FINAL REPORT

ST. MARYS RIVER MONITORING PROJECT FOR TMDL DEVELOPMENT

PREPARED FOR:

MICHIGAN DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENT
525 WEST ALLEGAN STREET, PO BOX 30473
LANSING, MI 48909-7973

U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3507

USEPA CONTRACT NUMBER EP-RS-10-03
TASK ORDER 0001

DECEMBER, 2010

Montgomery Associates
Resource Solutions, LLC

LAKE SUPERIOR STATE UNIVERSITY

LimnoTech
Water | Environment | Scientists | Engineers

119 South Main Street, Suite A • Cottage Grove, WI 53527 ph 608.223.9585 fx 608.223.9586

Citation Format:

Montgomery Associates (2010). St. Marys River Monitoring Project for TMDL Development: Final Report. Prepared for U.S. Environmental Protection Agency Region 5 and Michigan Department of Natural Resources and Environment.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

ARL	LSSU Aquatic Research Laboratory
BST	Bacterial Source Tracking
CFU	Colony Forming Unit
CN	Copy Number
CSO	Combined Sewer Overflow
EAL	LSSU Environmental Analysis Laboratory
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
ERP	Ecological Research Partners
GLWI	UWM-Great Lakes Water Institute
GPS	Global Positioning System
LSSU	Lake Superior State University
MARS	Montgomery Associates Resource Solutions
mL	Milliliter
MDNRE	Michigan Department of Natural Resources and Environment
NOAA	National Oceanic and Atmospheric Administration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
qPCR	Quantitative Polymerase Chain Reaction
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
TMDL	Total Maximum Daily Load.
UWM	University of Wisconsin – Milwaukee

This page intentionally left blank to facilitate double-sided printing.

1. PROJECT SUMMARY

1.1. PROJECT PURPOSE

The main purpose of this project was to collect *Escherichia coli (E. coli)* data from the main stem of the St. Marys River and its tributaries in an effort to characterize the bacterial contamination in the area around Sault Ste. Marie, Michigan and provide the data needed to determine if a Total Maximum Daily Load (TMDL) is needed for the waters. This report was produced as a joint effort between the United States Environmental Protection Agency (EPA) and Michigan Department of Natural Resources and Environment (MDNRE). It presents the monitoring results and preliminary observations about potential bacterial sources; it is not intended to provide a comprehensive analysis of the data.

Samples to be tested for *E. coli* concentrations were collected in U.S. and Canadian waters to help characterize the entire St. Marys River however, the EPA and MDNRE do not have authority over water quality in Canadian waters or of Canadian sources. Therefore, any conclusions drawn regarding impairment or sources are specific to the U.S. waters and sources.

Another goal of the project was to collect water samples for Bacterial Source Tracking (BST) analysis. These samples were collected in waters suspected to have high concentrations of *E. coli* bacteria and the results provide insight as to the source (human or otherwise) of the bacterial contamination.

1.2. BACKGROUND

The St. Marys River is located in northeastern Chippewa County in Michigan's eastern Upper Peninsula. The River drains Lake Superior, starting at the end of Whitefish Bay and flowing southeast into Lake Huron. Water in the St Marys' River is directed through a variety of locks and power canals as it moves past Sault Ste. Marie, the combination of which regulates the outflow of water into the lower section of river. Also an international border, the St. Marys River separates Michigan from Ontario, Canada, with Sugar Island, Neebish Island and Drummond Island on the U.S. side of the border. Major U.S. tributaries include Frechette Creek, Seymour Creek, Ashmun Creek, Shunk Creek, Gogomain River, Munuscong River, Charlotte River, Waishkey River and Mission Creek.

The St. Marys River receives discharges from numerous point sources such as stormwater outfalls, wastewater treatment plants, several industrial outfalls, as well as occasional releases from combined sewer overflows (CSOs) from Sault Ste. Marie, Michigan during large rain events.

In the St. Marys River, *E. coli* has been identified as a pollutant of concern on Michigan's 303d list. General sources of *E. coli* include, but are not limited to, untreated human sewage from CSOs and sanitary sewer overflows (SSOs), storm sewer discharges, failing septic systems, agricultural runoff, pets and wildlife, and illicit connections. The water quality problems associated with *E. coli* in the St. Marys River are summarized in **Table 1**.

Table 1: St. Marys River impaired segments on Michigan's approved 2008 303(d) List

Reach	Description	Length	River AUID	Affected Uses	Pollutant
St. Marys River	Entire River from Lake Huron near Drummond Island to Lake Superior at Sault Ste. Marie	45.28 miles	040700010302-01	Partial and Total Body Contact	*Escherichia coli*

Part 4 of the Michigan Water Quality Standards (WQS), R323.1062 Microorganisms, requires that all waters of the state be protected for total and partial body contact recreation. The total body contact WQS states that waters of the state shall not contain more than 300 *E. coli* colonies per 100 mL as a daily maximum during the total body contact recreation season, from May 1 to October 31st. Additionally, waters of the state shall not contain more than 130 *E. coli* colonies per 100 mL of sample water as a 30-day geometric mean (based on a minimum of five daily maximum values, collected over a 30 day period). The partial body contact WQS applies year-round, and dictates that waters of the state shall not contain more than 1,000 *E. coli* colonies per 100 mL as a daily maximum. Compliance with the daily maximum total and partial body contact WQS is determined by calculating the geometric mean of at least three representative samples collected during the same sampling event.

1.3. PROJECT TEAM ORGANIZATION

The ***U.S. Environmental Protection Agency*** Region 5 provided funding for this project. The EPA also provided technical advice, oversight and contract administration.

The ***Michigan Department of Natural Resources and Environment*** provided technical advice and oversight on behalf of the State of Michigan.

Montgomery Associates Resource Solutions (MARS) was the prime contractor through Task Order 0001 under the EPA Region 5 Technical Support Services for Clean Water Act contract EP-RS-10-03. MARS was responsible for all contracting issues with the EPA and was responsible for monthly financial and status reporting to the EPA. MARS was responsible for project planning, data interpretation and final report preparation, as well as oversight of the sampling operation and all laboratory analyses.

LimnoTech was responsible for quality assurance project plan (QAPP) preparation and technical consulting on the project, as a subcontractor to MARS.

Ecological Research Partners (ERP) provided technical consulting on the project and interfaced with the BST laboratory, as a subcontractor to MARS.

Lake Superior State University (LSSU) Aquatic Research Laboratory (ARL) was responsible for sample collection, handling, and delivery to the appropriate laboratories. LSSU was a subcontractor to MARS.

Lake Superior State University Environmental Analysis Laboratory (EAL) was the laboratory for *E. coli* enumeration, as a subcontractor to MARS.

The ***University of Wisconsin-Milwaukee (UWM), Great Lakes Water Institute (GLWI)*** performed the bacterial source tracking analyses, as a subcontractor to MARS.

Table 2: Key project team members

U.S. Environmental Protection Agency – Region 5

Name/Title	**Contact Address/Phone/Email**
Julianne Socha Contracting Officer Representative Water Division	77 West Jackson Blvd., Chicago, IL 60604 312-886-4436 socha.julianne@epa.gov
Jean Chruscicki QA Coordinator Water Division	77 West Jackson Blvd., WW-16J Chicago, IL 60604 312-353-1435 chruscicki.jean@epa.gov

Michigan Department of Natural Resources and Environment

Name/Title	**Contact Address/Phone/Email**
Molly Rippke Technical Lead Water Resource Division – Surface Water Assessment Section	525 West Allegan Street, Lansing, MI 48909 517-335-1125 rippkem@michigan.gov

Montgomery Associates: *Resource Solutions*, LLC

Name/Title	Contact Address/Phone/Email
Robert Montgomery Program Manager MARS	119 South Main Street, Cottage Grove, WI 53527 608-223-9585 rob@ma-rs.org
Dr. Steve Gaffield Project Manager MARS	119 South Main Street, Cottage Grove, WI 53527 608-223-9585 steve@ma-rs.org
Ben Nelson Lead Scientist MARS	119 South Main Street, Cottage Grove, WI 53527 608-223-9585 ben@ma-rs.org
Kelly Doyle Project Engineer MARS	119 South Main Street, Cottage Grove, WI 53527 608-223-9585 kelly@ma-rs.org
Jon Radloff QA Manager MARS	119 South Main Street, Cottage Grove, WI 53527 608-223-9585 radloff@ma-rs.org

University of Wisconsin – Milwaukee and Ecological Research Partners, LLC

Name/Title	Contact Address/Phone/Email
Dr. Tim Ehlinger Project Scientist Ecological Research Partners, LLC	4634 N. 105th Street, Wauwatosa, WI 53225 414-243-7672 ehlinger@uwm.edu
Dr. Sandra McLellan Laboratory Manager Great Lakes Water Institute University of Wisconsin - Milwaukee	600 E. Greenfield Ave. , Milwaukee, WI 53204 414-382-1710 mclellan@uwm.edu
Beth Sauer Laboratory QA Manager Great Lakes Water Institute University of Wisconsin - Milwaukee	600 E. Greenfield Ave. , Milwaukee, WI 53204 414-382-1747 pearsone@uwm.edu

Lake Superior State University

Name/Title	Contact Address/Phone/Email
Dr. Geoffrey Steinhart Field Task Manager Aquatics Research Laboratory	650 West Easterday Avenue, Sault Ste. Marie, MI 49783 906.635.2093 gsteinhart@lssu.edu
Dr. Ashley Moerke Sampling Team Supervisor Aquatics Research Laboratory	650 West Easterday Avenue, Sault Ste. Marie, MI 49783 906.635.2153 amoerke@lssu.edu
Dr. Judy Westrick Laboratory Manager Environmental Analysis Laboratory	650 West Easterday Avenue, Sault Ste. Marie, MI 49783 906-635-2165 jwestrick@lssu.edu
Ben Southwell Laboratory QA Manager Environmental Analysis Laboratory	650 West Easterday Avenue, Sault Ste. Marie, MI 49783 906-635-2165 bsouthwell@lssu.edu

LimnoTech

Name/Title	Contact Address/Phone/Email
Cathy Whiting Project Scientist LimnoTech	501 Avis Drive, Ann Arbor, MI 48108 734-332-1200 cwhiting@limno.com

2. METHODS

2.1 SAMPLING OVERVIEW

The primary objective of this project is to collect *E. coli* and bacterial source data to evaluate *E. coli* concentrations and potential sources in the St. Marys River and its U.S. tributaries, with potential application to a future TMDL if the total or partial body contact recreation designated use is determined to be impaired. Weekly *E. coli* sampling was conducted for 18 weeks from June 8, 2010 through October 7, 2010, during the partial and total body contact recreational season. In addition, bacterial source tracking (BST) analyses were conducted on 7 samples to provide information on the presence of human fecal contamination.

2.2 SAMPLING LOCATIONS

E. coli samples were collected from the St. Marys River along 14 transects in U.S. and Canadian waters, and U.S. tributaries were sampled at 23 road crossings (**Figures 1** and **2**, and **Table 3**). All locations were sampled for the first 16 weeks, and sampling was reduced to only the tributaries and power canal during weeks 17 and 18 based on low *E. coli* concentrations in the St. Marys River. *E. coli* samples were collected in accordance with Michigan's Rule 62 which requires at least 3 samples to be collected in a representative area during the same sampling event. St. Marys River was sampled at 4 to 9 locations along each transect, with the number of samples being dependent on the width of the river. The first sample at each transect was collected within 50-feet of the right bank (looking downstream), and the last sample was collected within 50-feet of the left bank. Three samples were collected at each tributary site from the center of the channel and near the right left banks. Tributary samples were collected from the upstream side of the bridge, unless debris or other conditions prohibited this. Where samples were initially collected from the downstream side of the crossing, all subsequent samples were collected from the downstream side, regardless of conditions upstream.

