | | 32 | | | 3 | 5 | | 32 | |
| | 8 | | | 2 | 3 | | 16 | | 33 | | | | | ✓ | 42 | depth 0.35 ft |
| | 9 | | | 2 | 3 | | 9 | | 34 | | | | | ✓ | 26 | |
| | 10 | | | 3 | 3 | | 25 | | 35 | | | 2 | 4 | | 16 | |
| width 13.3 ft | 11 | 2 | | | | ✓ | 11 | | 36 | | | 4 | 4 | | 4 | |
| | 12 | | | | | ✓ | 14 | | 37 | | | 4 | 5 | | 26 | |
| depth 0.4 ft | 13 | | | | | ✓ | 24 | | 38 | | | 2 | 2* | | 23 | |
| | 14 | | | | | ✓ | 21 | | 39 | | | 3 | 3 | | 14 | |
| | 15 | | | | | ✓ | 9 | | 40 | | | 4 | 2* | | 27 | |
| | 16 | | | 3 | 2 | | 17 | | 41 | 5 | | 3 | 2 | | 7 | width 10.9 ft |
| | 17 | | | 4 | 3 | | 24 | | 42 | | | 3 | 4 | | 12 | |
| | 18 | | | 3 | 3 | | 26 | | 43 | | | 2 | 5 | | 13 | depth 0.5 ft |
| | 19 | | | 2 | 3 | | 19 | | 44 | | | 3 | 2 | | 17 | |
| | 20 | | | 4 | 5 | | 16 | | 45 | | | 3 | 2 | | 19 | |
| width 14.5 ft | 21 | 3 | | 0 | 2 | | 21 | | 46 | | | 2 | 1 | | 9 | |
| | 22 | | | 2 | 2 | | 22 | | 47 | | | 3 | 3 | | 17 | |
| depth 0.25 ft | 23 | | | 4 | 3 | | 17 | | 48 | | | 3 | 2 | | 7 | |
| | 24 | | | 4 | 3 | | 17 | | 49 | | | 3 | 2 | | 21 | |
| | 25 | | | | | ✓ | 39 | | 50 | | | 1 | 2 | | 18 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

2* yes biofilm

Surface Area Sampled = 66.1 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

③ Unnamed Trib below Tricklewood

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 1 | 1×1= 1 | 1 | 1×1= 1 | 0 | 1×0 = 0 |
| 2 | 0 | 0 | 8 | 2×8= 16 | 11 | 2×11= 22 | 12 | 2×12 = 24 |
| 2* (heterotrophic biofilm)[1] | | | | | 2 | 2×2= 4 | | |
| 3 | 0 | 0 | 17 | 3×17= 51 | 11 | 3×11= 33 | 27 | 3×27 = 81 |
| 4 | 0 | 0 | 11 | 4×11= 44 | 10 | 4×10= 40 | 9 | 4×9 = 36 |
| 5 | | | | | 5 | 5×5= 25 | 2 | 5×2 = 10 |
| NA | 10 | | 10 | | 10 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.93 | | 1.0 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{112}{40}$ = 2.80 | | $\frac{125}{40}$ = 3.13 | | $\frac{151}{50}$ = 3.02 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0.70 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{102}{40}$ = 2.55 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{933}{2500}$ = 0.37 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

LimnoTech
Water | Environment | Scientists | Engineers

# MEMORANDUM

DATE: March 27, 2013

FROM: Doug Bradley
Derek Schlea
Chris Cieciek

PROJECT: GRR13

TO: Mr. Thomas R. Ecklund, P.E.
Facilities Management Director
Gerald R. Ford International Airport

CC:

SUBJECT: Gerald R. Ford International Airport (GFIA) March 2013 Biofilm Monitoring Results

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## Summary

The purpose of this memo is to summarize the observations collected during the March 2013 biofilm monitoring survey in the unnamed tributary to the Thornapple River. This is the eleventh biofilm monitoring event conducted as required by Part I.A.7.d. of GFIA's NPDES Permit (MI0055735). The monitoring results and metric calculations are described below.


## General Observations

Heterotrophic biofilm was observed on substrate surfaces sampled during this survey.

## Monitoring Approach

On March 25, 2013, biofilm monitoring was conducted at three locations (sample stations) in the unnamed tributary of the Thornapple River. Stream assessment reaches were established at each of the locations during the first survey (July 2011) using a hand-held global position system (GPS) device. The monitoring locations are at 36th Street, Thornapple River Drive, and Tricklewood Drive and are shown in Figure 1. Consistent with previous surveys, monitoring was conducted using the Stevenson and Rollins 2007 procedure described in the Proposed Biofilm Monitoring Procedure memo submitted to and approved by MDEQ in June 2011 (LimnoTech, June 3, 2011).

At each of the three sample stations, five transects were designated and marked. The transects were selected based on substrate type. Riffles and/or run segments with coarse substrate materials were specifically targeted because they are most appropriate for periphyton and biofilm attachment and provide repeatable and reliable long-term monitoring locations (Stevenson and Rollins, 2007 in *Methods in Stream Ecology*, 2007). Sampling was conducted at 10 equally spaced points on each transect using the rapid periphyton survey method, Basic Method 1 (Stevenson and Rollins, 2007). Measurements were recorded on the field data sheet (Table 1). Physical habitat characterization forms from the EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* were used to record field observations and measurements at each monitoring reach (EPA, 1999).

**Figure 1. Unnamed Tributary Biofilm/Macroinvertebrate Monitoring Locations.**

Community metric calculations include density and distribution estimates for functional categories of moss, macro, and micro (biofilm) algal species. As noted previously, slight modifications necessary to differentiate between microalgae and heterotrophic biofilm were added to the data collection procedure as described below.

1) The Sz column in the Field Data Sheet (Table 1) is intended for inventory of substrate particles >2 cm in size. Since a primary purpose of this monitoring effort is to characterize the presence of biofilm (which is associated with larger size substrates), the Sz column has been modified to instead identify substratum of < 2 cm (where it is not possible to collect community information). The sum of the Sz column observations is transferred to the NA row in Table 3 for extent and magnitude calculations. This modification was discussed with Stevenson and Rollins (personal communication with Doug Bradley, LimnoTech) and the authors stated that this modification is appropriate for the purpose of this monitoring effort.

2) The Algal Cover and Thickness Class Description (Table 2) include estimated cover classes for moss and macroalgae but not microalgae. The purpose of the monitoring was discussed with the procedure authors and it was suggested by Stevenson that including cover class for microalgae would provide estimated cover and thickness values that will improve the applicability of the procedure for tracking the status of the heterotrophic biofilm community. This component of the protocol was expanded for this monitoring event by adding a column (Table 2) to quantify the number of grid points counted over microalgae at 10 equally spaced points on each transect using a viewing bucket (EPA, 1999) with a 50-dot grid. The grid is used as a quantifiable and repeatable means for measuring distribution and density of biofilm across transects.

3) The calculations for the extent and magnitude of moss, and benthic algal cover (Table 3) include a row named NA. Following clarification from the authors, NA includes the points not sampled because no substrate particle >2 cm was present.

4) The microalgae functional class includes heterotrophic biofilm. The dominance of non-nuisance biofilm microalgae observed during the July and September field visits highlights the need to identify and calculate heterotrophic-specific biofilm observations as well as the other forms of microalgae. The calculation table (Table 3) used for the biofilm monitoring events beginning with the September 2011 event was expanded to quantify the extent and magnitude of biofilm-specific observations, and to estimate the cover of all microalgae as measured with the viewing bucket.

5) The microalgae thickness Class 2 of 0.5 to 1 mm is a transition category between non-visible (thin slimy layer) and visible microalgae (Stevenson and Bahls 1999). The category may misrepresent the presence of heterotrophic biofilm because the study approach prior to July 2012 grouped naturally occurring microalgae (diatoms and bluegreens) with heterotrophic biofilm in Class 2. Beginning with the September 2012 sampling event, we modified the Class 2 calculations to differentiate autotrophic/photosynthetic microalgae from heterotrophic biofilm in the extent and magnitude microalgae metrics (Table 3). Other calculations remain unchanged.

The information being collected and calculations being performed are consistent with the procedures described in the monitoring plan. The additional calculations provide added information on the biofilm community. The metrics will continue to be calculated consistently to support the evaluation of relative changes in the biofilm community.

Monitoring Summary

Site 1 36th Street – The site is approximately 75 meters long and average channel width was approximately 2.4 meters. Maximum stream velocity was measured at 0.12 m/sec. The site includes a mix of natural and re-establishing riparian vegetation, and channel re-alignment from the 36th Street road work conducted in 2006. The channel substrate is generally coarse with patches of fine sediment deposits. Heterotrophic biofilm was present at all transects sampled and an organic odor was noted.

Site 2 Thornapple River Drive – The site is approximately 350 meters long and average channel width was approximately 3.2 meters. Maximum stream velocity was measured at 0.19 m/sec. This reach is longer than Sites 1 and 3 because of the limited amount of suitable coarse substrate upon which to locate survey transects. The site is densely vegetated along the banks and in the immediate riparian area. Evidence of bed material movement, bank erosion and deposition is present throughout the reach. Heterotrophic biofilm was present at all transects sampled. The majority of heterotrophic biofilm was attached to woody debris and coarse substrate and found less frequently on the sand substrate that dominates the reach. An organic odor was noted.

Site 3 Tricklewood Drive – The site is approximately 135 meters long and average channel width was approximately 3.6 meters. Maximum stream velocity was measured at 0.09 m/sec. The northern banks of the site are more closely bound by residences than the other sites yet retain thick overhead cover but thin understory. The reach is characterized by a slightly higher gradient than Site 2 and contains a greater dominance of coarser substrates along with an outcrop of exposed hardpan clay. Heterotrophic biofilm was present at all transects sampled and a faint organic odor was noted.

The field sheets and metric calculations are included as Attachment 1.

## References

D. Bradley, LimnoTech. July 2011. Personal communication with J. Stevenson and S. Rollins.

MDEQ (Michigan Department of Environmental Quality). 2008. Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers. Water Bureau Policy and Procedures, WB-SWAS-051 (SWAS Procedure 51), revised December 2008.

Stevenson, R. J., and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in M. T. Barbour,J. Gerritsen, and B. D. Snyder (Eds.) Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. U. S. Environmental Protection Agency, Washington, D.C.

Stevenson, R.J. and S.L. Rollins. 2007. Ecological assessments with benthic algae. Pages 785-803 in F.R. Hauer and G.A. Lamberti (Eds.) Methods in Stream Ecology. Second edition, Academic Press, Burlington, MA.

