



Recreational Water Quality Criteria for Primary Contact Recreation

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Current Types of Recreational Criteria Recommendations

EPA now has CWA Section 304(a) recommendations for:

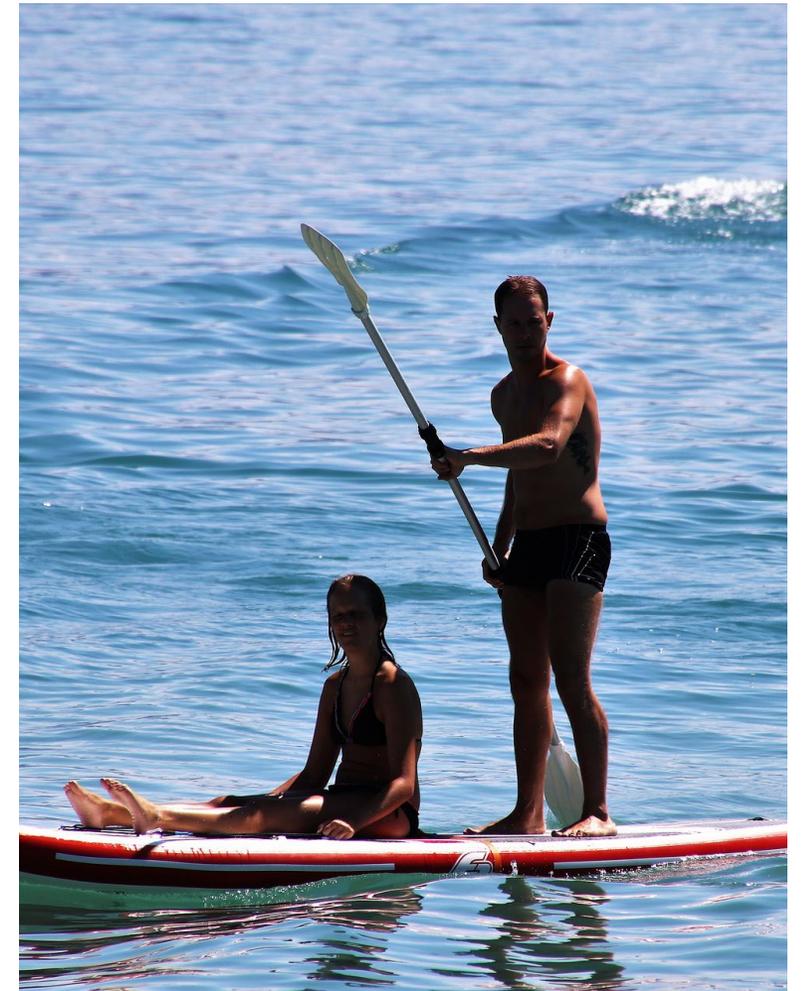
- Fecal contamination (bacterial indicators)
- Cyanotoxins



Photo credit: USEPA via flickr

2012 Recreational Water Quality Criteria (RWQC)

- Prevent illness
 - Controls on point source permits (NPDES permits) reduce amount of fecal contamination in waterways
- Identify impaired waters
 - 303(d) Listing, Total Maximum Daily Loads (TMDLs)
- Identify potentially hazardous conditions
 - Beach notifications



BEACH Act of 2000

- 2000 Beaches Environmental Assessment and Coastal Health (BEACH) Act amended the CWA.
 - Applies to all coastal recreation waters: marine and Great Lakes designated for primary contact recreation.
 - Requires States/authorized Tribes to adopt the 1986 Criteria before 2004 for their coastal waters, OR EPA must promulgate the criteria for them.
 - Requires States/authorized Tribes to adopt the revised (i.e., 2012) RWQC for their coastal waters.
 - Requires EPA to complete a review of the revised criteria every 5 years.
 - Provides grants for beach monitoring and notification programs for coastal waters.
 - Required specific research on pathogen indicators, analytical methods, etc. to inform the revisions to the RWQC.

