BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	
EFFLUENT LIMITATIONS FOR THE	)	R08-9
CHICAGO AREA WATERWAY SYSTEM	)	(Rulemaking – Water)
AND THE LOWER DES PLAINES RIVER:	)	
PROPOSED AMENDMENTS TO 35 ILL..	)	
ADM. CODE PARTS 301, 302, 303 and 304	)	

NOTICE OF FILING

To: see attached Service List

PLEASE TAKE NOTICE that on the 4th Day of August, 2008, I filed with the Office of the Clerk of the Illinois Pollution Control Board the attached Prefiled Testimony of Marylynn V. Yates, Ph.D., a copy of which is hereby served upon you.

PLEASE TAKE FURTHER NOTICE that pursuant to 35 Ill. Admin. Code 102.424(c), Natural Resources Defense Council moves for a waiver of service requirements for Exhibits 2 and 5. Exhibit 2 is an Excel spreadsheet containing 5 megabytes of information; is impossible to copy onto 81/2 X 11 paper; and is 434 pages long when printed. Exhibit 7 is a CD-Rom of the video presentation, containing more than 2 gigabytes of information. Both exhibits would be very costly to copy and send to all participants on the service list.

Ann Alexander

By: _____
Ann Alexander, Natural Resources Defense Council

Dated: August 4, 2008

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CERTIFICATE OF SERVICE

I, Ann Alexander, the undersigned attorney, hereby certify that I have served the attached Prefiled Testimony of Marylynn V. Yates on all parties of record (Service List attached), by depositing said documents in the United States Mail, postage prepaid, from 227 W. Monroe, Chicago, IL 60606, before the hour of 5:00 p.m., on this 4th Day of August, 2008.

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Adm. Code Parts 301, 302, 303, and 304	)	

TESTIMONY OF DR. MARYLYNN V. YATES

I. Introduction and summary

My name is Dr. Marylynn V. Yates. I appreciate the opportunity to testify today on behalf of Natural Resources Defense Council, Environmental Law and Policy Center, Sierra Club – Illinois Chapter, Friends of the Chicago River, and Openlands in support of the water quality standards regulations proposed by the Illinois Environmental Protection Agency ("IEPA") requiring disinfection of effluent discharged to the Chicago Area Waterway System ("CAWS") from the wastewater treatment plants ("WWTPs") operated by the Metropolitan Water Reclamation District ("MWRD").

My testimony today is based upon my nearly 25 years of experience in the field of microbiology, in which my sub-specialty is waterborne pathogen contamination; as well as review of microbial sampling data, risk studies, and other data specifically pertinent to the CAWS. From my years of experience, I know that disinfection of WWTP effluent is fundamental to public health whenever there is any appreciable human contact with the receiving waterbody; and that such disinfection is standard practice in both major cities and many smaller communities across the United States. From my review of data pertinent to the CAWS, including submissions from MWRD in connection with the use attainability analysis ("UAA") process preceding the IEPA rulemaking, it is clear to me that the CAWS is no exception. Continued failure to disinfect sewage effluent discharged to the CAWS may result in a substantial and unnecessary risk to public health.

Specifically, I have found as follows:

- Dry-weather pathogen contamination comes from WWTPs. The CAWS contains measurable human pathogen levels during dry-weather conditions, which are largely attributable to WWTP effluent discharge. Disinfection of WWTP effluent discharged to the CAWS would thus reduce pathogen loads, and the concomitant human health risks associated with exposure to those pathogens, during dry weather.
- Dangerous human pathogens are very likely present in the CAWS. The levels of indicator bacteria present in the CAWS downstream of the WWTP outfalls are very strong evidence of the presence of high levels of human fecal material, which likely contains human

pathogens. There are hundreds of different types of pathogens that can be present in sewage-contaminated wastewater, many of which can cause multiple types of serious illnesses – particularly in sensitive populations such as children, pregnant women, the elderly, and immunocompromised individuals (e.g., people undergoing chemotherapy).

- Previous research shows risk to recreational users. Previous studies of waterbodies with much lower concentrations of indicator bacteria than the CAWS have demonstrated risk to recreational users from waterborne pathogens, even absent primary contact (swimming/intentional immersion) use.
- Current efforts to re-evaluate pathogen indicator criteria have no bearing on the question of effluent disinfection. Although the current federal criteria for pathogen indicators are imperfect and currently undergoing revision, the outcome of this revision process will almost certainly not lead to a conclusion that disinfection of MWRD WTTP effluent is unnecessary or inappropriate. The revision is taking place out of concern that the current criteria are insufficiently protective, such that any new standard that emerges will likely be more protective of public health, not less so.
- MWRD's risk assessment has numerous flaws. The wet and dry weather risk assessment performed by MWRD's subcontractor, Geosyntec consultants, is rife with large and small analytical errors that create a strong bias toward its conclusion of no significant risk to CAWS recreators. Among other things, the risk assessment evaluates only a small fraction of the human pathogens typically associated with sewage-contaminated wastewater, and only one of many types of illness generally associated with such pathogens.
- MWRD's epidemiological study is not a sufficient tool to assess the need for disinfection. Regardless of its outcome several years from now, the epidemiological study being conducted by MWRD concerning recreational use of the CAWS will not be sufficient basis for a decision whether disinfection is necessary.

II. Qualifications

A copy of my curriculum vitae is attached as Exhibit 1.

I am an expert in environmental microbiology. My research is concentrated in the area of water and wastewater microbiology, focusing in particular on assessing the potential for the contamination of water by human pathogenic microorganisms. Among other things, I have done substantial work concerning identification of waterborne pathogens, assessing the potential for human pathogen contamination of water bodies (through use of indicator bacteria and other methods) and fate and transport of such pathogens and indicator microorganisms in the environment. I also have experience in the area of environmental microbial risk assessment, and have personally been involved with the United States Environmental Protection Agency ("USEPA") in the development of methods for indicator microorganisms, specifically methods 1601 and 1602, which are used for the detection of bacteriophages.

I received my Ph.D. in 1984 from the University of Arizona, and am currently a Professor of Environmental Microbiology at University of California, Riverside. I also serve as statewide Program Leader for Natural Resources and Animal Agriculture in the Division of Agriculture and Natural Resources of the University of California system. I have additionally served as

Chair of the Department of Environmental Sciences, and as Associate Executive Vice Chancellor at the University of California, Riverside.

I have published more than 50 peer-reviewed scholarly articles in my field, and written or contributed to 6 books. The articles include the following:

- Rose, J.R., R.L. Mullinax, S.N. Singh, M.V. Yates and C.P. Gerba. 1987. Occurrence of rota and enteroviruses in recreational waters of Oak Creek, Arizona. *Water Research* 21:1375-1381.
- Anderson, M. A., M.H. Stewart, M.V. Yates, and C.P. Gerba. 1998. Modeling the impact of body-contact recreation on pathogen concentrations in a source drinking water reservoir. *Water Research* 32:3293-3306.
- Stewart, M.H., M.V. Yates, M.A. Anderson, C.P. Gerba, J.B. Rose, R. DeLeon, and R.L. Wolfe. 2002. Predicted public health consequences of body-contact recreation on a potable water reservoir. *J. Amer. Water Works Assoc.* 94:84-97.
- Davis, K., M.A. Anderson, and M.V. Yates. 2005. Distribution of indicator bacteria in Canyon Lake, California. *Wat. Res.*, 39:1277-1288.
- Yates, M.V., J. Malley, P. Rochelle, and R. Hoffman. 2006. Effect of adenovirus resistance on UV disinfection requirements – a report on the state of adenovirus science. J. Amer. Wat. Works Assoc., 98(6):93-106.
- Yates, M.V. 2007. Classical Indicators in the 21st Century -- Far and Beyond the Coliform. *Wat. Environ. Res.* 79(3):279-286.

The books include the following:

- Committee to Improve the U.S. Geological Survey National Water Quality Assessment Program. 2002. Opportunities to Improve the U.S. Geological Survey National Water Quality Assessment Program. National Academy Press, Washington, DC. 238 pp.
- Committee on Indicators for Waterborne Pathogens. 2004. Indicators for waterborne pathogens. National Academies Press, Washington, D.C. 315 pp.

I have participated in numerous expert workshops, including the following:

- Invited participant, Workshop on Indicators for Pathogens in Wastewater, Stormwater, and Biosolids, Water Environment Research Foundation, San Antonio, TX, December 11-12, 2003
- Invited participant, Models and Tools for Including Susceptibility, Immunity, and Secondary Spread into Microbial Risk Assessment Workshop, Cincinnati, OH, November 18-19, 2004
- Invited participant, Major Accomplishments and Future Directions in Public Health Microbiology Workshop, United States Geological Survey, Columbus, OH February 15 - 18, 2005.
- Invited participant, Pathogens in Groundwater Experts Workshop. Toronto, Ontario, Canada, June 5-6, 2006.

I have given dozens of invited presentations, including the following:

- The Framework. Microbial Risk Factor: Recommendations to the USEPA on the Process pf Determination of Microbial Standards in Drinking Water, Water Quality Technology Conference, Salt Lake City, UT, November 7, 2000.
- Body-Contact Recreation: Microbial Health Risks. American Water Works Association conference on Source-Water Protection. Las Vegas, NV, January 27, 2002
- Interpreting Results from Emerging and Traditional Methods for Detection of Microorganisms, Major Accomplishments and Future Directions in Public Health Microbiology Workshop, United States Geological Survey, Columbus, OH, February 16, 2005
- Microorganisms in water: quantitative risk assessment, School of Engineering, Mathematics, and Science, Purdue University Calumet, Hammond, IN, July 6, 2005
- Waterborne Viruses: Types, Health Effects, and Detection Methods. Viruses in Water Symposium, Walkerton Clean Water Center, Toronto, Ontario, Canada, October 26, 2006
- Keynote Speaker. Adenoviruses and Ultraviolet Light: an Introduction. Adenovirus and UV Disinfection session. World Congress on Ozone and Ultraviolet Technologies, Los Angeles, California USA. August 27-29, 2007

I have served on numerous scientific panels and professional and scientific committees, including the following:

- Expert Advisory Panel, Canadian Water Network Consortium on Pathogens and Groundwater, 07-present
- Member, project advisory committee, Challenge organisms for inactivation of viruses by ultraviolet treatment, American Water Works Association Research Foundation—06-present
- Member, Committee on Indicators of Waterborne Pathogens, National Research Council – 02-04

I also serve as an Editor for *Applied & Environmental Microbiology*, handling more than 150 manuscripts per year. In addition, I have reviewed numerous scientific manuscripts for other scholarly journals, and have served as a grant proposal reviewer (ad hoc and on governmental panels), and have served as a reviewer and consultant in numerous other capacities.

III. Documents reviewed

I have reviewed, inter alia, the following documents concerning the CAWS in connection with this testimony:

- The UAA final report, previously submitted as evidence in this proceeding.
- MWRD CAWS monitoring data available on MWRD's web site, http://www.mwrdgc.dst.il.us/.

- The MWRD pathogen sampling data compiled by USEPA Region 5 in connection with its Urban Rivers analysis, submitted separately as Exhibit 2.[1]
- The charts summarizing MWRD pathogen sampling data prepared by USEPA Region 5 (the "USEPA Graphs"), attached as Exhibit 3.
- The Dry and Wet Weather Risk Assessment of Human Health Impacts of Disinfection or No Disinfection of the Chicago Area Waterway System (CWS)" prepared by Geosyntec Consultants (the "Risk Assessment"), available on MWRD's web site, http://www.mwrdgc.dst.il.us/.
- Review of the Risk Analysis by USEPA ("USEPA Review"), attached as Exhibit 4.
- A videotape and powerpoint slides from an oral presentation by Dr. Sam Dorevich of the University of Illinois at Chicago ("UIC") School of Public Health on February 27, 2008 concerning the epidemiological study being conducted by UIC on behalf of MWRD (the "Epidemiological Study"). The powerpoint slides are available on MWRD's web site, http://www.mwrdgc.dst.il.us/. The videotape is submitted separately as Exhibit 5.[2]

In addition, I have conducted a literature search for peer-reviewed scientific publications concerning pathogen risk to non-primary contact recreational waterway users.

IV. MWRD WWTPs are the Predominant Dry Weather Pathogen Source

I have concluded from the documents I have reviewed in this matter that the MWRD WWTPs are the largest source of pathogens in the CAWS during dry weather (excluding the few days immediately following a wet weather event when there may be lingering pathogen contamination from combined sewer overflows ("CSOs")). Accordingly, disinfection of WWTP effluent would greatly reduce pathogen contamination of the CAWS during dry weather.

A. MWRD Sampling Data Reflect WWTP Effluent as the Primary Source of Pathogens During Dry Weather

As stated in the final UAA report and the Risk Assessment, the CAWS is heavily effluent dominated, with approximately 70 percent of the flow on dry days coming from the MWRD WWTPs. Logically speaking, given this effluent domination and the absence of CSOs during dry weather, pathogens in the WWTP effluent will be the predominant source of pathogens in the waterway. This logical inference is borne out by the available data.

The presence of pathogens is generally assessed by testing for indicator bacteria – i.e., types of bacteria that are typically not pathogenic (disease-causing), but which signal the presence of fecal contamination, and thus the likely presence of at least some pathogens. The most commonly-used indicator bacteria, for purposes of regulation and recreational closing

[1] Counsel note -- Natural Resources Defense Council has filed a copy of Exhibits 2 and 5 with the Board, and moves for a waiver of service requirements upon hearing participants pursuant to 35 Ill. Admin. Code 102.424(c), as indicated in the Notice of Filing.

[2] Please see footnote 1.

determinations, are total and fecal coliforms and *E. coli*; enterococci are also used. Generally speaking, there are a number of potential contributors of indicator bacteria to water. These include wastewater, direct inputs of human fecal material, and animals, both domestic and wild. The same is true for several bacterial pathogens (e.g., *Salmonella, Campylobacter*), as well as certain species of *Giardia* and *Cryptosporidium*. This is not typically the case for the human viruses (*e.g.*, enteroviruses, human adenoviruses), which are typically species-specific.

The indicator bacteria sampling data collected by MWRD in the CAWS indicates a strong pattern during dry weather of high levels of bacterial contamination at the plant outfall, which drops gradually as the effluent travels downstream. For example, monitoring data from the North Shore channel and North Branch Chicago River show that the fecal coliform concentrations are lower (<2000 cfu/100 ml) upstream of the Northside treatment plant, increase to more than 19,000 cfu/100 ml at the discharge point from the plant, then remain above the upstream concentrations for at least 6.75 miles. A similar trend is observed in the Little Calumet River and Cal-Sag River: upstream fecal coliform concentrations are below 200 cfu/100 ml, the concentration increases to more than 8,000 cfu/100 ml at the discharge point from the Calumet plant, and the concentration remains above the upstream levels for at least 6.3 miles downstream.

This pattern is visible in the following USEPA Graphs, for the CAWS regions near the Northside and Calumet WWTPs, respectively:

FIGURE 1: NORTHSIDE REGION SAMPLING DATA

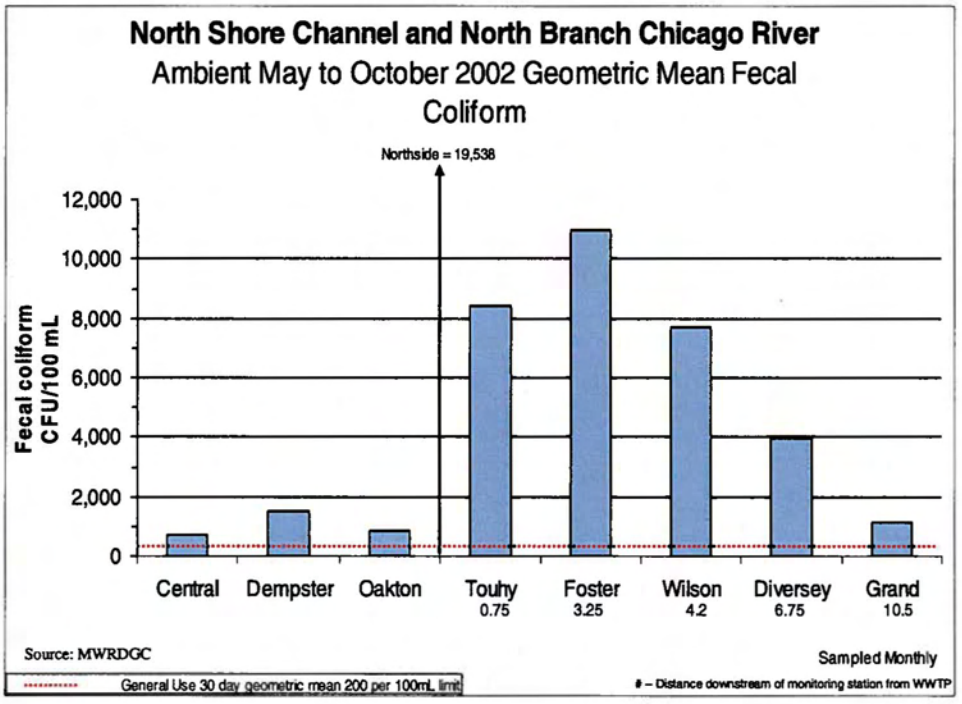
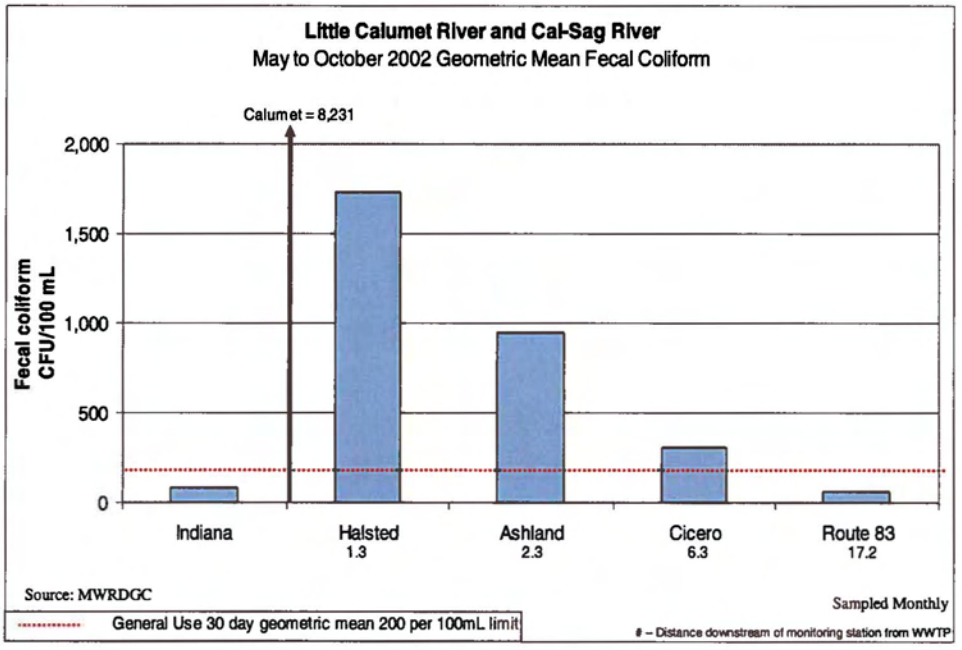


FIGURE 2: CALUMET REGION SAMPLING DATA



As illustrated, the level of indicator bacteria at the sites upstream of the WWTP outfalls is low, increases to very high levels at the WWTP outfall, and declines downstream of the outfall.