**Attachment 1**
GFIA Biofilm Monitoring Field Sheets
March 25, 2013

①

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib at 36th St. | LOCATION Upstream 36th St. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |

| | | |
|---|---|---|
| FORM COMPLETED BY D. Schlea | DATE 3-25-13<br>TIME 9:55 AM<br>PM ~11:05 | REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 100% ☒ | % cloud cover | ☒ % |
| ☐ | Clear/sunny | ☐ |

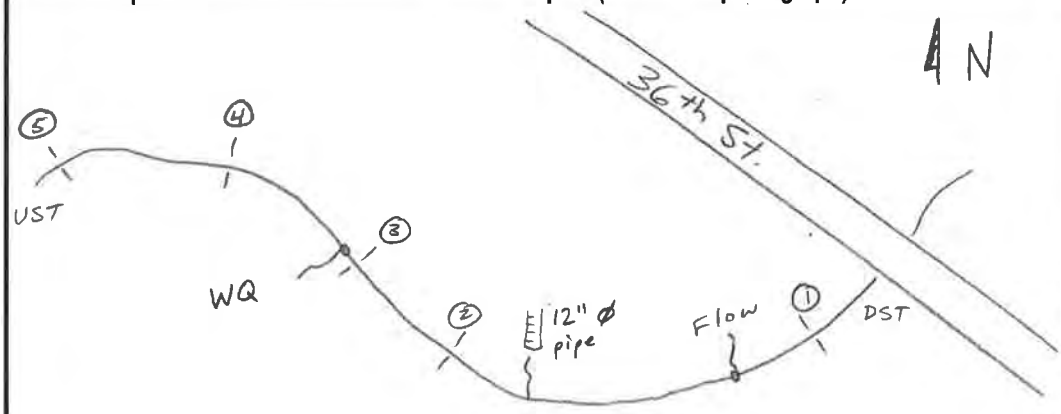
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 1 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

①

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☒ Other Road<br>☐ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☐ Trees ☒ Shrubs ☒ Grasses ☒ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 75 m<br>**Estimated Stream Width** 2.3 m<br>**Sampling Reach Area** 173 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.10 m<br>**Surface Velocity (at thalwag)** 0.12 m/sec<br>**Canopy Cover**<br>☒ Partly open ☐ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 35 % ☐ Run 50 %<br>☐ Pool 15 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 8 ~~m²~~ pieces<br>**Density of LWD** 0.046 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 20 % |
| **WATER QUALITY** | **Temperature** 2.72 °C<br>**Specific Conductance** 904 µS/cm<br>**Dissolved Oxygen** 12.08 mg/L<br>**pH** 8.07<br>**Turbidity** 8.4 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other See note<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☒ Other silt<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Organic odor noted
- Heterotrophic biofilm observed throughout reach

1

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 35 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 35 | | | |
| Sand | 0.06 – 2mm (gritty) | 20 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | — | | | |

①

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib at 36th St. Date: 3-25-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 6.1 ft | 1 | 1 | | | 4 | | 41 | | 26 | 3 | | | 4 | | 31 | |
| | 2 | 1 | | 2 | 4 | | 46 | | 27 | 1 | | | 4 | | 36 | |
| depth 0.3 ft | 3 | 1 | | | 4 | | 46 | | 28 | 1 | | | 5 | | 40 | |
| | 4 | 1 | | | | ✓ | 42 | | 29 | 1 | | | 2 | | 39 | |
| | 5 | 1 | | | 4 | | 47 | | 30 | ↓ | | | 5 | | 39 | |
| | 6 | 1 | | 2 | 4 | | 48 | | 31 | 4 | – | – | – | | 13 | width 5.2 ft |
| | 7 | 1 | | 3 | 4 | | 49 | | 32 | 1 | | 4 | 2 | | 31 | |
| | 8 | 1 | | | 3 | | 36 | | 33 | 1 | | | 3 | | 41 | depth 0.3 ft |
| | 9 | 1 | | 3 | 4 | | 42 | | 34 | 1 | | | 5 | | 38 | |
| | 10 | ↓ | | | 4 | | 28 | | 35 | 1 | | | 5 | | 35 | |
| width 5.0 ft | 11 | 2 | | 2 | 2 | | 40 | | 36 | 1 | | | 4 | | 39 | |
| | 12 | 1 | | | 1 | | 36 | | 37 | 1 | | | 4 | | 32 | |
| depth 0.3 ft | 13 | 1 | | | 2 | | 42 | | 38 | 1 | | | 5 | | 36 | |
| | 14 | 1 | | | 4 | | 17 | | 39 | 1 | | 3 | 5 | | 40 | |
| | 15 | 1 | | 2 | 5 | | 41 | | 40 | ↓ | | | 4 | | 34 | |
| | 16 | 1 | | | 2 | | 49 | | 41 | 5 | | | 2 | | 3 | width 15.5 ft |
| | 17 | 1 | | | 5 | | 29 | | 42 | 1 | | | 2 | | 17 | |
| | 18 | 1 | | 2 | 4 | | 39 | | 43 | 1 | | | 2 | | 8 | depth 0.5 ft |
| | 19 | 1 | | | 2 | | 35 | | 44 | 1 | | | 1 | | 29 | |
| | 20 | ↓ | | | 2 | | 37 | | 45 | 1 | | | 4 | | 37 | |
| width 6.0 ft | 21 | 3 | | | 4 | | 41 | | 46 | 1 | | | 4 | | 33 | |
| | 22 | 1 | | | 5 | | 42 | | 47 | 1 | | | 5 | | 42 | |
| depth 0.3 ft | 23 | 1 | | | 4 | | 39 | | 48 | 1 | | 2 | 4 | | 29 | |
| | 24 | 1 | | | 5 | | 33 | | 49 | 1 | | | 4 | | 26 | |
| | 25 | ↓ | | | 3 | | 36 | | 50 | ↓ | | | 5 | | 18 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 37.8 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

① Unnamed Trib at 36th Street

**Table 2. Algae and Moss Cover and Thickness Class Descriptions. Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover. Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 2 | 1 × 2 = 2 | 0 | 0 |
| 2 | 0 | 0 | 6 | 2 × 6 = 12 | 10 | 2 × 10 = 20 | 2 | 2 × 2 = 4 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 3 | 3 × 3 = 9 | 3 | 3 × 3 = 9 | 4 | 3 × 4 = 12 |
| 4 | 0 | 0 | 1 | 4 × 1 = 4 | 21 | 4 × 21 = 84 | 20 | 4 × 20 = 80 |
| 5 | | | | | 12 | 5 × 12 = 60 | 24 | 5 × 24 = 120 |
| NA | 1 | | 1 | | 1 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.20 | | 0.98 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{25}{49}$ = 0.51 | | $\frac{175}{49}$ = 3.57 | | $\frac{216}{50}$ = 4.32 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0.73 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{153}{49}$ = 3.12 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{1747}{2500}$ = 0.70 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below TRD | LOCATION Downstream Thornapple River Dr. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |

| FORM COMPLETED BY | DATE 3-25-13 | REASON FOR SURVEY |
|---|---|---|
| D. Schlea | TIME 11:30 AM<br>PM -12:55 | GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 100% ☒ | % cloud cover | ☒ ___% |
| ☐ | Clear/sunny | ☐ |

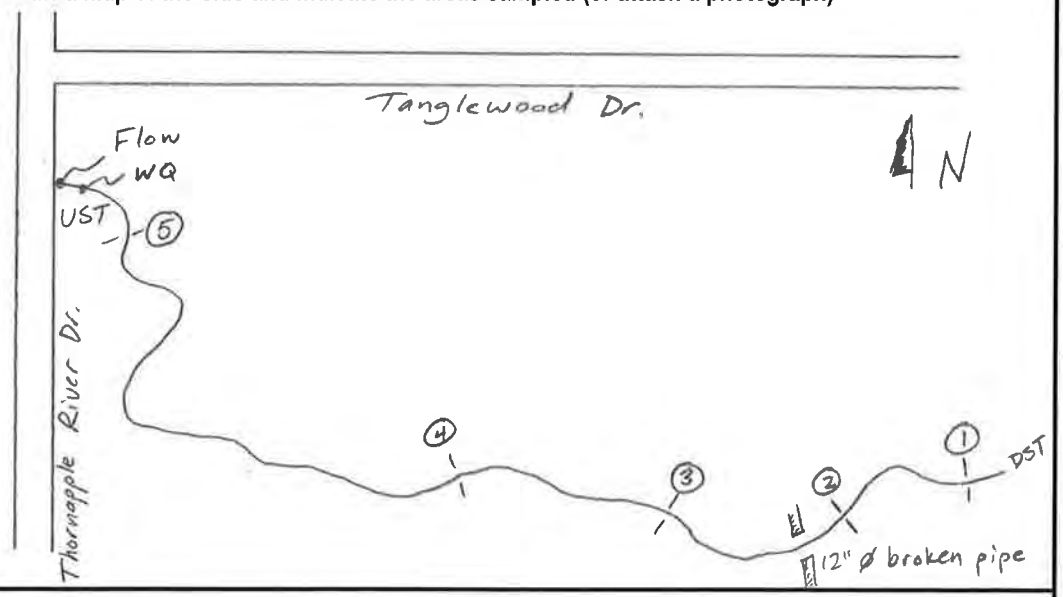
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 2 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☐ Moderate ☒ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 350 m<br>**Estimated Stream Width** 3.2 m<br>**Sampling Reach Area** 1120 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.13 m<br>**Surface Velocity (at thalwag)** 0.19 m/sec<br>**Canopy Cover**<br>☐ Partly open ☐ Partly shaded ☒ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 10 % ☐ Run 60 %<br>☐ Pool 30 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 218 ~~m²~~ pieces<br>**Density of LWD** 0.195 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 10 % |
| **WATER QUALITY** | **Temperature** 4.37 °C<br>**Specific Conductance** 972 µS/cm<br>**Dissolved Oxygen** 10.49 mg/L<br>**pH** 7.84<br>**Turbidity** 1.5 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other See Note<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☐ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☐ Other _____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- organic odor noted
- Heterotrophic biofilm observed throughout reach

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 30 |
| Boulder | >256mm (10") | – | | | |
| Cobble | 64-256mm (2.5" – 10") | 5 | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 5 | | | |
| Sand | 0.06 – 2mm (gritty) | 80 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 10 | | | |
| Clay | <0.004mm (slick) | – | | | |

②

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below TRD Date: 3-25-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 13.5 ft | 1 | 1 | | | | ✓ | 11 | | 26 | 3 | | | | ✓ | 11 | |
| | 2 | | | | | ✓ | 7 | | 27 | | | | 4 | | 42 | |
| depth 0.4 ft | 3 | | | | | ✓ | 5 | | 28 | | | | 5 | | 32 | |
| | 4 | | | | | ✓ | 26 | | 29 | | | | 5 | | 21 | |
| | 5 | | | | | ✓ | 22 | | 30 | | | | 5 | | 25 | |
| | 6 | | | | | ✓ | 9 | | 31 | 4 | | | | ✓ | 26 | width 8.6 ft |
| | 7 | | | | | ✓ | 18 | | 32 | | | | | ✓ | 37 | |
| | 8 | | | | | ✓ | 31 | | 33 | | | | 5 | | 46 | depth 0.5 ft |
| | 9 | | | | | ✓ | 28 | | 34 | | | | | ✓ | 44 | |
| | 10 | | | | 4 | | 46 | | 35 | | | | | ✓ | 40 | |
| width 11.7 ft | 11 | 2 | | | | ✓ | 48 | | 36 | | | | 5 | | 46 | |
| | 12 | | | | 5 | | 49 | | 37 | | | | 4 | | 45 | |
| depth 0.35 ft | 13 | | | | 5 | | 41 | | 38 | | | | | ✓ | 44 | |
| | 14 | | | | 5 | | 35 | | 39 | | | | 4 | | 37 | |
| | 15 | | | | 5 | | 43 | | 40 | | | 3 | 4 | | 37 | |
| | 16 | | | | | ✓ | 41 | | 41 | 5 | | 4 | 5 | | 36 | width 7.6 ft |
| | 17 | | | | | ✓ | 35 | | 42 | | | 3 | 5 | | 39 | |
| | 18 | | | | 5 | | 13 | | 43 | | | | 5 | | 42 | depth 0.4 ft |
| | 19 | | | | 5 | | 43 | | 44 | | | | | ✓ | 39 | |
| | 20 | | | | 3 | | 18 | | 45 | | | | 3 | | 45 | |
| width 11.5 ft | 21 | 3 | | | | ✓ | 16 | | 46 | | | | 3 | | 38 | |
| | 22 | | | | | ✓ | 40 | | 47 | | | | 4 | | 46 | |
| depth 0.5 ft | 23 | | | | 5 | | 48 | | 48 | | | | | ✓ | 37 | |
| | 24 | | | | 5 | | 6 | | 49 | | | | 5 | | 46 | |
| | 25 | | | | | ✓ | 12 | | 50 | | | | 5 | | 48 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 52.9 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

② Unnamed Trib below TRD

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 2×7 = 14 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 2 | 3×2 = 6 | 3 | 3×3 = 9 | 6 | 3×6 = 18 |
| 4 | 0 | 0 | 1 | 4×1 = 4 | 6 | 4×6 = 24 | 13 | 4×13 = 52 |
| 5 | | | | | 18 | 5×18 = 90 | 24 | 5×24 = 120 |
| NA | 23 | | 23 | | 23 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.11 | | 1.00 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{10}{27}$ = 0.37 | | $\frac{123}{27}$ = 4.56 | | $\frac{204}{50}$ = 4.08 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 1.00 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{123}{27}$ = 4.56 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{1640}{2500}$ = 0.66 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below Tricklewood | LOCATION Downstream Tricklewood Dr. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley Derek Schlea / LimnoTech | |

| | | |
|---|---|---|
| FORM COMPLETED BY D. Schlea | DATE 3-25-13<br>TIME 13:20 AM<br>PM - 14:20 | REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 100% ☒ | % cloud cover | ☒ % |
| ☐ | Clear/sunny | ☐ |