BST sampling sites were selected where elevated *E. coli* concentrations occurred in previous weeks. The BST tests were conducted only if the *E. coli* count of the concurrent sample was greater than 300 CFU/100 mL. Based on this approach, a total of seven BST samples from tributary sites were analyzed throughout the season, beginning during week 7. Additional details of BST testing are presented in Sections 2.4 and 3.2.

Sample locations were recorded in World Geodetic System 1984 coordinates using Trimble RX Global Positioning System equipment during the first week of sampling. Coordinates for each site are included in **Appendix A**, and photographs of sampling sites are included in **Appendix B**. A hand-held GPS, boat-mounted GPS, and/or visual landmarks were used to find these sample locations during each subsequent sampling week, and samples were collected within 50 feet of the original location.

2.3 SAMPLING METHODS

Data collection, analysis and reporting were conducted following the Quality Assurance Project Plan (QAPP) prepared for this project (**Appendix C**). The QAPP specifies sampling procedures, laboratory analytical procedures, and quality assurance and quality control procedures. Samples from each site were collected on the same day of the week according to the schedule in the QAPP (**Table 4**), except in the presence of unsafe weather conditions, such as small craft advisories, lighting, and gale-force winds. If samples could not be collected during the normal sampling time, they were collected at the next possible opportunity, without disrupting additional sample collection. All deviations from the sampling schedule were noted on the sample collection data sheets and weekly reports.

All samples were collected in sterile sample containers from commercial suppliers. *E. coli* containers included sodium thyosulfate preservative tablets to neutralize any residual chlorine from waste water treatment plant effluent. As practical, samples from the St. Marys River transects were collected from the bow of the boat, with the boat facing upstream. Samples were named based on their sample location (e.g. T10: Transect 10, As1: Ashmun 1) and by position in the stream/river. For all locations, the sample collected nearest the right bank (looking downstream) was designated "A" (e.g. T02A, Wa2A) ,and each subsequent sample was labeled alphabetically.

Quality control samples, including field duplicates and blanks, were collected daily according to the QAPP. Quality assurance details are presented in Section 4.

Flow direction was noted at each tributary site, because some sites near the St. Marys River can experience flow reversals due to wind and wave action. Relative water level was also recorded weekly at most sites, using either a stationary staff gage or a measured chord from a consistent location on each bridge. In some locations, the physical geometry of the site prevented collection of water level. In others, severe weather damaged or destroyed the staff gages, preventing further data collection. These measurements were collected only as additional data to help interpret the *E. coli* results and thus did not follow the same QA/QC procedures as other data collection for this project.

Table 3: Sampling locations

Location Prefix	Location Type	Number of Samples	Location Description
As1	Road Crossing	3	I75Ashmun Creek
As2	Road Crossing	3	Ashmun Creek @ I75
As3	Road Crossing	3	Ashmun Creek @ Business I75.
Ca1	Road Crossing	3	Upstream Canal @ W Portage Ave
Ca2	Road Crossing	3	Downstream Canal @ E. Portage Ave
Ch1	Road Crossing	3	Charlotte River @ Shunk Rd.
Ch2	Road Crossing	3	Charlotte River Tributary @ Shunk Rd.
Ch3	Road Crossing	3	Upstream Charlotte River @ Riverside Dr
Ch4	Road Crossing	3	Downstream Charlotte River @ S Scenic Dr
Fr1	Road Crossing	3	Downstream Frechette Creek @ S. Riverside Drive
Lm1	Road Crossing	3	Little Munuscong River @ E. 17 Mile Rd
Lm2	Road Crossing	3	Little Munuscong River @ S. Riverside Dr
Mi1	Road Crossing	3	Upstream Mission Creek @ E 11th Ave. & 14th St. E
Mi2	Road Crossing	3	Downstream Mission Creek @ S. Riverside Drive
Mu1	Road Crossing	3	Munuscong River @ Town Line Road
Mu2	Road Crossing	3	Munuscong River @ E. Gogomain Road
Mu3	Road Crossing	3	Munuscong River @ Riverside Road
Mu4	Road Crossing	3	Munuscong River @ S. Riverside Dr
Mu5	Road Crossing	3	East Branch Munuscong River @ E. Gogomain Road
Se1	Road Crossing	3	Seymour Creek @ W. 4th Ave
Wa1	Road Crossing	3	Waishkey River @ 6 Mile Road
Wa2	Road Crossing	3	West Branch of Waishkey River @ 7 1/2 mile Road
Wa3	Road Crossing	3	East Branch of Waishkey River @ Forest Side Road
T01	Transect	6	Baseline transect at Point aux Pins upstream from SSM.
T02	Transect	8	Above Seymour Creek
T03	Transect	5	Above power canal discharge
T04	Transect	8	Aune-Osborne boat launch, downstream of SSM CSO's
T05	Transect	5	Early North Channel
T06	Transect	6	North Channel above Little Lake George
T07	Transect	5	North Channel below Little Lake George
T08	Transect	4	Above Frechette Creek
T09	Transect	8	Upper Lake Nicolet
T10	Transect	5	West Neebish Channel
T11	Transect	4	Middle Neebish Channel
T12	Transect	4	East Neebish Channel
T13	Transect	9	Point aux Frenes
T14	Transect	7	DeTour Passage, downstream of DeTour Village.
Total		**153**	

Table 4: Sampling schedule

Name	Samples	Day	Drop	Description
T01	6	1	1	Shallows to Pointe aux Pins
T02	8	1	1	Sherman Park to Algoma
As1	3	1	1	Ashmun Creek at first culvert
As2	3	1	1	Near I-75 Crossing
As3	3	1	1	Upstream Ashmun, near police station
Wa1	3	1	2	Mouth of Waishkey on 6 Mile Road
Wa2	3	1	2	West Waishkey on 7 1/2 Mile Road
Wa3	3	1	2	East Waishkey on Forrest Side Road
Se1	3	1	2	Seymour Creek, close to SMR
Fr1	3	1	2	Mouth of Frechette Creek
Mi2	3	1	2	Mouth of Mission Creek
Mi1	3	1	2	Upstream Mission Creek
T07	5	2	1	E. North Channel
T06	6	2	1	Mid North Channel
T05	5	2	1	W. North Channel
T08	4	2	1	Frechette to Sugar Island
T04	8	2	1	Aune Osborne
T03	5	2	1	Powerplant
Ca2	3	2	1	Downstream canal, Portage bridge
Ca1	3	2	1	Upstream canal, Portage bridge
T12	4	2	2	W. of Sugar Island, Lake George outflow
T11	4	2	2	N. of Neebish
T09	8	2	2	Mid Lake Nicolet
T10	5	2	2	S. of Charlotte
Ch4	3	2	2	Mouth of Charlotte
Ch3	3	2	2	Charlotte, Riverside Dr.
Ch2	3	2	2	Charlotte, N. Shunk Rd (tributary)
Ch1	3	2	2	Charlotte,S. Shunk Rd (main)
T14	7	3	1	DeTour Village
T13	9	3	1	Raber to St. Joes (s. of Munuscong)
Mu5	3	3	1	E. Br. Munuscong, Gogomain Road
Mu2	3	3	1	Munuscong, Gogomain Road
Mu1	3	3	1	Munuscong, w of Pickford (Main St., first crossing)
Mu3	3	3	1	Munuscong, E 22 Mile Rd (E. of golf course)
Mu4	3	3	1	Munuscong, Riverside
Lm2	3	3	1	Little Munuscong, Riverside
Lm1	3	3	1	Little Munuscong, E 17 Mile (E. of Marathon station)

2.4 LABORATORY ANALYTICAL METHODS

E. coli and biological source tracking analyses of water samples collected in this project were analyzed using the methods summarized in **Table 5**. Details are included in the QAPP, including the laboratory quality assurance (QA) manual and laboratory standard operating procedures (SOPs) for the project.

Table 5: Analytical methods and details

Parameter	Lab	Method Number	Method Detection Limit (CFU/100 mL)	Sample Volume (mL)	Bottle Type	Hold Time (hours)
E. coli	LSSU	Colilert-18	Lower: 1 Upper: 240,000	100	Plastic	8
Human *Bacteroides* sp.	UWM	EPA 1600	N/A	500	Plastic	N/A
Total *Bacteroides spp.*						

3. SAMPLING RESULTS

3.1 *E. COLI* ANALYSIS

Results of all *E. coli* analyses for the 18-week sampling period are included in **Appendix D**. Results for each week are summarized in **Figures 3 – 20**, and summarizes the frequency at which *E. coli* concentrations exceeded the MDNRE criteria for total and partial body contact. In general, *E. coli* concentrations were elevated in the tributaries and below the water quality standard in the St. Marys River. **Figures 21, 22**, and **23** display the percentage of sampling dates with total body contact daily maximum and 30-day geometric mean WQS exceedances and the partial body contact WQS exceedances, respectively.

Table 6: Frequency of exceedance of MDNR total body contact WQSs (daily maximum of 300 *E. coli* per 100mL and 30-day geometric mean of 130 *E. coli* per 100mL) and partial body contact WQS (daily maximum of 1,000 *E. coli* per 100mL).

	Daily Maximum		30-Day Geometric mean		Partial Body Contact	
Sample Location	Number of sampling dates where WQS was exceeded	% of sampling dates where WQS was exceeded (18 total weeks) [1]	Number of sampling dates where WQS was exceeded	% of sampling dates where WQS was exceeded (14 total weeks)	Number of sampling dates where WQS was exceeded	% of sampling dates where WQS was exceeded (18 total weeks) [1]
As1	13	72%	14	100%	8	44%
As2	5	28%	13	93%	1	6%
As3	8	44%	14	100%	4	22%
Ca1	0	0%	0	0%	0	0%
Ca2	0	0%	0	0%	0	0%
Ch1	11	61%	14	100%	6	33%
Ch2	8	44%	14	100%	5	28%
Ch3	8	44%	14	100%	5	28%
Ch4	2	11%	4	29%	1	6%
Fr1	12	67%	14	100%	4	22%
Lm1	8	44%	14	100%	2	11%
Lm2	8	44%	14	100%	3	17%
Mi1	12	67%	14	100%	6	33%
Mi2	12	67%	14	100%	4	22%
Mu1	11	61%	14	100%	4	22%
Mu2	15	83%	14	100%	3	17%
Mu3	16	89%	14	100%	5	28%
Mu4	7	39%	14	100%	4	22%
Mu5	15	83%	14	100%	7	39%
Se1	15	83%	14	100%	5	28%
Wa1	1	6%	1	7%	0	0%
Wa2	4	22%	7	50%	0	0%
Wa3	3	17%	7	50%	0	0%
T01	0	0%	0	0%	0	0%
T01 (US)	0	0%	0	0%	0	0%
T02	0	0%	0	0%	0	0%
T02 (US)	0	0%	0	0%	0	0%
T03	0	0%	0	0%	0	0%
T03 (US)	0	0%	0	0%	0	0%

	Daily Maximum		30-Day Geometric mean		Partial Body Contact	
Sample Location	Number of sampling dates where WQS was exceeded	% of sampling dates where WQS was exceeded (18 total weeks) [1]	Number of sampling dates where WQS was exceeded	% of sampling dates where WQS was exceeded (14 total weeks)	Number of sampling dates where WQS was exceeded	% of sampling dates where WQS was exceeded (18 total weeks) [1]
T04	0	0%	0	0%	0	0%
T04 (US)	0	0%	0	0%	0	0%
T05	0	0%	0	0%	0	0%
T05 (US)	0	0%	0	0%	0	0%
T06	0	0%	0	0%	0	0%
T06 (US)	0	0%	0	0%	0	0%
T07	0	0%	0	0%	0	0%
T07 (US)	0	0%	0	0%	0	0%
T08	0	0%	0	0%	0	0%
T09	0	0%	0	0%	0	0%
T10	0	0%	0	0%	0	0%
T11	0	0%	0	0%	0	0%
T12	0	0%	0	0%	0	0%
T12 (US)	0	0%	0	0%	0	0%
T13	0	0%	0	0%	0	0%
T13 (US)	0	0%	0	0%	0	0%
T14	0	0%	0	0%	0	0%

[1] 16 total weeks of sampling for St. Marys River transects T01 – T14.