In addition, many of the dry weather analyses in the CAWS for human viruses – which, as noted above, are typically species specific and cannot be attributed to animal sources such as seagulls and other wildlife – frequently showed higher levels of pathogens at the WWTP outfalls as compared with the upstream levels. For example, on 8/18/05 and 8/25/05 (the only dates on which measurable concentrations of "enteric"[3] viruses were detected) at the Northside site, the concentrations were <1 MPN/100L and 1.04 MPN/100L at the upstream surface sites, and 2.12 MPN/100L and 16.07 MPN/100L at the downstream sites.

If the major dry-weather contributor of fecal coliforms were animal sources – e.g., seagulls and other wildlife – one would expect that the concentration would be relatively consistent upstream and downstream of the treatment plant. Where, as here, that is not the case,

[3] The method used detects viruses that are culturable on the specific cell line used, in this case the BGM cells. The use of the term "enteric viruses" is not an accurate characterization of the analyses performed, but is the term used in the Geosyntec report; thus its use here..

it is more likely than not that the high concentrations of fecal coliforms are due to inputs from the wastewater treatment plant.

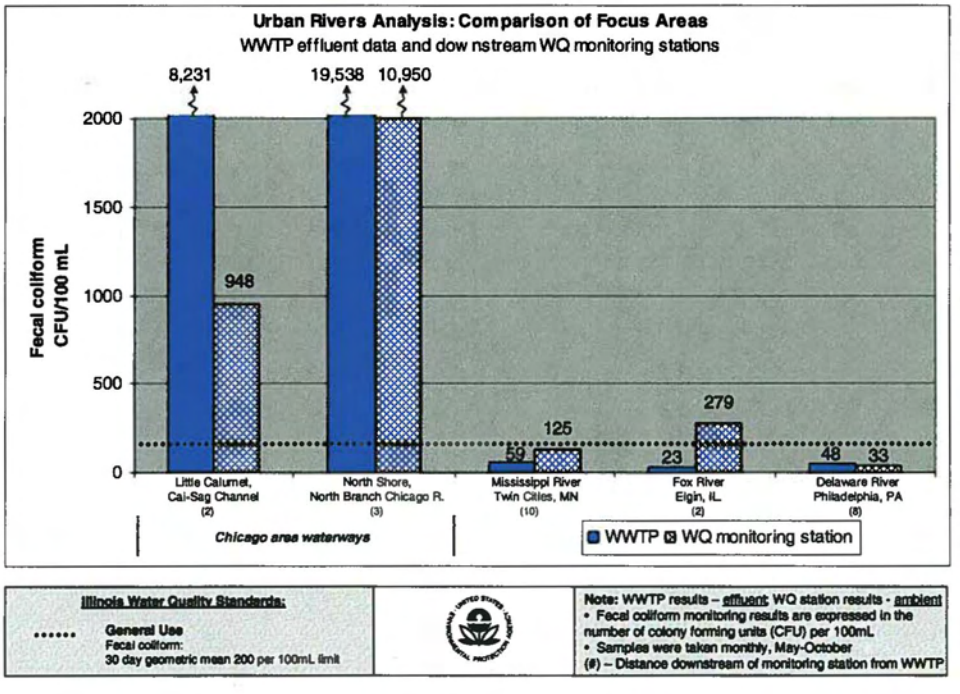
B. Disinfection of WWTP Effluent Would Substantially Reduce CAWS Pathogen Loading During Dry Weather

Since MWRD WWTP effluent is the primary source of pathogens in the CAWS during dry weather, disinfection of that effluent will substantially reduce CAWS dry weather pathogen loading. Conventional WWTPs that do not disinfect their effluent, such as those discharging to the CAWS, are not specifically designed to reduce the number of human-excreted pathogens, including excreted viruses; it is the disinfection step that is specifically designed to decrease pathogen concentrations (Oragui, 2003). Although disinfection affects different organisms to different degrees, and different disinfectants may be more or less effective for each, broadly speaking disinfection greatly reduces effluent pathogen levels. Indeed,

> "Disinfection is an essential and final barrier against human exposure to disease-causing pathogenic microorganisms, including viruses, bacteria, and protozoan parasites. Chlorination was initiated at the beginning of the twentieth century to provide an additional safeguard against pathogenic microorganisms. The destruction of pathogens and parasites disinfection helped considerably in the reduction of waterborne and food-borne diseases." (Bitton, 2005)

The effectiveness of disinfection in reducing indicator bacteria loads is well illustrated by USEPA's Urban Rivers analysis, prepared by USEPA Region 5, which compared indicator bacteria levels in the CAWS with levels in urban waterbodies where effluent disinfection is required. The results are set forth in Figure 3 below:

FIGURE 3: URBAN RIVERS ANALYSIS



While the concentrations of pathogens were not measured, as noted above, it is generally true that the greater the numbers of indicator microorganisms present in the water, the greater the number of pathogens present as well (Committee on Indicators for Waterborne Pathogens. 2004). In each of the three communities studied that practice disinfection described in this chart, levels of bacteria in the WWTP effluent were much lower than the 200 colonies/100 ml general use/primary contact standard (represented by the dotted line), and downstream fecal coliform levels rose only slightly higher from other urban sources (CSOs, wildlife, etc.), only in one case marginally higher than the general use standard.

I note also that disinfection is longstanding standard practice in most major metropolitan areas in the U.S., and is implemented in many smaller communities as well (occasionally with limitations based on season or other factors). Chicago is very much an outlier in implementing this basic public health precaution that has long been in place elsewhere.

V. The Sampled Levels of Indicator Bacteria Show a Likely Presence of Dangerous Pathogens

A. Types of Waterborne Pathogens Associated with Sewage

Effluent from WWTPs treating human sewage can potentially contain more than 100 different types of waterborne pathogens that can cause illness in humans. These pathogens can include bacteria, viruses, and parasites. A list of types of human pathogens that can be transmitted through ingestion of or contact with water can be found in Exhibit 6 (Moe, 2007). The majority of these organisms are associated with fecal material, although there are some exceptions (e.g., *Legionella*).

Some of the more harmful and/or prevalent types of human pathogens associated with fecal material, and therefore present in domestic sewage, are as set forth in Table 1 below:

TABLE 1: HUMAN PATHOGENS ASSOCIATED WITH FECAL MATERIAL

Organism	Disease	Comments
Adenovirus	respiratory illness, conjunctivitis, vomiting, diarrhea	Highly resistant to disinfection using standard UV light; used by EPA as the basis of the UV disinfection requirements in LT2ESWTR[4]. On EPA's Drinking Water Contaminant Candidate List 2.
Coxsackie A and B viruses	meningitis, fever, herpangina, respiratory illness, myocarditis, congenital heart anomalies, rash, fever, pleurodynia	Non-polio enteroviruses are estimated to cause 10-15 million symptomatic infections per year in the U.S.[5] On EPA's Drinking Water Contaminant Candidate List 2

[4] Long-Term 2 Enhanced Surface Water Treatment Rule.

[5] All numbers of cases per year cited in this table are total numbers of cases reported. Not all such cases are attributable to water.

Echoviruses	meningitis, encephalitis, respiratory illness, rash, diarrhea, fever	Non-polio enteroviruses are estimated to cause 10-15 million symptomatic infections per year in the U.S. On EPA's Drinking Water Contaminant Candidate List 2.
Hepatitis A virus	infectious hepatitis	Among the more persistent waterborne viruses. High degree of asymptomatic infections in children. Greatest danger of spreading the disease to others occurs well before the onset of symptoms. On EPA's draft Drinking Water Contaminant Candidate List 3.
Norovirus	vomiting and diarrhea	Estimated to cause 23 million cases of illness per year in the U.S.; illness is relatively mild and short-lived. No method to detect infective viruses has been established. On EPA's draft Drinking Water Contaminant Candidate List 3.
Rotavirus	diarrhea, vomiting	Major cause of diarrhea in young children; causes more than 3 million cases of illness per year in the U.S. Significant cause of childhood death in developing countries (~1 million/year). Excreted in very high numbers in feces (~10 billion/gram).
Salmonella	typhoid, paratyphoid, salmonellosis	The most predominant bacterial pathogens in wastewater; ~0.1% population are healthy carriers and excrete it in their feces. Causes 2-4 million cases of illness per year in the U.S. *Salmonella enterica* is on EPA's draft Drinking Water Contaminant Candidate List 3.
Shigella	bacillary dysentery	Principally a disease of humans. Has relatively low infectious dose relative to most enteric bacteria (~10 organisms). Causes ~300,000 cases of illnesses per year in the U.S. *Shigella sonnei* is on EPA's draft Drinking Water Contaminant Candidate List 3.

pathogenic *E. coli*	gastroenteritis, hemolytic uremic syndrome	Some strains cause hemolytic uremic syndrome, and may lead to permanent kidney damage or mortality. Young children and the elderly appear more susceptible to severe illness. *E. coli* O157:H7 is on EPA's draft Drinking Water Contaminant Candidate List 3.
Campylobacter	gastroenteritis	Causes ~4 millions cases/year in U.S. Infection may lead to Guillain-Barré syndrome, an acute paralytic illness. *Campylobacter jejuni* is on EPA's draft Drinking Water Contaminant Candidate List 3.
Vibrio	cholera	This disease is endemic in certain areas (e.g., Asia, Bangladesh), and causes epidemics as well, but is relatively rare in the U.S. *Vibrio cholerae* is on EPA's draft Drinking Water Contaminant Candidate List 3.
Giardia lamblia	diarrhea, malabsorption	Domestic and wild animals are reservoirs. May be most frequent cause of non-bacterial diarrhea in North America. Relatively long incubation period (1-8 weeks). Infection may last months, but is rarely fatal. Regulated by EPA as a drinking water contaminant.
Cryptosporidium	diarrhea	Caused largest documented waterborne disease outbreak in U.S. history (>400,000 illnesses, 100 deaths). Particularly severe in immunocompromised populations. Relatively resistant to removal by traditional drinking water treatment processes. Regulated by EPA as a drinking water contaminant.

While the concentrations of pathogens may be reduced incidentally during primary and secondary sewage treatment processes, disinfection is specifically designed to decrease the concentrations of pathogenic microorganisms, as discussed above.

As noted in the table, many waterborne pathogens are considerably more dangerous for members of sensitive populations, i.e. those whose age or physical condition make them more vulnerable to infection. These sensitive populations include, among others, children, the elderly, pregnant women, and immunocompromised persons (including people undergoing chemotherapy or taking organ transplant anti-rejection medication).

B. Multiple Exposure Pathways From Non-Primary Contact Use

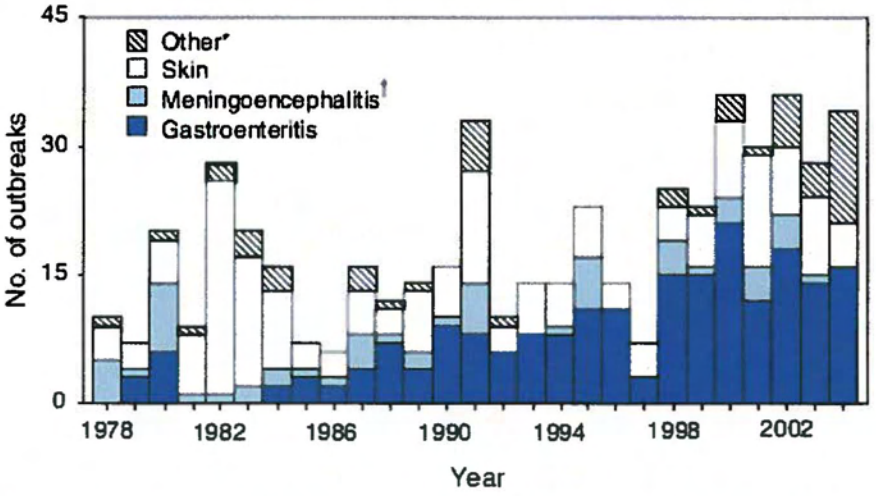
There are multiple ways that non-primary contact users of a waterway can be exposed to waterborne pathogens that may be present there. Water may be ingested in large amounts – e.g., resulting from accidental immersion and associated involuntary gulping – or small amounts – e.g., from eating food with wet hands, or small children with high levels of hand- to- mouth contact. Water droplets may also be inhaled, or may be absorbed through the skin – particularly when there are skin cuts and abrasions present. Infections may also result from the exposure of mucous membranes to contaminated water, causing eye infections (i.e., conjunctivitis), for example.

Illnesses associated with contact with water vary depending on type of contact (ingestion, inhalation, skin contact) and specific organism(s) to which exposure occurs. Ingestion can result in gastroenteritis, which may be caused by numerous organisms (such as those in the table above); inhalation can result in respiratory infections, caused by organism such as adenoviruses; skin contact can result in dermatitis, conjunctivitis, and otitis.

The chart below (CDC,2006) summarizing recreational water-associated outbreaks illustrates the distribution of various types of illnesses (gastroenteritis, skin infections, respiratory infections, etc.) for the past 26 years:

FIGURE 4: CDC SUMMARY OF RECREATIONAL WATER-ASSOCIATED OUTBREAKS

Number of recreational water-associated outbreaks (n = 508), by year and illness — United States, 1978–2004



* Includes keratitis, conjunctivitis, otitis, bronchitis, meningitis, hepatitis, leptospirosis, Pontiac fever, acute respiratory illness, and combined illnesses.

† Also includes data from report of ameba infections (**Source:** Visvesvara GS, Stehr-Green JK. Epidemiology of free-living ameba infections. J Protozool 1990;37:25S–33S).

Note that gastroenteritis, associated with the ingestion exposure pathway, is not always the cause of the majority of water recreation-associated outbreaks.

C. High Levels of Indicator Bacteria Signal the Presence of High Levels of Pathogens

High levels of indicator bacteria, while not providing information regarding the presence of specific types of pathogens, are generally correlated with a higher overall level of pathogens, as stated above. My review of MWRD sampling data indicates a level of indicator bacteria – both fecal coliform and *E.coli* – signaling the likely presence of human pathogens in the CAWS, with the potential to cause illness to recreational users.

As a frame of reference, Illinois' standard for general use waterways – i.e., those in which primary contact is permitted – is 200 fecal coliform colony-forming units ("cfu")/100 ml (generally associated with the 400 cfu/100 ml for effluent discharge as proposed in the IEPA rulemaking). USEPA has in recent years informally applied a standard of 5 times the primary contact standard (sometimes as high as 10 times), or 1000 cfu/100 ml– in evaluating proposed state standards for recreational waters in which non-primary contact recreation takes place. (See Exhibit 7 (EPA, 2002). By contrast, the MWRD sampling in the CAWS near its outfalls reveals indicator bacteria levels that can be more than ten times higher than these benchmarks. See the Northside Ambient Chart and Calumet Ambient Chart in the previous section, indicating geometric mean fecal coliform concentrations in the Northside and Calumet effluent at levels of 19,538 and 8,231 cfu/100 ml respectively; and ambient levels at the nearest downstream monitoring station of > 8,000 and > 1,500, respectively. Note also the red horizontal line toward the bottom of each chart, representing the primary contact use standard of 200 cfu/100 ml.

Many times, concentrations are reported as a geometric mean. This means that there were times when the indicator bacteria concentrations were higher. The following USEPA Graphs (Figure 5 pertaining to Northside, Figure 6 pertaining to Calumet) representing the level of fecal coliform in the effluent at the Northside and Stickney WWTPs during the period reflected in the Northside and Calumet Ambient Charts illustrate the importance of this point:

FIGURE 5: NORTHSIDE WWTP EFFLUENT

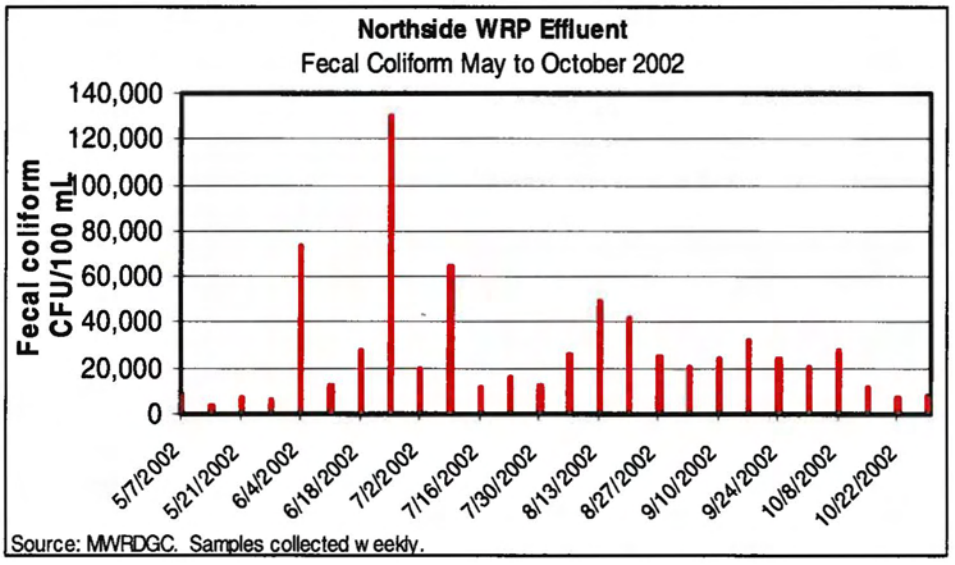
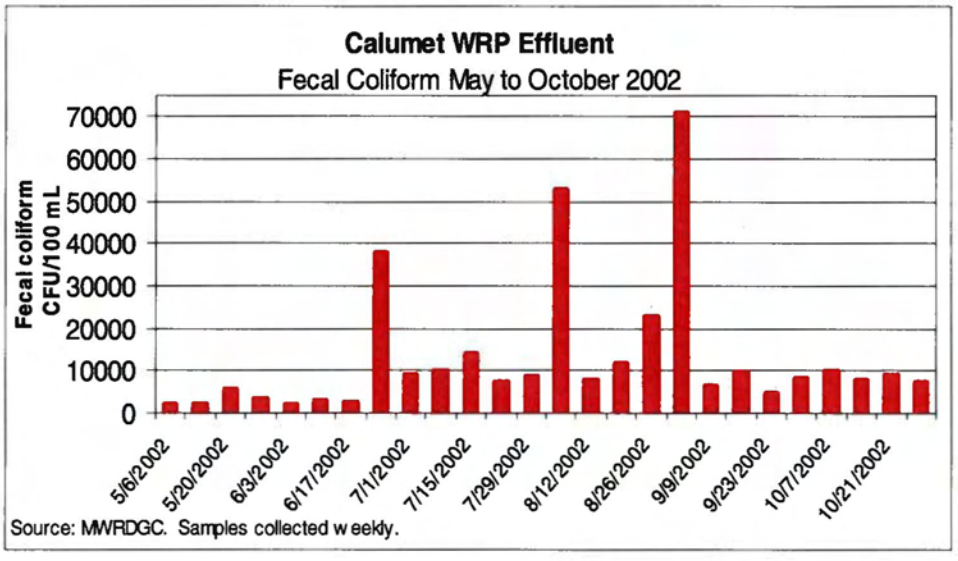


FIGURE 6: CALUMET WWTP EFFLUENT



The geometric mean concentration of fecal coliforms in the Northside effluent during this period was 19,538 cfu/100 ml. Note that fecal coliform bacteria levels in the Northside effluent exceeded 40,000 cfu/100 ml on several occasions, and exceeded120,000 cfu/100 ml in June. The

geometric mean concentration in the Calumet effluent was 8231 fecal coliforms/100 ml, and the levels in the Calumet effluent at times exceeded 70,000 cfu/100 ml. Thus, recreators present on the CAWS during those times potentially would have been exposed to substantially higher levels of fecal contamination, and by inference, higher levels of pathogenic microorganisms, than the levels that are reflected by the geometric mean fecal coliform numbers.

Finally, while I am aware that primary contact recreation is not one of the uses that IEPA has proposed for the CAWS, I note that the levels of indicator bacteria – both fecal coliform and *E.coli* - in the CAWS are far higher than the threshold at which bathing beaches are closed. Illinois' indicator bacteria criteria, consistent with the USEPA's water quality criteria, are generally used to require that bathing beaches be closed when levels of *E. coli* reach 235 per 100 ml.

D. Reports of Illness or Disease Outbreaks are Not a Good Measure of Risk

Many of the symptoms caused by the types of pathogenic microorganisms associated with undisinfected sewage effluent are extremely common and have multiple causes – for example, diarrhea or skin rashes. Infected persons may not attribute their illness to water contact at all, and hence would not report it as a waterborne illness. Additionally, most people would not seek medical care if they experience a mild case of diarrhea.

Thus, causes of these symptoms are difficult to trace, and even large-scale outbreaks can go undetected, because treating physicians and their patients are often unlikely to report such symptoms to public health authorities. Even the largest waterborne disease outbreak in U.S. history -- in Milwaukee in 1993 caused by drinking water contaminated with *Cryptosporidium*-containing raw and unreated water and ultimately sickening 400,000 people and resulting in the deaths of dozens of people – went undetected for a substantial amount of time. In fact, one of the first signs of the outbreak in Milwaukee was newspaper reports that local pharmacies had sold out of antidiarrheal medications (Debjani et al., 2005), illustrating the difficulties of detecting even a massive outbreak.

Complicating the matter further is that exposure to a microorganism doesn't always result in clinical illness. The ratio of clinical illness to asymptomatic infections can be quite low. For example, less than 30% of children infected with rotavirus show clinical signs of illness, and only 12.5% of adults infected with astroviruses show clinical signs of illness (Gerba and Rose, 1993). Individuals suffering from asymptomatic infections may well infect others, and those secondary infections may be symptomatic. However, it is unlikely that those secondary infections will be traced to contact with a contaminated waterway, because the symptomatic individuals will not report having been in contact with water, or with someone who was in contact with the water.

VI. Previous Research Shows Risk from Pathogens to Recreational Users

In preparation for this testimony, I conducted a search of the peer-reviewed scientific literature for epidemiological studies and risk assessments concerning recreational users of pathogen-contaminated waterbodies. The studies shown in Table 2 are among those finding a

higher risk of health effects to limited-water contact recreational users of waters than to those who were not exposed to the water. It is important to note that the concentrations of fecal coliforms in some of the cases (e.g., DeWailly et al., 1986; Fewtrell et al., 1992) were much lower than those that have been measured in the CAWS. It is also notable that the relative risk of adverse health effects were higher in the individuals who were exposed to water in which the concentrations of fecal coliforms were higher, and enteric viruses were detected (Fewtrell et al., 1992).

TABLE 2. STUDIES OF RISKS TO RECREATORS

Activity	Number of subjects	Microbial Concentration	Comments	Risks	Reference
windsurfing	79 competitors 41 controls	fecal coliforms: 1000/100 ml (estimated)	competitors and non-competitors were followed for 9 days for occurrence of gastrointestinal, wound, skin, ear, and eye infections	Competitors were 2.9 times more likely to have at least 1 symptom of an adverse health effect, and 6.9 times more likely to experience diarrhea, than non-exposed individuals	DeWailly et al.,1986
white-water canoeing	146 canoeists 173 controls	fecal coliforms:285/100 ml (geometric mean) enteroviruses: 198 pfu/10 L	canoeists and non-canoeists were followed for 28 days for occurrence of gastrointestinal, respiratory, skin, ear, and eye infections	Canoeists were 2.04 times more likely to have at least 1 symptom of an adverse health effect, and 4.25 times more likely to experience gastrointestinal illness, than non-exposed individuals	Fewtrell et al., 1992
white-water canoeing	206 canoeists 173 controls	fecal coliforms:22/100 ml (geometric mean) enteroviruses: 0/10 L	canoeists and non-canoeists were followed for 28 days for occurrence of gastrointestinal, respiratory, skin, ear, and eye infections	Canoeists were 1.28 times more likely to have at least 1 symptom of an adverse health effect, and 1.43 times more likely to experience gastrointestinal illness, than non-exposed individuals	Fewtrell et al., 1992
canoeing	577 canoeists 207 controls	not reported	examined blood samples for evidence of immune response following exposure to waterborne pathogens	Canoeists (≤30 years old) had a 1.58, 1.34, and 7.87 times higher chance of having evidence of being exposed to hepatitis A virus, norovirus, and *Shistosoma,*	Taylor et al., 1995

				respectively, than non-canoeists.	
fishing	46 samples	not reported	surfaces of anglers' hands and fish were examined for the presence of *Cryptosporidium*	Based on the concentrations of *Cryptosporidium* detected in the water after washing of the fish or anglers' hands, the mean probabilities of infection were 11% and 81%, respectively.	Roberts et al., 2007

I note, as discussed in Section IX below, that epidemiological studies are not in all cases a useful tool for determining whether precautionary measures are appropriate – particularly where, as here, the risk at issue is not merely a lower-level risk to a broad population but also an acute risk to a small category of users (sensitive populations and/or people who suffer accidental immersion). However, as demonstrated in Table 2, there is a small but significant body of literature indicating a positive correlation between recreational use of pathogen-contaminated water and risk of health effects. These data – viewed as a whole and in connection with the known and documented risks of pathogens generally associated with undisinfected sewage effluent – support a conclusion that it is more likely than not that any substantial level of contact with pathogen-contaminated water (not just immersion) carries with it a significant risk of illness.

I note, in this regard, that the studies listed in Table 2 demonstrate that even activities that are not intended to involve immersion, with the resulting accidental ingestion of water, do often result in sufficient ingestion to cause adverse health effects. For example, Fewtrell et al. (1994) found that 16% of freshwater canoers reported ingestion of water. Schijven and de Roda Husman (2006) found that even occupational divers wearing full face masks or helmets commonly ingest 5 to 30 ml of water.

VII. Indicator Bacteria Guidelines are Broadly Sufficient to Suggest Potential Human Health Risk from Pathogens in the CAWS

Illinois' current ambient water quality criteria for fecal coliform bacteria in general use waters – a limit of 200 colonies/100 ml based on a risk factor of 8 illnesses per 1,000 users -- was developed by USEPA more than 30 years ago to protect swimmers. (As noted in Section V, USEPA's informal "5 times" primary contact standard is used to assess protection of non-primary contact users as well). The current USEPA indicator bacteria criteria -- which updated the original fecal coliform-based criteria, and use *E. coli* and/or enterococci as indicators instead -- are currently undergoing a thorough re-evaluation by USEPA, based on concerns regarding the accuracy of the current indicators as predictors of human health risks. However, this re-

evaluation is in no way inconsistent with a conclusion that the levels of fecal coliform found in the CAWS indicate the potential for adverse human health effects; or that disinfection is appropriate to reduce that health risk.

The concern being addressed by the indicator bacteria re-evaluation is not that the presence of indicator bacteria *over*predicts the risk potential from human pathogens, but rather that it *under*predicts the risks posed by such pathogens. While indicator bacteria may correlate well with the presence of some types of pathogens, especially pathogenic bacteria, USEPA's primary concern is that the *absence* of indicator bacteria may give a false assurance of safety when in fact there are pathogens present that would not be detected through indicator bacteria measurement. Thus, any standard that emerges from this re-evaluation process is likely to result, ultimately, in more stringent controls on the presence of human waterborne pathogens, not less stringent controls.

A. The Water Quality Criteria Review Process is Grounded in Concern that the Current Criteria are Insufficiently Protective

Some history regarding the use of indicator bacteria to measure the presence of human pathogens is helpful in understanding the purpose and significance of the current revision process. Coliform bacteria were established as indicators of microbiological quality of water more than 75 years ago. This was based on early studies by the American Public Health Service that showed that the concentration of *Salmonella typhi* (the causative agent of typhoid fever) could be estimated from the number of *E. coli* (a coliform bacterium) in the water (Kerr and Butterfield, 1943, as referenced by the Committee on Indicators for Waterborne Pathogens, 2004), and the finding that *E. coli* were more resistant to disinfection than several bacterial pathogens (Wattie and Butterfield, 1944, as referenced by the Committee on Indicators for Waterborne Pathogens, 2004). At that time, the emphasis was on ensuring that the known major causes of waterborne disease, which were bacteria such as *Salmonella* and *Vibrio cholerae*, were not present in water. However, over time, concern arose that these indicators were insufficiently protective because destruction of the indicators did not necessarily signal destruction of certain types of pathogens, especially viruses and protozoan parasites:

> "Problems have been identified with indicator organisms (e.g. members of the *Enterobacteriaceae*), such as the fact that viruses and protozoa can be present and viable when indicator bacteria are inactive. Also, coliforms and other indicator bacteria may be more sensitive to chlorine than some pathogenic organisms, so the resulting treated water quality assessment can be inadequate. Many communities have experienced waterborne disease outbreaks even though their water supplies have met mandated coliform standards (Craun, et al., 1997)." (Percival et al., 2004)

In recent years, scientific advances have supported and reaffirmed concerns that currently-used indicator bacteria may be insufficiently protective. The existing ambient water quality criteria, which were designed to protect swimmers from illnesses due to exposure to pathogens in recreational waters, were developed more than 20 years ago (EPA, 1986). Since that time, "... there have been significant scientific advances, particularly in the areas of

molecular biology, virology, and analytical chemistry. EPA believes these new scientific and technological advances need to be considered and evaluated for feasibility and applicability in the development of new or revised criteria for pathogens and pathogen indicators." (USEPA, 2007).

Indeed, the basis for the establishment of drinking water standards for microorganisms other than coliform bacteria during the last 20 years is the recognition and acknowledgement by the USEPA that the use of coliform bacteria as the indicators of the microbiological quality of water is inadequate to protect public health. When proposing maximum contaminant level goals for viruses and *Giardia* in drinking water (USEPA, 1987), the EPA reviewed the status of waterborne disease outbreaks in the U.S., with an emphasis on the relative number of individuals involved in outbreaks associated with untreated vs. treated systems. They stated:

> "EPA believes these data support the need for better control of microbiological contaminants in drinking water, and support the use of treatment requirements, specifically filtration and disinfection requirements. EPA believes that if all surface water systems were to comply with the requirements of the proposed rule, most incidences of waterborne disease associated with these systems would be eliminated.

(Note that the only microbiological standards in place at the time were for total coliform bacteria.).

Based on similar concerns, in October, 2000, the President signed into law the Beaches Environmental Assessment and Coastal Health Act ("BEACH Act"). The BEACH Act amended the Clean Water Act to require USEPA to conduct studies associated with pathogens and human health, and to publish new or revised recreational water quality criteria for pathogens and pathogen indicators based on those studies. The goal of the legislation is to find more accurate means to assess human health risks so as to better protect the health of recreational users of U.S. waterways.

Certainly, there are some types of pathogens for which indicator bacteria may overpredict the presence of human pathogens – i.e., the indicator bacteria may be present in high numbers but the pathogens in question are not. However, there are many different pathogens whose presence is underpredicted by the indicators, prompting USEPA's concern and ultimately the passage of the BEACH Act. On balance, indicator bacteria are more likely to underpredict rather than overpredict the presence of pathogens. This is due to the fact that many pathogenic microorganisms, especially the viruses and protozoan parasites survive longer in the environment compared to coliform bacteria, thereby raising questions about the suitability of coliforms as indicators (Committee on Indicators for Waterborne Pathogens, 2004; Rusin et al., 2000). So, while the presence of coliforms might signify the presence of fecal contamination, their absence cannot be relied upon as a definitive signal that the water is microbiologically safe.

B. The Likelihood that the Revised BEACH Act Pathogen Criteria Will Allow the Level of Contamination Now Evident in the CAWS is Extremely Low

For the reasons discussed above, the fecal coliform levels measured in the CAWS do not present a complete picture of the human pathogen levels present there. Specifically, there are likely to be viruses and parasites present in water, even in the absence of indicator bacteria such as fecal coliform bacteria. *E.coli*, for which MWRD has also collected CAWS ambient data, presents similar problems of underprotectiveness, i.e., the possibility that there may be high levels of certain pathogens present, even in the absence of *E. coli.*

However, notwithstanding any such uncertainty associated with indicator bacteria, it is well established that the presence of these bacteria is likely to be correlated with at least *some* types of human pathogens – generally pathogenic bacteria – that are associated with human health risks. Thus, even if currently used indicator bacteria (e.g., fecal coliform bacteria, enterococci, and *E. coli*) may not present a perfect picture of the risk of adverse health effects associated with all human pathogens in the CAWS, they tell us enough to know that high levels of these indicators are likely to be correlated with diverse health effects in exposed individuals. To the extent a better indicator bacteria or pathogen identification system may be discovered, it will likely identify the risks with more accuracy. But it almost certainly will not result in a determination that health risks previously found to be associated with current levels of indicator bacteria do not exist. Thus, the chance that the BEACH Act study process will produce a pathogen risk assessment procedure that renders disinfection unnecessary is almost vanishingly remote.

As an overall matter, it is important to note that the purpose of the indicator bacteria criteria is to create a bright line for decisionmaking about whether to keep beaches and other waterbodies open on any given day, given fluctuations in ambient bacterial levels that vary based on a variety of factors that may affect bathing beaches (storm water runoff, CSOs, waterfowl, etc.). Local authorities need to have a fixed ambient water quality number at which they can say a beach is safe or unsafe on any given day; and the current revision efforts are an attempt to ensure that this number is in fact adequately protective of human health.

In a decision regarding disinfection, however, this type of "fine tuning" of the ambient indicator bacteria standard is neither relevant nor meaningful. I note at the outset that the proposed IEPA regulation does not include any ambient standard at all; it merely requires reduction of pathogen loading in the effluent. More broadly speaking, the process of disinfection itself is not susceptible to fine tuning. Its impact is binary. That is, if a WWTP does not disinfect – as with the MWRD facilities – pathogen levels in the effluent will be high. But if it does disinfect, pathogen levels will be much lower. This fact is illustrated by the Urban Rivers Analysis chart in subsection IV.B., which shows extremely low levels of indicator bacteria in the effluent of facilities that disinfect, in every case well under 100 cfu/100 ml.

Thus, since we can fairly safely conclude (as discussed above in this subsection) that the revision to the ambient indicator bacteria criteria will not allow MWRD to continue unabated its discharge of high levels of human pathogens, we can conclude that it is very likely that

disinfection will be required at the conclusion of the process. The current BEACH Act revisions of the ambient water quality criteria might conceivably affect such matters as the type of reporting that MWRD would be required to conduct, or even the strength of the disinfection required (for example, more intense UV irradiation if that is the chosen disinfection method). It might even potentially be relevant to determining an ambient standard for the CAWS to be put into place at a later date. But it is unlikely that it will alter the fundamental necessity of disinfection. Accordingly, waiting for this lengthy process to conclude would merely delay protection of public health without good reason.

Finally, I question whether the ambient indicator bacteria criteria, and the methodology and assumptions on which they are based, are really appropriate at all in the context of long-term public health decisionmaking of the type at issue here. The current criteria are derived from an acceptable risk standard established by USEPA of 8 illnesses per 1,000 swimmers. It is notable that the current ambient water quality criteria present different risk levels to recreators swimming in fresh water (8 illnesses per 1000 swimmers) compared to marine waters (19 illnesses per 1000 recreators). More importantly, as stated by the EPA (1986), these risk levels are based on the historically accepted risk (dating back to at least the 1976 Quality Criteria for Water), which was arbitrarily set. This type of illness rate standard arguably makes sense when determining whether to allow recreation in the presence of ambient bacteria determined on any given day to be present. Members of the public wish to recreate, and the relevant judgment is whether it is safe to let them. Here, however, the relevant judgment is not merely whether recreation in current conditions will result in a risk below the currently accepted standard. It is whether that risk can be diminished in the future through implementation of appropriate controls. Where a risk is in that manner remediable in the future, the risk standard that we are willing to apply to present conditions is not particularly appropriate. Simply put, we may be willing to let people spend the day at a beach known to be contaminated with pathogens if only 8 out of 1,000 of them are going to get sick, as an alternative to closing it to the public on a given hot summer day. But if we know that we can permanently diminish that risk, such that in future summers only, say, 2 out of 1,000 will get sick, we should not refuse to do so simply because the EPA has arbitrarily established 8 out of 1,000 as an acceptable risk for current day-to-day decisionmaking about beach closures. That is a separate risk question altogether.

VIII. The Risk Assessment Prepared on Behalf of MWRD has Numerous Flaws

In April, 2008, Geosyntec Consultants completed the Risk Assessment concerning recreational use of the CAWS in wet and dry weather (available on MWRD's web site, http://www.mwrdgc.dst.il.us/). The Assessment is based on collection of samples in 2005 and 2006, which were sampled to determine ambient levels of a select handful of human pathogens. Based on the pathogen levels in the samples, and various assumptions made regarding dose-response rates for the selected pathogens and the nature of waterway use, the Assessment concludes that risk to non-primary contact users of the CAWS is minimal, and that disinfection would not have a significant impact on risk.

My review of the Assessment leads me to the conclusion that there are so many flaws, in multiple respects, that its conclusions are not meaningful and should not be relied upon in making a decision regarding the need for disinfection of WWTP effluent. The Assessment employs several critical assumptions and methodologies that likely result in a serious

underestimate of risk, and concomitant underestimate of the benefits of disinfection. In addition, it contains several more minor but still significant scientific and methodological errors that may not significantly impact the final result standing alone, but taken together seriously undercut the credibility of the Assessment, calling into question its overall accuracy and scientific integrity. Finally, the Assessment contains significant gaps in information that must be supplied in order to fully assess the accuracy and value of the research. These flaws and omissions are detailed in the subsections below.

I have also reviewed an analysis conducted by USEPA of the Interim Phase I Dry Weather Microbial Risk Assessment Report prepared by Geosyntec Consultants in November 2006. See Exhibit 4. That analysis expresses many of the same concerns with the Assessment that I have identified.[6]

A. Overarching Flaws in Methodology and Assumptions

The following are major flaws in the overarching methodology and assumptions underlying the Risk Assessment, which separately and collectively render the conclusions of the Assessment unreliable:

- Study of exclusively gastrointestinal illness. The Risk Assessment bases all of its conclusions solely on the study of gastrointestinal illness. No data were factored in, assumptions made, or risks assessed for any other type of illness that may be contracted from contact with waterborne pathogens. This assumption is wholly unjustified. There are of studies that have found that respiratory, eye, and ear infections are more common outcomes from waterborne pathogen infection than gastroenteritis. For example, Fewtrell et al. (1992) found that, at one of the contaminated sites, the relative risk of respiratory symptoms among the exposed individuals was higher than that of gastrointestinal symptoms. The study by Taylor et al. (1995) found that the evidence of infection by *Shistosoma* (an organism that causes itchiness and rashes) among the exposed individuals was much higher than the evidence of infection by either norovirus or hepatitis A virus.

  Indeed, as set forth in Figure 4., in the Centers for Disease Control's compilations of recreational water-associated outbreaks (CDC, 2006), non-gastrointestinal disease is frequently more common than gastroenteritis (as discussed in that section, outbreaks are not a good measure of overall risk, but they can be informative as to the nature of the risk). Thus, the Assessment's exclusive focus on gastrointestinal illness underestimates risk.

- Study of only a small subgroup of pathogens. The Assessment is based solely on the study of 8 pathogens or groups of pathogens (the virus assay using BGM cells can detect a number of viruses). As discussed in Section V, there are literally hundreds of waterborne pathogens that are typically associated with undisinfected sewage effluent. The stated basis for assessing only this limited universe of waterborne pathogens is

[6] Note that the combined dry weather and wet weather risk assessment did partially address the issues of the sensitivity analysis and the uncertainty analysis.

inadequate. The authors state that this subset of sewage pathogens was selected based on (i) the association of these pathogens with documented outbreaks, and (ii) the availability of USEPA-approved laboratory standard operating procedures ("SOPs") for measurement of these pathogens. Neither of these reasons, however, either adequately justifies the decision to limit the scope of the Assessment in this manner, nor supports the reliability of the results. The availability of SOPs for certain pathogens have no bearing on the question of whether those pathogens are representative for purposes of assessing risk. In any event, USEPA-approved laboratory SOPs are not available for two of the pathogens studied (adenoviruses and noroviruses), yet they were included in this analysis. Additionally, as discussed in Section V.D., documented outbreaks are not generally a good measure of the risk associated with any given pathogen. The inadequately justified selection of a small universe of pathogens on which to base the Assessment likely results in an underestimate of risk.

- Failure to take into account sensitive populations. As discussed in Section V, sensitive populations – children, pregnant women, the elderly, and immunocompromised persons – are more likely to experience serious adverse health effects as a result of infection by some waterborne pathogens. Yet the Assessment fails entirely to take this factor into account, and makes risk calculations based solely on a healthy adult population.

- Conflation of upstream and downstream pathogen levels. For the pathogens (with the exception of *Pseudomonas*) evaluated in the Risk Assessment, the Assessment concludes that, in dry weather conditions, concentrations downstream of the WWTPs are often higher than concentrations upstream of the WWTPs. Yet for purposes of determining risk, the Assessment averages the upstream and downstream concentrations. No information is provided on the process used to average the concentrations. In any event, this averaging causes the calculated risks associated with the higher pathogen levels downstream of the WWTP outfalls to be lower, by diluting them with the lower upstream levels. The Assessment justifies this method by stating that "[t]he average pathogen concentration along the waterway is the best representation of the exposure that a receptor might encounter." (Assessment p. 122). This is, simply put, not true. There is no basis for the assumption that recreators will necessarily use both the upstream and downstream portions of the CAWS. Different recreators will use different locations, and a valid risk assessment needs to determine likely illness rates at all such locations, in particular the more heavily contaminated downstream locations.

- Conflation of wet and dry weather conditions. As discussed in Section IV, the sources of pathogens, and their distribution along the CAWS, are substantially different in dry versus wet weather. In dry weather, given that the CAWS is effluent dominated, the WWTPs are the primary source of pathogens, such that disinfection of CAWS effluent will necessarily reduce dry-weather pathogen loading. During wet weather, however, CSOs appear to be a substantial source of pathogens in the CAWS, such that disinfection would not likely have nearly as significant an impact on ambient pathogen levels during such weather. The Assessment itself concluded that, "[f]or each waterway segment the risks associated with exposure to the wet weather concentrations were higher than those associated with dry weather concentrations." (Assessment p. 127). Yet for no sound reason, the risk assessment combined wet and dry weather conditions for purposes of

assessing post-disinfection conditions. In addition, as noted above, the upstream and downstream concentrations are combined. Separate calculations need to be performed, and the results for risks post-disinfection need to be presented for wet weather and dry weather conditions, as well as upstream and downstream locations. This unjustified assumption greatly diminishes the assessed benefit of disinfection.

- Calculations are based on limited data. The risk assessment calculations are based on the analyses of a limited number of samples collected during a short period of time (i.e., 5 weeks for dry weather, 3 occasions for wet weather). It is unknown whether the concentrations of pathogens detected in these samples are representative of those that typically occur, as there are a number of factors that could influence these concentrations. These include differences in temperature, sunlight, turbidity of the water, etc.

B. Other Significant Flaws in Methodology and Assumptions

I have identified additional flaws in the Assessment's methodology and assumptions that could potentially have an impact on the reliability of the study's conclusions. The following are examples:

- Insufficiently conservative dose-response assumptions. The Assessment makes assumptions about the dose-response – i.e., degree of infectivity – characteristics of the pathogens studied that are insufficiently justified and not always conservative. The dose-response data for echovirus was used as a surrogate for the dose-response behavior of adenovirus. The justification for the use of the lower infectivity values was that the only dose-response data available for adenoviruses are based on respiratory infections caused by adenoviruses, in which the infectivity has been found to be very high. The authors state that, because they are only considering gastrointestinal illness, the use of the lower infectivity values obtained for echovirus was justified (Assessment p. 108). This failure to apply conservative assumptions skews the analysis toward a conclusion of lower risk.

- Invalid sampling methods. The method described by the authors that was used to sterilize the sampling equipment does not follow EPA protocols. Per the EPA's ICR Manual for disinfecting equipment to be used for virus sampling (EPA, 1996. ICR Microbiology Laboratory Manual. EPA/600/R-95/178), the concentration of chlorine that is to be used to disinfect sampling equipment is 0.1%; the authors state that at least a 0.5% solution was used. In addition, after chlorination, the chlorine must be neutralized with sodium thiosulfate. The authors state that the equipment was simply rinsed with sterile distilled water. The failure to dechlorinate the sampling equipment with sodium thiosulfate may have resulted in residual chlorine in the equipment, which can inactivate microorganisms in the water samples. Thus, the validity of the numbers of viruses presented is unknown.

- Insufficient information is presented to enable an accurate evaluation of sampling results. During dry weather, the volume of water sampled for viruses was stated to vary from approximately 100 liters for the outfall samples to 300 liters for the upstream and downstream samples (no information regarding the sample volumes for the wet weather

virus samples was provided.) However, the entire sample was not analyzed for each of the viruses. For the culturable enteroviruses (termed "enteric viruses" by the authors) and the adenoviruses, no information on the actual volume of sample that was analyzed for each of these viruses for each sample was provided; the results are simply presented as MPN/100 L. If only 1 liter were analyzed, and no viruses were detected in that one liter, the result would be presented as <1 MPN/100 L. However, it is not known whether there were viruses present in the portion of the sample that was not analyzed. Without knowing the volume of sample actually analyzed, one cannot assess the magnitude of the extrapolation that was done to arrive at the concentrations presented.

- Extrapolation of concentration based on examination of a small fraction of the sample. In the case of the noroviruses, only a small fraction of the total sample volume was actually analyzed. For example, for a downstream water sample, it was stated that approximately 300 liters was collected. Per Table 3.7, a typical volume of sample analyzed was 0.2 liters. This represents less than 0.1% of the total sample collected. If no viruses were detected in that small fraction of the sample, the result was listed as negative. If, indeed, the >99.9% of the sample that was not analyzed did contain viruses, that information was not determined, and thus, the sample would be listed as having no noroviruses present at detectable levels. Therefore, the detection of noroviruses in only 5 samples is not surprising. Additionally, characterization of the high calicivirus concentration found in one sample as an outlier because only the highest dilution of the sample was positive is not appropriate. The distribution of viruses in the water may be highly variable, and there is a statistical probability that a more dilute sample may contain more viruses than a less dilute sample; thus the result may, indeed, be valid.

- Lack of specificity of the adenovirus assay. The cell culture analysis for adenoviruses appears to have produced a relatively large number of false positive results, as shown by the subsequent polymerase chain reaction ("PCR") analyses. However, the lack of information on the specific adenoviruses detected by the PCR assay makes it impossible to determine whether the conclusion that these samples did not contain adenoviruses is appropriate.

- Insufficient information on input variables is provided to enable an assessment of the risk calculations. The probability distributions of the input values are provided for only two of the input variables (ingestion rate for canoeists and duration for canoeists (Assessment Figure 5-2 and 5-3.) This information needs to be provided for each of the input variables to enable a thorough evaluation of the risk assessment calculations.

- Lack of probability distribution results. The authors go to great lengths to use a Monte Carlo approach to make risk calculations, which evaluates data using probability ranges to account for inherent uncertainty and variability in the input values. However, the final results are presented as single numbers, without showing the calculated cumulative probability distribution functions. The fact that the authors do not even state the probability associated with the risk numbers they present makes it impossible to assess the calculated risk probabilities appropriately.

C. Gaps in Essential Information

The following are gaps in essential information regarding the methods, analysis, and assumptions used in the Risk Assessment that must be resolved in order for the study to be properly evaluated, let alone used as the basis for policy judgments. These questions must be answered before the Assessment is even considered in this proceeding:

- What primers were used for the calicivirus analyses? What caliciviruses are detected using those primers? (Assessment p. 25)
- What method was used to analyze samples for adenoviruses? It is not until p. 42 that the cell line used is mentioned. What serotypes of adenoviruses are detected using that cell line? (Assessment p. 25)
- The authors indicate that Blue Green Monkey cells were used for the positive and negative virus control assays (Assessment p. 30). This is not the cell line required by USEPA for culturable virus assays.
- The authors state that PCR was used to confirm the presence of adenoviruses in the samples which were cell-culture positive, as other viruses can grow in the cell line (Assessment p. 50). What primers were used for this analysis? What serotypes of adenoviruses are detected using these primers? How was this information used to determine the concentrations of adenoviruses in the water samples?
- The authors state that Tables 3-5a through 3-5f present a summary of the "total enteric virus" analytical results (Assessment p. 48). However, the samples were not analyzed using a method that detects total enteric viruses – there is no established procedure for such an assay.
- It is stated that the reverse transcription polymerase chain reaction (RT-PCR) results were used to calculate the concentrations of noroviruses in the water samples (Assessment pp. 52-53). How were these calculations done?
- The dose response data for *Cryptosporidium* has been documented to vary by strain. What is the rationale for the values used?
- What is the basis for changing several of the values used for the secondary infection rates from the interim dry weather report to the combined dry and wet weather report?
- How was the contribution of each pathogen to the total risk computed, given that a distribution of risk was calculated for each organism?
- What were the "... representative pathogen concentrations used as inputs for the simulation ..."? How were they developed?

IX. The UIC Epidemiological Study is an Inadequate Basis for a Decision Concerning Disinfection

As noted in Section III, I have reviewed information concerning the epidemiological study currently being conducted on behalf of the MWRD by the UIC School of Public Health. I have no reason to believe, based on my review, that the methodology of this study is inappropriate, or that it is otherwise scientifically flawed in any meaningful way. I start with the assumption that the study constitutes sound science.

That said, based upon my knowledge of the nature of waterborne pathogens and the risks they present, I do not believe that the epidemiological study represents an appropriate tool for making a determination as to the magnitude of the risk of pathogens to CAWS recreators, or whether disinfection is appropriate to alleviate that risk. Epidemiological studies can, as a general matter, be a useful tool for identifying risks in everyday settings. But the difficulty of controlling for other sources of risk in such settings counsels against excessive reliance upon epidemiological study results, particularly when those results are negative.

The following are the major reasons why I believe excessive reliance on results of the UIC CAWS epidemiological study, or postponing disinfection of the MWRD WWTPs until after its completion, would be inappropriate:

- Difficulty of obtaining an adequate sample size. Results of an epidemiological study are unreliable unless the study is based on a sufficiently large sample. If the sample is too small, then the associated margin of error will be so large as to render the results functionally meaningless. Here, even if UIC obtains a sufficiently large overall sample (and I am aware that there have been difficulties in this area), it still is not likely to obtain sufficiently large samples of the subcategories of users at most severe risk of infection – sensitive populations and users who suffer accidental immersion. Since the nature of the risk of infection from secondary contact recreation is grounded in such infrequently-occurring but nonetheless present variables, such that it is difficult or impossible to amass a sufficient sample of participants specifically reflecting variables, an epidemiological study is really not a good tool for identifying that risk.

- Incomplete assessment of risk. This study is going to extraordinary lengths to document adverse health effects attributable to recreational exposure, including gastrointestinal, wound, and eye infections. However, it will not be able to assess the number of recreators who become infected as a result of recreation, but do not exhibit signs and symptoms of that infection. As discussed previously, a significant fraction of the infected individuals may never show any overt signs of the infection. However, they may still serve as sources of secondary infection to their contacts. Thus, the risks that are determined from this, as is the case with other, epidemiologic studies will likely be an underestimate of the true risks.

- Varying water conditions make risk hard to pinpoint. The level of pathogens in water can vary greatly with such ephemeral, constantly changing variables as the amount of sunlight (which can inactivate microorganisms), the temperature (which generally affects microbial inactivation by increasing the rate at higher temperatures), and turbidity of the water (which blocks sunlight). Different people recreating on different days or different portions of the water body may encounter very different pathogen loads depending on these variables, and it is difficult if not impossible for an epidemiological study to meaningfully sort out those variables, even though the levels of a few pathogens are being determined in this study. Thus, the results will not adequately account for the risk to users during periods or in isolated locations where the pathogen load is higher.

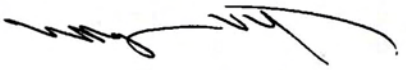
- Differing levels of use. An epidemiological study can only capture, at best, risk associated with the particular manner in which recreators use the body of water being studied. Thus, for instance, while the UIC CAWS epidemiological study uses canoers on a clean body of water as a control group, the manner in which people engage in canoeing – in particularly their willingness to come into contact with water – is likely to vary widely between the users of the clean versus contaminated water. That is, people canoeing on clean water are much more likely to be careful to avoid accidental immersion and otherwise behave in a manner unlikely to result in ingestion of water. Accordingly, at best, an epidemiological study of the CAWS represents an assessment of risk of a very cautious, incomplete recreational use of the water.

- Results must be replicated. It is a basic principle of any scientific study that no result is reliable unless it can be reproduced. At the very least, one should not draw any conclusions from the epidemiological study – particularly any conclusions with so great a potential impact on public health as a decision whether to disinfect – unless the results are reproduced in at least one more study.

X. Conclusion

There are abundant data and information currently available to support a conclusion that WWTP effluent to the CAWS should be disinfected in order to protect public health. We know that the CAWS contains high levels of at least some sewage-related human pathogens, despite any uncertainty as to their exact nature and level. We know that disinfection can inactivate these pathogens. And very importantly, we know that the types of pathogens associated with undisinfected sewage effluent, and hence likely present in the CAWS, are capable of causing potentially serious infection among the population that uses the CAWS recreationally (as well as those who come into contact with them).

Perhaps most importantly, we know that disinfection of sewage effluent is a widespread and standard practice, nearly universal in large cities. There is no reason to wait for a period of years pending further study when we have sufficient information today to conclude that disinfection of MWRD's effluent would serve to protect public health.



Marylynn V. Yates, Ph.D

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Percival, S.L., R.M. Chalmers, M. Embrey, P.R. Hunter, J. Sellewood, and P. Wyn-Jones. 2004. Microbiology of Waterborne Diseases, Elsevier, London, p. 7.

Roberts, J.D., E.K. Silbergeld, and T. Graczyk. 2007. A probabilistic risk assessment of Cryptosporidium exposure among Baltimore anglers. J. Toxicol. Environ. Health, part A 70:1568-1576.

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Schijven, J. and A.M. de Roda Husman. 2006. A survey of diving behavior and accidental water ingestion among Dutch occupational and sports divers to asses the risk of infection with waterborne pathogenic microorganisms. Environ. Health Perspect. 114(5):712-717.

Shuval, H. and B. Fattal. 2003. Control of pathogenic microorganisms in wastewater recycling and reuse in agriculture. In: The Handbook of Water and Wastewater Microbiology, Academic Press, London, Chapter 15.

Taylor, M.B., P.J. Beckler, E. Janse van Rensberg, B.N. Harris, IW. Bailey, and W.O.K. Grabow. 1995. A serosurvey of water-borne pathogens amongst canoeists in South Africa. Epidemiol. Infect. 115:299-307.

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USEPA. 2006. National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule , Federal Register: January 5, 2006, Volume 71, Number 3, Pages 653-702, available at http://www.epa.gov/fedrgstr/EPA-WATER/2006/January/Day-05/w04a.htm.

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EXHIBIT 1

CURRICULUM VITAE
Marylynn Villinski Yates

2008

Education

8/82 - 5/84	Department of Microbiology & Immunology, University of Arizona, Tucson, Arizona. Ph.D. in Microbiology
1/81 - 5/82	Department of Chemistry, New Mexico Institute of Mining and Technology, Socorro, New Mexico. M.S. in Chemistry
8/75 - 8/80	University of Wisconsin, Madison, Wisconsin. B.S. in Nursing

Professional Positions (1987-present; all at University of California, Riverside)

7/07 – present	Program Leader, Natural resources and Animal Agriculture Division of Agriculture and Natural Resources, University of California
7/92 - present	Associate Professor/Professor of Environmental Microbiology Department of Environmental Sciences
12/87 – 6/05	Ground-Water Quality Specialist Department of Environmental Sciences
7/99 – 12/00	Chair Department of Environmental Sciences
1/01-6/04	Associate Executive Vice Chancellor

Honors and Awards

Fellow, American Association for the Advancement of Science, 2007

Distinguished Teaching Professor, University of California, Riverside, 2006

National Associate, National Academies of Science, 2004

University of California, Riverside 2001-02 Distinguished Teaching Award

American Water Works Association 2001-02 Publication Award

American Society for Microbiology Foundation for Microbiology Lecturer, 1997 - 1999

American Water Works Association 1996 Publication Award

Outstanding Research Award, University of California Cooperative Extension, 1996

American Society for Microbiology Foundation for Microbiology Lecturer, 1990-1991

American Association for the Advancement of Science/ U.S. Environmental Protection Agency Environmental Science and Engineering Fellow, Summer 1985

PROFESSIONAL ACTIVITY AND SERVICE

PROFESSIONAL ACTIVITY (2000 – present)

Panels/Professional and Scientific Committees

1 Expert Advisory Panel, Canadian Water Network Consortium on Pathogens and Groundwater, 07-present

2 Review Coordinator, Water Science and Technology Board, National Academies of Science, 06-07

3 Member, project advisory committee, Challenge organisms for inactivation of viruses by ultraviolet treatment, American Water Works Association Research Foundation—06-present

4 Member, Editorial Board, Applied and Environmental Microbiology, 02-04

5 Member, Committee on Indicators of Waterborne Pathogens, National Research Council – 02-04

6 Member, Committee on Water System Security Research, National Research Council – 02-03

7 Consultant, Committee on Restoration of the Greater Everglades Ecosystem, National Research Council – 02

8 Member, Committee to Improve the U.S.G.S. National Water Quality Assessment Program, National Research Council—99-02

9 Member, Peer review panel, Microbiology Research Program Relevancy Review, National Exposure Research Laboratory, Office of Research and Development, U.S. EPA, Cincinnati, OH July 17-19, 2001

10 Member, Unsolicited Proposal Review Committee, American Water Works Association Research Foundation - 01

11 Member, American Water Works Association Ground-Water Disinfection Rule Workgroup—97-00

12 Member, ASM Public and Scientific Affairs Board, Committee on Environmental Microbiology—97-00

13 Member, American Water Works Association Disinfection and Microbial Technical Advisory Workgroup—97-00

14 Member, project advisory committee, Study to Compare Current Fecal Bacterial Monitoring with Fecal Coliphage Monitoring on an Equivalent Volume Basis, American Water Works Association Research Foundation—97-00

15 Member, project advisory committee, Investigation of Soil Aquifer Treatment for Sustainable Water Reuse, American Water Works Association Research Foundation—97-00

16 Member, Committee to Improve the U.S.G.S. National Water Quality Assessment Program, National Research Council—99-00

Expert Workshops

1 Invited Participant, Expert Workshop on Microbial/Disinfection By-products Research Needs, Disinfection By-Products Research Council, Vail, CO, July 23-25, 2001 (declined due to schedule conflict)

2 Invited Participant, Renewable Natural Resources Foundation congress, "Control of Nonpoint Source Pollution: Options and Opportunities", Baltimore, MD, September 18-21, 2002 (declined due to schedule conflict)

3 Invited Participant, Interstate Waters Crossing Boundaries for Sustainable Solutions Workshop, The Utton Center, University of New Mexico, Snowbird, UT, October 9-12, 2002

4 Invited Participant, Workshop to Develop a Protocol for Reliable Genetic Methods for the Detection of Viruses, for use in EPA's Water Programs, Cincinnati, OH, January 15-16, 2003

5 Invited participant, Research on Microorganisms in Drinking Water, U.S. EPA, Cincinnati, OH, August 5-7, 2003

6 Invited participant, Workshop on Indicators for Pathogens in Wastewater, Stormwater, and Biosolids, Water Environment Research Foundation, San Antonio, TX, December 11-12, 2003

7 Invited participant, Pathogens in the Environment Workshop, USDA/CSREES, Kansas City, MO, February 24-25, 2004

8 Invited participant, International Workshop on Coliphages as Indicators of Fecal Contamination in Water and Other Environmental Media, Washington, DC, April 20-21, 2004

9 Invited participant, First International Conference on Fate of Biological Agents, U.S. Army Edgewood Biological Center, Williamsburg, VA, June 8-10, 2004

10 Invited participant, Environmental Science and Engineering Forum, National Decentralized Water Resources Capacity Development Project, St. Louis, MO, October 19-20, 2004 (declined due to teaching conflict).

11 Invited participant, Models and Tools for Including Susceptibility, Immunity, and Secondary Spread into Microbial Risk Assessment Workshop, Cincinnati, OH, November 18-19, 2004

12 Invited discussant, Methodology for Implementing a Timely Incident Response Mechanism workshop, Water Environment Research Foundation, Alexandria, VA, January 10-11, 2005 (declined due to prior service commitment).

13 Invited participant, Major Accomplishments and Future Directions in Public Health Microbiology Workshop, United States Geological Survey, Columbus, OH February 15 - 18, 2005.

14 Invited participant, Watershed/Catchments Management Summit, American Water Works Association/ Australian Water Association, Honolulu, HI, March 10-11, 2005

15 Invited participant, State of the Science on Adenoviruses: Expert Workshop, American Water Works Association, Manhattan Beach, CA, September 26-27, 2005.

16 Invited participant, Pathogens in Groundwater Experts Workshop. Toronto, Ontario, Canada, June 5-6, 2006.

17 Invited Participant, Water Reuse and Desalination Research Needs Workshop. San Diego, CA, November 28-30, 2006.

Invited Presentations

1 Environmental Science, American Association of University Women First Annual Pass Area Conference on Math and Science for Eighth Grade Girls, Mt. San Jacinto College, November 3, 2000

2 Detection of Coliphages in Water: Methods 1601 and 1602. Southern Regional Safety and Training Conference, California Water Environment Association, Riverside, CA, November 3, 2000

3 The Framework. Microbial Risk Factor: Recommendations to the USEPA on the Process pf Determination of Microbial Standards in Drinking Water, Water Quality Technology Conference, Salt Lake City, UT, November 7, 2000.

4 Viruses in Ground Water. California Water Association, 59th Annual Meeting. Monterey, CA, November 16, 2000

5 Use of Batch Adsorption Isotherm Data to Predict Virus Transport. Department of Soil, Water, and Environmental Science, University of Arizona, Tucson, AZ, March 5, 2001

6 Microbiological Contamination of Water. Soil Science faculty from National Agricultural University, Chapingo, Mexico, UCR, March 30, 2001

7 Ground Water Risks and Protection: Monitoring and Modeling Needs. American Society for Microbiology Annual Meeting, Orlando, FL, May 20-24, 2001

8 Body-Contact Recreation: Microbial Health Risks. American Water Works Association conference on Source-Water Protection. Las Vegas, NV, January 27, 2002

9 Invited Discussant, Workshop to Develop a Protocol for Reliable Genetic Methods for the Detection of Viruses, for use in EPA's Water Programs, Cincinnati, OH, January 15-16, 2003

10 Development of a quantitative method for the detection of infective coxsackie and echo viruses in drinking water. Research on Microorganisms in Drinking Water, U.S. EPA, Cincinnati, OH, August 5-7, 2003

11 Groundwater recharge using reclaimed wastewater: microbial considerations, 24th Biennial Groundwater Conference, UC Water Resources Center, Ontario, CA, October 28, 2003

12 Assessment of the Fate of Emerging Pathogens in Biosolids, Workshop on Indicators for Pathogens in Wastewater, Stormwater, and Biosolids, Water Environment Research Foundation, San Antonio, TX, December 11-12, 2003

13 Coliphages as indicators of fecal contamination of ground water. International Workshop on Coliphages as Indicators of Fecal Contamination in Water and Other Environmental Media, Washington, DC, April 20-21, 2004

14 Modeling the fate and transport of microorganisms in the subsurface, Pathogens and Onsite Sewage Treatment Systems meeting, Sacramento, CA, May 11, 2004

15 Fate and transport of pathogens in the environment, First International Conference on Fate of Biological Agents, U.S. Army Edgewood Biological Center, Williamsburg, VA, June 8-10, 2004

16 Microbiological indicators, coliphages, and ground water protection zones, Source Water Protection Symposium on Pathogen Management Zones, Ontario Ministry of the Environment, Toronto, Canada, July 23, 2004

17 Environmental Factors Affecting Microbial Dose, Models and Tools for Including Susceptibility, Immunity, and Secondary Spread into Microbial Risk Assessment Workshop, Cincinnati, OH, November 18-19, 2004

18 Viruses in Water: Sources and Monitoring, Source Water Protection Symposium, Palm Beach Gardens, FL, January 25, 2005

19 Interpreting Results from Emerging and Traditional Methods for Detection of Microorganisms, Major Accomplishments and Future Directions in Public Health Microbiology Workshop, United States Geological Survey, Columbus, OH, February 16, 2005

20 Keynote Speaker: Our Future, Our Water: Protecting Our Water Supply, launching of the Water Institute, Purdue University, Calumet, IL, July 6, 2005

21 Microorganisms in water: quantitative risk assessment, School of Engineering, Mathematics, and Science, Purdue University Calumet, Hammond, IN, July 6, 2005

22 Pathogen Reduction, The Compost Solution workshop. Riverside, CA, September 12, 2005

23 Overview of Factors Affecting Subsurface Transport of Microorganisms, Subsurface Transport of Microorganisms and other Colloids Symposium, RIVM, Bilthoven, The Netherlands, March 16, 2006

24 Keynote Speaker, Emerging Issues in Source Water Management and Strategies for Addressing New Drinking Water Regulations International Workshop, Central Indiana Water Resources Partnership, Indianapolis, IN, April 12-13, 2006

25 Waterborne Viruses: Types, Health Effects, and Detection Methods. Viruses in Water Symposium, Walkerton Clean Water Center, Toronto, Ontario, Canada, October 26, 2006

26 Pathogens 101. Waterborne Pathogens Speaker Series, Michigan State University, East Lansing, MI, February 9, 2007

27 Pathogens and Produce: what we know and what we need to know; Regulatory Issues. American Society for Microbiology Annual Meeting, Toronto, Ontario, Canada, May 23, 2007 (declined due to schedule conflict)

28 Biosolids Management and Legislation: The USA Experience. Workshop on Biosolids Management: Legislation and International Experience. Hellenic Union of Water and Sewerage Municipal Companies, Municipality Of Larissa, Larissa, Greece, May 25-26, 2007

29 Keynote Speaker. Adenoviruses and Ultraviolet Light: an Introduction. Adenovirus and UV Disinfection session. World Congress on Ozone and Ultraviolet Technologies, Los Angeles, California USA. August 27-29, 2007

Editorial Boards

1 Member, Editorial Board, Quantitative Microbiology, 00-02
2 Member, Editorial Board, Applied and Environmental Microbiology, 02-04
3 Editor, Applied and Environmental Microbiology, 04 – present

Reviewer, manuscripts

1 Applied & Environmental Microbiology (58)
2 Applied Microbiology & Biotechnology (1)
3 Environmental Science & Technology (4)
4 Ground Water (1)
5 International Journal of Water and Health (2)
6 Journal of the American Water Works Association (1)
7 Letters in Applied Microbiology (1)
8 Water Research (1)
9 Water Resources Research (2)
10 Water Science & Technology (4)

Ad hoc *Reviewer, grant proposals*

1 BARD (1)
2 Canadian Water Network (1)
3 CRDF (1)
4 Michigan Sea Grant (1)
5 New York Sea Grant (1)
6 NSF (1)
7 UC AES (2)
8 USDA (2)
9 USEPA (2)

Grant Proposal Review Panels

1 American Water Works Association Research Foundation (1)
2 Canadian Water Network (1)
3 NIH (4)
4 NOAA (1)
5 NSF (4)
6 U.S. Environmental Protection Agency (2)
7 U.S. Environmental Protection Agency (declined due to conflict of interest)

Reviewer, other

1 New River Pathogen Total Maximum Daily Load Plan, California Regional Water Quality Control Board, Colorado River Basin - 2001
2 Fifteen-year reviews of three UC Multi-Campus Research Units: UC Observatories/Lick, Institute of Nuclear and Particle Astrophysics and Cosmology, White Mountain Research Station – 2002
3 Protecting Water Resources – DANR Publication - 2002
4 Regional Cooperation for Water Quality Improvement in Southwestern Pennsylvania, Water Science and Technology Board, National Research Council, National Academies - 04
5 Bridges to Independence: Fostering the Independence of New Investigators in the Life Sciences, Board of Life Science, National Research Council, National Academies – 05
6 Globalization effects on water quality: Impact on the spread of infectious disease in aquatic and human populations, chapter in: Globalization: Effects on Fisheries Resources – 04
7 Draft TMDL for Bacterial Indicators in Middle Santa Ana River Watershed Waterbodies, Santa Ana Regional Water Quality Control Board – 05
8 Where will future emerging pathogens come from? What approaches can we use to find them, in addition to VFARS? Chapter for U.S. EPA publication on VFARs (virulence factor activity relationships) – 05
9 Improving the Nation's Water Security: Opportunities for Research, Water Science and Technology Board, National Research Council, National Academies – 06-07

Consulting

1 Expert for County of Los Angeles, California re: BEACHES Environmental Assessment and Coastal Health Act litigation, 2007- present
2 Expert for Horton, Oberrecht & Kirkpatrick re: food-borne disease outbreak litigation, 2006-07
3 Expert for Board of Water Supply, City of Honolulu, Hawaii re: water reuse, 2002-05
4 Reviewer for Bigelow Companies, Clark County Health District Proposed Regulations for Sanitation and Safety for Public Accommodation Facilities, 2004
5 Expert for State of California, Department of Justice, Assessing the potential for pathogen contamination of drinking water at California Correctional Institute-Tehachapi, 1999-2000
6 Consultant for Metropolitan Water District of Southern California, Lake Perris Water Quality scoping team, 1998
7 Lead consultant for Metropolitan Water District of Southern California, Eastside Valley Reservoir Pathogen Risk Assessment project, 1995-98
8 Consultant for Metropolitan Water District of Southern California, Pathogen survival during desalination of sea water, 1995-96

PUBLICATIONS

TECHNICAL JOURNAL ARTICLES

1. Yates, M.V., J.A. Brierley, C.L. Brierley, and S.E. Follin. 1983. Effect of microorganisms on in situ uranium mining. *Appl. Environ. Microbiol.* 46:779-784.

2. Yates, M.V., C.P. Gerba, and L.M. Kelley. 1985. Virus persistence in ground water. *Appl. Environ. Microbiol.*, 49:778-781.

3. Yates, M.V. 1985. Septic tank density and ground water contamination. *Ground Water* 23:586-591.

4. Yates, M.V., S.R. Yates, A.W. Warrick, and C.P. Gerba. 1986. Use of geostatistics to predict virus decay rates for determination of septic tank setback distances. *Appl. Environ. Microbiol.* 52:479-483.

5. Yates, M.V., S.R. Yates, J. Wagner, and C.P. Gerba. 1987. Modeling virus survival and transport in the subsurface. *Journal of Contaminant Hydrology* 1:329-345.

6. Rose, J.R., R.L. Mullinax, S.N. Singh, M.V. Yates and C.P. Gerba. 1987. Occurrence of rota and enteroviruses in recreational waters of Oak Creek, Arizona. *Water Research* 21:1375-1381.

7. Yates, M.V. and S.R. Yates. 1987. Comparison of geostatistical methods for predicting virus inactivation rates in ground water. *Water Research* 21:1119-1125.

8. Yates, M.V. and S.R. Yates. 1987. Modeling microbial fate in the subsurface environment. *CRC Critical Reviews in Environmental Control,* 17:307-344.

9. Henson, J.M., M.V. Yates, J.W. Cochran and D.L. Shackleford. 1988. Microbial removal of halogenated methane, ethanes and ethylenes in an aerobic soil exposed to methane. *FEMS Microbiology Ecology* 53:193-201.

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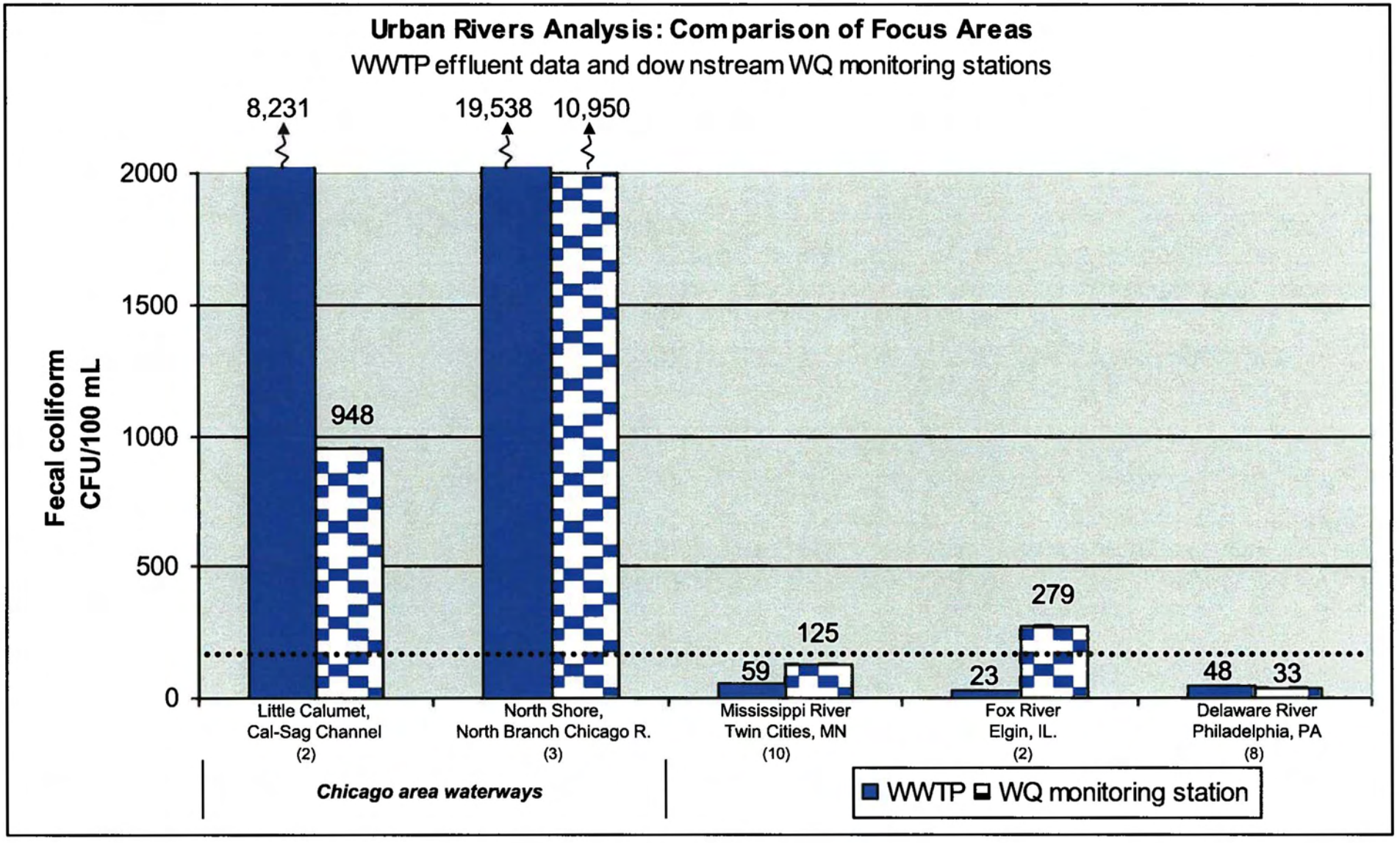
EXHIBIT 2

Document filed with the Clerk. Waiver of service requirements upon hearing participants requested pursuant to 35 Ill. Admin. Code 102.424(c)

EXHIBIT 3



Illinois Water Quality Standards:

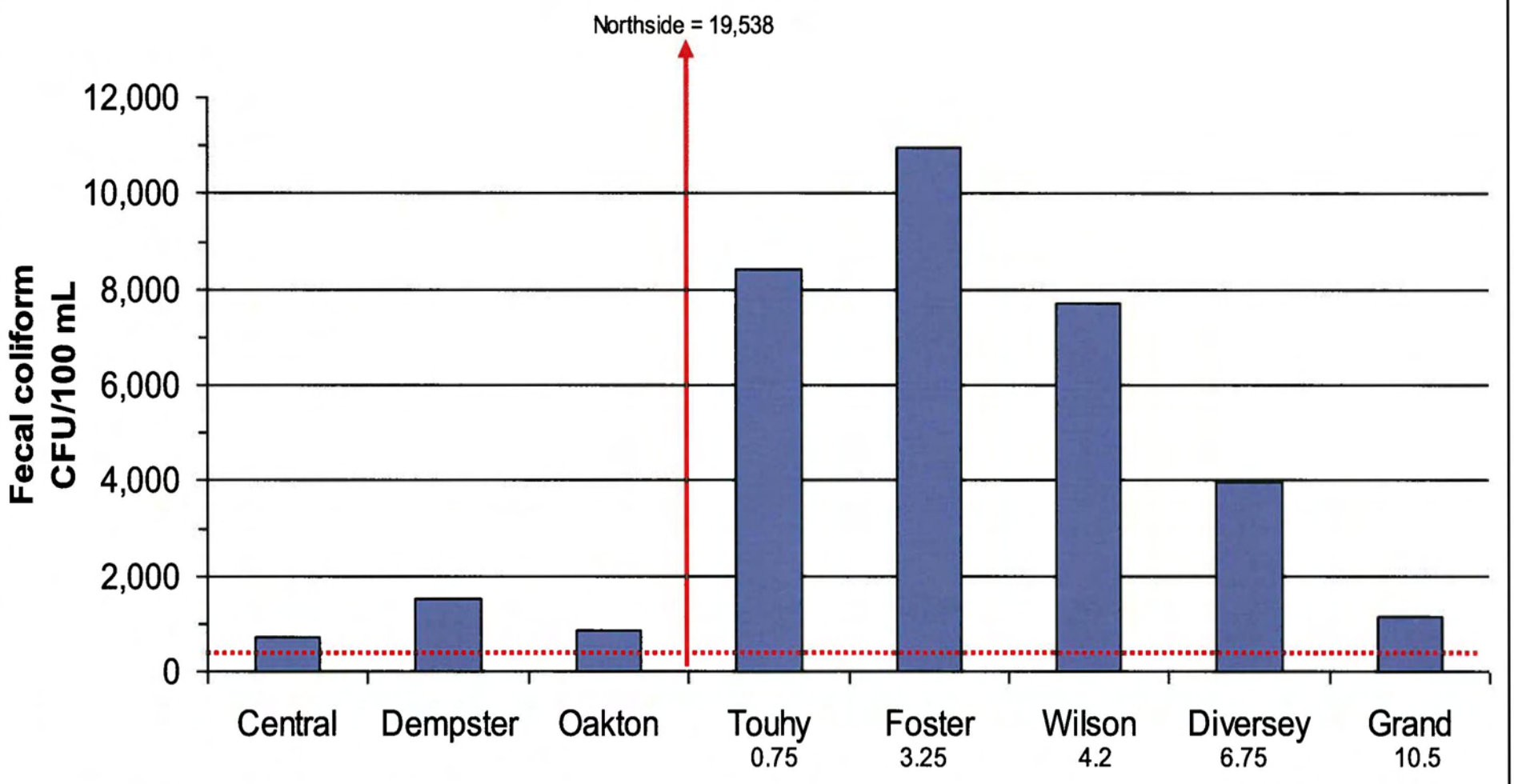
..... **General Use**
Fecal coliform:
30 day geometric mean 200 per 100mL limit

Note: WWTP results – effluent; WQ station results - ambient
- Fecal coliform monitoring results are expressed in the number of colony forming units (CFU) per 100mL
- Samples were taken monthly, May-October

(#) – Distance downstream of monitoring station from WWTP

North Shore Channel and North Branch Chicago River

Ambient May to October 2002 Geometric Mean Fecal Coliform

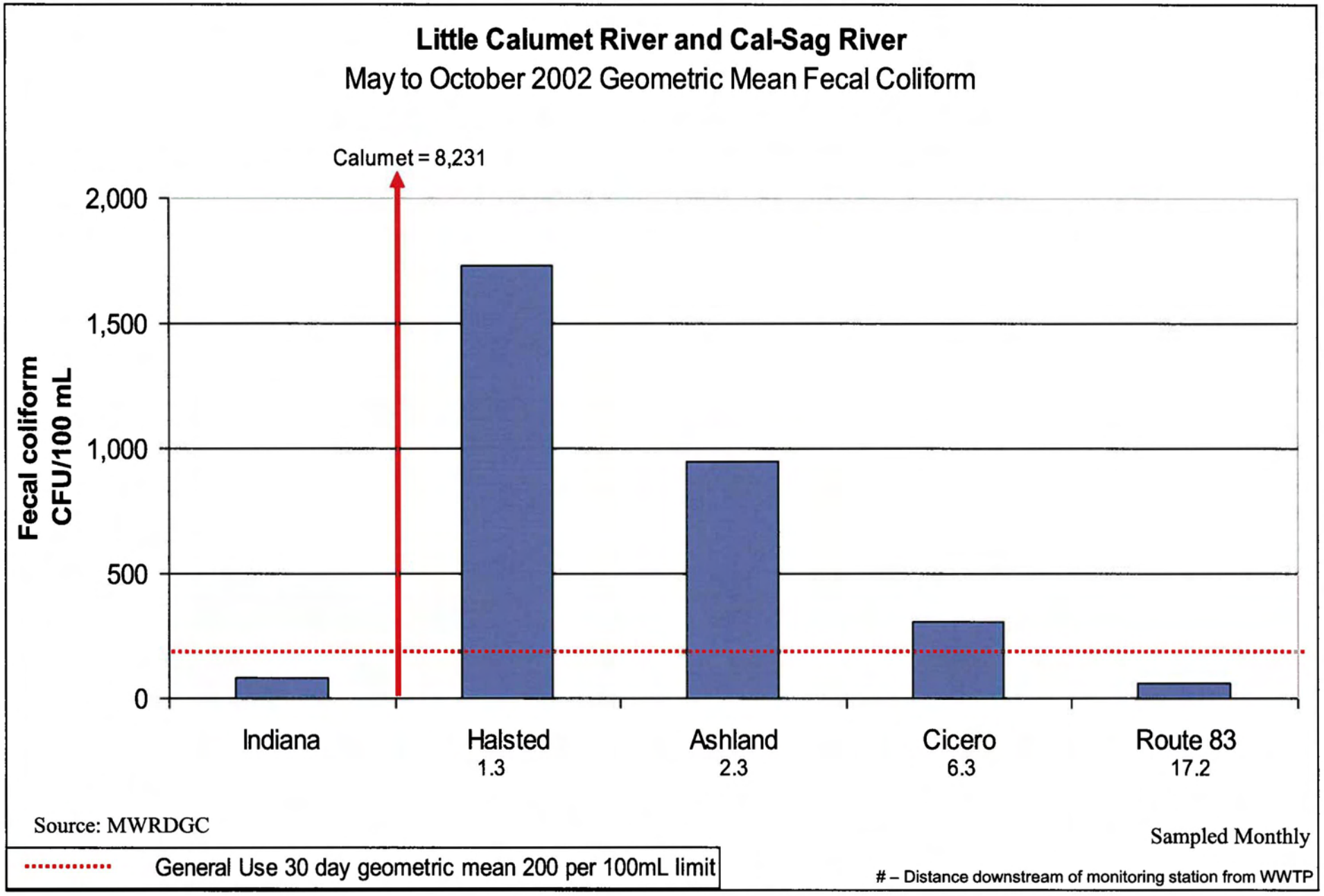


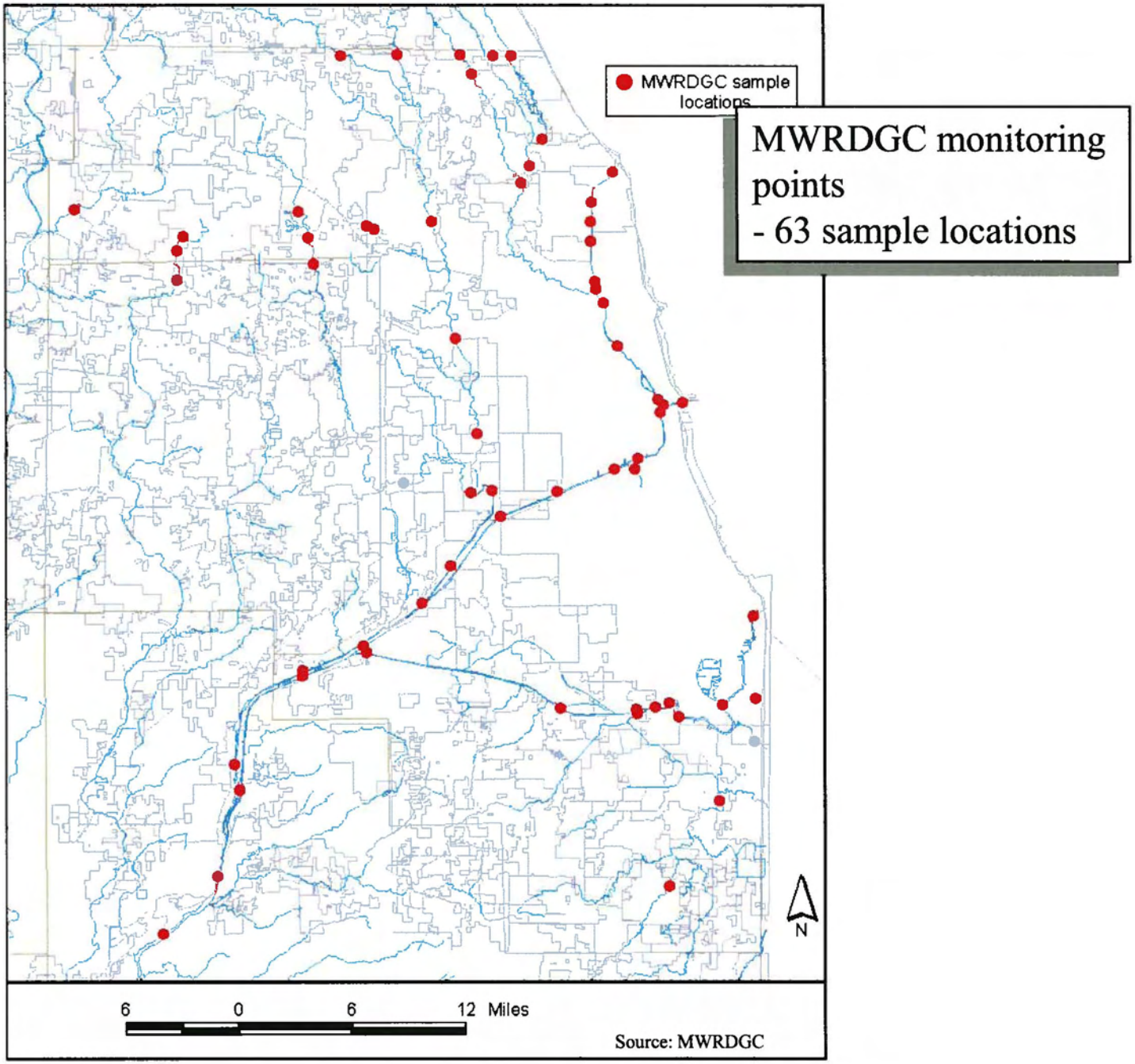
Source: MWRDGC

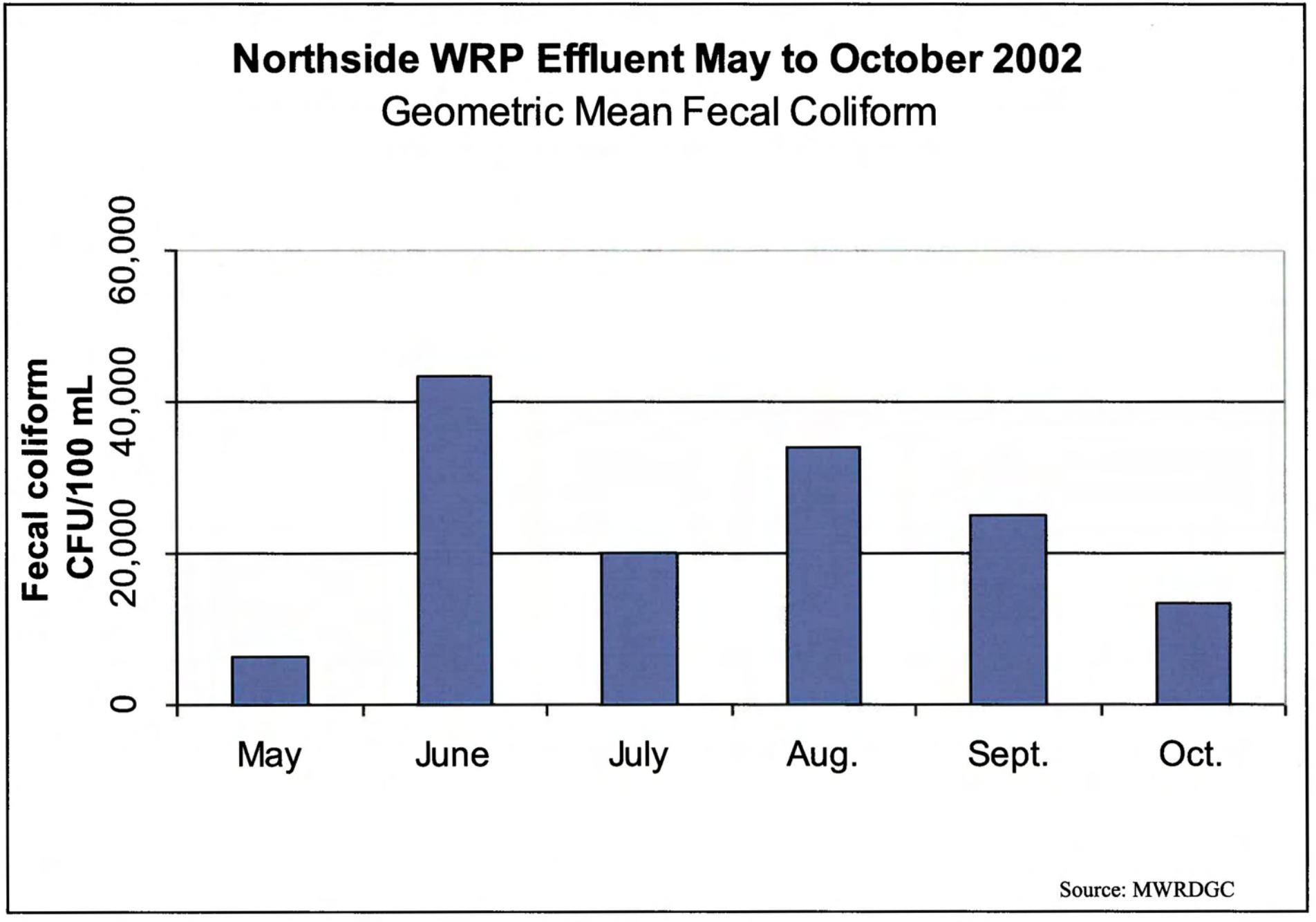
Sampled Monthly

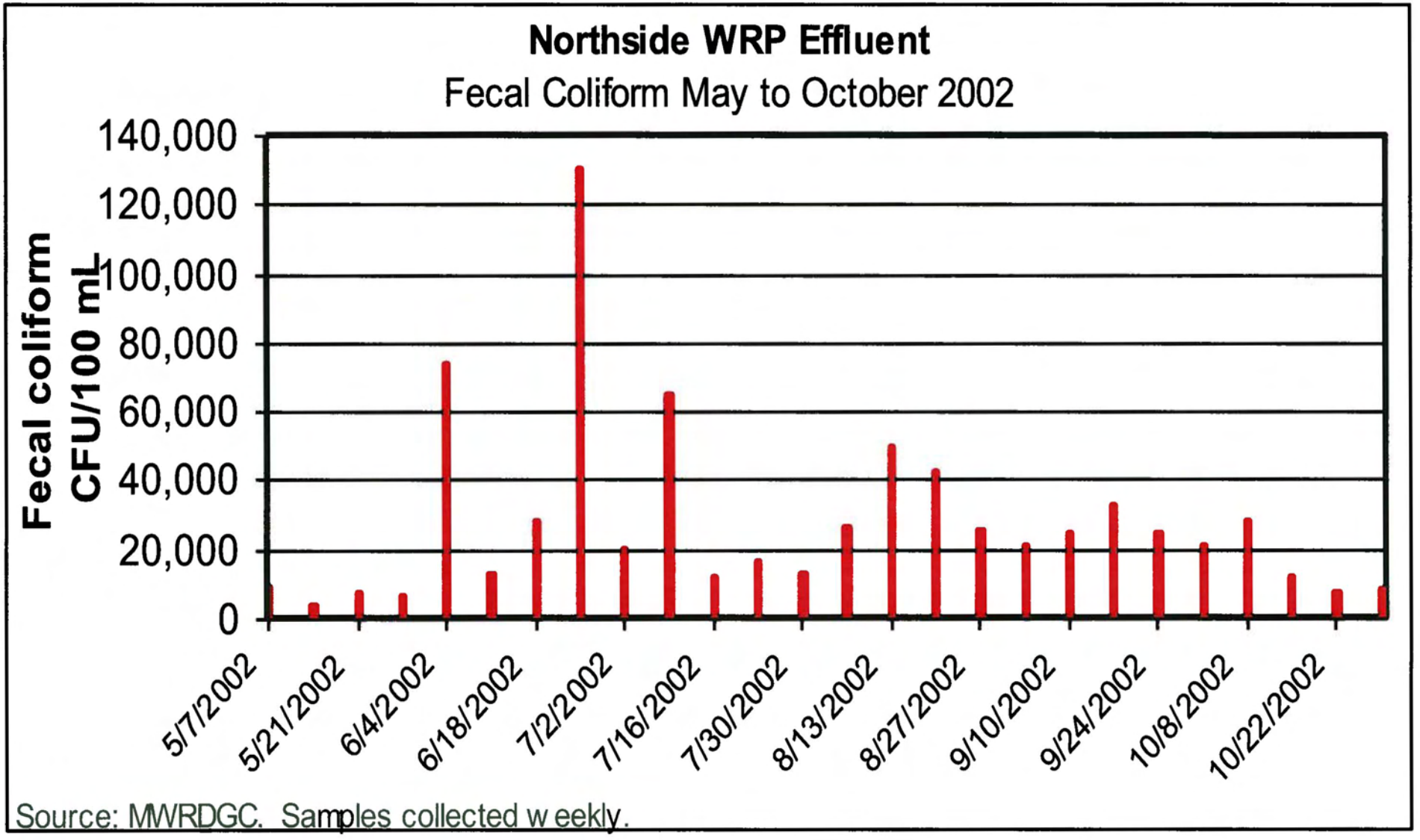
General Use 30 day geometric mean 200 per 100mL limit

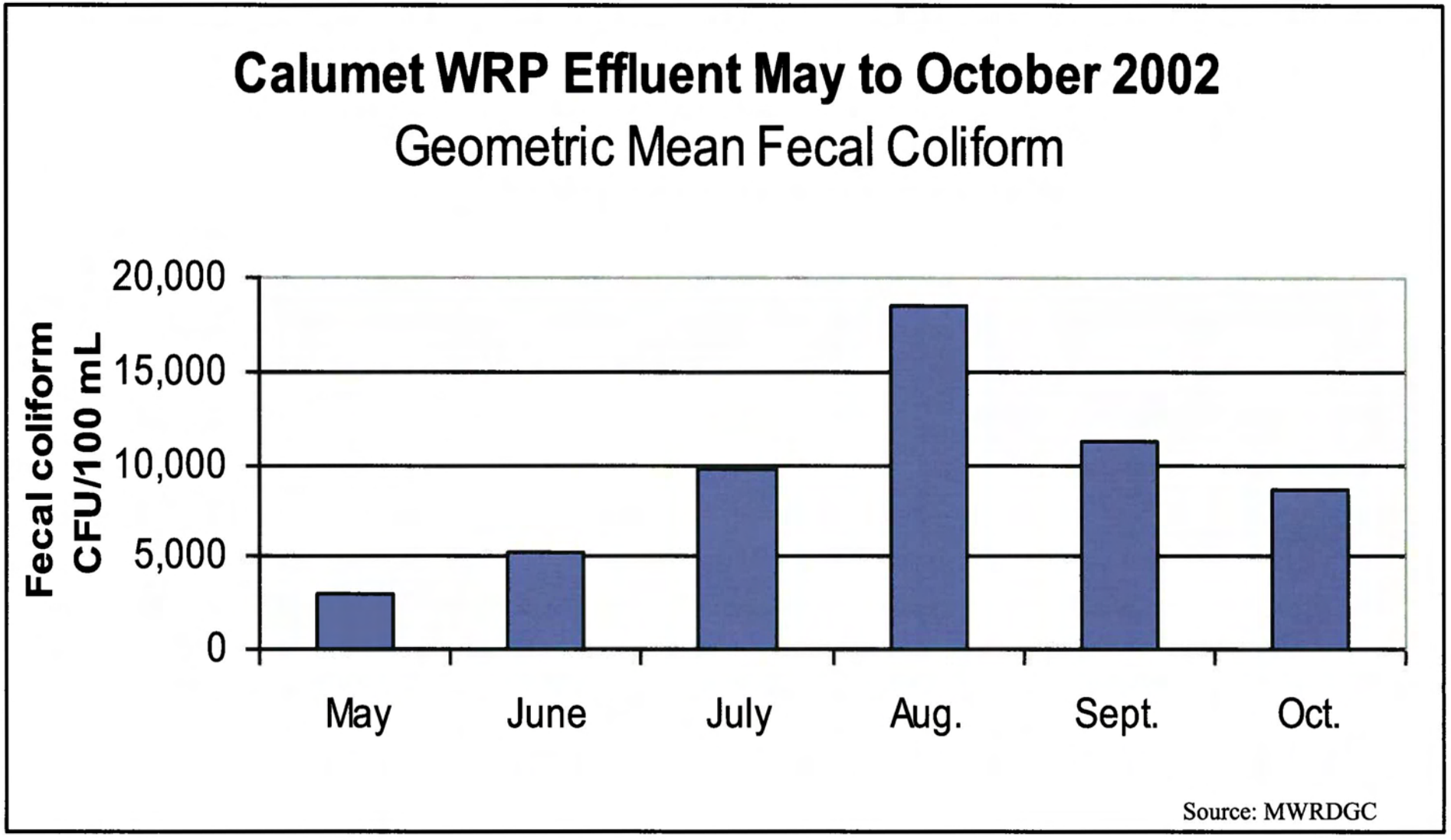
– Distance downstream of monitoring station from WWTP


Little Calumet River and Cal-Sag River
May to October 2002 Geometric Mean Fecal Coliform
Calumet = 8,231
Fecal coliform CFU/100 mL
2,000
1,500
1,000
500
0
Indiana
Halsted
1.3
Ashland
2.3
Cicero
6.3
Route 83
17.2
Source: MWRDGC
Sampled Monthly
General Use 30 day geometric mean 200 per 100mL limit
– Distance downstream of monitoring station from WWTP


MWRDGC sample locations
MWRDGC monitoring points
- 63 sample locations
N
6 0 6 12 Miles
Source: MWRDGC


Northside WRP Effluent May to October 2002
Geometric Mean Fecal Coliform
Fecal coliform CFU/100 mL
0
20,000
40,000
60,000
May
June
July
Aug.
Sept.
Oct.
Source: MWRDGC


Northside WRP Effluent
Fecal Coliform May to October 2002
Fecal coliform CFU/100 mL
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
5/7/2002
5/21/2002
6/4/2002
6/18/2002
7/2/2002
7/16/2002
7/30/2002
8/13/2002
8/27/2002
9/10/2002
9/24/2002
10/8/2002
10/22/2002
Source: MWRDGC. Samples collected w eekly.


Calumet WRP Effluent May to October 2002
Geometric Mean Fecal Coliform
Fecal coliform CFU/100 mL
20,000
15,000
10,000
5,000
0
May
June
July
Aug.
Sept.
Oct.
Source: MWRDGC

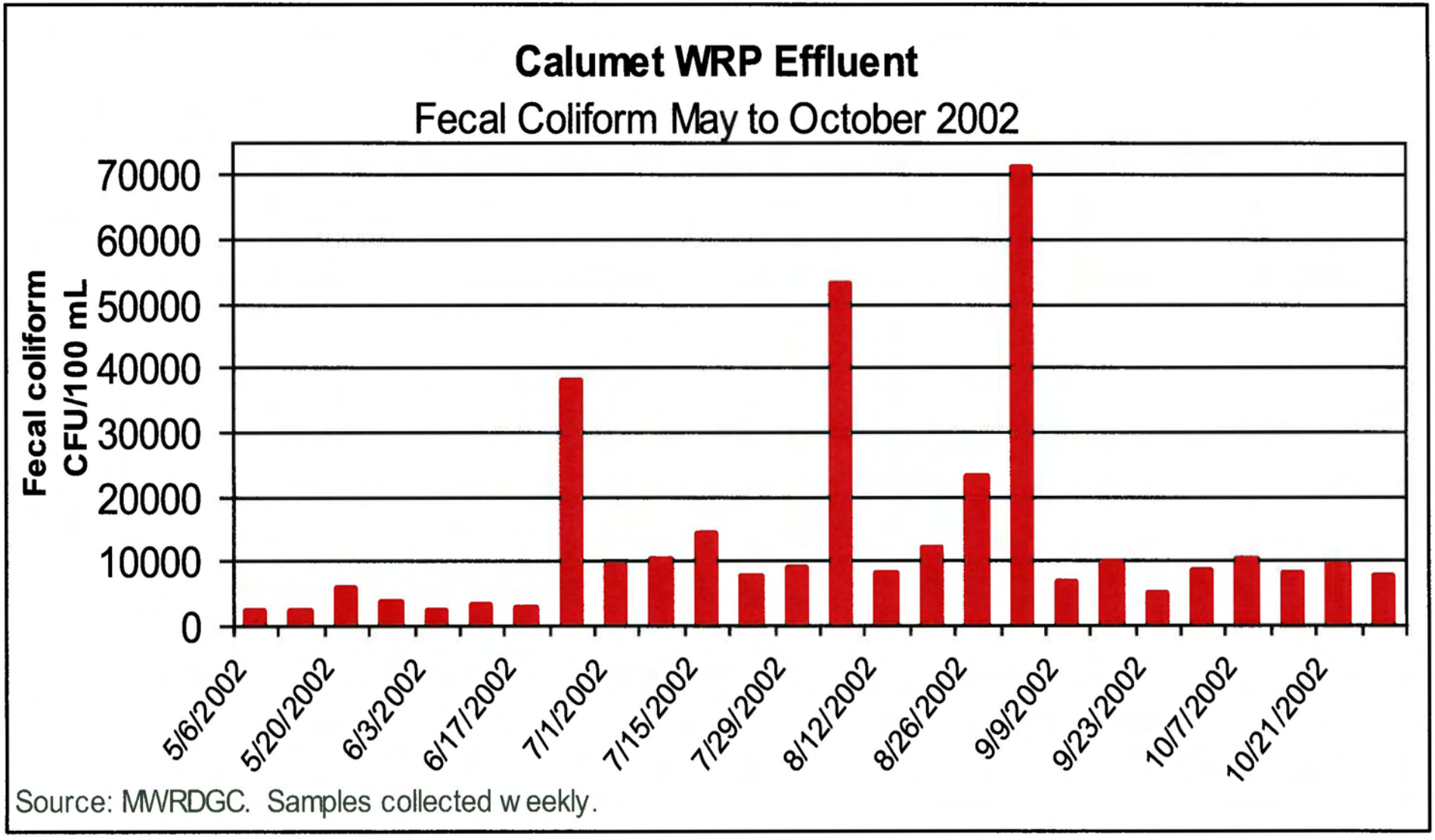

Calumet WRP Effluent
Fecal Coliform May to October 2002
Fecal coliform CFU/100 mL
70000
60000
50000
40000
30000
20000
10000
0
5/6/2002
5/20/2002
6/3/2002
6/17/2002
7/1/2002
7/15/2002
7/29/2002
8/12/2002
8/26/2002
9/9/2002
9/23/2002
10/7/2002
10/21/2002
Source: MWRDGC. Samples collected w eekly.

EXHIBIT 4

Dry Weather Risk Assessment of Human Health Impacts of Disinfection vs. No Disinfection of the Chicago Area Waterways System

Review conducted for: US EPA Region 5, Office of Water,
Review conducted by: US EPA Office of Research and Development

Summary:

A Quantitative Microbial Risk Assessment (QMRA) of the Chicago Area Waterways (CAW) was conducted to evaluate the risk of illness posed to recreational users of the CAW with the current practice of not disinfecting the effluent at three wastewater treatment plants with discharges into the CAW. Using monitoring data for pathogenic microorganisms and integrating over dose response functions, exposure times and ingestion rates, the conclusion was made that the risk for gastrointestinal illness was well under the 8-10/1000 currently deemed "acceptable" by the US EPA 1986 Ambient Water Quality Criteria, and that there was therefore no need for additional disinfection to adequately protect public health

This QMRA was only done for the Phase I "dry" weather season, and does not present results for the wet season. So presumably any conclusions would be only applicable to the dry season until the wet season analysis is completed.