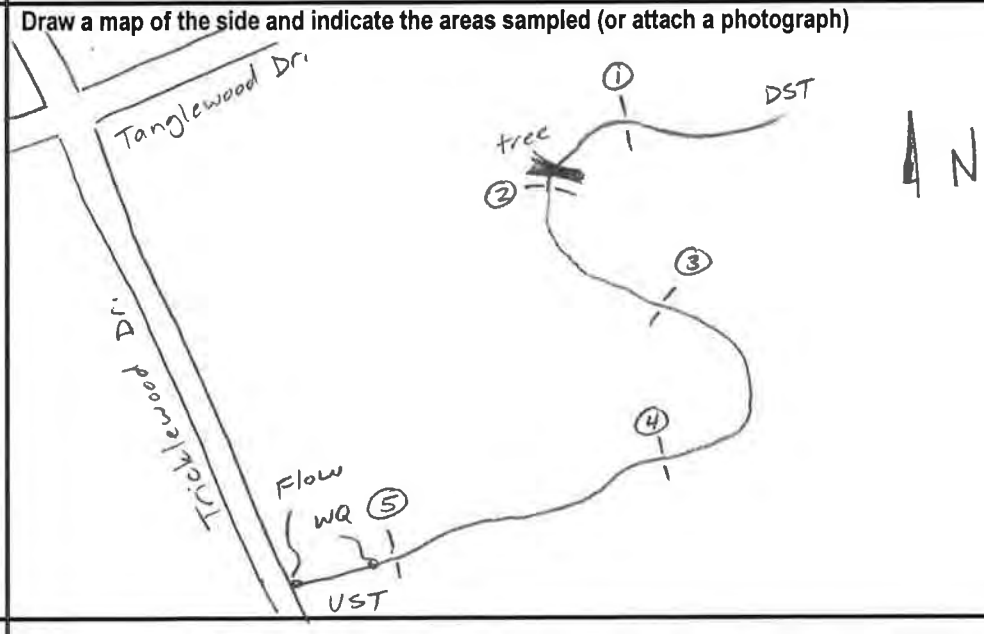
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 3 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 135 m<br>**Estimated Stream Width** 3.6 m<br>**Sampling Reach Area** 486 $m^2$<br>**Area in $km^2$ ($m^2$x1000)** _____ $m^2$<br>**Estimated Stream Depth** 0.09 m<br>**Surface Velocity** 0.15 m/sec (at thalwag)<br>**Canopy Cover**<br>☐ Partly open ☒ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 50 % ☐ Run 40 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 24 ~~$m^2$~~ pieces<br>**Density of LWD** 0.049 ~~$m^2/km^2$~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 20 % |
| **WATER QUALITY** | **Temperature** 5.23 °C<br>**Specific Conductance** 1077 µS/cm<br>**Dissolved Oxygen** 10.58 mg/L<br>**pH** 7.87<br>**Turbidity** 1.4 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other See note<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand<br>☐ Relict Shells ☐ Other _____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Slight organic odor observed
- Heterotrophic biofilm observed throughout reach

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 20 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 20 | | | |
| Sand | 0.06 – 2mm (gritty) | 25 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 10 | | | |
| Clay | <0.004mm (slick) | 20 | | | |

③

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below Tricklewood Date: 3-25-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 9.8 ft | 1 | 1 | | 3 | 5 | | 34 | | 26 | 3 | | 3 | 5 | | 36 | |
| | 2 | | | | 5 | | 39 | | 27 | | | | 5 | | 18 | |
| depth 0.3 ft | 3 | | | 4 | 5 | | 44 | | 28 | | | 3 | 4 | | 46 | |
| | 4 | | | | 5 | | 41 | | 29 | | | | 4 | | 39 | |
| | 5 | | | 3 | 5 | | 46 | | 30 | | | | 5 | | 41 | |
| | 6 | | | 3 | 5 | | 40 | | 31 | 4 | | 2 | 3 | | 36 | width 16.0 ft |
| | 7 | | | 4 | 5 | | 47 | | 32 | | | | | ✓ | 41 | |
| | 8 | | | | 5 | | 39 | | 33 | | | 4 | 5 | | 50 | depth 0.2 ft |
| | 9 | | | 3 | 5 | | 34 | | 34 | | | 4 | 5 | | 44 | |
| | 10 | | | | 5 | | 38 | | 35 | | | | 5 | | 50 | |
| width 13.1 ft | 11 | 2 | | 4 | 5 | | 35 | | 36 | | | 4 | 5 | | 50 | |
| | 12 | | | 4 | 5 | | 43 | | 37 | | | | 5 | | 41 | |
| depth 0.3 ft | 13 | | | | 5 | | 49 | | 38 | | | | 5 | | 46 | |
| | 14 | | | | | ✓ | 37 | | 39 | | | 3 | 5 | | 31 | |
| | 15 | | | 4 | 5 | | 48 | | 40 | | | | 5 | | 44 | |
| | 16 | | | | 5 | | 42 | | 41 | 5 | | 4 | 5 | | 46 | width 9.6 ft |
| | 17 | | | | 5 | | 41 | | 42 | | | 2 | 5 | | 39 | |
| | 18 | | | | 5 | | 47 | | 43 | | | 4 | 5 | | 41 | depth 0.5 ft |
| | 19 | | | | 5 | | 44 | | 44 | | | 4 | 5 | | 42 | |
| | 20 | | | | | ✓ | 46 | | 45 | | | | 5 | | 43 | |
| width 10.8 ft | 21 | 3 | | 4 | 4 | | 50 | | 46 | | | 2 | 5 | | 43 | |
| | 22 | | | 3 | 4 | | 42 | | 47 | | | 4 | 5 | | 44 | |
| depth 0.2 ft | 23 | | | 3 | 5 | | 38 | | 48 | | | 2 | 5 | | 43 | |
| | 24 | | | | 5 | | 36 | | 49 | | | 4 | 5 | | 48 | |
| | 25 | | | | 5 | | 22 | | 50 | | | 2 | 5 | | 39 | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 59.3 ft²
Substrata Sampled: (circle) rock/wood/plant sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

③ Unnamed Trib below Tricklewood Dr.

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2 | 0 | 0 | 5 | 2×5 = 10 | 0 | 0 | 0 | |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 9 | 3×9 = 27 | 1 | 3×1 = 3 | 2 | 3×2 = 6 |
| 4 | 0 | 0 | 14 | 4×14 = 56 | 4 | 4×4 = 16 | 8 | 4×8 = 32 |
| 5 | | | | | 42 | 5×42 = 210 | 40 | 5×40 = 200 |
| NA | 3 | | 3 | | 3 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.60 | | 1.00 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{93}{47}$ = 1.98 | | $\frac{229}{47}$ = 4.87 | | $\frac{238}{50}$ = 4.76 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 1.00 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{229}{47}$ = 4.87 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{2063}{2500}$ = 0.83 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

LimnoTech
Water | Environment | Scientists | Engineers

# MEMORANDUM

DATE: May 9, 2013

FROM: Doug Bradley
Derek Schlea
Chris Cieciek

PROJECT: GRR13

TO: Mr. Thomas R. Ecklund, P.E.
Facilities Management Director
Gerald R. Ford International Airport

CC:

SUBJECT: Gerald R. Ford International Airport (GFIA) May 2013 Biofilm Monitoring Results

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## Summary

The purpose of this memo is to summarize the observations collected during the May 2013 biofilm monitoring survey in the unnamed tributary to the Thornapple River. This is the twelfth biofilm monitoring event conducted as required by Part I.A.7.d. of GFIA's NPDES Permit (MI0055735). The monitoring results and metric calculations are described below.


## General Observations

Heterotrophic biofilm was observed on substrate surfaces sampled during this survey.

## Monitoring Approach

On May 8, 2013, biofilm monitoring was conducted at three locations (sample stations) in the unnamed tributary of the Thornapple River. Stream assessment reaches were established at each of the locations during the first survey (July 2011) using a hand-held global position system (GPS) device. The monitoring locations are at 36th Street, Thornapple River Drive, and Tricklewood Drive and are shown in Figure 1. Consistent with previous surveys, monitoring was conducted using the Stevenson and Rollins 2007 procedure described in the Proposed Biofilm Monitoring Procedure memo submitted to and approved by MDEQ in June 2011 (LimnoTech, June 3, 2011).

At each of the three sample stations, five transects were designated and marked. The transects were selected based on substrate type. Riffles and/or run segments with coarse substrate materials were specifically targeted because they are most appropriate for periphyton and biofilm attachment and provide repeatable and reliable long-term monitoring locations (Stevenson and Rollins, 2007 in *Methods in Stream Ecology*, 2007). Sampling was conducted at 10 equally spaced points on each transect using the rapid periphyton survey method, Basic Method 1 (Stevenson and Rollins, 2007). Measurements were recorded on the field data sheet (Table 1). Physical habitat characterization forms from the EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* were used to record field observations and measurements at each monitoring reach (EPA, 1999).

**Figure 1. Unnamed Tributary Biofilm/Macroinvertebrate Monitoring Locations.**

Community metric calculations include density and distribution estimates for functional categories of moss, macro, and micro (biofilm) algal species. As noted previously, slight modifications necessary to differentiate between microalgae and heterotrophic biofilm were added to the data collection procedure as described below.

1) The Sz column in the Field Data Sheet (Table 1) is intended for inventory of substrate particles >2 cm in size. Since a primary purpose of this monitoring effort is to characterize the presence of biofilm (which is associated with larger size substrates), the Sz column has been modified to instead identify substratum of < 2 cm (where it is not possible to collect community information). The sum of the Sz column observations is transferred to the NA row in Table 3 for extent and magnitude calculations. This modification was discussed with Stevenson and Rollins (personal communication with Doug Bradley, LimnoTech) and the authors stated that this modification is appropriate for the purpose of this monitoring effort.

2) The Algal Cover and Thickness Class Description (Table 2) include estimated cover classes for moss and macroalgae but not microalgae. The purpose of the monitoring was discussed with the procedure authors and it was suggested by Stevenson that including cover class for microalgae would provide estimated cover and thickness values that will improve the applicability of the procedure for tracking the status of the heterotrophic biofilm community. This component of the protocol was expanded for this monitoring event by adding a column (Table 2) to quantify the number of grid points counted over microalgae at 10 equally spaced points on each transect using a viewing bucket (EPA, 1999) with a 50-dot grid. The grid is used as a quantifiable and repeatable means for measuring distribution and density of biofilm across transects.

3) The calculations for the extent and magnitude of moss, and benthic algal cover (Table 3) include a row named NA. Following clarification from the authors, NA includes the points not sampled because no substrate particle >2 cm was present.

4) The microalgae functional class includes heterotrophic biofilm. The dominance of non-nuisance biofilm microalgae observed during the July and September field visits highlights the need to identify and calculate heterotrophic-specific biofilm observations as well as the other forms of microalgae. The calculation table (Table 3) used for the biofilm monitoring events beginning with the September 2011 event was expanded to quantify the extent and magnitude of biofilm-specific observations, and to estimate the cover of all microalgae as measured with the viewing bucket.

5) The microalgae thickness Class 2 of 0.5 to 1 mm is a transition category between non-visible (thin slimy layer) and visible microalgae (Stevenson and Bahls 1999). The category may misrepresent the presence of heterotrophic biofilm because the study approach prior to July 2012 grouped naturally occurring microalgae (diatoms and bluegreens) with heterotrophic biofilm in Class 2. Beginning with the September 2012 sampling event, we modified the Class 2 calculations to differentiate autotrophic/photosynthetic microalgae from heterotrophic biofilm in the extent and magnitude microalgae metrics (Table 3). Other calculations remain unchanged.

The information being collected and calculations being performed are consistent with the procedures described in the monitoring plan. The additional calculations provide added information on the biofilm community. The metrics will continue to be calculated consistently to support the evaluation of relative changes in the biofilm community.

