BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	R08-9
EFFLUENT LIMITATIONS FOR THE	)	(Rulemaking - Water)
CHICAGO AREA WATERWAY SYSTEM	)	
AND THE LOWER DES PLAINES RIVER:	)	Subdocket A
PROPOSED AMENDMENTS TO 35 Ill.	)	
Adm. Code Parts 301, 302, 303 and 304	)	

NOTICE OF FILING

To: ALL COUNSEL OF RECORD
(Service List Attached)

PLEASE TAKE NOTICE that on the 5th day of May, 2010, I, on behalf of the Metropolitan Water Reclamation District of Greater Chicago (the "District"), electronically filed with the Office of the Clerk of the Illinois Pollution Control Board, **CHEERS Research Update, An Interim Technical Report Prepared for Submission to the Illinois Pollution Control Board, and Appendices (the "CHEERS Technical Report")**.

The District is filing the CHEERS Technical Report in Subdocket A concurrently with filing the Report in Subdocket B, as the Report is relevant to the issues involved in both Subdockets. As to Subdocket A, in its Final Comments on Recreational Use Designations filed on April 15, 2010, the District argued, among many other points, that "the Board should at least wait to determine whether fishing should be included within the definition of Incidental Contact Recreation until the [CHEERS] Study, currently being conducted by Dr. Samuel Dorevitch, is completed by late summer this year, as the CHEERS study will provide information on the actual water exposure involved with fishing." Dist. Final Comments, at 6. The CHEERS Technical Report that is being filed today will form the basis for the final CHEERS study that the District will file later this year and that is referenced in the District's final comments. Because the CHEERS Technical Report relates to a point raised in the District's Final Comments on Recreational Use Designations, the District is filing the Report in Subdocket A, as well as Subdocket B.

Dated: May 5, 2010

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

By: *<u>/s/ David T. Ballard</u>*
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PROOF OF SERVICE

The undersigned, a non-attorney, certifies, under penalties of perjury pursuant to 735 ILCS 5/1-109, that I caused a copy of the forgoing, **Notice of Filing** and **CHEERS Research Update, An Interim Technical Report Prepared for Submission to the Illinois Pollution Control Board, and Appendices**, to be served via First Class Mail, postage prepaid, from One North Wacker Drive, Chicago, Illinois, on the 5th day of May, 2010, upon the attorneys of record on the attached Service List.

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CHEERS Research Update

An Interim Technical Report

Prepared for Submission to the

Illinois Pollution Control Board

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and the

CHEERS Research Group

University of Illinois at Chicago

School of Public Health

May 5, 2010

CHEERS

WATER CHICAGO SPORTS

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Chapter I.Background

Section 1.01 The Chicago Area Waterways System

The Chicago Area Waterways System (CAWS) is a 78-mile engineered system that receives secondary treated wastewater from Chicago and numerous other municipalities. Four water reclamation plants (WRPs) of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) treat, but do not disinfect, wastewater that is then discharged to the CAWS. During wet weather the CAWS receives urban runoff. Additionally, combined sewer overflows (CSOs) result in the discharge of untreated stormwater and wastewater into the CAWS. The effluent from the WRPs account for approximately 70% of the flow on the CAWS, overall. During dry weather, the effluent accounts for more than 90% of the flow. Other inputs into the CAWS include the North Branch of the Chicago River at the North Branch Dam, the Grand Calumet River, the Little Calumet River (south leg), and Lake Michigan via pumping stations and locks.

The CAWS has become a popular setting for paddling, rowing, fishing, and boating. The Illinois Environmental Protection Agency (IEPA) has proposed recreational uses and effluent fecal coliform standards that would require disinfection of WRP effluents discharged into reaches of the CAWS designated for incidental contact and non-contact recreation. This proposal is currently before the Illinois Pollution Control Board.

Section 1.02 The UIC CHEERS research study

The MWRDGC has sought to characterize the health risks of recreational use of the CAWS under current (i.e., non-disinfection) conditions. A quantitative microbial risk assessment has been conducted by Geosyntec Consultants. The risk assessment concluded that about 1-2 cases of gastrointestinal illness are expected to occur per 1,000 recreational uses of the CAWS. To further characterize the health risks of CAWS recreation, an epidemiologic study has been conducted by a research group at the University of Illinois at Chicago (UIC) School of Public Health for the MWRDGC. The overall goal of that study is to characterize the health risks of CAWS recreation. The study is referred to as CHEERS, the Chicago Health, Environmental Exposure, and Recreation Study. CHEERS is a prospective cohort study, designed using the US Environmental Protection Agency (EPA) National Epidemiological and Environmental Assessment of Recreational Water (NEEAR) study as a template. The CHEERS research protocol has undergone a peer review coordinated by the Water Environment Research Foundation. The peer review process began prior to the field launch of the study, and has included annual reviews of data quality, data analysis methods, and summaries of findings.

The primary research questions that the UIC research team seeks to address are:

1) What are the health risks attributable to incidental contact recreation on the CAWS under current (i.e., non-disinfection) conditions?

2) What is the relationship between microbial measures of water quality and the risks of illness due to incidental contact recreation?

3) What pathogens cause illness attributable to recreation on the CAWS?

In order to meet these study objectives, three groups of study participants were recruited. After taking into account demographic and other differences across the three groups, it will be possible to compare rates, predictors, and causes of illness among the three groups.

The groups are:

1) CAWS: People who row, canoe, kayak, boat, or fish on the CAWS.

2) GUW: Those who engage in the same activities on general use waters (GUW), such as Lake Michigan, several small inland lakes (Busse, Crystal, Skokie Lagoons, Tampier, and others), and area rivers (Des Plaines, Fox, DuPage).

3) UNX: Those who engage in outdoor recreational activities that do not involve water (jogging, walking, cycling, playing sports). These individuals are recruited at locations and times of recruiting CAWS and GUW participants. This group is referred to as the unexposed, or UNX group.

A schematic overview of data collection in CHEERS is presented in Figure I-1. Figure I-2 and Figure I-3 depict the geography of the study on the North and Cal-Sag systems, respectively.

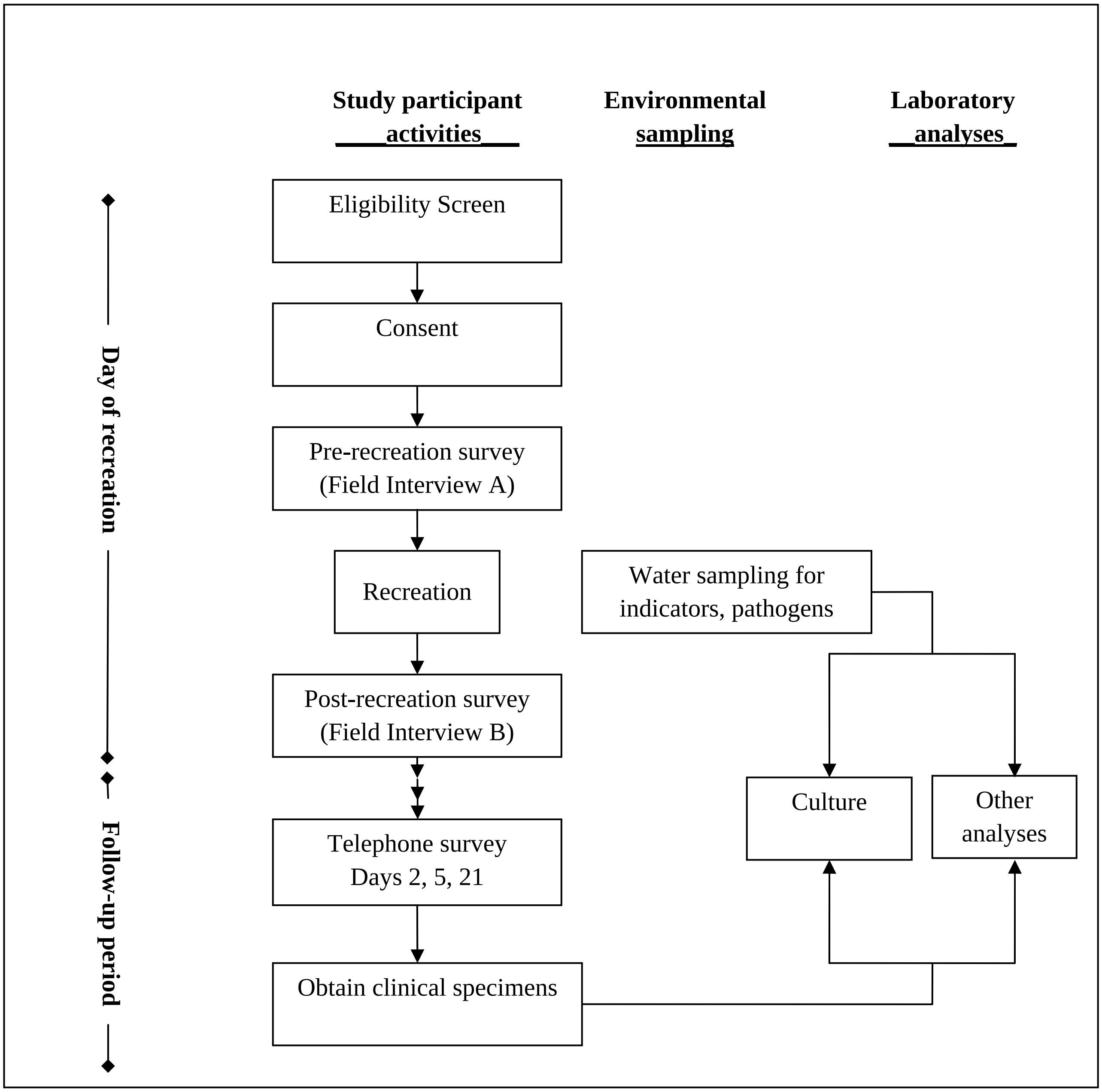


Figure I-1: Overview of CHEERS data collection elements

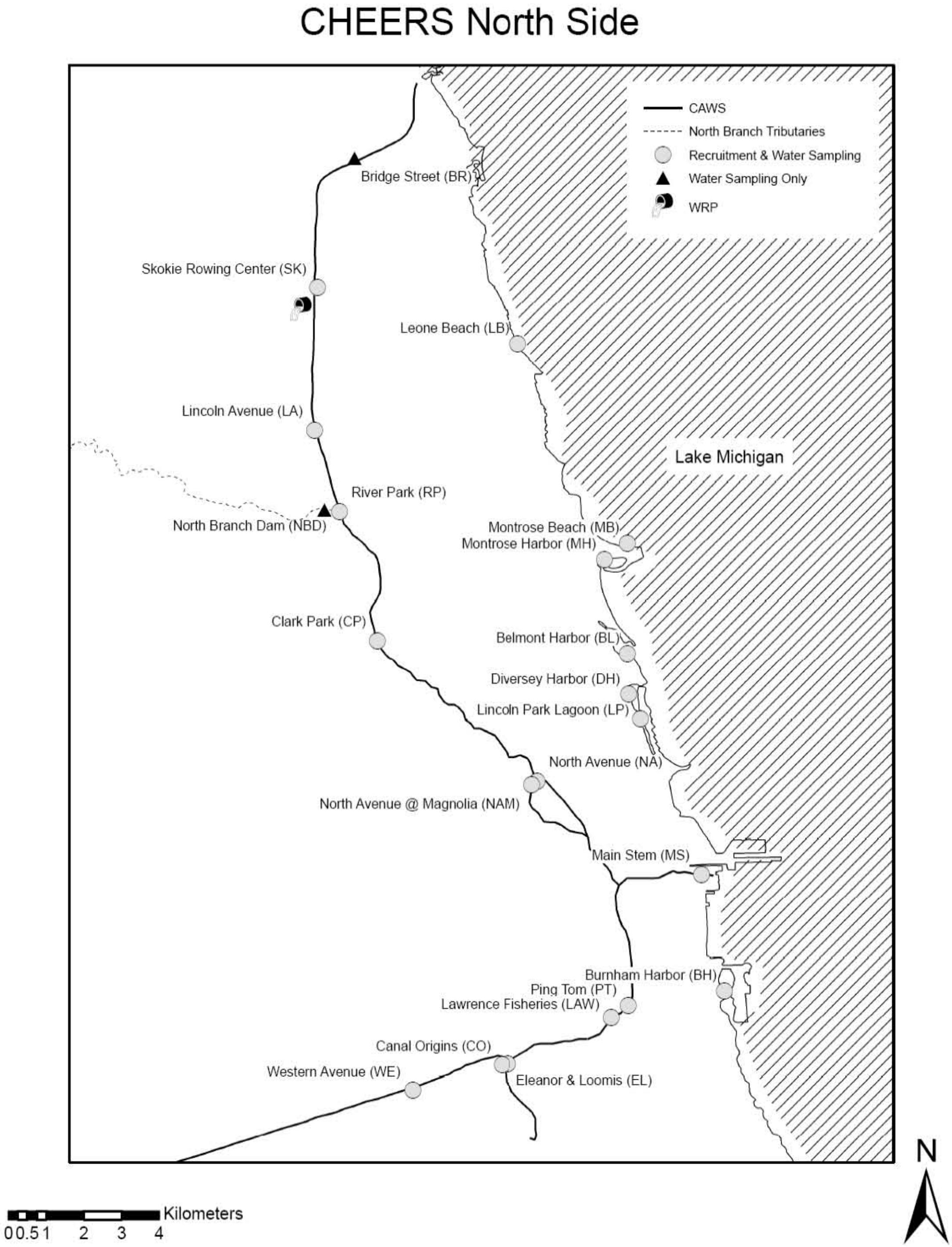


Figure I-2: CHEERS study sites, north side, including CAWS-North, CAWS-South Branch, and GUW locations at or near Lake Michigan beaches. WRP=water reclamation plant

CHEERS South Side

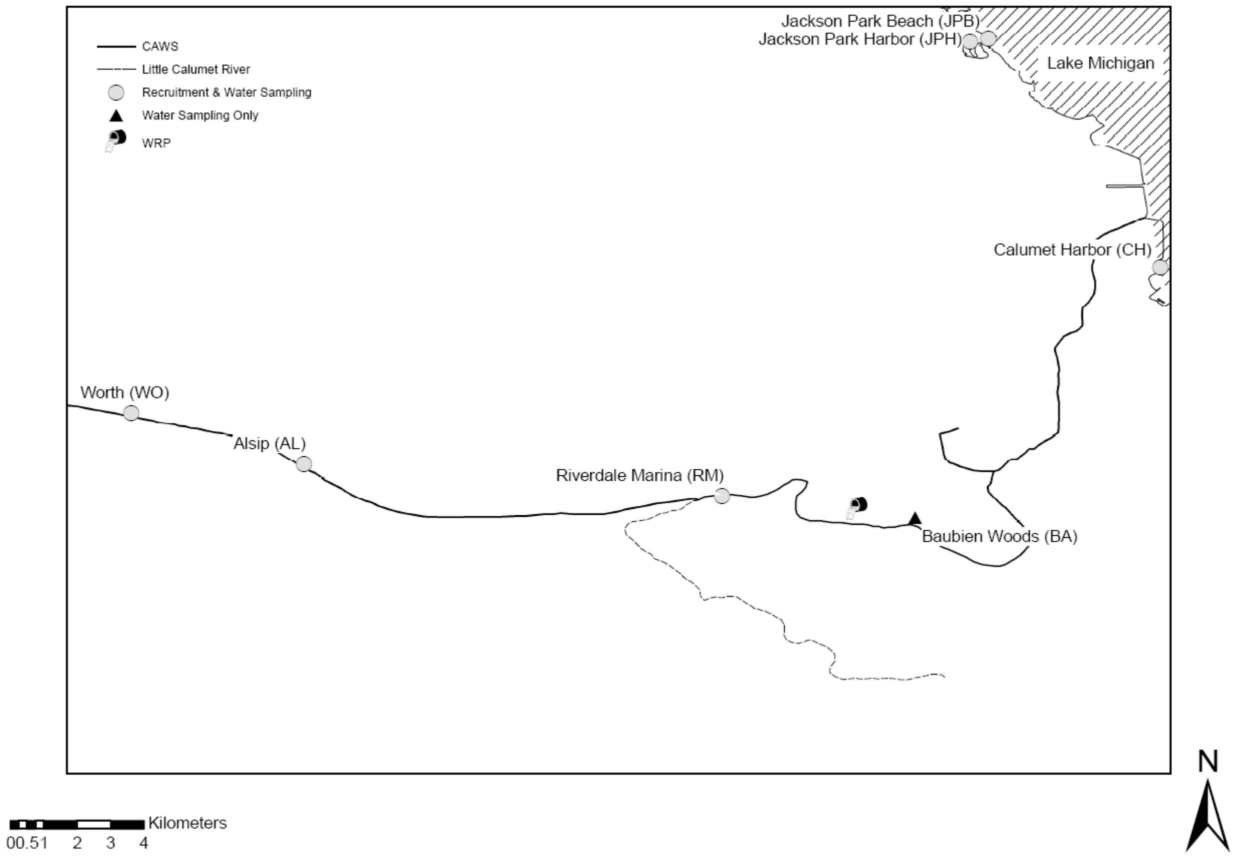


Figure I-3: CHEERS study sites, on the Cal-Sag Channel and southern Lake Michigan sites.
WRP=Water Reclamation Plant

Section 1.03 This document

This Interim Technical Report provides a status update for the Illinois Pollution Control Board regarding the CHEERS research study. Participant recruitment and health follow-up have been completed and statistical analysis is ongoing. Final results of this research are not yet available. However, interim summaries of key data elements are presented in this Technical Report. The summaries that comprise this report should not be viewed as answers to primary study questions. This report summarizes preliminary results of water quality, recreational use of the CAWS, participant recruitment, the occurrence of gastrointestinal illness, and microbes isolated from stool samples of study participants who developed gastrointestinal symptoms following recreation. The summary of water quality, though not final at this stage, is more comprehensive than other aspects of the data. This is because the supporting data analyses are closer to completion and have been evaluated more comprehensively in prior peer reviews than those of health risks. Detailed research methods are not presented in this report, as they have been previously submitted to the Illinois Pollution Control Board (Dorevitch testimony, filed August 4, 2008).

Yet to be completed are analyses of health risks of incidental contact water recreational activities. Such analyses will take into account multiple factors that must be considered when describing relationships between key variables (such as water quality) and health outcomes (such as the development of gastrointestinal illness). For example, if users of the CAWS are different in important ways compared to users of other waters – such as their age or presence of underlying health conditions – real differences in the health risk between the CAWS group and other groups may be distorted. The ongoing data analysis focuses on accounting for such differences in order to generate appropriate comparisons of risk across study groups.

Chapter II. Water quality

Section 2.01 Water sampling: general approach

The primary purpose of the CHEERS water sampling activities was to provide an estimate of microbial quality of the water to which study participants may have been exposed. By collecting water samples at the approximate times and locations of water recreation, we aimed to identify water quality measures that predict the risk of illness among people who engaged in secondary contact water recreational activities. Extensive characterization of spatial and temporal variability on the CAWS resulted in a water sampling strategy that underwent peer review. Samples were analyzed for fecal indicator bacteria, viral indicators, and pathogenic organisms.

Surface waters were sampled for the quantification of indicator microbes (enterococci, *E. coli* and male-specific/somatic coliphages) and pathogens (*Giardia*, *Cryptosporidium*, and norovirus). In 2007, samples were also analyzed for *Pseudomonas*, *Salmonella*, and *Shigella* but this was discontinued in 2008 because of concerns about the precision, accuracy and validity of the 2007 analyses of these bacteria (the peer review panel concurred with this decision). The 2009 water sampling plan was expanded to include three additional methods for measuring water quality: 1) enterococci and *E. coli* analysis by qPCR, 2) enterococci and *E. coli* analysis by immunomagnetic separation ⁄ adenosine triphosphate (IMS ⁄ ATP) and 3) large-volume sampling for viral pathogens. The results of these microbial analyses will be presented in the CHEERS Final Report.

The methods used for measuring water quality during each of the three study years are listed in Table II-1 (indicators) and Table II-2 (pathogens).

Indicator	**Analysis Method**	**2007**	**2008**	**2009**
Enterococci	USEPA Method 1600	x	x	x
Enterococci	IMS/ATP			x
Enterococci	qPCR draft method 1606			x
E. coli	USEPA Method 1603	x	x	x
E. coli	IMS/ATP			x
E. coli	qPCR			x
Coliphages (male-specific, somatic)	USEPA Method 1602	x	x	x

Table II-1: Methods used to measure indicator organisms

Pathogen	**Collection Method**	**2007**	**2008**	**2009**
Giardia	CFC (USEPA Method 1623)	x	x	x
Cryptosporidium	CFC (USEPA Method 1623)	x	x	x
Norovirus	ViroCap filter	x	x	x
Norovirus	1MDS filter			x
Adenoviruses	1MDS filter			x
Enteroviruses	1MDS filter			x
Pseudomonas	CFC (SM 9213E)	x		
Salmonella	CFC (SM 9260E)	x		
Shigella	CFC (USEPA Method 1682)	x		

Table II-2: Methods used to measure pathogenic organisms

Water samples were collected according to USEPA protocols and can be categorized into two main groups: 1) grab sampling for indicator microbes (enterococci, *E. coli* and coliphages) and 2) large-volume sampling for pathogenic organisms (*Giardia*, *Cryptosporidium*, norovirus, adenovirus and enterovirus). All samples were collected by CHEERS water sampling specialists and transported to commercial laboratories for analysis.

(a) Frequency of water sampling

Table II-3 summarizes frequency of sampling at CAWS and GUW locations. For the purpose of this study, an access point has been defined as the site of recreation or entry onto a body of water. Indicators were collected as grab samples every two hours during participant recruitment; pathogens were collected every six hours. In addition to collecting water samples at access points, indicators and pathogens were collected at sites above and below the nearest upstream water reclamation plant (WRP). Frequency of water sampling at GUW locations was identical to sampling at CAWS access points; however, WRP-oriented sampling was not performed at GUW locations.

Location	Indicator sampling	Pathogen sampling
CAWS		
Access point	Every 2 hours	Every 6 hours
Upstream of WRP	Every 6 hours	Every 6 hours
Downstream of WRP	Every 6 hours	Every 6 hours
GUW		
Access point	Every 2 hours	Every 6 hours

Table II-3: Frequency of indicator and pathogen sampling

(b) Data analysis

Water quality measures approximated log-normal distributions and for that reason, data were log-10 transformed prior to statistical analyses. Values that were below the limit of detection were converted to 1/10 of the lowest reportable level. The lowest reportable values were: bacterial indicators 1 CFU/100mL, somatic coliphages 10 PFU/100mL, male-specific coliphages 1 PFU/100mL, protozoan parasites 0.5 (oo)cysts/10L).

Section 2.02 Water quality: Findings

(a) Data quality

Quality monitoring of laboratory analyses of water microbes has been performed extensively throughout the study. Analyses of accuracy, precision, sensitivity, and adherence to EPA method requirements indicate the data collected are of sufficient quality to meet the study objectives. Detailed information about quality monitoring of water microbiology measures are provided in Appendix 1.

(b) Water sampling locations and groups

Water quality was measured at 39 unique locations over the study period (2007-2009) within the CAWS and in other surface waters in the greater Chicago area. To facilitate water quality description and comparison, the sampling locations have been organized into location-groups on the basis of water system type, water quality, and geographic proximity.

CAWS

In the CAWS, there are four location-groups: North Branch/North Shore Channel, South Branch, Cal-Sag Channel and Other.

The North Branch/North Shore Channel location-group (Figure I-2) includes the sampling locations: Bridge Street (BR), Skokie Rowing Center (SK), Lincoln Avenue (LA), River Park (RP), Clark Park (CP) and North Avenue (NA). Bridge Street and Skokie Rowing Center are physically located 4.2 and 0.7 km upstream of the North Side WRP, while the remaining locations are 3.2, 5.8, 9.1, and 14.6 km downstream of the WRP, respectively. Review of the water quality data in the North Branch, however, indicates that the SK sampling location has higher microbe densities than the BR location, and is more similar to locations downstream of the WRP. This may be due to dispersion of effluent from the WRP towards the SK site. As a result, The Skokie Rowing Center location is considered to be effectively downstream of the WRP.

The South Branch location-group (Figure I-2) includes the sampling locations: Ping Tom Park (PT), Lawrence Fisheries (LAW), Canal Origins Park (CO), and Western Avenue Boat Launch (WE). All of these locations are downstream of the North Side WRP, but are separated from the North Branch group due to their long distance from the WRP. The South Branch locations are also downstream of the Main Stem, which has much lower indicator microbe densities than those seen on the North Branch. Ping Tom Park and Canal Origins Park are 21.0 and 24.2 km downstream of the North Side WRP.

The Cal-Sag Channel location-group (Figure I-3) includes the sampling locations: Beaubien Woods (BA), Riverdale Marina (RM), Alsip (AL), and Worth (WO). Beaubien Woods is located 1.3 km upstream of the Calumet Water Reclamation Plant, while the other locations are 4.8, 14.6, and 18.8 km downstream of the WRP, respectively.

The CAWS Other location-group includes the sampling locations: Willow Springs (WS) and Main Stem (MS). Willow Springs is on the Chicago Sanitary and Ship Canal, and is the only location downstream of the Stickney WRP. Water was sampled there only on one day of the study. The Main Stem is in downtown Chicago, just downstream of the Chicago Locks and Controlling Works.

GUW

The General Use Waters are divided into five location groups: Lake Michigan Harbors, Lake Michigan Beaches, Inland Lakes, Rivers, and Other. The Lake Michigan Harbors location-group includes the sampling locations (listed North to South): Montrose Harbor (MH), Belmont Harbor (BH), Diversey Harbor (DH), Burnham Harbor (BH), Jackson Park Harbor (JPH), and Calumet Harbor (CH) (Figure I-2 and Figure I-3). The Lake Michigan Beach location-group includes the sampling locations (listed North to South): Leone Beach (LB), Montrose Beach (MB), and Jackson Park Beach (JPB). The Lake Michigan Beach locations are separated from the Harbors for presentation of the water quality data due to the somewhat higher microbe densities at the beaches. The Inland Lakes location-group includes sampling locations at freshwater lakes located to the West of Lake Michigan: Busse Woods (BW), Crystal Lake (CL), Lake Arlington (LAR), Lovelace Park Pond (LPP), Maple Lake (ML), Mastodon Lake (MT), Skokie Lagoons (SL), and Tampier Lake (TL). The Rivers location-group includes: the Fox River (FR), the Des Plaines River (DP), and the DuPage River (HW). Multiple sampling locations were used along each river to capture changes in water quality over the course of boating events. However, the variation along the length of the

Rivers is relatively small, and for brevity, the data collected at all locations on a river on a particular day are combined to estimate the daily mean microorganism density.

The GUW Other location-group includes: the North Branch Dam (NBD) and Lincoln Park Lagoon (LP). Water reaches the NBD from a forest preserve area and then flows into the CAWS at the junction of the North Shore Channel and the North Branch of the Chicago River at River Park. Because it is not an effluent-dominated waterway, nor is it considered to be part of the CAWS in the context of the current regulatory proceedings, it is not considered a CAWS location for the purposes of this study. Lincoln Park Lagoon is an extension of Diversey Harbor that is predominantly stagnant water: Because there is limited water exchange with the Harbor or Lake Michigan, this location has relatively poor water quality compared to the Lake Michigan location-groups. As a result, the Lincoln Park Lagoon has been placed into the GUW Other location-group.

(c) Organization of findings

This report contains a summary of the results of microbial analyses of water samples. The results are described as "densities" of microbes, which for all practical purposes means microbe "concentration." Water quality has been summarized using three levels of aggregation. The least aggregated data is the annual average of daily mean of microbes at a given location. In other words, these data represent the average of daily means, which generally includes multiple water samples collected per day per location. These daily averages are aggregated as a summary of water quality, by location, by year.

The next level of aggregation is by location within each location group. This level summarizes data within locations across the three years of the study. These latter two levels of data aggregation are summarized in Appendix II.

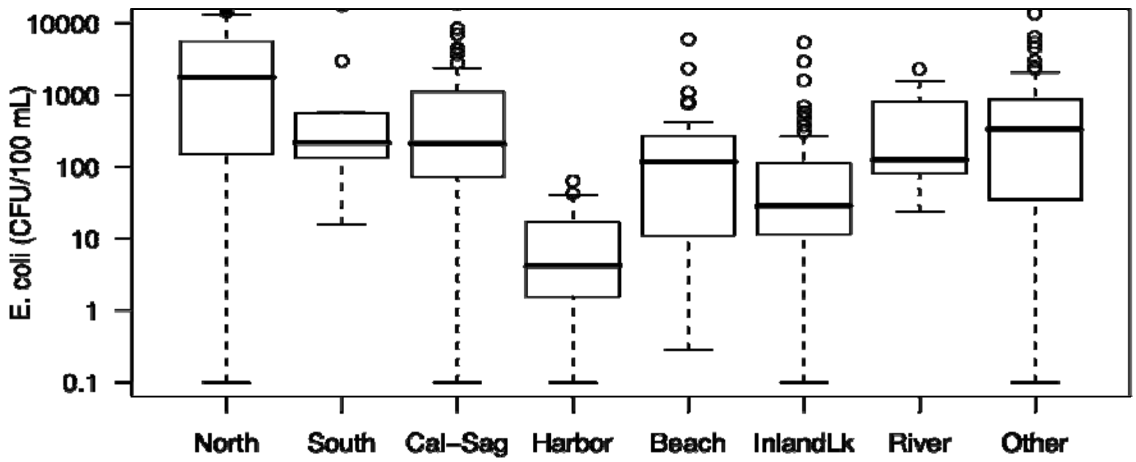
The most aggregated data, a summary of microbe densities by location group, is contained within the text of this section. The data contained in these summaries aggregates locations within groups, over the three years of the study.

In addition, time trends in water quality within a location within a year are presented in Appendix II, Figures II-7 through II-11.

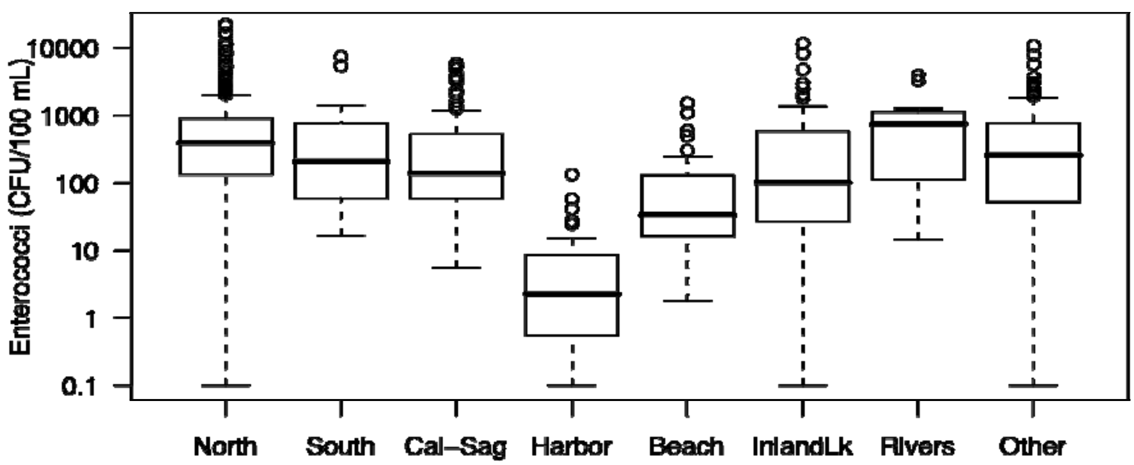
(d) Indicator microbes, by location group

The general trends in the daily mean microorganism densities by location-group over the entire study period (2007-2009) are described in Figure II-1. As an orientation to the "box and whiskers" plots, the top and bottom of the "box" indicate the 25th and 75th percentile, respectively. The horizontal bar through the box is the 50th percentile (the median value). The whiskers are 1.5 times the interquartile range (the range of values between the 1st and 3rd quartiles), and circles are values that exceed 1.5 times the interquartile range. Densities of indicator microbes, both bacterial and viral (the coliphages), were generally higher at CAWS locations than at GUW locations. One notable exception to this general observation is that densities of enterococci at the GUW rivers were often comparable to those seen on the CAWS. The contrast between CAWS and GUW locations is most apparent for measures of somatic coliphages, which were generally more than 100-fold higher at CAWS compared to GUW locations. Median indicator microbe densities in the North location group were generally 5-10 fold greater than in the South and Cal-Sag location groups. Densities of somatic coliphages, like the other indicators, were generally about 10-fold higher at GUW river locations compared to other GUW location groups. The highest median densities of *E. coli*, somatic coliphage, and male-specific coliphage are in the CAWS North. By contrast, the median density of enterococci was slightly higher in the GUW river group that in the CAWS North group.

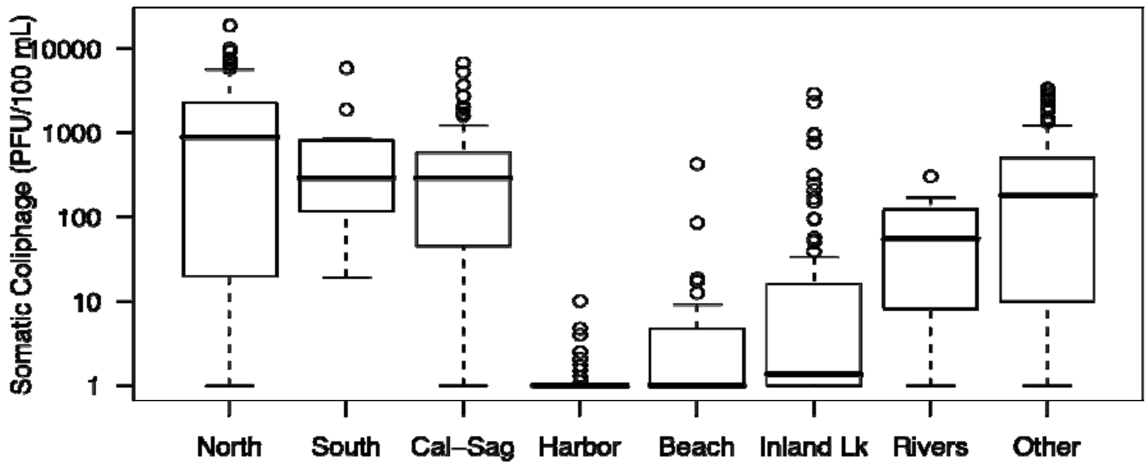
Figure II-1 (a-d): Indicator microbe densities, by location-group. See text for details. "North." "South," and "Cal-Sag" are CAWS locations, while "Harbor," "Beach," "Inland Lk," and "River" are GUW locations.



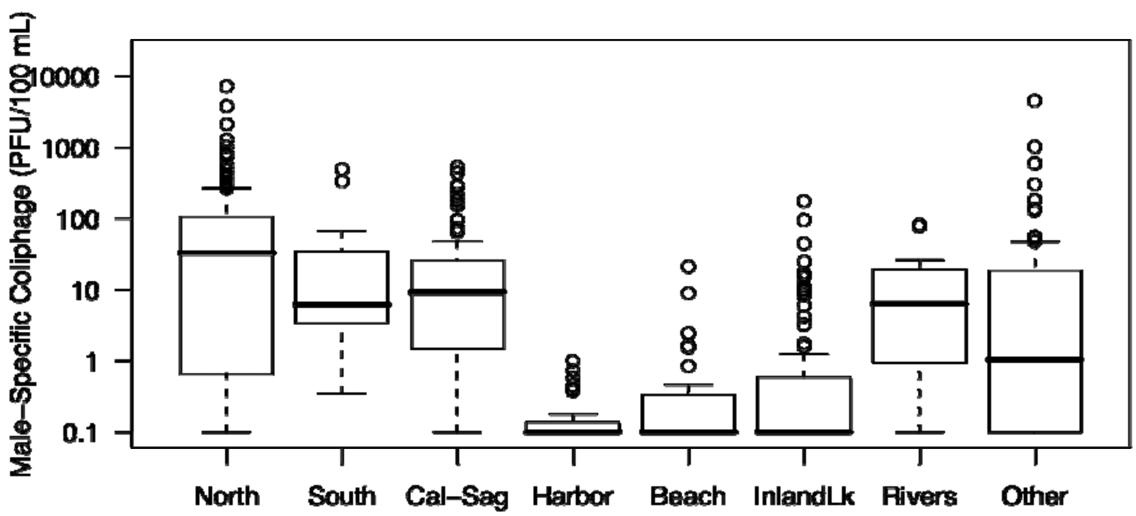
(a) ***E. Coli***



(b) Enterococci



(c) Somatic coliphage



(d) Male-specific coliphage

(e) Protozoan Pathogens

The detection of *Giardia* cysts and *Cryptosprodium* oocysts is summarized in Table II-4. *Giardia* was detected more frequently than *Cryptosporidium*. Samples collected at CAWS and North Branch Dam locations generally contained detectable parasites more frequently than did samples collected at GUW locations. *Giardia* cysts were present in approximately 70-90% of CAWS samples, with the exception of those collected at the Main Stem, where the detection rate was about 10%. *Giardia* cysts were detected in about 20% of GUW samples, excluding rivers, where the detection rate was over 80%. Of the 60 samples collected at the North Branch Dam, a tributary to the CAWS that drains a forest preserve system (considered here to be a GUW location), more than 90% contained *Giardia* cysts.

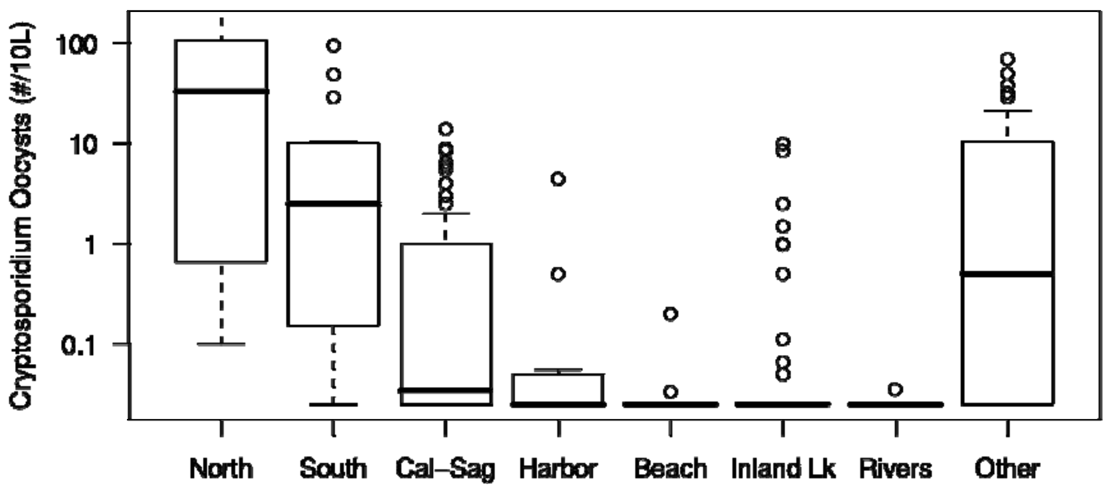
Cryptosporidium oocysts were present in about 30-50% of CAWS samples on the North and Cal-Sag systems, but in about 80% of samples collected on or near the South Branch. No Main Stem samples contained detectable cryptosporidium oocysts. Oocysts were detected in more than 70% of samples at the North Branch Dam, but in less than 20% of samples at other GUW locations. Rivers had a higher Rates of Cryptosporidium detection were higher at the GUW rivers than at other GUW location groups.

Location	No. of Samples Collected	Giardia detected n	Giardia detected (%)	Crypto detected n	Crypto detected (%)
CAWS Total	**439**	**380**	**(86.6)**	**225**	**(51.3)**
CAWS North	292	273	(93.5)	166	(56.8)
CAWS Cal-Sag	120	88	(73.3)	44	(36.7)
CAWS South Branch	18	18	(100)	15	(83.3)
Main Stem	9	1	(11.1)	0	(0.0)
GUW Total	**253**	**65**	**(25.7)**	**20**	**(7.9)**
Lake Michigan	96	14	(14.6)	2	(2.1)
Inland Lake	128	31	(24.2)	14	(10.9)
Rivers	24	20	(83.3)	4	(16.7)
GUW Other	5	0	(0.0)	0	(0.0)
North Branch Dam	**60**	**56**	**(93.3)**	**43**	**(71.7)**

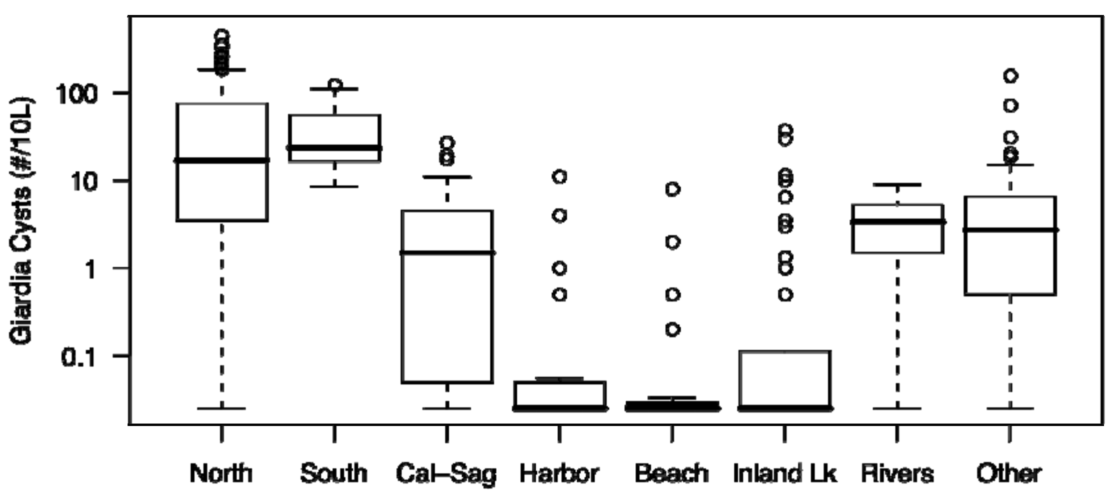
Table II-4: Detection of protozoan (oo)cycsts, by water sampling location groups

The general trends in the daily mean parasite cyst and oocyst concentrations by location-group over the study period (2007-2009) are described in Figure II-2. Median densities of *Cryptosporidium* oocysts were slightly higher in the CAWS South location group than in other location groups. Median densities of *Giardia* cysts are highest in the CAWS North and CAWS South location groups, though there is larger variation in the North group. *Giardia* was frequently below the limit of detection at Lake Michigan Harbors and Beaches, and in Inland Lakes.

Figure II-2: Densities of protozoan pathogens, by location group. "North." "South," and "Cal-Sag" are CAWS locations, while "Harbor," "Beach," "Inland Lk," and "River" are GUW locations.