2012 Recreational Water Quality Criteria: Fecal Contamination

- Used by States/Tribes adopting water quality standards to protect the designated use of primary contact recreation.
- Help protect against illness caused by fecal pathogens from recreational exposure (swimming)



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Bacterial Indicators of Fecal Contamination

- Fecal pathogens are disease-causing microorganisms (viruses, protozoa, and bacteria) associated with fecal contamination.
- Monitoring for the many pathogens associated with fecal contamination is not possible and the available analytical methods are difficult and costly.
- EPA's current RWQC are based on **bacteria** (*E.coli* and enterococci) that indicate fecal contamination, and thus **indirectly**, the presence of fecal pathogens.

NEEAR Epidemiology Studies

- 2003-2010 EPA conducted 9 epidemiological studies:
 - National Epidemiological and Environmental Assessment of Recreational Waters (NEEAR)
- Based on the results of NEEAR studies, EPA was able to update the RWQC in 2012.
 - Recommended culture methods
 - Enterococci in marine and freshwaters, and *E. coli* in freshwaters.
 - Recommended uniform illness rates in marine and freshwaters (previously different).
 - NEEAR marine and freshwater data sets were similar enough to combine.
 - Provided a rapid method – quantitative polymerase chain reaction (qPCR) and values that correlate to the illness rates of the enterococci culture values.
 - New method can provide results in 4-6 hours.

2012 RWQC (1)

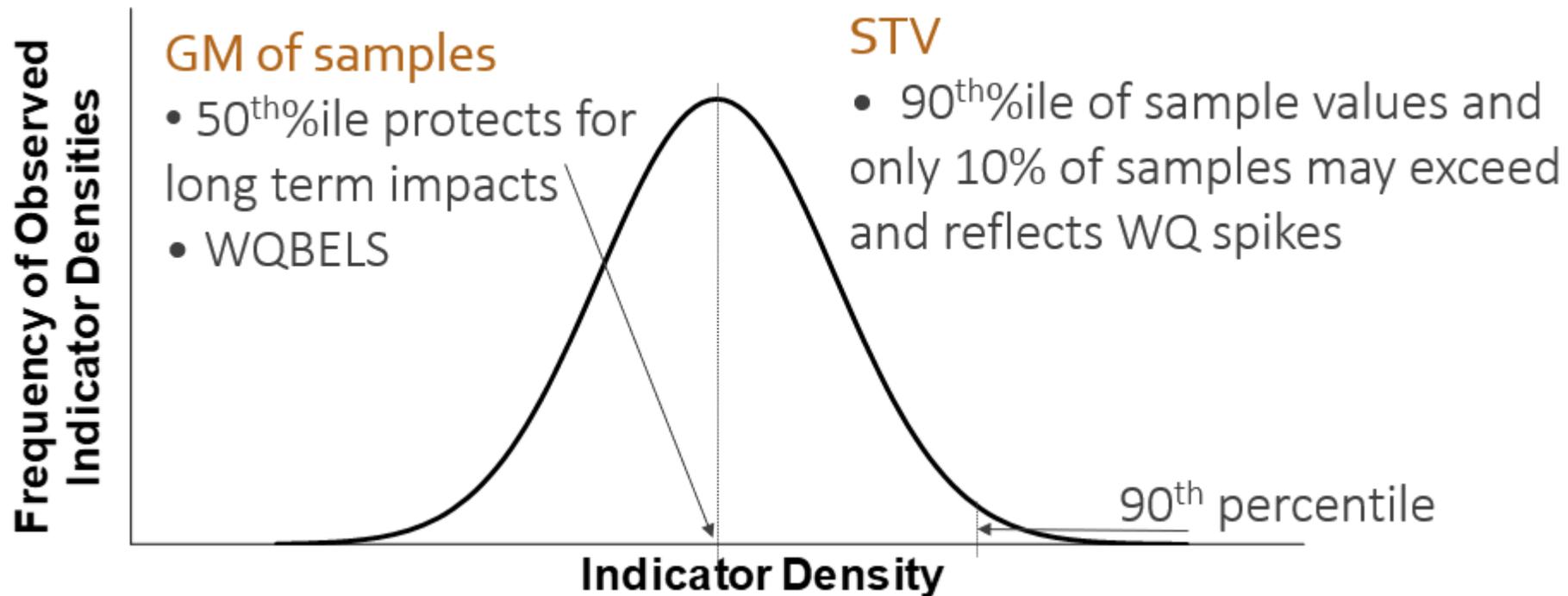
- 2012 RWQC are CWA 304(a) criteria and are national recommendations for all waters
 - Values are appropriate for inland and coastal waters that are designated for the “primary contact recreational use”
- States/Tribes designate the majority of waters for primary contact recreation
 - 2012 RWQC does not address secondary contact recreational uses (e.g., fishing)
 - Resources for secondary contact rec questions:
 - [An Approach for Applying EPA’s 2012 Recreational Water Quality Criteria Recommendation to Non-primary Contact Exposure Scenarios White Paper](#)
 - [Adopting Water Quality Criteria for Secondary Contact Recreation: A User Guide](#)

2012 RWQC (2)

- EPA's 2012 recommended CWA Section 304(a) RWQC consist of a magnitude, duration, and frequency of fecal contamination indicated by fecal indicator bacteria.
- 2012 RWQC provides two sets of recommended criteria, each of which corresponds to a different illness rate
 - Either can be adopted in State/Tribal WQS
 - Both are protective
 - Allows for risk management decision
- The magnitude, duration, and frequency should be included in the State's/Tribe's Water Quality Standard (WQS).

Magnitude

E. coli and enterococci values are derived from NEEAR studies and expressed by both a Geometric Mean (GM) and Statistical Threshold Value (STV).



Duration and Frequency

- Recommended duration is 30 days
- Recommended frequency: GM = 0%, STV = 10%
 - Waterbody's GM should not be greater than the adopted recreational WQS GM in any 30-day interval (zero exceedance) and there should not be a greater than 10% excursion frequency of the selected STV in the same 30-day interval.
 - Duration beyond 90 days should be accompanied by scientific rationale.
- The 30-day duration with limited excursions above the STV, allows for the detection of transient fluctuations (i.e., spikes) in water quality in a timely manner.
 - The 30-day duration can be either static or rolling.
- Magnitude, duration and frequency apply regardless of the number of samples within the 30-days.

2012 RWQC

Criteria Elements	Estimated Illness Rate (NGI): 36 per 1,000 primary contact recreators		OR	Estimated Illness Rate (NGI): 32 per 1,000 primary contact recreators	
	Magnitude			Magnitude	
Indicator	GM (cfu/100 mL) ^a	STV (cfu/100 mL) ^a	OR	GM (cfu/100 mL) ^a	STV (cfu/100 mL) ^a
Enterococci – marine and fresh	35	130		30	110
OR				OR	
<i>E. coli</i> – fresh	126	410		100	320

Duration and Frequency: The waterbody GM should not be greater than the selected GM magnitude in any 30-day interval. There should not be greater than a ten percent excursion frequency of the selected STV magnitude in the same 30-day interval.

^a EPA recommends using EPA Method 1600 (U.S. EPA, 2002a) to measure culturable enterococci, or another equivalent method that measures culturable enterococci and using EPA Method 1603 (U.S. EPA, 2002b) to measure culturable *E. coli*, or any other equivalent method that measures culturable *E. coli*.

Implementation of 2012 RWQC

- Waters designated for primary contact recreation would be protected if either set of magnitude values (GM and STV) are adopted into state WQS and approved by EPA.
- EPA recommends States/Tribes select the set of criteria values most appropriate for their waters based on a risk management decision regarding illness rate.
- EPA recommends States/Tribes apply their risk management decision (i.e., selection of 32 or 36 illness/1000) State/Tribe-wide.

Supplemental Elements for Enhanced Protection (1)

In addition to the RWQC values, the 2012 RWQC provides supplemental tools for consideration:

- 1. qPCR method:** RWQC provides GM and STV values for state/Tribes interested in adopting the *Enterococcus* qPCR method (Method 1609.1) into their WQS.
 - The qPCR method allows for timely same-day beach notification (~4-6 hours).
 - EPA encourages a site-specific analysis of the method's performance prior to use.
- 2. Beach Action Values (BAV):** values for making precautionary beach notification decisions.
 - BAVs correspond to the 75th percentile of the water quality distribution of the RWQC.
 - BAVs are available for both culturable indicators and for the *Enterococcus* qPCR method (rapid method).

Supplemental Elements for Enhanced Protection (2)

qPCR Method 1609.1

Element	Estimated Illness Rate (NGI): 36/1,000 primary contact recreators		OR	Estimated Illness Rate (NGI): 32/1,000 primary contact recreators	
	Magnitude			Magnitude	
	GM (cce per 100 mL)	STV (cce per 100 mL)		GM (cce per 100 mL)	STV (cce per 100 mL)
qPCR ^a	470	2,000		300	1,280

Duration and Frequency: The waterbody GM should not be greater than the selected GM magnitude in any 30-day interval. There should not be greater than a 10% excursion frequency of the selected STV magnitude in the same 30-day interval.

^a EPA *Enterococcus* spp. Method 1609.1 for qPCR.

Supplemental Elements for Enhanced Protection (3)

BAV Values

Indicator	Estimated Illness Rate (NGI): 36 per 1,000 primary contact recreators	OR	Estimated Illness Rate (NGI): 32 per 1,000 primary contact recreators
	BAV (Units per 100 mL)		BAV (Units per 100 mL)
Enterococci – culturable (fresh and marine) ^a	70 cfu		60 cfu
<i>E. coli</i> – culturable (fresh) ^b	235 cfu		190 cfu
<i>Enterococcus</i> spp. – qPCR (fresh and marine) ^c	1,000 cce		640 cce

^a Enterococci measured using EPA Method 1600 (U.S. EPA, 2002a), or another equivalent method that measures culturable enterococci.

^b *E. coli* measured using EPA Method 1603 (U.S. EPA, 2002b), or any other equivalent method that measures culturable *E. coli*.

^c EPA *Enterococcus* spp. Method 1609.1 for qPCR.

Tools for Evaluating Rec Waters

Predictive models:

- A tool to more timely notification.
 - [Six Key Steps for Developing and Using Predictive Tools at Your Beach](#)
 - [Virtual Beach Model Builder](#)

Sanitary surveys:

- A tool to characterize a recreational water and identify sources of fecal contamination to focus mitigation efforts.
 - [EPA's Sanitary Survey App for Marine and Freshwaters](#) includes routine and annual surveys for both fresh and marine waters.
 - The App enables jurisdictions to easily gather information on possible existence of harmful algal blooms, in addition to sources of bacterial pollution.



Tools for Developing Site-Specific Alternative Criteria for Rec Waters

- States/Tribes may conduct epidemiological- or Quantitative Microbial Risk Assessment (QMRA)-based health studies using locally-collected data.
- EPA has developed technical support materials for states/Tribes to develop site-specific alternative criteria:
 - Use of QMRA to modify EPA's 2012 recommended criteria for waterbodies with predominantly non-human fecal source contributions.
 - Characterization of human health risks from non-human sources of fecal contamination in recreational waters using QMRA
 - Evaluation of alternative fecal indicators compared to EPA's recommended fecal indicators. (completed)
 - Alternative Indicators and Methods Technical Support Materials
 - Excel-based calculator to support alternative fecal indicator development

RWQC : Fecal Contamination – Future Directions: Coliphage (1)

- EPA developing recreational AWQC for Coliphage
 - Health studies indicate enteric viruses cause majority of swimming-associated illnesses in waters affected by human fecal contamination.
 - Traditional wastewater treatment processes are not designed to reduce enteric viral loads in human sewage but do reduce culturable fecal indicator bacteria.
 - Enteric viruses enter surface waters from treated and untreated human fecal sources.
 - There is a need for an indicator that can reflect the potential risks from enteric viruses in contaminated recreational waters.

RWQC : Fecal Contamination – Future Directions: Coliphage (2)

- Coliphages are viruses that infect bacteria and are found in high levels in human sewage.
- Proposed as alternative fecal indicator organisms in the published scientific literature.
- Currently used to gauge water quality in groundwater, shellfish harvesting water, and potable water reuse.
- Physically similar to enteric viruses.
- Exhibit similar responses to treatment and environmental behavior compared to enteric viruses.
- Not pathogenic and have a low potential to multiply in the environment once discharged.

Recreational AWQC/ Swimming Advisories for Cyanotoxins (1)



- Cyanobacteria occur naturally in marine and freshwater ecosystems.
- Cyanobacteria can multiply rapidly to high densities forming blooms, these are known as Harmful Algal Blooms (HABs) and further produce harmful cyanotoxins.
- Significantly-elevated levels of cyanotoxins can be associated with HABs although the toxins can be present in the absence of a visually-confirmed bloom.
- Blooms are dependent on numerous factors, including nutrient loading, temperature, and weather patterns.
- Different toxins can be produced by several different species and multiple toxins can be produced by a single species.

Recreational AWQC/ Swimming Advisories for Cyanotoxins (2)



EPA issued final recommended criteria values for microcystins and cylindrospermopsin below which human health is protected.

- Recommended values can be used as CWA Section 304(a) recreational criteria or swimming advisories.
- Based on children’s recreational exposures.
- EPA did not recommend a cell density value for cyanobacteria.
 - Provided additional information in the document to aid recreational water managers in protecting recreators from the potential risks that cyanobacteria can pose.

2019 Cyanotoxin AWQC/SA

Table 6-1. Recreational Criteria or Swimming Advisory Recommendations for Microcystins and Cylindrospermopsin^a

Application of Recommended Values	Microcystins			Cylindrospermopsin		
	Magnitude (µg/L)	Duration	Frequency	Magnitude (µg/L)	Duration	Frequency
Recreational Water Quality Criteria	8	1 in 10-day assessment period across a recreational season	More than 3 excursions in a recreational season, not to be exceeded in more than one year ^b	15	1 in 10-day assessment period across a recreational season	More than 3 excursions in a recreational season, not to be exceeded in more than one year ^b
Swimming Advisory		One day	Not to be exceeded		One day	Not to be exceeded

^a These recommendations can apply independently within an advisory program or in WQS. States can choose to apply either or both toxin recommendations when evaluating excursions within and across recreational seasons.

^b An excursion is defined as a 10-day assessment period with any toxin concentration higher than the criteria magnitude. When more than three excursions occur within a recreational season and that pattern reoccurs in more than one year, it is an indication the water quality has been or is becoming degraded and is not supporting its recreational use. As a risk-management decision, states should include in their WQS an upper-bound frequency stating the number of years that pattern can reoccur and still support its recreational use.

2019 AWQC/SA: Children's Exposure and Health

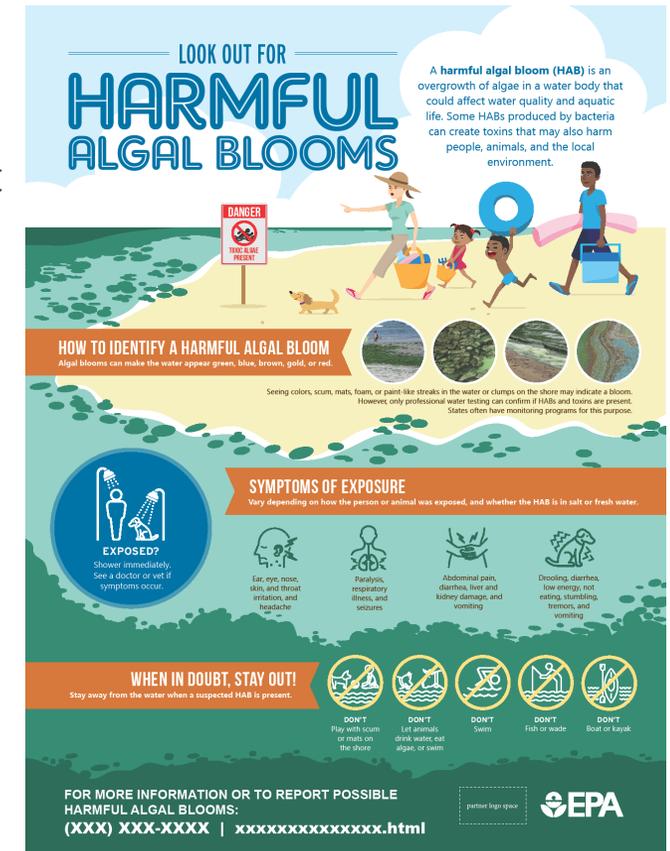
- Children experience a disproportionate share of the incidents during HAB-associated outbreaks (Hilborn et al. 2014; Weirich and Miller 2014).
 - 66% of the outbreaks in 2009-2010 were <19 yr.
 - 35% were <9 yr.
 - 80% of all confirmed illness reports due to fresh water cyanotoxin exposure involved children.
- Children have greater potential exposure compared to others when recreating.
 - Incidentally ingest a larger volume of water.
 - Spend more time in the water compared to other age groups.
- Evidence shows younger children can be more highly exposed (DeFlorio-Barker et al. 2017; Dufour et al. 2017; Schets et al. 2011).



Implementation Materials Supporting Cyanotoxin Recreational AWQC/SA

To support adoption and implementation of the Ambient Water Quality Criteria (AWQC), EPA published:

- *Monitoring and Responding to Cyanobacteria and Cyanotoxins in Recreational Waters*
 - Suite of materials posted online that states and communities can use to protect public health during cyanobacterial blooms.
 - Information intended for recreational waterbody managers to develop a cyanotoxin monitoring program, communicate potential health risks to the public, and address HAB outbreaks.
- *Final Technical Support Document: Implementing the 2019 Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin*
 - Explains how states, territories, and authorized Tribes may adopt EPA's recommended criteria for two cyanotoxins into their water quality standards, use the criteria in swimming advisory programs, identification and listing of impaired waters, and TMDL development.
- *Infographics to help educate the public on HABs*



Take Home Messages

- EPA's 2012 RWQC for fecal contamination recommend the use of culturable *E. coli* and enterococci to protect the designated use of primary contact recreation.
- When using the 2012 RWQC, states and Tribes have flexibility to:
 - make appropriate risk management decisions.
 - consider alternative criteria/evaluation tools.
 - use rapid methods (qPCR).
- EPA now has 304(a) recommendations to address:
 - algal toxins via AWQC/Swimming Advisories for Cyanotoxins.
- EPA is working to address:
 - viral fecal contamination via a coliphage-based RWQC.

For More Information

- Visit [EPA's Recreational Water Quality Criteria and Methods Website](#)
 - Google: “EPA Recreational Criteria”
 - Provides info/links on all Recreational Criteria
 - 2012 Recreational Water Quality Criteria
 - Human Health Recreational Ambient Water Quality Criteria and/or Swimming Advisories for Microcystins and Cylindrospermopsin and related implementation support materials
 - EPA's efforts to develop Coliphage Criteria
 - EPA microbial methods for ambient water and wastewater