Monitoring Summary

Site 1 36th Street – The site is approximately 75 meters long and average channel width was approximately 2.3 meters. Maximum stream velocity was measured at 0.15 m/sec. The site includes a mix of natural and re-establishing riparian vegetation, and channel re-alignment from the 36th Street road work conducted in 2006. The channel substrate is generally coarse with patches of fine sediment deposits. Evidence of active channel conditions was observed[1]. Heterotrophic biofilm was present at all transects sampled and an organic odor was noted.

Site 2 Thornapple River Drive – The site is approximately 350 meters long and average channel width was approximately 3.2 meters. Maximum stream velocity was measured at 0.18 m/sec. This reach is longer than Sites 1 and 3 because of the limited amount of suitable coarse substrate upon which to locate survey transects. The site is densely vegetated along the banks and in the immediate riparian area. Evidence of channel shape modification, bed material movement, bank erosion and deposition is present throughout the reach. Heterotrophic biofilm was present at all transects sampled. The density and distribution of heterotrophic biofilm had increased relative to the previous survey.

Site 3 Tricklewood Drive – The site is approximately 135 meters long and average channel width was approximately 4.0 meters. Maximum stream velocity was measured at 0.14 m/sec. The northern banks of the site are more closely bound by residences than the other sites yet retain thick overhead cover but thin understory. The reach is characterized by a slightly higher gradient than Site 2 and contains a greater dominance of coarser substrates along with an outcrop of exposed hardpan clay. Localized evidence of active channel conditions was

[1] A significant high flow period occurred in mid-April when approximately 5.5 inches of precipitation was recorded at the airport from the 15th to the 18th. Overall, the 11.10 inches of precipitation during the month made April 2013 the wettest April on record (according to the National Weather Service).

observed. Heterotrophic biofilm was present at all transects sampled. The density and distribution of heterotrophic biofilm had increased relative to the previous survey.

The field sheets and metric calculations are included as Attachment 1.

## References

D. Bradley, LimnoTech. July 2011. Personal communication with J. Stevenson and S. Rollins.

MDEQ (Michigan Department of Environmental Quality). 2008. Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers. Water Bureau Policy and Procedures, WB-SWAS-051 (SWAS Procedure 51), revised December 2008.

Stevenson, R. J., and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in M. T. Barbour,J. Gerritsen, and B. D. Snyder (Eds.) Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. U. S. Environmental Protection Agency, Washington, D.C.

Stevenson, R.J. and S.L. Rollins. 2007. Ecological assessments with benthic algae. Pages 785-803 in F.R. Hauer and G.A. Lamberti (Eds.) Methods in Stream Ecology. Second edition, Academic Press, Burlington, MA.

**Attachment 1**
GFIA Biofilm Monitoring Field Sheets
May 8, 2013

(1)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | | |
|---|---|---|
| STREAM NAME Unnamed Trib at 36th St. | LOCATION Upstream 36th St. | |
| STATION # _____ RIVERMILE _____ | STREAM CLASS | |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River | |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech | |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | | |
| FORM COMPLETED BY D. Schlea | DATE 5-8-13<br>TIME 9:25 AM<br>PM -11:00 | REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| % ☐ | % cloud cover | ☒ % |
| ☒ | Clear/sunny | ☒ |

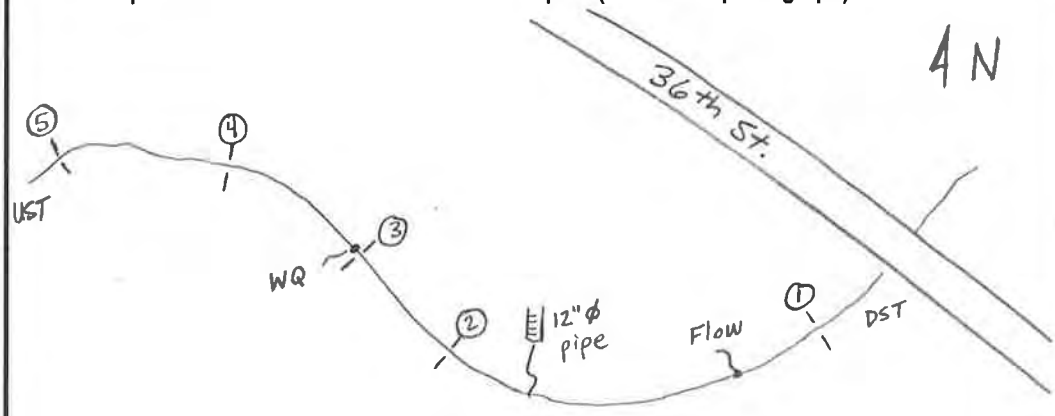
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 22 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

(1)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☒ Other Road<br>☐ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☐ Trees ☒ Shrubs ☒ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 75 m<br>**Estimated Stream Width** 2.3 m<br>**Sampling Reach Area** 173 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.13 m<br>**Surface Velocity (at thalwag)** 0.15 m/sec<br>**Canopy Cover**<br>☒ Partly open ☐ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 40 % ☐ Run 50 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 5 ~~m²~~ pieces<br>**Density of LWD** 0.029 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 5 % |
| **WATER QUALITY** | **Temperature** 9.33 °C<br>**Specific Conductance** 820 µS/cm<br>**Dissolved Oxygen** 9.67 mg/L<br>**pH** 7.96<br>**Turbidity** 9.4 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☐ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☒ Other See Note<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand<br>☐ Relict Shells ☐ Other _____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Significant flood event occured in mid-April 2013 (~5.5" rain 4/15-4/18)
- Organic odor noted
- Slight turbidity
- Thin layer of recently deposited clay/silt observed
- Biofilm present throughout survey site
- Evidence of active channel conditions (locally eroded banks, gravel bar expansion, and pool elongation) observed
- Channel conditions at transects 3 and 5 have changed relative to past surveys

1

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 35 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 35 | | | |
| Sand | 0.06 – 2mm (gritty) | 20 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | — | | | |

①

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib at 36th St. Date: 5-8-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 6.0 ft | 1 | 1 | | | 4 | | 36 | | 26 | 3 | | | 4 | | 11 | |
| | 2 | | | | 5 | | 29 | | 27 | | | | 2 | | 7 | |
| depth 0.25 ft | 3 | | | | 5 | | 32 | | 28 | | | | | ✓ | 13 | |
| | 4 | | | | 5 | | 27 | | 29 | | | | | ✓ | 9 | |
| | 5 | | | | 5 | | 38 | | 30 | | | | | ✓ | 23 | |
| | 6 | | | | 4 | | 30 | | 31 | 4 | | | 3 | | 29 | width 4.7 ft |
| | 7 | | | | 4 | | 35 | | 32 | | | | | ✓ | 16 | |
| | 8 | | | | 4 | | 32 | | 33 | | | | 2 | | 26 | depth 0.25 ft |
| | 9 | | | | 4 | | 16 | | 34 | | | | 4 | | 37 | |
| | 10 | | | | 3 | | 9 | | 35 | | | | 3 | | 39 | |
| width 6.3 ft | 11 | 2 | | | 3 | | 38 | | 36 | | | | 4 | | 29 | |
| | 12 | | | | 4 | | 41 | | 37 | | | | 4 | | 11 | |
| depth 0.15 ft | 13 | | | | 5 | | 30 | | 38 | | | | 5 | | 31 | |
| | 14 | | | | 5 | | 41 | | 39 | | | | 4 | | 19 | |
| | 15 | | | | 4 | | 26 | | 40 | | | | 4 | | 22 | |
| | 16 | | | | 3 | | 16 | | 41 | 5 | | | | ✓ | 16 | width 14.5 ft |
| | 17 | | | | 3 | | 13 | | 42 | | | | 1 | | 36 | |
| | 18 | | | | | ✓ | 29 | | 43 | | | | 4 | | 29 | depth 0.7 ft |
| | 19 | | | | 2 | | 21 | | 44 | | | | 2 | | 26 | |
| | 20 | | | | 4 | | 31 | | 45 | | | | 3 | | 16 | |
| width 6.5 ft | 21 | 3 | | | 2* | | 16 | | 46 | | | | | ✓ | 22 | |
| | 22 | | | | 2 | | 11 | | 47 | | | | 2 | | 11 | |
| depth 0.8 ft | 23 | | | | 4 | | 15 | | 48 | | | | 4 | | 11 | |
| | 24 | | | | | ✓ | 9 | | 49 | | | | | ✓ | 14 | |
| | 25 | | | | | ✓ | 7 | | 50 | | | | 2 | | 7 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 38.0 $ft^2$
Substrata Sampled: (circle) rock/wood/plant sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

① Unnamed Trib at 36th Street

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 × 1 = 1 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 7 | 2 × 7 = 14 | 11 | 2 × 11 = 22 |
| 2* (heterotrophic biofilm)[1] | | | | | 1 | 2 × 1 = 2 | | |
| 3 | 0 | 0 | 0 | 0 | 7 | 3 × 7 = 21 | 15 | 3 × 15 = 45 |
| 4 | 0 | 0 | 0 | 0 | 17 | 4 × 17 = 68 | 19 | 4 × 19 = 76 |
| 5 | | | | | 7 | 5 × 7 = 35 | 5 | 5 × 5 = 25 |
| NA | 10 | | 10 | | 10 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0 | | 1.00 | | | |
| Sum ÷ (50 – NA) | | 0 | | 0 | | $\frac{141}{40}$ = 3.53 | | $\frac{168}{50}$ = 3.36 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0.80 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{126}{40}$ = 3.15 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{1138}{2500}$ = 0.46 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below TRD | LOCATION Downstream Thornapple River Dr. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| ~~STORET#~~ AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |

| FORM COMPLETED BY | DATE | REASON FOR SURVEY |
|---|---|---|
| D. Schlea | DATE 5-8-13<br>TIME 11:30 AM<br>PM – 12:45 | GFIA BioFilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| % ☐ | % cloud cover | ☒ % |
| ☒ | Clear/sunny | ☒ |

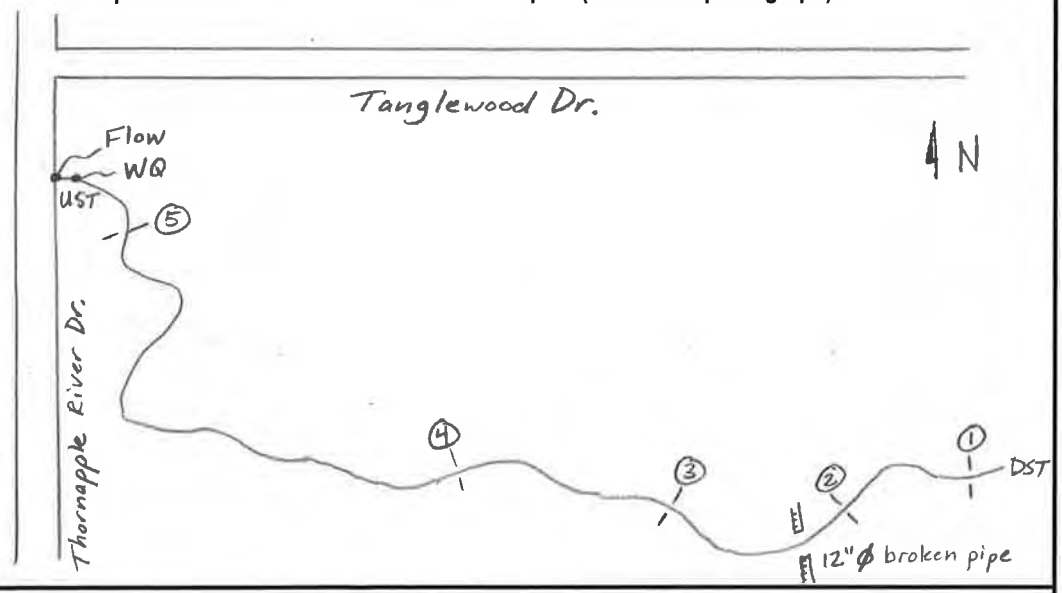
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 24 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☐ Moderate ☒ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 350 m<br>**Estimated Stream Width** 3.2 m<br>**Sampling Reach Area** 1120 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.17 m<br>**Surface Velocity (at thalwag)** 0.18 m/sec<br>**Canopy Cover**<br>☐ Partly open ☐ Partly shaded ☒ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 10 % ☐ Run 60 %<br>☐ Pool 30 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 230 ~~m²~~ pieces<br>**Density of LWD** 0.205 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 5 % |
| **WATER QUALITY** | **Temperature** 12.66 °C<br>**Specific Conductance** 852 µS/cm<br>**Dissolved Oxygen** 5.34 mg/L<br>**pH** 7.72<br>**Turbidity** 1.2 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☐ Other _____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Significant flood event occurred in mid-April 2013 (~5.5" rain 4/15-4/18)
- Evidence of active channel conditions (newly fallen trees, bed material movement, sand deposition, and channel shape modifications) observed
- Biofilm present throughout survey site
- Channel conditions at transects 1 and 3 have changed relative to past surveys