(a) *Cryptosporidium* oocysts



(b) *Giardia* cysts

Section 2.03 Influence of Rainfall and CSO on Water Quality

(a) Overview

Rain runoff and combined sewer overflow (CSO) carry microbes into the CAWS, and, as a result, may negatively impact microbial water quality. Direct runoff likely acts as a diffuse source, but the land use patterns (i.e. bank type) may lead to spatial variation in the magnitude and quality of runoff. Some runoff, such as that from the local highways, enters the CAWS through point source storm sewers. CSO enters the CAWS through gravity outfalls, which are ubiquitous throughout the CAWS, and may represent another diffuse source (Figure II-3). Pumping stations are few in number, and may discharge CSO for longer durations and in greater volumes than gravity outfalls. We expect pumping station discharge to be uniformly dispersed some distance downstream and immediately upstream of the pumping stations, but not uniformly throughout the CAWS. This hypothesis suggests that the impact of pumping station activity on microbial pollution in the CAWS may vary spatially, like a point source of pollution.

(b) Summary CSO Events and Rainfall

We defined a CSO event as a period of continuous discharge from at least one gravity outfall or pumping station, and equated the event start time as the time the first discharge started, and the event stop time as the time the last discharge ended. CSO events were defined separately for the CAWS North/South Branch, which are impacted by the Northside Water Reclamation Plant and CSO, and Cal-Sag Channel, which is impacted by the Calumet Water Reclamation Plant and CSO. During the study period, there were 88 discrete CSO events on the North Branch and 32 CSO events on the Cal-Sag Channel (Table II-5). Sampling occurred on only one day in the Sanitary and Ship Canal, below the Stickney Water Reclamation Plant, so the Stickney CSO events have not been considered. Figure II-3 demonstrates the close proximity of many CSO outfalls near CHEERS enrollment/water sampling locations. Additionally, the locations of the pumping stations on the North Branch and South Branch are included. CSO and pumping station locations outside of the City of Chicago (i.e., the Cal-Sag) are not included in this map.

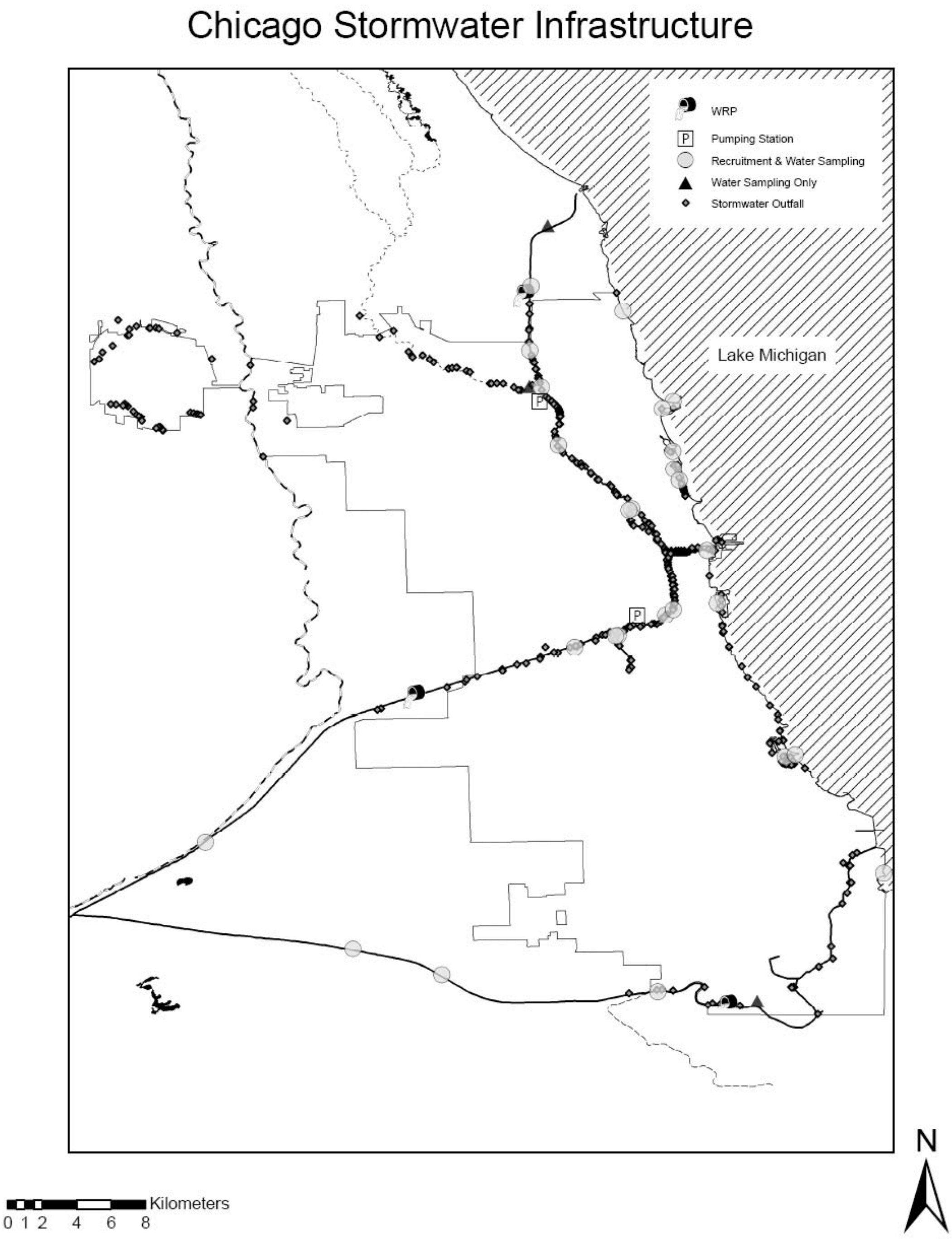


Figure II-3: Map of pumping stations and stormwater outfalls, (including CSO outfalls), Chicago

		Volume (gallons)		Duration (h)	
	N	**Mean**	**SD**	**Mean**	**SD**
North & South Branches	88	1.1×10^{9}	3.9×10^{9}	21	44
Cal-Sag Channel	32	4.1×10^{8}	9.7×10^{8}	24	30

Table II-5: Summary of CSO Events in the CAWS during the study period

The Illinois State Water Survey gauge system data was used to quantify rainfall during the study period. The gauge system is a grid array across the Chicago area, and three gauge locations were selected to match the CAWS sampling location-groups. The limit of quantification at the gauges is 0.025 in/h. Hourly precipitation was averaged across the three gauges. When rainfall data was matched to sample day-location-hours, we identified the most recent precipitation event. We distinguished precipitation events by a period of 6 hours with no measurable precipitation. Considering all day-location-hours with microorganism measurements, the time since the last rain event ranged 0-353 h, with mean 62 h and median 39 h.

(c) Initial Exploratory Analysis

Initial analyses indicated that mean microbe densities were indistinguishable whether w 96 h or 144 hours had passed since the last rain and last CSO. For the comparisons presented here, we define *dry* or *baseline* water quality, as the microbial densities when at least 96 h has passed since the last rain with CSO. Results for mean microbe densities at CAWS locations for various intervals since the most recent rain event with CSO are summarized in Table II-6 and Table II-7. Note that if the time since last CSO is ≤ 24 h, it happens that the water sample was collected while the CSO was ongoing: No CSO events stopped in the 24 h prior to any sample collection.

Based on t-tests of log10-transformed data, the mean densities of all microbes except *Cryptosporidium* were higher in the three time windows since rainfall with CSO activity relative to baseline. Shorter intervals between the end of CSO/rainfall and water sample collection were associated with greater increases in microbe densities relative to baseline. The increase in microbe densities following rain/CSO events relative to baseline appears to vary among the microbes, with 30-fold increases for *E. coli* compared to 5 to 10 fold increases for other microbes in the 24-hours since rain with CSO.

Hour since last Rain/CSO	n	*E. coli*	Enterococci	Somatic Coliphage	Male-Specific Coliphage
		Mean Density (CFU/100mL or PFU/100mL)			
>96 (baseline)	180	123.0	104.7	125.9	4.7
≤ 96	294	645.7*	309.0*	281.8*	14.1*
≤ 48	146	1,349.0*	416.9*	302.0*	20.4*
≤ 24	76	3,548.1*	631.0*	724.4*	58.9*

Table II-6. Mean densities of indicator microbes at CAWS locations as a function of hours since last rain and last CSO. Student's t-test compares densities with recent rain and CSO to "baseline" conditions (no rain or CSO for at least 96 h), where an asterisk indicates $p<0.05$.

Hours since last rain/CSO	n	*Giardia* cysts	*Cryptosporidium* oocysts
		Mean Concentration (#/10L)	
> 96 (baseline)	65	3.2	0.3
≤ 96	139	12.3*	0.3
≤ 48	53	15.5*	0.3
≤ 24	22	19.5*	0.3

Table II-7. Mean densities of protozoan pathogens at CAWS locations as a function of hours since last rain and last CSO. Student's t-test compares densities with recent rain or CSO to "baseline" conditions (no rain or CSO for at least 96 h), where an asterisk indicates $p<0.05$.

Chapter III. CAWS Uses

The methodology for the use survey has remained consistent during the three years of CHEERS data collection, as described in the Protocol and Quality Assurance Project Plan. New users are counted when they begin their activity on a given day, at a given location, for a specific activity. Thus, three people going out in a boat would be counted as three users rather than one event. An individual who boated and then fished from shore would be counted twice, once for each recreational activity. People in a boat who passed by an access point where the use survey was being conducted were not counted. This is to prevent counting the same user twice for the same activity on a given day, and to estimate the number of new users per unit of time.

Table III-1 summarizes the distribution of CAWS uses observed during the conduct of the epidemiologic study, 2007-2009, by location. The most heavily used launch/use locations include two locations where the majority of observed uses occurred during special events. These are Clark Park (the Chicago River Flatwater Classic) and Ping Tom Park (Dragon Boat Races). Table III-2 summarizes the distribution of CAWS uses by recreational activity. Nearly 97% of all CAWS uses were boating, canoeing, fishing, kayaking, and rowing, the activities studied in CHEERS. The "other" category was comprised of the users of non-motorized vessel that were not readily classifiable as rowboats, rowing shells, canoes, or kayaks. Often the "other" vessels were creativly decorated small boats used in the Flatwater Classic. It should be noted that some of the boaters were also fishers, but that was not recorded as part of the use survey (boaters who fished were differentiated from boaters who did not fish in the analysis of epidemiologic data). The distribution of recreational activities, by location, is presented in Table III-3.

	All Recreation	
Location	**N**	**(%)**
Clark Park	2,167	(19.48)
Worth Boat Launch	1,999	(17.97)
Alsip Boat Launch	1,876	(16.86)
Skokie Rowing Center	1,591	(14.30)
North Ave. at LeMoyne/Mag.	1,546	(13.90)
Main Stem	713	(6.41)
Ping Tom Park	656	(5.90)
North Ave. at Kingsbury	228	(2.05)
River Park	150	(1.35)
Canal Origins Park	83	(0.75)
Riverdale Marina	66	(0.59)
Evanston Ecology Center	32	(0.29)
Eleanor & Loomis	9	(0.08)
Western Ave. Boat Launch	8	(0.07)

Table III-1: Distribution of CAWS recreation activities, by location

Activity	*Number*	*Percent of total*
Boating	3,981	(35.79)
Kayaking	2,546	(22.89)
Canoeing	1,913	(17.20)
Rowing	1,482	(13.32)
Fishing Stationary	860	(7.73)
Other	248	(2.23)
Jet Skiing	79	(0.71)
Wading	9	(0.08)
Water Skiing	3	(0.03)
Diving/Jumping	2	(0.02)
Tubing	1	(0.01)
Swimming	0	(0.00)
Sailing	0	(0.00)
Total	**11,124**	**100.00**

Table III-2: Distribution of recreational uses, by location

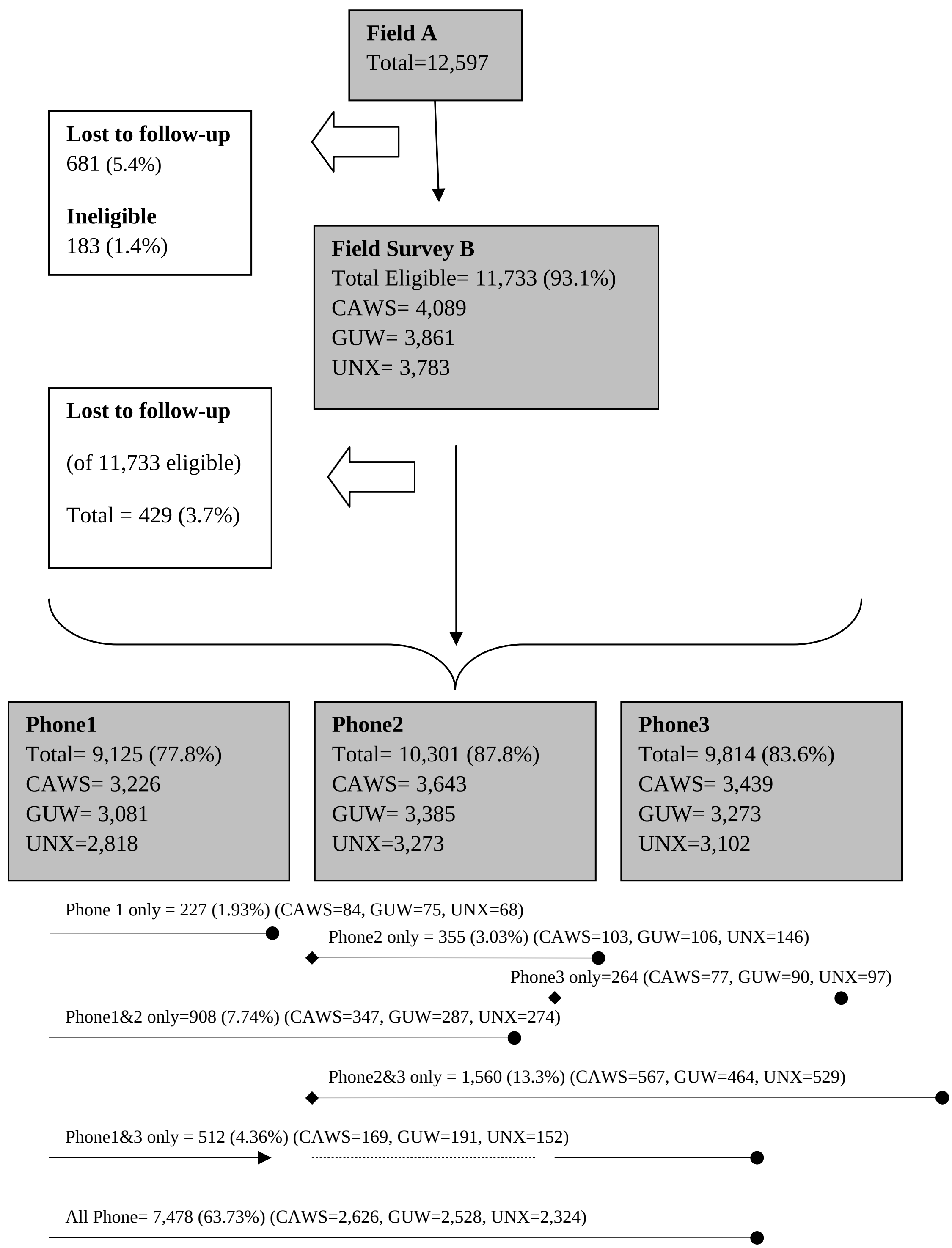
CAWS Location	Boating		Canoeing		Fishing (Stationary)		Kayaking		Rowing		Other	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Evanston Ecology Center	0	(0.0)	23	(1.2)	0	(0.0)	9	(0.4)	0	(0.0)	0	(0.0)
Skokie Rowing Center	59	(1.5)	212	(11.1)	0	(0.0)	220	(8.6)	1077	(72.7)	20	(8.1)
River Park	21	(0.5)	37	(1.9)	91	(10.6)	1	(0.0)	0	(0.0)	0	(0.0)
Clark Park	4	(0.1)	1031	(53.9)	22	(2.6)	924	(36.3)	0	(0.0)	175	(70.6)
North Ave. at Kingsbury	9	(0.2)	26	(1.4)	0	(0.0)	0	(0.0)	193	(13)	0	(0.0)
North Ave. at LeMoyne/Mag.	24	(0.6)	41	(2.1)	1	(0.1)	1389	(54.6)	84	(5.7)	7	(2.8)
Main Stem	13	(0.3)	0	(0.0)	659	(76.6)	0	(0.0)	0	(0.0)	41	(16.5)
Ping Tom Park	0	(0.0)	540	(28.2)	3	(0.3)	0	(0.0)	113	(7.6)	0	(0.0)
Canal Origins Park	4	(0.1)	0	(0.0)	71	(8.3)	0	(0.0)	5	(0.3)	3	(1.2)
Eleanor & Loomis	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	9	(0.6)	0	(0.0)
Western Ave. Boat Launch	5	(0.1)	0	(0.0)	3	(0.3)	0	(0.0)	0	(0.0)	0	(0.0)
Riverdale Marina	62	(1.6)	0	(0.0)	1	(0.1)	0	(0.0)	0	(0.0)	1	(0.4)
Alsip Boat Launch	1847	(46.4)	3	(0.2)	1	(0.1)	2	(0.1)	0	(0.0)	1	(0.4)
Worth Boat Launch	1933	(48.6)	0	(0.0)	8	(0.9)	1	(0.0)	1	(0.1)	0	(0.0)
TOTAL	**3981**	**(100.0)**	**1913**	**(100.0)**	**860**	**(100.0)**	**2546**	**(100.0)**	**1482**	**(100.0)**	**248**	**(100.0)**

Table III-3: Distribution of recreational uses, by location (continues on the following page).

CAWS Location	Diving/ Jumping		Jet Skiing		Sailing		Swimming		Tubing		Wading		Water Skiing	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Evanston Ecology Center	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Skokie Rowing Center	0	(0.0)	3	(3.8)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
River Park	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Clark Park	2	(100.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	9	(100.0)	0	(0.0)
North Ave. at Kingsbury	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
North Ave. at LeMoyne/Mag.	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Main Stem	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Ping Tom Park	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Canal Origins Park	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Eleanor & Loomis	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Western Ave. Boat Launch	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Riverdale Marina	0	(0.0)	2	(2.5)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Alsip Boat Launch	0	(0.0)	21	(26.6)	0	(0.0)	0	(0.0)	1	(100.0)	0	(0.0)	0	(0.0)
Worth Boat Launch	0	(0.0)	53	(67.1)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	3	(100.0)
TOTAL	**2**	**(100.0)**	**79**	**(100.0)**	**0**	**(0.0)**	**0**	**(0.0)**	**1**	**(100.0)**	**9**	**(100.0)**	**3**	**(100.0)**

Chapter IV. Study Participants

Section 4.01 Recruitment and attrition



A total of 11,297 subjects (those who participated more than once in the study are counted more than once) participated in at least one telephone follow-up interview. The remainder of the descriptions and analyses are restricted to the 11,297 with usable follow-up information. Table IV-1 presents the distribution of subjects, by study year, by study group. The distribution of groups by season of enrollment is summarized in Table IV-2.

Group	**CAWS**	**GUW**	**UNX**	**Total**
2007	342	127	323	792
2008	2,430	2,106	2,080	6,616
2009	1,199	1,506	1,184	3,889
Total	3,971	3,739	3,587	11,297
Percent of total	**35.2%**	**33.1%**	**31.8%**	**100.0%**

Table IV-1: Enrollment of participants with follow-up data, by group, by year

	CAWS	**GUW**	**UNX**	**Total**
March-May	576 (14.5)	1,107 (29.6)	1,604 (44.7)	3,287
June-August	2,756 (69.4)	1,992 (53.3)	1,216 (33.9)	5,964
Sept-Nov	639 (16.1)	640 (17.1)	767 (21.4)	2,046
Total	**3,971 (100.0)**	**3,739 (100.0)**	**3,587 (100.0)**	**11,297**

Table IV-2: Recruitment, by group, by season

Section 4.02 Characteristics of study participants

The gender distribution was fairly consistent across the three water recreation seasons, as summarized in Table IV-3. The GUW group had a lower percent of female participants than the CAWS and UNX groups.

Year	CAWS†		GUW **		UNX**		Total**	
	Male	Female	Male	Female	Male	Female	Male	Female
2007	49.1%	50.9%	59.1%	40.9%	54.2%	45.8%	52.8%	47.2%
2008	50.3%	49.8%	59.2%	40.8%	49.1%	50.9%	52.7%	47.3%
2009	49.7%	50.3%	60.3%	39.7%	47.5%	52.5%	53.1%	46.9%
Total	**50.0%**	**50.0%**	**59.6%**	**40.4%**	**49.0%**	**51.0%**	**52.9%**	**47.1%**

Table IV-3: Gender distribution, by group, by year. †$p=0.13$ **$p<0.0001$

The age distribution of study participants is summarized in Table IV-4. While participants in the 18-44 and 45-64 age categories are distributed fairly evenly, the 10-17 year olds are over-represented in the CAWS group, and the 0-4 and 65+ year olds are over-represented in the UNX group. The GUW group has a higher percent of participants in the 5-9 year age category compared to the other two groups.

Age group	CAWS		GUW		UNX		Total	
	n	(%)	n	(%)	n	(%)	n	(%)
0-4 years	33	(0.8)	37	(1.0)	62	(1.7)	132	(1.2)
5-9 years	148	(3.7)	181	(4.8)	110	(3.1)	439	(3.9)
10-17 years	403	(10.1)	369	(9.9)	193	(5.4)	965	(8.5)
18-44 years	2,331	(58.7)	1,727	(46.2)	1,830	(51.0)	5,888	(52.1)
45-64 years	925	(23.3)	1,278	(34.2)	1,175	(32.8)	3,378	(29.9)
65+ years	131	(3.3)	147	(3.9)	217	(6.0)	495	(4.4)
Total	**3,971**	**(100.0)**	**3,739**	**(100.0)**	**3,587**	**(100.0)**	**11,297**	**(100.0)**

Table IV-4: Age category distribution, by study group

Overall, about 75% of study participants indentified their race/ethnicity as white, and the remaining participants were divided fairly evenly among black, Hispanic, and other (which includes Asian, Pacific Islander, and those who identified themselves as being of more than one race/ethnicity category). Table IV-5 demonstrates that the UNX group had a higher percent of black participants and a lower percent of white participants than the two water-exposed groups.

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The discrepancy between the total number of participants (11,297) and the number who provided self-identified race/ethnicity information (11,112) is due to non-reporting of race/ethnicity by approximately 2% of study participants.

Race/Ethnicity	**CAWS**		**GUW**		**UNX**		**Total**	
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
White (only)	3,052	(78.1)	3,072	(83.2)	2,274	(64.8)	8,398	(75.6)
Black (only)	286	(7.3)	126	(3.4)	574	(16.4)	986	(8.9)
Hispanic (only)	208	(5.3)	246	(6.7)	340	(9.7)	794	(7.2)
Other / multiple	361	(9.2)	250	(6.8)	323	(9.2)	934	(8.4)
Total	**3,907**	**(35.2)**	**3,694**	**(33.2)**	**3,511**	**(31.6)**	**11,112**	**(100.0)**

Table IV-5: Distribution of race/ethnicity by study group. Chi square $p<0.0001$

Section 4.03 Water activity

The two groups of water recreators (CAWS and GUW) are composed of boaters, canoeists, fishers, kayakers, rafters and rowers. The distribution of recreational activities, by year, and by group, is summarized in Table IV-6. Overall, boating and rowing were more common among CAWS recreators, while fishing and canoeing were more common among GUW recreators. Kayaking was distributed fairly evenly across the two groups. One notable difference across study years is the absence of canoers in the 2007 GUW group.

	2007**		**2008****		**2009****		**2007-2009****	
Water activity	**CAWS**	**GUW**	**CAWS**	**GUW**	**CAWS**	**GUW**	**CAWS**	**GUW**
Boating	9.4%	18.1%	17.8%	7.8%	23.1%	4.3%	18.7%	6.8%
Canoeing	42.4%	0.0%	21.8%	31.7%	18.1%	38.1%	22.4%	33.2%
Fishing	0.9%	22.8%	5.3%	20.2%	17.5%	23.3%	8.6%	21.5%
Kayaking	26.3%	40.2%	38.6%	31.8%	27.2%	30.7%	34.1%	31.6%
Rafting	0.3%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%	0.1%
Rowing	20.8%	18.9%	16.5%	30.8%	14.1%	3.5%	16.2%	6.9%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table IV-6: Distribution of water recreation activities among 7,710 CAWS and GUW recreators, by year. **$p<0.0001$

The age distribution by water recreation activity is summarized in Table IV-7. Kayaking accounted for a higher percent of recreational activities for those age 18 and older, compared to the younger age groups. Fishing was the most frequent recreational activity in the two age categories under age 10. Rowing was the most frequent water recreational activity among the 10-17 year old group, likely reflecting the participation of high school rowing teams.

Recreational Activity	**0-4 yrs**	**5-9 yrs**	**10-17 yrs**	**18-44 yrs**	**45-64 yrs**	**65+ yrs**
Boating	27.1%	14.3%	11.3%	11.5%	15.5%	12.6%
Canoeing	18.6%	32.2%	22.5%	26.5%	30.8%	30.6%
Fishing	42.9%	38.3%	21.1%	11.7%	12.5%	27.7%
Kayaking	7.1%	14.0%	19.8%	36.4%	35.6%	26.3%
Rafting	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Rowing	4.3%	1.2%	25.3%	14.0%	5.7%	2.9%
	100.0%	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table IV-7: Distribution of 7,710 CAWS and GUW subjects by recreational activity and age category

Section 4.04 Self-reported water exposure

Self-reported water exposure, summarized by group and activity, is presented in Table IV-8. While getting wet generally and rates of capsize are generally higher among GUW recreators, face and head exposure, as well as rates of swallowing water are generally higher among CAWS recreators. Further analyses will clarify whether these differences are associated with demographic, frequency of use, perceived risk, and other variables.

Self reported water exposure	CAWS Yes/total	CAWS % yes	GUW Yes/total	GUW % yes	GUW-CAWS % diff	p-value	Total number
Wet while launching - kayaking	200/1008	19.84	477/813	58.67	38.83	<0.0001	1,821
Wet while launching - canoeing	149/558	26.70	339/757	44.78	18.08	<0.0001	1,315
Wet while launching - boating	40/334	11.98	19/97	19.59	7.61	0.0648	431
Wet While launching - Rowing	79/430	18.37	37/136	27.21	8.84	0.0288	566
Wet while launching - all activities	468/2333	20.06	875/1868	46.84	26.78	<0.0001	4,201
Capsize - All Activities	10/1169	0.86	117/1497	7.82	6.96	<0.0001	2,666
Capsize Kayaking	5/475	1.05	74/690	10.72	9.67	<0.0001	1,165
Capsize - Canoeing	4/301	1.33	43/636	6.76	5.43	<0.0001	937
Face/head wet (yes/no) - boating	272/744	36.56	63/255	24.71	-11.85	<0.0001	999
Face/head wet (yes/no) Canoeing	446/891	50.06	457/1240	36.85	-13.21	<0.0001	2,131
Face/Head wet (yes/no) kayaking	872/1360	64.12	542/1198	45.24	-18.88	<0.0001	2,558
Face/head wet (yes/no) Rowing	361/642	56.23	108/256	42.19	-14.04	<0.0001	898
Face/head wet (yes/no) - all activities	1965/3971	49.48	1236/3739	33.06	-16.42	<0.0001	7,710
Water in mouth (yes/no) kayaking	261/1360	19.19	156/1198	13.02	-6.17	<0.0001	2,558
Water in mouth (yes/no) Canoeing	179/891	20.09	146/1240	11.77	-8.32	<0.0001	2,131
Water in mouth (yes/no) Rowing	101/642	15.73	28/256	10.94	-4.79	0.073	898
Water in mouth (yes/no) All activities	586/3971	14.76	359/3739	9.60	-5.16	<0.0001	7,710
Swallow Water Boating	14/744	1.88	12/255	4.71	2.83	0.0212	999
Swallow Water All Activities	172/3971	4.33	130/3759	3.48	-0.85	0.06	7,710

Table IV-8: Comparison of self-reported water exposure, by study group

Chapter V. Occurrence of illness among study participants

Section 5.01 Introduction

On the day of recreation/enrollment in CHEERS, participants were asked (in Field Interview B) whether they had any baseline gastrointestinal and other symptoms. Those who did not have a given category of symptoms (gastrointestinal, respiratory, dermatologic, eye, and ear) at baseline were considered to be at risk for developing incident illness. Participants who did have baseline symptoms related to one organ system were considered to be at risk for developing incident illness related to another organ system. For example, an individual with baseline respiratory symptoms would be at risk for developing gastrointestinal illness, but not respiratory illness.

Study participants were contacted by telephone on approximately days 2, 5, and 21 following recreation/enrollment. Participants were asked if they developed any one of a variety of gastrointestinal and other symptoms in the interval “since we last spoke with you”. For the day 2 phone call, this interval refers to the period that began following the completion of Field Interview B (post-recreation), and the later phone calls refer to prior phone contact. The date of onset of symptoms and the duration of symptoms were recorded.

Section 5.02 Acute gastrointestinal illness

(a) Introduction

Acute gastrointestinal illness (AGI) was defined in accordance with the EPA NEEAR study, namely: any vomiting OR, three or more diarrheal stools in a 24-hour period, OR nausea with stomach ache, OR nausea that interferes with daily activities, OR stomach ache that interferes with daily activities.

(b) Data analysis

Because the research team communicated with participants by phone for three weeks following recreation, the farther into the follow-up period, the greater the number of days on which participants could have developed symptoms. Thus, the number of cases of illness increases over time, but the incidence density (the number of cases of illness divided by the number of person-days of follow-up) does not follow this pattern. The analysis of the time to developing illness (or never developing illness during the follow-up period) uses statistical methods known as “survival analysis” and will be presented in detail in the CHEERS Final Report. Survival analysis has demonstrated that the first few days following recreation are when higher rates of illness are observed in the two water exposed study groups (CAWS and GUW) compared to the unexposed group. For that reason, the data summarized here focus on that interval.

(c) Preliminary Findings

Of the 11,297 research participants, 297 had GI symptoms at baseline (the day of enrollment) and 2 were not sure at baseline whether they had GI symptoms or not. Of the remaining 10,998, follow-up information was not available from 251 participants until the third round of telephone interviews (approximately day 21) regarding the development of new symptoms. Because of the 3-week delay in obtaining this information, data regarding the first week following recreation was considered missing in these participants. Thus, information regarding the development of (new) AGI through day 3 was available for 10,747 participants.

As summarized in Table V-1, by day 2 (the day of enrollment and recreation is day 0), 3.29% of study subjects developed AGI. The percent was higher in the two water-exposed groups than in the UNX group. The odds of developing AGI was 1.24 times greater in the CAWS group compared to the UNX group during the day 0-2 time window. This was not statistically significant (95% confidence interval [CI]) 0.95-1.62, p=0.12). During this same time window the odds of developing AGI were 1.32 times greater in the GUW group compared to the UNX group. This did reach a 0.05 level of statistical significance (CI 1.01-1.63, p=0.04).

The same pattern is apparent for the follow-up window of days 0-3 (Table V-2). During the day 0-3 time window, the odds of developing AGI were 1.26 times higher in the CAWS group than in the UNX group and this approached, but did not quite attain a 0.05 level of statistical significance (CI 0.99-1.61, p=0.06). During this same time window the odds were 1.25 higher in the GUW group compared to the UNX group, again, approaching, but not attaining, a 0.05 level of statistical significance (CI 0.98-1.60, p=0.075).

The relatively elevated percent of AGI cases among the water exposed groups (compared to the unexposed group) becomes less apparent over the days 0-4 and 0-5 follow-up periods, as presented in Table V-3.

It must be emphasized that these comparisons do not account for differences in the demographic and other characteristics of the three groups highlighted in Chapter 4. For that reason, the differences summarized in the tables below may be due to 1) differences in recreational water exposure, 2) differences in factors other than water exposure that lead to differences in symptoms of AGI (such as differences in the demographic composition of the groups, the prevalence of underlying medical conditions, dietary exposures, or rates of contact with people who have infectious diarrhea), or 3) a combination of water-related and non-water related factors that differ across groups. Thus, firm conclusions can not be drawn from these data regarding differences in AGI across groups or recreational water exposure as a cause of AGI. Multivariate modeling approaches that allow the comparison of illness rates after taking into account potentially confounding factors are currently nearing completion and will be presented in the CHEERS Final Report.

	CAWS		**GUW**		**UNX**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
AGI	130	3.42	130	3.64	94	2.78	354	3.29
No AGI	3,668	96.58	3,440	96.36	3,285	97.22	10,393	96.71
Total	**3,798**		**3,570**		**3,379**		**10,747**	**100.00**

Table V-1: Number and percent of cases of AGI, by study group during day 0-2 of follow-up.

	CAWS		**GUW**		**UNX**		Total	
	n	**%**	**n**	**%**	**n**	**%**	n	%
AGI	163	4.29	152	4.26	116	3.43	431	4.01
No AGI	3,635	95.71	3,418	95.74	3,263	96.57	10,316	95.99
Total	**3,798**		**3,570**		**3,379**		**10,747**	**100.00**

Table V-2: Number and percent of cases of AGI, by study group during day 0-3 of follow-up.

Time window	**CAWS (vs. UNX)**			**GUW (vs. UNX)**		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Day 0-2	1.24	0.95, 1.62	0.12	1.32	1.01, 1.73	0.04
Day 0-3	1.26	0.99, 1.61	0.06	1.25	0.98, 1.60	0.08
Day 0-4	1.09	0.88, 1.34	0.45	1.07	0.86, 1.32	0.54
Day 0-5	1.08	0.89, 1.32	0.43	1.06	0.86, 1.29	0.60

Table V-3: Odds ratios for the development of AGI, unadjusted

(d) Indicators of severity of acute gastrointestinal illness

Study participants who report the development of new gastrointestinal symptoms (not necessarily AGI) are asked a series of questions to evaluate the severity of their symptoms. These questions include inquiries into whether the symptoms interfered with the participants daily activities, whether they took over the counter medications, sought medical attention (office or phone contact), took prescription medication, were evaluated in an emergency department, or were hospitalized. These categories are not mutually exclusive. Figure V-1 demonstrates the absence of apparent differences across groups. The majority of those with gastrointestinal symptoms denied all indicators of severity, though about 40% noted that their symptoms interfered with their usual activities. Few required prescription medication and less than 5% visited an emergency department or were hospitalized.

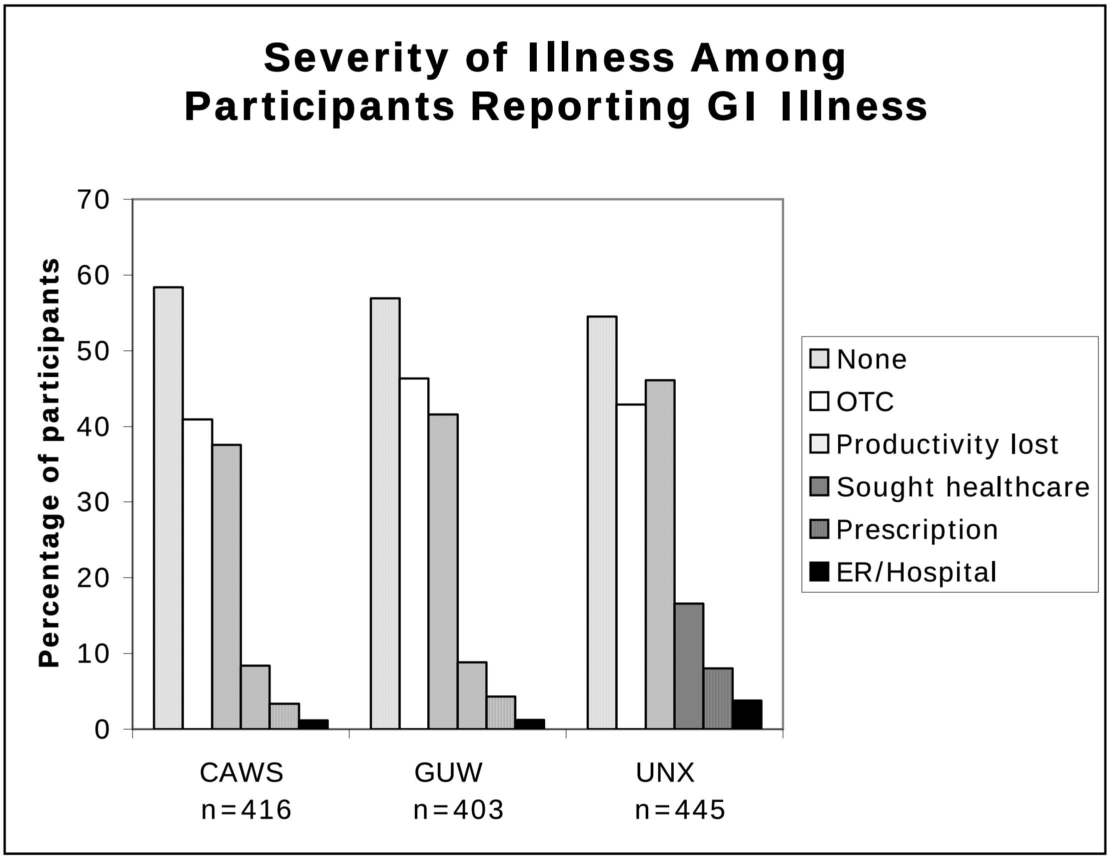

Figure V-1: Severity of illness indicators reported by participants with symptoms of GI Illness. This is based on information collected over all three phone surveys. None refers to individuals reporting symptoms but no indicator of severity.

Chapter VI. Clinical Microbiology

Section 6.01 Introduction

Study participants who developed any new gastrointestinal symptom (not limited to those who developed acute gastrointestinal illness defined in Chapter 5) were asked to provide up to three stool samples (collected 48 hours apart) for microbial analyses. All clinical microbiology analyses were conducted at the University of Illinois Medical Center, with the exception of the norovirus and shigatoxin assays, which were conducted by the Illinois Department of Public Health Chicago Laboratory.

Of the 11,297 research participants, 297 had GI symptoms at baseline and 2 were not sure at baseline if they had GI symptoms or not. Of the remaining 10,998, a total of 2,433 (22.1%) developed a gastrointestinal symptom (as opposed to AGI as described in Chapter 5). Of those, 745 provided at least one stool specimen for analysis.

Table VI-1 summarizes the microbes detected in stool samples. The numbers in this table refer to participants, rather than tests. In other words, a participant who provided 2 stool samples, one of which tested positive for a pathogen and the other of which tested negative, would be counted as one individual who tested positive. The most frequently identified pathogens were viruses. Numerous non-pathogenic microbes were detected as well. No sample tested for *Cryptosporidium spp.* or for *Cyclospora spp.*

Because stool samples were not collected from asymptomatic participants, it is not known how the rate of detection of the non-pathogenic microbes compares to that of an asymptomatic population.

There were no statistically significant differences in the rate of positive tests across study groups. The distribution of the detection of pathogens by study group is provided for rotavirus and norovirus, the two most frequently identified pathogens, are summarized in Table VI-2 and Table VI-3, respectively.

	n	Negative	Positive	Positive%
Viral pathogens				
Rotavirus	704	646	58	8.2%
Norovirus	638	623	15	2.4%
Echovirus type 11	702	700	2	0.3%
Adenovirus	702	700	2	0.3%
Bacterial pathogens				
Pseudomonas aeruginosa	707	705	2	0.3%
Aeromonas caviae	707	706	1	0.1%
Shigatoxin-positive organism	617	616	1	0.2%
Protozoan pathogens				
Giardia lamblia	767	763	3	0.4%
Dientamoeba fragilis	767	765	2	0.3%
Protozoan microbe that may be pathogenic				
Blastocyctis hominis	767	736	31	4.0%
*Entamoeba histolytica/E. dispar**	767	761	6	0.8%
Non-pathogenic intestinal protozoa				
Endolimax nana	767	757	10	1.3%
Entamoeba coli	767	760	7	0.9%
Entamoeba hartmanni	767	762	5	0.7%
Dientamoeba fragilis	767	765	2	0.3%
Iodamoeba bustchlii	767	766	1	0.1%
Chiliomastix mesnili	767	766	1	0.1%

Table VI-1: Microbes identified in stool samples. *The laboratory method does not distinguish *Entamoeba histolytica*, which is a pathogen, from *E. dispar*, which is not a pathogen.

	CAWS	GUW	UNX	Total
Rotavirus negative	199	233	214	646
	93.4%	90.0%	92.2%	91.8%
Rotavirus Positive	14	26	18	58
	6.6%	10.0%	7.8%	8.2%
Total	**213**	**259**	**232**	**704**
	100%	**100%**	**100%**	**100%**

Table VI-2: Detection of rotavirus in stool samples of symptomatic participants, by study group. Fisher's exact p-value=0.38

	CAWS	GUW	UNX	Total
Norovirus negative	191	233	199	623
	98.0%	98.7%	96.1%	97.6%
Norovirus positive	4	3	8	15
	2.1%	1.3%	3.9%	2.4%
Total	**195**	**236**	**207**	**638**
	100%	**100%**	**100%**	**100%**

Table VI-3: Detection of norovirus in stool samples of symptomatic participants, by study group. Fisher's exact p-value=0.2061

Chapter VII. Ongoing research activities

The UIC School of Public Health CHEERS research group is continuing to analyze data. Among the key efforts currently underway are the following:

- Analyses of the relationship between study group (CAWS, GUW, UNX) and the occurrence of gastrointestinal illness, taking into account potential confounding and effect modifying variables.
- Analyses of the relationship between water quality (indicators and pathogens) and the occurrence of acute gastrointestinal illness, taking into account potential confounders and effect modifiers.
- The occurrence of health endpoints other than gastrointestinal illness (such as the development of respiratory, skin, eye, and ear symptoms) in relation to study group and demographic variables.
- The exploration of propensity scores in statistical models as a method for best addressing the non-random distribution of participant characteristics across study groups
- Analysis of data from the "ingestion study" which was conducted in swimming pools in the summer of 2009. This research, based on the methods used by the US EPA in a study of swimmers, compares the volume of water ingested during swimming to the volume ingested during canoeing, kayaking, wading/splashing, and fishing.
- Analyses of the results of viral pathogens (adenovirus, enterovirus, and rotavirus) in large volume water samples collected at study locations in the 2009 season.
- Analysis of water quality with wet and dry weather conditions and health risks associated with each.

The research team will meet with the peer review panel on May 25-26th (the study timeline is outlined in Table VII-1). A draft final report will be discussed with the peer reviewers at that time. Unlike this Interim Technical Report, the Final Report will present our findings in the context of prior research. The strengths and limitations of the research will also be described, and a final set of conclusions will be offered to address the study objectives.