National Health and Environmental Effects Research Laboratory (NHEERL):
Note: This lab's review does not assess in detail the adequacy of the microbial methods, QA procedures and sampling techniques.

Comments:

The QMRA was conducted by a consulting group, GeoSyntec Consultants, based in Chicago, with analytical assistance from Dr. Charles Gerba at University of Arizona, and Dr. Jennifer Clancey of Clancey Environmental, among others.

The microbial sampling and characterization seems thorough and adequate. World-renowned experts were consulted and retained to conduct the analyses for pathogenic microorganisms and details of the sampling scheme, rationale and methods are well described.

The general approach described for the QMRA also seems appropriate. The authors do a thorough job of explaining and justifying their selections of dose-response functions and their parameters. Generally, citations from peer reviewed literature are provided to support their decisions.

However, there are some fundamental problems in the application, presentation and interpretation of the results of the QMRA. These are detailed below:

- No justification was provided for the organisms measured or pathogens considered in the QMRA

The risks presented are only for a few gastrointestinal pathogens. Risks were not presented for Hepatitis A, Shigella, Camplyobacter, to name a few. Therefore risks presented will be biased low.

- Only gastrointestinal illness was considered

Since *Pseudomonas* and adenovirus were found, descriptions of non GI Illness should also be provided to present a clear picture of the actual risk associated with recreating in the CAW

- Conservative assumptions were not made

In nearly every case, when simplifications and assumptions were made in such a way to ultimately minimize the estimated risk. For example, high Calicivirus measures were dismissed as an artifact and an outlier. High infectivity parameters for adenovirus were dismissed because they usually cause respiratory illness. The lower infectivity of echovirus was considered instead of rotavirus. The notable exception to this is secondary transmission where some apparent conservative assumptions were made, but since it is not clear how secondary transmission was modeled and since there was no sensitivity analysis conducted it is impossible to evaluate how these assumptions ultimately affected the results.

There is also some question about the activities considered. Why wasn't full body jet skiing considered? Or other full body exposures even if they area rare and prohibited, would still result in risk of illness.

- Inadequate reporting of risk assessment results and methods

The actual risk assessment is brief and contains no graphs and few brief tables. It is unclear how microbial pathogen densities were estimated. Were distribution functions estimated based on the observed results, or were the potential values sampled from the actual results? Were only viable Cryptosporidium results considered? A table should be provided listing the details of all parameters and their ranges in used in the risk assessment. Furthermore, it is not clear how activities were randomly assigned, were they assigned based on their frequency of occurrence, or were they completely random? It is also not clear how secondary illness was modeled or incorporated into the estimate.

- Interval estimates were not reported

This is a major failing since only one estimate of the risk was reported. With the significant amount of assumptions and uncertainty, bounds on these estimates must be provided (95% bounds). Complete details of the Monte Carlo analysis should be provide so the distribution of risk can be visualized.

- No sensitivity analysis was provided

A sensitivity analysis should describe which assumptions most affected the risk estimates and how they affected the risk estimates. Since so many assumptions that were made were not necessarily conservative, this is a vital aspect to a risk assessment.

- Variability and uncertainty were not discussed, evaluated or quantified

Each step of the risk assessment contains variability and uncertainty. Uncertainty could be considered in the dose-response parameters or in the microbial densities

- Limitations were not discussed

One clear limitation is that only a few pathogens were considered and this methodology does not characterize the cumulative risk associated with all pathogens potentially present in an environment. Another clear limitation is the failure to discuss sensitive or susceptible limitations, illnesses other than GI and the potential for long term sequelae resulting from infection.

In summary, while the QMRA methodology is appropriate, many assumptions are questionable, important details are left out, there is no evaluation of the potential range of risks, and no sensitivity analysis. Therefore the QMRA does not provide sufficient information to support he assertion that there is minimal risk with the current state of no disinfection. These details should either be provided to support the claims made, or another, independent risk assessment should be conducted.

Additional specific comments:

Introduction:

Did all the consultants listed contribute? While Drs. Gerba and Clancy role was clear, that of Dr. Jack Colford was not. If Dr. Colford contributed specifically to this study, his role should be clearly defined.

Page 2:

"..no outbreaks..traceable to treated wastewater…"

Statement is misleading because outbreaks are not a reliable health indicator due to problems with consistent and reliable detection. Furthermore, statements such as these require citation from peer reviewed literature or other outside sources to avoid the perception of bias.

"The year round implementation of chlorination to disinfect the sewage treatment effluents has been reported to have adverse environmental effects"

The purpose of statements such as these is unclear and their presence in the introduction of a presumably unbiased risk assessment is concerning. While this may be true, citations from peer reviewed literature are necessary following statements such as these to avoid the perception of bias. Furthermore, benefits of chlorination should also be discussed if the downsides are going to be presented.

Page 32:

If censoring is greater than 80%, all data are statistically insignificant? Even though there was 20% detection?

Page 33:

What is the point to the detailed analysis of the correlation of indicator organisms? These are not used in the risk assessment. Rather energy should have been spent on providing more details of the actual risk assessment.

Page 36:

Although the EC/FC differences in upstream vs. downstream samples were not statistically significant this could be a function of sample size—there is a consistent difference and there could be more sophisticated measures to assess this. The p-value should be reported, not simply stated as >0.05.

The difference in the EC:FC ratios with what the District obtained calls into question the representativeness of the data for the risk assessment (Fig 3-19)

Page 41:

"While levels of potentially viable *Giardia* cysts may pose public health risk, it is important to note that not all viable organisms are capable of infection"

Seems to be a prejudicial statement. Not clear why this is important to note.

Page 42:

"The results indicate that a relatively small number of samples (23%) had detectable concentrations of enteric virus."

Relative to what? This could be an important contribution to pathogen exposure, but no information is provided to support the assertion that it is "relatively" small.

Page 44:

Citations need to be provided for statements to the effect of that b/c the RT PCR does not provide infectivity information it impedes meaningful health risk evaluation. Certainly it puts bounds on the levels of potential risk (0% viable, to 100% viable). Other sources could be evaluated for viability of norovirus in wastewater.

Page 91:

Inhalation not considered important—need citations to support this anti-conservative simplification and assumption.

For canoeists, kayakers, this could be an important pathway

Page 92:

Activities such as water skiing, etc. were excluded because they are not allowed, but do they occur? Is the prohibition enforced? An accurate risk assessment would consider these activities if they occurred especially when evaluating the potential benefit of disinfection.

Jet Skis-classified as pleasure boating with minimal contact. This is problematic-also "the RA does not consider jet skis that result in immersion.

Page 100:

Using echovirus (less infectious) instead of rotavirus (the most infectious) for the dose response relation, results in less conservative (fewer illness) estimates.

Page 101:

Was genetic immunity/susceptibility to norovirus infection considered?

Page 102:

By using the more conservative GI model for adenovirus, total health effects are underestimated. Should also evaluate respiratory risks with the more infectious model. What is the justification for using the less infectious parameter?

Page 105:

Again the focus on GI results in a conservative estimate of overall risk

Page 111:

Since Monte Carlo analysis was used, why wasn't a risk distribution (e.g., 50^{th} percentile, 90^{th} percentile, etc) generated?

Details on how secondary spread was modeled are not clear.

Page 117:

How was recreation type selected in the simulation? Were they in proportion to the actual usage?

Page 134:

Risk assessment was only conducted for limited number of GI pathogens.

National Center for Environmental Assessment (NCEA):
Note: this lab's comments are based on a cursory review only.

Comments

There are some serious surrogacy issues -- e.g., using rotavirus data for a norovirus dose-response is implausible.

Page 133:

Table 4-6 presents a summary of the secondary attack rates that appear quite high. Additional investigation of the original references are needed to get a better idea of whether or not the values posted are reasonable.

Page 115-116:

The discussion of the "disease transmission model" and secondary attack rates is very sketchy. The authors vaguely mention "dynamic models" (which do not seem to be provided anywhere in the document) and appear to be rather naive about the difficulty of parameterizing such models. They state that secondary attack rates depend on virulence, shedding rate, and environmental stability of the organisms. But probably human contact patterns, characteristics, and age groups are more important.

It does appear that this risk assessment has weaknesses that could potentially be meaningful

National Exposure Research Laboratory (NERL):

Comments

Since the overall goal of the study is to determine whether or not to disinfect the effluent why the protozoans were included in this study?

The chlorine concentrations that would be used would result in little or no inactivation of the G/C. However, CEC's summation of the protozoan results and interpretation and method limitations were quite reasonable.

The number of Giardia cysts is lower than some other reports for sewage; however, this may because there are only dry weather events in this portion of the study.

It should be more clearly emphasized that the number of Cryptosporidium oocysts from the samples were below the cell culture detection limit and even if all of the oocysts applied were infectious it is unlikely that a foci would develop.

The documents treatment of the parasite issue was really not adequate.

The risk assessment appears to be a standard boiler plate, which is only as good as the data used to form it.

EXHIBIT 5

Document filed with the Clerk. Waiver of service requirements upon hearing participants requested pursuant to 35 Ill. Admin. Code 102.424(c)

EXHIBIT 6

TABLE 1 *Illnesses acquired by ingestion of water*

Agent	Source	Incubation period	Clinical syndrome	Duration
Viruses				
Astrovirus	Human feces[a]	1–4 days	Acute gastroenteritis	2–3 days; occasionally 1–14 days
Norovirus (Norwalk virus, Snow Mountain agent, and other related viruses)	Human feces[a]	1–3 days	Acute gastroenteritis with predominant nausea and vomiting	1–3 days
Enteroviruses (polioviruses, coxsackieviruses, echoviruses)	Human feces	3–14 days (usually 5–10 days)	Febrile illness, respiratory illness, meningitis, herpangina, pleurodynia, conjunctivitis, myocardiopathy, diarrhea, paralytic disease, encephalitis, ataxia, diabetes	Variable
Hepatitis A virus	Human feces	15–50 days (usually 25–30 days)	Fever, malaise, jaundice, abdominal pain, anorexia, nausea	1–2 wk to several months
Hepatitis E virus	Human feces	15–65 days (usually 35–40 days)	Fever, malaise, jaundice, abdominal pain, anorexia, nausea	1–2 wk to several months
Rotavirus A	Human feces[a]	1–3 days	Acute gastroenteritis with predominant nausea and vomiting	5–7 days
Rotavirus B	Human feces[a]	2–3 days	Acute gastroenteritis	3–7 days
Bacteria				
Aeromonas hydrophila	Fresh water	Unknown	Watery diarrhea	Avg 42 days
Campylobacter jejuni	Human and animal feces	3–5 days (1–7 days)	Acute gastroenteritis, possible bloody and mucoid feces, possible Guillain-Barré syndrome	1–4 days, occasionally >10 days
Enterohemorrhagic *E. coli* O157:H7	Human and animal feces	3–8 days	Watery, then grossly bloody diarrhea, vomiting, possible HUS	1–12 days (usually 7–10 days)
Enteroinvasive *E. coli*	Human feces	2–3 days	Possible dysentery with fever	1–2 wk
Enteropathogenic *E. coli*	Human feces	2–6 days	Watery to profuse watery diarrhea	1–3 wk
Enterotoxigenic *E. coli*	Human feces	12–72 h	Watery to profuse watery diarrhea	3–5 days
Plesiomonas shigelloides	Fresh surface water, fish, crustaceans, wild and domestic animals?	1–2 days	Bloody and mucoid diarrhea, abdominal pain, nausea, vomiting	Avg 11 days
Salmonellae	Human and animal feces	8–48 h	Loose, watery, occasionally bloody diarrhea, possible reactive arthritis	3–5 days
Salmonella enterica serovar Typhi	Human feces and urine	7–28 days (avg 14 days)	Fever, malaise, headache, cough, nausea, vomiting, abdominal pain, possible pericarditis, orchitis and splenic or liver abscesses	Weeks to months

(Continued on next page)

TABLE 1 Illnesses acquired by ingestion of water *(Continued)*

Agent	Source	Incubation period	Clinical syndrome	Duration
Shigellae	Human feces	1–7 days	Possible dysentery with fever, possible reactive arthritis	4–7 days
Vibrio cholerae O1	Human feces	9–72 h	Profuse, watery diarrhea, vomiting, rapid dehydration	3–4 days
Vibrio cholerae non-O1	Human feces	1–5 days	Watery diarrhea	3–4 days
Yersinia enterocolitica	Animal feces and urine	2–7 days	Abdominal pain, mucoid, occasionally bloody diarrhea, fever, possible reactive arthritis	1–21 days (avg, 9 days)
Parasites				
Balantidium coli	Human and animal feces	Unknown	Abdominal pain, occasional mucoid or bloody diarrhea	Unknown
Cryptosporidium parvum	Human and animal feces	1–2 wk	Profuse, watery diarrhea	4–21 days
Entamoeba histolytica	Human feces	2–4 wk	Abdominal pain, occasional mucoid or bloody diarrhea	Weeks to months
Giardia lamblia	Human and animal feces	5–25 days	Abdominal pain, bloating, flatulence, loose, pale, greasy stools	1–2 wk to months and years
Algae				
Cyanobacteria (*Anabaena* spp., *Aphanizomenon* spp., *Microcystis* spp.)	Cyanobacterial blooms in water	A few hours	Toxin poisoning (blistering of mouth, gastroenteritis, pneumonia)	Variable
Helminths				
Dracunculus medinensis (guinea worm)	Larvae discharged from worms protruding from skin of infected person	8–14 mo (usually 12 mo)	Blister, localized arthritis of joints adjacent to site of infection	Months

[a]Animal strains of these viruses are believed to be nonpathogenic for humans.

TABLE 2 Illnesses acquired by recreational contact with water[a]

Agent	Source	Incubation period	Clinical syndrome	Duration
Viruses				
Adenovirus (serotypes 3, 7, 1, 4, 14)	Humans	4–12 days	Conjunctivitis, pharyngitis, fever	7–15 days
Bacteria				
Aeromonas hydrophila	Fresh and brackish water	8–48 h	Wound infections	Weeks to months
Legionellae	Freshwater, soil	Legionnaires' disease: 2–14 days (usually 5–6 days); Pontiac fever: 5–66 h (usually 24–48 h)	Legionnaires' disease: pneumonia with anorexia, malaise, myalgia and headache, rapid fever and chills, cough, chest pain, abdominal pain and diarrhea; Pontiac fever: fever, chills, myalgia, headache	Legionnaires' disease: variable (usually weeks to months); Pontiac fever: 2–7 days
Leptospira spp.	Urine from infected domestic and wild animals	2–20 days (usually 7–12 days)	Leptospirosis (headache, chills, fever, myalgia, nausea, neck or joint pain)	A few days to 3 wk
Mycobacterium spp. (*M. marinum*, *M. balnei*, *M. platy*, *M. kansasii*, *M. szulgai*)	Marine or brackish waters, freshwater	2–4 wk	Lesions of skin or subcutaneous tissues	Months
Pseudomonas spp.	Water	Unknown	Dermatitis, ear infections, conjunctivitis	Unknown
Vibrio spp. (*V. alginolyticus*, *V. parahaemolyticus*, *V. vulnificus*, *V. mimicus*)	Marine water	*V. vulnificus*, 24 h; *V. parahaemolyticus*, 4–48 h	*V. vulnificus*: acute gastroenteritis, wound infections, septicemia *V. parahaemolyticus*: acute gastroenteritis, wound infections Ear infections	*V. vulnificus*: septicemia fatal in 2–4 days *V. parahaemolyticus*: usually 3 days
Other				
Cyanobacteria (*Anabaena*, *Aphanizomenon*, and *Microcystis* species)	Cyanobacterial blooms in marine water or freshwater	A few hours 3–7 days	Dermatitis	10 days
Naegleria fowleri	Freshwater in warm climates, soil, decaying vegetation	A few minutes to hours	Meningoencephalitis, headache, anorexia, fever, nausea and vomiting; usually fatal	
Acanthamoeba species	Water		Subcutaneous abscesses, conjunctivitis	8 days to several months
Schistosoma species	Feces and urine of infected animals and birds		Dermatitis, prickly sensation, itching	Years

[a]Agents acquired through ingestion of water are not included in this table.

EXHIBIT 7

Table 4.1 Recreation Uses, Criteria, and Supporting Analyses

Designated Use	Criterion	Supporting Analysis
Primary Contact Recreation		
Identified/Popular Beach Areas	Criteria based on risk levels of 8 or fewer illnesses/1000 swimmers (fresh waters) and 19 or fewer illnesses/1000 swimmers (marine waters).	None.
Other Primary Contact Recreation Waters	Criteria based on risk level not greater than 14 illnesses/1000 swimmers (fresh waters) and not greater than 19 illness/1000 swimmers (marine waters).	None.
Seasonal Recreation Use	Primary contact recreation criteria apply during specified recreational season; secondary contact recreation criteria apply rest of year.	Information explaining choice of recreation season (e.g., water & air temperatures, time of use, etc.).
Recreational Use Subcategories		
Exceptions for High Flow Events	Exception to criteria at high flows on a waterbody-by-waterbody basis based on flow statistic or number of exceedances allowed.	Use Attainability Analysis consistent with 40 CFR 131.10(g); demonstration that primary contact recreation is not an existing use.
Wildlife Impacted Recreation	Criteria to reflect the natural levels of bacteria while providing greater protection than criteria adopted to protect a secondary contact recreation use.	Use Attainability Analysis consistent with 40 CFR 131.10(g) and data demonstrating wildlife contributes a significant portion of fecal contamination; demonstration that primary contact recreation is not an existing use.
Other Categories of Recreation		
Secondary Contact Recreation	Criteria sufficient to protect the use. May use numeric criterion protective of secondary contact recreation(suggest specifying criterion expressed as maximum value or criterion expressed as geometric mean five times primary contact recreation geometric mean value) or narrative criterion.	Use Attainability Analysis consistent with 40 CFR 131.10(g); demonstration that primary contact recreation is not an existing use.