2

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 35 |
| Boulder | >256mm (10") | – | | | |
| Cobble | 64-256mm (2.5" – 10") | 5 | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 5 | | | |
| Sand | 0.06 – 2mm (gritty) | 85 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | – | | | |

(2)

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below TRD Date: 5-8-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 14.2 ft | 1 | 1 | | | 5 | | 46 | | 26 | 3 | | | | ✓ | 42 | |
| | 2 | | | | | ✓ | 50 | | 27 | | | | 5 | | 40 | |
| depth 0.3 ft | 3 | | | | | ✓ | 48 | | 28 | | | | | ✓ | 37 | |
| | 4 | | | | | ✓ | 50 | | 29 | | | | 5 | | 43 | |
| | 5 | | | | 5 | | 50 | | 30 | | | | 5 | | 47 | |
| | 6 | | | | | ✓ | 42 | | 31 | 4 | | | | ✓ | 49 | width 8.8 ft |
| | 7 | | | | | ✓ | 44 | | 32 | | | | 5 | | 50 | |
| | 8 | | | | 5 | | 48 | | 33 | | | | 5 | | 50 | depth 0.5 ft |
| | 9 | | | | 5 | | 46 | | 34 | | | | | ✓ | 50 | |
| | 10 | | | | 5 | | 50 | | 35 | | | | 5 | | 49 | |
| width 11.3 ft | 11 | 2 | | | 5 | | 50 | | 36 | | | | 5 | | 39 | |
| | 12 | | | | 4 | | 50 | | 37 | | | | 5 | | 50 | |
| depth 0.4 ft | 13 | | | | 5 | | 48 | | 38 | | | | | ✓ | 49 | |
| | 14 | | | | | ✓ | 49 | | 39 | | | | 5 | | 50 | |
| | 15 | | | | 5 | | 43 | | 40 | | | | 5 | | 48 | |
| | 16 | | | | 5 | | 46 | | 41 | 5 | | | 5 | | 50 | width 7.7 |
| | 17 | | | | | ✓ | 47 | | 42 | | | | 5 | | 45 | |
| | 18 | | | | 3 | | 49 | | 43 | | | | 5 | | 47 | depth 0.4 ft |
| | 19 | | | | 5 | | 50 | | 44 | | | | | ✓ | 42 | |
| | 20 | | | | 5 | | 49 | | 45 | | | | | ✓ | 49 | |
| width 9.8 ft | 21 | 3 | | | | ✓ | 42 | | 46 | | | | 5 | | 47 | |
| | 22 | | | | | ✓ | 42 | | 47 | | | | 4 | | 47 | |
| depth 1.2 ft | 23 | | | | | ✓ | 47 | | 48 | | | | 3 | | 45 | |
| | 24 | | | | | ✓ | 13 | | 49 | | | | 5 | | 44 | |
| | 25 | | | | | ✓ | 44 | | 50 | | | | | ✓ | 46 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 51.8 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

② Unnamed Trib below TRD

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 0 | 0 | 2 | 3 × 2 = 6 | 1 | 3 × 1 = 3 |
| 4 | 0 | 0 | 0 | 0 | 2 | 4 × 2 = 8 | 1 | 4 × 1 = 4 |
| 5 | | | | | 26 | 5 × 26 = 130 | 48 | 5 × 48 = 240 |
| NA | 20 | | 20 | | 20 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0 | | 1.00 | | | |
| Sum ÷ (50 – NA) | | 0 | | 0 | | $\frac{144}{30}$ = 4.80 | | $\frac{247}{50}$ = 4.94 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 1.00 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{144}{30}$ = 4.80 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{2298}{2500}$ = 0.92 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

(3)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below Tricklewood | LOCATION Downstream Tricklewood Dr. |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| STORET # AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |

| FORM COMPLETED BY | DATE | REASON FOR SURVEY |
|---|---|---|
| D. Schlea | 5-8-13<br>TIME 13:20 AM<br>PM -14:20 | GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 20% ☒ | % cloud cover | ☒ % |
| ☒ | Clear/sunny | ☒ |

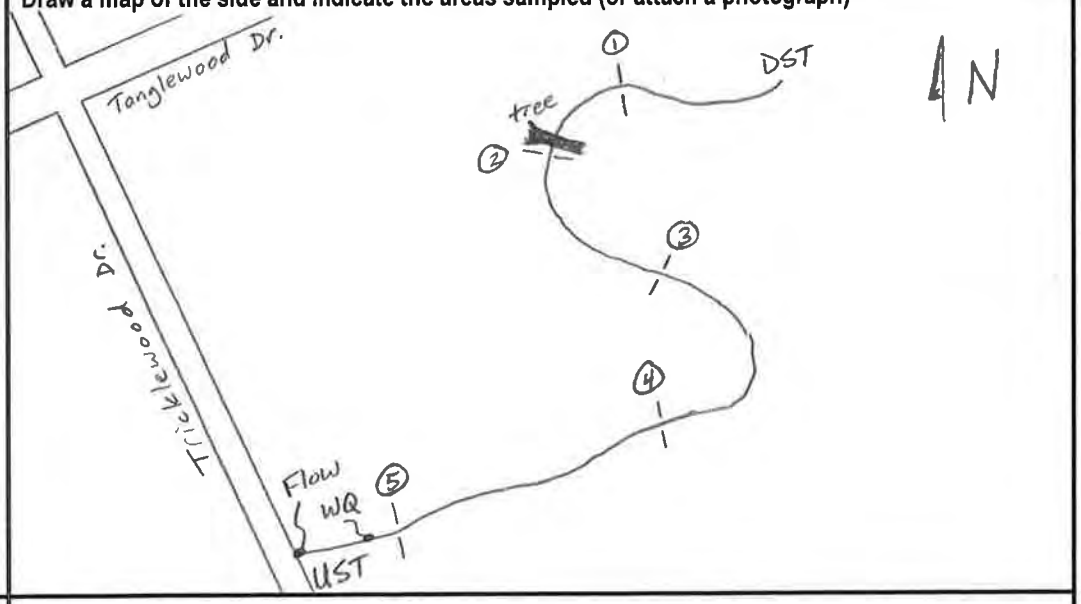
**Has there been a heavy rain in the last 7 days?** ☐ Yes ☒ No

**Air Temperature** 25 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal |

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | | |
|---|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential | **Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ | |
| **INSTREAM FEATURES** | **Estimated Reach Length** 135 m<br>**Estimated Stream Width** 4.0 m<br>**Sampling Reach Area** 540 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.10 m<br>**Surface Velocity (at thalwag)** 0.14 m/sec | **Canopy Cover**<br>☐ Partly open ☒ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 50 % ☐ Run 40 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 17 ~~m²~~ pieces<br>**Density of LWD** 0.031 ~~m²/km²~~ (LWD/reach area) | |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 5 % | |
| **WATER QUALITY** | **Temperature** 13.85 °C<br>**Specific Conductance** 946 µS/cm<br>**Dissolved Oxygen** 6.80 mg/L<br>**pH** 7.80<br>**Turbidity** 0 NTU<br>**WQ Instrument Used** YSI 6920 | **Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☒ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse | **Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☐ Other _____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Significant flood event occurred in mid-April 2013 (~5.5" rain 4/15-4/18)
- Localized evidence of active channel conditions (newly fallen trees, bed material movement, sand deposition, and channel shape modifications) observed
- Biofilm present throughout survey site
- Channel conditions at transect 3 have changed relative to past surveys

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 20 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 25 | | | |
| Sand | 0.06 – 2mm (gritty) | 25 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | 20 | | | |

③

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below Trickleward Date: 5-8-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 10.4 ft | 1 | 1 | | | 5 | | 50 | | 26 | 3 | | | 5 | | 47 | |
| | 2 | | | | 5 | | 48 | | 27 | | | | | ✓ | 47 | |
| depth 0.3 ft | 3 | | | | | ✓ | 47 | | 28 | | | | 5 | | 50 | |
| | 4 | | | | 5 | | 47 | | 29 | | | | | ✓ | 50 | |
| | 5 | | | | 5 | | 50 | | 30 | | | | 5 | | 49 | |
| | 6 | | | | 5 | | 45 | | 31 | 4 | | | | ✓ | 49 | width 16.2 ft |
| | 7 | | | | 5 | | 42 | | 32 | | | | 5 | | 47 | |
| | 8 | | | | | ✓ | 50 | | 33 | | | | 5 | | 44 | depth 0.3 ft |
| | 9 | | | | 5 | | 42 | | 34 | | | | 5 | | 50 | |
| | 10 | | | | 5 | | 50 | | 35 | | | | 5 | | 50 | |
| width 12.4 ft | 11 | 2 | | | | ✓ | 50 | | 36 | | | | 5 | | 50 | |
| | 12 | | | | 5 | | 50 | | 37 | | | | | ✓ | 50 | |
| depth 0.3 ft | 13 | | | | 5 | | 50 | | 38 | | | | 5 | | 50 | |
| | 14 | | | | 5 | | 50 | | 39 | | | | 5 | | 50 | |
| | 15 | | | | 5 | | 48 | | 40 | | | | 5 | | 50 | |
| | 16 | | | | 5 | | 36 | | 41 | 5 | | | 5 | | 48 | width 12.0 |
| | 17 | | | | | ✓ | 46 | | 42 | | | | 5 | | 44 | |
| | 18 | | | | 5 | | 38 | | 43 | | | | 5 | | 47 | depth 0.55 ft |
| | 19 | | | | 1 | | 35 | | 44 | | | | 5 | | 48 | |
| | 20 | | | | 5 | | 6 | | 45 | | | | 5 | | 49 | |
| width 14.7 ft | 21 | 3 | | | 5 | | 42 | | 46 | | | | 5 | | 49 | |
| | 22 | | | | 5 | | 47 | | 47 | | | | 5 | | 50 | |
| depth 0.25 ft | 23 | | | | 5 | | 46 | | 48 | | | | 5 | | 50 | |
| | 24 | | | | | ✓ | 50 | | 49 | | | | | ✓ | 50 | |
| | 25 | | | | 5 | | 50 | | 50 | | | | 5 | | 50 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 65.7 $ft^2$
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

③ Unnamed Trib below Tricklewood Dr.

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 1 | 1×1 = 1 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2×1 = 2 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4×2 = 8 |
| 5 | | | | | 39 | 5×39 = 195 | 47 | 5×47 = 235 |
| NA | 10 | | 10 | | 10 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0 | | 1.00 | | | |
| Sum ÷ (50 – NA) | | 0 | | 0 | | $\frac{196}{40}$ = 4.90 | | $\frac{245}{50}$ = 4.90 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0.98 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | $\frac{195}{40}$ = 4.88 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{2333}{2500}$ = 0.93 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

LimnoTech
Water | Environment | Scientists | Engineers

# MEMORANDUM

DATE: July 26, 2013

FROM: Doug Bradley
Derek Schlea
Chris Cieciek

PROJECT: GRR13

TO: Mr. Thomas R. Ecklund, P.E.
Facilities Management Director
Gerald R. Ford International Airport

CC:

SUBJECT: Gerald R. Ford International Airport (GFIA) July 2013 Biofilm Monitoring Results

---


## Summary

The purpose of this memo is to summarize the observations collected during the July 2013 biofilm monitoring survey in the unnamed tributary to the Thornapple River. This is the thirteenth biofilm monitoring event conducted as required by Part I.A.7.d. of GFIA's NPDES Permit (MI0055735). The monitoring results and metric calculations are described below.