Time period	Research Activity
January, 2007	First contact between MWRDGC and UIC regarding an epidemiologic study
February 22, 2007	Meeting with national experts on water recreation and risk, MWRDGC, and UIC to discuss proposed research
June 4, 2007	Research design and methods discussed with US EPA Office of Water, Washington, DC
June, 2007	Piloting of questionnaires in the field
June 26, 2007	Human research subjects ("IRB") approval for the epidemiologic study
July 9, 2007	Local stakeholders meeting
July 17-18, 2007	Peer review of CHEERS research protocols
July, 2007	Water sampling strategies evaluated on the CAWS
August 4, 2007	Participant recruitment begins
November, 2007	Year 1 data collection ends. A total of 792 people with usable follow-up data participated in the study.
Winter, 2007-2008	Analyses of Year 1 data begins
February 27, 2008	Peer review of 2007 data quality and 2008 research plans
Spring, 2008	Staffing levels increased to scale up field study
March 10, 2008	Year 2 participant recruitment begins
October 12, 2008	Year 2 data collection ends. A total of 6,616 people with usable follow-up data participated in the study (Years 1-2 combined).
Winter 2007-2008	Analysis of combine Year 1- Year 2 data begins
March 30-31, 2009	Years 1-2 data quality review by peer review panel
April 13, 2009	Year 3 participant recruitment begins
July 26, 2009	Participant recruitment ends. A total of 11,297 people with usable follow-up data participated in the study
September, 2009	Analysis of Year 1-3 data began.
April 8, 2010	Peer review of data quality, data analysis methods, preliminary findings
Upcoming milestones	
May 25-26, 2010	Peer review of final data analyses
July, 2010	Complete final report

Table VII-1: Milestones in the CHEERS research study

CHEERS Research Update

Appendix I: Quality Monitoring of

Water Microbiology Data

Appendix II: Water quality summary

An Interim Technical Report
Prepared for Submission to the
Illinois Pollution Control Board

May 5, 2010

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Appendix I. Quality Monitoring of Water Microbiology Data

Section 1.01 Overview of quality monitoring

During the three-year period of the project, the research team collected a total of 11,762 water samples for analyses of indicator organisms and protozoan pathogens. Table I-1 summarizes the number and percent of samples collected over the past three years for characterizing water quality and for quality monitoring purposes. Three types of QC samples were collected: field blanks, field splits, and spiked samples for recovery studies. The indicator organism samples refer to all samples analyzed for: *E. coli*, enterococci, somatic coliphages, and male-specific (or F+) coliphages. The protozoan pathogen samples refer to all samples analyzed for both *Giardia* and *Cryptosporidium* (oo)cysts.

Type of sample	Planned to collect	Collected & analyzed	Collected: Type/Total	Collected/ Planned
Indicators				
Regular	6,192	5,675	54.2%	91.7%
Blank	1,433	1,343	12.8%	93.7%
Split	2,580	2,452	23.4%	95.0%
Spike	1,055	1,000	9.6%	94.8%
Total (overall average)	**11,260**	**10,470**	**100.0%**	**93.0%**
Protozoan				
Regular	1,284	1,082	83.7%	84.3%
Blank	21	18	1.4%	85.7%
Split	83	76	5.9%	91.6%
Spike	137	116	9.0%	84.7%
Total (overall average)	**1,525**	**1,292**	**100.0%**	**84.7%**

Table I-1: Number and percent of water samples by type collected, 2007-2009

Section 1.02 Evaluation of contamination: adherence to labeling and handling protocols: Blanks

Method blanks and field blanks were both used to monitor quality. EPA methods for the indicator bacteria, *E. coli* and enterococci, require method blanks to have an absence of growth. For indicator viruses, male-specific and somatic coliphages, the method blank requirement is zero growth detected (no plaque forming units). Field blanks were prepared in the field using sterile water, while water sampling was in progress. Field blank samples were sent to the laboratory for analysis along with field samples.

Of 444 enterococci samples, 387 (87.16%) showed no growth (Table I-2). Thirty-four samples (7.66%) had detectable enterococci under 10 CFU/100mL. The number of samples which had detectable enterococci levels of 10-100 CFU/100mL and greater than 100 CFU/100mL were 18 (4.0aa5%) and 5 (1.13%), respectively.

For *E. coli*, of 451 samples, 428 (94.9%) showed no growth (Table I-3). Thirteen samples (2.88%) had detectable *E. coli* under 10 CFU/100mL. Eight samples (1.77%) had *E. coli* levels of 10-100 CFU/100mL and 2 samples (0.44%) were greater than 100 CFU/100mL.

For male-specific coliphage, 97.26% (426 samples) of the 438 blank samples met the criteria for no detectable growth (Table I-4). The detection limit is 1 PFU/100mL. Six samples (1.37%) had detectable male-specific coliphages with concentration under 10 PFU/100mL. Three samples (0.68%) detected male-specific coliphage densities of 10-100 PFU/100mL and 3 (0.68%) had greater than 100 PFU/100mL.

For somatic coliphage, of 438 samples, 438 (98.63%) blank samples met the criteria for no detectable growth (Table I-5). The detection limit is 10 PFU/100mL. Six samples (1.37%) had detectable somatic coliphages at the level 10-100 PFU/100mL.

All blank samples of *Giardia* and *Cryptosporidium* (oo)cysts met the criteria for no detectable growth (Table I-6 and Table I-7).

Density, CFU/100mL	Sample Number	Percentage
0	387	87.16%
≤ 10	34	7.66%
10 to 100	18	4.05%
Greater than 100	5	1.13%
TOTAL	444	100.00%

Table I-2: Results of enterococci blank samples, 2007-2009

Density, CFU/100mL	Sample Number	Percentage
0	428	94.90%
≤ 10	13	2.88%
10 to 100	8	1.77%
Greater than 100	2	0.44%
TOTAL	451	100.00%

Table I-3 Results of *E. coli* blank samples, 2007-2009

Density, PFU/100mL	Sample Number	Percentage
<1	426	97.26%
≤ 10	6	1.37%
10 to 100	3	0.68%
Greater than 100	3	0.68%
TOTAL	438	100.00%

Table I-4: Results of male-specific coliphage blank samples, 2007-2009

Density, PFU/100mL	Sample Number	Percentage
<10	432	98.63%
10 to 100	6	1.37%
TOTAL	**438**	**100.00%**

Table I-5: Results of *Somatic coliphages* blank samples, 2007-2009

Density, Counts/20L	Sample Number	Percentage
0	18	100.00%
TOTAL	**18**	**100.00%**

Table I-6: Results of *Giardia* blank samples, 2007-2009

Density, Counts/20L	Sample Number	Percentage
0	18	100.00%
TOTAL	**18**	**100.00%**

Table I-7: Results of *Cryptosporidium* blank samples, 2007-2009

(a) Time trends/control chart

Control charts were created to examine any potential systematic errors. For each microorganism, the results of blank samples (field and method) were plotted against sampling time. A random distribution of values above the limit detection on the chart argues against systematic error. For *Giardia* and *Cryptosporidium* (oo)cysts, since all the results of blank samples were zero for the past three years, control charts were not created. Control charts of enterococci, *E. coli*, male-specific coliphage, and somatic coliphage are presented in Figure I-1 through Figure I-4. No systematic errors were observed for *E. coli*, enterococci, and somatic coliphage. For male-specific coliphage, several blanks collected in August and September of 2008 had high values. Field records and laboratory reports were reviewed, however no explanations of the high blanks were found.

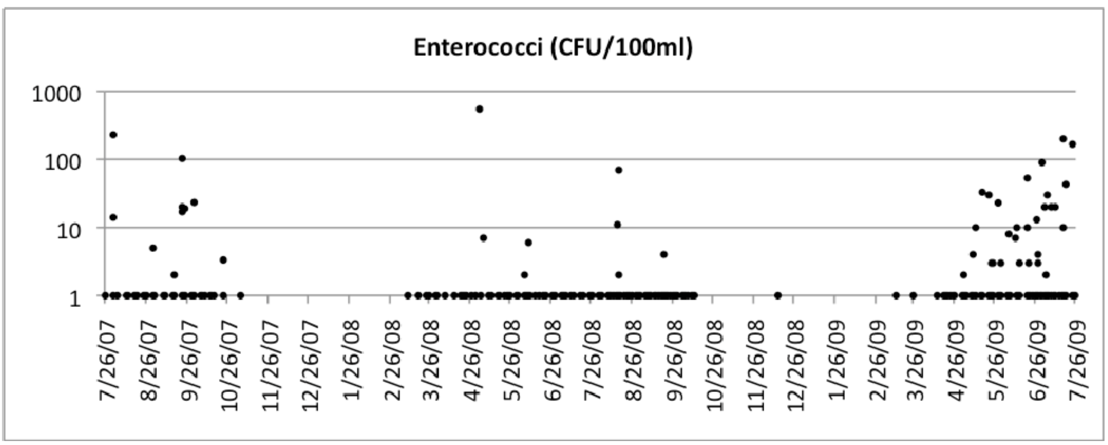


Figure I-1: Control charts of enterococci blanks

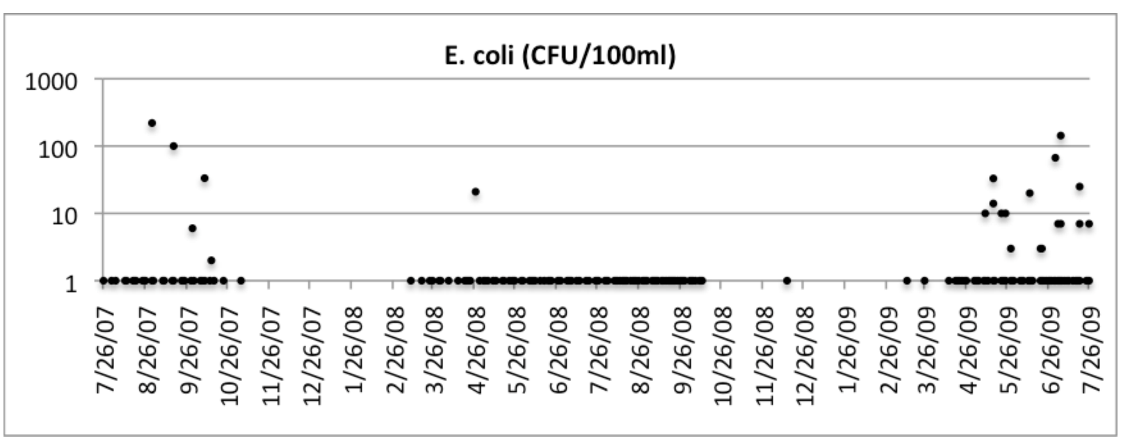


Figure I-2: Control chart of *E. coli* blanks

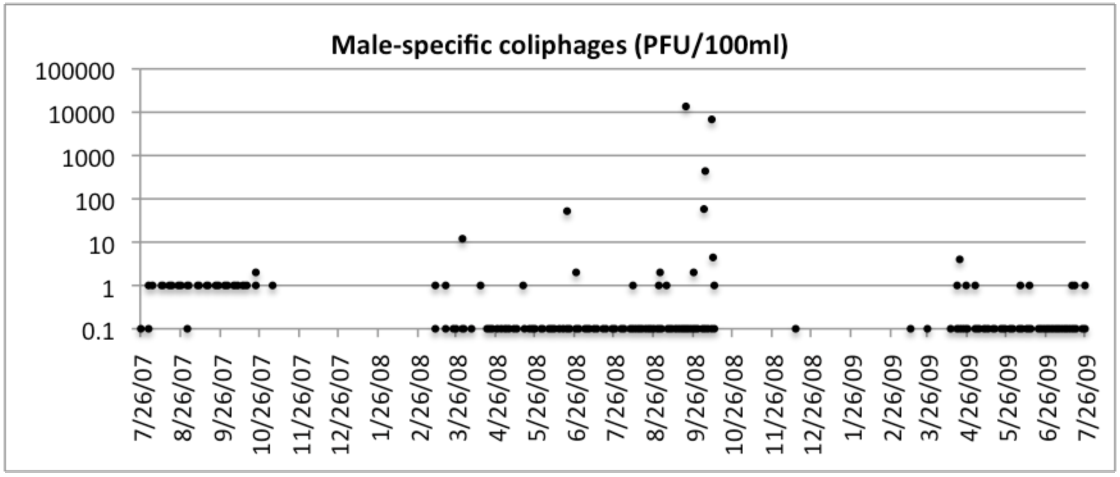


Figure I-3: Control chart of male-specific coliphages blanks

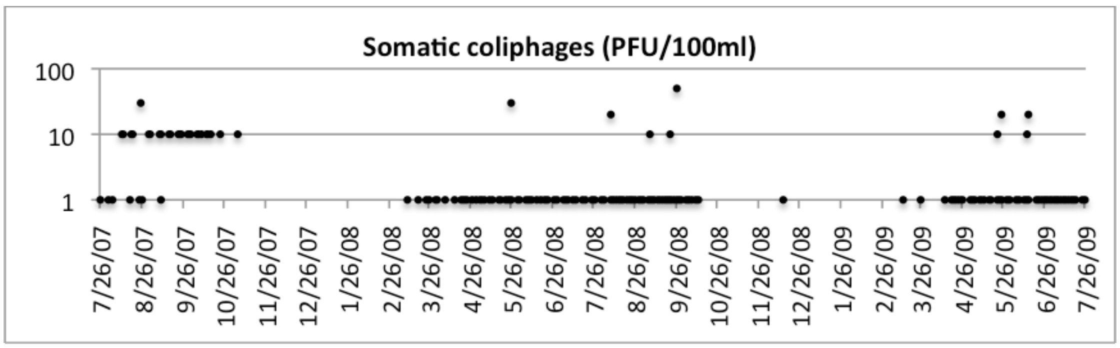


Figure I-4: Control chart of somatic coliphages blanks

Section 1.03 Precision of methods and adherence to labeling and handling protocols: split sample analyses

(a) Split Sample Concordance

To evaluate the influence of sampling handling and laboratory analysis, a series of samples were collected in 2 L bottles and separated into two or three sample containers for analysis. These are termed "split samples." Analyses were conducted to assess agreement between results we received from split sample pairs. When the sample had been split three-ways, two out of three were randomly selected and used for these analyses. The data were log-transformed before conducting the analysis to improve normality.

First, scatter plots of the measured microorganism densities from the pairs of split samples were created. The y = x line is shown in red to indicate perfect correlation. The closer the data points are to the line, the higher agreement between the pairs. Second, the difference between the splits, divided by their average, was plotted against their average: The ratio between the difference and average is presented in the form of a percentage. The average value is presented in the log-scale (x-axis). The purpose of this data presentation is to identify trends in variability as a function of concentration.

Overall, precision is lower at lower microorganism densities. For enterococci (Figure I-5 and Figure I-6) and *E. coli* (Figure I-7 and Figure I-8), agreement between the split samples was reduced at densities below 10 CFU/100mL. For male-specific coliphages (Figure I-10 and Figure I-11), agreement between the split samples is reduced at densities below 10 PFU/100mL. For somatic coliphages (Figure I-12 and Figure I-13), the reduction of precision was observed at densities below 100 PFU/100mL. For *Giardia* (Figure I-14 and Figure I-15), precision was reduced for densities under 10 cysts /10L. Due to the small number of split samples, detectable *Cryptosporidium* oocysts, trends are difficult to discern (Figure I-15 and Figure I-16).

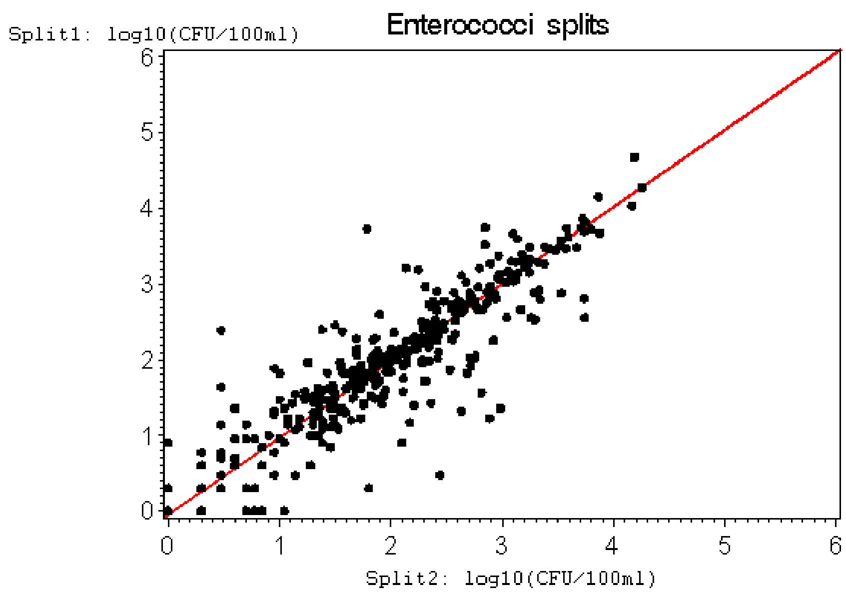


Figure I-5: Enterococci split pair scatter plot

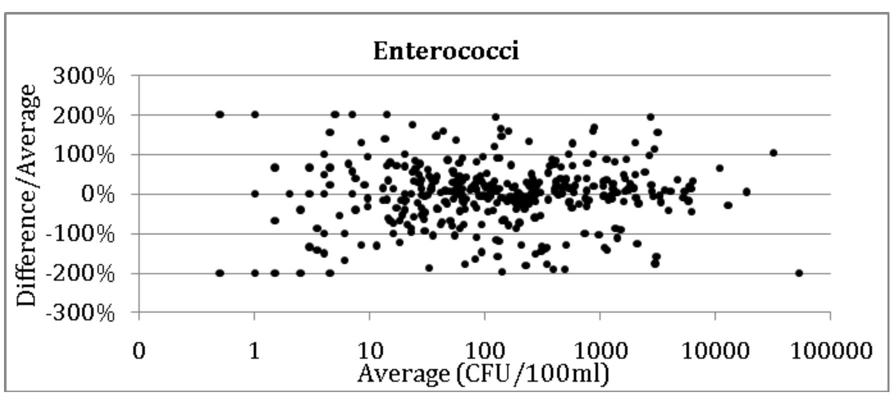


Figure I-6: Enterococci split difference/average vs. average

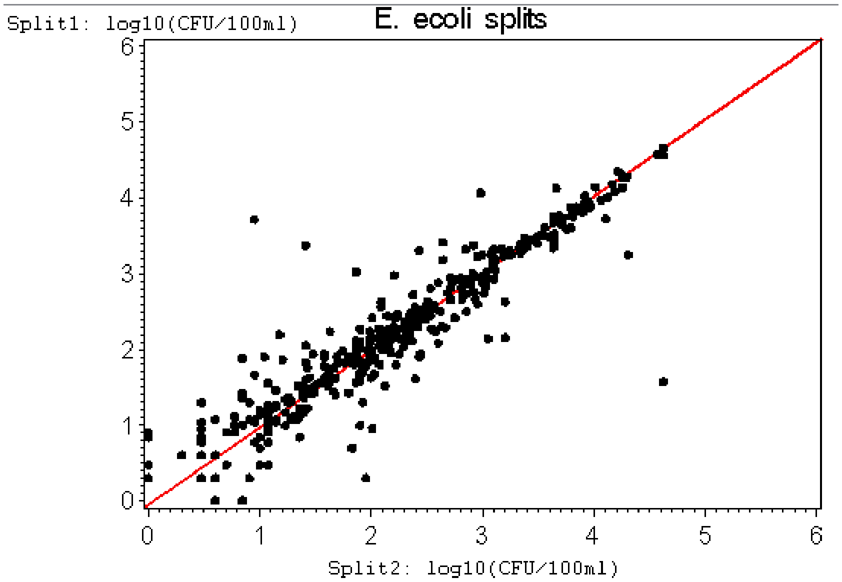


Figure I-7: *E. coli* split pair scatter plot

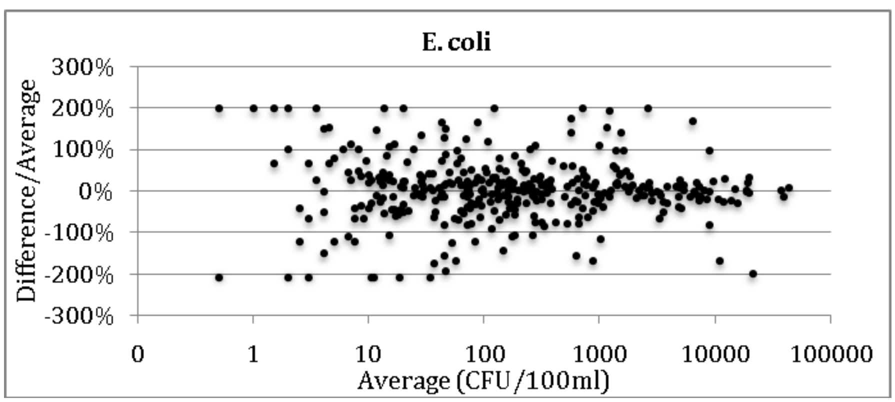


Figure I-8: *E. coli* split difference/average vs. average

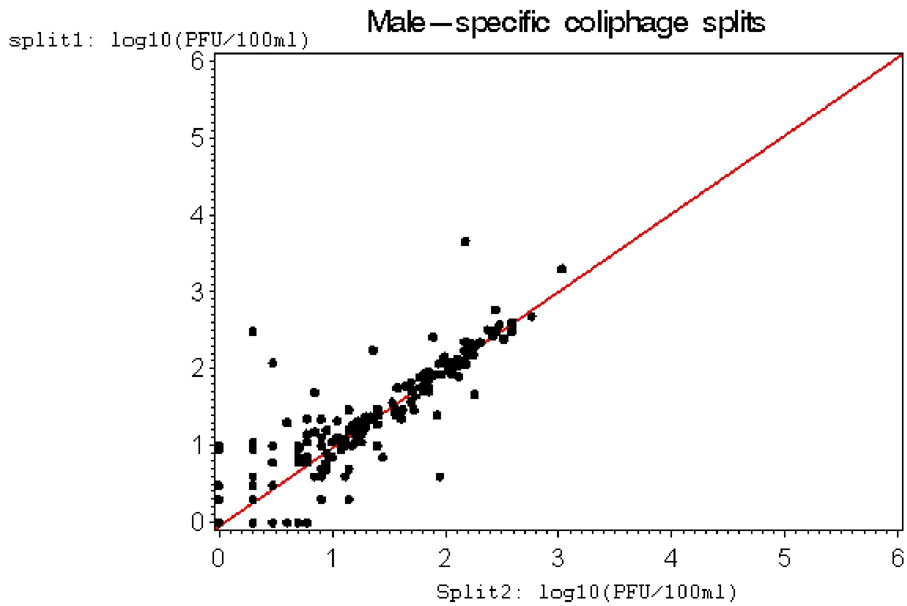


Figure I-9: Male-specific coliphage split pair scatter plot

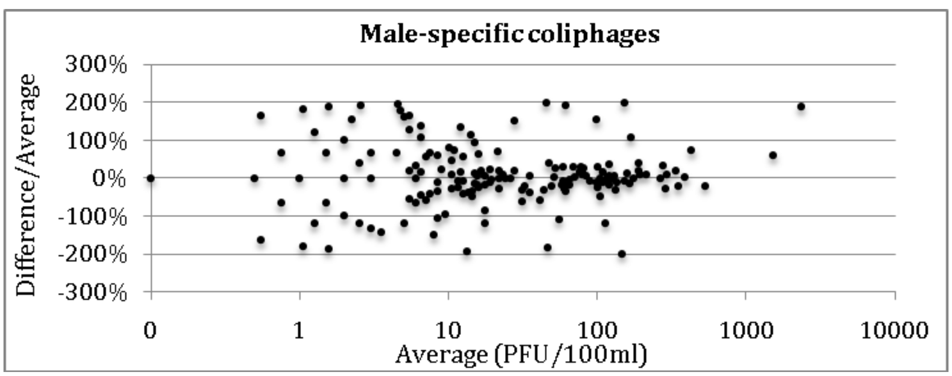


Figure I-10: Male-specific coliphage split difference/average vs. average

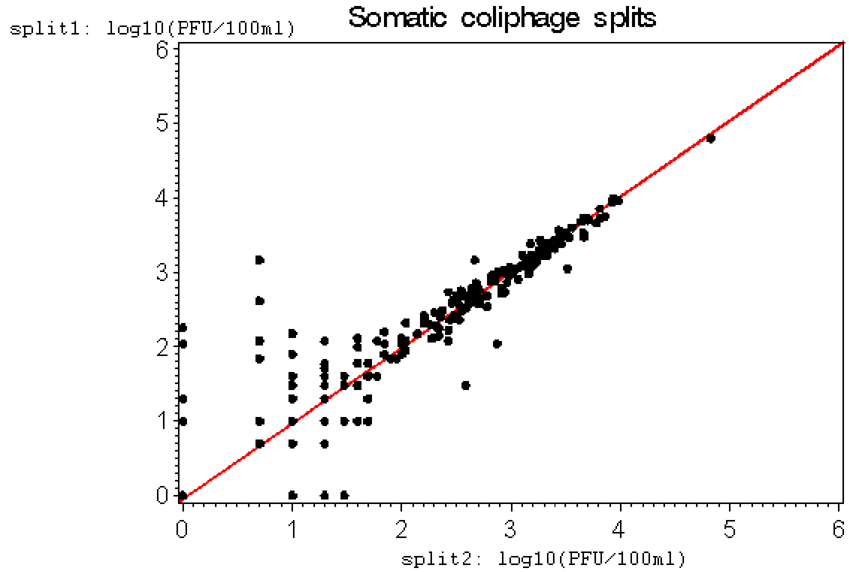


Figure I-11: Somatic coliphage split pair scatter plot

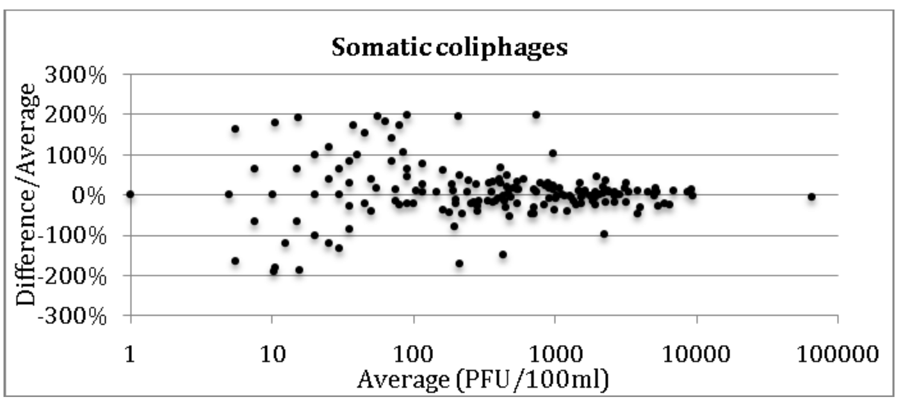


Figure I-12: Somatic coliphage split difference/average vs. average

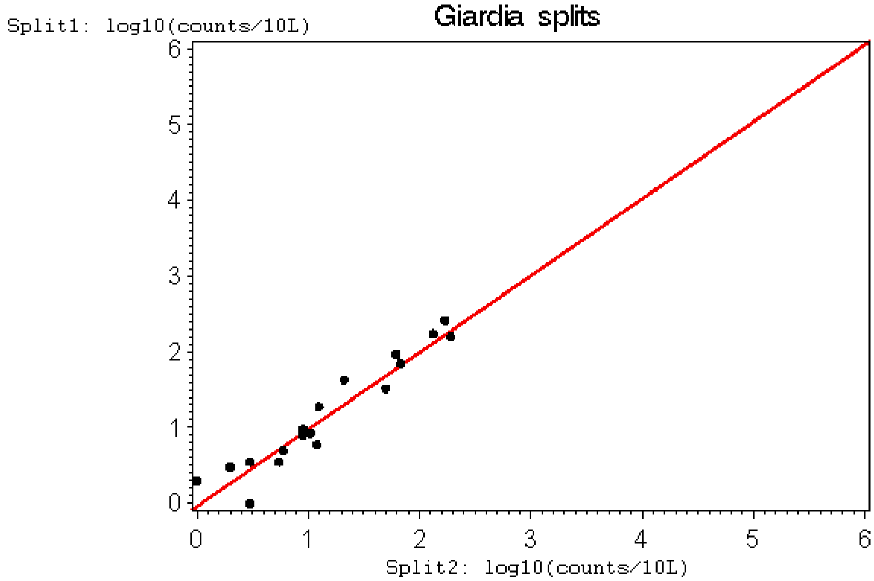


Figure I-13: *Giardia* split pair scatter plot

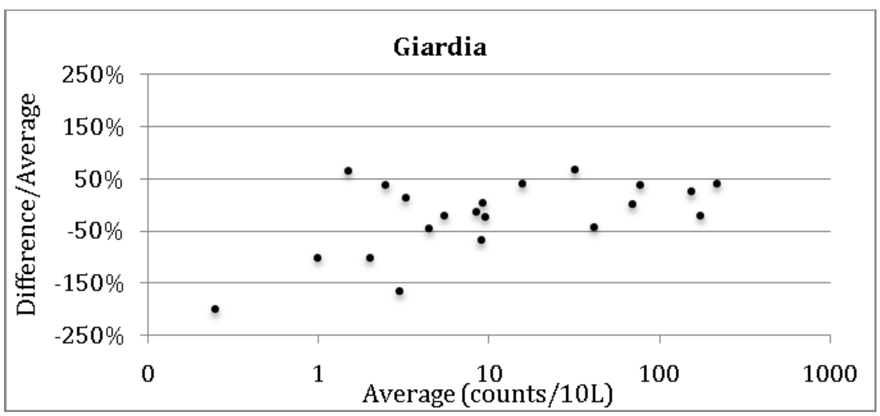


Figure I-14: *Giardia* split difference/average vs. average

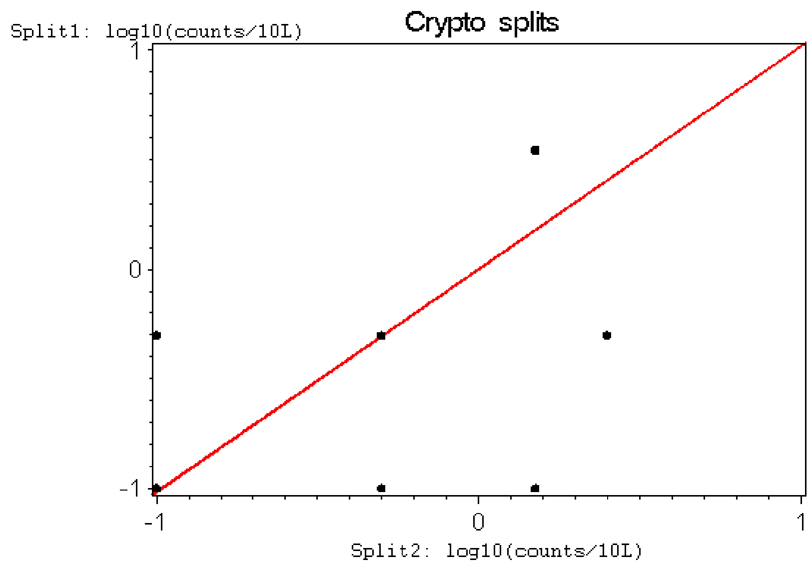


Figure I-15: *Cryptosporidium* split pair scatter plot

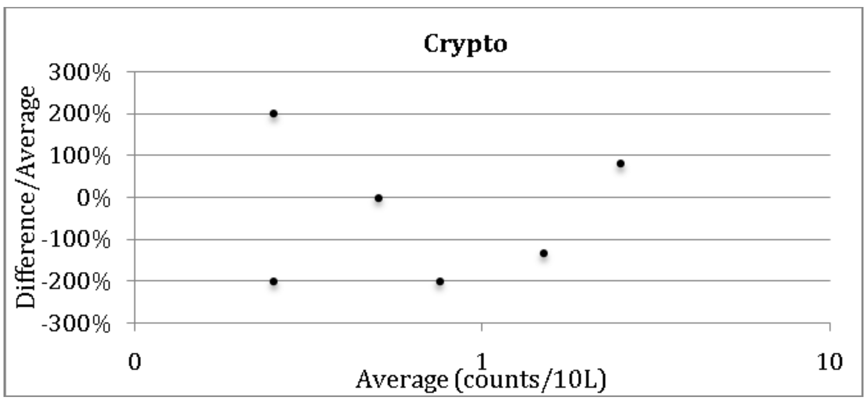


Figure I-16: *Cryptosporidium* split difference/average vs. average

(b) Time trends/control chart

Control charts were created to examine any systematic errors in concordance of the split sample results (Figure I-17 through Figure I-22). For each pair of split samples, the absolute value of the difference was calculated, and plotted against time of sample collection. The y-axis (difference of the splits) was log scaled in order to easily observe both the small value and the extreme large value in the same plot. In order to use a log-scale plot, for the split samples with zero difference, 0.1 was assigned. Therefore, all the dots with 0.1 values in the plots represent the paired splits which had the same results. No systematic errors were observed.

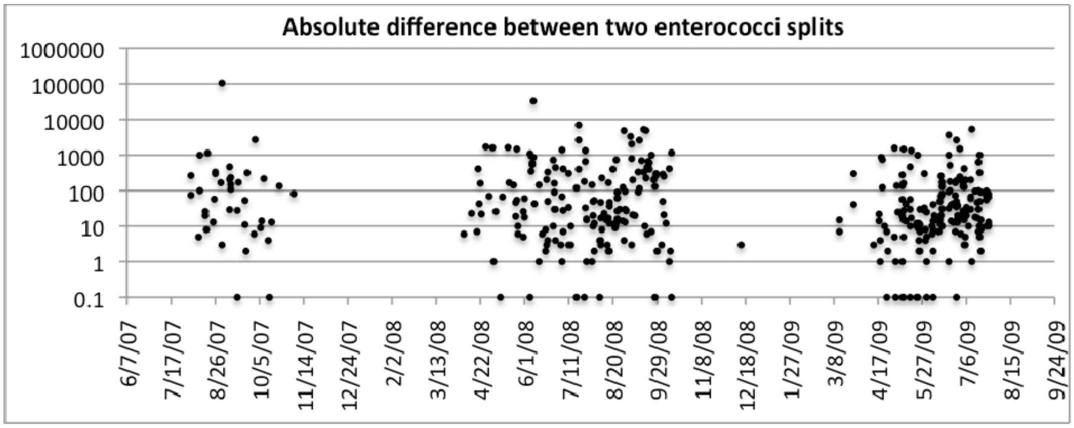


Figure I-17: Enterococci split control chart

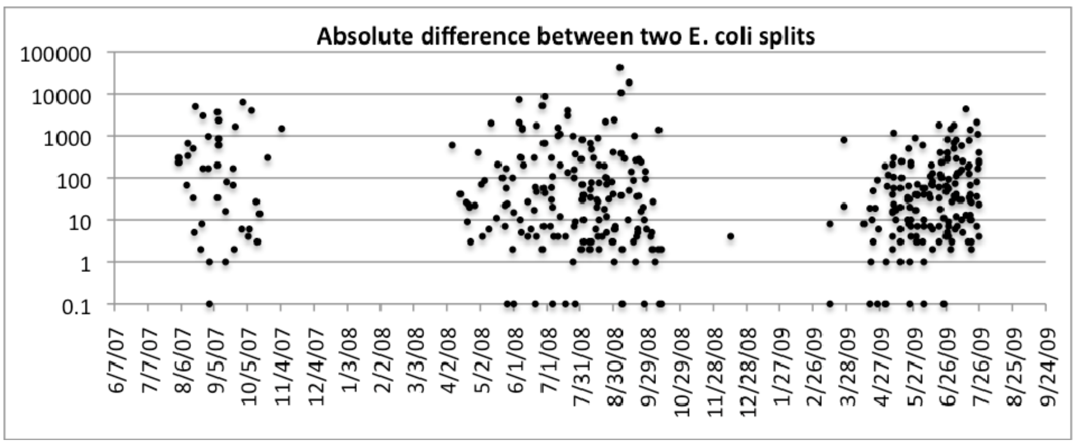


Figure I-18: *E. coli* split control chart

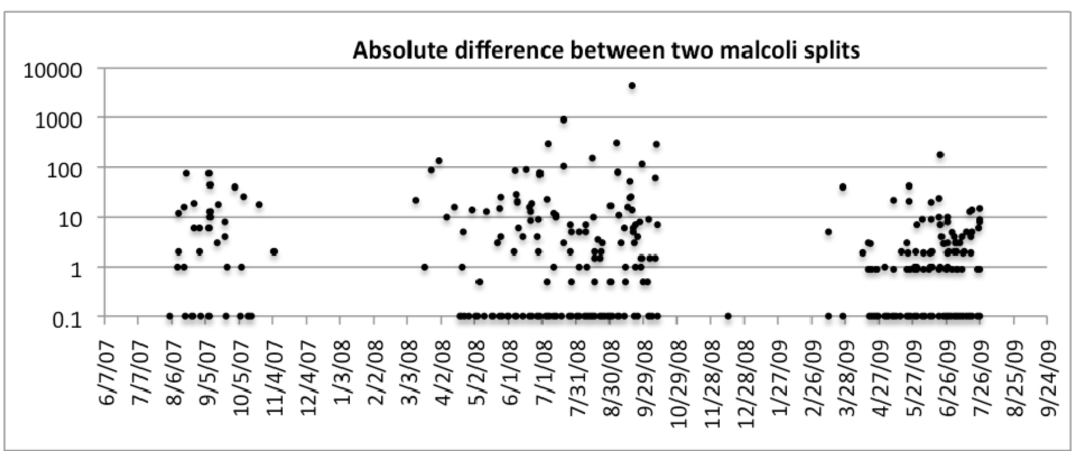


Figure I-19: Male-specific coliphages split control chart

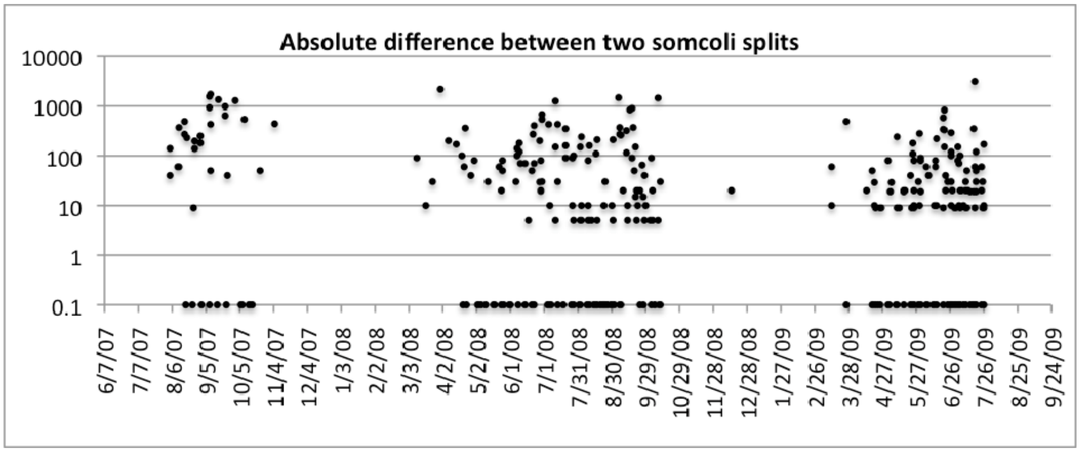


Figure I-20: Somatic coliphages split control chart

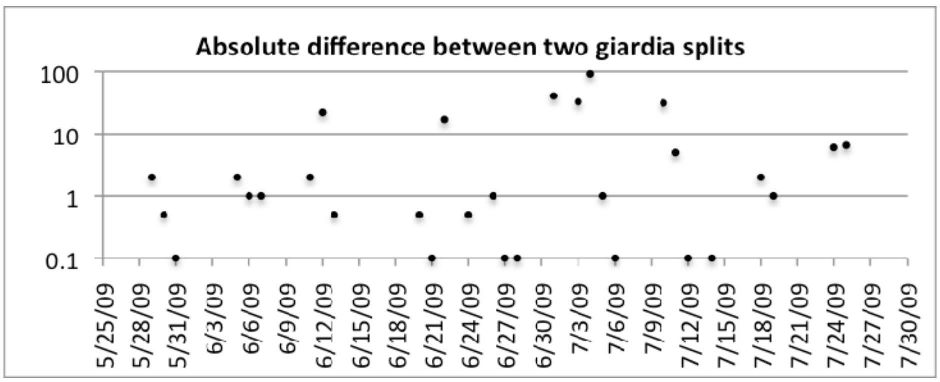


Figure I-21: *Giardia* split control chart

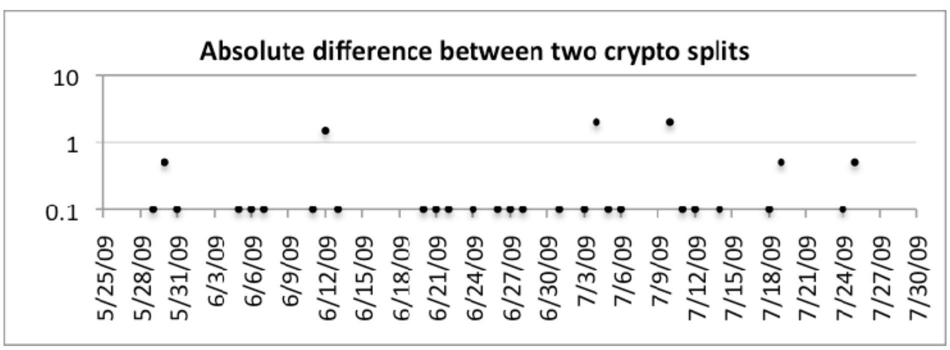


Figure I-22: *Cryptosporidium* split control chart

Section 1.04 Accuracy: recovery calculations

(a) Recovery Magnitudes

Recovery studies were conducted throughout the study. A subset of all water samples collected in the field were spiked at UIC or in the field and then sent to the laboratory: The laboratory was blinded to the spiking. For indicator organisms, the goal was to spike a minimum of 1 sample per site per day per method. For protozoan pathogens, the goal was to spike 5% of samples per day, and evenly cover all the sampling sites throughout the study period. As noted in Table I-8, 9.6% of all indicator organism samples and 9.0% of protozoan pathogen samples were spiked for recovery analyses.

Samples were collected for matrix spike samples during every sampling day-location for quality control purposes. EPA methods 1600 and 1603 require a split sample (unspiked matrix) and one matrix spike sample for each batch of sample analysis. The matrix spike level was determined based on the previous or expected microbe level at that location. BioBalls (BTF Pty. Ltd., Sydney, Australia) were used for spiking in the field, where the balls were dropped directly into the sample. Small containers were prepared in advance with the appropriate number of BioBall vials and stored on ice until use. Immediately following sample collection, field staff added the balls to the samples on site and shook the bottle to make sure the balls dissolved entirely. The quality of the BioBall spike material was verified using defined substrate methods at the UIC School of Public Health water quality laboratory.

Samples for coliphage analysis were spiked at the UIC School of Public Health water laboratory by pipetting 1mL spike material for Male-specific coliphage and 1 mL for Somatic coliphage into the 500 mL sample bottle. Spike material was prepared in advance by Scientific Methods, Inc. (SMI, Granger, IN) and the exact concentration provided by SMI. One spike material was used for both coliphages (EPA 1602).

For the 2008 and 2009 sampling campaign, protozoan pathogen samples were collected in cubitainers in the field, and centrifuged in the UIC School of Public Health water laboratory. In 2007, the centrifuge was operated in the field. Spike materials for *Giardia* and *Cryptosporidium* (oo)cysts were provided in small tubes that were washed into the 20L cubitainers coded for spiking prior to continuous flow centrifuge (CFC) processing.

A summary of the recovery studies conducted by UIC ("spiked sample") overall is provided in Table I-8. The distribution of recovery is presented in Figure I-23.

	E. coli	**Enterococci**	**Male-specific coliphage**	**Somatic coliphage**	***Giardia* cysts**	***Cryptosporidium* oocysts**
Count	313	325	269	261	114	114
Average	81%	73%	72%	63%	20%	27%
EPA criteria	17-117%	63-110%	48-291%	48-291%	15-118%	13-111%

Table I-8: Recovery from spiked samples at all locations, 2007-2009

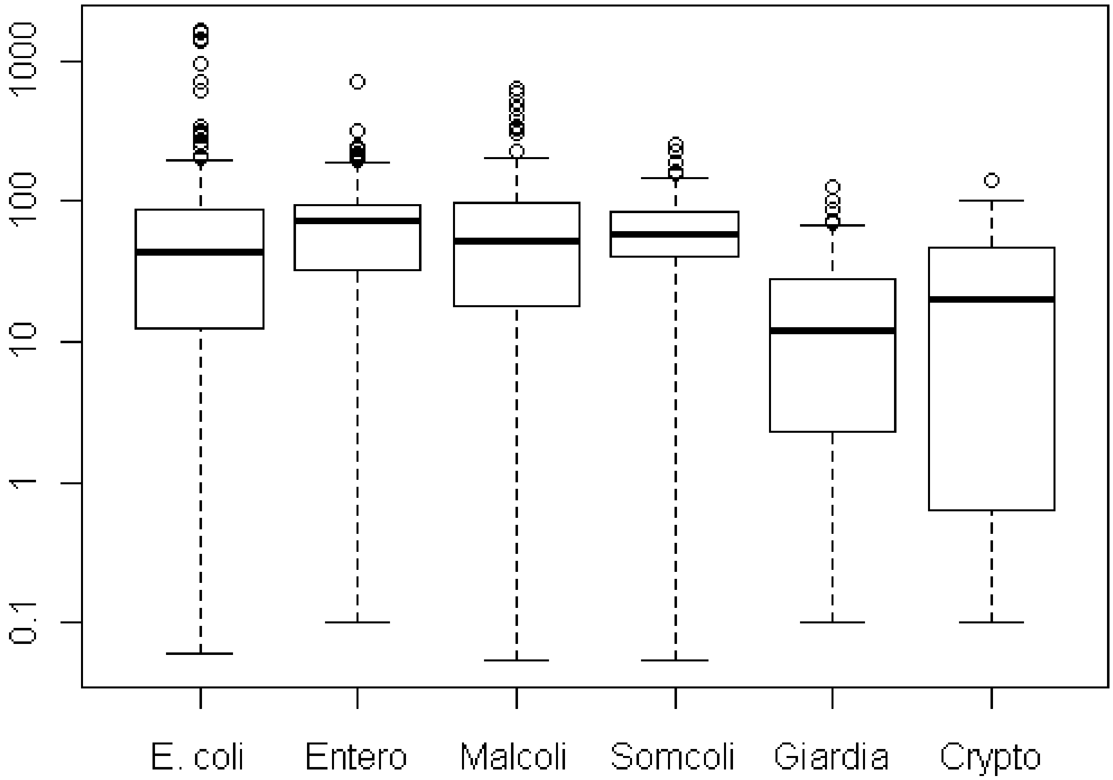


Figure I-23: Boxplot of microbe recovery. The numbers on the Y-axis indicate the recovery percent

(b) Time trends/control chart

Control charts were created to identify any systematic errors for the spike samples: The percent recovery in the spiked samples is plotted against sampling time (Figure I-24 through Figure I-29). All the charts showed a random pattern except Male-specific coliphage, for which the recovery rate peaked in August 2008, and declined after October of the same year. Field records and laboratory reports from these months were reviewed, however no explanations for the high recoveries (such as errors in data entry) were found.

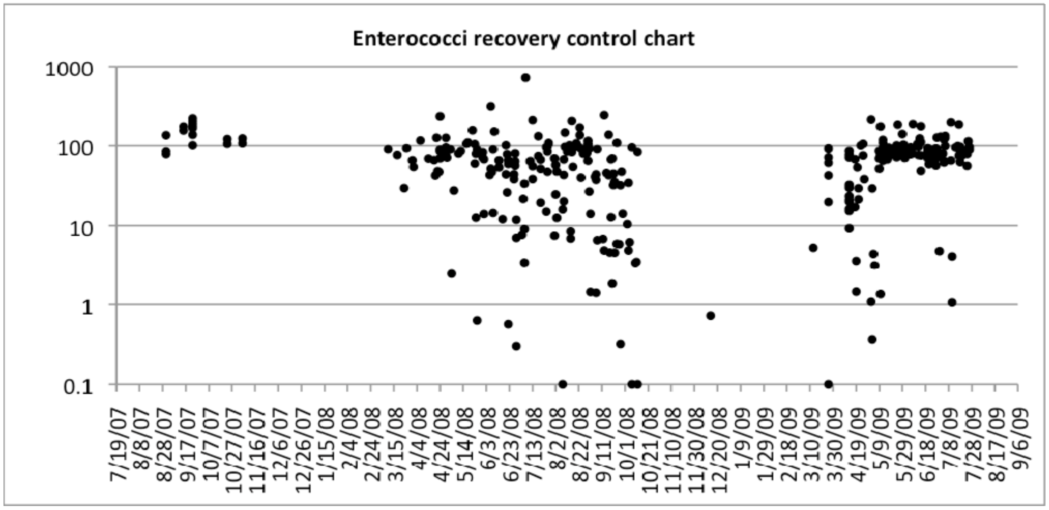


Figure I-24: Enterococci recovery control chart. Numbers on the Y-axis indicate the recovery percent

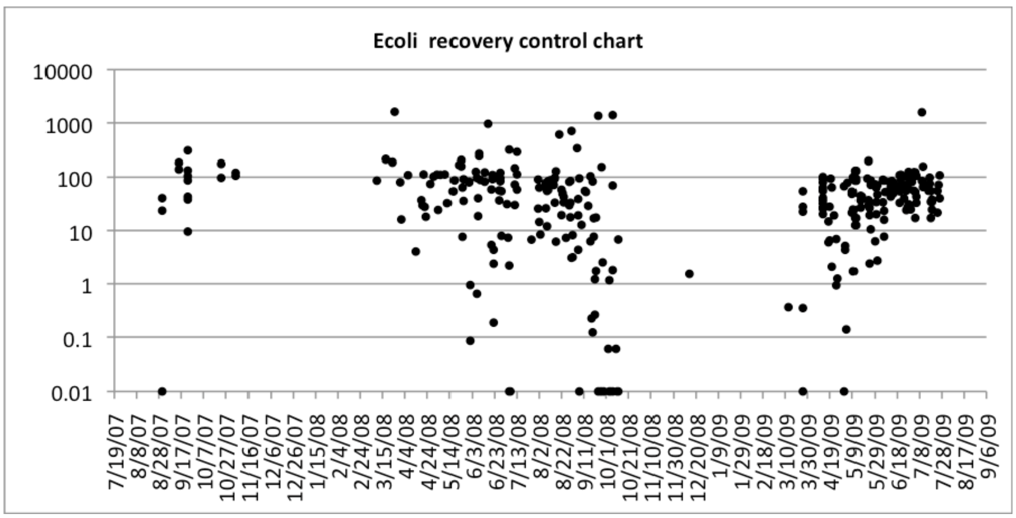


Figure I-25: *E. coli* recovery control chart. Numbers on the Y-axis indicate the recovery percent

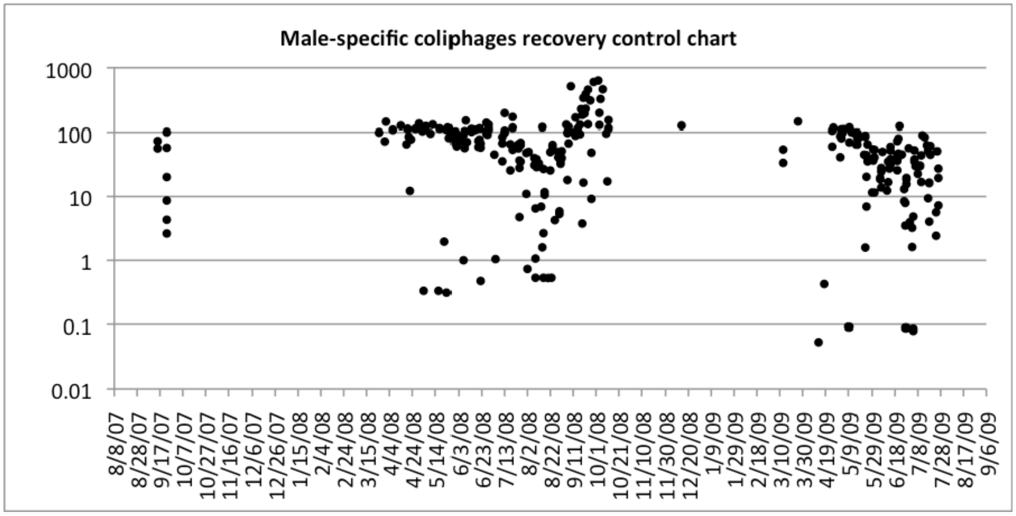


Figure I-26: Male-specific coliphage recovery control chart. Numbers on the Y-axis indicate the recovery percent

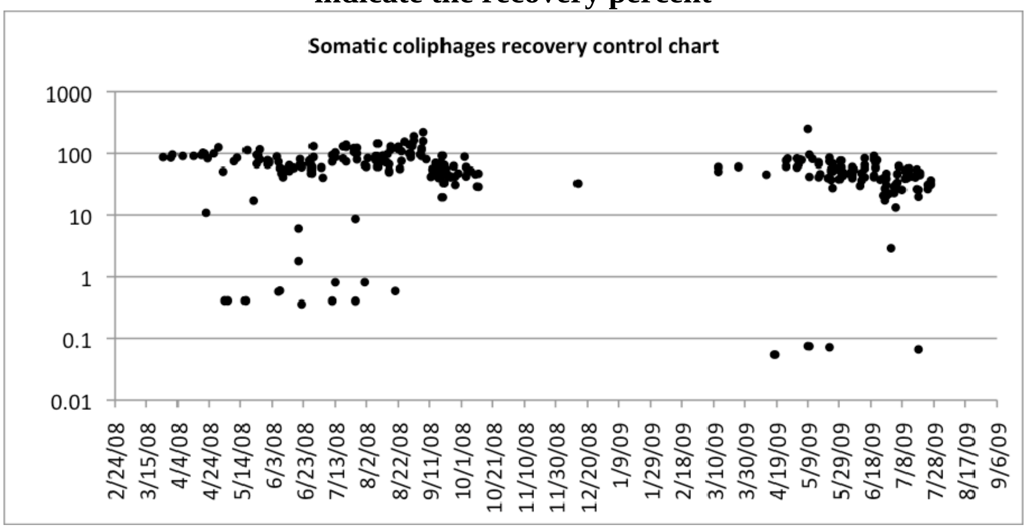


Figure I-27: Somatic coliphage recovery control chart Numbers on the Y-axis indicate the recovery percent

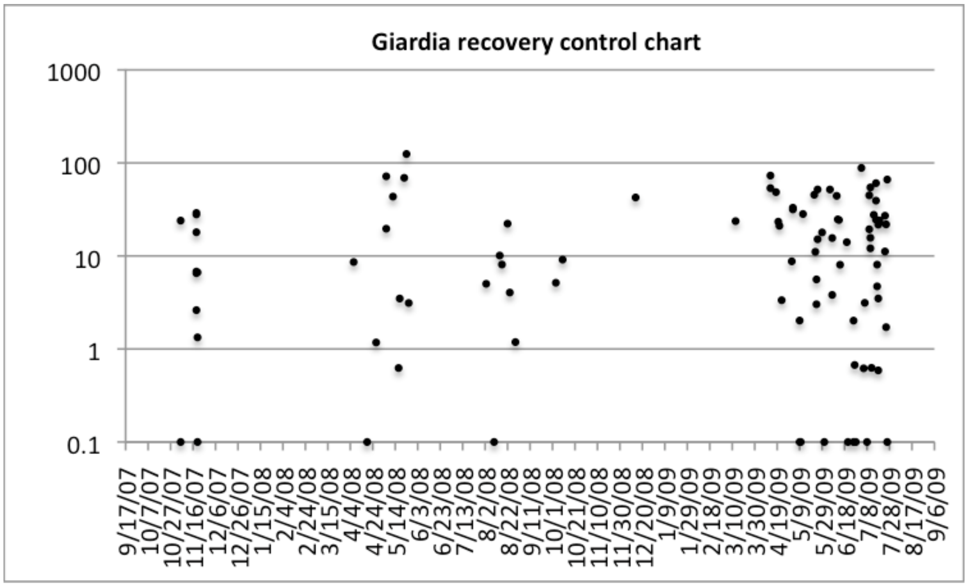


Figure I-28: *Giardia* recovery control chart

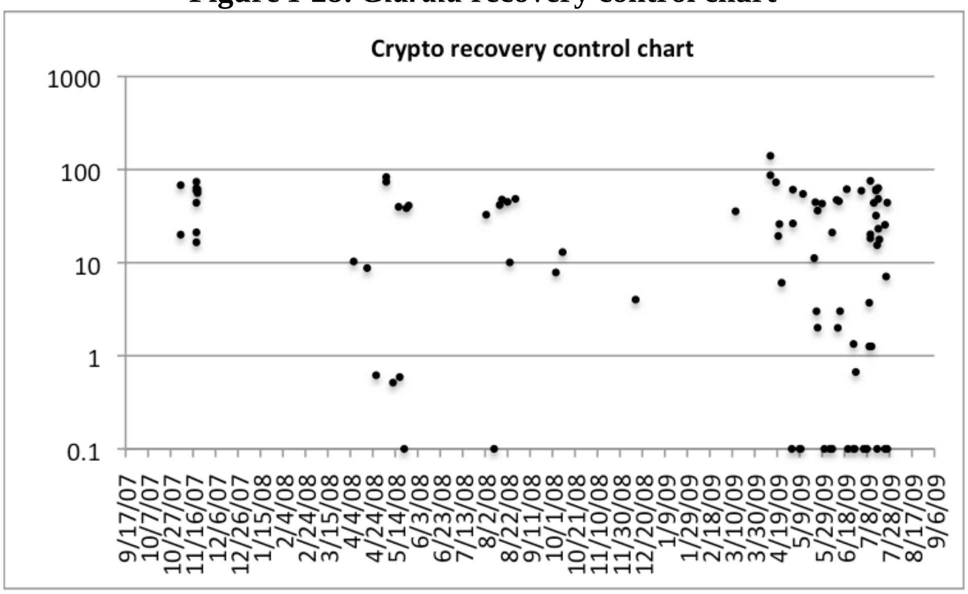


Figure I-29: *Cryptosporidium* recovery control chart

Section 1.05 Hold time

Water samples were sent to 3 different laboratories for 4 different laboratory analyses, each with different hold time requirements. For *E. coli* and enterococci, the EPA method requires the hold time from collection to receipt at the laboratory to be no more than 6 hours and sample should be processed within 2 hours of receipt at laboratory. For the coliphages the requirement is 48 hours, and for the protozoan pathogens it is 72 hours. Out of a total of 6,943 samples of *E. coli* and enterococci, 96% arrived in less than 6 hours. Out of a total of 3,709 coliphage samples, 95% arrived in less than 48 hours. Out of a total of 1,451 protozoan pathogen samples, 99% arrived in less than 72 hours.

The distribution of hold times is presented below in Figure I-30 for indicator bacteria samples, in Figure I-31 for coliphage samples, and in Figure I-32 for protozoan pathogen samples.

The mean concentration of microbes for which the hold time exceeded the method requirement was compared to the mean concentration of microbes collected from the same location groups for which the hold time requirement was satisfied. No meaningful differences were observed based on hold time.

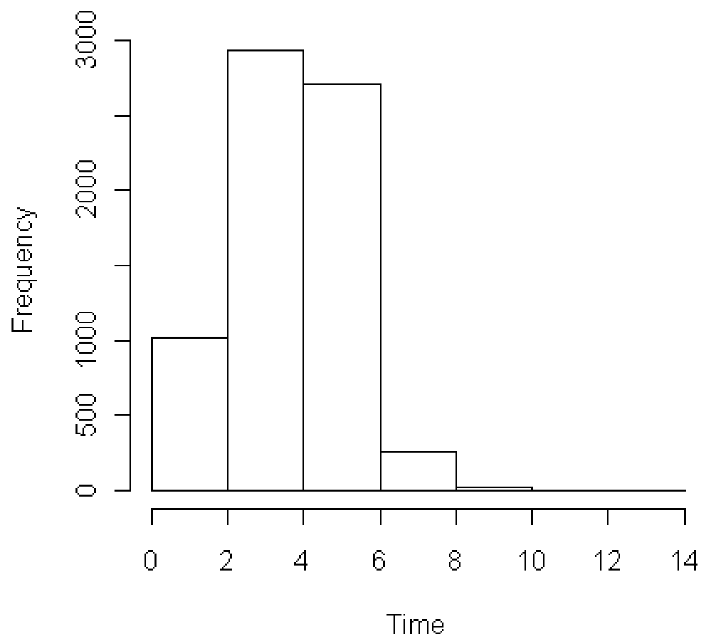


Figure I-30: Distribution of hold time (h) for *E. coli* and enterococci samples

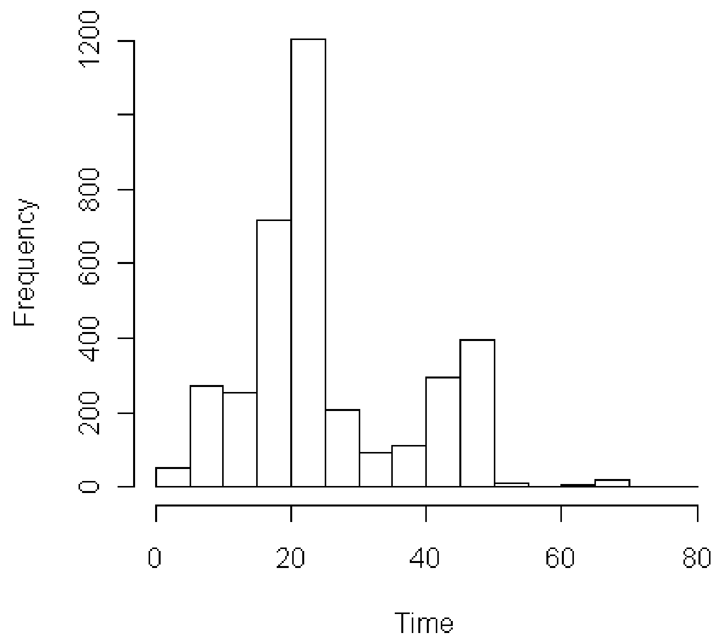


Figure I-31: Distribution of hold time (h) for coliphage samples

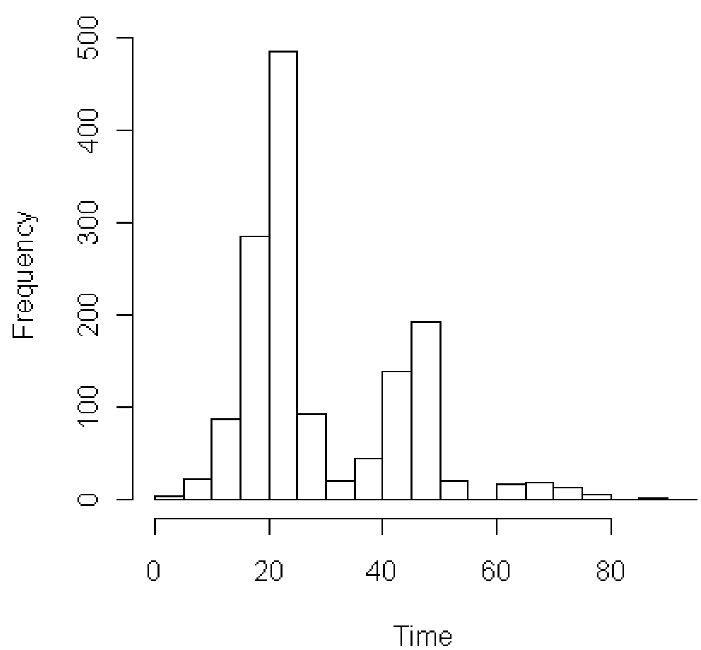


Figure I-32: Distribution of hold time (h) for protozoan pathogen samples

Section 1.06 Temperature

Water samples were transported to the laboratories for analysis in coolers containing crushed ice, and the temperature recorded by the laboratories. The mean and range of temperatures (°C) for each microbe is listed in Table I-9.

The distribution of recorded temperature is presented below in Figure I-33 for enterococci samples, Figure I-34 for *E. coli* samples, Figure I-35 for coliphage samples, and Figure I-36 for protozoan pathogen samples. Freezing of samples did not occur.

	E. coli	**Enterococci**	**Coliphages**	**Protozoa**
Average	12.5	12.8	6.5	7.9
Minimum	1	0.4	0	0
Maximum	32.2	28.4	17	20

Table I-9: Temperature (^{o}C) for samples of each microbe

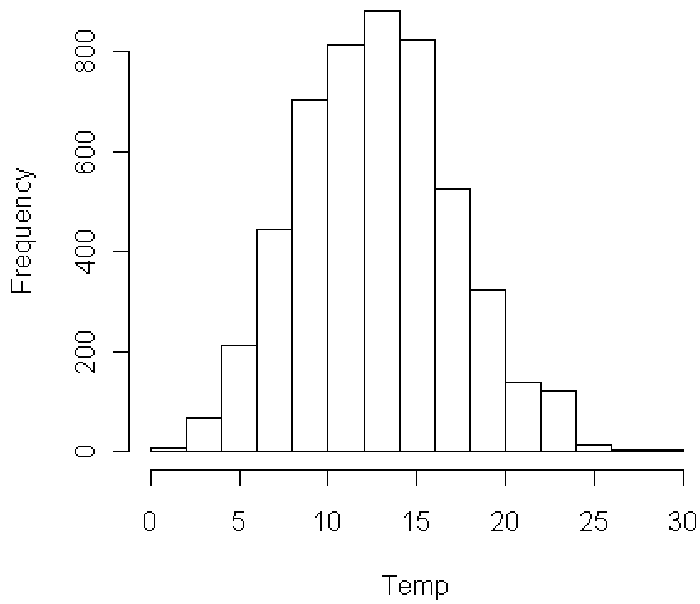


Figure I-33: Distribution of temperature (^{o}C) for enterococci samples

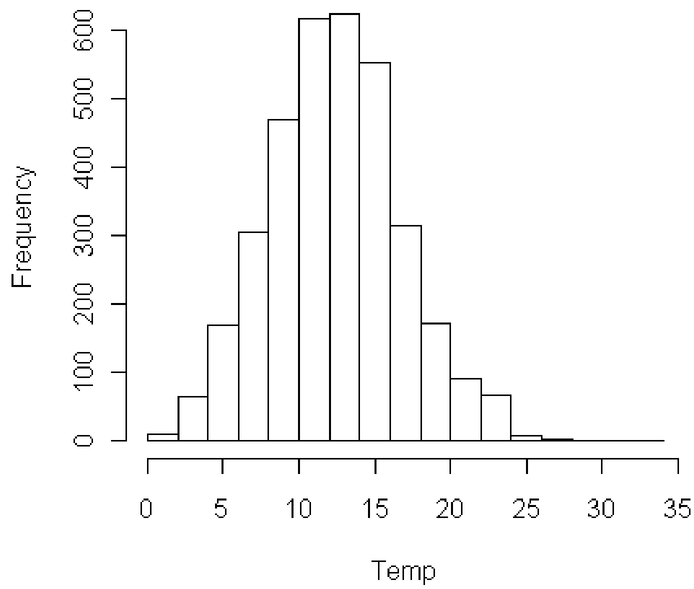


Figure I-34: Distribution of temperature (^{o}C) for *E. coli* samples

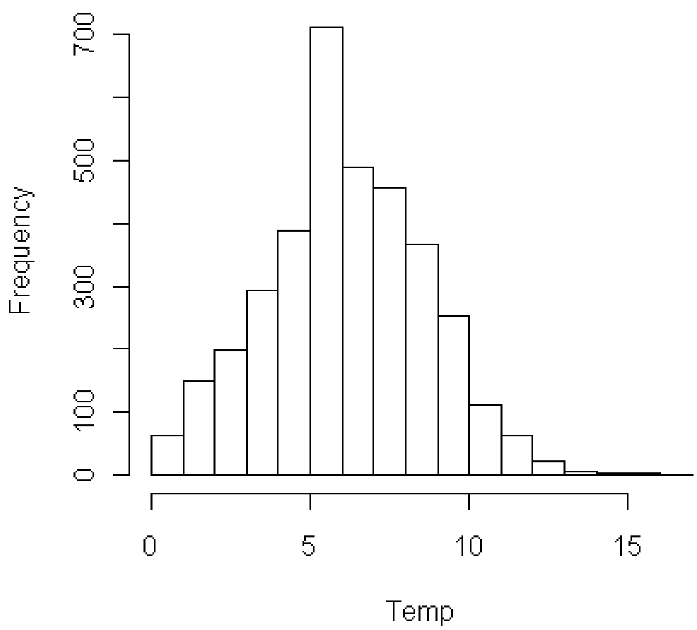


Figure I-35: Distribution of temperature (^{o}C) for coliphage samples

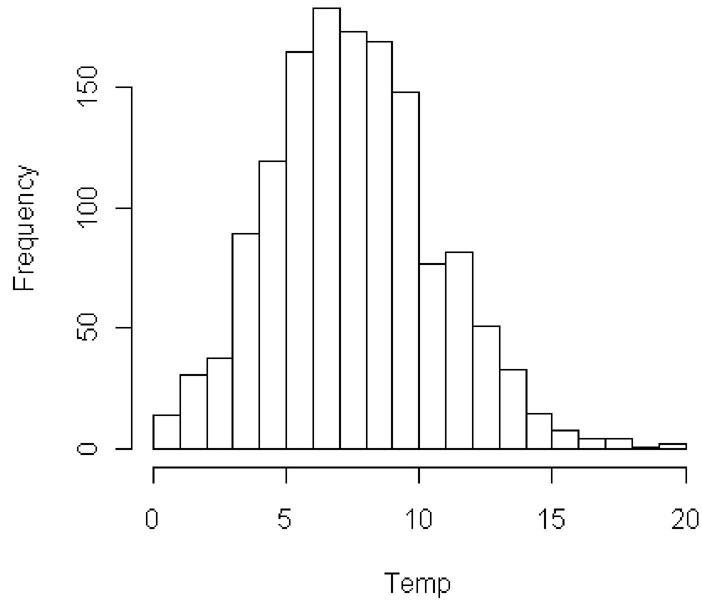


Figure I-36: Distribution of temperature (^oC) for protozoan pathogen samples

Appendix II. Water quality summary

Section 2.01 Water quality summary by location

(a) Daily Mean E. coli Densities

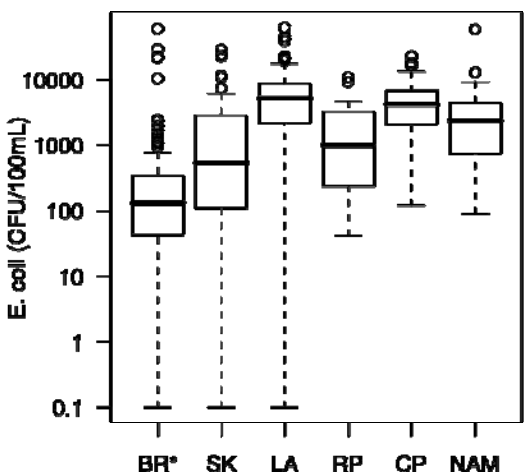
The daily mean densities of *E. coli* are summarized by location over the duration of the study period in Figure II-1. All figures have the same scale on the y-axis to facilitate comparisons. Results are described for each location and location-group in each study year.

In each year studied, daily mean densities of *E. coli* were higher below than above the Water Reclamation Plants on both the CAWS North system and Cal-Sag Channel. On the North system, for all years combined, the mean (median) *E.coli* concentration above the plant was 1,700 (130) CFU/100mL compared to 6,320 (3,300) CFU/100mL below the plant. In the Cal-Sag Channel, for all years combined, the mean (median) *E. coli* concentration was 460 (100) CFU/100 mL above the Calumet Water Reclamation Plant and 1200 (330) CFU/100mL below the Plant. In the Cal-Sag Channel, the average *E. coli* concentration decreased monotonically with distance from the Plant in each year studied Figure II-1 (c). On the North Branch, there was no monotonic trend with distance from the plant, though variability in the *E. coli* densities was relatively smaller at the downstream locations River Park, Clark Park and North Avenue Figure II-1 (a).

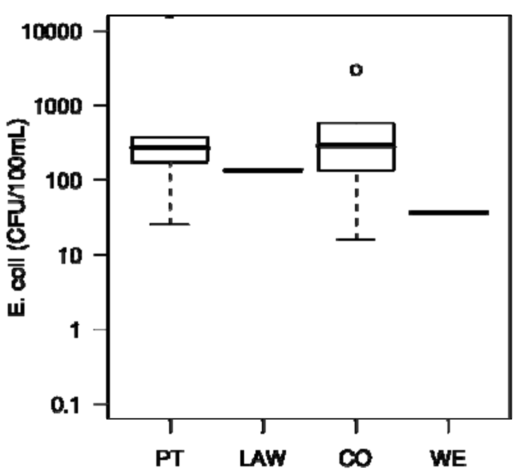
The daily mean densities of *E. coli* are generally lower at Lake Michigan Harbors than Lake Michigan Beaches Figure II-1 (g). Over the study period the mean (median) *E.coli* concentration was 11 (4.2) CFU/100mL at harbors and 410 (120) CFU/100mL at beaches. Median *E. coli* densities are similar at Lake Michigan Beaches and most Inland Lake locations, ranging from10-250 CFU/100mL. Over the study period, the daily mean concentration of *E. coli* in Inland Lakes had mean (median) 2100 (29) CFU/100mL. The skewness in the Inland Lake location-group is largely due to high densities of *E.coli* measured at Skokie Lagoons in 2008 (mean 8,500 CFU/100mL) and Lake Arlington in 2009 (mean 2930 CFU/100mL). *E. coli* densities measured at the Lake Michigan Beaches were also similar to those measured in the CAWS Main Stem, where the mean (median) concentration of *E. coli* was 340 (26) over the study period. This similarity is not surprising because the Main Stem is predominately Lake Michigan water.

E. coli densities were similar in the DesPlaines (DP) and DuPage (HW) Rivers, with mean (median) densities 130 (110) CFU/100mL and 96 (96) CFU/100mL, respectively, over the years 2008-2009. *E. coli* densities were higher in the Fox River, with mean (median) 940 (810) CFU/100mL over the same years Figure II-1 (e). The Fox river *E. coli* densities were more similar to those measured at the North Branch Dam (NBD), where the mean (median) was 1,700 (480) CFU/100mL over the study period, than the other rivers studied.

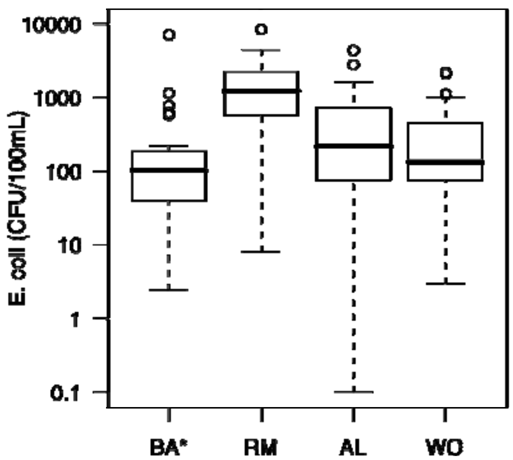
Figure II-1. Daily mean densities of *E. coli* (CFU/100mL) at all sampling locations for all years (2007-2009) combined.



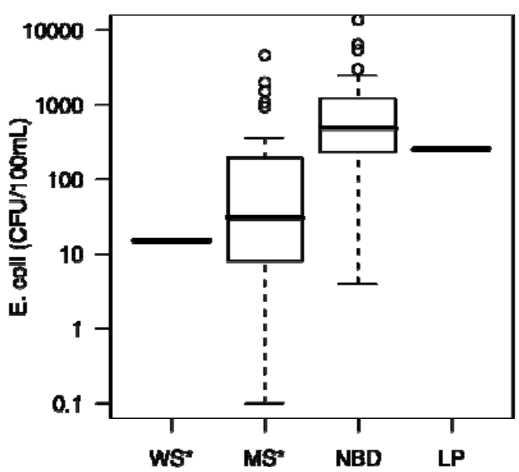
(a) CAWS North Branch
***Above WRP**



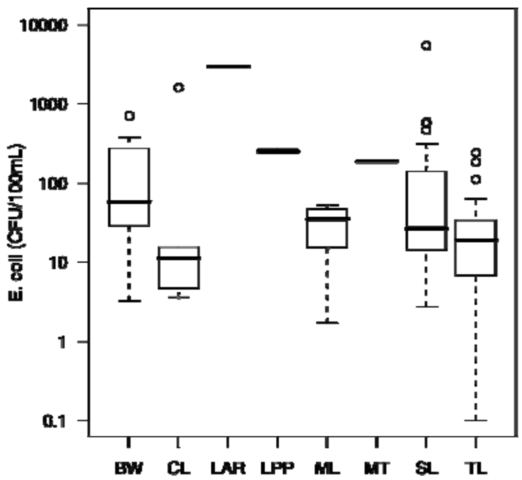
(b) CAWS South Branch



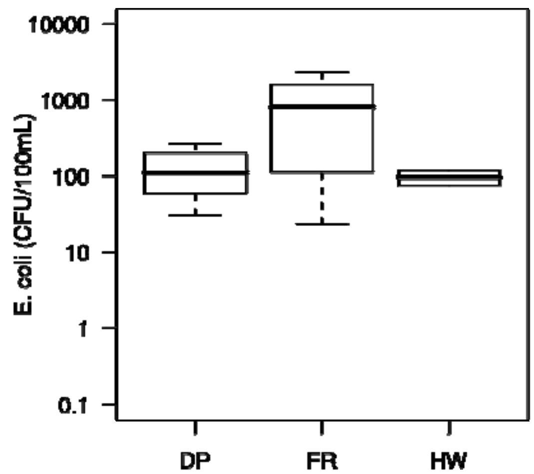
(c) Cal-Sag Channel
***Above WRP**



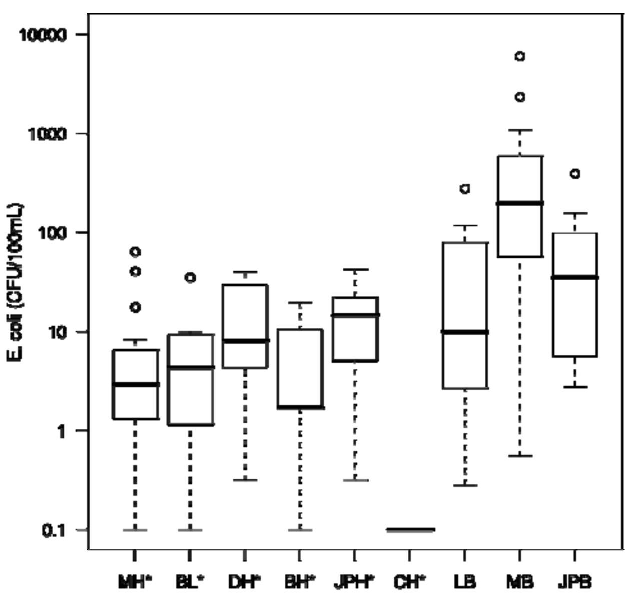
(d) Other Locations
***CAWS**



(e) Inland Lakes



(f) Rivers



(g) Lake Michigan
***Harbors**

(b) Daily mean enterococci densities

The daily mean densities of enterococci are summarized by location over the duration of the study period in Figure II-2. All figures have the same scale on the y-axis to facilitate comparisons. Results are described for each location and location-group in each study year.

In each year studied, median densities of enterococci were higher below than above the Water Reclamation Plants on both CAWS North Branch and in the Cal-Sag Channel Figure II-2 (a,c). The exception is in 2007 on CAWS North Branch when the mean, but not the median, enterococci concentration above the Plant was higher than below the plant: The mean (median) enterococci concentration above the Plant was 2800 (260) CFU/100mL, compared to 2000 (980) CFU/100mL below the Plant.

On the CAWS North Branch, for all years combined, the mean (median) enterococci concentration above the Plant was 700 (120) CFU/100mL compared to 1300 (510) CFU/100mL below the Plant. The median enterococci concentration increases downstream from the Plant until Lincoln Avenue (LA) or River Park (RP), at which point the enterococci concentration decreases in all years studied. In the Cal-Sag Channel, for all years combined, the mean (median) enterococci concentration was 580 (82) CFU/100 mL and 720 (180) CFU/100mL above and below the Calumet Water Reclamation Plant, respectively. In the Cal-Sag Channel, the enterococci concentration does not decrease with increasing distance from the Plant. Enterococci densities in the CAWS South Branch are lower than densities in the CAWS North Branch below the Plant, but similar to those in the Cal-Sag Channel, with mean (median) 1000 (210) CFU/100mL over all years.

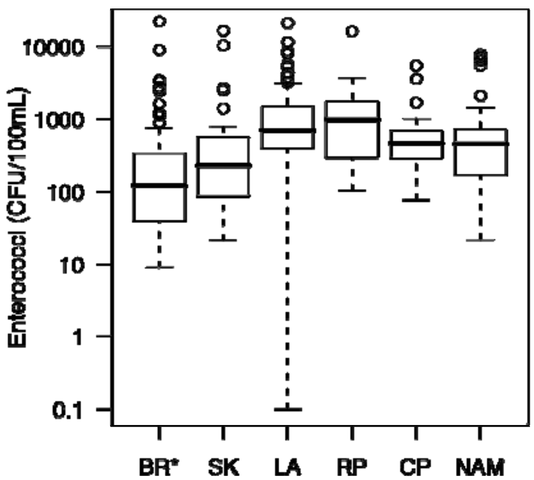
Overall, the median daily mean densities of enterococci are lower at Lake Michigan Harbors than Lake Michigan Beaches Figure II-2 (g). Over the study period the mean (median) enterococci densities are 9.1 (2.3) CFU/100mL at harbors and 170 (34) CFU/100mL at beaches. Daily mean *Enterococci* densities measured at the Main Stem (MS), which is predominately Lake Michigan water, had mean (median) 380 (28) CFU/100mL: Densities at the Main Stem were much higher than Lake Michigan beach locations in 2008.

The median enterococci densities over the entire study period varied three orders of magnitude in Inland Lakes Figure II-2 (e), from 27 CFU/100mL in Crystal Lake (CL, 6 days of sampling) to 4,760 CFU/100mL in Lake Arlington (LAR, 1 day of sampling). This magnitude of variability is similar to the day-to-day variability observed at locations with frequent monitoring, like Skokie Lagoons (SL) and Tampier Lake (TL).

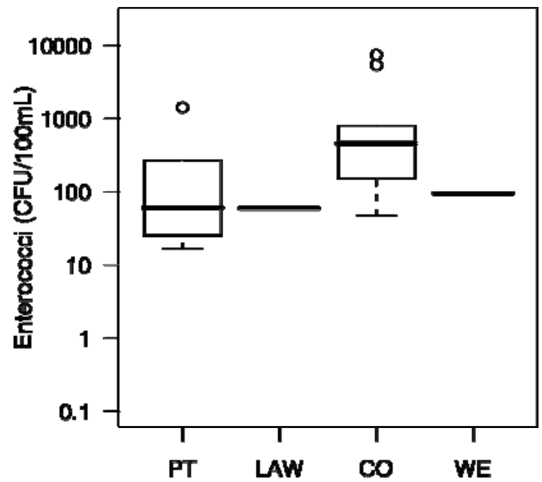
The enterococci densities measured at the Des Plaines (DP) and Fox (FR) Rivers were similar over the study duration, with mean concentration 1300 CFU/100mL and 1,100 CFU/100mL, respectively. Densities at the North Branch Dam (NBD) were similar, with mean (median) 1,010 CFU/100mL (490 CFU/100mL).

Enterococci densities in the DuPage River (HW) were much lower, than the other rivers and the tributary location, with a mean concentration of 320 CFU/100mL over the study duration.

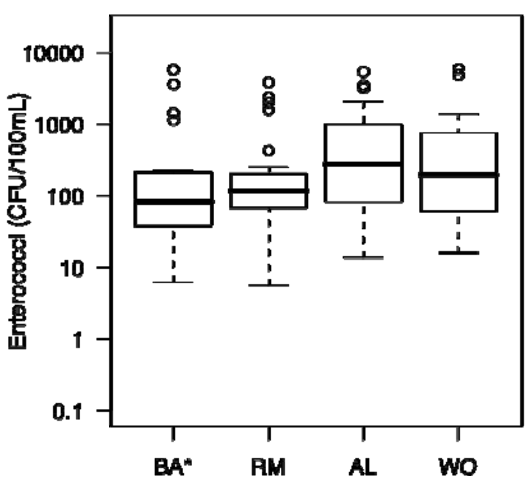
Figure II-2. Daily mean densities of *Enterococci* (CFU/100mL) by sampling location for all years (2007-2009) combined.



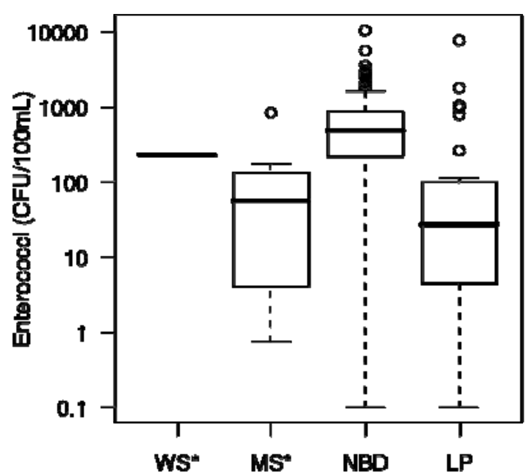
(a) CAWS North Branch
***Above WRP**



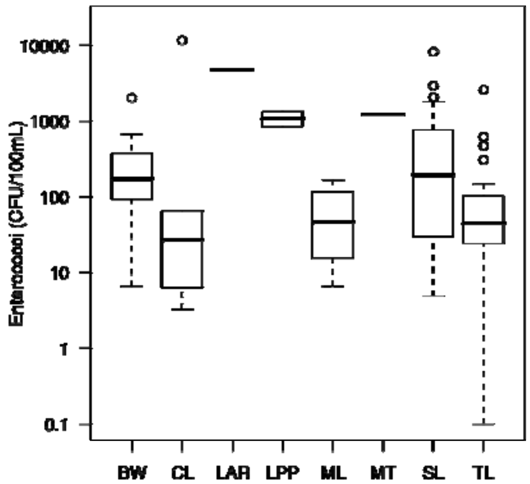
(b) CAWS South Branch



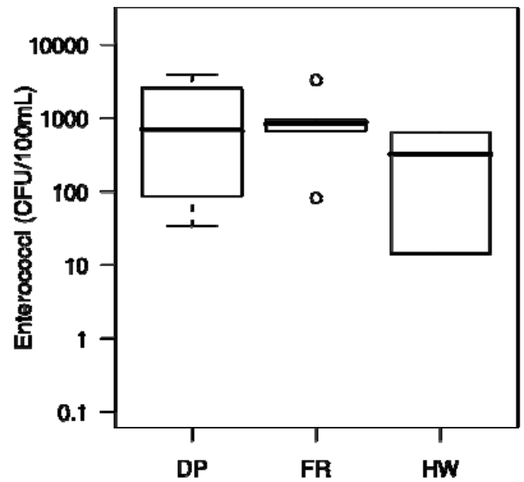
(c) Cal-Sag Channel
***Above WRP**



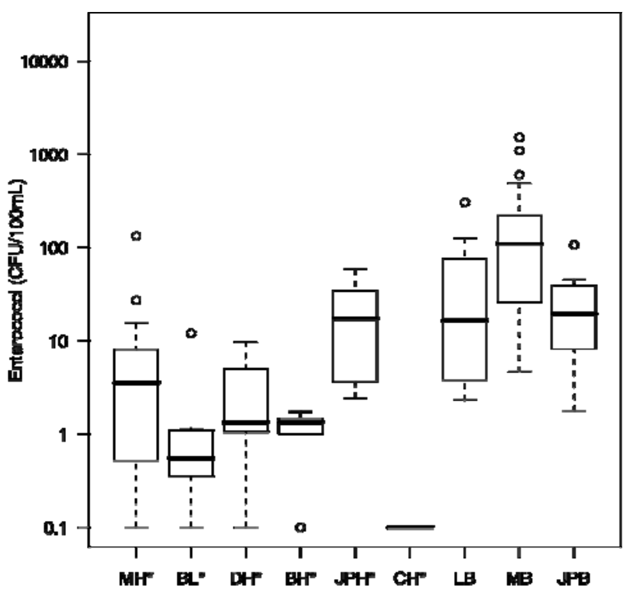
(d) Other Locations
***CAWS**



(e) Inland Lakes



(f) Rivers



(g) Lake Michigan
***Harbors**

(c) Daily mean Somatic coliphage densities

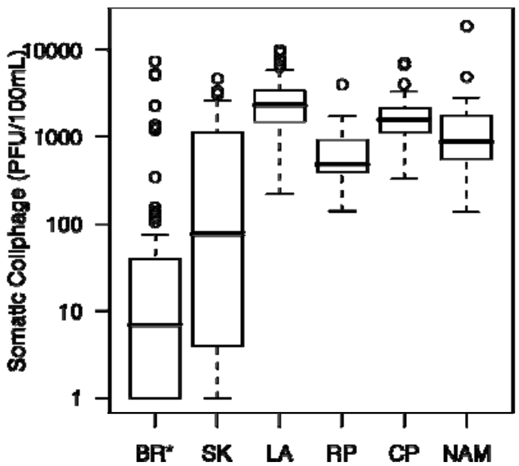
The daily mean densities of Somatic coliphage are summarized by location over the duration of the study period in Figure II-3. All figures have the same scale on the y-axis to facilitate comparisons. Results are described for each location and location-group in each study year.

In each year studied, daily mean densities of Somatic coliphage were higher below than above Water Reclamation Plants on both the CAWS North Branch and Cal-Sag Channel. On the North system, for all years combined, the mean (median) Somatic coliphage concentration above the plant was 350 (6.9) PFU/100mL compared to 2100 (1500) PFU/100mL below the Plant. Downstream of the Northside Water Reclamation Plant, the concentration of Somatic coliphage peaked at Lincoln Avenue (LA) and again at Clark Park (CP). In the Cal-Sag Channel, for all years combined, the mean (median) Somatic coliphage concentration was 140 (11) PFU/100 mL and 680 (340) PFU/100mL above and below the Calumet Water Reclamation Plant, respectively. The mean and median Somatic coliphage concentration decreased monotonically with increasing distance from the Plant.

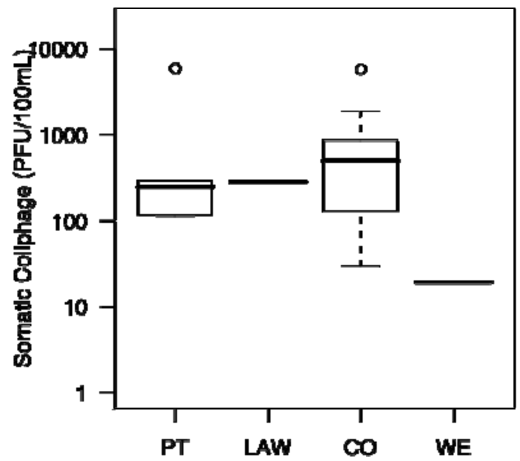
Somatic coliphage was not detected on 39 of 50 (78%) sampling days at Lake Michigan harbor locations, nor on 20 of 35 (57%) sampling days at Lake Michigan beach locations. Mean (median) Somatic coliphage densities at Lake Michigan beach locations are 18 (1.0) PFU/100mL, over the study period; and are higher than at the harbor locations, which have mean (median) 1.5 (1.0) PFU/100mL. This difference is largely due to high densities measured at Montrose Beach in 2008. In the CAWS Main Stem (MS), which is mostly water from Lake Michigan, Somatic coliphage densities are higher than at Lake Michigan locations, with mean (median) 93 (8.7) PFU/100mL over the study period. Somatic coliphage densities were particularly high at the Main Stem in 2008, with mean 190 PFU/100mL.

At the Inland Lake locations, Somatic coliphage was not detected on 38 of 85 (45%) sampling days. Over the study period the mean (median) concentration is 110 (1.4) PFU/100mL, which are more similar to densities seen in the Rivers than in Lake Michigan. The highest concentration of Somatic coliphage was measured in 2009 at Lake Arlington (LAR), 2300 PFU/100mL in 2009. More frequent monitoring occurred at Busse Woods (BW) and Skokie Lagoons (SL). At these locations relative high densities – mean (median) 82 (3.2) PFU/100mL and 170 (2.9) PFU/100mL at Busse Wood and Skokie Lagoons, respectively. The densities at these locations were also highly variable. Somatic coliphages were detected in 11 of 12 (92%) sampling days at the river locations. Over the study period, the mean (median) Somatic coliphage concentration is 78 (55) PFU/100ml at the river locations. Somatic coliphage densities were higher at the North Branch Dam (NBD), with mean (median) 710 (370)PFU/100mL.

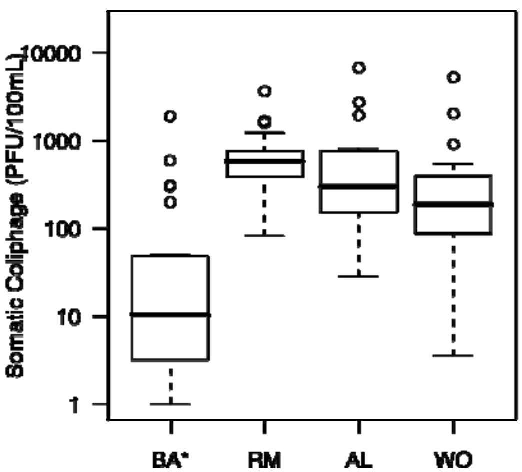
Figure II-3. Daily mean densities of Somatic coliphage (PFU/100mL) by sampling location for all years (2007-2009) combined.



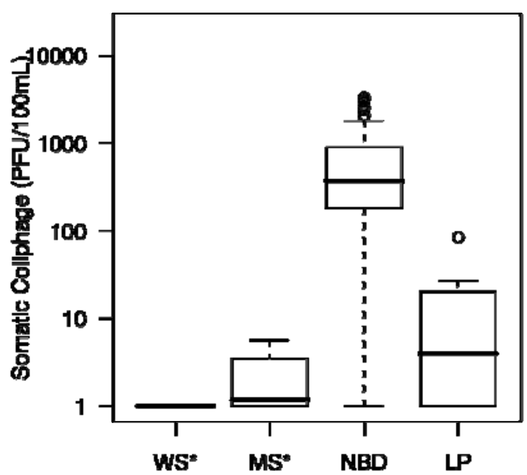
(a) CAWS North Branch
***Above WRP**



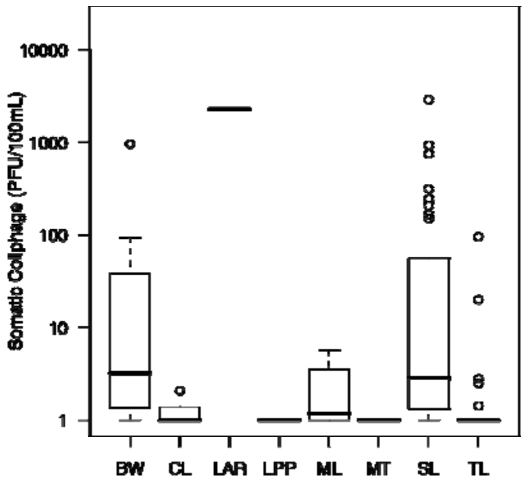
(b) CAWS South Branch



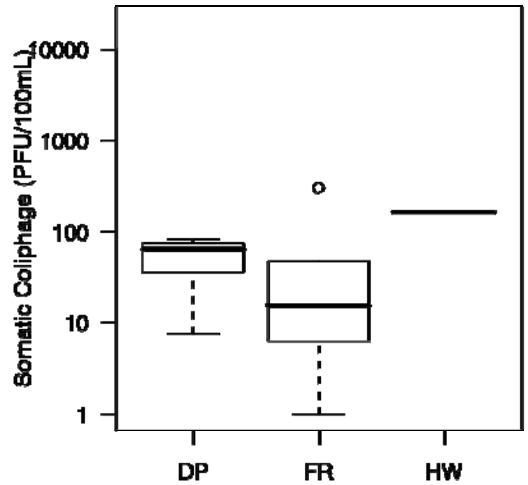
(c) Cal-Sag Channel
***Above WRP**



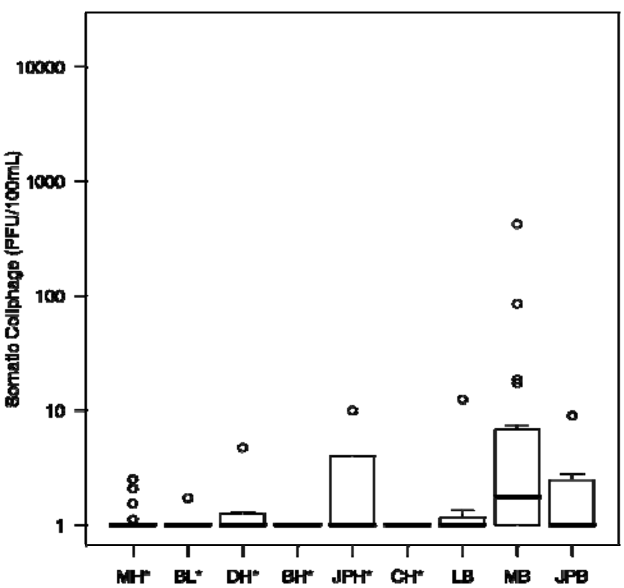
(d) Other Locations
***CAWS**



(e) Inland Lakes



(f) Rivers



(g) Lake Michigan
***Harbors**

(d) Daily mean Male-specific coliphage densities

The daily mean densities of Male-specific coliphage are summarized by location over the duration of the study period in Figure II-3. All figures have the same scale on the y-axis to facilitate comparisons. Results are described for each location and location-group in each study year.

In each year studied, the mean and median densities of Male-specific coliphage were higher below than above the Water Reclamation Plant on both the CAWS North Branch and the Cal-Sag Channel. On the CAWS North Branch, for all years combined, the mean (median) Male-specific coliphage concentration above the plant was 49 (0.10) PFU/100mL, compared to 170 (63) PFU/100mL below the Plant. At Bridge Street (BR), upstream of the Northside Plant, Male-specific coliphage was not detected on 50 of 98 (51%) sampling days. Downstream of plant, below Lincoln Avenue (LA), the median concentration of Male-specific coliphage decreases with distance from the Plant. In the Cal-Sag Channel, for all years combined, the mean (median) Male-specific coliphage concentration was 33 (0.55) PFU/100 mL and 50 (12) PFU/100mL above and below the Plant, respectively. Male-specific coliphage was not detected at Baubien Woods (BA), above the Calumet Plant on 9 of 26 (35%) sampling days. The median concentration of Male-specific coliphage decreases monotonically with distance from the plant in 2007 and 2009, but not in 2008. In 2008, at Alsip (AL) and Worth (AL) locations, Male-specific coliphage densities are high, with mean 82 and 75 PFU/100mL respectively, and highly variable (Table II-4).

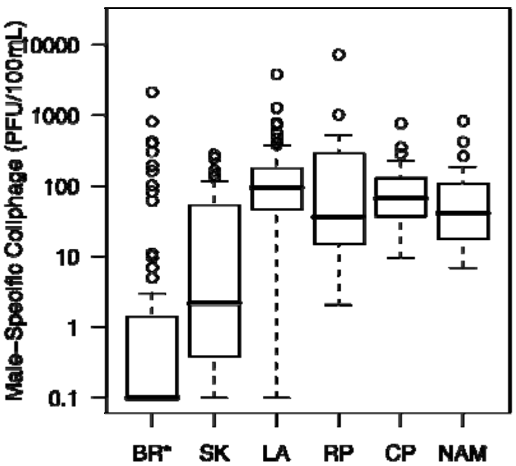
Male-specific coliphage was frequently not detected at Lake Michigan locations. The coliphage was not detected on 35 of 50 (70%) sampling days at harbor locations, and 22 of 35 (63%) sampling days at beach locations. Overall, Male-specific coliphage densities were similarly low at the harbor and beach locations, with mean (median) densities 0.18 (0.10) PFU/100mL and 1.2 (0.10) PFU/100mL, respectively. Similarly to Somatic coliphage, the highest Male-specific coliphage densities were measured at Montrose Beach (MB) in 2008, with mean 3.0 PFU/100ml, and range [0.1, 21] PFU/100mL.

In the CAWS Main Stem (MS), Male-specific coliphage was not detected on 14 of 36 (39%) sampling days. Male-specific coliphage densities in the CAWS Main Stem were higher than at Lake Michigan locations; particularly in 2008 when the mean (median) concentration is 32 (1.0) PFU/100mL.

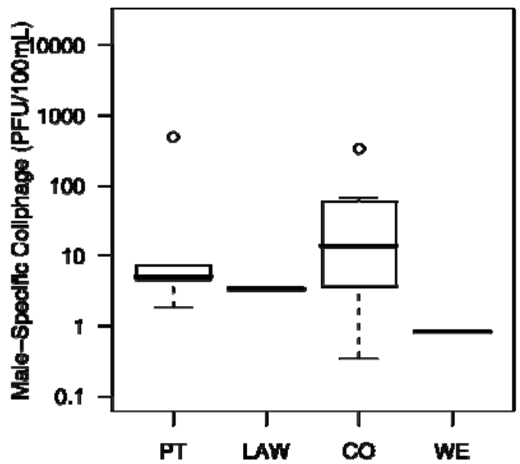
Male-specific coliphage was not detected on 44 of 85 (52%) sampling days at Inland Lake locations. The highest concentration of Male-specific coliphage was measured in 2009 at Lake Arlington (LAR) (96 PFU/100mL). Though an order of magnitude lower than at Lake Arlington, relatively high Male-specific coliphage densities were detected at Busse Woods and Skokie Lagoons Figure II-4(e).

Male-specific coliphage was detected on 10 of 12 (83%) sampling days at River locations, and were higher in the Fox River (FR) than the DesPlaines (DP) and DuPage (HW) Rivers, with mean (median) 35 (19) PFU/100mL compared to 0.52 (0.33) PFU/100mL and 6.8 (6.8) PFU/100mL in the latter two rivers, respectively.

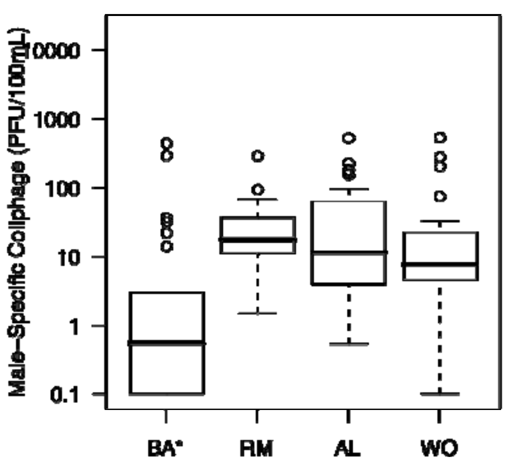
Figure II-4. Daily mean densities of Male-specific coliphage (PFU/100mL) by sampling location for all years (2007-2009) combined.



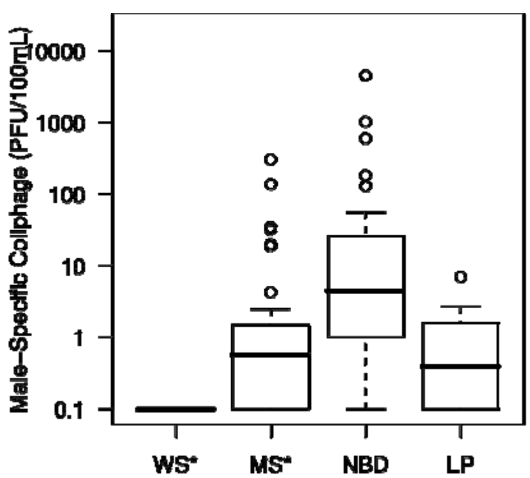
(a) CAWS North Branch
***Above WRP**



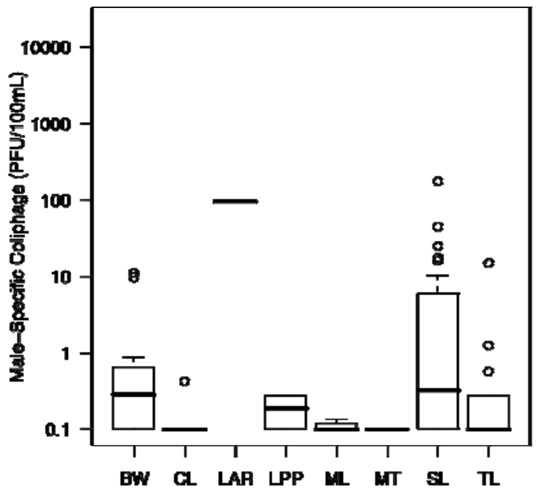
(b) CAWS South Branch



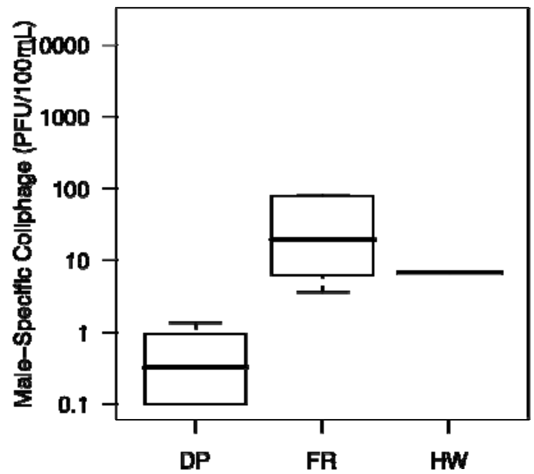
(c) Cal-Sag Channel
***Above WRP**



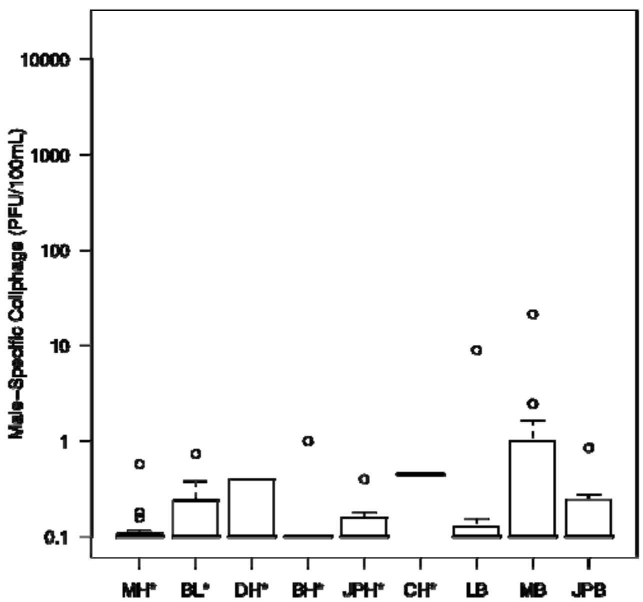
(d) Other Locations
***CAWS**



(e) Inland Lakes



(f) Rivers



(g) Lake Michigan
***Harbors**

(e) Daily mean Cryptosporidium oocyst densities

The daily mean densities of *Cryptosporidium* oocysts are summarized by location over the duration of the study period in Figure II-5: All plots have the same scale on the y-axis to facilitate comparisons. Results are described for each location and location-group in each study year.

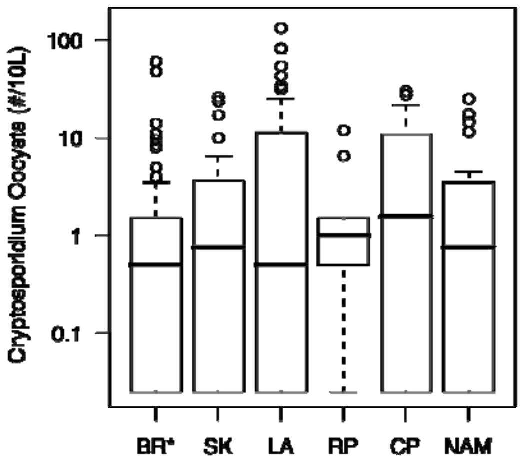
Densities of *Cryptosporidium* oocysts are similar above and below the Water Reclamation Plants on the CAWS North Branch and the Cal-Sag Channel, and the oocyst concentration is similar at all distances downstream from the Plants (Figure II-5a,c;Table II-5). In the CAWS North Branch, *Cryptosporidium* oocysts were not detected on 98 of 261 (38%) sampling location-days: The rate of non-detection is similar above and below the Plant (40% versus 37%). In the Cal-Sag Channel, *Cryptosporidium* oocysts were not detected on 29 of 63 (46%) sampling location-days: *Cryptosporidium* was not detected more frequently above the Plant (60% of 25 sampling days) than below the Plant (37% of 38 sampling days). In the CAWS South Branch, *Cryptosporidium* occysts were not detected on only 3 of 16 (19%) sampling location-days. The overall mean (median) on the CAWS South Branch is 13 (3.8) oocysts /10L, which is higher than seen in both the North Branch and Cal-Sag channel. *Cryptosporidium* oocysts were not detected at the CAWS Main Stem location on any of the 8 sampling days.

Cryptosporidium oocysts were not detected at the Lake Michigan harbors on 32 of 45 (71%) sampling location-days: The overall mean (median) is 0.14 (0.03) oocysts/10L. Similarly, *Cryptosporidium* oocysts were not detected at Lake Michigan beaches on 18 of 20 (90%) sampling location-days: The overall mean (median) is 0.03 (0.03) oocysts/10L.

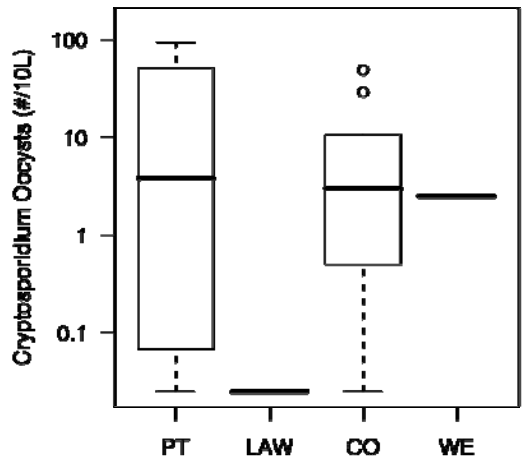
At the Inland Lake locations, *Cryptosporidium* oocysts were not detected on 60 of 77 (78%) sampling location-days. Oocysts were detected at four locations (Appendix): Busse Woods (BW), Crysal Lake (CL), Lovelace Park Pond (LPP) and Skokie Lagoons (SL). The highest densities were at Skokie Lagoons in 2008, when the mean (median) is 1.5 oocysts /10L (0.03 oocysts /10L).

At the River locations, *Cryptosporidium* oocysts were not detected on 11 of 12 (92%) sampling location-days. A daily mean concentration of 0.03 oocysts/10L was detected on in the Fox River in 2009. *Cryptosporidium* oocysts, in contrast, were not detected on only 12 of 50 (24%) of sampling days at the North Branch Dam (NBD): At this location, the overall mean (median) concentration is 8.6 (1.2) oocysts /10L.

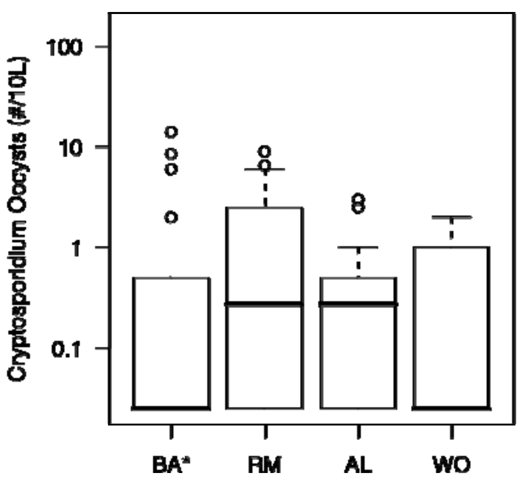
Figure II-5. Daily mean densities of *Cryptosporidium* oocysts (#/10L) by sampling location for all years (2007-2009) combined.



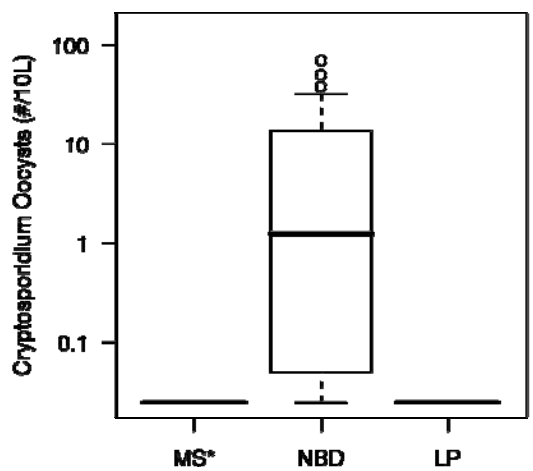
(a) CAWS North Branch
***Above WRP**



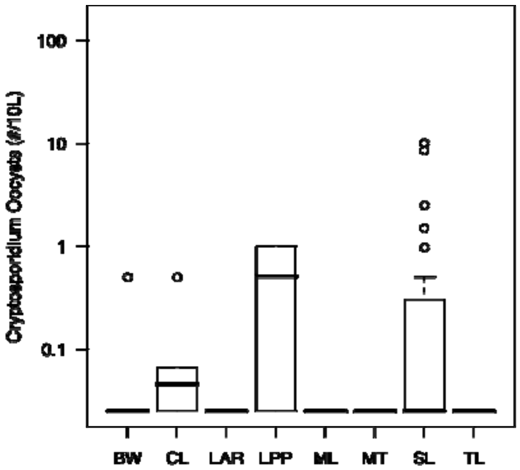
(b) CAWS South Branch



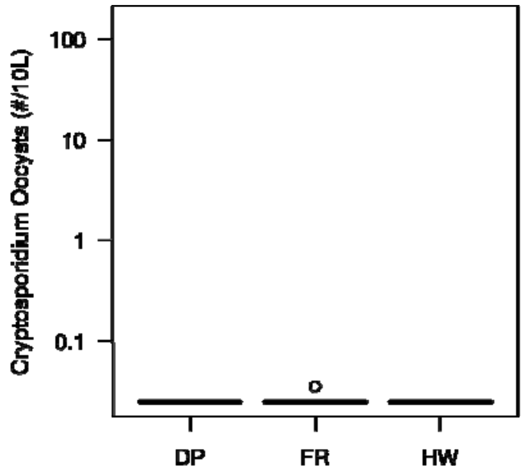
(c) Cal-Sag Channel
***Above WRP**



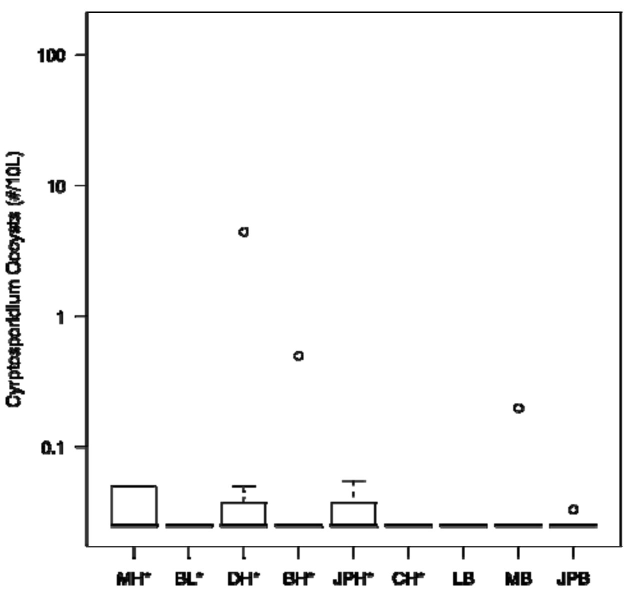
(d) Other Locations
***CAWS**



(e) Inland Lakes



(f) Rivers



(g) Lake Michigan
***Harbor**

(f) Daily mean Giardia cyst densities

The daily mean densities of *Giardia* cysts are summarized by location over the duration of the study period in Figure II-6. All plots have the same scale on the y-axis to facilitate comparisons. Results are described for each location and location-group in each study year ..

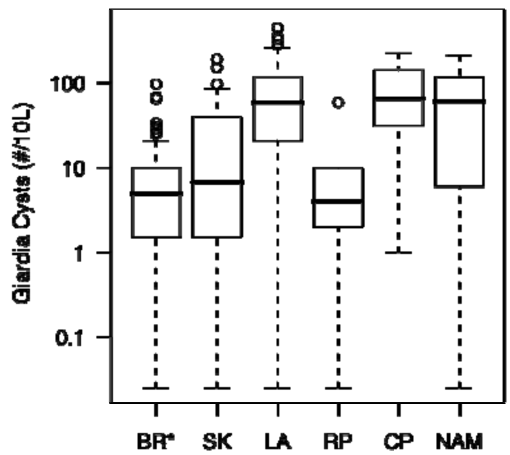
Giardia cysts were not detected on 16 of 261 (6%) of sampling days in the CAWS North Branch. The rates of detection were similar above and below the North Side Water Reclamation Plant, though the median (mean) concentration of *Giardia* cysts was higher below the Plant than above the Plant: 69 (44) cysts /10L versus 9.5 (5.0) cysts /10L, over all study years. On the CAWS North Branch, downstream of the Plant, the cyst concentration peaks at Lincoln Avenue (LA) and Clark Park (CP). Cysts were not detected more frequently above the Calumet Plant (60% of 25 sampling days) than below the Plant (6% of 63 sampling location-days). The *Giardia* cyst concentration has mean (median) 4.1 (2.5) cysts /10L below the Calumet Plant, compared to 0.66 (0.03) cysts /10L above the Plant, over all study years. The cyst concentration decreases with distance from the Plant along the Cal-Sag Channel (Figure II-6c). *Giardia* cyst densities in the CAWS South Branch have mean (median) 39 (24) cysts /10L, over all study years.

Giardia cysts were rarely detected at the Lake Michigan Harbors and Beaches, with 31 of 45 (69%) and 15 of 20 (75%) sampling location-days having no detectable *Giardia* cysts, respectively. The highest cyst densities were at Diversey Harbor (DH) and Montrose Beach (MB), which have mean (median) 1.41 (0.06) cysts /10L and 1.4 (0.11) cysts /10L, respectively, over the study period. Similarly, in the CAWS Main Stem, *Giardia* cysts were not detected on 6 of 7 (86%) of sampling days: The daily mean densities were below the detection limit (0.50 cyst/10L).

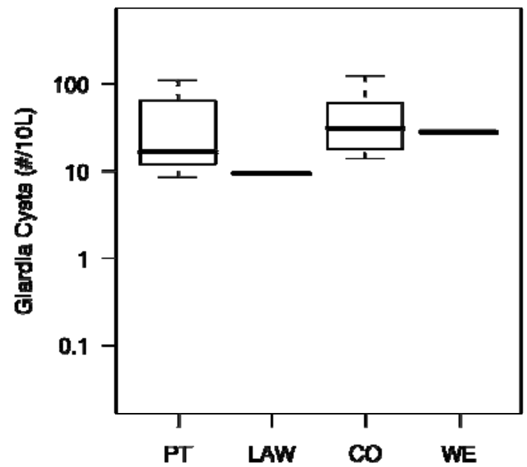
Giardia cyst densities were below the limit of detection on 2 of 12 (17%) sampling days at River locations. Cyst densities are higher in the DesPlaines and Fox Rivers than in the DuPage River (HW), with mean (median) 3.9 (3.5) cysts /10L and 4.4 (4.2) cysts /10L, compared to 0.26 (0.11) cysts /10L (Figure IV-7e). The densities measured at the DesPlaines and Fox Rivers are similar to those measured at the North Branch Dam (NBD) location, where over the study period, the mean (median) concentration is 9.9 (4.0) cysts /10L.

At the Inland Lake locations, *Giardia* cysts were not detected in 52 of 77 (67%) sampling location-days. *Giardia* cysts were detected at three locations – Busse Woods (BW), Crystal Lake (CL), and Skokie Lagoons (SL). The highest densities were at Skokie Lagoons, where the mean (median) concentration was 6.6 (0.50) cysts /10L in 2009, and 3.4 (0.05) cysts /10L over the entire study period.

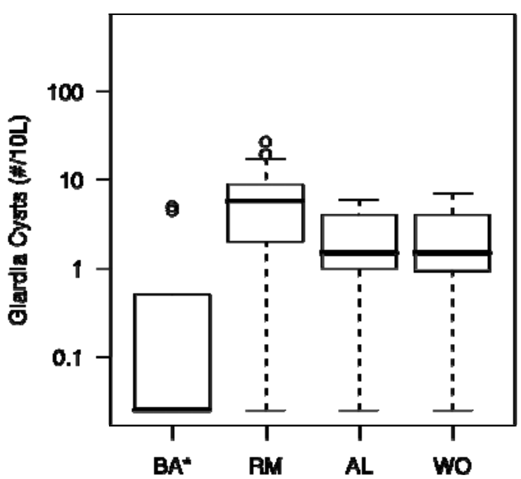
Figure II-6. Daily mean densities of *Giardia* cysts (cysts/10L) by sampling location for all years (2007-2009) combined.



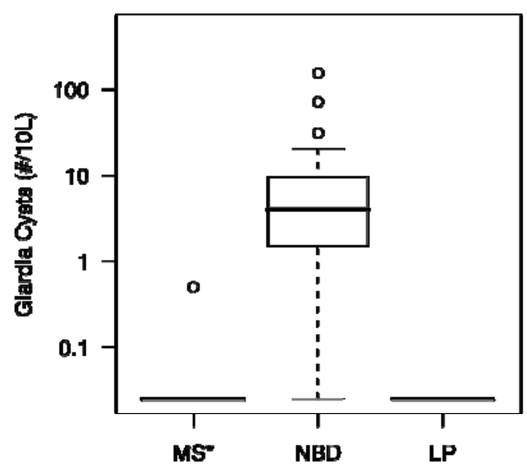
(a) CAWS North Branch
***Above WRP**



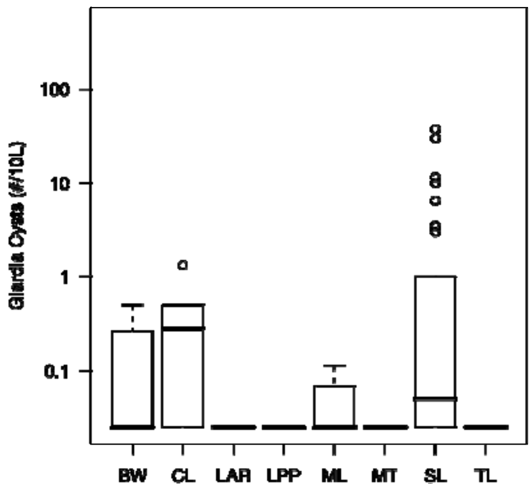
(b) CAWS South Branch



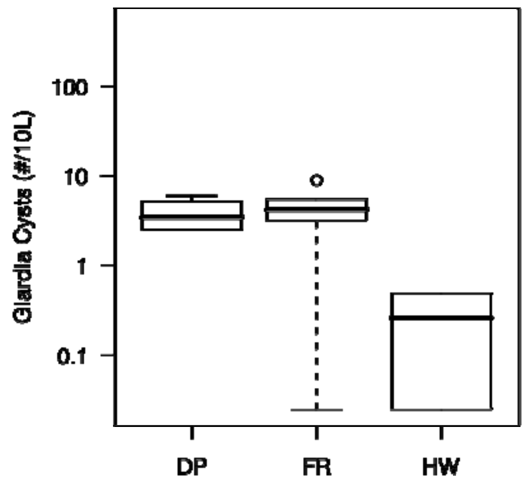
(c) Cal-Sag Channel
***Above WRP**



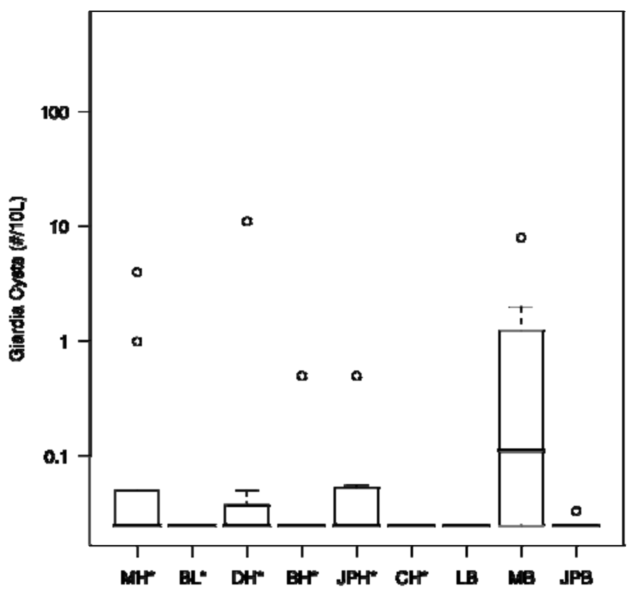
(d) Other Locations
***CAWS**



(e) Inland Lakes



(f) Rivers



(g) Lake Michigan
***Harbors**

Section 2.02 Water Quality Summary by Location, by Year

Table II-1. Daily mean *E. coli* densities (CFU/ 100mL) by location-group and location, over the study period (2007-2009). Row 1 contains the mean and median (M) of the daily mean densities. Row 2 contains the central 90% range [5^{th}, 95^{th}] percentiles. Row 3 contains the number of sampling days, and number of samples (n).

Location	Legend	2007	2008	2009	All Years
CAWS North Branch					
BR	Mean (M)	8800 (710)	1100 (48)	270 (150)	1700 (130)
-4.2 km	[5^{th}, 95^{th}]%	[33, 29000]	[0.1, 1700]	[20, 770]	[0.63, 2500]
	days (n)	12 (48)	53 (299)	33 (238)	90 (585)
Below	Mean (M)	10000 (7400)	6500 (3400)	4100 (2400)	6320 (3300)
WRP	[5^{th}, 95^{th}]%	[120, 23000]	[9.5, 23000]	[27, 10000]	[40, 22000]
(All)	days (n)	25 (522)	128 (990)	56 (504)	209 (2016)
SK	Mean (M)	4800 (19000)	4300 (540)	420 (89)	3770 (550)
-0.68 km	[5^{th}, 95^{th}]%	[120, 23000]	[0.1, 24000]	[30, 2000]	[3.6, 23000]
	days (n)	7 (177)	24 (251)	6 (50)	37 (478)
LA	Mean (M)	15000 (13000)	8200 (4700)	6000 (4000)	8300 (5200)
+3.2 km	[5^{th}, 95^{th}]%	[860, 23000]	[8.0, 39000]	[1700, 17000]	[52, 23000]
	days (n)	12 (141)	54 (215)	31 (119)	97 (475)
RP	Mean (M)	4600	2800 (990)	370	2800 (990)
+5.38 km	[5^{th}, 95^{th}]%	-	[42, 110000]	-	[42, 9200]
	days (n)	1 (45)	9 (74)	1 (12)	11 (131)
CP	Mean (M)	9000 (6300)	7400 (4900)	2900 (2100)	6100 (4200)
+9.1 km	[5^{th}, 95^{th}]%	[4600, 16300]	[120, 18000]	[1500, 6800]	[160, 16500]
	days (n)	3 (117)	17 (207)	10 (179)	30 (503)
NAM	Mean (M)	5500 (5500)	5800 (2710)	1400 (1100)	4700 (2400)
+14.6 km	[5^{th}, 95^{th}]%	[3900, 7000]	[90, 13000]	[110, 3290]	[110, 9300]
	days (n)	2 (42)	24 (243)	8 (144)	34 (429)

Table II-1**. *E. coli* densities (CFU/100ml) continued**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS South Branch					
All	Mean (M)	210	5100 (340)	590 (220)	2800 (220)
	[5^{th}, 95^{th}]%	-	[16, 27000]	[36, 3000]	[16, 18000]
	days (n)	1 (42)	9 (96)	4 (113)	18 (251)
PT	Mean (M)	210	6000 (350)	280 (280)	3100 (270)
+21.0 km	[5^{th}, 95^{th}]%	-	[26, 17000]	[170, 380]	[26, 18000]
	days (n)	1 (42)	3 (42)	2 (36)	6 (120)
LAW	Mean (M)			130	130
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (15)	1 (15)
CO	Mean (M)		4600 (250)	1000 (400)	3170 (290)
+24.2 km	[5^{th}, 95^{th}]%		[16, 27000]	[210, 3000]	[16, 27000]
	days (n)		6 (54)	4 (47)	10 (101)
WE	Mean (M)			36	36
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (15)	1 (15)
CAWS Cal-Sag Channel					
BA	Mean (M)	330 (100)	150 (55)	1200 (160)	460 (100)
-1.3 km	[5^{th}, 95^{th}]%	[100, 770]	[2.4, 220]	[24, 7100]	[2.4, 1150]
	days (n)	3 (18)	16 (114)	7 (60)	26 (192)
Below	Mean (M)	1000 (330)	1100 (190)	1300 (920)	1200 (330)
WRP	[5^{th}, 95^{th}]%	[140, 3700]	[3, 2800]	[97, 4500]	[5, 3800]
(All)	days (n)	7 (216)	50 (572)	18 (296)	75 (886)
RM	Mean (M)	2100 (1600)	2500 (820)	2000 (1600)	2300 (1200)
+4.8 km	[5^{th}, 95^{th}]%	[1100, 3700]	[8.0, 8500]	[730, 450]	[8.0, 8500]
	days (n)	3 (54)	17 (176)	7 (39)	27 (269)
AL	Mean (M)	210 (210)	470 (160)	1400 (580)	650 (2200)
+14.6 km	[5^{th}, 95^{th}]%	[210, 220]	[0.1, 1600]	[300, 4400]	[0.1, 2800]
	days (n)	2 (90)	17 (207)	5 (116)	24 (413)
WO	Mean (M)	240 (240)	450 (100)	390 (220)	420 (130)
+18.8 km	[5^{th}, 95^{th}]%	[140, 330]	[3.0, 2100]	[96, 1110]	[3.0, 2100]
	days (n)	2 (72)	16 (189)	6 (141)	24 (204)

Table II-1. ***E. coli* densities (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS Other Locations					
MS	Mean (M)	4	100 (10)	580 (67)	340 (26)
+19.7 km	[5th, 95th]%	-	[0.1, 210]	[6.0, 2000]	[0.1, 1500]
	days (n)	1 (3)	17 (84)	18 (221)	36 (308)
WS	Mean (M)		15		15
+12.7 km	[5th, 95th]%		-		-
	days (n)		1 (9)		1 (9)
GUW Other Locations					
LP	Mean (M)		90 (40)		90 (40)
	[5th, 95th]%		[7.0, 400]		[7.0, 400]
	days (n)		7 (72)		7 (72)
NBD	Mean (M)	460	1510 (440)	2100 (570)	1700 (480)
	[5th, 95th]%	-	[4.0, 5400]	[5.0, 14000]	[5.0, 6500]
	days (n)	1 (3)	37 (143)	27 (116)	65 (262)
Rivers					
All	Mean (M)		660 (190)	400 (120)	530 (130)
	[5th, 95th]%		[24, 2300]	[74, 1600]	[24, 2600]
	days (n)		6 (105)	6 (94)	12 (199)
DP	Mean (M)		150 (150)	110 (110)	130 (110)
	[5th, 95th]%		[31, 270]	[88, 130]	[31, 270]
	days (n)		2 (39)	2 (30)	4 (69)
FR	Mean (M)		1170 (1200)	710 (440)	940 (810)
	[5th, 95th]%		[24, 230]	[110, 1600]	[24, 2300]
	days (n)		3 (45)	3 (51)	6 (96)
HW	Mean (M)		120	74	96 (96)
	[5th, 95th]%		-	-	[74, 120]
	days (n)		1 (21)	1 (13)	2 (34)

Table II-1**. *E. coli* densities (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Inland Lakes					
All	Mean (M)	47 (22)	3900 (19)	340 (42)	2100 (29)
	[5^{th}, 95^{th}]%	[3.6, 140]	[0.23, 470]	[5.4, 5400]	[1.3, 590]
	days (n)	4 (144)	42 (680)	39 (708)	85 (1532)
BW	Mean (M)		170 (58)	150 (78)	160 (58)
	[5^{th}, 95^{th}]%		[3.3, 700]	[13, 370]	[3.3, 380]
	days (n)		9 (135)	6 (118)	15 (253)
CL	Mean (M)	9.6 (9.6)	6.8 (6.8)	810 (810)	270 (11)
	[5^{th}, 95^{th}]%	[3.6, 16]	[4.7, 8.9]	[13, 370]	[3.6, 1600]
	days (n)	2 (42)	2 (24)	2 (16)	6 (82)
LAR	Mean (M)			2930	2930
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (15)	1 (15)
LPP	Mean (M)			250 (250)	250 (250)
	[5^{th}, 95^{th}]%			[240, 260]	[240, 260]
	days (n)			2 (18)	2 (18)
ML	Mean (M)			31 (35)	31 (35)
	[5^{th}, 95^{th}]%			[1.7, 53]	[1.7, 53]
	days (n)			4 (84)	4 (84)
MT	Mean (M)			190	190
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (12)	1 (12)
SL	Mean (M)	84 (84)	8500 (20)	500 (28)	5000 (27)
	[5^{th}, 95^{th}]%	[27, 140]	[2.7, 590]	[5.4, 560]	[4.4, 590]
	days (n)	2 (102)	19 (313)	13 (249)	34 (664)
TL	Mean (M)		23 (11)	62 (30)	41 (19)
	[5^{th}, 95^{th}]%		[0.1, 62]	[5.9, 240]	[0.1, 180]
	days (n)		12 (208)	10 (196)	22 (404)

Table II-1**. *E. coli* densities (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Harbors					
All	Mean (M)	17 (7.6)	10 (5.9)	6.7 (2.2)	11 (4.2)
	[5th, 95th]%	[0.31, 64]	[0.1, 30]	[0.1, 19]	[0.1, 40]
	days (n)	11 (364)	26 (242)	13 (164)	50 (842)
MH	Mean (M)	20 (4.9)	3.7 (2.8)	1.7 (1.8)	8.5 (2.9)
	[5th, 95th]%	[0.78, 64]	[0.17, 8.2]	[0.1, 3.0]	[0.1, 41]
	days (n)	7 (220)	7 (112)	6 (85)	20 (417)
BL	Mean (M)		15 (8.7)	3.7 (2.3)	8.6 (4.3)
	[5th, 95th]%		[2.0, 35]	[0.1, 10]	[0.1, 35]
	days (n)		3 (25)	4 (48)	7 (73)
DH	Mean (M)	16 (16)	16 (8.0)		16 (8.0)
	[5th, 95th]%	[0.31, 32]	[3.7, 39]		[0.31, 39]
	days (n)	2 (72)	7 (72)		9 (144)
BH	Mean (M)		6.7 (1.7)		6.7 (1.7)
	[5th, 95th]%		[0.1, 19]		[0.1, 19]
	days (n)		5 (54)		5 (54)
JPH	Mean (M)	9.7 (9.7)	15 (17)	21 (19)	16 (15)
	[5th, 95th]%	[7.6, 12]	[2.5, 25]	[0.31, 43]	[0.32, 43]
	days (n)	2 (72)	3 (45)	3 (31)	8 (148)
CH	Mean (M)		0.1		0.1
	[5th, 95th]%		-		-
	days (n)		1 (6)		1 (6)

Table II-1**. *E. coli* concentration (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Beaches					
All	Mean (M)	120	540 (42)	270 (160)	410 (120)
	$[5^{th}, 95^{th}]$%	-	[0.55, 2300]	[0.28, 810]	[0.28, 1080]
	days (n)	1 (51)	19 (243)	15 (270)	35 (564)
LB	Mean (M)	120	6.9 (3.7)	81 (23)	58 (10)
	$[5^{th}, 95^{th}]$%	-	[1.6, 15]	[0.28, 280]	[0.28, 280]
	days (n)	1 (51)	3 (33)	4 (69)	8 (153)
MB	Mean (M)		980 (230)	350 (190)	670 (200)
	$[5^{th}, 95^{th}]$%		[0.55, 6000]	[16, 1100]	[0.55, 2300]
	days (n)		10 (132)	10 (183)	20 (315)
JPB	Mean (M)		81 (21)	150	91 (35)
	$[5^{th}, 95^{th}]$%		[2.8, 390]	-	[2.8, 390]
	days (n)		6 (78)	1 (18)	7 (96)

Table II-2. Daily mean enterococci densities (CFU/ 100mL) by location-group and location, over the study period (2007-2009). Row 1 contains the mean and median (M) of the daily mean densities. Row 2 contains the central 90% range [5th, 95th] percentiles. Row 3 contains the number of sampling days, and number of samples (n).

Location	Legend	2007	2008	2009	All Years
CAWS North Branch					
BR	Mean (M)	2800 (260)	520 (120)	230 (110)	700 (120)
-4.2 km	[5th, 95th]%	[10, 9000]	[10, 2800]	[14, 750]	[10, 2800]
	days (n)	12 (48)	53 (299)	33 (238)	98 (585)
Below	Mean (M)	2000 (980)	1500 (480)	670 (490)	1300 (510)
WRP	[5th, 95th]%	[140, 5200]	[43, 7000]	[36, 2100]	[58, 5500]
(All)	days (n)	25 (522)	130 (996)	58 (508)	213 (2026)
SK	Mean (M)	1800 (410)	1160 (200)	230 (170)	1110 (230)
-0.7 km	[5th, 95th]%	[140, 10000]	[21, 2700]	[27, 570]	[27, 2700]
	days (n)	7 (177)	24 (251)	7 (52)	38 (480)
LA	Mean (M)	2400 (1800)	1700 (580)	930 (630)	1500 (700)
+3.2 km	[5th, 95th]%	[610, 5200]	[67, 8000]	[250, 2300]	[110, 5200]
	days (n)	12 (141)	56 (221)	32 (121)	100 (483)
RP	Mean (M)	970	2900 (1200)	210	2500 (970)
+5.4 km	[5th, 95th]%	-	[100, 16000]	-	[100, 3700]
	days (n)	1 (45)	9 (74)	1 (12)	11 (131)
CP	Mean (M)	1550 (600)	880 (500)	360 (340)	770 (470)
+9.1 km	[5th, 95th]%	[450, 3600]	[77, 1700]	[99, 690]	[88, 1700]
	days (n)	3 (117)	17 (207)	10 (179)	30 (503)
NAM	Mean (M)	850 (850)	1500 (500)	450 (190)	1200 (450)
+14.6 km	[5th, 95th]%	[720, 980]	[22, 7000]	[37, 2100]	[36, 6400]
	days (n)	2 (42)	24 (243)	8 (144)	34 (429)

Table II-2**. Enterococci densities (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS South Branch					
All	Mean (M)	17	1800 (350)	270 (120)	1000 (210)
	[5th, 95th]%	-	[25, 7400]	[44, 800]	[17, 5400]
	days (n)	1 (42)	9 (96)	8 (113)	18 (251)
PT	Mean (M)	17	570 (270)	60 (60)	310 (60)
+21.0 km	[5th, 95th]%	-	[25, 1400]	[44, 77]	[17, 1400]
	days (n)	1 (42)	3 (42)	2 (36)	6 (120)
LAW	Mean (M)			60	60
	[5th, 95th]%			-	-
	days (n)			1 (15)	1 (15)
CO	Mean (M)		2400 (560)	460 (460)	1600 (460)
+24.2 km	[5th, 95th]%		[47, 7400]	[140, 800]	[47, 7400]
	days (n)		6 (54)	4 (47)	10 (101)
WE	Mean (M)			95	95
	[5th, 95th]%			-	-
	days (n)			1 (15)	1 (15)
CAWS Cal-Sag Channel					
BA	Mean (M)	32 (32)	890 (290)	85 (100)	580 (82)
-1.4 km	[5th, 95th]%	[23, 41]	[14, 3600]	[6.2, 220]	[6.2, 3600]
	days (n)	3 (18)	16 (114)	7 (60)	26 (192)
Below	Mean (M)	250 (140)	900 (250)	270 (81)	720 (180)
WRP	[5th, 95th]%	[71, 790]	[22, 3800]	[12, 1100]	[16, 3500]
(All)	days (n)	7 (216)	50 (572)	18 (296)	75 (1084)
RM	Mean (M)	120 (130)	550 (192)	380 (130)	460 (120)
+4.8 km	[5th, 95th]%	[80, 140]	[5.6, 2400]	[12, 2000]	[5.6, 2400]
	days (n)	3 (54)	17 (176)	7 (39)	27 (269)
AL	Mean (M)	250 (250)	1100 (290)	270 (63)	870 (280)
+14.6 km	[5th, 95th]%	[200, 310]	[31, 3500]	[14, 1100]	[14, 3500]
	days (n)	2 (90)	17 (207)	5 (116)	24 (413)
WO	Mean (M)	430 (430)	1100 (320)	150 (61)	800 (190)
+18.8 km	[5th, 95th]%	[72, 790]	[22, 4900]	[16, 520]	[16, 4900]
	days (n)	2 (72)	16 (189)	6 (141)	24 (402)

Table II-2**. Enterococci densities (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS Other Locations					
MS	Mean (M)	7.0	650 (12)	150 (53)	380 (28)
+19.7 km	[5^{th}, 95^{th}]%	-	[0.1, 1800]	[0.1, 790]	[0.1, 1100]
	days (n)	1 (3)	17 (84)	18 (221)	36 (308)
WS	Mean (M)		232		232
+12.7 km	[5^{th}, 95^{th}]%		-		-
	days (n)		1 (9)		1 (9)
Other Locations - GUW					
LP	Mean (M)		170 (57)		170 (57)
	[5^{th}, 95^{th}]%		[0.76, 850]		[0.76, 850]
	days (n)		7 (72)		7 (72)
NBD	Mean (M)	800	1260 (500)	660 (420)	1010 (490)
	[5^{th}, 95^{th}]%	-	[0.1, 3600]	[50, 2180]	[50, 3080]
	days (n)	1 (3)	38 (145)	27 (116)	66 (264)
Rivers					
All	Mean (M)		3600 (840)	760 (110)	1100 (750)
	[5^{th}, 95^{th}]%		[630, 3900]	[14, 3300]	[14, 3300]
	days (n)		6 (105)	6 (94)	12 (109)
DP	Mean (M)		2600 (2200)	87 (87)	1300 (710)
	[5^{th}, 95^{th}]%		[1300, 3900]	[34, 140]	[34, 3900]
	days (n)		2 (39)	2 (30)	4 (69)
FR	Mean (M)		780 (780)	1400 (950)	1100 (840)
	[5^{th}, 95^{th}]%		[670, 850]	[83, 3300]	[83, 3300]
	days (n)		3 (45)	3 (51)	6 (6)
HW	Mean (M)		630	14	320 (95)
	[5^{th}, 95^{th}]%		-	-	[14, 630]
	days (n)		1 (21)	1 (13)	2 (34)

Table II-2. **Enterococci densities (CFU/100ml) continued.**

Location	Legend	2007	2008	2009	All Years
Inland Lakes					
All	Mean (M)	140 (140)	450 (160)	920 (63)	650 (100)
	[5^{th}, 95^{th}]%	[6.3, 270]	[7.5, 1800]	[3.4, 4800]	[4.9, 2600]
	days (n)	4 (144)	42 (680)	39 (708)	85 (1532)
BW	Mean (M)		440 (240)	200 (160)	340 (170)
	[5^{th}, 95^{th}]%		[88, 2000]	[6.6, 580]	[6.6, 680]
	days (n)		9 (135)	6 (118)	15 (253)
CL	Mean (M)	14 (14)	49 (46)	5820 (5800)	2000 (27)
	[5^{th}, 95^{th}]%	[6.4, 21]	[33, 65]	[3.3, 12000]	[3.6, 12000]
	days (n)	2 (42)	2 (24)	2 (16)	6 (82)
LAR	Mean (M)			4760	4760
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (15)	1 (15)
LPP	Mean (M)			1100 (1100)	1100 (1100)
	[5^{th}, 95^{th}]%			[840, 1300]	[840, 1300]
	days (n)			2 (18)	2 (18)
ML	Mean (M)			67 (47)	67 (47)
	[5^{th}, 95^{th}]%			[6.6, 170]	[6.6, 170]
	days (n)			4 (84)	4 (84)
MT	Mean (M)			1200	1200
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (12)	1 (12)
SL	Mean (M)	270 (270)	590 (330)	1000 (30)	740 (190)
	[5^{th}, 95^{th}]%	[260, 270]	[19, 1360]	[5.0, 3000]	[5.1, 2100]
	days (n)	2 (102)	19 (313)	13 (249)	34 (664)
TL	Mean (M)		310 (41)	110 (59)	220 (45)
	[5^{th}, 95^{th}]%		[0.1, 470]	[3.4, 620]	[0.1, 620]
	days (n)		12 (208)	10 (196)	22 (404)

Table II-2**. Enterococci densities (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Harbors					
All	Mean (M)	21 (7.7)	3.7 (1.0)	10 (2.8)	9.1 (2.3)
	[5th, 95th]%	[0.15, 28]	[0.1, 9.7]	[0.37, 24]	[0.1, 28]
	days (n)	11 (364)	26 (314)	13 (164)	50 (842)
MH	Mean (M)	27 (7.7)	2.3 (0.42)	5.0 (2.9)	12 (3.6)
	[5th, 95th]%	[0.15, 130]	[0.1, 9.0]	[1.9, 15]	[0.1, 27]
	days (n)	7 (220)	7 (112)	6 (85)	20 (417)
BL	Mean (M)		0.33 (0.33)	3.6 (1.1)	2.2 (0.55)
	[5th, 95th]%		[0.1, 0.55]	[0.37, 12]	[0.1, 12]
	days (n)		3 (25)	4 (48)	7 (73)
DH	Mean (M)	5.1 (5.1)	2.8 (1.3)		3.3 (1.3)
	[5th, 95th]%	[1.3, 8.8]	[0.1, 9.7]		[0.1, 9.7]
	days (n)	2 (72)	7 (72)		9 (144)
BH	Mean (M)		1.1 (1.3)		1.1 (1.3)
	[5th, 95th]%		[0.1, 1.7]		[0.1, 1.7]
	days (n)		5 (54)		5 (54)
JPH	Mean (M)	16 (16)	18 (9.8)	28 (24)	21 (17)
	[5th, 95th]%	[4.5, 28]	[2.7, 42]	[2.4, 58]	[2.4, 58]
	days (n)	2 (72)	3 (45)	3 (31)	8 (148)
CH	Mean (M)		0.1		0.1
	[5th, 95th]%		-		-
	days (n)		1 (6)		1 (6)

Table II-2**. Enterococci densities (CFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Beaches					
All	Mean (M)	27	130 (25)	210 (120)	170 (34)
	[5^{th}, 95^{th}]%	-	[1.8, 490]	[2.3, 600]	[2.3, 600]
	days (n)	1 (51)	19 (243)	15 (270)	35 (564)
LB	Mean (M)	27	12 (13)	110 (65)	62 (16)
	[5^{th}, 95^{th}]%	-	[3.1, 20]	[2.3, 300]	[2.3, 300]
	days (n)	1 (51)	3 (33)	4 (69)	8 (153)
MB	Mean (M)		240 (39)	270 (140)	250 (110)
	[5^{th}, 95^{th}]%		[4.6, 1500]	[11, 1100]	[4.6, 1100]
	days (n)		10 (132)	10 (183)	20 (315)
JPB	Mean (M)		19 (16)	110	32 (19)
	[5^{th}, 95^{th}]%		[1.8, 45]	-	[1.8, 110]
	days (n)		6 (78)	1 (18)	7 (96)

Table II-3. Daily mean Somatic coliphage densities (PFU/100mL) by location-group and location, over the study period (2007-2009). Row 1 contains the mean and median (M) of the daily mean densities. Row 2 contains the central 90% range [5th, 95th] percentiles. Row 3 contains the number of sampling days, and number of samples (n).

Location	Legend	2007	2008	2009	All Years
CAWS North System					
BR	Mean (M)	240 (20)	570 (11)	45 (3.2)	350 (6.9)
-4.2 km	[5th, 95th]%	[1, 1200]	[1, 5100]	[1, 20]	[1, 2200]
	days (n)	12 (48)	53 (299)	33 (238)	98 (585)
Below	Mean (M)	3300 (2800)	2100 (1600)	1600 (110)	2100 (1500)
WRP	[5th, 95th]%	[1, 9300]	[1.4, 5800]	[30, 3500]	[5.5, 5770]
	days (n)	25 (522)	129 (992)	58 (508)	212 (2022)
SK	Mean (M)	720 (175)	790 (78)	302 (30)	690 (77)
-0.7 km	[5th, 95th]%	[1, 2400]	[1, 3300]	[1.4, 1100]	[1, 3100]
	days (n)	7 (177)	24 (251)	7 (52)	38 (480)
LA	Mean (M)	4900 (4400)	2800 (2400)	1900 (1700)	2800 (2300)
+3.2 km	[5th, 95th]%	[1500, 9300]	[810, 5800]	[300, 3500]	[500, 630]
	days (n)	12 (141)	55 (217)	32 (121)	99 (479)
RP	Mean (M)	1700	930 (480)	140	930 (480)
+5.4 km	[5th, 95th]%	-	[210, 4000]	-	[140, 1700]
	days (n)	1 (45)	9 (74)	1 (12)	11 (131)
CP	Mean (M)	4000 (3300)	2200 (1800)	990 (850)	2000 (1600)
+9.1 km	[5th, 95th]%	[1700, 7100]	[450, 4000]	[330, 2000]	[340, 4000]
	days (n)	3 (117)	17 (207)	10 (179)	30 (503)
NAM	Mean (M)	2600 (2600)	1990 (950)	2800 (570)	2200 (880)
+14.6 km	[5th, 95th]%	[2300, 2800]	[140, 4900]	[200, 19000]	[200, 4900]
	days (n)	2 (42)	24 (243)	8 (144)	34 (429)

Table II-3**. Somatic coliphage densities (PFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS South Branch					
All	Mean (M)	300	1800 (550)	250 (190)	1000 (200)
	[5th, 95th]%	-	[120, 5900]	[19, 820]	[19, 5800]
	days (n)	1 (42)	9 (96)	8 (113)	18 (251)
PT	Mean (M)	300	2100 (220)	190 (190)	1200 (250)
+21.0 km	[5th, 95th]%	-	[120, 5900]	[110, 270]	[110, 5900]
	days (n)	1 (42)	3 (42)	2 (36)	6 (120)
LAW	Mean (M)			280	280
	[5th, 95th]%			-	-
	days (n)			1 (15)	1 (15)
CO	Mean (M)		1600 (710)	330 (240)	1100 (500)
+24.2 km	[5th, 95th]%		[130, 5800]	[30, 820]	[30, 5800]
	days (n)		6 (54)	4 (47)	10 (101)
WE	Mean (M)			19	19
	[5th, 95th]%			-	-
	days (n)			1 (15)	1 (15)
CAWS Cal-Sag Channel					
BA	Mean (M)	22 (11)	200 (11)	57 (17)	140 (11)
-1.3 km	[5th, 95th]%	[5.5, 50]	[1, 600]	[1, 310]	[1, 600]
	days (n)	3 (18)	16 (114)	7 (60)	26 (192)
Below	Mean (M)	430 (340)	790 (370)	480 (320)	680 (340)
WRP	[5th, 95th]%	[52, 1200]	[28, 2700]	[99, 1600]	[29, 2000]
(All)	days (n)	7 (216)	50 (572)	18 (296)	75 (1084)
RM	Mean (M)	710 (610)	760 (570)	770 (580)	760 (580)
+4.8 km	[5th, 95th]%	[280, 1200]	[82, 1700]	[200, 1700]	[82, 1700]
	days (n)	3 (54)	17 (176)	7 (39)	27 (269)
AL	Mean (M)	210 (210)	930 (300)	370 (300)	750 (300)
+14.6 km	[5th, 95th]%	[52, 370]	[29, 2700]	[140, 800]	[29, 2700]
	days (n)	2 (90)	17 (207)	5 (116)	24 (413)
WO	Mean (M)	220 (220)	660 (210)	230 (180)	520 (190)
+18.8 km	[5th, 95th]%	[92, 340]	[3.6, 2000]	[99, 440]	[3.6, 2000]
	days (n)	2 (72)	16 (189)	6 (141)	24 (402)

Table II-3**. Somatic coliphage densities (PFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS Other					
MS	Mean (M)	1.0	190 (10)	7.9 (6.9)	93 (8.7)
+19.7 km	[5th, 95th]%	-	[1, 790]	[1, 20]	[1, 730]
	days (n)	1 (3)	17 (84)	18 (221)	36 (308)
WS	Mean (M)		1.0		1.0
+12.7 km	[5th, 95th]%		-		-
	days (n)		1 (9)		1 (9)
GUW Other					
LP	Mean (M)		19 (4.0)		19 (4.0)
	[5th, 95th]%		[1, 85]		[1, 85]
	days (n)		7 (72)		7 (72)
NBD	Mean (M)	460	900 (440)	460 (210)	710 (370)
	[5th, 95th]%	-	[90, 2700]	[1, 1490]	[40, 2670]
	days (n)	1 (3)	37 (140)	27 (116)	65 (259)
Rivers					
All	Mean (M)		44 (15)	110 (73)	78 (55)
	[5th, 95th]%		[1.0, 600]	[8.6, 300]	[1.0, 170]
	days (n)		6 (105)	6 (94)	12 (199)
DP	Mean (M)		37 (37)	73 (73)	55 (65)
	[5th, 95th]%		[7.6, 66]	[63, 84]	[7.6, 84]
	days (n)		2 (39)	2 (30)	4 (69)
FR	Mean (M)		9.9 (6.3)	120 (47)	64 (16)
	[5th, 95th]%		[1.0, 22]	[8.6, 300]	[1.0, 300]
	days (n)		3 (45)	3 (51)	6 (96)
HW	Mean (M)		160	170	170 (170)
	[5th, 95th]%		-	-	[160, 170]
	days (n)		1 (21)	1 (13)	2 (34)

Table II-3**. Somatic coliphage densities (PFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Inland Lakes					
All	Mean (M)	11 (1.3)	43 (1.2)	200 (1.4)	110 (1.4)
	[5^{th}, 95^{th}]%	[1, 39]	[1, 170]	[1, 970]	[1, 760]
	days (n)	4 (144)	42 (680)	39 (708)	85 (1532)
BW	Mean (M)		19 (1.7)	180 (15)	82 (3.2)
	[5^{th}, 95^{th}]%		[1.0, 94]	[3.1, 970]	[1.0, 94]
	days (n)		9 (135)	6 (118)	15 (253)
CL	Mean (M)	1.2 (1.2)	1.0 (1.0)	1.5 (1.5)	1.2 (1.0)
	[5^{th}, 95^{th}]%	[1.0, 1.4]	[1.0, 1.0]	[1.0, 2.1]	[1.0, 2.1]
	days (n)	2 (42)	2 (24)	2 (16)	6 (82)
LAR	Mean (M)			2300	2300
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (15)	1 (15)
LPP	Mean (M)			1 (1)	1 (1)
	[5^{th}, 95^{th}]%			[1, 1]	[1, 1]
	days (n)			2 (18)	2 (18)
ML	Mean (M)			2.3 (1.2)	2.3 (1.2)
	[5^{th}, 95^{th}]%			[1, 5.7]	[1, 5.7]
	days (n)			4 (84)	4 (84)
MT	Mean (M)			1.0	1.0
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (12)	1 (12)
SL	Mean (M)	20 (20)	79 (3.8)	340 (2.5)	170 (2.9)
	[5^{th}, 95^{th}]%	[1.3, 39]	[1.0, 250]	[1.0, 940]	[1.0, 760]
	days (n)	2 (102)	19 (313)	13 (249)	34 (664)
TL	Mean (M)		11 (1.0)	1.3 (1.0)	6.3 (1.0)
	[5^{th}, 95^{th}]%		[1.0, 20]	[1.0, 2.8]	[1.0, 20]
	days (n)		12 (208)	10 (196)	22 (404)

Table II-3**. Somatic coliphage densities (PFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Harbors					
All	Mean (M)	1.2 (1.1)	5.0 (1.0)	2.1 (1.0)	1.5 (1.0)
	[5th, 95th]%	[1.0, 1.3]	[1.0, 14]	[1.0, 2.5]	[1.0, 10]
	days (n)	11 (364)	26 (314)	13 (164)	50 (842)
MH	Mean (M)	1.2 (1.1)	1.0 (1.0)	1.3 (1.0)	1.2 (1.0)
	[5th, 95th]%	[1.0, 2.1]	[1.0, 1.0]	[1.0, 2.5]	[1.0, 2.1]
	days (n)	7 (220)	7 (112)	6 (85)	20 (417)
BL	Mean (M)		1.0 (1.0)	1.2 (1.0)	1.1 (1.0)
	[5th, 95th]%		[1.0, 1.0]	[1, 1.7]	1.2 [1, 1.7]
	days (n)		3 (25)	4 (48)	7 (73)
DH	Mean (M)	1.3 (1.3)	1.5 (1.0)		1.5 (1.0)
	[5th, 95th]%	[1.3, 1.3]	[1, 4.7]		[1, 4.7]
	days (n)	2 (72)	7 (72)		9 (144)
BH	Mean (M)		1.0 (1.0)		1.0 (1.0)
	[5th, 95th]%		[1.0, 1.0]		[1.0, 1.0]
	days (n)		5 (54)		5 (54)
JPH	Mean (M)	1.0 (1.0)	2.0 (1.0)	5.0 (4.0)	2.6 (1.0)
	[5th, 95th]%	[1.0, 1.0]	[1.0, 4.0]	[1.0, 10]	[1.0, 10]
	days (n)	2 (72)	3 (45)	3 (31)	8 (148)
CH	Mean (M)		1.0		1.0
	[5th, 95th]%		-		-
	days (n)		1 (6)		1 (6)

Table II-3**. Somatic coliphage densities (PFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Beaches					
All	Mean (M)	1.3	26 (1.0)	8.5 (1.0)	18 (1.0)
	[5th, 95th]%	-	[1, 19]	[1, 13]	[1, 19]
	days (n)	1 (51)	19 (243)	15 (270)	35 (564)
LB	Mean (M)	1.3	1.0 (1.0)	3.9 (1.0)	2.5 (1.0)
	[5th, 95th]%	-	[1.0, 1.0]	[1.0, 12]	[1.0, 12]
	days (n)	1 (51)	3 (33)	4 (69)	8 (153)
MB	Mean (M)		48 (4.8)	10 (1.0)	29 (1.8)
	[5th, 95th]%		[1.0, 420]	[1.0, 85]	[1.0, 85]
	days (n)		10 (132)	10 (183)	20 (315)
JPB	Mean (M)		1.5 (1.0)	9.0	2.6 (1.0)
	[5th, 95th]%		[1.0, 2.8]	-	[1.0, 9.0]
	days (n)		6 (78)	1 (18)	7 (96)

Table II-4. Daily mean Male-specific coliphage densities (PFU/100mL) by location-group and location, over the study period (2007-2009). Row 1 contains the mean and median (M) of the daily mean densities. Row 2 contains the central 90% range [5th, 95th] percentiles. Row 3 contains the number of sampling days, and number of samples (n).

Location	Legend	2007	2008	2009	All Years
CAWS North Branch					
BR	Mean (M)	37 (0.1)	80 (0.55)	2.8 (0.1)	49 (0.10)
-4.2 km	[5th, 95th]%	[0.1, 11]	[0.1, 310]	[0.1, 0.8]	[0.1, 190]
	days (n)	12 (48)	53 (299)	33 (238)	98 (585)
Below	Mean (M)	110 (72)	230 (76)	60 (44)	170 (63)
WRP	[5th, 95th]%	[0.1, 300]	[0.38, 770]	[0.25, 150]	[0.38, 480]
(All)	days (n)	25 (522)	129 (992)	58 (508)	212 (2022)
SK	Mean (M)	18 (1.1)	57 (3.9)	19 (1.0)	43 (2.2)
-0.7 km	[5th, 95th]%	[0.1, 70]	[0.1, 250]	[0.1, 72]	[0.1, 170]
	days (n)	7 (177)	24 (251)	7 (52)	38 (480)
LA	Mean (M)	170 (130)	260 (110)	84 (66)	190 (95)
+3.2 km	[5th, 95th]%	[50, 300]	[28, 760]	[14, 160]	[21, 570]
	days (n)	12 (141)	55 (217)	32 (121)	99 (479)
RP	Mean (M)	54	1000 (36)	3.5	820 (36)
+5.4 km	[5th, 95th]%	-	[2.1, 7280]	-	[2.1, 1000]
	days (n)	1 (45)	9 (74)	1 (12)	11 (131)
CP	Mean (M)	110 (62)	150 (85)	43 (37)	110 (67)
+9.1 km	[5th, 95th]%	[49, 220]	[31, 360]	[9.6, 110]	[13, 290]
	days (n)	3 (117)	17 (207)	10 (179)	30 (503)
NAM	Mean (M)	66 (66)	120 (53)	25 (13)	95 (42)
+14.6 km	[5th, 95th]%	[59, 72]	[7, 420]	[10, 90]	[8.4, 270]
	days (n)	2 (42)	24 (243)	8 (144)	34 (429)

Table II-4**. Male-Specific coliphage densities (PFU/100ml) continued.**

Location	Legend	2007	2008	2009	All Years
CAWS South Branch					
All	Mean (M)	7.3	110 (15)	6.4 (2.6)	59 (6.2)
	[5th, 95th]%	-	[5.0, 500]	[0.35, 35]	[0.35, 340]
	days (n)	1 (42)	9 (96)	8 (113)	18 (251)
PT +21.0 km	Mean (M)	7.3	170 (5.1)	3.2 (3.2)	87 (5.0)
	[5th, 95th]%	-	[5.0, 500]	[1.8, 4.5]	[1.8, 500]
	days (n)	1 (42)	3 (42)	2 (36)	6 (120)
LAW	Mean (M)			3.4	3.4
	[5th, 95th]%			-	-
	days (n)			1 (15)	1 (15)
CO +24.2 km	Mean (M)		84 (37)	10 (2.7)	54 (14)
	[5th, 95th]%		[13, 340]	[0.35, 35]	[0.35, 340]
	days (n)		6 (54)	4 (47)	10 (101)
WE	Mean (M)			0.83	0.83
	[5th, 95th]%			-	-
	days (n)			1 (15)	1 (15)
CAWS Cal-Sag Channel					
BA -1.3 km	Mean (M)	4.7 (0.10)	52 (0.8)	0.40 (0.21)	33 (0.55)
	[5th, 95th]%	[0.10, 14]	[0.10, 290]	[0.10, 1]	[0.10, 290]
	days (n)	3 (18)	16 (114)	7 (60)	26 (192)
Below WRP (All)	Mean (M)	5.1 (3.4)	66 (13)	25 (13)	50 (12)
	[5th, 95th]%	[0.53, 15]	[0.55, 280]	[4.6, 68]	[0.55, 230]
	days (n)	7 (216)	50 (572)	18 (296)	76 (1084)
RM +4.8 km	Mean (M)	8.6 (8.9)	41 (22)	33 (26)	36 (18)
	[5th, 95th]%	[1.5, 15]	[2.4, 94]	[4.5, 68]	[1.5, 94]
	days (n)	3 (54)	17 (176)	7 (39)	27 (269)
AL +14.6 km	Mean (M)	2.0 (2.0)	82 (12)	28 (13)	65 (11)
	[5th, 95th]%	[0.54, 3.4]	[0.7, 230]	[7.6, 96]	[0.54, 230]
	days (n)	2 (90)	17 (207)	5 (116)	24 (413)
WO +18.8 km	Mean (M)	3.1 (3.1)	75 (6.7)	12 (9.0)	53 (97.7)
	[5th, 95th]%	[1.3, 5.0]	[0.10, 280]	[7.5, 23]	[0.10, 280]
	days (n)	2 (72)	16 (189)	6 (141)	24 (402)

Table II-4. **Male-specific coliphage densities (PFU/100ml) continued.**

Location	Legend	2007	2008	2009	All Years
CAWS Other					
MS	Mean (M)	0.11	32 (1.0)	1.7 (0.33)	16 (0.58)
	[5th, 95th]%	-	[0.10, 140]	[0.10, 4.3]	[0.10, 35]
	days (n)	1 (3)	17 (84)	18 (221)	36 (308)
WS	Mean (M)		0.10		0.10
	[5th, 95th]%		-		-
	days (n)		1 (9)		1 (9)
GUW Other					
LP	Mean (M)		1.6 (0.40)		1.6 (0.40)
	[5th, 95th]%		[0.10, 7.1]		[0.10, 7.1]
	days (n)		7 (72)		7 (72)
NBD	Mean (M)	28	210 (13)	8.3 (1.4)	120 (4.5)
	[5th, 95th]%	-	[0.10, 600]	[0.10, 48]	[0.10, 600]
	days (n)	1 (3)	37 (140)	27 (116)	65 (259)
Rivers					
All	Mean (M)		29 (5.3)	8.9 (6.4)	19 (6.4)
	[5th, 95th]%		[0.10, 83]	[0.55, 26]	[0.10, 78]
	days (n)		6 (105)	6 (94)	12 (199)
DP	Mean (M)		0.1 (0.10)	0.94 (0.94)	0.52 (0.33)
	[5th, 95th]%		[0.10, 0.10]	[0.55, 1.3]	[0.10, 1.3]
	days (n)		2 (39)	2 (30)	4 (69)
FR	Mean (M)		55 (78)	15 (13)	35 (19)
	[5th, 95th]%		[3.6, 83]	[6.3, 26]	[3.6, 83]
	days (n)		3 (45)	3 (51)	6 (96)
HW	Mean (M)		7.1	6.5	6.8 (6.8)
	[5th, 95th]%		-	-	[6.5, 7.1]
	days (n)		1 (21)	1 (13)	2 (34)

Table II-4**. Male-Specific coliphage densities (PFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Inland Lakes					
All	Mean (M)	2.6 (0.51)	6.2 (0.10)	5.1 (0.10)	5.5 (0.10)
	[5th, 95th]%	[0.10, 9.2]	[0.10, 15]	[0.10, 18]	[0.10, 18]
	days (n)	4 (144)	42 (680)	39 (708)	85 (1532)
BW	Mean (M)		1.5 (0.32)	1.9 (0.22)	1.6 (0.29)
	[5th, 95th]%		[0.10, 11]	[0.10, 9.7]	[0.10, 9.7]
	days (n)		9 (135)	6 (118)	15 (253)
CL	Mean (M)	0.26 (0.26)	0.1 (0.10)	0.1 (0.10)	0.15 (0.10)
	[5th, 95th]%	[0.10, 0.43]	[0.10, 0.10]	[0.10, 0.10]	[0.10, 0.43]
	days (n)	2 (42)	2 (24)	2 (16)	6 (82)
LAR	Mean (M)			96	96
	[5th, 95th]%			-	-
	days (n)			1 (15)	1 (15)
LPP	Mean (M)			0.19 (0.19)	0.19 (0.19)
	[5th, 95th]%			[0.10, 0.27]	[0.10, 0.27]
	days (n)			2 (18)	2 (18)
ML	Mean (M)			0.11 (0.10)	0.11 (0.10)
	[5th, 95th]%			[0.10, 0.14]	[0.10, 0.14]
	days (n)			4 (84)	4 (84)
MT	Mean (M)			0.10	0.10
	[5th, 95th]%			-	-
	days (n)			1 (12)	1 (12)
SL	Mean (M)	4.9 (4.9)	12 (6.1)	7.0 (0.32)	9.7 (0.32)
	[5th, 95th]%	[0.59, 9.2]	[0.10, 25]	[0.10, 18]	[0.10, 25]
	days (n)	2 (102)	19 (313)	13 (249)	34 (664)
TL	Mean (M)		1.4 (0.19)	0.22 (0.10)	0.88 (0.10)
	[5th, 95th]%		[0.10, 0.58]	[0.10, 1.3]	[0.10, 1.3]
	days (n)		12 (208)	10 (196)	22 (404)

Table II-4. **Male-specific coliphage densities (PFU/100ml) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Harbors					
All	Mean (M)	0.12 (0.10)	0.49 (0.10)	2.1 (0.10)	0.18 (0.10)
	[5th, 95th]%	[0.10, 0.18]	[0.10, 1.0]	[0.10, 0.58]	[0.10, 0.45]
	days (n)	11 (364)	26 (314)	13 (164)	50 (842)
MH	Mean (M)	0.12 (0.10)	0.10 (0.10)	0.19 (0.14)	0.13 (0.10)
	[5th, 95th]%	[0.10, 0.18]	[0.10, 0.10]	[0.10, 0.58]	[0.10, 0.18]
	days (n)	7 (220)	7 (112)	6 (85)	20 (417)
BL	Mean (M)		0.10 (0.10)	0.33 (0.24)	0.23 (0.10)
	[5th, 95th]%		[0.10, 0.10]	[0.10, 0.73]	[0.10, 0.7]
	days (n)		3 (25)	4 (48)	7 (73)
DH	Mean (M)	0.1 (0.10)	0.23 (0.10)		0.2 (0.10)
	[5th, 95th]%	[0.10, 0.10]	[0.10, 0.4]		[0.10, 0.4]
	days (n)	2 (72)	7 (72)		9 (144)
BH	Mean (M)		0.28 (0.10)		0.28 (0.10)
	[5th, 95th]%		[0.10, 1.0]		[0.10, 1.0]
	days (n)		5 (54)		5 (54)
JPH	Mean (M)	0.16 (0.16)	0.20 (0.10)	0.10 (0.10)	0.15 (0.10)
	[5th, 95th]%	[0.14, 0.18]	[0.10, 0.4]	[0.10, 0.10]	[0.10, 0.4]
	days (n)	2 (72)	3 (45)	3 (31)	8 (148)
CH	Mean (M)		0.44		0.44
	[5th, 95th]%		-		-
	days (n)		1 (6)		1 (6)

Table II-4. **Male-specific coliphage densities (PFU/100ml) continued.**

Location	Legend	2007	2008	2009	All Years
Lake Michigan Beaches					
All	Mean (M)	0.10	2.2 (0.22)	0.14 (0.10)	1.2 (0.10)
	[5th, 95th]%	-	[0.10, 9.0]	[0.10, 0.24]	[0.10, 2.5]
	days (n)	1 (51)	19 (243)	15 (270)	35 (564)
LB	Mean (M)	1.1	3.1 (0.10)	0.11 (0.10)	1.2 (0.10)
	[5th, 95th]%	-	[0.10, 9.0]	[0.10, 0.15]	[0.10, 9.0]
	days (n)	1 (51)	3 (33)	4 (69)	8 (153)
MB	Mean (M)		3.0 (1.0)	0.15 (0.10)	1.6 (0.10)
	[5th, 95th]%		[0.10, 21]	[0.10, 0.46]	[0.10, 2.5]
	days (n)		10 (132)	10 (183)	20 (315)
JPB	Mean (M)		0.27 (0.16)	0.10	0.25 (0.10)
	[5th, 95th]%		[0.10, 0.85]	-	[0.10, 0.85]
	days (n)		6 (78)	1 (18)	7 (96)

Table II-5. Daily mean *Cryptosporidium* densities (oocysts/10L) by location-group and location, over the study period (2007-2009). Row 1 contains the mean and median (M) of the daily mean densities. Row 2 contains the central 90% range [5th, 95th] percentiles. Row 3 contains the number of sampling days, and number of samples (n).