3.2 BST ANALYSIS

E. coli is a very general fecal indicator because it is commonly found in most warm-blooded animals. Therefore, simple detection of *E. coli* does not provide information as to the source of fecal pollution. The genus *Bacteroides* is a highly diverse group of fecal anaerobes and another common inhabitant of the gastrointestinal tract of humans and other animals. One species of *Bacteroides* has been found to be specific to humans and has been used extensively in BST studies to determine if human or other sources are present (Bernhard and Field 2000; Bower, Scopel et al. 2005; Noble, Griffith et al. 2006; Santoro and Boehm 2007; Shanks, Kelty et al. 2009). The BST analysis performed for the St. Marys study employed quantitative polymerase chain reaction (qPCR) to detect and quantify the human *Bacteroides* sp. Other BST genetic markers based on *Bacteroides* and other members of the order *Bacteroidales* have been described that include cattle and other ruminants (Bernhard and Field 2000), which may be useful in watersheds that have suspected human and cattle sources (Bower, Scopel et al. 2005; Shanks, Nietch et al. 2006).

BST analysis was carried out on one sample from each of seven different tributaries (**Table 7**). The tributary sample Se1 from 7/21/2010 had high levels of human *Bacteroides* sp. present and comprised 0.86% of the total *Bacteroides* present. As reference, the proportion of human *Bacteroides* to total *Bacteroides* in untreated sewage from a major metropolitan area can range from 1 to 4%. Sample Mu5 from 10/1/2010 was found to have high to moderate levels of human *Bacteroides* sp. with similar ratios of human to total *Bacteroides* as compared to the Se1 sample. Sample Mi2 from 8/21/2010 also had moderate to high levels of human *Bacteroides* sp., however, the total *Bacteroides* levels were higher, indicating other sources of fecal pollution were also present. Sample Fr1 from 7/21/2010 had low amounts of human *Bacteroides* sp. detected, and also relatively low levels of total *Bacteroides*. Samples As1, Mi1, and Ch2 can be considered negative (below 100 CN is classified as background).

The results are expressed in copy number (CN), which refers to the number of copies of the 16S rRNA gene that were detected. Surface waters with concentrations above 860 genomic copies per 100 ml of human *Bacteroides* are considered unsafe for recreational use (Ashbolt, Schoen et al.). Multiple factors influence the actual concentration of human *Bacteroides* sp., including precipitation patterns, stream flow, and mixing with other source of fecal pollution. Watersheds are typically impacted by multiple source of fecal pollution and fecal indicators, including source specific indicators such as human *Bacteroides*, is modulated physical and biological influences that will determine the actual concentration found in a sample. Extensive spatial and temporal sampling is usually necessary to characterize major fecal pollution sources in a watershed.

Because a very limited number of samples were analyzed, no conclusions can be drawn as to the source of fecal indicator bacteria for these individual watersheds. However, these results do provide an indication of some problem areas. In general, human sources are a concern in three of the seven tributaries analyzed. Human sources cannot be ruled out in the remaining seven watersheds. Importantly, BST analysis was only conducted on samples that exceeded recommended levels of *E. coli*, and large amounts of rainfall may have reduced overall levels below this threshold; samples containing human sources could have been missed. Further sampling would be warranted in areas with either sewer systems or high densities of septic tanks.

Table 7: Bacterial source tracking results

Site Code	Week of Sample Collection	Date of BST Testing	*Bacteroides* Human (CN/100ml)	*Bacteroides* Total (CN/100ml)	Ratio Human/Total
Fr1	Week 7	7/21/2010	142	53,768	0.26%
Se1	Week 7	7/21/2010	1,455	178,099	0.82%
As1	Week 11	8/19/2010	18	22,115	0.08%
Mi1	Week 11	8/19/2010	0	6,162	0.00%
Ch2	Week 11	8/19/2010	10	4,105	0.24%
Mu5	Week 17	10/1/2010	652	105,441	0.62%
Mi2	Week 18	10/8/2010	482	489,777	0.10%

3.3 PRECIPITATION

Daily precipitation was acquired from two National Oceanic and Atmospheric Administration (NOAA) rain gages, one located in Sault Ste. Marie, the other located in DeTour Village. Precipitation data are included in **Appendix E**.

4. QUALITY ASSURANCE SUMMARY

Sample collection, laboratory analysis, and data validation were conducted in conformance with MARS' approved Quality Management Plan and the QAPP for the St. Marys River Monitoring Project for TMDL Development. QA activities for this project were coordinated by MARS Quality Assurance Manager Jon Radloff. Dr. Geoffrey Steinhart, of the LSSU ARL was responsible for oversight of the sample collection program and ensuring that the field QA requirements were met. Additional field quality oversight was provided by MARS staff during two sample collection observation visits. QA for laboratory analysis of *E. coli* samples was the responsibility of Ben Southwell, the Laboratory QA Manager for the LSSU EAL. Beth Sauer, UMW GLWI Laboratory QA Manager, oversaw all aspects of the laboratory QA for BST analyses.

Data validation was conducted each week by the MARS Quality Assurance Manager and other project quality staff. This data review included identifying and correcting any QAPP deviations and evaluating project performance relative to the data quality objectives and criteria specified in Section 3 of the QAPP and summarized below.

- *Precision*. Checked that sample blanks had *E. coli* counts <1.0 CFU/100 mL, and that the 95% confidence intervals of sample – duplicate pairs overlapped.
- *Accuracy*. Checked results of positive & negative laboratory controls. Only 1 control sample failed: a Week 7 method blank had a Maximum Probable Number of 4.1 CFU/100 mL.
- *Representativeness*. Checked sufficiency of number of samples collected, spatial distribution of samples and sample volumes, as well as proper sampling times, sampling locations and hold times.
- *Completeness*. Calculated field and laboratory sample completeness measures and evaluated them versus criteria specified in the QAPP (see **Table 8**).
- *Comparability*. Checked that field sampling procedures and laboratory methods were conducted as specified in the QAPP.
- *Sensitivity*. Checked that minimum detection limits were 1 CFU/100 mL and that sample hold times were less than 8 hours, as specified in the QAPP.

Data validation also included:

- ➢ An inspection of the data verification completed by the field and lab personnel to ensure no oversights
- ➢ An evaluation of the data in the context of overall project objectives (Section 2 of the QAPP).
- ➢ Communication of data validation results to the project team.

Table 8: Summary of field and laboratory completeness for *E. coli* samples

Measure	Target	Actual	Completeness
Field (criterion = 90%)			
Valid samples collected *	2,586	2,586	100.0%
Valid duplicates	272	273	100.4%
Valid blanks	138	138	100.0%
Laboratory (criterion = 95%)			
Valid samples analyzed *	2,586	2,580	99.8%
Blanks below *E. coli* detection limit	138	135	97.8%
Duplicate-sample pairs with overlapping 95% confidence intervals	273	261	95.6%

** Not including duplicates, blanks, or BST samples.*

Deviations from the QAPP were reported promptly to MDNRE and EPA, and they are summarized in **Appendix F**.

5. SOURCE IDENTIFICATION

The goal of this section is to shed some light on potential U.S. sources of *E. coli* contamination in the St. Marys River watershed based on the sampling results and visual observations of the watershed. It is not meant to be an exhaustive discussion of contamination sources, nor a comprehensive analysis of the data.

The sampling for this project covered a large spatial extent, encompassing an area of more than 600 square miles. The northern-most samples were collected in Sault Ste. Marie, a primarily urban area. Agricultural and forested sampling locations were prevalent in the southern portion of the project area. The sampling site overview in Section 2 describes each of the road-crossing locations and some potential sources of contamination observed at each site.

Information sources on potential bacterial contamination sources include the 2009 National Agriculture Imagery Program aerial orthophotograph, discussions with LSSU staff, and tours of the watershed. Potential contamination sources include:

- *Combined Sewer Overflows*. A CSO originating from the Sault Ste. Marie, Michigan waste water treatment plant occurred during Week 16, on September 23 and 24, 2010, after a rainfall of 3.15 inches. Approximately 4.4 million gallons of diluted, raw sewage were discharged to the St. Marys River and the power canal. Week 16 sampling was completed before this CSO event occurred. Subsequent samples of the power canal in weeks 17 and 18 did not contain elevated *E. coli* concentrations, and the St. Marys River transects were not sampled in weeks 17 or 18.
- *Agricultural runoff*. There was evidence of direct access for cattle to enter the stream at site Ch3. Sites Ch2, Ch3 and Mu1 were located near large cattle pastures.
- *Urban wildlife.* There are several parks and golf courses in the greater Sault Ste. Marie area. These open spaces are notorious for attracting large flocks of both Canada geese and gulls. Dog feces were also seen near the Fr1 road crossing site, and conversations with LSSU staff suggest that dogs are often allowed to defecate in roadside ditches.
- *Failing or improperly designed septic systems*. No obvious problem septic systems were observed during the sampling period. It is assumed that many residences in the watershed outside of sewage service areas use septic systems or holding vaults. Based on statewide failure rates, it is probable that some systems are failing or improperly designed and contributing to the human *Bacteroides* genetic marker found in water samples.
- *Wastewater treatment plant discharge*. There are two waste water treatment plants located in Sault Ste. Marie, Michigan and two in Sault Ste. Marie, Canada. Treated and disinfected effluent is discharged to the St. Marys River. All wastewater treatment plant discharge permits in Michigan contain fecal coliform limits designed to meet Michigan's Water Quality Standards for total and partial body contact.
- *Stormwater*. Stormwater systems collect and effectively transport fecal pollution from impervious surfaces to surface waters. In addition, stormwater conveyance systems can act as a conduit for leaking sanitary sewer lines and illicit sanitary connections and thereby contribute human sources of fecal pollution. Direct sampling of stormwater outfalls in the future would provide estimates of the magnitude of fecal pollution inputs from this source. Few stormwater Best Management Practices (BMPs) are currently in place in the watershed, and storm sewer outfalls and storm drainage ditches typically discharge to streams with no controls. However, the City of Sault Ste. Marie and Soo Township have participated in development of a watershed plan that calls for implementation of structural and non-structural BMPs to improve water quality (CEMCD, 2007). A similar planning study for the Munuscong watershed was initiated in 2010 and is in progress.

The daily geometric means for all mainstem St. Marys River transects (T01-T14) were below the 300 CFU/100mL daily maximum WQS for all 16 of the sampling weeks. Transects T04, T05, T08, and T09 all had values at their most near-shore sampling locations that were greater than 300 CFU/100mL, and one individual sample value was above 14,000 CFU/100mL. This suggests that the volume of water passing through the river is large enough to dilute most bacteria, but that near-shore water quality may be affected by local runoff, discharges, stagnant conditions or other sources.

The sampling spanned 18 weeks from June to the beginning of October. The limited sampling duration makes any conclusions about the impact of seasonality difficult. Week 17 and Week 18 had much lower *E. coli* counts in most sampling locations, but there are many factors that could have resulted in the lower concentrations. *E. coli* are affected by both increases and decreases in temperature, with water above 50°F (10°C) accelerating growth (AWWA 1999), but there are other factors that must be considered. Rainfall and runoff characteristics are also a significant factor in *E. coli* enumeration; on one hand, light rainfall can capture sediment (and feces) that have accumulated after a dry period. This is often known as the first flush and can be thought of as a type of wash-off effect. Theoretically, once the surfaces are "clean" there will be fewer pollutants in the runoff. On the other hand, heavy rainfall can dislodge sediment, causing erosion and transport of sediment and fecal matter, and particularly heavy rainfall can cause CSO discharges.

6. REFERENCES

Ashbolt, N. J., M. E. Schoen, et al. "Predicting pathogen risks to aid beach management: the real value of quantitative microbial risk assessment (QMRA)." Water Res 44(16): 4692-703.

American Water Works Association. "Water Quality and Treatment: A Handbook of Community Water Supplies." Fifth Edition, New York, New York: American Water Works Association, 1999: 18.1-18.49

Bernhard, A. E. and K. G. Field (2000). "Identification of nonpoint sources of fecal pollution in coastal waters by using host-specific 16S ribosomal DNA genetic markers from fecal anaerobes." Appl Environ Microbiol 66(4): 1587-94.

Bernhard, A. E. and K. G. Field (2000). "A PCR assay To discriminate human and ruminant feces on the basis of host differences in Bacteroides-Prevotella genes encoding 16S rRNA." Appl Environ Microbiol 66(10): 4571-4.

Bower, P. A., C. O. Scopel, et al. (2005). "Detection of genetic markers of fecal indicator bacteria in Lake Michigan and determination of their relationship to Escherichia coli densities using standard microbiological methods." Appl Environ Microbiol 71(12): 8305-13.

Chippewa/East Mackinac Conservation District (2007). Sault Ste. Marie Area Watershed Management Plan.

Michigan Department of Natural Resources and Environment Water Bureau, "Quality Assurance Manual for Water, Sediment, and Biological Monitoring", 1994.

Noble, R. T., J. F. Griffith, et al. (2006). "Multitiered approach using quantitative PCR to track sources of fecal pollution affecting Santa Monica Bay, California." Appl Environ Microbiol 72(2): 1604-12.

Santoro, A. E. and A. B. Boehm (2007). "Frequent occurrence of the human-specific Bacteroides fecal marker at an open coast marine beach: relationship to waves, tides and traditional indicators." Environ Microbiol 9(8): 2038-49.

Shanks, O. C., C. A. Kelty, et al. (2009). "Quantitative PCR for genetic markers of human fecal pollution." Appl Environ Microbiol.

Shanks, O. C., C. Nietch, et al. (2006). "Basin-wide analysis of the dynamics of fecal contamination and fecal source identification in Tillamook Bay, Oregon." Appl Environ Microbiol 72(8): 5537-46.

USEPA, "EPA Requirements for Quality Assurance Project Plans", Document Number EPA QA/R-5, March 2001.

USEPA, "Guidance on Environmental Data Verification and Data Validation", Document EPA QA/G-8, November 2002.

Figure 1: St. Marys River Transect Sampling Locations

Sampling Transect

0 2.5 5 10 Miles

St. Marys River Monitoring Project
for TMDL Development Final Report
Prepared for USEPA Region 5 and MDNRE
Developed by KCD - Dec. 2010

Montgomery Associates:
Resource Solutions, LLC
119 South Main St.
Cottage Grove, WI 53527

Figure 2: Tributary Sampling Locations

Sampling Location

St. Marys River Monitoring Project
for TMDL Development Final Report
Prepared for USEPA Region 5 and MDNRE
Developed by KCD - Dec. 2010

0 1.5 3 6 Miles

Montgomery Associates:
Resource Solutions, LLC
119 South Main St.
Cottage Grove, WI 53527

APPENDIX A

GLOBAL POSITIONING SYSTEM COORDINATES OF SAMPLING LOCATIONS

Table A1: GPS Coordinates of Road Crossings (World Geodetic System 1984)

Sample Location	Latitude	Longitude
As1	46.49516	-84.3714
As2	46.48416	-84.3791
As3	46.46453	-84.3720
Ca1	46.49822	-84.3639
Ca2	46.49612	-84.3337
Ch1	46.37410	-84.3220
Ch2	46.37554	-84.3223
Ch3	46.35563	-84.2803
Ch4	46.32038	-84.2254
Fr1	46.45792	-84.2861
Lm1	46.25877	-84.3603
Lm2	46.22882	-84.2896
Mi1	46.48184	-84.3168
Mi2	46.47782	-84.3042
Mu1	46.15831	-84.4939
Mu2	46.15792	-84.3596
Mu3	46.18710	-84.3269
Mu4	46.21635	-84.2903
Mu5	46.15791	-84.3446
Se1	46.48769	-84.4015
Wa1	46.41133	-84.5719
Wa2	46.39693	-84.5333
Wa3	46.40609	-84.4991

Table A2: GPS Coordinates of River Transects (World Geodetic System 1984)

Location	Latitude	Longitude
T01A	46.47254	-84.4517
T01B	46.47249	-84.4531
T01C	46.47348	-84.4550
T01D	46.47403	-84.4574
T01E	46.47486	-84.4592
T01F	46.47594	-84.4619
T02A	46.49053	-84.4079
T02B	46.49190	-84.4082
T02C	46.49355	-84.4085
T02D	46.49579	-84.4088
T02E	46.49764	-84.4092
T02F	46.49965	-84.4094
T02G	46.50139	-84.4101
T02H	46.50359	-84.4095
T03A	46.49955	-84.3347
T03B	46.50056	-84.3338
T03C	46.50179	-84.3329
T03D	46.50270	-84.3322
T03E	46.50428	-84.3305
T04A	46.48966	-84.3066
T04B	46.49092	-84.3059
T04C	46.49281	-84.3049
T04D	46.49377	-84.3044
T04E	46.49554	-84.3035
T04F	46.49693	-84.3028
T04G	46.49839	-84.3021
T04H	46.49933	-84.3014
T05A	46.49553	-84.2574
T05B	46.49662	-84.2581
T05C	46.49732	-84.2587
T05D	46.49856	-84.2596
T05E	46.50032	-84.2615
T06A	46.53104	-84.2227
T06B	46.53213	-84.2239
T06C	46.53317	-84.2251
T06D	46.53409	-84.2262
T06E	46.53484	-84.2270
T06F	46.53608	-84.2288
T07A	46.52936	-84.1316
T07B	46.52991	-84.1312
T07C	46.53041	-84.1308
T07D	46.53122	-84.1304
T07E	46.53190	-84.1300

Location	Latitude	Longitude
T08A	46.46120	-84.2861
T08B	46.46199	-84.2845
T08C	46.46272	-84.2825
T08D	46.46346	-84.2802
T09A	46.39245	-84.2502
T09B	46.39293	-84.2466
T09C	46.39312	-84.2442
T09D	46.39329	-84.2416
T09E	46.3935	-84.2387
T09F	46.39363	-84.2369
T09G	46.39387	-84.2343
T09H	46.39420	-84.2295
T10A	46.309800	-84.2217
T10B	46.30978	-84.2186
T10C	46.30967	-84.2170
T10D	46.30961	-84.2157
T10E	46.30945	-84.2119
T11A	46.32282	-84.1583
T11B	46.32383	-84.1573
T11C	46.32508	-84.1566
T11D	46.32545	-84.1559
T12A	46.34372	-84.1268
T12B	46.34396	-84.1249
T12C	46.34427	-84.1231
T12D	46.34459	-84.1214
T13A	46.13089	-84.0236
T13B	46.13024	-84.0196
T13C	46.12991	-84.0176
T13D	46.12949	-84.0150
T13E	46.12913	-84.0129
T13F	46.12871	-84.0105
T13G	46.12825	-84.0080
T13H	46.12788	-84.0056
T13I	46.12720	-84.0016
T14A	45.98369	-83.8998
T14B	45.98400	-83.8970
T14C	45.98371	-83.8933
T14D	45.98383	-83.8898
T14E	45.98364	-83.8865
T14F	45.98362	-83.8831
T14G	45.98368	-83.8799

Table D1: St. Marys River Monitoring Project for TMDL Development
E. coli Testing Result Summary
All results reported as CFU/100 mL

< 1.0	Results below the reporting limit
300.0	Light grey shaded cell shows exceedance of total body contact daily maximum WQS (300 CFU/100 mL)
1,000.0 *	Light grey shaded cell with asterisk shows exceedance of partial body contact daily maximum WQS (1,000 CFU/100 mL)
130.0	Dark grey shaded cell shows exceedance of total body contact 30-day geomean WQS (130 cfu/100 mL)
75.0	Underlined values show daily geomean of samples collected the day of, or after, a precipitation event greater than 0.25"

SAMPLE LOCATION	NAME	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
As1	As1A	46.5	387.3	727.0	2,419.6	2,954.0	344.8	275.5	1,413.6	3,089.0	410.6	5,633.0	235.9	214.3	6,382.0	5,756.0	1,203.3	161.6	360.9
	As1B	44.1	360.9	816.4	1,732.9	2,419.6	344.8	307.6	2,419.6	1,989.0	272.3	4,165.0	201.4	218.7	6,437.0	4,257.0	920.8	214.2	461.1
	As1C	37.9	365.4	866.4	1,553.1	3,986.0	387.3	248.9	1,986.3	3,267.0	387.3	3,692.0	248.1	387.3	6,053.0	4,195.0	1,413.6	198.9	328.2
	Daily Geomean	42.7	371.0	801.2	1,867.4 *	3,054.2 *	358.4	276.3	1,894.0 *	2,717.7 *	351.2	4,424.6 *	227.6	262.8	6,288.4 *	4,684.4 *	1,161.4 *	190.2	379.4
	30-Day Geomean	--	--	--	--	591.4	905.2	853.4	1,013.6	1,092.6	708.9	1,171.8	1,127.3	759.4	898.1	1,507.9	1,154.0	1,113.3	1,198.1
As2	As2A	53.6	64.4	344.8	90.9	435.2	980.4	135.4	686.7	1,203.3	198.9	66.3	206.4	325.5	387.3	261.3	36.9	124.6	16.1
	As2B	59.8	74.9	261.3	122.3	613.1	517.2	75.4	547.5	1,046.2	290.9	85.7	191.8	365.4	224.7	135.4	35.0	162.4	26.2
	As2C	60.5	67.7	261.3	131.4	613.1	816.4	83.6	648.8	1,553.1	193.5	93.3	547.5	307.6	290.9	156.5	42.8	101.7	22.8
	Daily Geomean	57.9	68.8	286.6	113.4	546.9	745.3	94.9	624.8	1,250.5 *	223.7	81.0	278.8	332.0	293.6	176.9	38.1	127.2	21.3
	30-Day Geomean	--	--	--	--	147.9	246.6	262.9	307.3	496.6	415.3	266.4	330.5	291.3	218.0	208.0	178.9	152.9	88.3
As3	As3A	3,544.0	290.9	686.7	387.3	2,419.6	142.1	209.8	56.5	N/A	325.5	261.3	214.3	155.3	13,169.0	217.8	98.8	88.4	54.8
	As3B	3,931.0	866.4	1,299.7	579.4	1,732.9	172.2	248.1	63.7	8,126.0	201.4	214.3	365.4	198.9	14,209.0	461.1	75.4	90.6	51.2
	As3C	5,940.0	816.4	866.4	579.4	1,732.9	93.3	193.5	65.7	9,075.0	261.3	214.2	387.3	307.6	14,972.0	260.3	73.8	124.6	48.7
	Daily Geomean	4,357.7 *	590.4	917.8	506.6	1,936.8 *	131.6	216.0	61.8	8,587.4 *	257.8	228.9	311.8	211.8	14,097.2 *	296.8	81.9	99.9	51.5
	30-Day Geomean	--	--	--	--	1,183.0	587.5	480.5	280.1	493.4	329.6	368.2	396.2	506.9	559.7	575.7	468.8	373.4	281.4
Ca1	Ca1A	2.0	2.0	1,119.9	14.6	4.1	4.1	6.3	40.2	5.2	3.1	7.4	1.0	12.2	9.5	< 1.0	2.0	26.5	4.1
	Ca1B	< 1.0	1.0	17.5	9.5	5.2	4.1	2.0	13.5	3.0	5.2	2.0	9.8	1.0	3.1	33.6	2.0	32.3	1.0
	Ca1C	2.0	7.3	71.2	12.2	7.4	1.0	2.0	6.2	4.1	3.1	3.1	11.0	5.2	5.2	1.0	2.0	24.3	1.0
	Daily Geomean	1.6	2.5	111.7	11.9	5.4	2.6	2.9	15.0	4.0	3.6	3.6	4.8	4.0	5.3	3.2	2.0	27.5	1.6
	30-Day Geomean	--	--	--	--	7.8	8.5	8.9	5.9	4.8	4.4	4.7	5.2	4.0	4.2	4.1	3.7	5.2	4.3
Ca2	Ca2A	7.4	10.8	185.0	5.2	6.3	< 1.0	5.2	21.8	7.4	3.0	3.1	2.0	7.5	5.2	1.0	4.1	29.2	< 1.0
	Ca2B	4.1	2.0	10.8	17.3	3.1	6.3	6.3	12.1	3.1	5.2	3.1	6.3	7.4	12.0	< 1.0	< 1.0	27.9	4.1
	Ca2C	5.2	2.0	387.3	14.8	5.2	3.0	5.2	17.5	6.3	2.0	5.2	3.1	3.1	10.8	< 1.0	1.0	34.6	1.0
	Daily Geomean	5.4	3.5	91.8	11.0	4.6	2.7	5.6	16.7	5.2	3.2	3.7	3.4	5.5	8.7	1.0	1.6	30.4	1.6
	30-Day Geomean	--	--	--	--	9.8	8.5	9.3	6.6	5.7	5.3	5.6	5.1	4.1	4.5	3.6	3.0	4.7	3.7
Ch1	Ch1A	186.0	11,264.0	648.8	104.6	387.3	1,119.9	727.0	1,299.7	2,590.0	344.8	224.7	214.3	2,419.6	2,419.6	387.3	155.3	228.2	127.4
	Ch1B	206.4	11,582.0	1,046.2	127.4	517.2	1,203.3	816.4	1,732.9	1,413.6	488.4	178.9	125.9	1,732.9	2,419.6	461.1	108.6	206.4	139.6
	Ch1C	172.3	10,144.0	1,203.3	125.9	365.4	770.1	920.8	1,732.9	1,986.3	547.5	224.7	193.5	1,553.1	2,419.6	613.1	127.4	228.2	143.9
	Daily Geomean	187.7	10,979.0 *	934.8	118.8	418.3	1,012.4 *	817.6	1,574.4 *	1,937.4 *	451.8	208.2	173.5	1,867.4 *	2,419.6 *	478.4	129.0	220.7	136.8
	30-Day Geomean	--	--	--	--	625.5	876.2	521.2	578.5	1,011.0	1,026.7	748.3	548.8	567.9	593.7	600.5	545.7	572.6	339.5
Ch2	Ch2A	206.4	10,918.0	2,419.6	201.4	290.9	78.9	1,299.7	1,553.1	435.2	160.7	110.6	325.5	979.0	980.4	307.6	101.4	167.0	81.6
	Ch2B	387.3	8,782.0	1,986.3	201.4	235.9	81.3	1,119.9	1,986.3	344.8	193.5	130.9	238.2	2,419.6	816.4	224.7	104.3	198.9	118.7
	Ch2C	1,732.9	10,860.0	1,553.1	235.9	101.7	107.6	1,553.1	1,299.7	2,419.6	166.4	131.4	290.9	2,419.6	579.4	231.0	98.8	131.4	55.6
	Daily Geomean	517.4	10,135.7 *	1,954.3 *	212.3	191.1	88.4	1,312.4 *	1,588.6 *	713.4	173.0	123.9	282.6	1,789.6 *	774.1	251.8	101.5	163.4	81.4
	30-Day Geomean	--	--	--	--	839.0	589.2	391.5	375.6	478.6	469.2	502.0	369.2	378.1	384.4	414.3	398.1	356.8	192.3
Ch3	Ch3A	547.5	10,807.0	1,413.6	248.9	140.1	68.3	920.8	298.7	248.9	214.3	93.4	228.2	1,413.6	1,119.9	435.2	307.6	190.4	157.6
	Ch3B	816.4	10,712.0	1,203.3	307.6	111.2	93.2	1,203.3	344.8	290.9	261.3	98.5	172.3	1,203.3	1,732.9	378.4	261.3	201.4	107.6
	Ch3C	648.8	9,599.0	1,119.9	272.3	248.1	64.4	1,203.3	435.2	214.3	248.1	73.3	204.6	1,413.6	1,299.7	461.1	143.0	285.1	98.7
	Daily Geomean	661.9	10,357.8 *	1,239.6 *	275.2	157.0	74.3	1,100.7 *	355.2	249.4	240.4	87.7	200.4	1,339.7 *	1,361.2 *	423.5	225.7	221.9	118.7
	30-Day Geomean	--	--	--	--	818.4	528.4	337.5	262.8	257.7	280.6	290.1	206.4	269.1	377.8	423.2	511.2	521.8	321.4
Ch4	Ch4A	32.3	166.4	69.7	18.9	28.8	35.5	71.2	81.6	65.7	39.9	35.5	46.4	151.5	1,413.6	980.4	178.5	218.7	31.3
	Ch4B	19.9	167.0	66.3	11.0	19.9	60.2	96.0	105.0	98.8	21.8	6.3	39.9	143.9	1,413.6	461.1	111.2	104.3	21.8
	Ch4C	38.8	148.3	113.7	38.4	30.5	78.5	150.0	152.9	142.1	78.9	9.8	70.3	307.6	1,299.7	727.0	113.7	272.3	30.9
	Daily Geomean	29.2	160.3	80.7	20.0	26.0	55.1	100.8	109.4	97.3	40.9	13.0	50.6	188.6	1,374.6 *	690.1	131.2	183.8	27.6
	30-Day Geomean	--	--	--	--	45.5	51.7	47.1	50.1	68.8	75.3	56.4	49.2	54.8	93.1	163.7	260.0	336.5	229.2
Fr1	Fr1A	307.6	290.9	1,553.1	275.5	4,103.0	365.4	980.4	167.4	1,299.7	365.4	344.8	18.1	146.7	979.0	1,203.3	290.9	248.9	115.3
	Fr1B	488.4	344.8	1,299.7	218.7	3,498.0	613.1	1,119.9	238.2	1,553.1	248.9	488.4	83.6	152.9	1,119.9	613.1	387.3	261.3	123.6
	Fr1C	290.9	275.5	1,553.1	228.2	2,917.0	517.2	727.0	167.0	1,203.3	313.0	307.6	68.3	224.7	1,046.2	1,046.2	328.2	198.9	86.0
	Daily Geomean	352.3	302.3	1,463.6 *	239.6	3,472.3 *	487.5	927.6	188.1	1,344.2 *	305.3	372.8	46.9	171.4	1,046.8 *	917.3	333.2	234.7	107.0
	30-Day Geomean	--	--	--	--	664.6	709.2	887.5	588.8	831.4	511.2	484.5	266.8	261.8	249.1	310.4	303.5	418.7	381.1

Table D1: St. Marys River Monitoring Project for TMDL Development
E. coli Testing Result Summary
All results reported as CFU/100 mL

< 1.0	Results below the reporting limit
300.0	Light grey shaded cell shows exceedance of total body contact daily maximum WQS (300 CFU/100 mL)
1,000.0 *	Light grey shaded cell with asterisk shows exceedance of partial body contact daily maximum WQS (1,000 CFU/100 mL)
130.0	Dark grey shaded cell shows exceedance of total body contact 30-day geomean WQS (130 cfu/100 mL)
75.0	Underlined values show daily geomean of samples collected the day of, or after, a precipitation event greater than 0.25"

SAMPLE LOCATION	NAME	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
Lm1	Lm1A	191.8	325.5	275.5	111.2	248.9	261.3	866.4	290.9	2,419.6	201.4	488.4	307.6	307.6	75.4	3,410.0	686.7	31.5	25.9
	Lm1B	325.5	161.6	275.5	77.6	387.3	579.4	579.4	307.6	2,419.6	238.2	290.9	235.9	307.6	75.4	2,954.0	547.5	36.9	41.0
	Lm1C	129.6	228.2	290.9	122.3	461.1	547.5	613.1	172.2	1,986.3	290.9	290.9	238.2	1,732.9	90.9	2,790.0	648.8	43.5	30.9
	Daily Geomean	200.8	229.0	280.6	101.8	354.2	436.0	675.2	248.8	2,265.5 *	240.8	345.8	258.6	547.3	80.2	3,040.3 *	624.8	37.0	32.0
	30-Day Geomean	--	--	--	--	215.5	251.7	312.5	305.1	567.4	525.2	501.4	413.8	484.5	248.4	412.5	464.3	314.6	178.3
Lm2	Lm2A	187.2	461.1	344.8	39.9	118.7	410.6	2,281.0	122.3	4,798.0	124.6	461.1	151.5	920.8	131.4	2,419.6	980.4	90.6	28.8
	Lm2B	186.0	579.4	298.7	83.3	129.6	770.1	2,419.6	178.9	3,877.0	178.0	461.1	186.0	920.8	108.1	1,986.3	435.2	101.7	40.8
	Lm2C	260.3	686.7	260.3	88.4	137.6	517.2	2,419.6	142.1	5,121.0	172.5	410.6	166.4	648.8	116.9	1,203.3	461.1	108.6	32.7
	Daily Geomean	208.5	568.2	299.3	66.5	128.4	546.9	2,372.5 *	145.9	4,567.1 *	156.4	443.6	167.4	819.4	118.4	1,795.0 *	581.6	100.0	33.7
	30-Day Geomean	--	--	--	--	197.8	239.8	319.2	276.5	644.3	670.2	642.7	378.2	534.1	257.2	419.1	442.4	399.1	210.9
Mi1	Mi1A	151.5	344.8	1,986.3	235.9	19,349.0	547.5	1,986.3	290.9	10,144.0	344.8	1,986.3	172.2	166.4	1,986.3	224.7	290.9	307.6	38.9
	Mi1B	129.1	298.7	920.8	461.1	17,260.0	410.6	1,732.9	365.4	8,823.0	387.3	1,986.3	155.3	365.4	1,986.3	127.4	325.5	248.9	38.4
	Mi1C	127.4	435.2	1,553.1	290.9	13,540.0	307.6	1,986.3	344.8	10,712.0	365.4	1,732.9	161.6	155.3	1,413.6	166.4	410.6	135.4	30.5
	Daily Geomean	135.6	355.2	1,416.3 *	316.3	16,536.3 *	410.4	1,898.0 *	332.2	9,860.5 *	365.4	1,898.0 *	162.9	211.3	1,773.4 *	168.3	338.8	218.0	35.7
	30-Day Geomean	--	--	--	--	813.7	1,015.5	1,419.9	1,062.4	2,113.7	986.1	1,339.5	819.7	748.8	531.3	455.0	322.3	341.7	239.5
Mi2	Mi2A	142.1	3,129.0	344.8	261.3	648.8	178.5	261.3	143.0	6,382.0	579.4	435.2	517.2	4,284.0	1,413.6	435.2	139.6	261.3	75.4
	Mi2B	344.8	648.8	387.3	214.3	648.8	275.5	488.4	107.6	2,419.6	488.4	488.4	488.4	4,500.0	1,810.0	547.5	172.3	410.6	54.8
	Mi2C	190.4	770.1	547.5	228.2	488.4	231.0	488.4	112.6	5,208.0	325.5	435.2	435.2	5,539.0	2,419.6	686.7	155.3	290.9	59.1
	Daily Geomean	210.5	1,160.6 *	418.2	233.8	590.2	224.8	396.5	120.1	4,316.4 *	451.7	452.2	479.0	4,744.2 *	1,836.2 *	546.9	155.1	314.8	62.5
	30-Day Geomean	--	--	--	--	426.4	432.0	348.5	271.6	486.6	461.2	530.4	550.9	1,149.1	968.6	1,006.4	812.5	747.1	314.3
Mu1	Mu1A	816.4	2,419.6	547.5	344.8	517.2	307.6	248.1	122.3	579.4	307.6	23,822.0	119.8	920.8	488.4	9,599.0	290.9	193.5	49.6
	Mu1B	629.4	2,419.6	387.3	298.7	866.4	387.3	161.6	172.3	613.1	248.9	15,152.0	131.4	1,553.1	547.5	10,807.0	307.6	155.3	68.3
	Mu1C	1,299.7	3,013.0	547.5	613.1	579.4	290.9	228.2	101.4	579.4	248.9	17,247.0	160.7	1,732.9	547.5	9,338.0	290.9	198.9	56.5
	Daily Geomean	874.1	2,603.1 *	487.8	398.2	638.0	326.0	209.2	128.8	590.5	267.1	18,395.9 *	136.3	1,353.3 *	527.1	9,894.5 *	296.4	181.5	57.6
	30-Day Geomean	--	--	--	--	776.3	637.4	384.9	294.9	319.1	268.1	600.6	551.3	882.4	862.6	1,776.4	778.0	823.9	438.2
Mu2	Mu2A	1,203.3	2,686.0	365.4	328.2	290.9	313.0	435.2	410.6	727.0	816.4	980.4	240.0	2,419.6	435.2	N/A	1,046.2	209.8	185.0
	Mu2B	980.4	3,089.0	461.1	285.1	547.5	313.0	461.1	410.6	727.0	686.7	648.8	488.4	1,986.3	517.2	7,976.0	613.1	178.5	135.4
	Mu2C	686.7	4,959.0	410.6	193.5	727.0	325.5	547.5	648.8	816.4	866.4	1,046.2	344.8	2,419.6	275.5	7,227.0	866.4	261.3	157.6
	Daily Geomean	932.2	3,452.3 *	410.5	262.6	487.4	317.1	478.9	478.2	755.7	786.1	873.1	343.2	2,265.5 *	395.8	7,592.3 *	822.2	213.9	158.0
	30-Day Geomean	--	--	--	--	700.8	564.9	380.5	392.3	484.7	533.3	653.1	610.9	833.9	732.7	1,153.3	1,139.5	1,036.7	608.6
Mu3	Mu3A	980.4	2,433.0	613.1	547.5	686.7	547.5	727.0	325.5	365.4	410.6	1,553.1	488.4	2,419.6	410.6	6,995.0	3,267.0	191.8	166.4
	Mu3B	770.1	2,954.0	613.1	365.4	579.4	727.0	648.8	461.1	613.1	547.5	1,203.3	579.4	3,129.0	387.3	9,594.0	5,461.0	307.6	127.4
	Mu3C	1,119.9	2,917.0	488.4	235.9	488.4	387.3	547.5	307.6	488.4	488.4	1,413.6	365.4	2,011.0	517.2	16,071.0	3,692.0	228.2	142.1
	Daily Geomean	945.6	2,757.4 *	568.4	361.4	579.2	536.2	636.8	358.8	478.3	478.8	1,382.4 *	469.4	2,478.5 *	434.9	10,255.2 *	4,038.6 *	237.9	144.4
	30-Day Geomean	--	--	--	--	791.3	706.4	526.9	480.6	508.3	489.3	591.4	556.4	818.9	803.5	1,483.0	1,837.6	1,604.1	908.5
Mu4	Mu4A	178.0	4,882.0	387.3	186.0	111.9	135.4	125.0	71.7	517.2	191.8	866.4	228.2	1,203.3	517.2	2,419.6	344.8	248.1	95.9
	Mu4B	145.5	1,890.0	488.4	166.4	83.6	145.0	201.4	83.3	290.9	131.4	1,413.6	209.8	1,299.7	387.3	1,989.0	235.9	209.8	88.0
	Mu4C	139.6	4,954.0	261.3	201.4	101.7	130.9	344.8	111.9	186.0	107.1	1,203.3	365.4	1,413.6	365.4	2,419.6	325.5	290.9	57.6
	Daily Geomean	153.5	3,575.5 *	367.0	184.0	98.4	137.0	205.5	87.4	303.6	139.2	1,138.0 *	259.6	1,302.7 *	418.3	2266.6 *	298.1	247.4	78.6
	30-Day Geomean	--	--	--	--	325.3	318.0	179.6	134.8	149.0	159.8	244.0	255.6	438.8	467.8	817.4	625.3	619.3	353.2
Mu5	Mu5A	153.9	866.4	686.7	435.2	488.4	1,299.7	980.4	4,519.0	866.4	816.4	1,299.7	410.6	1,986.3	410.6	15,648.0	5,448.0	6.0	135.4
	Mu5B	195.6	920.8	648.8	231.0	488.4	1,046.2	1,046.2	2,011.0	1,986.3	816.4	1,413.6	727.0	2,419.6	290.9	12,740.0	6,266.0	198.9	146.7
	Mu5C	488.4	517.2	488.4	387.3	344.8	1,299.7	727.0	5,291.0	1,413.6	461.1	1,299.7	648.8	2,419.6	275.5	16,695.0	6,568.0	248.9	115.3
	Daily Geomean	245.0	744.5	601.5	338.9	434.9	1,209.0 *	906.8	3,636.3 *	1,344.9 *	674.8	1,336.6 *	578.6	2,265.5 *	320.5	14,930.4 *	6,075.1 *	66.7	131.8
	30-Day Geomean	--	--	--	--	438.3	603.1	627.4	899.1	1,184.5	1,293.3	1,319.5	1,206.1	1,097.2	823.6	1,529.9	2,071.0	1,344.5	761.2
Se1	Se1A	161.6	686.7	1,732.9	307.6	648.8	488.4	770.1	1,046.2	1,413.6	547.5	727.0	613.1	866.4	770.1	1,119.9	686.7	131.4	45.7
	Se1B	185.0	387.3	1,413.6	307.6	2,419.6	980.4	1,553.1	1,203.3	1,413.6	980.4	866.4	579.4	648.8	410.6	648.8	517.2	129.6	62.0
	Se1C	238.2	461.1	1,119.9	325.5	26,025.0	1,732.9	1,203.3	1,046.2	2,419.6	435.2	517.2	613.1	648.8	488.4	579.4	648.8	172.5	56.3
	Daily Geomean	192.4	496.8	1,399.9 *	313.5	3,444.2 *	939.7	1,129.0 *	1,096.2 *	1,691.0 *	615.9	688.1	601.7	714.5	536.5	749.5	613.1	143.2	54.2
	30-Day Geomean	--	--	--	--	679.1	932.6	1,099.0	1,046.6	1,466.1	1,039.1	976.3	860.8	790.2	628.1	653.2	638.3	479.0	286.0

Table D1: St. Marys River Monitoring Project for TMDL Development
E. coli Testing Result Summary

All results reported as CFU/100 mL

< 1.0	Results below the reporting limit
300.0	Light grey shaded cell shows exceedance of total body contact daily maximum WQS (300 CFU/100 mL)
1,000.0 *	Light grey shaded cell with asterisk shows exceedance of partial body contact daily maximum WQS (1,000 CFU/100 mL)
130.0	Dark grey shaded cell shows exceedance of total body contact 30-day geomean WQS (130 cfu/100 mL)
75.0	Underlined values show daily geomean of samples collected the day of, or after, a precipitation event greater than 0.25"

SAMPLE LOCATION	NAME	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
Wa1	Wa1A	104.6	118.7	71.2	248.1	50.4	185.0	93.2	68.9	68.3	142.1	69.7	34.1	49.6	150.0	344.8	118.7	209.8	25.6
	Wa1B	101.7	118.7	66.3	135.4	53.8	105.0	102.5	52.9	48.7	142.1	52.1	23.3	65.7	214.2	488.4	79.8	190.4	38.3
	Wa1C	248.1	167.0	52.9	193.5	73.3	186.0	122.3	77.6	133.4	127.4	43.5	33.6	74.9	101.4	461.1	86.0	178.2	35.0
	Daily Geomean	***138.2***	***133.0***	***63.0***	***186.6***	***58.4***	***153.4***	***105.3***	***65.6***	***76.3***	***137.0***	***54.0***	***29.9***	***62.5***	***148.3***	***426.6***	***93.4***	***192.4***	***32.5***
	30-Day Geomean	--	--	--	--	**104.7**	**107.0**	**102.1**	**102.9**	**86.1**	**102.1**	**82.9**	**64.4**	**63.8**	**72.8**	**91.4**	**102.0**	**148.0**	**129.8**
Wa2	Wa2A	461.1	124.6	190.4	275.5	90.6	36.9	53.8	43.2	88.4	143.9	88.6	90.8	101.7	410.6	461.1	151.5	133.3	48.7
	Wa2B	613.1	214.3	165.8	290.9	111.9	77.6	48.8	51.2	78.0	137.6	70.6	151.5	86.2	307.6	517.2	148.3	123.6	48.0
	Wa2C	410.6	135.4	137.4	435.2	57.3	83.6	76.7	55.4	64.4	165.8	111.9	85.5	186.0	275.5	579.4	142.1	95.9	39.3
	Daily Geomean	***487.8***	***153.5***	***163.0***	***326.7***	***83.5***	***62.1***	***58.6***	***49.7***	***76.3***	***148.6***	***88.8***	***105.5***	***117.7***	***326.5***	***517.0***	***147.3***	***116.5***	***45.1***
	30-Day Geomean	--	--	--	--	**201.6**	**133.5**	**110.1**	**86.8**	**64.9**	**72.8**	**78.2**	**88.0**	**104.6**	**139.9**	**179.5**	**198.6**	**202.5**	**167.2**
Wa3	Wa3A	88.6	61.3	131.4	235.9	90.6	104.6	66.3	101.4	222.4	206.4	133.4	142.1	201.4	435.2	920.8	104.6	686.7	98.8
	Wa3B	53.8	67.0	114.5	248.9	85.5	135.4	103.9	125.9	155.3	108.1	131.4	110.6	105.4	344.8	1,046.2	86.0	238.2	78.0
	Wa3C	44.8	90.8	129.6	307.6	73.8	129.6	63.7	178.9	137.6	74.4	127.4	118.7	118.7	307.6	816.4	727.0	275.5	53.7
	Daily Geomean	***59.8***	***71.9***	***124.9***	***262.4***	***83.0***	***122.4***	***76.0***	***131.7***	***168.1***	***118.4***	***130.7***	***123.1***	***136.1***	***358.7***	***923.1***	***187.0***	***355.9***	***74.5***
	30-Day Geomean	--	--	--	--	**103.2**	**119.1**	**120.4**	**121.7**	**111.3**	**119.5**	**121.1**	**133.4**	**134.2**	**156.2**	**235.5**	**253.0**	**312.9**	**277.4**

Table D1: St. Marys River Monitoring Project for TMDL Development
E. coli Testing Result Summary
All results reported as CFU/100 mL

< 1.0	Results below the reporting limit
300.0	Light grey shaded cell shows exceedance of total body contact daily maximum WQS (300 CFU/100 mL)
1,000.0 *	Light grey shaded cell with asterisk shows exceedance of partial body contact daily maximum WQS (1,000 CFU/100 mL)
130.0	Dark grey shaded cell shows exceedance of total body contact 30-day geomean WQS (130 cfu/100 mL)
75.0	Underlined values show daily geomean of samples collected the day of, or after, a precipitation event greater than 0.25"

SAMPLE LOCATION	NAME	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
T01	T01A	< 1.0	18.5	4.1	9.7	16.1	17.5	2.0	4.1	19.5	4.1	12.2	6.3	4.1	5.2	< 1.0	2.0		
	T01B	1.0	3.1	6.3	5.2	14.8	9.7	4.1	4.1	14.8	1.0	4.1	3.0	17.3	4.1	10.4	3.1		
	T01C	< 1.0	3.1	4.1	5.1	1.0	1.0	5.2	< 1.0	6.3	2.0	8.5	< 1.0	1.0	3.1	1.0	1.0		
	T01D	2.0	7.5	4.1	9.8	8.5	2.0	7.2	7.5	14.4	20.1	4.1	3.1	2.0	6.3	2.0	1.0		
	T01E	< 1.0	2.0	4.1	< 1.0	10.8	6.3	7.5	8.5	5.2	5.2	5.2	1.0	< 1.0	3.1	2.0	1.0		
	T01F	< 1.0	1.0	2.0	< 1.0	13.5	7.4	11.0	6.3	4.1	10.9	4.1	2.0	5.2	1.0	2.0	1.0		
US Geomean		1.2	6.0	4.6	7.1	6.7	4.3	4.2	3.4	12.7	3.6	6.5	2.8	3.5	4.5	2.1	1.6		
Daily Geomean		1.1	3.7	3.9	3.7	8.2	5.0	5.4	4.4	9.0	4.6	5.8	2.2	3.0	3.3	2.1	1.4		
30-Day Geomean		--	--	--	--	3.5	4.7	5.0	5.1	6.1	5.5	5.6	4.7	4.4	3.6	3.1	2.3		
T02	T02A	1.0	1.0	8.6	< 1.0	11.0	101.4	2.0	5.2	9.7	15.2	16.9	13.4	13.1	6.3	2.0	8.4		
	T02B	1.0	14.8	1.0	2.0	3.1	5.2	3.1	< 1.0	17.5	< 1.0	3.1	< 1.0	6.2	5.2	< 1.0	4.1		
	T02C	< 1.0	1.0	8.6	< 1.0	3.0	1.0	3.0	2.0	7.5	2.0	1.0	< 1.0	< 1.0	8.6	2.0	5.2		
	T02D	< 1.0	< 1.0	8.6	< 1.0	4.1	5.2	1.0	1.0	6.3	2.0	6.3	< 1.0	< 1.0	2.0	3.1	5.2		
	T02E	< 1.0	1.0	1.0	3.1	2.0	2.0	8.6	1.0	1.0	< 1.0	1.0	1.0	1.0	3.1	2.0	7.5		
	T02F	1.0	< 1.0	8.6	1.0	1.0	1.0	2.0	2.0	2.0	18.7	1.0	1.0	< 1.0	5.2	< 1.0	4.1		
	T02G	< 1.0	< 1.0	2.0	< 1.0	3.1	6.3	3.0	1.0	2.0	5.2	4.1	1.0	3.0	9.8	6.3	1.0		
	T02H	< 1.0	4.1	3.1	3.1	613.1	5.1	5.2	11.0	16.0	20.1	38.8	5.2	6.3	9.8	53.6	6.2		
US Geomean		1.0	1.6	4.2	1.4	3.1	4.2	2.6	1.7	5.0	3.2	2.6	1.5	2.1	4.6	1.7	5.5		
Daily Geomean		1.0	1.7	3.7	1.4	6.0	4.5	2.9	2.0	5.2	4.3	3.9	1.7	2.5	5.5	3.1	4.5		
30-Day Geomean		--	--	--	--	2.2	3.0	3.3	3.0	3.8	3.6	3.5	3.1	3.3	3.3	3.1	3.2		
T03	T03A	9.8	52.8	10.7	7.4	15.8	3.1	27.2	25.6	8.6	14.8	5.2	2.0	19.9	14.6	3.0	5.1		
	T03B	24.3	39.5	3.1	8.4	8.4	2.0	36.4	17.5	22.3	9.7	7.4	4.1	30.5	19.9	8.5	7.5		
	T03C	8.4	166.4	3.1	6.3	23.3	4.1	72.3	11.0	5.1	3.1	4.1	< 1.0	12.1	9.8	6.2	2.0		
	T03D	2.0	6.3	5.2	4.1	2.0	9.7	32.3	3.1	5.2	8.4	4.1	5.2	22.8	25.9	4.1	5.2		
	T03E	28.8	488.4	8.5	6.3	8.6	22.8	41.0	23.3	16.1	14.6	3.1	22.3	461.1	26.2	3.0	7.5		
US Geomean		8.0	38.4	4.8	6.3	8.9	4.0	39.0	11.1	8.5	7.8	5.0	2.6	20.2	16.5	5.1	4.5		
Daily Geomean		10.3	63.9	5.4	6.3	8.8	5.6	39.4	12.9	9.6	8.8	4.6	4.0	37.8	18.1	4.6	5.0		
30-Day Geomean		--	--	--	--	11.5	10.1	9.2	11.0	11.9	11.9	11.5	7.2	9.0	10.2	8.9	9.1		
T04	T04A	43.5	14,497.0	62.0	9.8	8.4	14.6	23.1	82.0	21.1	1,046.2	82.0	146.4	7,227.0	238.2	231.0	122.3		
	T04B	10.9	35.0	8.6	6.3	9.8	7.5	13.4	21.6	18.5	7.5	6.3	12.2	22.8	35.5	5.2	8.6		
	T04C	6.3	16.0	4.1	5.2	13.4	11.0	41.4	14.8	9.8	11.0	8.5	7.5	65.7	27.5	25.6	6.3		
	T04D	6.3	26.2	4.1	10.8	19.5	8.6	42.2	23.1	10.8	9.6	5.2	8.5	101.0	46.4	2.0	9.5		
	T04E	23.1	146.7	9.6	8.4	17.5	7.5	86.0	32.7	17.3	11.0	10.8	17.5	19.9	35.5	12.1	35.0		
	T04F	21.3	68.3	6.3	11.0	53.8	6.3	139.6	20.1	45.9	17.3	16.1	24.3	18.3	38.4	5.2	29.2		
	T04G	224.7	78.9	8.6	6.3	60.2	14.8	686.7	41.4	48.7	12.2	11.8	14.8	28.1	41.4	7.5	19.7		
	T04H	55.7	3,454.0	118.7	8.6	488.4	59.8	201.4	185.0	248.1	142.1	68.3	117.8	4,954.0	365.4	28.1	77.1		
US Geomean		11.7	120.7	9.7	7.7	12.1	10.1	27.1	27.9	14.2	30.1	12.3	18.4	181.9	57.3	15.8	15.9		
Daily Geomean		24.1	166.1	12.4	8.0	29.6	12.0	73.9	36.3	28.2	26.9	15.4	23.2	123.9	62.1	13.0	23.6		
30-Day Geomean		--	--	--	--	26.0	22.6	19.2	23.8	30.6	30.0	31.6	25.0	32.0	37.5	32.4	35.3		
T05	T05A	70.8	1,413.6	16.0	11.0	47.1	9.6	45.9	69.1	35.5	22.8	11.0	14.6	17.9	18.5	6.3	18.5		
	T05B	52.0	114.5	11.0	9.7	52.0	9.8	16.9	35.9	27.2	6.3	12.2	11.0	22.8	23.5	2.0	13.5		
	T05C	88.0	93.3	5.2	6.3	74.9	17.3	47.1	23.3	25.6	8.6	6.3	9.8	21.6	19.9	10.9	17.5		
	T05D	21.1	5.2	6.3	9.8	30.9	8.6	61.3	21.6	11.0	3.1	11.0	7.5	12.2	30.1	8.5	12.2		
	T05E	40.4	686.7	16.9	10.9	56.5	17.3	17.9	70.6	51.2	14.8	9.6	42.8	86.0	32.3	16.1	19.5		
US Geomean		68.7	247.1	9.7	8.8	56.8	11.8	33.2	38.7	29.1	10.7	9.5	11.6	20.7	20.5	5.2	16.3		
Daily Geomean		48.8	139.8	10.0	9.4	50.3	11.9	33.2	38.8	26.8	8.9	9.8	13.8	24.7	24.3	7.2	16.0		
30-Day Geomean		--	--	--	--	31.7	23.9	17.9	23.5	29.1	20.6	19.8	16.6	15.2	14.9	14.2	15.7		

Table D1: St. Marys River Monitoring Project for TMDL Development
E. coli Testing Result Summary
All results reported as CFU/100 mL

< 1.0	Results below the reporting limit
300.0	Light grey shaded cell shows exceedance of total body contact daily maximum WQS (300 CFU/100 mL)
1,000.0 *	Light grey shaded cell with asterisk shows exceedance of partial body contact daily maximum WQS (1,000 CFU/100 mL)
130.0	Dark grey shaded cell shows exceedance of total body contact 30-day geomean WQS (130 cfu/100 mL)
75.0	Underlined values show daily geomean of samples collected the day of, or after, a precipitation event greater than 0.25"

SAMPLE LOCATION	NAME	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
T06	T06A	22.6	23.1	20.1	2.0	24.3	5.2	29.2	71.7	53.0	3.1	5.2	17.5	48.8	93.3	5.2	9.6		
	T06B	N/R	7.3	25.9	3.0	13.4	5.2	30.9	10.8	25.9	6.2	6.3	20.3	N/A*	90.9	5.2	7.5		
	T06C	28.8	13.4	10.7	5.2	12.2	5.2	21.1	14.6	28.8	2.0	4.1	8.4	5.2	74.4	7.5	16.0		
	T06D	96.0	14.8	12.1	6.3	12.0	5.1	23.1	13.1	25.0	4.1	5.2	6.3	8.5	111.2	6.3	20.1		
	T06E	86.2	***< 1.0***	13.2	5.2	18.5	2.0	16.1	16.0	30.5	8.4	8.5	6.2	7.4	290.9	2.0	17.3		
	T06F	45.5	2.0	7.4	3.1	9.7	2.0	8.6	21.6	27.9	6.3	2.0	3.1	33.6	185.0	7.4	13.4		
	US Geomean	***25.5***	***13.1***	***17.7***	***3.2***	***15.8***	***5.2***	***26.7***	***22.5***	***34.1***	***3.4***	***5.1***	***14.4***	***15.9***	***85.8***	***5.9***	***10.5***		
	Daily Geomean	***47.6***	***6.4***	***13.7***	***3.8***	***14.3***	***3.8***	***19.8***	***19.3***	***30.7***	***4.5***	***4.8***	***8.4***	***14.0***	***124.8***	***5.2***	***13.2***		
	30-Day Geomean	--	--	--	--	**11.8**	**7.1**	**8.9**	**9.5**	**14.5**	**11.5**	**12.0**	**10.1**	**9.5**	**12.6**	**12.9**	**15.9**		
T07	T07A	61.7	6.3	7.5	8.6	7.3	9.7	104.6	34.5	68.3	14.6	6.3	16.0	16.0	39.5	7.4	14.6		
	T07B	23.1	9.8	6.3	4.1	9.8	7.4	29.2	13.4	54.5	9.8	9.7	5.1	9.8	70.6	6.3	8.4		
	T07C	7.3	9.8	8.6	7.4	10.9	6.1	34.1	10.8	38.8	6.3	1.0	12.2	13.2	38.9	5.2	4.1		
	T07D	9.6	9.7	3.1	14.6	15.8	17.3	19.9	11.0	44.1	3.1	6.3	11.0	12.2	56.3	11.0	7.2		
	T07E	8.5	13.4	12.1	6.2	12.1	17.1	24.3	17.3	48.7	12.0	8.6	10.9	13.2	76.3	3.1	12.0		
	US Geomean	***21.8***	***8.4***	***7.4***	***6.4***	***9.2***	***7.6***	***47.0***	***17.1***	***52.4***	***9.7***	***3.9***	***10.0***	***12.7***	***47.7***	***6.2***	***7.9***		
	Daily Geomean	***15.3***	***9.5***	***6.8***	7.5	***10.8***	***10.5***	***34.7***	***15.7***	***49.9***	***8.0***	***5.0***	***10.4***	***12.7***	***54.2***	***6.1***	***8.5***		
	30-Day Geomean	--	--	--	--	**9.6**	**8.9**	**11.5**	**13.6**	**19.9**	**18.7**	**16.2**	**12.7**	**12.2**	**12.4**	**11.7**	**13.0**		
T08	T08A	121.1	920.8	29.4	21.1	26.9	17.5	63.8	31.7	38.4	18.7	8.6	115.3	307.6	547.5	13.2	9.7		
	T08B	43.5	55.6	16.1	14.6	20.1	***< 1.0***	21.8	15.8	13.5	17.3	13.5	37.3	12.1	12.2	2.0	6.3		
	T08C	30.5	38.9	6.3	7.5	24.1	9.8	39.3	18.9	12.2	11.0	7.4	14.5	9.5	17.1	3.0	6.3		
	T08D	45.0	69.7	80.5	13.4	38.8	14.6	95.9	25.6	44.1	11.0	7.5	43.9	37.9	18.5	7.3	8.5		
	Daily Geomean	***51.9***	***108.5***	***22.2***	***13.2***	***26.6***	***7.1***	***47.9***	***22.2***	***23.0***	***14.1***	***8.9***	***40.7***	***34.0***	***38.2***	***4.9***	***7.6***		
	30-Day Geomean	--	--	--	--	**33.8**	**22.7**	**19.3**	**19.3**	**21.5**	**18.9**	**19.8**	**19.2**	**20.9**	**23.1**	**18.8**	**18.2**		
T09	T09A	6.3	203.5	115.3	4.1	1,119.9	8.5	16.0	23.1	14.5	7.4	14.8	19.9	12.1	37.4	30.5	24.9		
	T09B	***< 1.0***	39.7	112.6	8.5	16.0	16.0	195.6	45.0	26.5	3.1	***< 1.0***	49.5	18.9	21.6	1.0	3.1		
	T09C	13.5	8.6	135.4	5.2	9.8	17.1	22.8	13.5	12.1	4.1	4.1	6.2	11.0	46.7	***< 1.0***	6.3		
	T09D	79.8	13.0	22.8	5.2	22.3	2.0	26.9	8.6	8.4	5.2	5.2	13.5	6.2	63.3	3.0	4.1		
	T09E	56.5	43.7	27.8	5.2	3.1	7.5	13.2	6.3	7.5	5.2	6.3	8.5	8.5	38.8	***< 1.0***	3.1		
	T09F	27.5	15.8	6.2	1.0	4.1	4.1	18.9	5.1	8.4	5.2	7.5	5.2	13.0	14.4	4.1	4.1		
	T09G	19.5	14.8	9.8	5.2	9.7	3.0	12.2	10.9	11.0	6.3	1.0	10.9	9.8	10.9	3.0	6.3		
	T09H	47.3	10.9	6.2	6.3	152.9	6.3	18.7	19.7	17.3	62.7	2.0	42.8	35.0	80.9	***< 1.0***	4.1		
	Daily Geomean	***17.7***	***23.7***	***28.4***	***4.5***	***22.8***	***6.4***	***24.0***	***13.0***	***12.1***	***6.9***	***3.6***	***14.2***	***12.5***	***32.2***	***2.4***	***5.3***		
	30-Day Geomean	--	--	--	--	**16.5**	**13.4**	**13.5**	**11.5**	**14.1**	**11.1**	**9.9**	**8.9**	**8.8**	**10.7**	**8.7**	**9.4**		
T10	T10A	579.4	275.5	33.6	22.8	22.8	65.7	N/R	16.9	33.6	44.3	11.0	6.2	4.1	118.7	290.9	26.9		
	T10B	***< 1.0***	***< 1.0***	1.0	***< 1.0***	1.0	1.0	***< 1.0***	2.0	***< 1.0***	1.0	3.1	2.0	1.0	325.5	56.3	4.1		
	T10C	4.1	2.0	2.0	2.0	13.1	5.2	***< 1.0***	***< 1.0***	1.0	1.0	1.0	2.0	4.1	6.3	3.1	***< 1.0***		
	T10D	3.0	2.0	17.1	4.1	15.8	1.0	6.2	6.3	12.2	3.0	1.0	4.1	7.4	8.5	2.0	5.2		
	T10E	33.6	1.0	13.4	***< 1.0***	7.5	11.0	2.0	2.0	6.3	1.0	3.1	4.1	11.0	7.5	2.0	2.0		
	Daily Geomean	***12.0***	***4.1***	***6.9***	***2.9***	***8.1***	***5.2***	***1.9***	***3.4***	***4.8***	***2.7***	***2.5***	***3.4***	***4.2***	***27.4***	***11.5***	***4.1***		
	30-Day Geomean	--	--	--	--	**6.0**	**5.1**	**4.3**	**3.8**	**4.2**	**3.3**	**2.9**	**3.3**	**3.4**	**4.8**	**6.5**	**7.1**		
T11	T11A	13.1	40.2	11.9	1.0	9.7	3.0	65.0	28.8	7.5	7.4	***< 1.0***	4.1	6.2	7.4	3.1	1.0		
	T11B	4.1	2.0	7.5	1.0	18.7	5.2	2.0	6.3	10.9	5.1	4.1	1.0	4.1	8.6	1.0	***< 1.0***		
	T11C	3.1	3.1	8.5	4.1	9.7	4.1	4.1	3.1	9.8	3.1	4.1	1.0	5.2	11.0	2.0	2.0		
	T11D	3.0	3.1	10.8	***< 1.0***	23.1	2.0	9.7	4.1	17.3	***< 1.0***	***< 1.0***	4.1	2.0	6.3	***< 1.0***	***< 1.0***		
	Daily Geomean	***4.7***	***5.3***	***9.5***	***1.4***	***14.2***	***3.4***	***8.5***	***6.9***	***10.8***	***3.3***	***2.0***	***2.0***	***4.1***	***8.1***	***1.6***	***1.2***		
	30-Day Geomean	--	--	--	--	**5.4**	**5.1**	**5.6**	**5.2**	**7.9**	**5.9**	**5.3**	**4.0**	**3.6**	**3.4**	**2.9**	**2.6**		

Table D1: St. Marys River Monitoring Project for TMDL Development
E. coli Testing Result Summary
All results reported as CFU/100 mL

< 1.0	Results below the reporting limit
300.0	Light grey shaded cell shows exceedance of total body contact daily maximum WQS (300 CFU/100 mL)
1,000.0 *	Light grey shaded cell with asterisk shows exceedance of partial body contact daily maximum WQS (1,000 CFU/100 mL)
130.0	Dark grey shaded cell shows exceedance of total body contact 30-day geomean WQS (130 cfu/100 mL)
75.0	Underlined values show daily geomean of samples collected the day of, or after, a precipitation event greater than 0.25"

SAMPLE LOCATION	NAME	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
T12	T12A	< 1.0	7.5	8.6	2.0	3.0	2.0	6.3	5.2	5.2	6.3	2.0	4.1	9.5	5.2	3.1	1.0		
	T12B	< 1.0	9.8	11.0	3.1	2.0	2.0	3.1	4.1	4.1	2.0	3.0	1.0	12.2	2.0	3.1	6.3		
	T12C	< 1.0	13.2	6.3	3.1	2.0	2.0	6.3	5.2	8.5	1.0	2.0	7.5	16.0	5.2	2.0	4.1		
	T12D	2.0	9.0	43.5	2.0	43.2	4.1	12.2	38.3	5.2	4.1	1.0	1.0	14.6	3.1	2.0	6.3		
	US Geomean	1.0	9.9	8.4	2.7	2.3	2.0	4.9	4.8	5.7	2.3	2.3	3.1	12.3	3.8	2.7	3.0		
	Daily Geomean	1.2	9.7	12.7	2.5	4.8	2.4	6.2	8.1	5.6	2.7	1.9	2.4	12.8	3.6	2.5	3.6		
	30-Day Geomean	--	--	--	--	4.5	5.1	4.7	4.3	5.0	4.5	4.3	3.5	3.9	3.5	3.5	3.9		
T13	T13A	2.0	28.8	< 1.0	3.1	10.7	12.2	1.0	4.1	7.4	< 1.0	< 1.0	< 1.0	2.0	25.3	2.0	3.1		
	T13B	1.0	8.5	6.3	< 1.0	4.1	< 1.0	< 1.0	4.1	2.0	< 1.0	< 1.0	1.0	< 1.0	4.1	2.0	< 1.0		
	T13C	1.0	1.0	2.0	1.0	3.1	< 1.0	< 1.0	3.1	2.0	< 1.0	< 1.0	3.1	< 1.0	5.2	2.0	< 1.0		
	T13D	< 1.0	4.1	3.0	< 1.0	< 1.0	4.1	< 1.0	4.1	6.3	< 1.0	1.0	< 1.0	< 1.0	4.1	1.0	5.2		
	T13E	1.0	< 1.0	< 1.0	< 1.0	3.1	5.2	1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.0	1.0	4.1	1.0	1.0		
	T13F	5.2	< 1.0	2.0	2.0	< 1.0	1.0	2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	3.0	1.0	1.0		
	T13G	1.0	1.0	1.0	1.0	< 1.0	8.4	< 1.0	< 1.0	1.0	< 1.0	< 1.0	1.0	< 1.0	4.1	< 1.0	1.0		
	T13H	21.1	1.0	65.7	2.0	23.1	15.8	4.1	12.0	3.0	4.1	3.0	< 1.0	1.0	5.2	1.0	< 1.0		
	T13I	4.1	1.0	39.5	14.6	15.6	88.6	12.1	3.1	2.0	< 1.0	3.0	2.0	20.1	44.8	2.0	1.0		
	US Geomean	1.4	2.7	1.9	1.3	2.4	3.0	1.1	2.2	2.1	1.0	1.0	1.3	1.1	5.3	1.4	1.5		
	Daily Geomean	2.1	2.2	3.9	1.8	3.8	5.2	1.7	2.7	2.2	1.2	1.3	1.3	1.5	6.7	1.4	1.4		
	30-Day Geomean	--	--	--	--	2.6	3.1	3.0	2.8	2.9	2.3	1.7	1.6	1.5	1.8	1.9	1.9		
T14	T14A	4.1	2.0	15.8	< 1.0	2.0	44.8	< 1.0	1.0	13.2	1.0	2.0	1.0	1.0	4.1	14.6	1.0		
	T14B	1.0	< 1.0	2.0	< 1.0	1.0	8.6	< 1.0	1.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
	T14C	< 1.0	2.0	< 1.0	< 1.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
	T14D	< 1.0	2.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	1.0	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.0	< 1.0		
	T14E	< 1.0	1.0	1.0	< 1.0	< 1.0	2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	N/A	< 1.0	2.0	1.0	< 1.0		
	T14F	< 1.0	1.0	< 1.0	< 1.0	< 1.0	9.7	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
	T14G	2.0	< 1.0	4.1	1.0	7.3	6.3	< 1.0	2.0	2.0	5.2	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		
	Daily Geomean	1.4	1.4	2.0	1.0	1.9	5.0	1.0	1.3	1.3	1.7	1.0	1.0	1.0	1.3	1.0	1.0		
	30-Day Geomean	--	--	--	--	1.5	1.9	1.8	1.6	1.7	1.7	1.2	1.2	1.2	1.2	1.0	1.0		