## General Observations

Heterotrophic biofilm was not observed at any of the monitoring locations.

## Monitoring Approach

On July 25, 2013, biofilm monitoring was conducted at three locations (sample stations) in the unnamed tributary of the Thornapple River. Stream assessment reaches were established at each of the locations during the first survey (July 2011) using a hand-held global position system (GPS) device. The monitoring locations are at 36th Street, Thornapple River Drive, and Tricklewood Drive and are shown in Figure 1. Consistent with previous surveys, monitoring was conducted using the Stevenson and Rollins 2007 procedure described in the Proposed Biofilm Monitoring Procedure memo submitted to and approved by MDEQ in June 2011 (LimnoTech, June 3, 2011).

At each of the three sample stations, five transects were designated and marked. The transects were selected based on substrate type. Riffles and/or run segments with coarse substrate materials were specifically targeted because they are most appropriate for periphyton and biofilm attachment and provide repeatable and reliable long-term monitoring locations (Stevenson and Rollins, 2007 in *Methods in Stream Ecology*, 2007). Sampling was conducted at 10 equally spaced points on each transect using the rapid periphyton survey method, Basic Method 1 (Stevenson and Rollins, 2007). Measurements were recorded on the field data sheet (Table 1). Physical habitat characterization forms from the EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* were used to record field observations and measurements at each monitoring reach (EPA, 1999).

**Figure 1. Unnamed Tributary Biofilm/Macroinvertebrate Monitoring Locations.**

Community metric calculations include density and distribution estimates for functional categories of moss, macro, and micro (biofilm) algal species. As noted previously, slight modifications necessary to differentiate between microalgae and heterotrophic biofilm were added to the data collection procedure as described below.

1) The Sz column in the Field Data Sheet (Table 1) is intended for inventory of substrate particles >2 cm in size. Since a primary purpose of this monitoring effort is to characterize the presence of biofilm (which is associated with larger size substrates), the Sz column has been modified to instead identify substratum of < 2 cm (where it is not possible to collect community information). The sum of the Sz column observations is transferred to the NA row in Table 3 for extent and magnitude calculations. This modification was discussed with Stevenson and Rollins (personal communication with Doug Bradley, LimnoTech) and the authors stated that this modification is appropriate for the purpose of this monitoring effort.

2) The Algal Cover and Thickness Class Description (Table 2) include estimated cover classes for moss and macroalgae but not microalgae. The purpose of the monitoring was discussed with the procedure authors and it was suggested by Stevenson that including cover class for microalgae would provide estimated cover and thickness values that will improve the applicability of the procedure for tracking the status of the heterotrophic biofilm community. This component of the protocol was expanded for this monitoring event by adding a column (Table 2) to quantify the number of grid points counted over microalgae at 10 equally spaced points on each transect using a viewing bucket (EPA, 1999) with a 50-dot grid. The grid is used as a quantifiable and repeatable means for measuring distribution and density of biofilm across transects.

3) The calculations for the extent and magnitude of moss, and benthic algal cover (Table 3) include a row named NA. Following clarification from the authors, NA includes the points not sampled because no substrate particle >2 cm was present.

4) The microalgae functional class includes heterotrophic biofilm. The dominance of non-nuisance biofilm microalgae observed during the July and September field visits highlights the need to identify and calculate heterotrophic-specific biofilm observations as well as the other forms of microalgae. The calculation table (Table 3) used for the biofilm monitoring events beginning with the September 2011 event was expanded to quantify the extent and magnitude of biofilm-specific observations, and to estimate the cover of all microalgae as measured with the viewing bucket.

5) The microalgae thickness Class 2 of 0.5 to 1 mm is a transition category between non-visible (thin slimy layer) and visible microalgae (Stevenson and Bahls 1999). The category may misrepresent the presence of heterotrophic biofilm because the study approach prior to July 2012 grouped naturally occurring microalgae (diatoms and bluegreens) with heterotrophic biofilm in Class 2. Beginning with the September 2012 sampling event, we modified the Class 2 calculations to differentiate autotrophic/photosynthetic microalgae from heterotrophic biofilm in the extent and magnitude microalgae metrics (Table 3). Other calculations remain unchanged.

The information being collected and calculations being performed are consistent with the procedures described in the monitoring plan. The additional calculations provide added information on the biofilm community. The metrics will continue to be calculated consistently to support the evaluation of relative changes in the biofilm community.

Monitoring Summary

Site 1 36th Street – The site is approximately 75 meters long and average channel width was approximately 2.4 meters. Maximum stream velocity was measured at 0.09 m/sec. The site includes a mix of natural and re-establishing riparian vegetation, and channel re-alignment from the 36th Street road work conducted in 2006. The channel substrate is generally coarse with patches of fine sediment deposits. Evidence of active channel conditions was observed. Heterotrophic biofilm was not present at any of the transects sampled.

Site 2 Thornapple River Drive – The site is approximately 350 meters long and average channel width was approximately 3.1 meters. Maximum stream velocity was measured at 0.16 m/sec. This reach is longer than Sites 1 and 3 because of the limited amount of suitable coarse substrate upon which to locate survey transects. The site is densely vegetated along the banks and in the immediate riparian area. Evidence of channel shape modification, bed material movement, bank erosion and deposition is present throughout the reach. Heterotrophic biofilm was not present at any of the transects sampled.

Site 3 Tricklewood Drive – The site is approximately 135 meters long and average channel width was approximately 3.8 meters. Maximum stream velocity was measured at 0.10 m/sec. The northern banks of the site are more closely bound by residences than the other sites yet retain thick overhead cover but thin understory. The reach is characterized by a slightly higher gradient than Site 2 and contains a greater dominance of coarser substrates along with an outcrop of exposed hardpan clay. Localized evidence of active channel conditions was observed. Heterotrophic biofilm was not present at any of the transects sampled.

The field sheets and metric calculations are included as Attachment 1.

## References

D. Bradley, LimnoTech. July 2011. Personal communication with J. Stevenson and S. Rollins.

MDEQ (Michigan Department of Environmental Quality). 2008. Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers. Water Bureau Policy and Procedures, WB-SWAS-051 (SWAS Procedure 51), revised December 2008.

Stevenson, R. J., and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in M. T. Barbour,J. Gerritsen, and B. D. Snyder (Eds.) Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. U. S. Environmental Protection Agency, Washington, D.C.

Stevenson, R.J. and S.L. Rollins. 2007. Ecological assessments with benthic algae. Pages 785-803 in F.R. Hauer and G.A. Lamberti (Eds.) Methods in Stream Ecology. Second edition, Academic Press, Burlington, MA.

**Attachment 1**
GFIA Biofilm Monitoring Field Sheets
July 25, 2013

①

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | | |
|---|---|---|
| STREAM NAME Unnamed Trib at 36th St. | LOCATION Upstream 36th St. | |
| STATION # _____ RIVERMILE _____ | STREAM CLASS | |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River | |
| STORET # AUID 04050007040 8-02 | AGENCY LimnoTech | |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | | |
| FORM COMPLETED BY D. Schlea | DATE 7-25-13<br>TIME 9:45 AM<br>PM -10:45 | REASON FOR SURVEY GFIA BioFilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| % ☐ | % cloud cover | ☒ % |
| ☒ | Clear/sunny | ☒ |

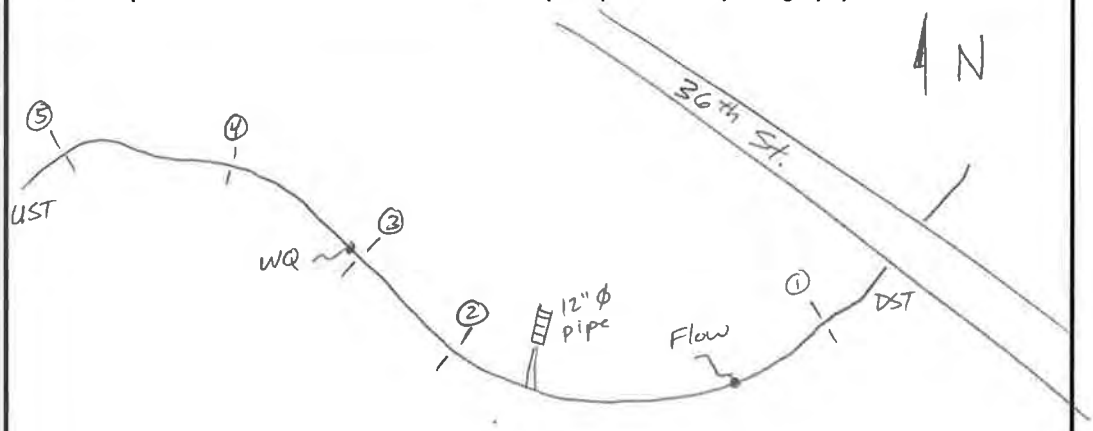
**Has there been a heavy rain in the last 7 days?** ☒ Yes ☐ No 0.90" on 7-21-13

**Air Temperature** 20 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

①

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | | |
|---|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☒ Other Road<br>☐ Residential | **Local Watershed NPS Pollution**<br>☐ No evidence ☐ Some potential sources<br>☒ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☐ Trees ☒ Shrubs ☒ Grasses ☐ Herbaceous<br>**Dominant species present** | |
| **INSTREAM FEATURES** | **Estimated Reach Length** 75 m<br>**Estimated Stream Width** 2.4 m<br>**Sampling Reach Area** 180 m²<br>**Area in km² (m²x1000)** ____ m²<br>**Estimated Stream Depth** 0.16 m<br>**Surface Velocity (at thalwag)** 0.09 m/sec | **Canopy Cover**<br>☒ Partly open ☐ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 30 % ☐ Run 60 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 12 ~~m²~~ pieces<br>**Density of LWD** 0.067 ~~m²/km²~~ (LWD/reach area) | |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 10 % | |
| **WATER QUALITY** | **Temperature** 14.43 °C<br>**Specific Conductance** 714 µS/cm<br>**Dissolved Oxygen** 6.38 mg/L<br>**pH** 7.92<br>**Turbidity** 9.6 NTU<br>**WQ Instrument Used** 6920 YSI | **Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other ____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other ____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other ____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other ____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse | **Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand<br>☐ Relict Shells ☐ Other ____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Apparent movement in gravel bed material noted between transects 2 and 3 and at transect 5, with decrease in embeddedness compared to previous samples observed within these riffle segments
- Slight turbidity observed in pool upstream of transect 3
- Pool upstream of transect 3 has continued to lengthen downstream
- Undercut bank development downstream of transect 3
- Increase in overhanging bank vegetation noted between transects 4 and 5
- Filamentous green algae present above pool to transect 5
- Continued morphological changes noted at transect 5 with the development of a central gravel bar and adjacent pools with fine sediment deposition

①

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 10 | | | |
| Cobble | 64-256mm (2.5" – 10") | 35 | Muck-Mud | Black, very fine organic (FPOM) | 3 |
| Gravel | 2-64mm (0.1" – 2.5") | 35 | | | |
| Sand | 0.06 – 2mm (gritty) | 15 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | – | | | |

①

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib at 36th St. Date: 7-25-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 6.2 ft | 1 | 1 | | | 1 | | 7 | | 26 | 3 | | 2 | 2 | | 2 | |
| | 2 | | | | 1 | | 5 | | 27 | | | 2 | 2 | | 16 | |
| depth 0.3 ft | 3 | | | 2 | 1 | | 3 | | 28 | | – | – | – | | 2 | |
| | 4 | | | 3 | 1 | | 12 | | 29 | | | 2 | 2 | | 9 | |
| | 5 | | | 2 | 2 | | 7 | | 30 | | | | | ✓ | 0 | |
| | 6 | | | | 1 | | 7 | | 31 | 4 | | 2 | – | | 11 | width 5.4 ft |
| | 7 | | | | 1 | | 15 | | 32 | | | | 1 | | 10 | |
| | 8 | | | | 1 | | 22 | | 33 | | | | 2 | | 8 | depth 0.4 ft |
| | 9 | | | | 1 | | 11 | | 34 | | | 2 | 1 | | 14 | |
| | 10 | | | | 1 | | 14 | | 35 | | | | 1 | | 11 | |
| width 5.8 ft | 11 | 2 | | | 1 | | 7 | | 36 | | | 2 | 1 | | 7 | |
| | 12 | | | | 1 | | 13 | | 37 | | | | 2 | | 9 | |
| depth 0.2 ft | 13 | | | | 1 | | 9 | | 38 | | | 3 | 2 | | 8 | |
| | 14 | | | | 1 | | 11 | | 39 | | | 4 | – | | 6 | |
| | 15 | | | | 1 | | 9 | | 40 | | | 4 | 2 | | 12 | |
| | 16 | | | | 1 | | 13 | | 41 | | | | | ✓ | 0 | width 15.0 ft |
| | 17 | | | | 1 | | 9 | | 42 | | | | | ✓ | 0 | |
| | 18 | | | | 1 | | 7 | | 43 | | | | | ✓ | 3 | depth 0.8 ft |
| | 19 | | – | – | – | | 4 | | 44 | | | | | ✓ | 0 | |
| | 20 | | | | | ✓ | 13 | | 45 | | | | | ✓ | 0 | |
| width 6.8 ft | 21 | 3 | | | | ✓ | 6 | | 46 | | | | 1 | | 5 | |
| | 22 | | | | | ✓ | 6 | | 47 | | | | 1 | | 0 | |
| depth 0.9 ft | 23 | | | | 2 | | 9 | | 48 | | | | 1 | | 0 | |
| | 24 | | | | 1 | | 8 | | 49 | | | | 1 | | 5 | |
| | 25 | | – | – | – | | 7 | | 50 | | | | 1 | | 3 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 39.2 ft2
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

①

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 27 | 1×27 = 27 | 2 | 1×2 = 2 |
| 2 | 0 | 0 | 8 | 2×8 = 16 | 9 | 2×9 = 18 | 33 | 2×33 = 66 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 2 | 3×2 = 6 | 0 | 0 | 8 | 3×8 = 24 |
| 4 | 0 | 0 | 2 | 4×2 = 8 | 0 | 0 | 0 | 0 |
| 5 | | | | | 0 | 0 | 0 | 0 |
| NA | 9 | | 9 | | 9 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.29 | | 0.88 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{30}{41}$ = 0.73 | | $\frac{45}{41}$ = 1.10 | | $\frac{92}{50}$ = 1.84 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{375}{2500}$ = 0.15 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

②

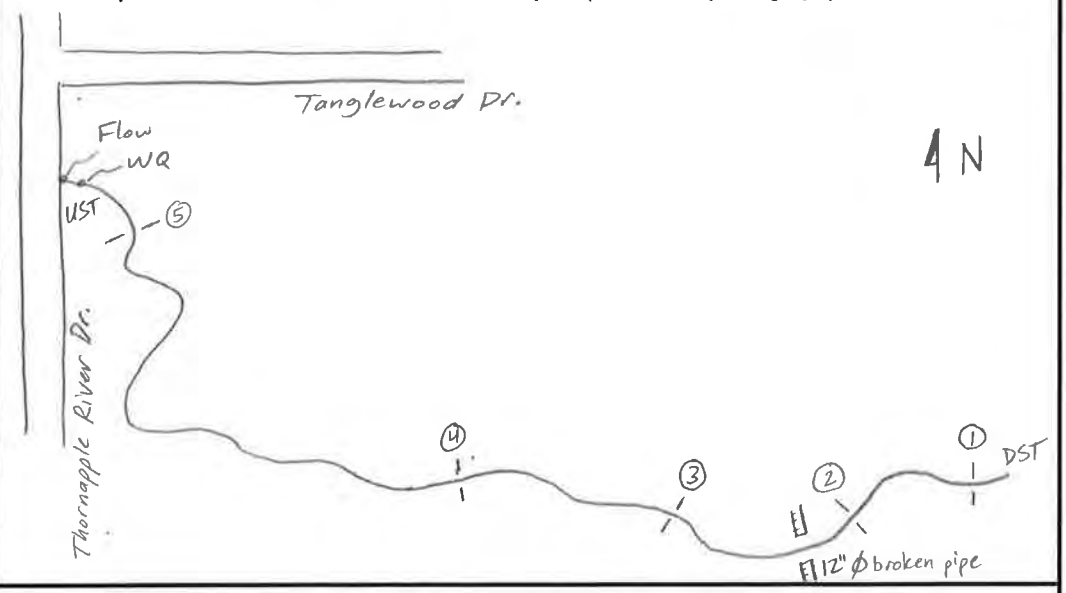
# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | | |
|---|---|---|
| STREAM NAME *Unnamed Trib below TRD* | LOCATION *Downstream Thornapple River Dr.* | |
| STATION # _____ RIVERMILE _____ | STREAM CLASS | |
| LAT _____ LONG _____ | RIVER BASIN *Thornapple River* | |
| STORET # *AUID 04050070408-02* | AGENCY *LimnoTech* | |
| INVESTIGATORS *Doug Bradley, Derek Schlea / LimnoTech* | | |
| FORM COMPLETED BY *D. Schlea* | DATE *7-25-13* TIME *11:15* AM PM *-12:15* | REASON FOR SURVEY *GFIA BioFilm Elimination / NPDES Requirement* |

| | | | | |
|---|---|---|---|---|
| **WEATHER CONDITIONS** | **Now** | | **Past 24 Hours** | **Has there been a heavy rain in the last 7 days?** ☒ Yes ☐ No *0.90" on 7-21-13* |
| | ☐ | Storm (heavy rain) | ☐ | |
| | ☐ | Rain (steady rain) | ☐ | |
| | ☐ | Showers (intermittent) | ☐ | **Air Temperature** *22* °C |
| | *20%* ☒ | % cloud cover | ☒ *%* | |
| | ☒ | Clear/sunny | ☒ | **Other** _____ |

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** *~ 9.1* km²

②

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | | |
|---|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential | **Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☐ Moderate ☒ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ | |
| **INSTREAM FEATURES** | **Estimated Reach Length** 350 m<br>**Estimated Stream Width** 3.1 m<br>**Sampling Reach Area** 1085 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.16 m<br>**Surface Velocity (at thalwag)** 0.20 m/sec | **Canopy Cover**<br>☐ Partly open ☐ Partly shaded ☒ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 10 % ☐ Run 70 %<br>☐ Pool 20 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 207 ~~m²~~ pieces<br>**Density of LWD** 0.191 ~~m²/km²~~ (LWD/reach area) | |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 2 % | |
| **WATER QUALITY** | **Temperature** 14.48 °C<br>**Specific Conductance** 858 µS/cm<br>**Dissolved Oxygen** 5.69 mg/L<br>**pH** 7.64<br>**Turbidity** 3.4 NTU<br>**WQ Instrument Used** YSI 6920 | **Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse | **Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☐ Other _____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Active channel conditions noted throughout site
- Dominant deposition material throughout reach was very fine sand
- Apparent channel filling (aggrading) with sand at transect 1 and portions of transect 3
- Several schools of minnows observed upstream of transects 2 and 4

(2)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | – | Detritus | Sticks, wood, coarse plant materials (CPOM) | 15 |
| Boulder | >256mm (10") | – | | | |
| Cobble | 64-256mm (2.5" – 10") | – | Muck-Mud | Black, very fine organic (FPOM) | 10 |
| Gravel | 2-64mm (0.1" – 2.5") | 10 | | | |
| Sand | 0.06 – 2mm (gritty) | 85 | Marl | Grey, shell fragments | – |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | – | | | |

②

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below TRD Date: 7-25-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 14.2 ft | 1 | 1 | | | | ✓ | 0 | | 26 | 3 | | | | ✓ | 6 | |
| | 2 | | – | – | – | | 0 | | 27 | | | | 1 | | 0 | |
| depth 0.2 ft | 3 | | | | | ✓ | 0 | | 28 | | | | | ✓ | 2 | |
| | 4 | | | | | ✓ | 0 | | 29 | | | | | ✓ | 0 | |
| | 5 | | – | – | – | | 0 | | 30 | | | | | ✓ | 0 | |
| | 6 | | | | 1 | | 2 | | 31 | 4 | | | | ✓ | 0 | width 7.9 ft |
| | 7 | | | | | ✓ | 0 | | 32 | | | | | ✓ | 4 | |
| | 8 | | | | | ✓ | 4 | | 33 | | – | – | – | | 2 | depth 0.6 ft |
| | 9 | | | | | ✓ | 0 | | 34 | | – | – | – | | 6 | |
| | 10 | | – | – | – | | 0 | | 35 | | | | 1 | | 6 | |
| width 11.8 ft | 11 | 2 | – | – | – | | 9 | | 36 | | | | 1 | | 9 | |
| | 12 | | | | 1 | | 4 | | 37 | | | | 1 | | 3 | |
| depth 0.3 ft | 13 | | – | – | – | | 10 | | 38 | | | | 2 | | 5 | |
| | 14 | | – | – | – | | 2 | | 39 | | | | 1 | | 4 | |
| | 15 | | – | – | – | | 1 | | 40 | | | | | ✓ | 2 | |
| | 16 | | – | – | – | | 6 | | 41 | 5 | – | – | – | | 3 | width 7.8 ft |
| | 17 | | – | – | 2 | | 2 | | 42 | | – | – | – | | 6 | |
| | 18 | | – | – | – | | 0 | | 43 | | | | 1 | | 5 | depth 0.25 ft |
| | 19 | | | 2 | 1 | | 2 | | 44 | | – | – | – | | 2 | |
| | 20 | | | | | ✓ | 0 | | 45 | | | | 1 | | 4 | |
| width 8.4 ft | 21 | 3 | | | | ✓ | 0 | | 46 | | | | 1 | | 3 | |
| | 22 | | | | 1 | | 0 | | 47 | | | | | ✓ | 0 | |
| depth 1.3 ft | 23 | | | | | ✓ | 0 | | 48 | | – | – | – | | 3 | |
| | 24 | | – | – | – | | 0 | | 49 | | | | | ✓ | 0 | |
| | 25 | | – | – | – | | 0 | | 50 | | | | | ✓ | 6 | |
| | | | | | | | | | | | | | | | | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 50.1 ft²
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

(2)

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 0 | 0 | 12 | 1 × 12 = 12 | 9 | 1 × 9 = 9 |
| 2 | 0 | 0 | 1 | 2 × 1 = 2 | 2 | 2 × 2 = 4 | 20 | 2 × 20 = 40 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | | | | | 0 | 0 | 0 | 0 |
| NA | 19 | | 19 | | 19 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.03 | | 0.45 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{2}{31}$ = 0.06 | | $\frac{16}{31}$ = 0.52 | | $\frac{49}{50}$ = 0.98 |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{123}{2500}$ = 0.05 |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 1/3; EPA 1999 (Form 1))

| | |
|---|---|
| STREAM NAME Unnamed Trib below Tricklewood | LOCATION Downstream Tricklewood Drive |
| STATION # _____ RIVERMILE _____ | STREAM CLASS |
| LAT _____ LONG _____ | RIVER BASIN Thornapple River |
| STORET # AUID 04050070408-02 | AGENCY LimnoTech |
| INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech | |
| FORM COMPLETED BY D. Schlea | DATE 7-25-13 TIME 12:45 AM PM – 13:30 / REASON FOR SURVEY GFIA Biofilm Elimination / NPDES Requirement |

**WEATHER CONDITIONS**

| Now | | Past 24 Hours |
|---|---|---|
| ☐ | Storm (heavy rain) | ☐ |
| ☐ | Rain (steady rain) | ☐ |
| ☐ | Showers (intermittent) | ☐ |
| 40% ☒ | % cloud cover | ☒ % |
| ☒ | Clear/sunny | ☒ |