Location	Legend	2007	2008	2009	All Years
CAWS North Branch					
BR	Mean (M)	2.6 (2.6)	9.6 (0.50)	1.2 (0.03)	6.1 (0.05)
-4.2 km	[5th, 95th]%	[0.07, 5.0]	[0.03, 480	[0.03, 4.0]	[0.03, 11]
	days (n)	4 (4)	47 (81)	32 (47)	83 (132)
Below	Mean (M)	5.7 (1.0)	9.2 (1.5)	2.4 (0.03)	6.7 (1.0)
WRP	[5th, 95th]%	[0.05, 17]	[0.03, 34]	[0.03, 13]	[0.03, 28]
(All)	days (n)	17 (18)	105 (179)	56 (101)	178 (298)
SK	Mean (M)	5.5 (2.4)	3.6 (0.50)	1.4 (0.50)	3.5 (0.75)
-0.7 km	[5th, 95th]%	[0.1, 17]	[0.03, 23]	[0.03, 4.0]	[0.03, 17]
	days (n)	6 (6)	21 (37)	7 (12)	34 (55)
LA	Mean (M)	6.3 (0.52)	15 (3.0)	1.9 (0.03)	9.4 (0.50)
+3.2 km	[5th, 95th]%	[0.05, 32]	[0.03, 82]	[0.03, 12]	[0.03, 43]
	days (n)	8 (9)	48 (83)	31 (50)	87 (142)
RP	Mean (M)	1 (1)	3.6 (1.5)	0.50	2.7 (1.0)
+5.4 km	[5th, 95th]%	[1, 1]	[0.03, 12]	-	[0.03, 12]
	days (n)	2 (2)	6 (11)	1 (1)	9 (14)
CP	Mean (M)	11	7.3 (2.0)	4.8 (1.1)	6.3 (1.6)
+9.1 km	[5th, 95th]%	-	[0.03, 28]	[0.03, 22]	[0.03, 28]
	days (n)	1 (1)	11 (16)	10 (20)	22 (37)
NAM	Mean (M)		4.2 (0.50)	2.1 (2.3)	3.6 (0.75)
+14.6 km	[5th, 95th]%		[0.03, 18]	[0.03, 4.5]	[0.03, 18]
	days (n)		19 (32)	7 (18)	26 (50)

Table II-5**. *Cryptosporidium* densities (oocysts/10L) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS South Branch					
All	Mean (M)		26 (11)	0.74 (0.15)	13 (3.8)
	[5th, 95th]%		[0.5, 95]	[0.03, 2.5]	[0.03, 95]
	days (n)		8 (15)	8 (21)	16 (36)
PT	Mean (M)		51 (51)	0.07 (0.07)	26 (3.8)
+21.0 km	[5th, 95th]%		[7.5, 95]	[0.03, 0.11]	[0.03, 95]
	days (n)		2 (3)	2 (8)	4 (11)
LAW	Mean (M)			0.03	0.03
	[5th, 95th]%			-	-
	days (n)			1 (5)	1 (5)
CO	Mean (M)		17 (10)	0.80 (0.35)	11 (3.0)
+24.2 km	[5th, 95th]%		[0.50, 49]	[0.03, 2.5]	[0.03, 49]
	days (n)		6 (12)	4 (7)	10 (19)
WE	Mean (M)			2.5	2.5
	[5th, 95th]%			-	-
	days (n)			1 (1)	1 (1)
CAWS Cal-Sag Channel					
BA	Mean (M)	0.70 (0.05)	2.2 (0.03)	0.09 (0.03)	1.4 (0.03)
-1.3 km	[5th, 95th]%	[0.05, 2.0]	[0.03, 8.5]	[0.03, 0.50]	[0.03, 8.5]
	days (n)	3 (3)	15 (27)	7 (15)	25 (45)
Below	Mean (M)	0.60 (0.05)	1.5 (0.05)	0.27 (0.03)	1.0 (0.05)
WRP	[5th, 95th]%	[0.04, 2.0]	[0.03, 6.0]	[0.03, 1.0]	[0.03, 5.5]
(All)	days (n)	7 (8)	38 (75)	18 (41)	63 (124)
RM	Mean (M)	1.0 (1.0)	2.5 (1.8)	0.16 (0.03)	1.7 (0.27)
+4.8 km	[5th, 95th]%	[0.05, 2.0]	[0.03, 6.5]	[0.03, 0.50]	[0.03, 6.5]
	days (n)	3 (3)	16 (29)	7 (16)	26 (48)
AL	Mean (M)	0.05 (0.05)	0.74 (0.50)	0.41 (0.50)	0.57 (0.27)
+14.6 km	[5th, 95th]%	[0.04, 0.05]	[0.03, 2.5]	[0.03, 1.0]	[0.03, 2.5]
	days (n)	2 (2)	11 (25)	5 (11)	18 (38)
WO	Mean (M)	0.52 (0.52)	0.69 (0.50)	0.27 (0.03)	0.54 (0.03)
+18.8 km	[5th, 95th]%	[0.05, 1]	[0.3, 1.5]	[0.03, 1.5]	[0.03, 1.5]
	days (n)	2 (3)	11 (21)	6 (14)	19 (38)

Table II-5**. *Cryptosporidium* densities (oocysts/10L) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
CAWS Other					
MS	Mean (M)			0.03 (0.03)	0.03 (0.03)
+19.7 km	[5th, 95th]%			[0.03, 0.03]	[0.03, 0.03]
	days (n)			8 (16)	8 (16)
GUW Other					
LP	Mean (M)		0.03 (0.03)		0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]		[0.03, 0.03]
	days (n)		4 (8)		4 (8)
NBD	Mean (M)	0.05	6.4 (2.5)	11 (0.50)	8.6 (1.2)
	[5th, 95th]%	-	[0.03, 19]	[0.03, 50]	[0.03, 38]
	days (n)	1 (1)	22 (36)	27 (46)	50 (83)
Rivers					
All	Mean (M)		0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	[0.03, 0.4]	[0.03, 0.03]
	days (n)		6 (20)	6 (15)	12 (35)
DP	Mean (M)		0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.03]
	days (n)		2 (7)	2 (5)	4 (12)
FR	Mean (M)		0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	[0.03, 0.04]	[0.03, 0.04]
	days (n)		3 (10)	3 (8)	6 (18)
HW	Mean (M)		0.03	0.03	0.03 (0.03)
	[5th, 95th]%		-	-	[0.03, 0.03]
	days (n)		1 (3)	1 (2)	2 (5)

Table II-5. ***Cryptosporidium* densities (oocysts/10L) continued.**

Location	Legend	2007	2008	2009	All Years
Inland Lakes					
All	Mean (M)	0.21 (0.06)	0.66 (0.03)	0.19 (0.03)	0.40 (0.03)
	[5th, 95th]%	[0.05, 0.98]	[003, 1.5]	[0.03, 1.0]	[0.03, 1.5]
	days (n)	6 (6)	32 (87)	39 (90)	77 (183)
BW	Mean (M)		0.03 (0.03)	0.10 (0.03)	0.06 (0.03)
	[5th, 95th]%		[0.03, 0.03]	[0.03, 0.50]	[0.03, 0.03]
	days (n)		6 (15)	6 (15)	12 (30)
CL	Mean (M)	0.07 (0.07)	0.03 (0.03)	0.26 (0.26)	0.12 (0.05)
	[5th, 95th]%	[0.07, 0.07]	[0.03, 0.03]	[0.03, 0.50]	[0.03, 0.50]
	days (n)	2 (2)	2 (4)	2 (2)	6 (8)
LAR	Mean (M)			0.03	0.03
	[5th, 95th]%			-	-
	days (n)			1 (3)	1 (3)
LPP	Mean (M)			0.51 (0.51)	0.51 (0.51)
	[5th, 95th]%			[0.03, 1.0]	[0.03, 1.0]
	days (n)			2 (3)	2 (3)
ML	Mean (M)			0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%			[0.03, 0.03]	[0.03, 0.03]
	days (n)			4 (10)	4 (10)
MT	Mean (M)			0.03	0.03
	[5th, 95th]%			-	-
	days (n)			1 (3)	1 (3)
SL	Mean (M)	0.28 (0.05)	1.5 (0.03)	0.37 (0.03)	0.86 (0.03)
	[5th, 95th]%	[0.05, 0.98]	[0.03, 8.5]	[0.03, 1.5]	[0.03, 2.5]
	days (n)	4 (4)	14 (46)	13 (32)	31 (82)
TL	Mean (M)		0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.03]
	days (n)		10 (22)	10 (22)	20 (44)

Table II-5. ***Cryptosporidium* densities (oocysts/10L) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Harbors					
All	Mean (M)	0.42 (0.05)	0.04 (0.03)	0.03 (0.03)	0.14 (0.03)
	[5th, 95th]%	[0.05, 0.06]	[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.06]
	days (n)	12 (16)	22 (57)	11 (18)	42 (91)
MH	Mean (M)	0.05 (0.05)	0.03 (0.03)	0.03 (0.03)	0.04 (0.03)
	[5th, 95th]%	[0.05, 0.05]	[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.05]
	days (n)	8 (11)	5 (19)	5 (9)	18 (39)
BL	Mean (M)		0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.03]
	days (n)		2 (6)	4 (6)	6 (12)
DH	Mean (M)	2.2 (2.2)	0.03 (0.03)		0.58 (0.03)
	[5th, 95th]%	[0.05, 4.4]	[0.03, 0.03]		[0.03, 4.4]
	days (n)	2 (2)	6 (16)		8 (18)
BH	Mean (M)		0.12 (0.03)		0.12 (0.03)
	[5th, 95th]%		[0.03, 0.50]		[0.03, 0.50]
	days (n)		5 (7)		5 (7)
JPH	Mean (M)	0.05 (0.05)	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%	[0.05, 0.06]	[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.06]
	days (n)	2 (3)	3 (7)	2 (3)	7 (13)
CH	Mean (M)		0.03		0.03
	[5th, 95th]%		-		-
	days (n)		1 (2)		1 (2)

Table II-5**. *Cryptosporidium* densities (oocysts/10L) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Beaches					
All	Mean (M)	0.20	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%	-	[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.03]
	days (n)	1 (1)	7 (13)	12 (26)	20 (40)
LB	Mean (M)		0.03	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		-	[0.03, 0.03]	[0.03, 0.03]
	days (n)		1 (2)	4 (7)	5 (9)
MB	Mean (M)	0.20		0.03 (0.03)	0.05 (0.03)
	[5th, 95th]%	-		[0.03, 0.03]	[0.03, 0.20]
	days (n)	1 (1)		7 (17)	8 (18)
JPB	Mean (M)		0.03 (0.03)	0.03	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	-	[0.03, 0.03]
	days (n)		6 (11)	1 (2)	7 (13)

Table II-6. Daily mean *Giardia* densities (cysts/10L) by location-group and location, over the study period (2007-2009). Row 1 contains the mean and median (M) of the daily mean densities. Row 2 contains the central 90% range [5th, 95th] percentiles. Row 3 contains the number of sampling days, and number of samples (n).

Location	Legend	2007	2008	2009	All Years
CAWS North Branch					
BR	Mean (M)	4.8 (4.5)	9.2 (2.3)	10 (8.2)	9.5 (5.0)
-4.2 km	[5th, 95th]%	[0.07, 10]	[0.03, 33]	[1.5, 24]	[0.03, 30]
	days (n)	4 (4)	47 (81)	32 (47)	83 (132)
Below	Mean (M)	21 (8.0)	58 (39)	110 (84)	69 (44)
WRP	[5th, 95th]%	[0.05, 73]	[0.03, 180]	[0.03, 260]	[0.05, 210]
(All)	days (n)	17 (18)	105 (179)	56 (101)	178 (298)
SK	Mean (M)	20 (4.0)	38 (8.0)	19 (6.5)	31 (6.8)
-0.7 km	[5th, 95th]%	[0.05, 85]	[0.03, 150]	[0.03, 73]	[0.03, 98]
	days (n)	6 (6)	21 (37)	7 (12)	34 (55)
LA	Mean (M)	26 (15)	73 (43)	120 (93)	86 (59)
+3.2 km	[5th, 95th]%	[0.05, 73]	[2.0, 190]	[2.5, 330]	[2.0, 260]
	days (n)	8 (9)	48 (83)	31 (50)	87 (142)
RP	Mean (M)	6.0 (6.0)	14 (3.2)	0.50	11 (4.0)
+5.4 km	[5th, 95th]%	[2.0, 10]	[0.03, 58]	-	[0.03, 58]
	days (n)	2 (2)	6 (11)	1 (1)	9 (14)
CP	Mean (M)	19	63 (31)	110 (100)	84 (65)
+9.1km	[5th, 95th]%	-	[1.0, 141]	[24, 220]	[1.0, 180]
	days (n)	1 (1)	11 (16)	10 (20)	22 (37)
NAM	Mean (M)		51 (13)	120 (130)	70 (60)
+14.6 km	[5th, 95th]%		[0.03, 160]	[39, 210]	[0.03, 170]
	days (n)		19 (32)	7 (18)	26 (50)

Table II-6. ***Giardia* densities (**cysts **/10L) continued.**

Location	Legend	2007	2008	2009	All Years
CAWS South Branch					
All	Mean (M)		41 (26)	38 (24)	39 (24)
	[5th, 95th]%		[14, 110]	[8.5, 120]	[8.5, 120]
	days (n)		8 (15)	8 (21)	16 (36)
PT +21.0 km	Mean (M)		65 (45)	12 (12)	38 (17)
	[5th, 95th]%		[18, 110]	[8.5, 15]	[8.5, 110]
	days (n)		2 (3)	2 (8)	4 (11)
LAW	Mean (M)			9.4	9.4
	[5th, 95th]%			-	-
	days (n)			1 (5)	1 (5)
CO +24.2 km	Mean (M)		33 (28)	61 (51)	44 (32)
	[5th, 95th]%		[14, 62]	[19, 120]	[14, 120]
	days (n)		6 (12)	4 (7)	10 (19)
WE	Mean (M)			28	28
	[5th, 95th]%			-	-
	days (n)			1 (1)	1 (1)
CAWS Cal-Sag Channel					
BA -1.3 km	Mean (M)	0.05 (0.05)	1.0 (0.11)	0.16 (0.03)	0.66 (0.03)
	[5th, 95th]%	[0.05, 0.05]	2.0 [0.03, 4.5]	[0.03, 0.50]	[0.03, 4.5]
	days (n)	3 (3)	15 (27)	7 (15)	25 (45)
Below WRP (All)	Mean (M)	1.9 (2.0)	4.0 (1.8)	5.3 (4.3)	4.1 (2.5)
	[5th, 95th]%	[0.04, 5.0]	[0.03, 9.5]	[0.03, 11]	[0.03, 11]
	days (n)	7 (8)	38 (75)	18 (41)	63 (124)
RM +4.8 km	Mean (M)	2.7 (2.0)	6.7 (2.6)	8.7 (7.5)	6.8 5.8)
	[5th, 95th]%	[2.0, 4.0]	[0.03, 19]	[2.5, 18]	[0.03, 19]
	days (n)	3 (3)	16 (29)	7 (16)	26 (48)
AL +14.6 km	Mean (M)	0.05 (0.05)	2.1 (1.3)	3.8 (4.0)	2.4 (1.5)
	[5th, 95th]%	[0.04, 0.05]	[0.03, 4.5]	[1.5, 6.0]	[0.03, 6.0]
	days (n)	2 (2)	11 (25)	5 (11)	18 (38)
WO +18.8 km	Mean (M)	2.5 (2.5)	2.0 (1.4)	2.6 (2.7)	2.2 (1.5)
	[5th, 95th]%	[0.05, 5.0]	[0.50, 4.0]	[0.03, 5.0]	[0.03, 5.0]
	days (n)	2 (3)	11 (21)	6 (14)	19 (38)

Table II-6. ***Giardia*** **densities (**cysts **/10L) continued.**

Location	Legend	2007	2008	2009	All Years
CAWS Other					
MS	Mean (M)			0.08 (0.03)	0.08 (0.03)
+19.7	[5th, 95th]%			[0.03, 0.50]	[0.03, 0.50]
	days (n)			8 (16)	8 (16)
GUW Other					
LP	Mean (M)		0.03 (0.03)		0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]		[0.03, 0.03]
	days (n)		4 (8)		4 (8)
NBD	Mean (M)	1.0	5.3 (1.8)	14 (5.0)	9.9 (4.0)
	[5th, 95th]%	-	[0.03, 18]	[0.03, 72]	[0.03, 31]
	days (n)	1 (1)	22 (36)	27 (46)	50 (83)
Rivers					
All	Mean (M)		3.3 (4.0)	3.8 (2.9)	3.5 (3.4)
	[5th, 95th]%		[0.03, 6.0]	[0.03, 9.0]	[0.03, 6.0]
	days (n)		6 (20)	6 (15)	12 (35)
DP	Mean (M)		5.2 (5.2)	2.5 (2.5)	3.9 (3.5)
	[5th, 95th]%		[4.5, 6.0]	[2.5, 2.5]	[2.5, 6.0]
	days (n)		2 (7)	2 (5)	4 (12)
FR	Mean (M)		2.8 (3.5)	5.9 (5.4)	4.4 (4.2)
	[5th, 95th]%		[0.03, 5.0]	[3.2, 9.0]	[0.03, 9.0]
	days (n)		3 (10)	3 (8)	6 (18)
HW	Mean (M)		0.50	0.03	0.26 (0.26)
	[5th, 95th]%		-	-	[0.03, 0.50]
	days (n)		1 (3)	1 (2)	2 (5)

Table II-6**. *Giardia* densities (**cysts **/10L) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Inland Lakes					
All	Mean (M)	0.27 (0.05)	0.71 (0.03)	2.2 (0.03)	1.4 (0.03)
	[5^{th}, 95^{th}]%	[0.05, 1.3]	[0.03, 3.0]	[0.03, 12]	[0.03, 6.5]
	days (n)	6 (6)	32 (87)	39 (90)	77 (183)
BW	Mean (M)		0.10 (0.04)	0.18 (0.03)	0.14 (0.03)
	[5^{th}, 95^{th}]%		[0.03, 0.50	[0.03, 0.50]	[0.03, 0.50]
	days (n)		6 (15)	6 (15)	12 (30)
CL	Mean (M)	0.70 (0.70)	0.26 (0.11)	0.26 (0.26)	0.41 (0.28)
	[5^{th}, 95^{th}]%	[0.07, 1.3]	[0.03, 0.50]	[0.03, 0.50]	[0.03, 1.3]
	days (n)	2 (2)	2 (4)	2 (2)	6 (8)
LAR	Mean (M)			0.03	0.03
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (3)	1 (3)
LPP	Mean (M)			0.03 (0.03)	0.03 (0.03)
	[5^{th}, 95^{th}]%			[0.03, 0.03]	[0.03, 0.03]
	days (n)			2 (3)	2 (3)
ML	Mean (M)			0.05 (0.03)	0.05 (0.03)
	[5^{th}, 95^{th}]%			[0.03, 0.11]	[0.03, 0.11]
	days (n)			4 (10)	4 (10)
MT	Mean (M)			0.03	0.03
	[5^{th}, 95^{th}]%			-	-
	days (n)			1 (3)	1 (3)
SL	Mean (M)	0.05 (0.05)	1.5 (0.03)	6.6 (0.50)	3.4 (0.05)
	[5^{th}, 95^{th}]%	[0.05, 0.05]	[0.03, 6.5]	[0.03, 30]	[0.03, 11]
	days (n)	4 (4)	14 (46)	13 (32)	31 (82)
TL	Mean (M)		0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5^{th}, 95^{th}]%		[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.03]
	days (n)		10 (22)	10 (22)	20 (44)

Table II-6**. *Giardia* densities (**cysts **/10L) continued.**

Location	Legend	2007	2008	2009	All Years
Lake Michigan Harbors					
All	Mean (M)	1.5 (0.05)	0.05 (0.03)	0.07 (0.03)	0.03 (0.03)
	[5th, 95th]%	[0.05, 4.0]	[0.03, 0.03]	[0.03, 0.03]	[0.03, 1.0]
	days (n)	12 (16)	22 (57)	11 (18)	44 (91)
MH	Mean (M)	0.78 (0.05)	0.03 (0.03)	0.03 (0.03)	0.36 (0.03)
	[5th, 95th]%	[0.05, 4.0]	[0.03, 0.03]	[0.03, 0.03]	[0.03, 1.0]
	days (n)	8 (11)	5 (19)	5 (9)	18 (39)
BL	Mean (M)		0.03 (0.03)	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	[0.03, 0.03]	[0.03, 0.03]
	days (n)		2 (6)	4 (6)	6 (12)
DH	Mean (M)	5.6 (5.6)	0.03 (0.03)		1.41 (0.06)
	[5th, 95th]%	[0.05, 11]	[0.03, 0.03]		[0.03, 11]
	days (n)	2 (2)	6 (16)		8 (18)
BH	Mean (M)		0.12 (0.03)		0.12 (0.03)
	[5th, 95th]%		[0.03, 0.50]		[0.03, 0.50]
	days (n)		5 (7)		5 (7)
JPH	Mean (M)	0.05 (0.05)	0.03 (0.03)	0.26 (0.26)	0.10 (0.03)
	[5th, 95th]%	[0.05, 0.06]	[0.03, 0.03]	[0.03, 0.50]	[0.03, 0.50]
	days (n)	2 (3)	3 (7)	2 (3)	7 (13)
CH	Mean (M)		0.03		0.03
	[5th, 95th]%		-		-
	days (n)		1 (2)		1 (2)

Table II-6**. *Giardia* densities (**cysts **/10L) continued.**

Location	**Legend**	**2007**	**2008**	**2009**	**All Years**
Lake Michigan Beaches					
All	Mean (M)	0.20	0.03 (0.03)	0.89 (0.07)	0.56 (0.03)
	[5th, 95th]%	-	[0.03, 0.03]	[0.03, 2.0]	[0.03, 2.0]
	days (n)	1 (1)	7 (13)	12 (26)	20 (40)
LB	Mean (M)		0.03	0.03 (0.03)	0.03 (0.03)
	[5th, 95th]%		-	[0.03, 0.03]	[0.03, 0.03]
	days (n)		1 (2)	4 (7)	5 (9)
MB	Mean (M)	0.20		1.5 (0.03)	1.4 (0.11)
	[5th, 95th]%	-		[0.03, 8.0]	[0.03, 8.0]
	days (n)	1 (1)		7 (17)	8 (18)
JPB	Mean (M)		0.03 (0.03)	0.03	0.03 (0.03)
	[5th, 95th]%		[0.03, 0.03]	-	[0.03, 0.03]
	days (n)		6 (11)	1 (2)	7 (13)

Section 2.03 Trends in microorganism densities over time

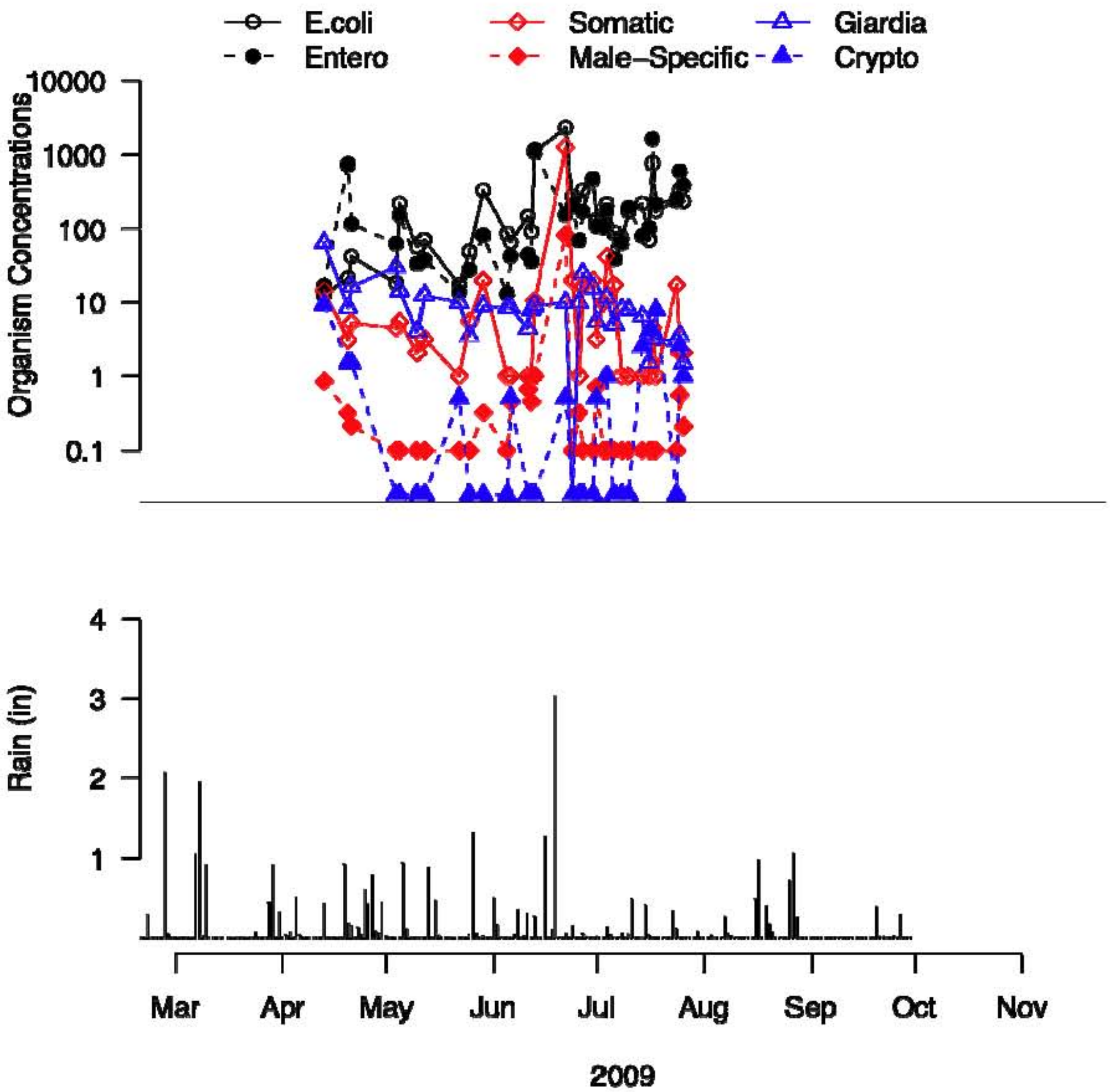


Figure II-8 through Figure II-11. At all locations over time, the densities of *E. coli* and enterococci are generally the highest, followed by Somatic coliphage, Male-specific coliphage, *Giardia* cysts and *Cryptosporidium* oocysts. Total daily rainfall is plotted below the microorganism densities, though in most cases there is no obvious association between microorganism densities and daily precipitation.

Microorganism densities above and below the WRP on the CAWS North system – Bridge Street (BR) and Lincoln Avenue (LA) locations – are compared across Figures II-7 and II-8 . The y-axis scales are the same in both figures, so that it is apparent that the densities of indicator organisms at Lincoln Avenue, below the Plant, are consistently higher than at Bridge Street, above the plant. The densest monitoring at these locations was in the fall of 2008 and the summer of 2009. Coliphage densities are the most variable indicator organisms at Bridge Street, above the plant, during these periods, while at Lincoln Avenue *E. coli* densities vary most in the Fall of 2008 and *Giardia* cyst densities in the Summer of 2009. Peaks in all organism densities are present at Bridge Street in July of 2008, but are not detected below the plant at Lincoln Avenue. At both locations, *Garidia* cyst densities, indicated by blue open triangles, are greater than *Cryptosporidium* oocyst densities during most of the study period. The exception is the fall of 2008 when *Giardia* and *Cryptosporidium* (oo) cyst densities were similar.

Monitoring at the Riverdale Marina (RM), downstream of the WRP on the CAWS South system shows less variability in microorganism densities (Figure II-9) than seen at Bridge Street and Lincoln Avenues. Some of the difference, however, may be due to the lower frequency of monitoring. The densities of Somatic coliphage are consistently greater than Male-specific coliphage. And, densities of *Giardia* cysts are greater than *Cryptosporidium* oocsyts, except in the summer-fall of 2008.

Microorganism densities at Skokie Lagoons (SL), an Inland Lake, trend closely together in Summer 2009 **(**Figure II-10). In 2008, enterococci densities were relatively stable, but were higher relative to the other organisms in spring and fall.

The North Branch Dam (NBD) drains a tributary from a forest preserve, but the water quality is more similar to locations in the CAWS North Branch than to Skokie Lagoons (Figure II-11). Protozoan pathogen densities are particularly high at this location.

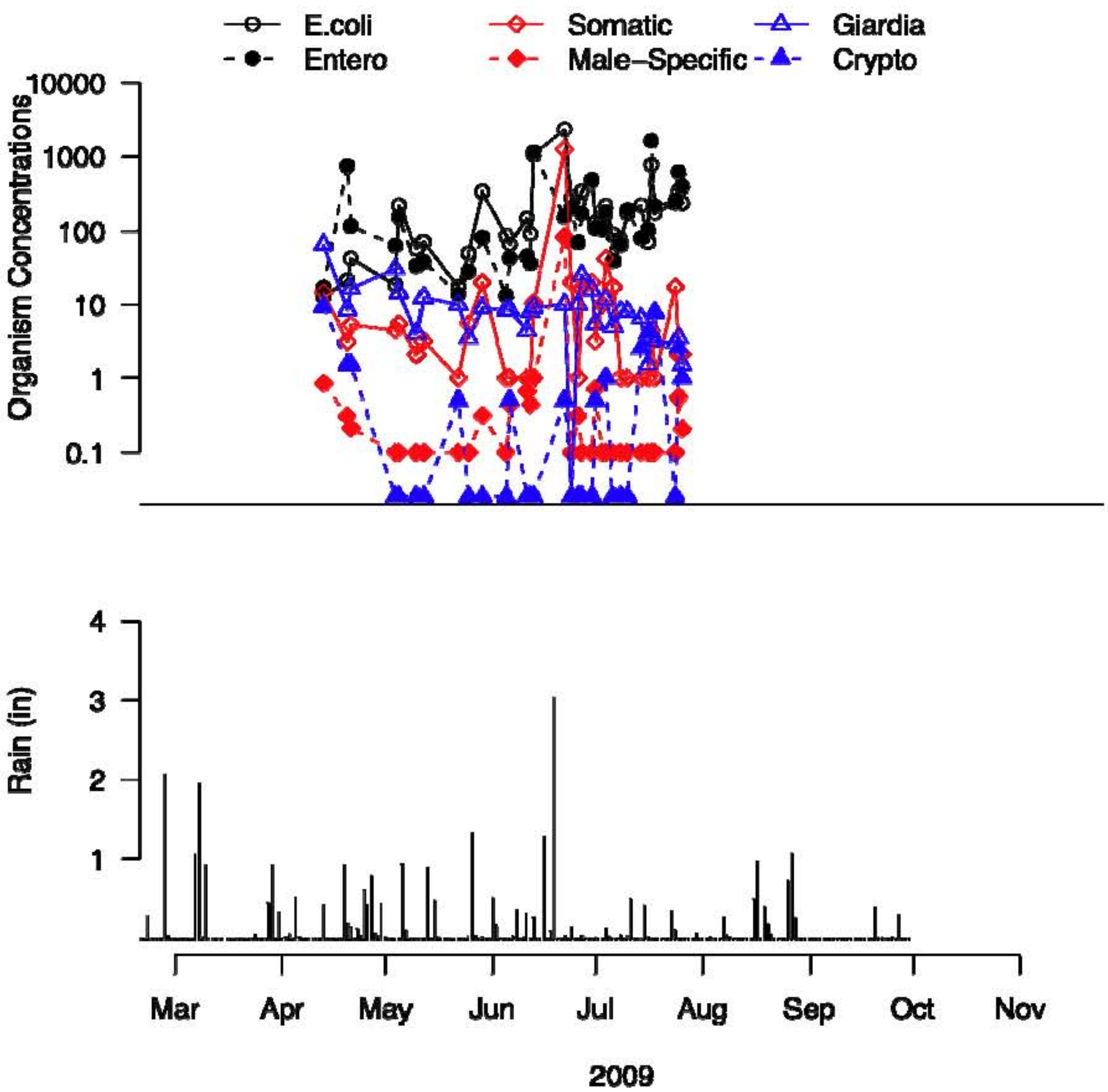
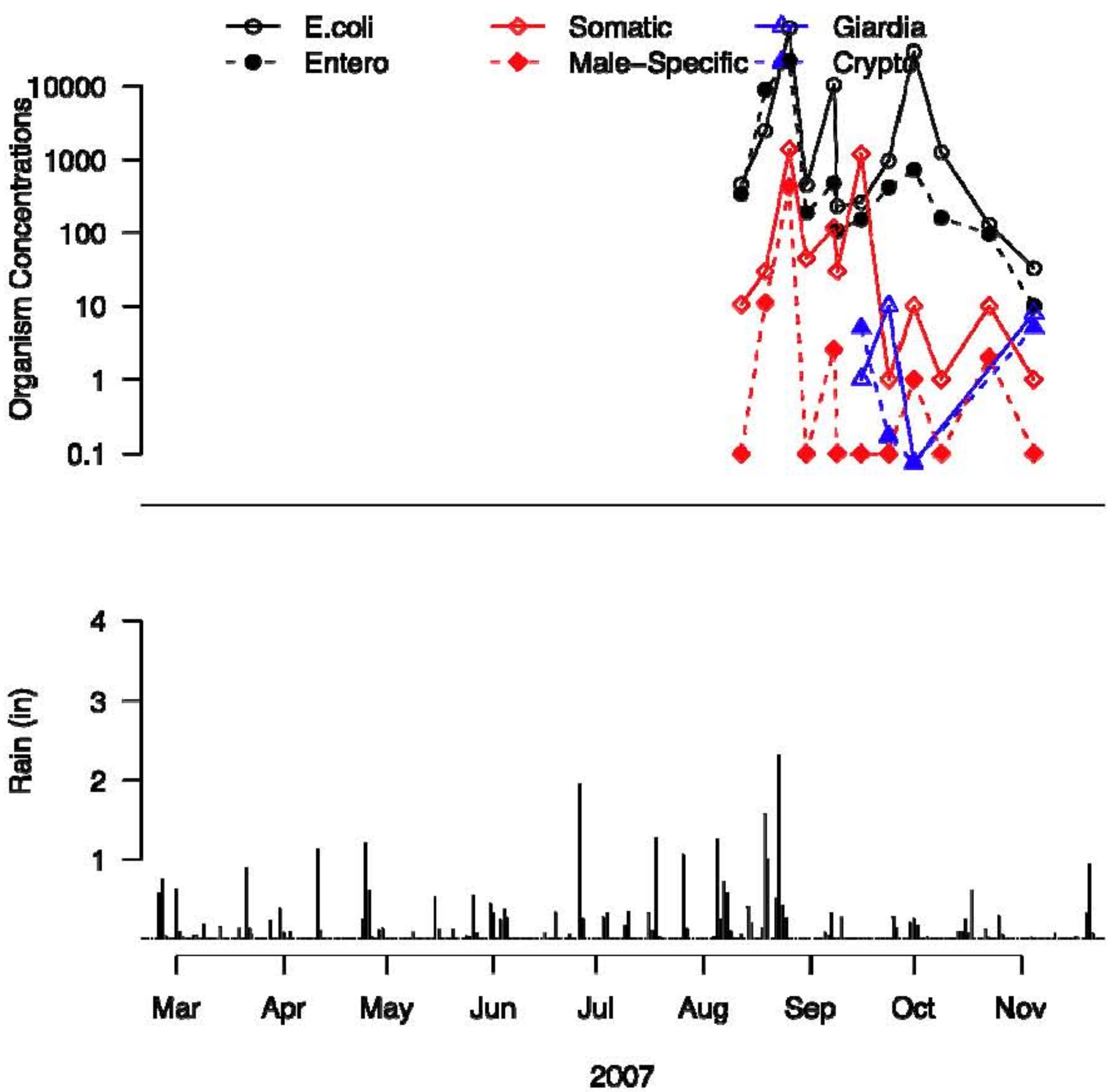
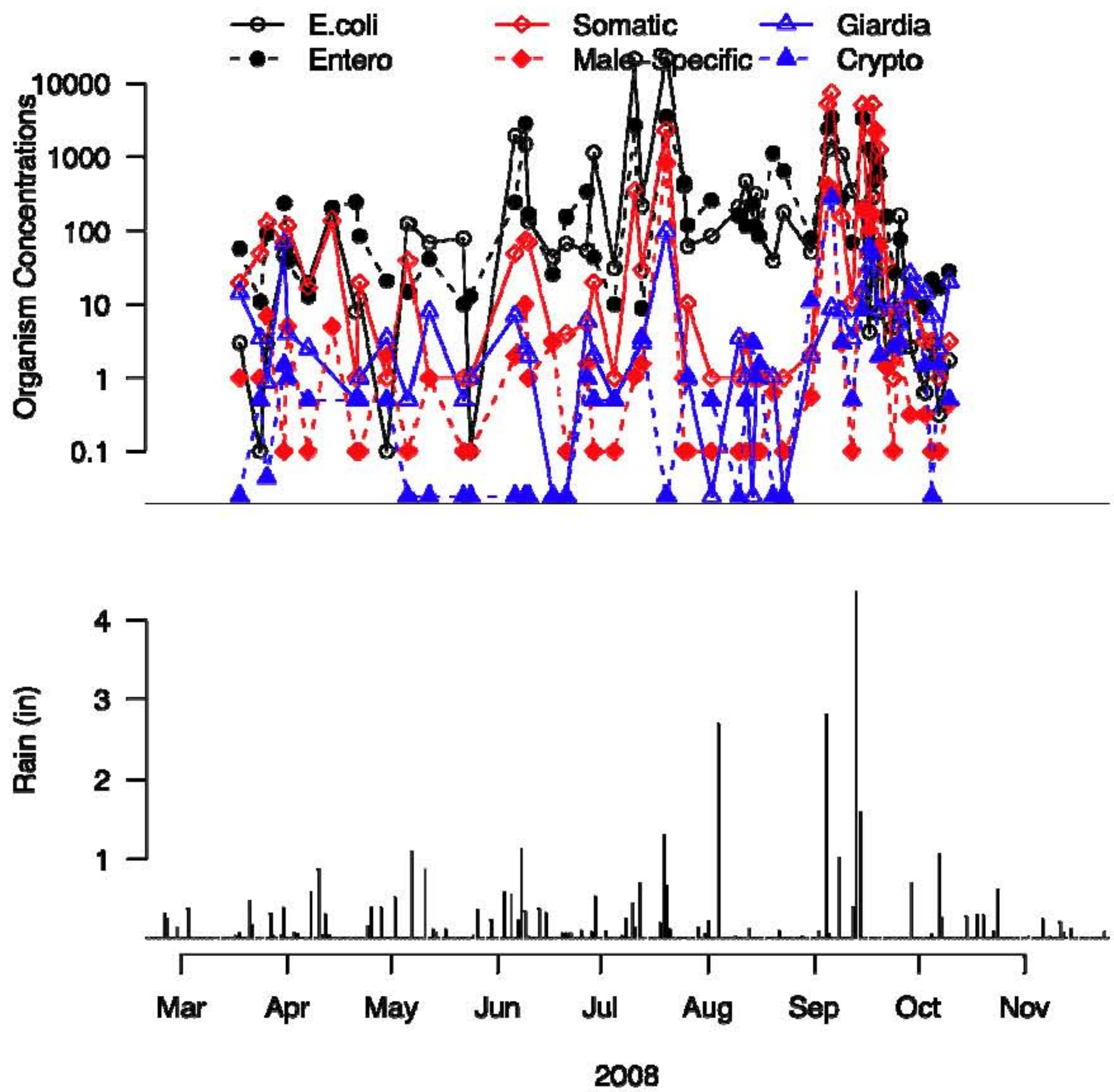

E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2009

Figure II-7. Time trends in microorganism densities at Bridge Street (BR) , with daily precipitation indicated below, by year. Points indicate dates of microbe measurement.

(a) 2007



(b) 2008


E.coli
Entero
Somatic
Male-Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2008

(c) 2009

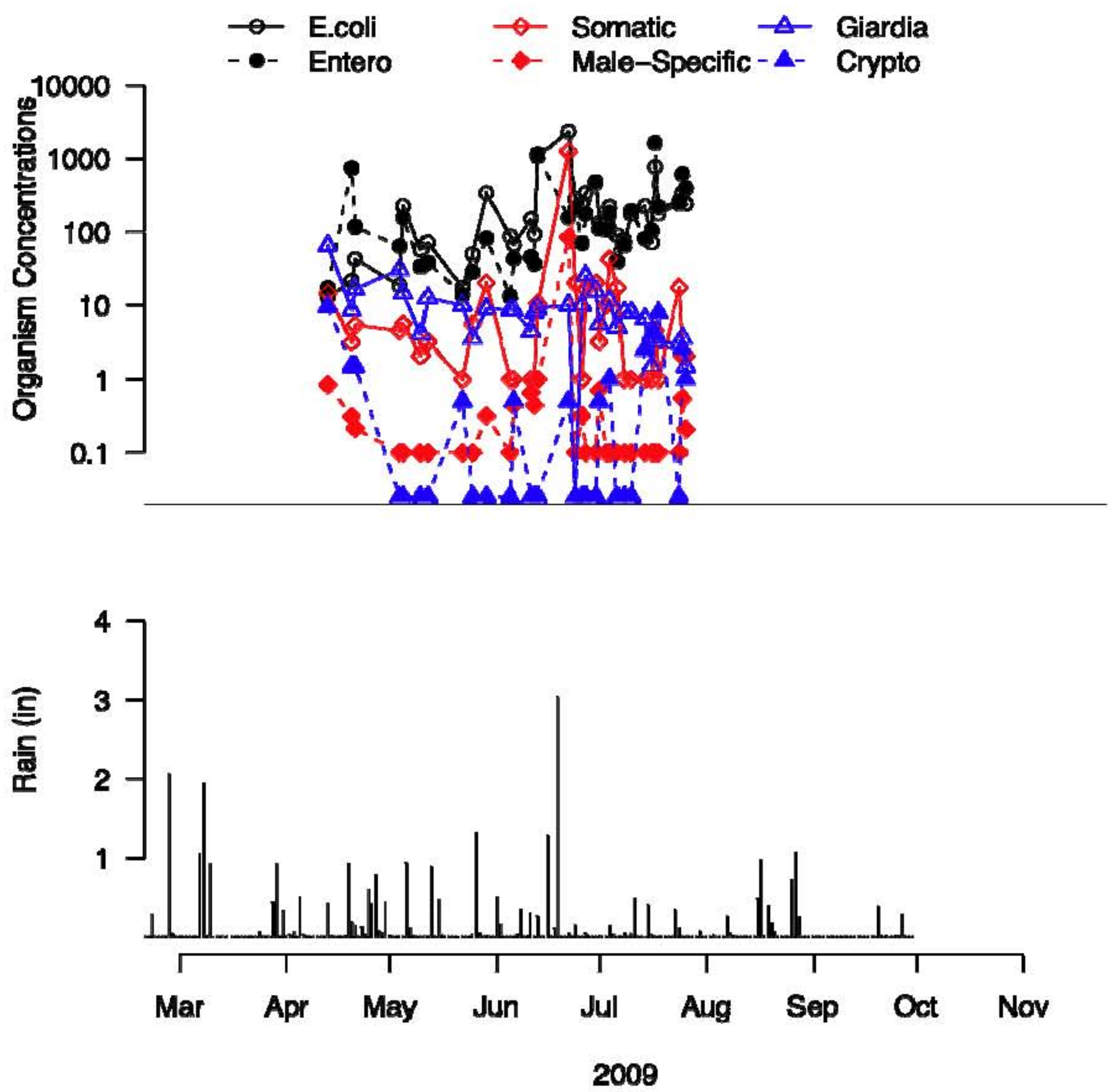
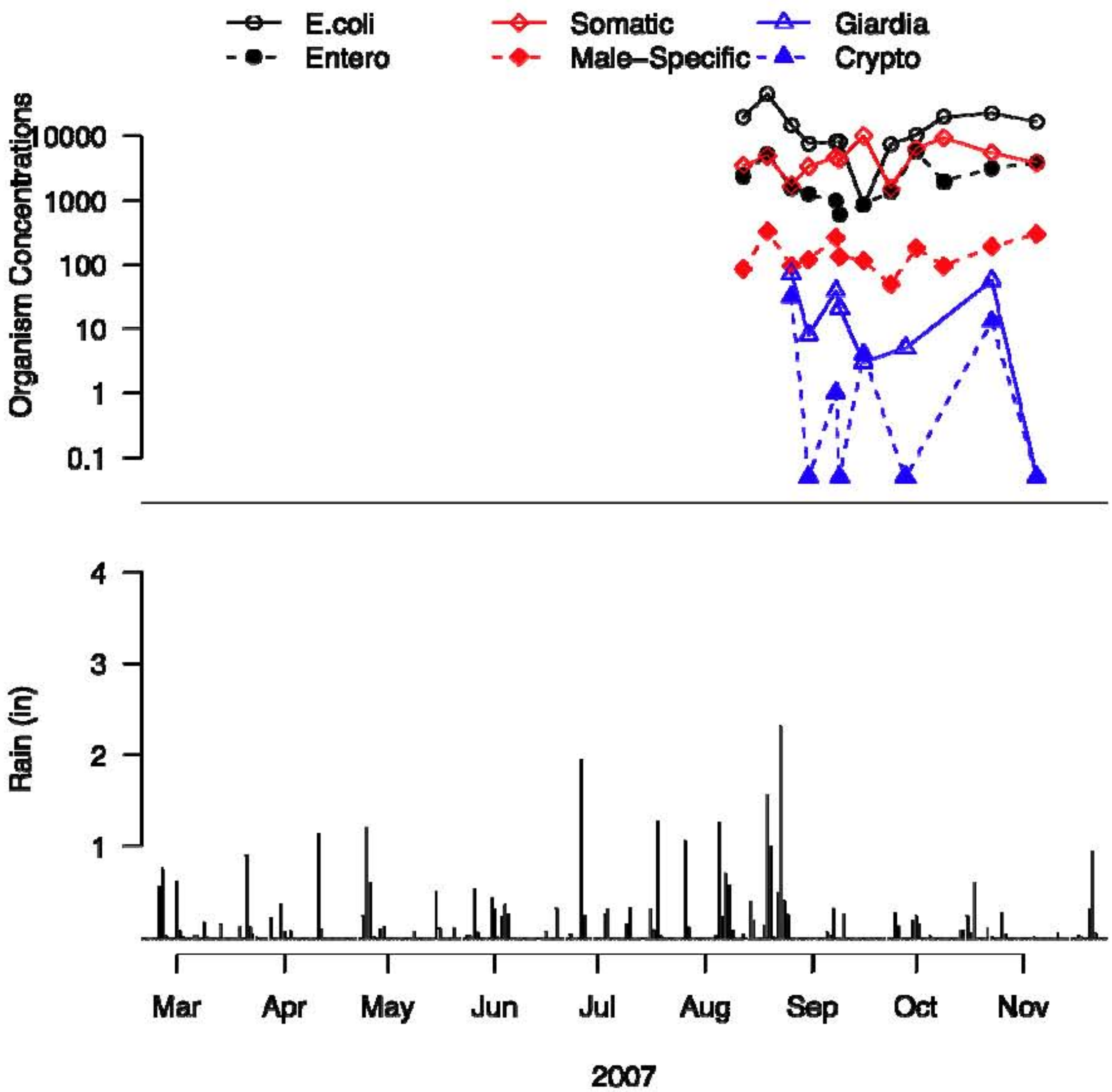
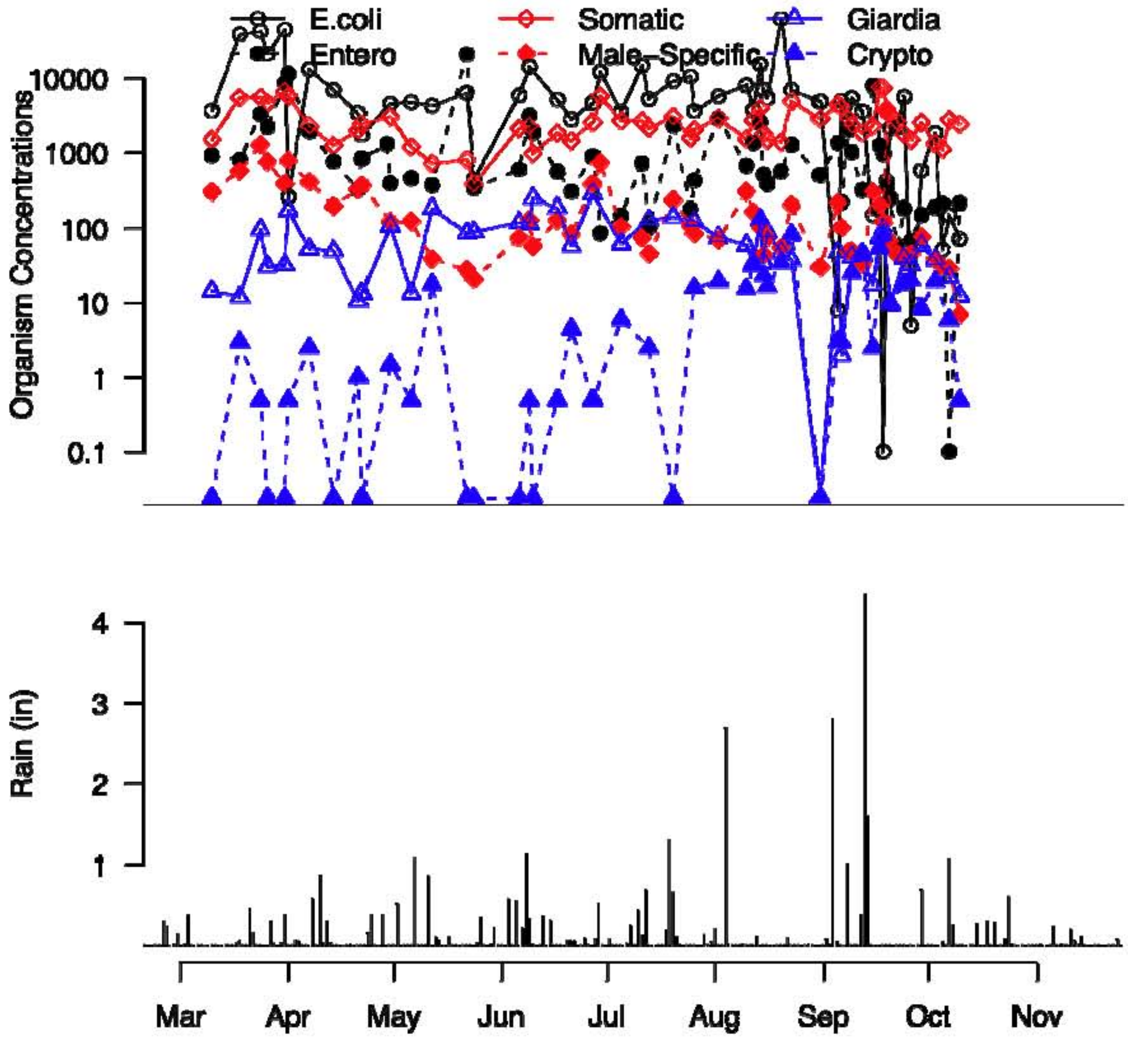

E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2009

Figure II-8. Time trends in microorganism densities at Lincoln Avenue (LA) , with daily precipitation indicated below, by year. Points indicate dates of microbe measurement.

(a) 2007



(b) 2008


E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov

(c) 2009

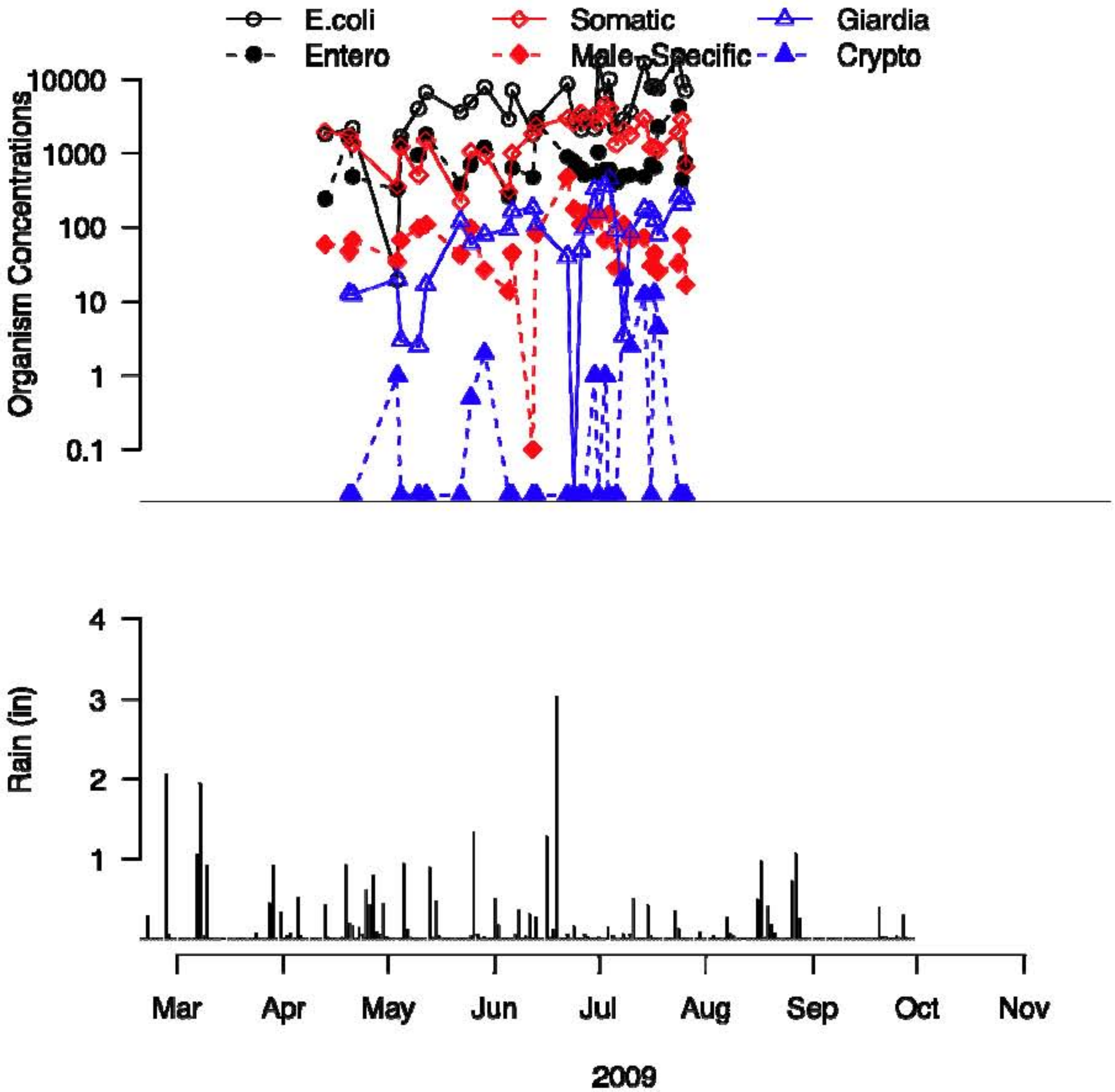
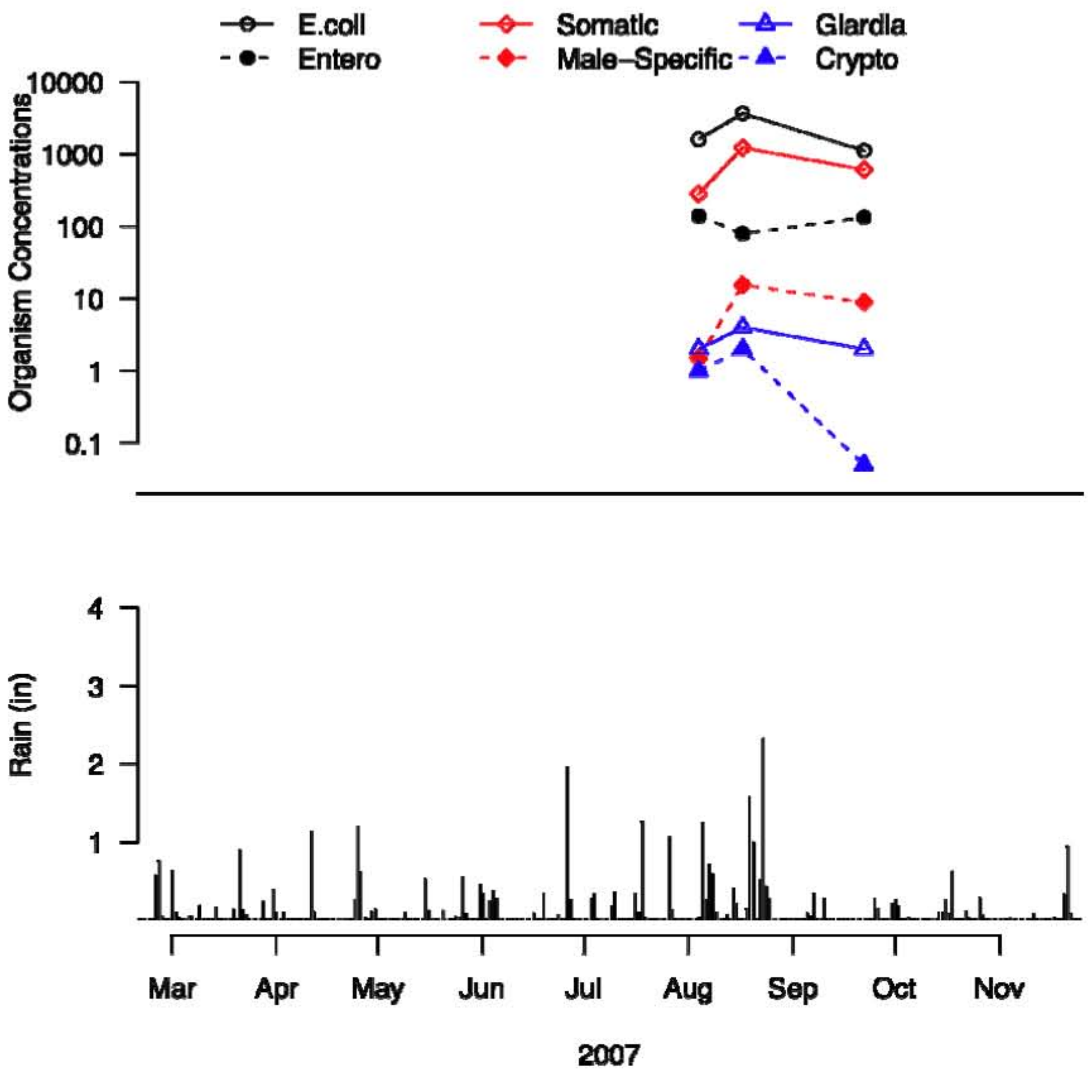
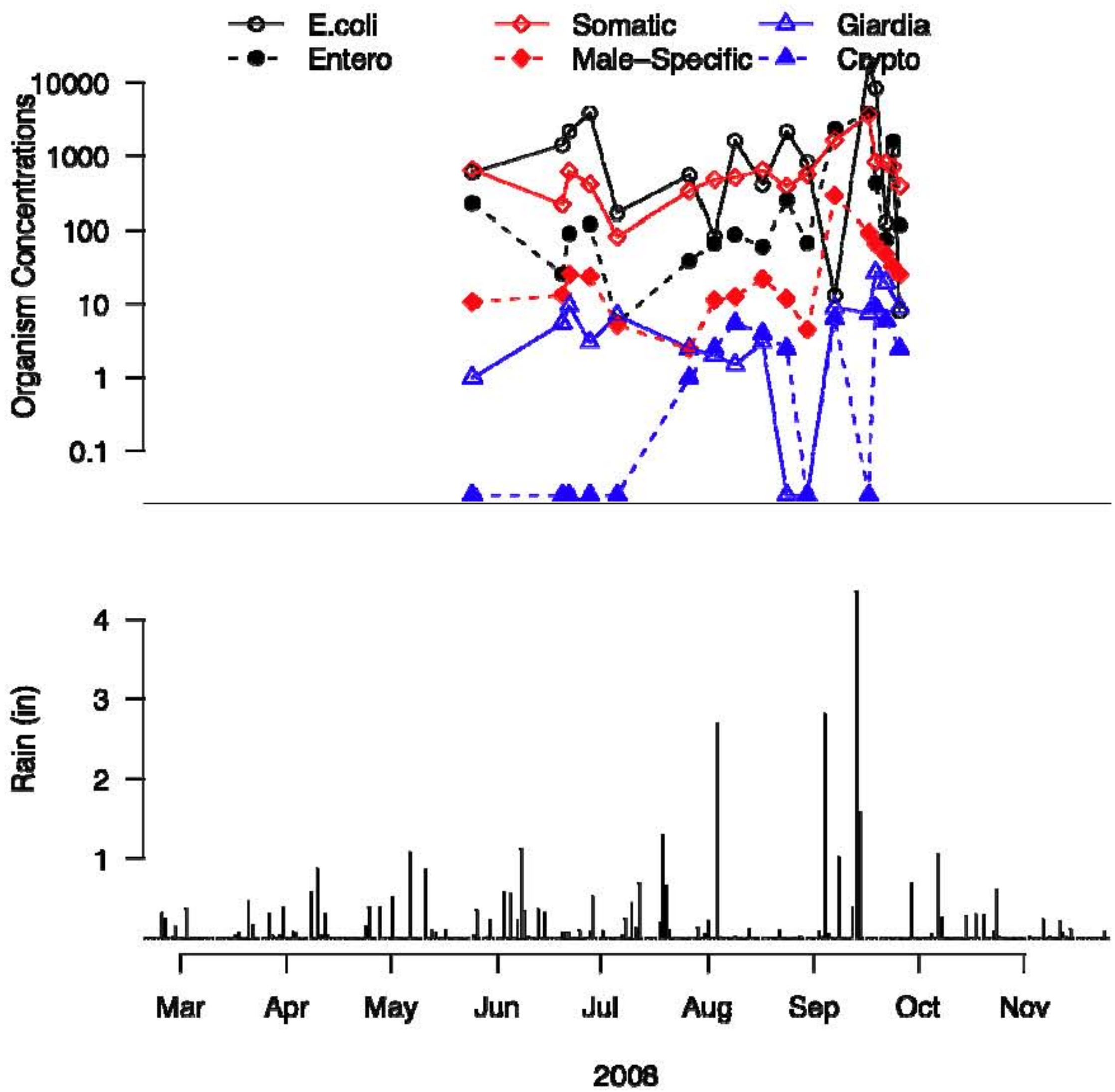

E.coli
Entero
Somatic
Male-Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2009

Figure II-9 Time trends in microorganism densities at Riverdale Marina (RM) , with daily precipitation indicated below, by year. Points indicate dates of measurement.

(a) 2007



(b) 2008


E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2008

(c) 2009

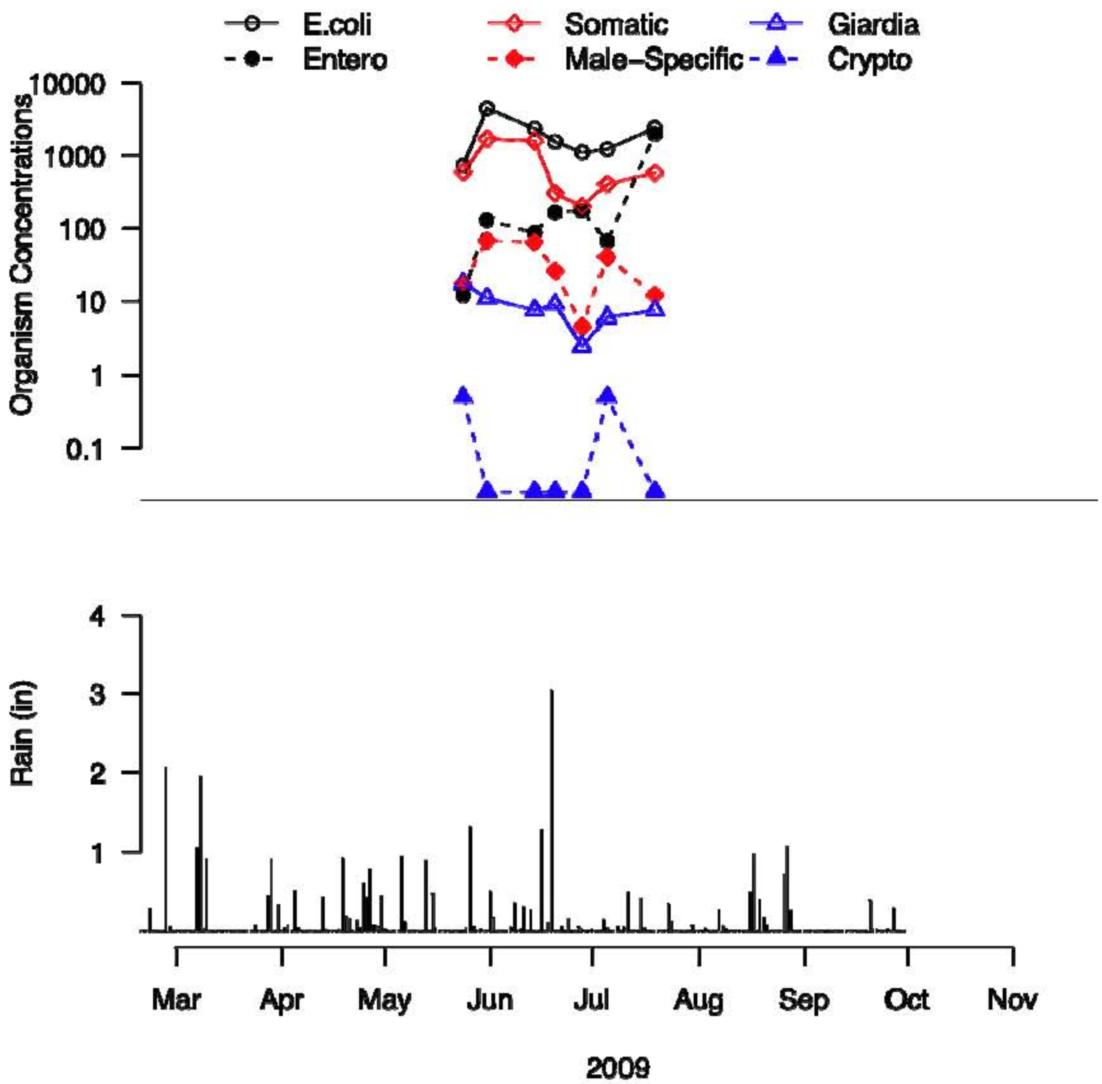
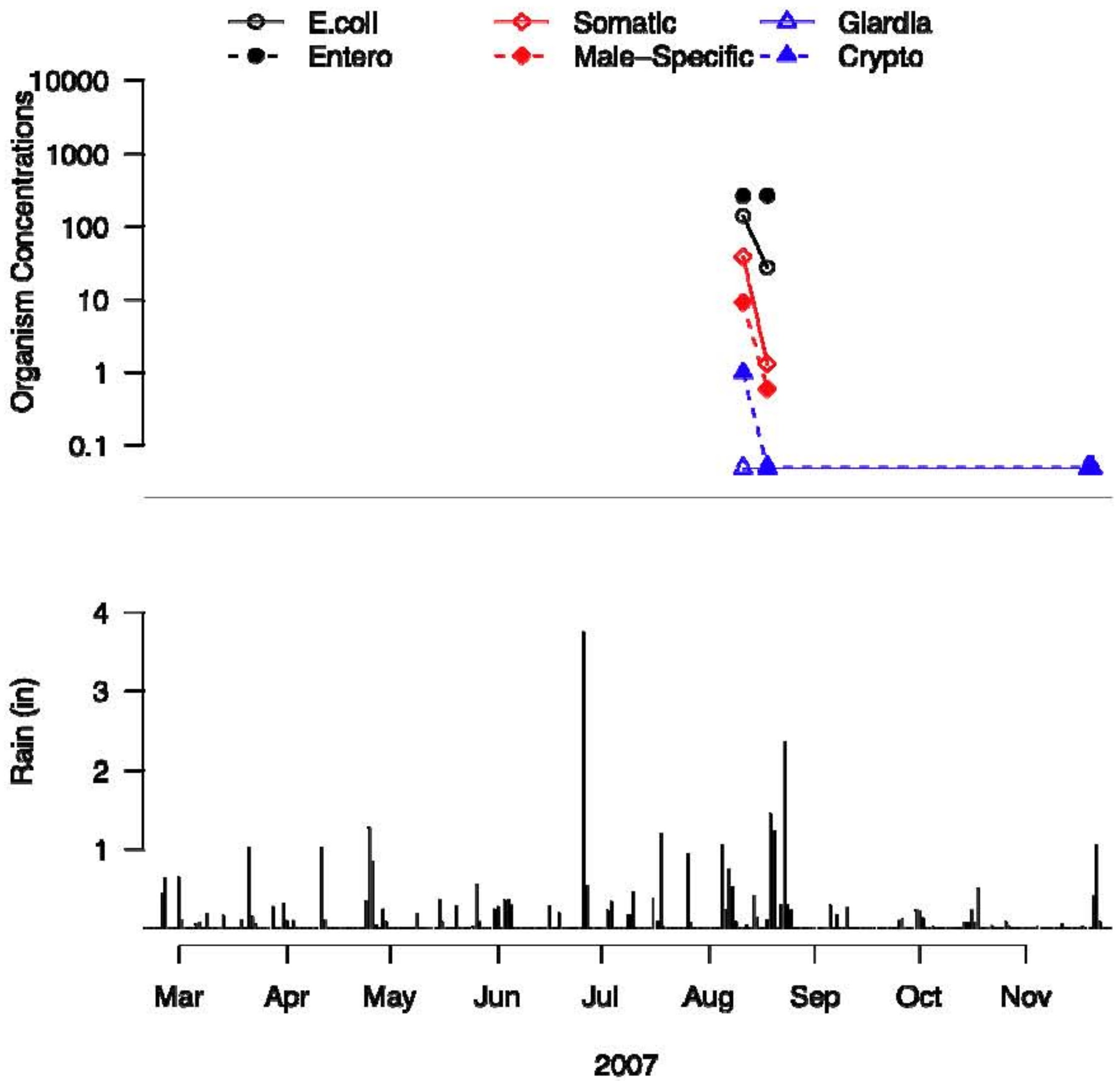
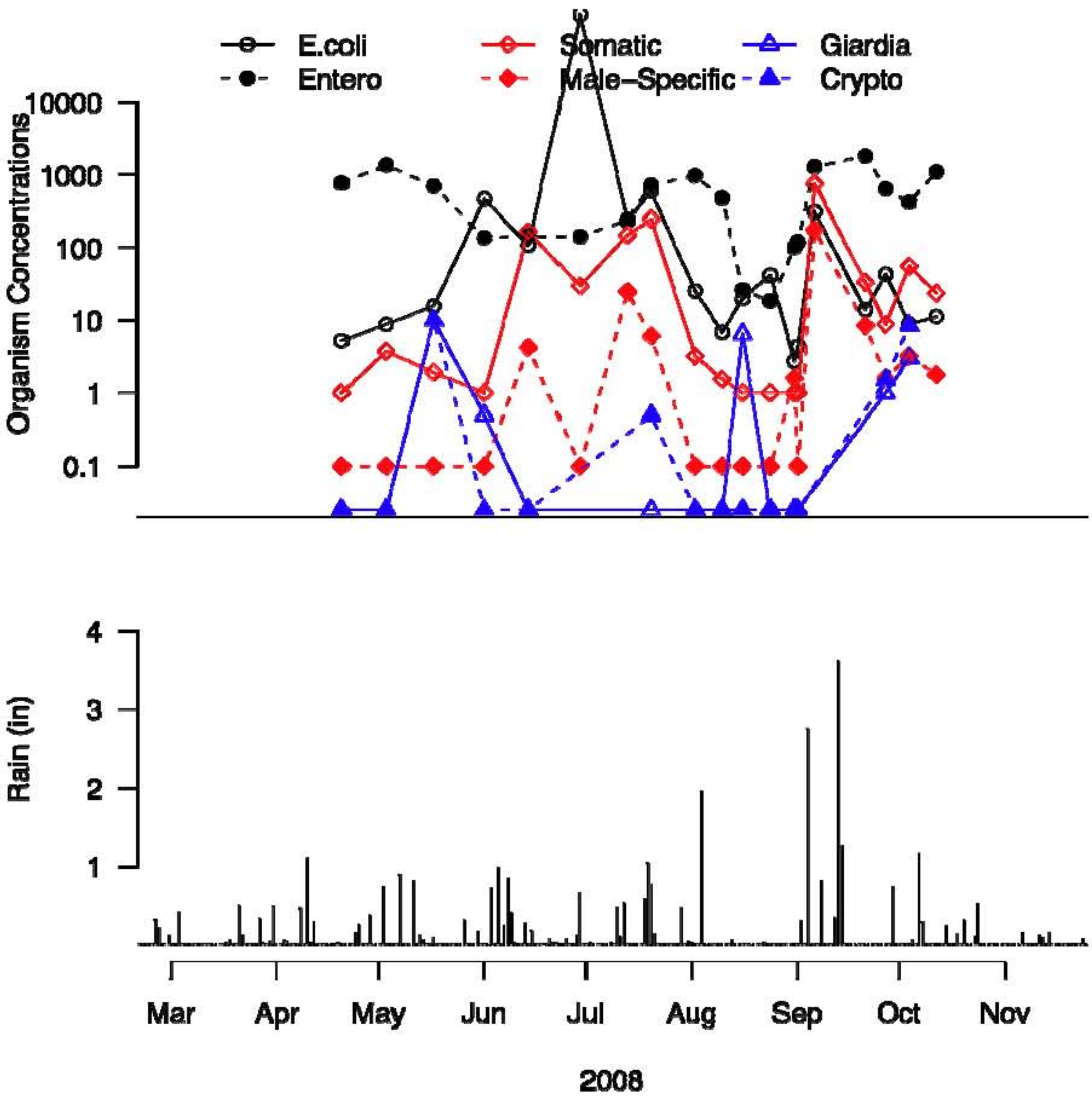

E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2009

Figure II-10. Time trends in microorganism densities at Skokie Lagoons (SL), with daily precipitation indicated below, by year. Points indicate dates of measurement.

(a) 2007



(b) 2008


E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2008

(c) 2009

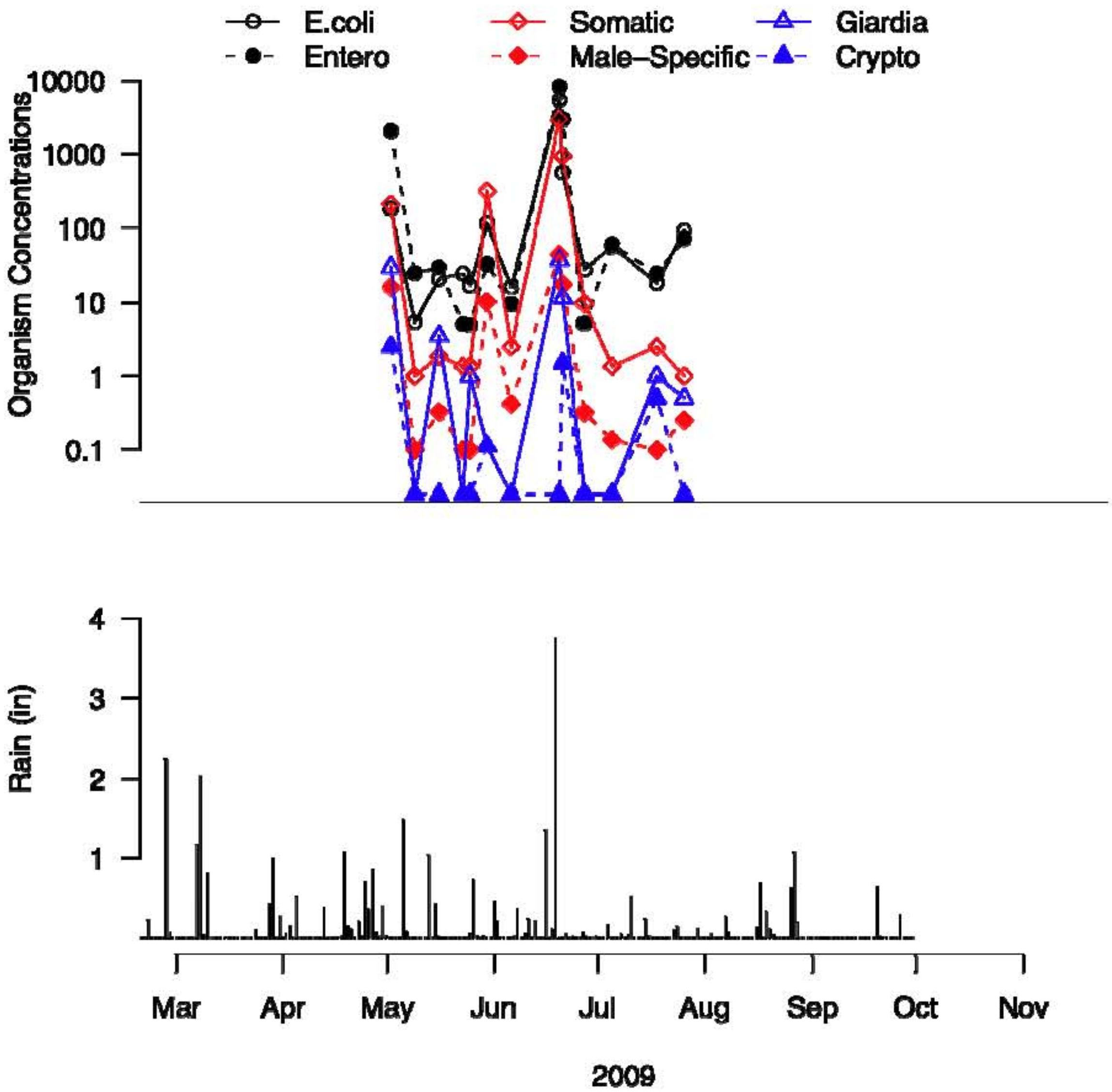
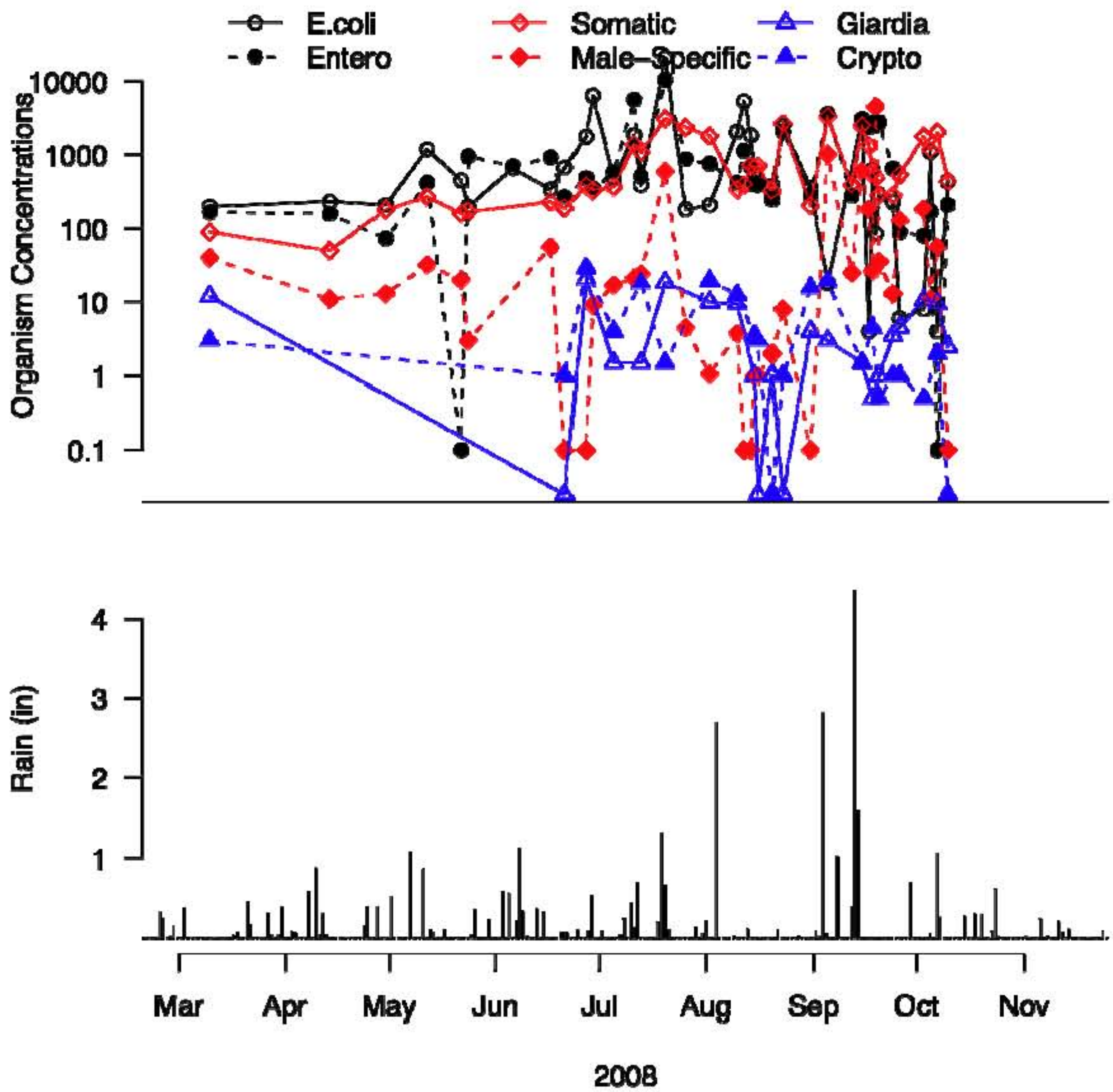
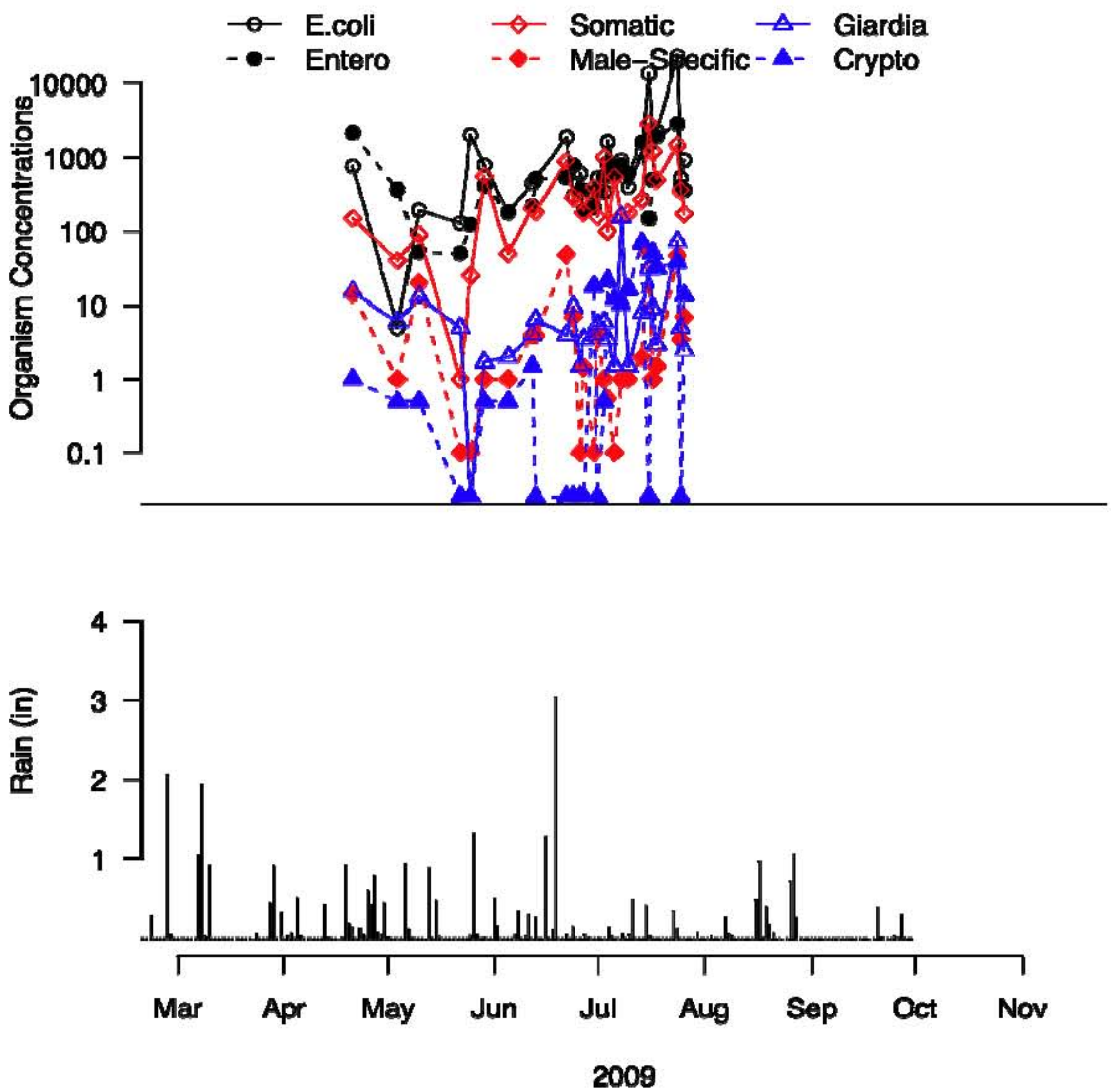

E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2009

Figure II-11. Time trends in microorganism densities at North Branch Dam (NBD) , with daily precipitation indicated below, by year. Points indicate dates of measurement.

(a) 2008



(b) 2009


E.coli
Entero
Somatic
Male–Specific
Giardia
Crypto
Organism Concentrations
10000
1000
100
10
1
0.1
Rain (in)
4
3
2
1
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
2009