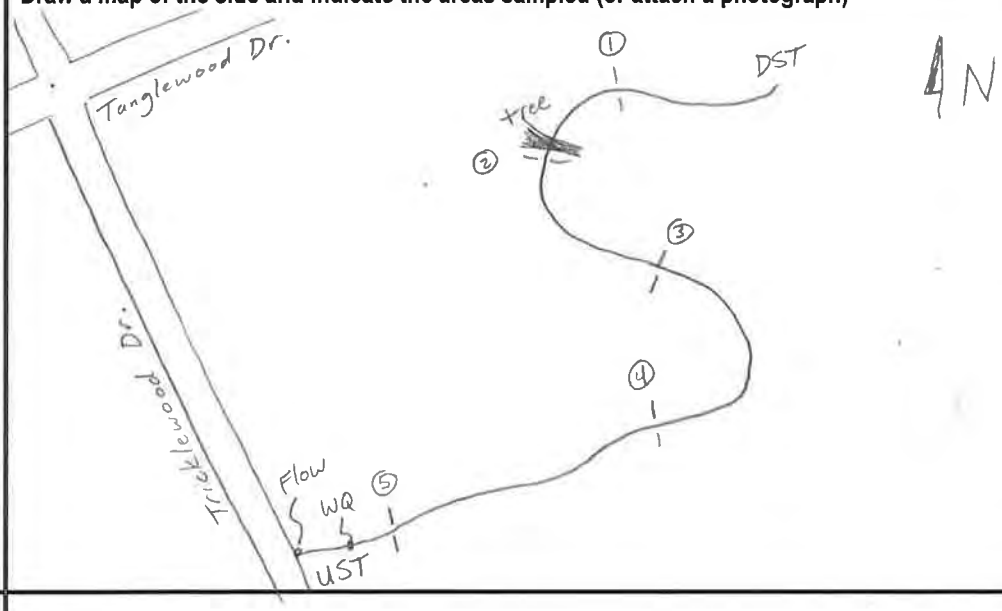
**Has there been a heavy rain in the last 7 days?** ☒ Yes ☐ No 0.90" on 7-21-13

**Air Temperature** 23 °C

**Other** _____

**SITE LOCATION MAP**

**Draw a map of the side and indicate the areas sampled (or attach a photograph)**




**STREAM CHARACTERIZATION**

**Stream Subsystem**
☒ Perennial | ☐ Intermittent | ☐ Tidal

**Stream Type**
☐ Coldwater ☒ Warmwater

**Stream Origin**
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

**Catchment Area** ~9.1 km²

③

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 2/3 EPA 1999 (Form 1))

| | |
|---|---|
| **WATERSHED FEATURES** | **Predominant Surrounding Landuse**<br>☒ Forest ☐ Commercial<br>☐ Field/Pasture ☐ Industrial<br>☐ Agricultural ☐ Other _____<br>☒ Residential<br>**Local Watershed NPS Pollution**<br>☐ No evidence ☒ Some potential sources<br>☐ Obvious sources<br>**Local Watershed Erosion**<br>☐ None ☒ Moderate ☐ Heavy |
| **RIPARIAN VEGETATION (18 meter buffer)** | **Indicate the dominant type and record the dominant species present**<br>☒ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous<br>**Dominant species present** _____ |
| **INSTREAM FEATURES** | **Estimated Reach Length** 135 m<br>**Estimated Stream Width** 3.8 m<br>**Sampling Reach Area** 513 m²<br>**Area in km² (m²x1000)** _____ m²<br>**Estimated Stream Depth** 0.10 m<br>**Surface Velocity (at thalwag)** 0.15 m/sec<br>**Canopy Cover**<br>☐ Partly open ☒ Partly shaded ☐ Shaded<br>**High Water Mark**<br>**Proportion of Reach Represented by Stream Morphology Types**<br>☐ Riffle 30 % ☐ Run 60 %<br>☐ Pool 10 %<br>**Channelized** ☒ Yes ☐ No<br>**Dam Present** ☐ Yes ☒ No |
| **LARGE WOODY DEBRIS** | **LWD** 19 ~~m²~~ pieces<br>**Density of LWD** 0.037 ~~m²/km²~~ (LWD/reach area) |
| **AQUATIC VEGETATION** | **Indicate the dominant type and record the dominant species present**<br>☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free floating<br>☐ Floating algae ☒ Attached algae<br>**Dominant species present**<br>**Portion of the reach with aquatic vegetation** 5 % |
| **WATER QUALITY** | **Temperature** 14.68 °C<br>**Specific Conductance** 997 µS/cm<br>**Dissolved Oxygen** 6.90 mg/L<br>**pH** 7.79<br>**Turbidity** 2.2 NTU<br>**WQ Instrument Used** YSI 6920<br>**Water Odors**<br>☒ Normal/None ☐ Sewage<br>☐ Petroleum ☐ Chemical<br>☐ Fishy ☐ Other _____<br>**Water Surface Oils**<br>☐ Slick ☐ Sheen ☐ Gloss ☐ Flecks<br>☒ None ☐ Other _____<br>**Turbidity (if not measured)**<br>☐ Clear ☐ Slightly turbid ☐ Turbid<br>☐ Opaque ☐ Stained ☐ Other _____ |
| **SEDIMENT SUBSTRATE** | **Odors**<br>☐ Normal ☐ Sewage ☐ Petroleum<br>☐ Chemical ☐ Anaerobic ☒ None<br>☐ Other _____<br>**Oils**<br>☒ Absent ☐ Slight ☐ Moderate ☐ Profuse<br>**Deposits**<br>☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand<br>☐ Relict Shells ☐ Other _____<br>**Looking at stones which are not deeply embedded, are the undersides black in color?**<br>☒ Yes ☐ No |

Notes:
- Schools of minnows observed in deeper run sections throughout reach
- Apparent increase in sand deposition between transect 2 and 3 since previous (May 8) survey

(3)

# PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
## (Pg 3/3; EPA 1999 (Form 1))

| INORGANIC SUBSTRATE COMPONENTS (should add up to 100%) | | | ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%) | | |
|---|---|---|---|---|---|
| **Substrate Type** | **Diameter** | **% Composition in Sampling Reach** | **Substrate Type** | **Characteristic** | **% Composition in Sampling Area** |
| Bedrock | | — | Detritus | Sticks, wood, coarse plant materials (CPOM) | 5 |
| Boulder | >256mm (10") | 5 | | | |
| Cobble | 64-256mm (2.5" – 10") | 10 | Muck-Mud | Black, very fine organic (FPOM) | 5 |
| Gravel | 2-64mm (0.1" – 2.5") | 10 | | | |
| Sand | 0.06 – 2mm (gritty) | 25 | Marl | Grey, shell fragments | — |
| Silt | 0.004 – 0.06 mm | 5 | | | |
| Clay | <0.004mm (slick) | 35 | | | |

③

**Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection. Modified from Stevenson and Rollins (2007; Table 34.1)**

Trns = transect number; Macro = macroalgae; Micro = microalgae; Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below Tricklewood Date: 7-25-13 Sampler: D. Bradley Recorder: D. Schlea

| | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | | Point | Trns | Moss | Macro | Micro | Sz | #Dots[1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| width 10.1 ft | 1 | 1 | – | – | – | | 4 | | 26 | 3 | | | 1 | | 4 | |
| | 2 | | – | – | – | | 3 | | 27 | | – | – | – | | 12 | |
| depth 0.4 ft | 3 | | | 2 | 1 | | 4 | | 28 | | | | | ✓ | 2 | |
| | 4 | | | | | ✓ | 4 | | 29 | | | 2 | 2 | | 14 | |
| | 5 | | | 1 | 1 | | 12 | | 30 | | – | – | – | | 6 | |
| | 6 | | | | 1 | | 7 | | 31 | 4 | – | – | – | | 4 | width 16.3 ft |
| | 7 | | | | 1 | | 4 | | 32 | | – | – | – | | 0 | |
| | 8 | | | 1 | 1 | | 4 | | 33 | | | | 1 | | 0 | depth 0.25 ft |
| | 9 | | | 2 | 1 | | 6 | | 34 | | | | 1 | | 4 | |
| | 10 | | | 2 | 2 | | 0 | | 35 | | | | | ✓ | 6 | |
| width 12.5 ft | 11 | 2 | – | – | – | | 9 | | 36 | | | | 2 | | 0 | |
| | 12 | | – | – | – | | 6 | | 37 | | | | | ✓ | 2 | |
| depth 0.3 ft | 13 | | | | 1 | | 9 | | 38 | | | | 1 | | 2 | |
| | 14 | | | | | ✓ | 7 | | 39 | | | | 1 | | 0 | |
| | 15 | | | | 1 | | 7 | | 40 | | – | – | – | | 0 | |
| | 16 | | | | 2 | | 4 | | 41 | 5 | | 2 | 2 | | 7 | width 11.3 ft |
| | 17 | | – | – | – | | 4 | | 42 | | | | 2 | | 16 | |
| | 18 | | | | 2 | | 7 | | 43 | | | | 1 | | 11 | depth 0.35 ft |
| | 19 | | | 3 | 2 | | 22 | | 44 | | | | 2 | | 7 | |
| | 20 | | – | – | – | | 7 | | 45 | | | | 2 | | 3 | |
| width 12.1 ft | 21 | 3 | | | 1 | | 9 | | 46 | | – | – | – | | 3 | |
| | 22 | | | 1 | 1 | | 16 | | 47 | | – | – | – | | 4 | |
| depth 0.4 ft | 23 | | | | 1 | | 11 | | 48 | | | | 1 | | 3 | |
| | 24 | | | | 2 | | 6 | | 49 | | | | 1 | | 0 | |
| | 25 | | | 1 | 2 | | 9 | | 50 | | | | 1 | | 0 | |

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = _____
Substrata Sampled: rock/wood/plant (circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

③

**Table 2. Algae and Moss Cover and Thickness Class Descriptions.**
**Modified from Stevenson and Rollins (2007; Table 34.2)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Moss and Macroalgae Cover Classes** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | >50% | | |
| | **Microalgae Thickness Class[1]** | | | | | | |
| Class | 0 | 1 | 2 | 2* | 3 | 4 | 5 |
| Thickness | 0 mm | <0.5 mm | 0.5 to 1 mm | 0.5 to 1 mm | 1 to 5 mm | 5 to 20 mm | >20 mm |
| Characteristics | rough | slimy; visible evidence of biofilm absent | naturally occurring microalgae | heterotrophic biofilm | | | |
| | **Microalgae Cover Class[2]** | | | | | | |
| Class | 0 | 1 | 2 | 3 | 4 | 5 | |
| Cover | 0% | <5% | 5% to 25% | 25% to 50% | 50% to 75% | 75% to 100% | |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

**Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.**
**Modified from Stevenson and Rollins (2007; Table 34.3)**
Shaded cells do not have appropriate records or calculations.

| Rank | Moss | | Macroalagae | | Microalgae Thickness | | Microalgae Cover[2] | |
|---|---|---|---|---|---|---|---|---|
| | No | Rank x No | No | Rank x No | No | Rank x No | No | Rank x No |
| 1 | 0 | 0 | 4 | 1 × 4 = 4 | 20 | 1 × 20 = 20 | 3 | 1 × 3 = 3 |
| 2 | 0 | 0 | 5 | 2 × 5 = 10 | 12 | 2 × 12 = 24 | 35 | 2 × 35 = 70 |
| 2* (heterotrophic biofilm)[1] | | | | | 0 | 0 | | |
| 3 | 0 | 0 | 1 | 3 × 1 = 3 | 0 | 0 | 4 | 3 × 4 = 12 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | | | | | 0 | 0 | 0 | 0 |
| NA | 5 | | 5 | | 5 | | | |
| (No > 0) ÷ (50 – NA) | 0 | | 0.22 | | 0.71 | | | |
| Sum ÷ (50 – NA) | | 0 | | $\frac{17}{45} = 0.38$ | | $\frac{44}{45} = 0.98$ | | $\frac{85}{50} = 1.70$ |
| (Count 2*, 3, 4, or 5) ÷ (50 – NA) | *Extent of heterotrophic biofilm→* | | | | 0 | | | |
| (Sum If 2*, 3, 4, or 5) ÷ (50 – NA) | *Magnitude of heterotrophic biofilm→* | | | | | 0 | | |
| (Sum #Dots) ÷ 2500 | *Density of all microalgae→* | | | | | | | $\frac{291}{2500} = 0.12$ |

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid