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National Beach Guidance and Required Performance Criteria for Grants, 2014 Edition

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National Beach Guidance and Required Performance Criteria for Grants, 2014 Edition

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Acronyms and Abbreviations

AFO	Animal feeding operation
AOAC	Association of Official Analytical Chemists International
APHA	American Public Health Association
ASTM	American Society for Testing and Materials International
ATP	Alternate Test Procedure
AWWA	American Water Works Association
BAV	Beach Action Value
BEACH Act	Beaches Environmental Assessment and Coastal Health Act of 2000
BEACON	Beach Advisory and Closing Online Notification
CAFO	Concentrated animal feeding operation
CCE	Calibrator cell equivalents
CFU	Colony-forming unit(s)
CFR	Code of Federal Regulations
CPD	Chicago Park District
CSO	Combined sewer overflow
CWA	Clean Water Act
DOHMH	[New York City] Department of Health and Mental Hygiene
DQO	Data quality objective
EMPACT	Environmental Monitoring for Public Access and Community Tracking
EPA	[United States] Environmental Protection Agency
FIB	Fecal indicator bacteria
FR	Federal Register
FY	Fiscal year
GM	Geometric mean
IAC	Internal amplification control
IMS/ATP	Immunomagnetic separation/adenosine triphosphate
mL	Milliliter
MPN	Most probable number
MST	Microbial source tracking
NEEAR	National Epidemiologic and Environmental Assessment of Recreational Water

NGI	NEEAR gastrointestinal illness
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
OW	Office of Water
POTW	Publicly owned treatment works
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QMP	Quality management plan
QMRA	Quantitative microbial risk assessment
qPCR	Quantitative polymerase chain reaction
RSS	Real Simple Syndication
RWQC	Recreational Water Quality Criteria
SCCWRP	Southern California Coastal Water Research Project
SOP	Standard operating procedure
SPC	Sample processing control
SSM	Single sample maximum
STORET	EPA's national database for STORage and RETrieval (STORET) of water quality data
STV	Statistical Threshold Value
TMDL	Total maximum daily load
USGS	United States Geological Survey
WHO	World Health Organization
WQS	Water quality standard(s)
WQX	Water Quality eXchange

This document discusses the required performance criteria for beach monitoring and notification programs for which the U.S. Environmental Protection Agency (EPA) provides implementation grants under Clean Water Act (CWA) section 406(b). It also provides additional guidance (recommendations) for grant recipients.

This document might also be used as nonbinding guidance for states, tribes, and local governments that do not have a CWA section 406(b) grant, but want to develop and implement beach monitoring and notification programs. This document contains a wealth of useful information and many best management practices that states, tribes, and local governments might want to follow.

The general approach and principles described here are also recommended for inland beaches, although some modifications might be appropriate.

Chapter 1: Introduction

The *National Beach Guidance and Required Performance Criteria for Grants* outlines the performance criteria that an eligible coastal or Great Lakes state,[1] territorial, tribal, or local government must meet to receive grants to implement coastal recreation water monitoring and public notification programs under section 406 of the Clean Water Act (CWA), as amended by the Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act). Section 3.2.1 defines the coastal recreation waters covered under the grant program. This document also provides useful guidance for both coastal and inland beach monitoring and notification programs. The BEACH Act, however, authorizes the award of grant funds to support monitoring and notification programs for coastal recreation waters only.

In 2002 the U.S. Environmental Protection Agency (EPA) published performance criteria for the BEACH Act grant program. That document raised the bar for beach monitoring and notification programs by standardizing required program elements, while still allowing states sufficient flexibility to accommodate their local conditions. Since then, EPA and the states have created a strong infrastructure to implement the national and state BEACH Act monitoring and notification programs. Together, EPA and the states have built a program that has greatly increased consistency among the states as well as the quality, quantity, and timeliness of beach water quality data. This information helps beachgoers to make informed decisions about beach-going activities and helps beach managers take actions to safeguard the health of their beaches and the people using them.

Today's beach programs are ready to take the next steps, and following the performance criteria and recommendations in this guidance will help them to accomplish that.

[1] For simplicity, throughout the remainder of this document, unless otherwise noted, we use the general term *state* to refer to the 30 coastal and Great Lakes states or local governments and the coastal territories defined in CWA section 502 as the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and the Trust Territory of the Pacific Islands. Eligible tribes are recognized independently and not included in the term *state*. If certain requirements or recommendations apply in a different manner to each governmental entity, the text will specify how they apply. This simplified terminology also applies to those entities using this document as nonbinding guidance, e.g., those not receiving CWA section 406(b) grants.

- Consistent with the BEACH Act, the guidance requires states receiving grants under CWA section 406 to adopt new or revised recreational water quality standards (WQS). **State adoption of new or revised standards will put in place the many public health protections from the 2012 Recreational Water Quality Criteria** (RWQC), including:
  - Addressing a broader range of illness symptoms.
  - Better accounting for pollution after heavy rainfall.
  - Ensuring equal protection for swimmers in coastal and Great Lakes waters.
  - Encouraging early alerts to beachgoers by identifying a conservative threshold for issuing beach notifications (i.e., advisories and closures).
  - Making available a quantitative molecular method (qPCR) that provides analytical results in hours.
  - Supporting tailored WQS for site-specific public health protection.
- The guidance also **paves the way for improved beach monitoring and public awareness.** The performance criteria and recommendations in the guidance will lead states into an era characterized by widespread use of sanitary surveys to identify sources of fecal pollution; the use of qPCR analysis and predictive modeling that facilitate same-day notification of water quality exceedances; site-specific solutions for protecting public health; and timely reporting of water quality results and advisory information for easy public access and dissemination.

1.1 Program and Document Overview

EPA initially published *National Beach Guidance and Required Performance Criteria for Grants* in June 2002. EPA is revising the guidance to accomplish the following:

- Reflect updated science.
- Incorporate key considerations deriving from EPA's most recent CWA section 304(a) criteria recommendations in the 2012 *Recreational Water Quality Criteria* (RWQC; USEPA 2012b).
- Emphasize using tools such as sanitary surveys in evaluating and classifying beaches.
- Encourage a more comprehensive approach optimizing resources by developing a tiered monitoring and notification plan that takes into account new tools, such as modeling and rapid methods, and historical information about each beach.
- Update the discussion on beach notification and communication to include tools such as social media, websites, and email.

Chapters 3, 4, and 5 of this guidance discuss these changes.

Key Changes to This Document from the 2002 Guidance

- Updates the science on pathogens, fecal indicator bacteria (FIB), and health concerns (sections 1.2, 1.3, and 1.4) and references.
- Discusses the beach program and the 2012 RWQC (sections 1.5 and 4.7).
- Makes sanitary surveys a central part of the beach classification process (section 3.4).
- Provides detailed guidance on developing the List of Beaches (section 3.6).
- Strengthens the link between prioritizing beaches and developing a tiered monitoring plan (sections 3.5, 3.6, and 4.2).
- Adds specific requirements to performance criteria 2, 3, 4, and 6 (sections 4.2, 4.4, 4.5, and 5.2, respectively).
- Updates the science on beach water quality monitoring (section 4.3).
- Updates monitoring procedures to include quantitative polymerase chain reaction (qPCR) (section 4.4.2).
- Expands the discussion on integrating predictive models into monitoring plans (section 4.6).
- Provides guidance on when to issue or remove a notification (section 5.3).
- Discusses new beach notification and communication tools, such as social media, email, and text messages (section 5.4).
- Adds a new performance criterion, Performance Criterion 10 (section 4.7.3).

The BEACH Act addresses the human health risks associated with water quality and swimming or similar water contact activities in coastal recreation waters. The BEACH Act, an amendment to the Federal Water Pollution Control Act (commonly known as the Clean Water Act, or CWA), addresses pathogens and pathogen indicators[2] in coastal recreation waters.

The BEACH Act contains four significant provisions:

1. The BEACH Act amended the CWA by adding section 303(i), which directs states with coastal recreation waters to adopt new or revised WQS for pathogens and pathogen indicators for which EPA had published criteria under CWA section 304(a) (i.e., EPA's 1986 Bacteria Criteria). Section 303(i) also directs EPA to promulgate standards for states that fail to establish standards as protective of human health as EPA's 1986 criteria. EPA promulgated standards for specific states and territories with the publication of *Water Quality Standards for Coastal and Great Lakes Recreation Waters Final Rule* (40 CFR [Code of Federal Regulations] part 131) in November 2004.

[2] The BEACH Act uses the terminology *pathogen* and *pathogen indicators*. The BEACH Act defines *pathogen indicator* as "a substance that indicates the potential for human infectious disease" [33 U.S.C. 1362(23)]. *Pathogen indicators* is a broad category of entities (which can include chemical and biological parameters) that can be used to indicate the presence of pathogens in water. In the case of BEACH Act implementation, EPA's current recreational water quality recommendations and state WQS are for FIB, which are a subset of the pathogen indicators used globally for management of recreational waters. Where appropriate throughout the remainder of this document, FIB are referred to specifically when discussing WQS. When a more inclusive discussion of indicators is presented, the reference is to pathogen indicators.

2. The BEACH Act amended the CWA by adding sections 104(v) and 304(a)(9), which together require EPA to conduct studies associated with pathogens and human health and to publish new or revised CWA section 304(a) criteria for pathogens and pathogen indicators on the basis of those studies. EPA completed studies in December 2010 and published new or revised criteria for recreation waters in November 2012.

3. Under section 303(i)(1)(B), states that have coastal recreation waters are directed to adopt new or revised WQS for all pathogens and pathogen indicators to which EPA's new or revised section 304(a) criteria are applicable by no later than three years after EPA's publication of the new or revised section 304(a) criteria.

4. The BEACH Act amended the CWA by adding section 406, which authorizes EPA to award grants to states or local governments to develop and implement beach monitoring and notification programs. It also requires EPA to maintain state monitoring and notification data and make them available to the public. In addition, the BEACH Act amended section 518(e) of the CWA to authorize EPA to treat tribes in the same manner as states for the purposes of section 406; therefore, EPA is authorized to award grants to tribes.

To read the full text of the BEACH Act, go to http://water.epa.gov/lawsregs/lawsguidance/beachrules/act.cfm.

1.1.1 Implementing the BEACH Act

Since the passage of the BEACH Act in 2000, EPA and states have created a strong infrastructure to implement national and state BEACH Act monitoring and notification programs. Significant progress has been made in providing more public health protection at beaches.

- ***Beach grants.*** Beginning with development grants in fiscal year (FY) 2001, EPA has continued to provide implementation grants to states and tribes to monitor their beaches and notify the public of exceedances or likely exceedances of WQS for pathogens and pathogen indicators. Since 2001, EPA has made available nearly $130 million in grants to 38 eligible grantees (30 states, five territories, and three tribes).
- ***State beach program infrastructure.*** States are the primary implementers of beach monitoring and notification programs funded under the BEACH Act. Since 2000, they have significantly refined, improved, and upgraded their beach programs, often through the use of innovative approaches. The number of monitored beaches more than doubled between 1997 and 2012. Since 2005, monitored beaches have been open for an average of 95 percent of the available beach days during each beach season.

  Many states are using innovative tools such as predictive models and rapid analytical methods to provide faster, more accurate public notification of exceedances or likely exceedances of applicable WQS for pathogen indicators. They have improved beach notification signage and outreach and communication with the public. Some states issue notifications in English and Spanish or use color-coded systems to indicate differences in risk. Many states now provide real-time beach water quality results and beach status information through the Internet so the public can be better informed.

- ***Sound science and new program tools.*** In 2008 EPA published the *Great Lakes Beach Sanitary Survey User Manual* (USEPA 2008) and sanitary survey forms to encourage using this tool to characterize beach environments and identify likely sources of pollution. Through the Great Lakes Restoration Initiative, states conducted more than 400 sanitary surveys at Great Lakes beaches. On the basis of the findings of the sanitary surveys, mitigation measures are currently being implemented at several Great Lakes beaches to reduce or eliminate contamination.

  In 2013 EPA published the *Marine Beach Sanitary Survey User Manual* (USEPA 2013) to help beach managers in coastal states synthesize beach and watershed information from the survey to improve water quality for swimming and develop models to predict daily water quality. The marine survey forms include detailed questions on winds, tides, and other characteristics that affect marine beaches; these were not included on the survey forms for the Great Lakes.

  EPA also developed and implemented a comprehensive research plan that includes the development and validation of rapid molecular methods for quantifying FIB to allow for rapid beach notification, the refinement and validation of predictive models for fresh and marine waters, and large-scale epidemiological studies in fresh and marine waters to determine the relationship between fecal indicator levels and illness.

- ***BEACON.*** EPA created the Beach Advisory and Closing Online Notification (BEACON) system to meet the BEACH Act requirement that EPA establish and maintain a publicly available database of pollution occurrences for coastal recreation waters. In January 2012 EPA launched BEACON 2.0, which provides access to mapped locational data (beaches and monitoring stations); monitoring results (pathogen indicators, algae, salinity, and more); and notification data (advisories and closures). For the first time, beachgoers can view reports containing both notification and water quality monitoring data. To access BEACON, go to http://watersgeo.epa.gov/BEACON2/about.html.

1.1.2 How to Use This Document

This document replaces the June 2002 *National Beach Guidance and Required Performance Criteria for Grants* and sets forth performance criteria for (1) monitoring and assessing coastal recreation waters adjacent to beaches (or similar points of access used by the public) to determine whether there are exceedances of applicable WQS for pathogen indicators and (2) promptly notifying the public of any exceedance or likely exceedance of applicable WQS for pathogen indicators for coastal recreation waters. EPA is required to publish performance criteria under CWA section 406(a). Section 406(b) authorizes EPA to award grants to states and tribes to implement monitoring and notification programs, but only if the program meets certain requirements. (See CWA section 406(b) and (c).) One such requirement is that monitoring and notification programs must be consistent with the performance criteria published under CWA section 406(a).

EPA will use the performance criteria to determine whether a monitoring and notification program is eligible for an implementation grant under CWA section 406(b). This document includes required performance criteria, general EPA grant rules under 40 CFR part 31, and nonbinding recommendations. This document can serve as a reference guide on how to develop and conduct a beach monitoring and notification program that is not funded by a CWA section

406(b) grant. It provides information on classifying recreational waters, performing monitoring and assessment, and notifying the public about beach advisories. This information is useful to beach or program managers of all beaches whether they are adjacent to coastal recreation waters or other waters. For states, tribes, and local governments without CWA 406(b) grants, the requirements this document describes would not be binding, but they can be used as recommendations to develop and implement effective beach monitoring and notification programs.

1.1.3 How This Document Is Organized

- ***Chapter 1*** discusses human health concerns associated with exposure to pathogens and discusses the establishment of WQS for pathogen indicators, specifically FIB.
- ***Chapter 2*** summarizes the basic requirements that an applicant must meet to receive a BEACH Act implementation grant. It identifies relevant sections of the BEACH Act, briefly describes the corresponding performance criteria that EPA has developed, and provides additional grant-related information.
- ***Chapter 3*** introduces a tiered, risk-based evaluation process that EPA recommends for states and tribes to classify and prioritize their recreational beaches. This step-by-step approach allows states to assess the relative human health risks and usage of their beaches and to assign an appropriate management ranking to each beach.
- ***Chapter 4*** discusses the performance criteria related to monitoring and assessment and provides detailed technical guidance. This chapter provides a step-by-step approach for developing a conceptual monitoring framework and applying it to ranked beaches. It also includes performance requirements related to recreational water quality criteria and beach notification thresholds.
- ***Chapter 5*** describes the performance criteria and technical guidance related to a beach program's public notification and risk communication. The chapter completes the conceptual framework by describing a tiered approach to notification.

1.2 Pathogens

Microorganisms that have the potential to cause disease in a host are called *pathogens*. The small subset of infectious microorganisms that are capable of causing human diseases are known as *human pathogens*.

Diseases from pathogens occur in a three-stage process: exposure, infection, and illness. Exposure to pathogens (e.g., in recreational water) might occur by direct contact, ingestion, inhalation, or entry into the body through an open wound. Infection occurs in a dynamic interaction involving the susceptibility of the host and the virulence of the pathogen. Illnesses that result from these various exposures and host-pathogen interactions can vary in their symptoms and severity. Commonly documented diseases from swimming in contaminated recreational waters include gastrointestinal illness; respiratory illnesses; skin rashes; and ear, eye, and wound infections. Sometimes these infections can result in death.

Human pathogens in recreational waters can be naturally occurring or of environmental origin, such as the bacterium *Vibrio vulnificus* and the amoeba *Naegleria fowleri*, or they can be introduced through contamination events with the feces of humans and other warm-blooded animals (e.g., norovirus, enterohemorrhagic *Escherichia coli*, and *Cryptosporidium* sp.). Modern wastewater treatment is designed to be effective at killing bacteria, such as those that cause cholera and typhus, but is less effective at reducing human infective enteric viruses and protozoa. In waters that contain human fecal contamination, potentially all the waterborne diseases spread by the fecal-oral route could be contracted by bathers. In recreational waters, three groups of pathogens—viruses, bacteria, and parasitic protozoa—are of concern.

- ***Viruses*** are a group of infectious agents that require a host to replicate. The most significant virus group affecting water quality and human health grows and reproduces in the gastrointestinal tract of people and animals and therefore is called *enteric viruses*. Enteric viruses are excreted in feces, and they can include hepatitis A, rotaviruses, caliciviruses, noroviruses, adenoviruses, enteroviruses, and retroviruses. Most gastrointestinal illness associated with swimming in water contaminated with wastewater effluent and other human fecal sources can be attributed to human enteric viruses (Soller et al. 2010). Typical wastewater treatment practices reduce the concentration of pathogenic viruses by 10- to 100-fold (Flannery et al. 2012; Lodder and de Roda Husman 2005), with secondary treated and disinfected effluent still containing human infective doses of enteric virus. Viruses are species-specific to their host; that is, human pathogenic viruses can cause disease in humans but not in other organisms.
- ***Bacteria*** are unicellular microorganisms that lack an organized nucleus and other membrane-bound organelles. Feces from humans and other warm-blooded animals contain large numbers of bacteria, including pathogenic species (such as *Campylobacter* spp. and *Salmonella* spp.). Some pathogenic bacterial species can be free-living and native to water environments, such as *Vibrio cholera* and *Vibrio vulnificus*. The pathogenic bacteria that are largely of concern for recreational waters are introduced into waters by fecal contamination (e.g., *Campylobacter jejuni*, *Salmonella* spp., pathogenic *E. coli*, *Shigella*).
- ***Protozoans*** are unicellular organisms with a defined nucleus. Pathogenic protozoans can be found in the feces of humans and other warm-blooded animals or can be part of the natural microflora found in the environment. Some species can exist in the environment as spores or cysts that hatch, grow, and multiply after ingestion, causing associated illness. Other species, such as *Naegleria fowleri* and schistosomes, cause disease in a free-living life stage (AWWA 2006). Two protozoan species of major concern as waterborne pathogens are *Giardia lamblia* and *Cryptosporidium parvum* (Academic Press 2003).

Waters contaminated by nonhuman fecal material can also pose a risk to swimmers because some pathogens that infect animals can also cause illness in humans. These types of pathogens are called *zoonotic pathogens*. EPA conducted a review of the scientific literature on zoonotic pathogens during the development of the 2012 RWQC and found information on key waterborne zoonotic pathogens and their potential survivability in the environment (USEPA 2009c). A World Health Organization (WHO) and EPA joint publication (WHO 2004) provides further detailed information on zoonotic pathogens, including their geographic prevalence, potential disease prevention measures, good management practices for animal waste disposal, and an international perspective. Table 1-1 lists some of the diseases that can result from contact with

water contaminated by human or animal waste, or naturally occurring bacterial, viral, and protozoan pathogens.

1.3 Fecal Indicators

A variety of pathogens can be present in waters contaminated by fecal pollution. The types and numbers of pathogens present will be determined by the source and magnitude of the fecal contamination reaching a water body. Because of the great diversity of pathogens that can affect human health (see table 1-1), and the fact that pathogens are often seasonally and geographically distributed, widespread monitoring of recreational waters directly for all disease-causing microorganisms from fecal contamination is infeasible. Therefore, protection of public health for those using recreational waters has been accomplished for more than a century through the use of FIB such as *E. coli* and *Enterococcus* sp. FIB are bacterial groups or species that are naturally found in the guts of warm-blooded animals (including humans) and therefore are excreted in high densities in the feces of such animals (NRC 2004). They provide an estimation of the amount of feces (or degree of contamination) and, indirectly, the presence and quantity of fecal pathogens in the water[3] (NRC 2004). Even though public health agencies have long used them to identify the potential for illness resulting from exposure to contaminated waters, numerous epidemiology studies have recently corroborated the use of FIB as predictors of adverse health outcomes (Colford et al. 2012; Pruss 1998; Wade et al. 2003; Wade et al. 2008; Wiedenmann et al. 2006; Zmirou et al. 2003).

Since the middle of the last century, EPA and its federal predecessors have recommended levels of various FIB groups for the protection of the health of those recreating in surface waters (USEPA 1976, 1986, 2012a). For more information on indicators of fecal contamination, refer to EPA's literature review of fecal indicator organisms in ambient waters (USEPA 2009a) and a scientific review of alternative indicators of fecal pollution (Savichtcheva and Okabe 2006).

EPA recommends that states use two different types of FIB to monitor ambient waters, culturable *E. coli* and *Enterococcus* sp. Indicators of fecal contamination are not limited to the FIB EPA recommends and might include other types of microorganisms, such as viruses (e.g., coliphage), bacteria (e.g., *Bacteroidales*), and other enumeration methods for traditional FIB (e.g., immunomagnetic separation/adenosine triphosphate [IMS/ATP], qPCR). Risk managers might wish to choose indicators that perform effectively given local climatological and hydrological conditions (e.g., *Clostridium perfringens* in tropical waters) or possess characteristics that help to identify specific fecal contamination sources (e.g., sterols, brighteners, microbial genetic markers). Whichever indicators are used for beach notification programs, they must be reliable predictors of an exceedance or the likelihood of an exceedance of the applicable WQS.

[3] This technical concept was captured and codified into 33 U.S.C. 1362(23) by the BEACH Act amendment to the CWA. The BEACH Act defines a substance that indicates the potential for human infectious disease to be a pathogen indicator. Although FIB are not direct indicators of the presence or number of pathogens, their presence have been shown in epidemiology studies to be predictive of the potential for human infectious disease (e.g., gastrointestinal illness).

Table 1-1. Examples of waterborne pathogens in the three groups: bacteria, viruses, and protozoans

Pathogen		Disease	Symptoms and Effects
Bacteria	*Aeromonas* spp.	Wound infections, gastroenteritis	Fever, chills, nausea, abdominal pain, cellulites
	Campylobacter spp.	Gastrointestinal illness	Diarrhea, abdominal pain, gastroenteritis
	Clostridium spp.	Gastrointestinal illness	Diarrhea, fever, nausea, gastroenteritis
	*Escherichia coli**	Gastrointestinal illness	Vomiting, diarrhea, gastroenteritis
	Helicobacter pylori	Gastritis	Diarrhea; peptic ulcers are a long-term sequela
	Legionella pneumophila	Legionellosis	Acute respiratory illness
	Leptospira spp.	Leptospirosis	Jaundice, fever (Weil's disease)
	Pseudomonas aeruginosa	Urinary tract infection, respiratory illness, wound infection	Dermatitis, soft tissue infections, bacteremia
	Salmonella typhi	Typhoid fever	High fever, diarrhea, ulceration of the small intestine
	Salmonella enterica	Salmonellosis	Diarrhea, dehydration
	Shigella sonnei	Shigellosis	Bacillary dysentery
	Vibrio vulnificus	Vibriosis	Wound infection, septicemia, diarrhea
	Vibrio cholerae	Cholera	Extremely heavy diarrhea, dehydration
	Yersinia enterolitica	Yersinosis	Diarrhea
Protozoa	*Balantidium coli*	Balantidiasis	Diarrhea, dysentery
	Cryptosporidium spp.	Cryptosporidiosis	Diarrhea
	Entamoeba histolytica	Amoebiasis (amoebic dysentery)	Prolonged diarrhea with bleeding, abscesses of the liver and small intestine
	Giardia lamblia	Giardiasis	Mild to severe diarrhea, nausea, indigestion
	Naegleria fowleri	Amoebic meningoencephalitis	Fatal disease; inflammation of the brain
Viruses	Adenoviruses	Gastrointestinal illness, respiratory disease	Gastroenteritis; vomiting; upper respiratory tract symptoms such as coughing, sore throat, fever
	Astrovirus	Gastrointestinal illness	Gastroenteritis, vomiting, diarrhea
	Enterovirus (including echovirus and Coxsackie virus)	Gastrointestinal illness, upper respiratory tract infection, myocarditis	Diarrhea, gastroenteritis, vomiting, fever, heart inflammation, cough, sore throat, bronchitis
	Hepatitis A and E	Infectious hepatitis	Jaundice, fever
	Norovirus	Gastrointestinal illness	Gastroenteritis, vomiting, diarrhea
	Rotavirus	Gastrointestinal illness	Gastroenteritis, vomiting, diarrhea

*Denotes pathogenic *E. coli*, which differs from the nonpathogenic *E. coli* used as an FIB.

Sources: Cloete et al. 2004; Guillot and Loret 2010; USEPA 2002, 2009b; and WHO 2004.

It is important to note that FIB are not exclusively of fecal origin, and they can be part of the natural microflora in the environment. FIB have also been shown to persist and even grow in sand, sediments, and soils; on plant surfaces; and within algal mats and biofilms (Byappanahalli and Ishii 2010; Byappanahalli et al. 2012; Verhougstraete et al. 2010). FIB from these nonfecal sources have not been demonstrated to be related to the potential for human illness. EPA recommends that beach managers understand the potential fecal sources in the watershed affecting their beach to most effectively protect the health of beachgoers. Performing a sanitary survey[4] (section 3.4.1) of the beach watershed is a good step toward this goal, and EPA has made available surveys for both marine and freshwater beaches.

1.4 Health Concerns

The primary route of exposure to enteric pathogens in recreational waters contaminated with feces is incidental or accidental ingestion of contaminated water. Swimming in contaminated waters results in an elevated potential of contracting gastrointestinal illness. Symptoms include chills, nausea, diarrhea, and fever and can vary in severity depending on the etiologic agent. Other health endpoints, such as respiratory illness, ear and eye infections, and skin rashes, have been observed from similar exposures, but gastrointestinal illness has been the disease observed most frequently. Pathogens from nonfecal sources can have various routes of exposure resulting in diseases affecting the eye, ear, skin, and upper respiratory tract. Infection can result when pathogenic microorganisms come into contact with small breaks and tears in the skin or ruptures in delicate membranes in the ear or nose.

People who acquire an illness from swimming in contaminated water do not always associate their illness with swimming because of the delay in the onset of the illness. For example, viral gastrointestinal illness is often mild, short-lived, and self-limiting, but symptoms usually take up to 24 hours to appear. Outbreaks of disease are documented when many people seek medical assistance because of a similar illness or the severity of the illness. However, people with mild illness often do not seek medical assistance. Therefore, disease outbreaks are often inconsistently recognized and the outbreak information in the literature is likely underestimated.

Pathogens can be difficult to routinely monitor in ambient waters because they often occur at levels below the detection limit, can require samples of large volumes of water, and often require concentration before enumeration (Borchardt and Spencer 2002; Girones et al. 2010; Rochelle and Schwab 2006). In addition, spatial and temporal variability in the occurrence and level of pathogens should be considered in any ambient pathogen-monitoring regime. As discussed in section 1.3, public health agencies have traditionally relied on FIB to measure the magnitude of fecal contamination in a water body. Since the 1950s, studies have been conducted to gauge how the level of fecal contamination translates into potential human health risks through FIB measurements. Many of these studies, called *epidemiology studies*, have established a link between the FIB level in bathing waters and the incidence of swimming-associated disease symptoms. EPA conducted a review of the epidemiology studies found in the scientific literature during the development of the 2012 RWQC (USEPA 2009b). For many of the epidemiology studies, the pathogens causing many of the reported illnesses were likely viral in nature (e.g., norovirus) (Cabelli 1983; Soller et al. 2010). Additional analyses of the existing

[4] http://www2.epa.gov/beach-tech/beach-sanitary-surveys

epidemiological data have shown that the presence of enteroviruses was strongly associated with the reported gastrointestinal illness (Wade et al. 2003). Viruses have characteristics, such as their susceptibility to treatment in a wastewater treatment plant and fate and transport behavior in the environment, that differ from those of the bacteria used as fecal indicators.

In 1972 EPA began to study the relationship between the quality of bathing water and the resulting health effects. Studies in the 1970s and 1980s examined the differences in symptomatic illness between swimming and non-swimming beachgoers at marine and freshwater bathing beaches affected by treated and nontreated human fecal contamination (Cabelli 1983; Dufour 1984). The studies found that swimmers who recreate in water contaminated with sewage are at greater risk of contracting gastrointestinal illness than non-swimmers, and that the reported swimming-associated illness rate increases as the quality of the bathing water (as measured by FIB) degrades.

A newer study has shown that even at frequently monitored beaches with very low concentrations of fecal indicators, there is a risk of contracting a swimming-related illness. Starting in 2003 and continuing through 2010, EPA conducted several epidemiological investigations as part of the National Epidemiologic and Environmental Assessment of Recreational Water (NEEAR) study program at freshwater and marine beaches affected predominantly by secondary treated and disinfected sewage effluent. The purpose of the NEEAR study program was to determine the relationship between health effects in swimmers and water quality measured using a quantitative polymerase chain reaction (qPCR) analytical methodology that produces quantitative results in two to three hours (Wade et al. 2008). Chapter 4 contains more information on the qPCR methodology.

The NEEAR results found increases in gastrointestinal illness with increasing FIB levels as measured through the use of the qPCR analytical methodology as specifically applied to enumeration of *Enterococcus* sp. (Wade et al. 2006, 2010). A stronger association was found with gastrointestinal illness than with other health endpoints (i.e., rash, upper respiratory illness, eye ailment, earache, and infected cut). The NEEAR epidemiological studies found the occurrence of gastrointestinal illness to be positively associated with levels of *Enterococcus* spp. as enumerated with EPA's *Enterococcus* spp. qPCR Method 1611 in marine and fresh waters and with *Bacteroidales* enumerated with EPA's *Bacteroidales* qPCR method in marine waters (Wade et al. 2008, 2010). The association between gastrointestinal illness and enterococci enumerated by membrane filtration (EPA Method 1600) in the NEEAR study was positive but was not statistically significant across the range of water quality observed. However, there was a similar significant increase of illness noted at 30 and 35 colony-forming units (CFU) enterococci per 100 milliliters (mL). The results of the NEEAR studies substantially informed the 2012 RWQC.

1.5 Water Quality Criteria and Standards for Bacteria

1.5.1 State Implementation of the 2012 Recreational Water Quality Criteria (RWQC)

WQS are provisions of state, tribal, or federal law consisting of a designated use or uses for the waters of the United States and water quality criteria based upon such use (40 CFR 131.3(i)).

They are the foundation of the nation's water quality management program and define the water quality goals for a water body.

Section 304(a)(1) of the CWA directs EPA to publish recommended water quality criteria accurately reflecting the latest scientific knowledge on the effects of the presence of pollutants in water on health and welfare, including recreation. The criteria EPA published under section 304(a) are intended to provide guidance to states in establishing water quality criteria in their WQS. Section 304(a)(9) of the CWA, as amended by the BEACH Act, directs EPA to publish new or revised water quality criteria recommendations for pathogens and pathogen indicators (including a revised list of testing methods, as appropriate) on the basis of the results of studies EPA conducted under section 104(v) of the CWA, for the purpose of protecting human health in coastal recreation waters. EPA's 2012 *Recreational Water Quality Criteria* (USEPA 2012b) meet the requirements of section 304(a)(9), but also include section 304(a) recommendations for noncoastal recreation waters because EPA developed the 2012 RWQC to protect all waters in the United States designated for primary contact recreation.

CWA section 303(i)(1)(B) directs BEACH Act coastal and Great Lakes states and tribes with coastal recreation waters designated for primary contact use for which EPA has approved WQS under the CWA to submit new or revised WQS for BEACH Act waters to EPA for review by December 2015 (i.e., "36 months after the date of publication" of the 2012 RWQC). EPA also encourages states and tribes with non-BEACH Act waters to review and revise their WQS as appropriate during their next triennial reviews.

Revised WQS from any state or tribe must include criteria that are scientifically defensible and protective of the primary contact recreation use. In the 2012 RWQC, EPA recommends that the state or tribal RWQC consist of a magnitude (the maximum amount of a pollutant that may be present in a water body that supports the designated use) expressed as a geometric mean (GM) and statistical threshold value (STV); a duration (the period of time over which the magnitude is calculated); and frequency of exceedance (the maximum number of times the pollutant may be present above the magnitude over the specified duration). If a state or tribe were to adopt criteria based on the 2012 RWQC recommendations, they would be considered scientifically defensible and protective of the primary contact recreation use.

EPA regulations at 40 CFR part 131 provide that in establishing numeric criteria, states should establish criteria values based on EPA's section 304(a) recommendations (e.g., the 2012 RWQC), or section 304(a) guidance modified to reflect site-specific conditions, or adopt criteria based on other scientifically defensible methods (40 CFR 131.11(b)(1)). EPA reviews and approves state WQS.

The 2012 RWQC, like the 1986 criteria, recommend using culturable *E. coli* and enterococci as indicators of fecal contamination for fresh water and enterococci for marine water. However, there are several differences between the current and previous criteria recommendations. The 2012 RWQC differ as follows. They:

- Offer similar public health protection for fresh and marine waters.
- Provide two sets of recommended criteria values that protect the designated use of primary contact recreation.

- Include a new statistical value, the STV, to be used in conjunction with the recommended GM value to evaluate the long-term health of a water body.
- Consist of a magnitude, duration, and frequency for both the GM and the STV.

The 1986 Bacteria Criteria document included four single sample maximum (SSM) values for different levels of beach usage (use intensities). In the 2012 RWQC, EPA removed those recommendations and instead provided states and tribes with options for selecting a beach notification threshold not adopted into WQS. The options differ, depending on whether the state or tribe receives a grant under CWA section 406.

States and tribes receiving grants under CWA section 406(b) must agree to take a notification action on an exceedance or likely exceedance of the applicable WQS as a condition of receiving a grant. The FY 2014 beach grant workplans must include a commitment to develop a schedule to adopt new or revised WQS pursuant to CWA section 303(i)(1)(B) by FY 2016 and a schedule to identify and use an appropriate beach notification threshold by FY 2016. EPA expects that states and tribes receiving beach grants under CWA section 406 will select as their beach notification threshold the Beach Action Value (BAV) based on the 75th percentile value that corresponds to the indicator and illness rate in their adopted WQS. However, they do have the option to submit a written justification to use a different value. The alternative value should be selected from the same statistical distribution as the illness rate and corresponding values adopted into state WQS, and the justification should explain why this value is preferable to the EPA-preferred 75th percentile value.

Other states and tribes have additional options, as discussed in sections 4.7.2.1 and 4.7.3.

The 2012 RWQC also make available information regarding a qPCR enumeration method (Method 1611) for the more rapid detection of *Enterococcus* spp. in marine and fresh water compared to the traditional culturable enumeration methods. Method 1611 and an improved Method 1609 are anticipated to provide increased public health protection by facilitating timely notification to swimmers of elevated FIB levels.

Section 4.7 discusses the beach program within the context of the 2012 RWQC recommendations, options for selecting a beach notification threshold, and other elements.

1.5.2 Implementation Guidance

It is beyond the scope of this document to provide an in-depth discussion of WQS and associated technical issues. However, EPA has developed some technical support materials as guidance to states on how to implement the 2012 *Recreational Water Quality Criteria* (USEPA 2012b) and plans to develop more in the near future.

EPA strongly encourages states and tribes to review the technical support materials because they provide guidance on how to implement tools that states and tribes can use (1) to enhance public health protection when implementing state and tribal WQS for primary contact recreation and (2) to develop WQS that differ from EPA's recommended criteria (i.e., alternative criteria). These tools include sanitary surveys; predictive models; epidemiological studies; quantitative microbial risk assessment (QMRA); analytical methods, including *Enterococcus* spp. qPCR

(Method 1611; USEPA 2012a); and approaches for developing criteria using alternative fecal indicators and methods. The technical support materials are available at http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/index.cfm. Method 1611 can be found at http://water.epa.gov/scitech/methods/cwa/bioindicators/index.cfm.

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Chapter 2: Grants and Required Performance Criteria

This chapter addresses the basic requirements that an applicant must meet to receive a BEACH Act program implementation grant. It identifies relevant sections of the BEACH Act, briefly describes the corresponding performance criteria that EPA developed, and provides additional grant-related information. Beginning with FY 2014 beach grants that are awarded after this document is final, states[5] and tribes must meet the performance criteria in this document to receive a grant under section 406(b). However, this document contains a wealth of information and many best management practices that states and tribes might want to follow. The general approach and principles would also be applicable to inland beaches, although some modifications might be necessary.

Key changes to chapter 2 from the 2002 guidance document

- Reorganizes the 9 performance criteria and renumbers them to 11.
- Introduces new requirements for performance criteria 2, 3, 4, and 6.
- Introduces new performance criterion 10.

2.1 BEACH Act Conditions and Requirements Applicable to Section 406 Grants

EPA's statutory authority to award grants under section 406(b) of the BEACH Act includes a series of conditions and requirements for developing and implementing a beach monitoring and notification program funded by the grant. Section 406(c) of the CWA, which includes grant conditions that address the content of state and tribal programs, applies to all grants awarded to states and tribes under the authority of section 406, regardless of whether the grant is for development or implementation of a beach monitoring program. Section 406(b)(3)(A), which addresses reporting, applies to all development and implementation grants awarded to states and tribes under the authority of section 406. Section 406(b)(3)(B), which addresses delegation to local governments, applies to development and implementation grants awarded to states only (not territories or tribes). The requirements set forth in section 406(b)(2)(A) apply to all implementation grants.

2.2 Performance Criteria

EPA has 11 performance criteria for implementing monitoring, assessment, and notification programs based on the requirements in CWA section 406. To be eligible for a grant to implement a monitoring and notification program, the state's or tribe's program must be consistent with the applicable performance criteria. FY 2014 beach grants awarded before this document is final must be consistent with the performance criteria in the 2002 *National Beach Guidance and Required Performance Criteria for Grants*. Beach grants for FY 2014 and beyond that are awarded after this document is final must be consistent with the performance criteria in this

[5] For simplicity, throughout the remainder of this document, unless otherwise noted, we use the general term *state* to refer to the grant recipients discussed above (i.e., eligible states, territories, or local governments).

document. The performance criteria also apply to federal agency programs and programs that EPA implements directly. Table 2-1 lists general requirements of the performance criteria, cross-referenced to the chapters in which they are discussed. They are also summarized in sections 2.2.1 through 2.2.11. Subsequent chapters provide the specific requirements associated with each performance criterion, along with more detailed discussions.

Table 2-1. Summary of BEACH Act performance criteria

Category	Performance criterion	General requirement	Chapter where discussed
Evaluation and Classification	1	Risk-based beach evaluation and classification process	3
Monitoring	2	Tiered monitoring plan	4
	3	Methods and assessment procedures	4
	4	Monitoring report submission	4
	5	Delegation of monitoring responsibilities	4
Public Notification and Prompt Risk Communication	6	Public notification and risk communication plan	5
	7	Actions to notify the public	5
	8	Notification report submission	5
	9	Delegation of notification responsibilities	5
Implementation Schedules	10	Adoption of new or revised WQS and identification and use of a beach notification threshold	4
Public Evaluation	11	Public evaluation of program	2

2.2.1 Risk-based Beach Evaluation and Classification Process (Performance Criterion 1)

Performance criterion 1 requires a state or tribe to develop a risk-based beach evaluation and classification process and apply the process to its coastal recreation waters. The process must describe the factors used in the state's or tribe's evaluation and classification process and explain how the state's or tribe's coastal recreation waters are ranked as a result of the process. That process must result in a list of specific coastal recreation waters adjacent to beaches or similar points of access used by the public. Chapter 3 discusses general and specific requirements for this performance criterion in more detail.

2.2.2 Tiered Monitoring Plan (Performance Criterion 2)

Performance criterion 2 requires a state or tribe to develop a tiered monitoring plan. The plan must adequately address the frequency and location of monitoring and the assessment of coastal recreation waters on the basis of the periods of recreational use of the waters, the nature and extent of use during certain periods, the proximity of the waters to known point and nonpoint sources of pollution, and any effect of storm events on the waters. EPA has added three new considerations to the basis for developing the tiered monitoring plan. Chapter 4 discusses general and specific requirements for this criterion in more detail.

2.2.3 Methods and Assessment Procedures (Performance Criterion 3)

Performance criterion 3 requires a state or tribe to develop detailed assessment methods and procedures. States and tribes must adequately address and submit to EPA methods for detecting levels of pathogens and pathogen indicators that are harmful to human health in coastal recreation areas. States and tribes must also provide documentation to support the validity of methods other than those that EPA validated or approved. Finally, states and tribes must identify and submit to EPA assessment procedures for identifying short-term increases in pathogens and pathogen indicators that are harmful to human health in coastal recreation areas. Chapter 4 discusses general and specific requirements for this criterion in more detail.

2.2.4 Monitoring Report Submission (Performance Criterion 4)

Performance criterion 4 requires states and tribes to develop a mechanism to collect and report monitoring data in timely reports. States and tribes must report their monitoring data to the public in a timely manner, including posting on a website. They must report their monitoring data to EPA at least annually or at a frequency required by the EPA Administrator. EPA encourages states to coordinate closely with local governments to ensure that monitoring information is submitted consistently. Reported data must be consistent with the list of required data elements (see http://water.epa.gov/grants_funding/beachgrants/datausers_index.cfm). Chapter 4 discusses general and specific requirements for this criterion in more detail.

2.2.5 Delegation of Monitoring Responsibilities (Performance Criterion 5)

Performance criterion 5 requires a state to document any delegation of monitoring responsibilities that might have been made to local governments. If monitoring responsibilities are delegated to local governments, the state grant recipient must describe the process by which the state may delegate to local governments responsibility for implementing the monitoring program. Chapter 4 discusses general and specific requirements for this criterion in more detail.

2.2.6 Public Notification and Risk Communication Plan (Performance Criterion 6)

Performance criterion 6 requires that a state or tribe develop a public notification and risk communication plan. The plan must describe the state's or tribe's public notification efforts and measures to inform the public of the potential risks associated with water contact activities in the coastal recreation waters that do not meet applicable WQS.

The state or tribe must adequately identify measures to promptly communicate the occurrence, nature, location, pollutants involved, and extent of any exceedance or likelihood of exceedance of applicable WQS for pathogens and pathogen indicators. The state or tribe must identify how it will promptly communicate that information to EPA. States are responsible for identifying how they will promptly communicate the failure to meet applicable standards to a designated official of the local government in the area adjoining the coastal recreation waters with water quality problems.

A state or tribal government program must describe procedures for posting signs at beaches or similar points of access, or taking functionally equivalent communication measures that are sufficient to give notice to the public that the coastal recreation waters are not meeting or are not

expected to meet applicable WQS for pathogens and pathogen indicators. Chapter 5 discusses general and specific requirements for this criterion in more detail.

2.2.7 Actions to Notify the Public (Performance Criterion 7)

Performance criterion 7 requires that a state or tribe give notice to the public when coastal recreation waters are not meeting or are not expected to meet applicable WQS for pathogens and pathogen indicators.

A state or tribe must post signs at beaches or similar points of access, or provide functionally equivalent communication measures that are sufficient to give notice to the public that the coastal recreation waters are not meeting or are not expected to meet applicable WQS for pathogens and pathogen indicators. Chapter 5 discusses general and specific requirements for this criterion in more detail.

2.2.8 Notification Report Submission (Performance Criterion 8)

Performance criterion 8 requires that states and tribes compile their notification data into timely reports. States and tribes must report to EPA the actions they have taken to notify the public when WQS are exceeded. Chapter 5 discusses general and specific requirements for this criterion in more detail.

2.2.9 Delegation of Notification Responsibilities (Performance Criterion 9)

Performance criterion 9 requires that states describe any notification responsibility they have delegated or intend to delegate to local governments. The state must describe the process by which the state may delegate to local governments responsibility for implementing the notification program. Chapter 5 discusses general and specific requirements for this criterion in more detail.

2.2.10 Adoption of New or Revised WQS and Identification and Use of a Beach Notification Threshold (Performance Criterion 10)

Performance criterion 10 is a new criterion, intended to focus on adoption of new or revised WQS as required by CWA section 303(i)(1)(B) and identification and use of an appropriate beach notification threshold. These requirements apply to states and tribes receiving grants under CWA section 406(b), and they will be implemented through conditions included in the grants. Chapter 4 discusses general and specific requirements for this criterion in more detail.

2.2.11 Public Evaluation of Program (Performance Criterion 11)

Performance criterion 11 requires that states and tribes provide the public with an opportunity to review the program through public notice and provide an opportunity to comment. This is not a one-time requirement; public input must be sought whenever a state or tribe makes significant changes to its beach program. If a state or tribe significantly changes its List of Beaches, beach ranking, or other elements of its monitoring and notification program, the public must have an opportunity to review the changes before implementation. Further, states and tribes should

consult with the applicable EPA Region prior to making significant program changes. Table 2-2 lists the general and specific requirements associated with this criterion.

The public evaluation can be accomplished through notice and public comment, meetings, forums, or workshops. For example, when classifying and ranking beaches, it is beneficial to gather input from members of the community regarding the recreational waters they would like monitored. Annual public or community meetings, surveys of the users at the beach, local newspaper articles, or other sources can provide insight into public opinion about the beach, including why the beach is or is not used (e.g., for sunning, running, swimming, or surfing); perceptions of water quality and health problems; and whether beach users desire a monitoring and notification program (if none exists) or how satisfied they are with the current program.

Table 2-2. Summary of public evaluation of program performance criterion

Performance criteria		Chapter section
General requirement	**Specific requirements**	
Public Evaluation of Program (Performance Criterion 11): This performance criterion requires a state, tribe, territory, or local government to provide the public with an opportunity to review the program through public notice and an opportunity to comment.	• Provide an opportunity for the public to comment on the following components of a beach monitoring and public notification program: o Beach evaluation and classification process, including a list of waters to be monitored and beach ranking. o Sampling design and monitoring plan, including sampling location and sampling frequency. o Public notification and risk communication plan, including methods to notify the public of a swimming advisory.	3.6.2 4.3.3.5 5.2.4

2.3 Additional Grant Information

2.3.1 Grant Program Phases

The BEACH Act authorizes EPA to award grants for both developing and implementing monitoring and notification programs. Accordingly, EPA established a two-phase grant program—an initial program *development* phase followed by a program *implementation* phase. The initial phase of the grant program focuses on developing a state or tribal beach monitoring and notification program. Currently, only tribes receive development grants. The second phase of the grant program focuses on implementing a state or tribal beach monitoring and notification program. All coastal and Great Lakes states and territories are currently receiving implementation grants.

2.3.2 Eligibility for Grants

- ***State governments.*** Coastal and Great Lakes states are eligible to apply for grants to develop and implement monitoring and notification programs for their coastal recreation waters. In the BEACH Act, the term *state* applies to 30 coastal and Great Lakes states and five coastal territories defined in CWA section 502—the Commonwealth of Puerto Rico, the U.S. Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

- ***Tribal governments.*** Section 518(e) of the CWA authorizes EPA to treat eligible Indian tribes in the same manner as states for the purpose of CWA section 406. To receive BEACH Act grant funds, a tribe must have coastal recreation waters designated for primary contact use for which EPA has approved WQS under the CWA. Currently, three tribes—the Grand Portage Band of Lake Superior Chippewa, the Makah Nation of Washington State, and the Bad River Band of the Lake Superior Tribe of Chippewa Indians—receive BEACH Act grants.
- ***Local governments.*** The BEACH Act authorizes EPA to make grants to local governments for developing and implementing monitoring and notification programs only if EPA determines that the state or tribe is not implementing a program that meets the requirements of the statute. Erie County, Pennsylvania, is the only local government currently receiving a BEACH Act grant.

As mentioned previously, for the remainder of this document the term *state* refers to states, territories, and local governments unless otherwise noted.

2.3.3 Selection Process

The EPA Administrator has delegated the authority to award BEACH Act program development and implementation grants to the Assistant Administrator of the Office of Water (OW) and to EPA Regional Administrators. EPA regional offices award program development and implementation grants through a noncompetitive process.

If funds are available, EPA expects to award grants to all eligible state, territorial, tribal, and local government applicants that meet the performance criteria specified in this document and other statutory and regulatory requirements pertaining to grants.

2.3.4 Grant Award Process

EPA will award and administer BEACH Act grants according to the regulations at 40 CFR part 31 (Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments). EPA regional offices have the lead responsibility for providing grant application packages and advice after EPA makes funding available. For information on specific grants, grant coordinators, or other pertinent information, visit the Beaches website at http://www2.epa.gov/beaches.

Chapter 3: Risk-based Beach Evaluation and Classification Process

Protecting public health is the primary objective for a beach monitoring and notification program. To meet this objective, beach program managers should strive to "know your beach" and understand the potential for exposure to fecal contamination, and thus the adverse public health risk that might occur at their beaches.

Conducting a risk-based beach evaluation and classification process is required for BEACH Act grantees. EPA may award BEACH Act grants to implement a monitoring and notification program only if (1) the grant recipient prioritizes its grant funds for particular coastal recreation waters based on the use of the water and the risk to human health presented by pathogens and pathogen indicators and (2) the grant recipient makes available to EPA the factors used to prioritize the use of funding (see CWA sections 406(b)(2)(A) (ii) and (iii)).

To meet this requirement, EPA recommends that states and tribes follow a stepwise approach to conducting a beach evaluation and classification of their beaches. EPA's recommended approach is discussed throughout this chapter and illustrated in figures 3-1 through 3-6. The term *use*, as employed in this context refers to the usage of beach waters by the public; for example, how many people use a beach and when do periods of peak usage occur. The term *risk* in this context refers to the susceptibility of beach waters to fecal contamination, particularly human, and therefore the increased risk of adverse public health effects due to pathogens.

Chapters 3, 4, and 5 should be considered together. This chapter (chapter 3) explains how to classify and rank beaches using risk management decisions based on potential public health impact. Chapter 4 explains how to translate the beach rankings into detailed tiered monitoring plans. Chapter 5 discusses the linkage to a state or tribe's notification and risk communication plans for beaches.

Key changes to chapter 3 from the 2002 guidance document

- Expands and clarifies the process for characterizing beach risk and use (section 3.4).
- Strengthens the link between prioritizing beaches and developing a tiered monitoring plan (sections 3.5 and 3.6).
- Makes sanitary surveys a central part of the beach classification process (section 3.4).
- Provides detailed guidance on developing the List of Beaches (section 3.6).

3.1 Performance Criterion

Performance criterion 1 (introduced in chapter 2) addresses the beach evaluation and classification process that states and tribes must conduct. Table 3-1 includes the general and specific requirements associated with this criterion, cross-referenced to the chapter sections. States and tribes may develop their own evaluation and classification approach, but they must address these requirements.

This approach might also be helpful for assessing beaches in programs not funded by section 406(b) BEACH Act grants. (For example, these could include inland beaches in states that do not receive beach grants.) For such programs, the requirements described below should be interpreted as helpful recommendations, not binding requirements.

Table 3-1. Summary of risk-based evaluation and classification process performance criterion

Performance criteria		Chapter section
General requirement	**Specific requirements**	
Risk-based Beach Evaluation and Classification Process (Performance Criterion 1). The state or tribe must develop a risk-based beach evaluation and classification process and apply it to the state's coastal recreation waters. A state or tribal program must describe the factors used in its evaluation and classification process and explain how its coastal recreation waters are ranked as a result. The process must result in a List of Beaches.	• Identify factors used to evaluate and rank beaches. • Identify state or tribal coastal recreation waters. • Notify EPA at least annually if the List of Beaches changes significantly because of revised beach rankings or changes to monitoring and notification requirements and considerations. • Provide for public review of the risk-based rank and classification.	3.2–3.6 2.2.10

EPA recommends using the following five steps in an evaluation and classification process to develop a statewide or tribal List of Beaches:

- **Step 1:** Identify coastal recreation waters.
- **Step 2:** Identify "BEACH Act" beaches.
- **Step 3:** Characterize the beach to determine risk and use.
- **Step 4:** Rank beaches by tiers.
- **Step 5:** Classify beaches into a List of Beaches, identifying program and non-program beaches.

Details on each step are provided below.

3.2 Step 1: Identify Coastal Recreation Waters

The first step in the risk-based classification process (figure 3-1) has two parts: identifying coastal waters and identifying the designated use of the waters.

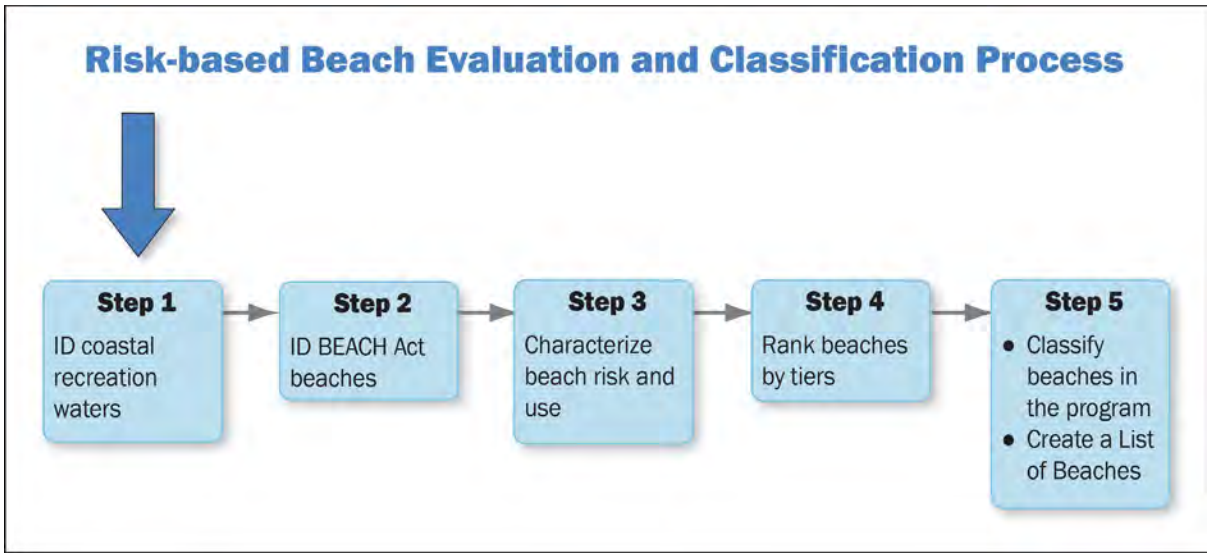

Figure 3-1. Step 1: Identify coastal recreation waters.

The BEACH Act defines *coastal recreation waters* as the Great Lakes and marine coastal waters (including coastal estuaries) designated under CWA section 303(c) by a state or tribe for swimming, bathing, surfing, or similar water contact activities.

3.2.1 Coastal Versus Noncoastal Waters

To identify coastal recreation waters, managers should first determine which of their waters are considered coastal waters. The BEACH Act specifically includes Great Lakes waters and marine coastal waters, including oceans and coastal estuaries.

The BEACH Act explicitly excludes from the definition of coastal recreation waters both inland waters and waters upstream of the mouth of a river or stream that has an unimpaired natural connection with the open sea. Figure 3-2 illustrates this difference. The heavy lines indicate areas that would be considered coastal waters; the thin lines indicate areas that would not be considered coastal waters.

A state or tribe, in consultation with EPA, should make the classification of coastal versus noncoastal, taking site-specific conditions into consideration.

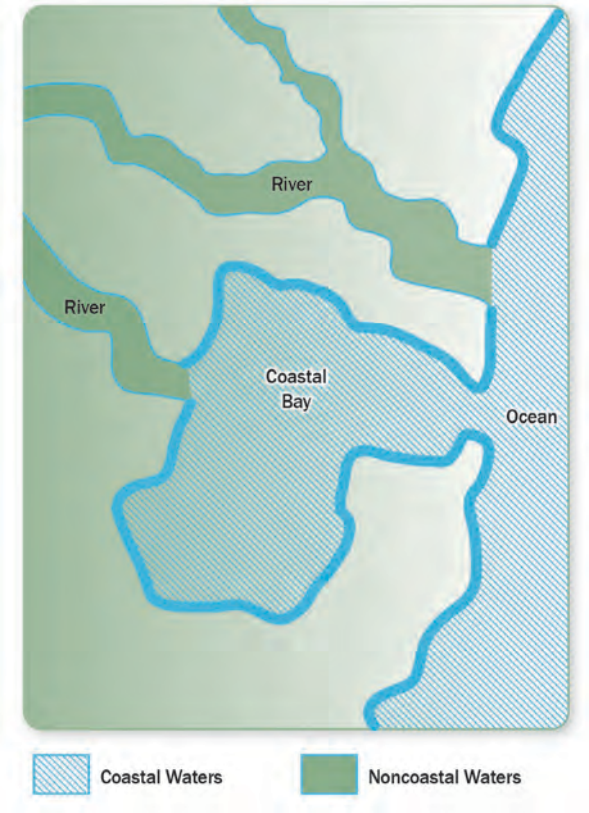

Figure 3-2. Coastal and noncoastal waters.

3.2.2 Designated Uses of Water Bodies

States should consult their state WQS to determine the "designated use" for their coastal waters. Under CWA section 303(c)(2)(A), each WQS adopted by a state or tribe must include a *designated use* for the waters to which the standard applies, along with criteria to protect the use(s).

Recreation occurs in many forms throughout the United States and frequently centers around water bodies and activities that take place in and on the water. Waters where people could engage in activities that might result in ingestion of the water or immersion are designated for use as *primary contact recreation* waters in state or tribal WQS. Such activities, for example, typically include swimming, water skiing, and surfing. Often a state will designate most or all of its surface waters for primary contact recreation. The waters adjacent to bathing beaches generally constitute a subset of the waters designated for primary contact recreation.

Most recreation waters are designated for year-round primary contact recreation. However, for some waters, a primary contact recreation use can be designated as "seasonal," attainable only for several months of the year such as during warm summer months. Use designations include seasonal, intermittent, or other recreation uses.

3.3 Step 2: Identify "BEACH Act" Beaches

The next step is to identify "BEACH Act" beaches as illustrated in figure 3-3. After beach program managers identify which coastal waters are designated as primary contact recreation, they should then determine which of these are considered "beaches." The BEACH Act grant program is for "coastal recreation waters adjacent to beaches" or "similar points of access that are used by the public"—waters where swimming, bathing, and other such activities occur. In this document, the term *beach* refers to both beaches and similar points of access adjacent to coastal recreation waters, not physical characteristics such as substrate and the like.

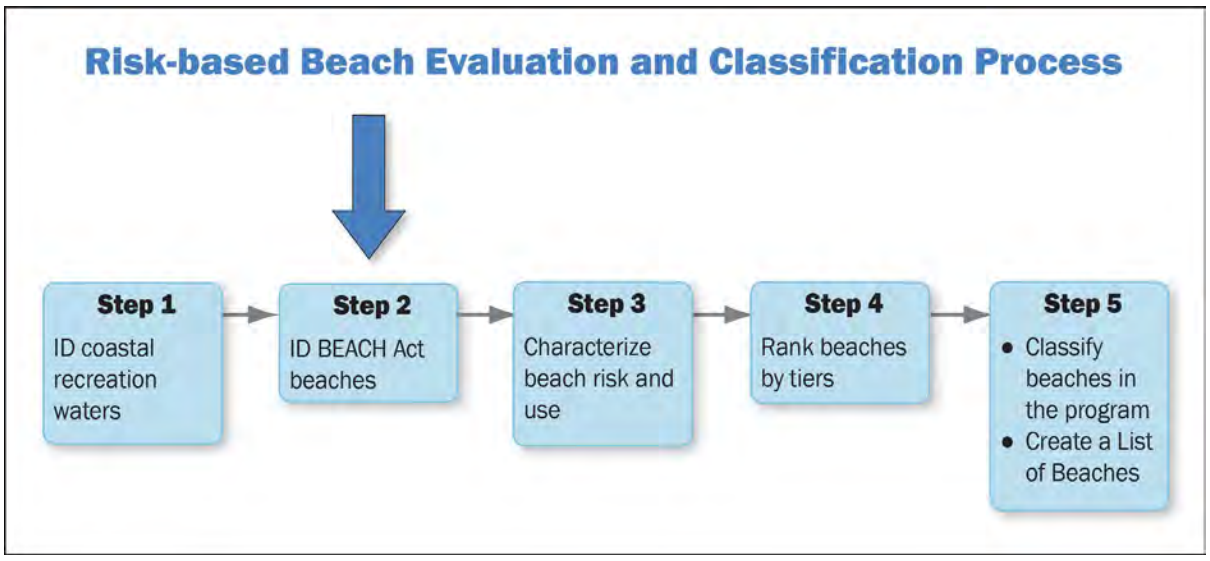

Figure 3-3. Step 2: Identify beaches and similar points of access.

A beach does not have to be in the public domain to be covered by a BEACH Act grant-funded program. Privately owned beaches that are used by the public for swimming, bathing, and other water contact activities should be included in the identification, evaluation, and classification of beaches to meet this performance criterion.

As general guidance, beach boundaries can be defined by the following:

- Jurisdictional boundaries or designated portions of shoreline within a jurisdictional boundary.
- Natural or artificial barriers that form an up-coast or down-coast beach boundary.
- Access factors, which include proximity to towns, roads, parking lots, visitor centers, shops, and other cultural landmarks.
- Limits on services such as lifeguards and monitoring programs.

Regardless of the factors involved, however, access and usage of the water body ultimately should determine whether a beach is included in a BEACH Act monitoring and notification program.

3.4 Step 3: Characterize the Beach to Determine Risk and Use

Two factors must be used in the third step (figure 3-4) to rank beaches in a BEACH Act grant-funded program: (1) factors that indicate the potential risk to human health presented by pathogens (section 3.4.1) and (2) use of the beach (section 3.4.2). As noted earlier, the term *use* refers to the usage of a beach by the public and the term *risk* refers to the susceptibility of beach waters to contamination from fecal contamination and, therefore, the increased likelihood of adverse public health risks due to pathogens.

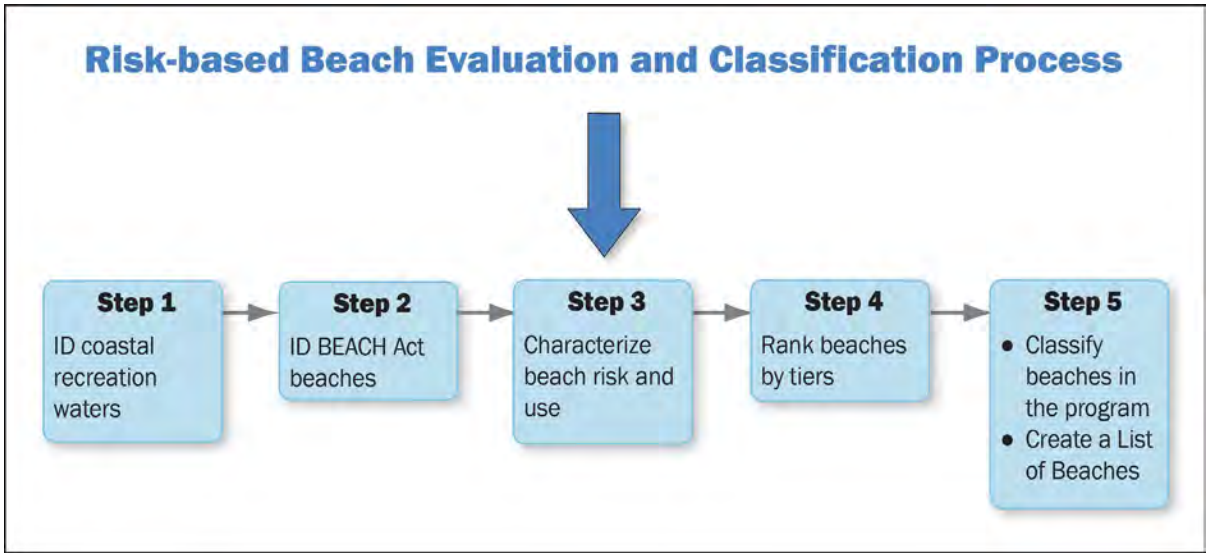

Figure 3-4. Step 3: Characterize the beach to determine risk and use.

3.4.1 Assess Potential Sources of Contamination and Risks

The first component of step 3 involves reviewing information to help beach managers assess potential sources of fecal contamination and possible public health risks. The grantee may consider a wide range of information sources. For example, available information may reside in many places, including government agency files, literature and records in local libraries, beach management reports, community association reports, public health records, scientific papers and journals, and work performed by local nonprofit organizations. The information sources are listed in order of relative importance.

3.4.1.1 Primary Information Sources

The most useful sources of information are sanitary surveys, reports on beach advisories and closings, water quality monitoring reports, water quality modeling reports, and microbial source tracking (MST) information.

3.4.1.1.1 Sanitary Surveys

Sanitary surveys are one of the most widely accepted tools to assess potential sources of pollution that might adversely affect public health. They have been employed extensively in the Great Lakes to evaluate sources of fecal contamination and help beach managers assess the magnitude of pollution.

Beach sanitary surveys involve collecting information on factors that can affect water quality, such as environmental, meteorological, physical, biological, and land-based parameters. Examples of information collected at the beach might include the number of birds at the beach, slope of the beach, location and type of sewage disposal, condition of bathrooms, recent rainfall amounts, wind speeds and wave heights, and amount of seaweed on the beach. Information collected in the watershed could include land use, location of stormwater outfalls, water quality tributaries such as rivers and estuaries, and residential septic tank placement and function.

Even though BEACH Act funds may not be spent for source mitigation and cleanup efforts, managers may use grant funds for sanitary surveys to help prioritize beaches for the List of Beaches. In addition, the survey results can help prioritize and allocate state or county resources to projects that can improve beach water quality. The survey results can also help develop models to predict beach water quality using readily available data (e.g., FIB levels, source flow, turbidity, and rainfall).

A beach sanitary survey also provides a documented historical record of beach and watershed water quality. By helping beach or program managers to establish baseline conditions and understand water quality trends, a sanitary survey enables such managers to perform long-range water quality and resource planning. A sanitary survey can support enforcement actions by recording conditions and operations at specific points in time (e.g., sewage spills). The information in a survey can benefit stormwater program managers, wastewater facility managers, local elected officials, local planning authorities, academic researchers, and other beach and water quality professionals.

For BEACH Act programs, beach managers should use surveys to help characterize health risks at specific beaches, prioritize beaches for monitoring and notification efforts, and focus the program to improve beach water quality.

The sanitary survey consists of two types of beach sanitary surveys—the *Routine On-site Sanitary Survey* and the *Annual Sanitary Survey*—to assist with short- and long-term beach assessments, respectively. The Routine On-site Sanitary Survey is designed to be performed at the same time that water quality samples are collected. The Annual Sanitary Survey is more comprehensive and can be used to record detailed information on the beach and the surrounding watershed that might affect beach water quality. Both surveys include versions tailored for freshwater and marine beaches. For example, the freshwater survey includes information on septic tanks in the contributing watershed and land use information. The marine survey forms include detailed questions on salinity, tides, and other characteristics, which the freshwater surveys do not include.

All forms are available at http://www2.epa.gov/beach-tech/beach-sanitary-surveys.

The User Manual includes additional detailed information supporting each of these survey questions, including detail about human and non-human sources. Additional information about assessing non-human sources is also available in EPA's RWQC technical support documents for QMRA.

3.4.1.1.2 Beach Notifications—Advisories and Closings

Previously issued beach notifications (i.e., advisories and closings) can provide insight into water quality problems. Information might include links to notifications caused by rain events, the frequency of notifications during the swimming season, causes of notifications (preemptive, outfalls, increased sampling, rain), and the number of swimming days affected by a notification.

3.4.1.1.3 Water Quality Monitoring Reports

Reports with data on bacterial indicator densities might be helpful. State water quality monitoring reports often contain temperature, flow, turbidity, or other water quality data that might be helpful in identifying water quality patterns because many factors influence the temporal and spatial variability of fecal indicators in recreational waters.

3.4.1.1.4 Water Quality Modeling Reports

Predictive tools, including water quality models, provide useful information. Water quality reports based on modeled results can identify or highlight beach areas that might pose increased public health risk. Many beach managers have noticed a connection between the

A recent special issue of *Water Research* (Reis and Wuertz 2013) was devoted to a large-scale, collaborative MST project that was coordinated by the Southern California Coastal Water Research Project (SCCWRP) (Boehm et al. 2013; Stewart et al. 2013). The project was called the Source Identification Pilot Project. Although the project was conducted only on human and animal fecal sources in California, it provides a state-of-the-art examination of MST methodological approaches and their potential application for source partitioning. General information on MST can be found at the SCCWRP website:

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/FactSheets/SourceIDFactSheet_web.pdf.

enumeration of FIB at a beach and the amount of rain received in nearby areas (USEPA 2010). Models that predict bacterial contamination during rainfall events can help reduce the risk of swimmer exposure to contaminants between normal sampling periods. Beach managers can develop a series of questions or a decision tree, considering factors such as rainfall to guide beach notifications (USEPA 2010). Chapter 4 provides additional information on those types of models.

3.4.1.1.5 Microbial Source Tracking

MST methods can help managers identify the types (e.g., human versus nonhuman) and sources of fecal contamination, including those from nonpoint sources. MST is based on the assumption that, given the appropriate method and source identifier, the source of pollution can be detected and quantified (USEPA 2005). Several types of analytical methods are employed for MST, and each has advantages, limitations, and applications. Determining which method is appropriate depends on the distinctive circumstances associated with the specific study area, the results of sanitary surveys, and budgetary and time constraints (USEPA 2005).

For more information on MST from EPA Region 10, visit http://www.epa.gov/region10/pdf/tmdl/mst_for_tmdls_guide_04_22_11.pdf. Although this document addresses using MST in the total maximum daily load (TMDL) program, it also provides general background information about MST approaches.

3.4.1.2 Other Information Sources

3.4.1.2.1 Point Source Discharge Data

Facilities authorized to discharge wastewater under the National Pollutant Discharge Elimination System (NPDES) program, including, but not limited to, publicly owned treatment works (POTWs), combined sewer systems, and concentrated animal feeding operations (CAFOs), can provide information on the contents, quality, history, and locations of their point source discharges.

3.4.1.2.1.1 Publicly Owned Treatment Works

POTWs are wastewater treatment works owned by a state or municipality (as defined by CWA section 502(4)) that include any devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature. The term also includes sewers, pipes, and other conveyances only if they convey wastewater to a POTW. POTWs can contribute sources of human-derived pathogens that can potentially pose a significant risk by adversely affecting human health. Therefore, the location, discharge loadings, operation, and compliance history of POTWs can be helpful to beach managers. For more information, visit http://cfpub.epa.gov/npdes/home.cfm?program_id=3.

3.4.1.2.1.2 Combined Sewer Systems

Combined sewer systems are collection systems that convey domestic sewage, industrial and commercial wastewaters, and stormwater into a POTW for treatment. During a wet-weather event, a combined sewer overflow (CSO) can occur when the volume of wastewater entering a combined sewer system exceeds the POTW's treatment capacity. This results in the discharge of

excess flow directly to surface waters. CSOs contain raw sewage with high levels of floatable materials, pathogens, conventional and toxic pollutants, and other pollutants. Information about CSO events can help beach managers because such discharges can cause exceedance of WQS at beaches, posing risks to human health (USEPA 2001). For more information on CSOs, visit http://cfpub.epa.gov/npdes/faqs.cfm?program_id=5.

3.4.1.2.1.3 Concentrated Animal Feeding Operations

CAFOs and other animal feeding operations (AFOs) can pose a number of risks to water quality and public health, mainly because of the amount of animal manure and wastewater they generate. Manure and wastewater from AFOs and CAFOs have the potential to contribute pollutants such as pathogens, nutrients (e.g., nitrogen and phosphorus), sediment, heavy metals, hormones, antibiotics, and ammonia to the environment. The NPDES permitting program defines and regulates CAFOs. Information about CAFOs can benefit beach managers because CAFOs might contribute to water quality concerns if there are discharges near beaches. For more information on CAFOs, visit http://cfpub.epa.gov/npdes/faqs.cfm?program_id=7.

3.4.1.2.2 State Water Quality Assessment Integrated Reporting

A state's integrated report is a biennial state submittal that includes the state's findings on the status of all of its assessed waters (as required by CWA section 305(b)), a listing of impaired waters and the causes of impairment, and the status of actions being taken to restore impaired waters (as required by CWA section 303(d)). EPA has encouraged states to integrate water quality assessment information into one report.

EPA compiles state-submitted integrated report data to develop the National Water Quality Inventory Report to Congress (CWA section 305(b)), determine states' variable portion of the section 106 grant allocation formula, inform water quality decisions, and conduct national analyses with various stakeholders to help restore the nation's waters.

The information in a state's CWA section 305(b) assessment typically identifies assessed water bodies that are in full attainment, partial attainment, or nonattainment of their designated uses. The 305(b) assessment is a good source of information for locating potential problem areas in recreational water bodies. The section 305(b) reporting information has been made available online through EPA's ATTAINS database. ATTAINS includes states' integrated water quality assessment reporting under both sections 305(b) and 303(d). For more information, see http://water.epa.gov/lawsregs/guidance/cwa/305b/index.cfm.

A state's CWA section 303(d) list of impaired waters includes water bodies that have been identified as not attaining WQS (that are considered impaired) and, therefore, require TMDLs. Each state must develop one or more TMDLs for all water body/pollutant combinations on the state's 303(d) list. The CWA section 303(d) list might provide important water quality information about the potential for fecal contamination.

For more information, visit http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm.

3.4.1.2.3 Nonpoint Source (CWA Section 319) Reports

Nonpoint source pollution can be caused by rainfall or snowmelt moving over and through the ground and carrying natural and human-made pollutants into lakes, rivers, streams, wetlands, estuaries, other coastal waters, and ground water. Since there are many potential nonpoint sources of fecal contamination, these sources can contribute to contamination at beaches. Thus, source identification or investigations should be factored into beach ranking decisions. Nonpoint source pollution also can result from resuspension of bacteria-laden beach sands and hydrological modification.

For more information on the CWA Section 319 Program, visit http://water.epa.gov/polwaste/nps/cwact.cfm.

3.4.1.2.4 Illness Reports (Swimmer Reports or Hospital Records)

Medical records and epidemiological studies can provide information related to the historical risk of swimming at a beach. Swimmer illness reports or complaints to a state agency are also possible sources of information and can help answer the following questions:

- Have any swimmers complained to the state agency about illnesses believed to be related to the water quality at the beach?
- Have any hospitals or other medical facilities documented such reports of illness? Have any epidemiological studies been conducted at the beach?
- Have other government agencies described health problems at the beach or adjacent shoreline areas?
- Approximately how many reports of illness have occurred? How many have occurred in the past year?

The frequency and severity of reports of swimming-associated illnesses can provide important insight into the risks of bathing at a beach. In many cases, however, people who contract illnesses as a result of bathing in contaminated water do not always associate their symptoms with swimming. They might associate illnesses with sources other than contaminated water. As a result, illness outbreaks are often inconsistently reported. States should exercise caution when determining the significance and validity of such data. Because interpretation of medical records and epidemiological information can be a complex process, professionals trained in data interpretation should perform this function.

3.4.1.2.5 Environmental Group Reports

Many environmental groups conduct studies and publish reports on local beaches and recreational waters. The reports can help in classifying beaches because they might evaluate levels of pathogen indicators and identify potential sources of pollution. The reports also might include historical information and report how water quality conditions have changed over time.

3.4.2 Determine Use of the Beach

The second component of characterizing a beach is determining its use. As noted at the beginning of this chapter, the term *use* refers to the usage of beach waters by the public. The

frequency of use—and thus potential exposure to pathogens—can be measured by determining how many people use beach waters and when the peak periods of usage occur. The methods for determining beach use include counting by hand, counting from photos, counting cars in the parking lot, and using a laser counter at the beach entrance. Use estimates can be refined by considering the percentage of people visiting the beach who actually enter the water, beach use during holidays, the length of the swimming season, and a number of other factors. There is no national definition of *high beach usage*. The determination of beach usage and associated monitoring relies on a state-specific evaluation.

3.5 Step 4: Rank Beaches by Tiers

The fourth step is to rank the beaches and assign them to tiers using the information and data collected in step 3 (figure 3-5).

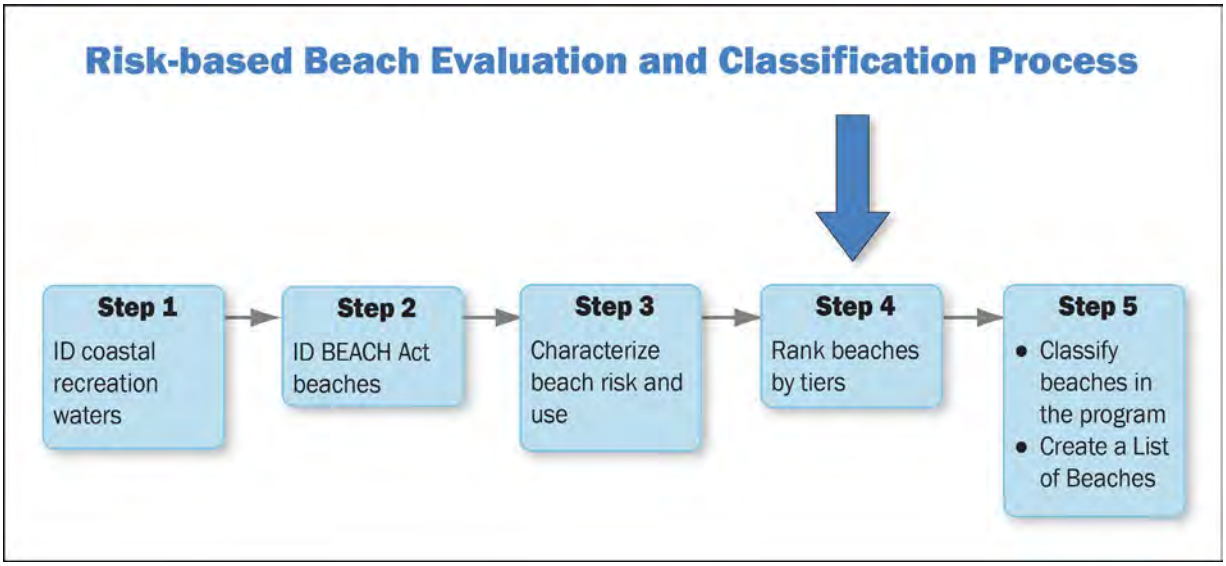

Figure 3-5. Step 4: Rank beaches by tiers.

Once there is a clear understanding of use and potential risk from the previous step, states and tribes should group beaches into tiers that share a similar risk or use level or both. As noted earlier, risk and use must be given highest priority when ranking beaches for inclusion in the monitoring and notification program. However, states and tribes may consider other factors such as economic issues, tourism, and public opinion.

3.5.1 Other Factors

States may evaluate other factors (e.g., importance to the local economy and community input) as secondary considerations in evaluating and classifying (i.e., ranking) beaches. Chambers of commerce and government agencies occasionally publish reports on the economic value of natural resources and how they contribute to the local economy.

The state or tribe should identify these other factors and describe how they affect beach rankings. For example, a state or tribe might determine that it has more beaches than it can monitor with

available resources and that beach usage presents equal risk to similar numbers of people. In this case, the state or tribe might review other factors to decide which beaches to include in its program, and which ones might either be moved to a lower tier or dropped from the program entirely. Beaches dropped from the program would still be "BEACH Act beaches," but they would not be included in the current monitoring and notification program.

3.5.2 Tiered Approach

EPA recommends that states and tribes consider using three tiers, and EPA's approach (here and in chapters 4 and 5) is linked to such a three-tier organization. Tier 1 beaches, for example, would include the group of beaches a jurisdiction considers its highest priority because of high risk, high use, or both. Typically a higher proportion of monitoring and notification efforts would be devoted to this group. Tier 3 beaches would be considered significantly lower on the risk/use scale. Risk might be judged lower, for example, because of consistently good water quality as evidenced by monitoring results. Tier 2 beaches fall somewhere in between.

3.6 Step 5: List of Beaches—Classify Beaches into "Program" Versus "Non-program" Beaches and Incorporate Them into a Final State List of Beaches

The fifth and final step (figure 3-6) is to use the ranked beaches from Step 4 to complete the state's or tribe's List of Beaches. In this document, EPA refers to the resulting list of BEACH Act beaches and their adjacent waters—showing those which are included in the monitoring and notification program and those which are not—as the List of Beaches. States and tribes need to identify their lists and submit them to EPA consistent with CWA sections 406(b)(2)(A)(iv)[6] and 406(c)(1). EPA will rely on this information to help fulfill its obligations under CWA section 406(g).

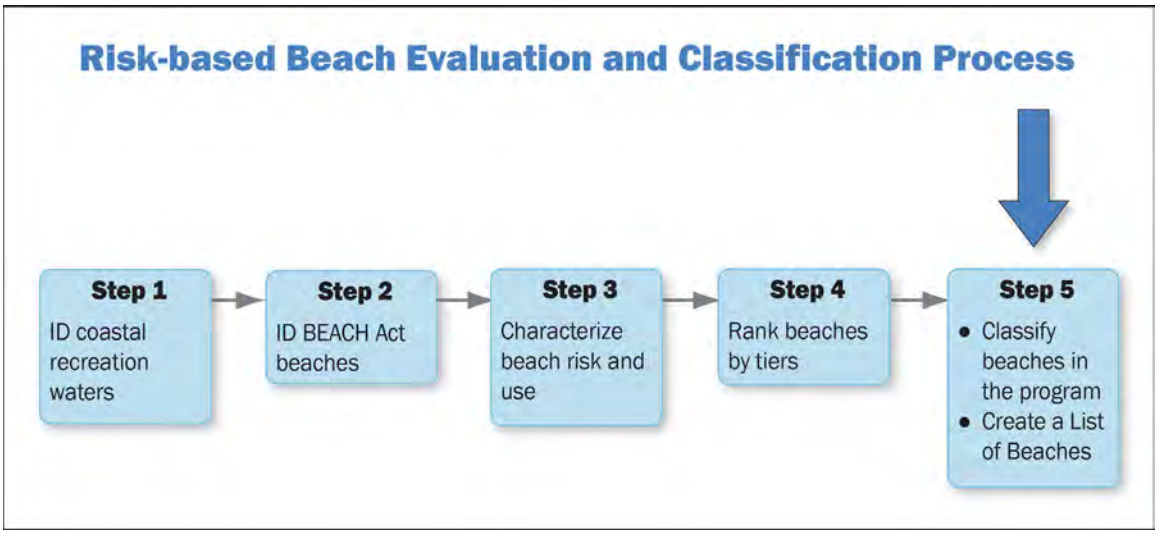

Figure 3-6. Step 5: Complete the List of Beaches.

[6] CWA section 406(b)(2)(A)(iv) directs states to provide a "list of discrete areas of coastal recreation waters that are subject to the program for monitoring and notification for which the grant is provided that specifies any coastal recreation waters for which fiscal constraints will prevent consistency with the performance criteria . . . ."

Program and non-program beaches are defined as follows:

- ***Program beaches*** are beaches and their adjacent waters subject to a state's or tribe's BEACH Act monitoring and notification program, consistent with the performance criteria.
- ***Non-program beaches*** are BEACH Act beach waters that are not subject to a state's or tribe's program, including those beach waters for which fiscal constraints prevent consistency with the performance criteria. Non-BEACH Act beaches would not be included in the List of Beaches regardless of their monitoring status because they would be eliminated during steps 1 and 2, as discussed earlier in this chapter.

Table 3-2 shows how a state or tribe might organize its List of Beaches.

Table 3-2. Example of a List of Beaches

Beach Rank # Beaches ranked individually by risk, use, or both)	Tier Beaches grouped by tiers, based on risk, use, or both)	Monitoring and Considerations (Add detail according to determinations in chapters 4 and 5*)
Program beaches Beaches subject to the state's or tribe's BEACH Act monitoring and notification program		
Tier 1		
1		
2		
3		
Tier 2		
4		
5		
Tier 3		
6		
7		
8		
Non-program beaches Beaches not subject to the state's or tribe's BEACH Act monitoring and notification program		
9		
10		

*Chapter 4 provides in-depth information on the requirements and recommendations for developing a detailed monitoring plan. It addresses such topics as sources of variability, sampling depth, locations, resampling, analytical methods (e.g., culture versus qPCR), modeling, analytical approaches, and quality assurance and control. Chapter 5 provides in-depth information on how to develop a detailed risk communication and notification plan. It addresses such topics as types of notifications, signs, locations, frequency, risk communication, and other considerations.

EPA recommends that each beach on the list include relevant information such as beach name, beach ID number, location, rank, and monitoring frequency.

3.6.1 Initial Submission to EPA

The state's or tribe's List of Beaches must be submitted to EPA after the state or tribe has given the public an opportunity to review it.

The BEACH Act authorizes EPA to award implementation grants only if the public is provided an opportunity to review the grant-funded monitoring and notification program through a process that provides for public notice and the opportunity to comment on the program, which would include ranking of beaches. (See performance criterion 10, section 2.2.10.) A state or tribe should review and address any public comments before submitting its List of Beaches to EPA.

3.6.2 Revising and Updating the List of Beaches

EPA expects that a state's or tribe's beach program will evolve over time and that its List of Beaches will be a living document that is updated to reflect changing circumstances, such as funding levels and evolving priorities. One specific requirement for performance criterion 1 (see table 3-1) is that a state or tribe must notify EPA at least annually if the List of Beaches changes significantly. These changes could include revised beach rankings, changes to monitoring and notification requirements, or other important considerations. Therefore, a state or tribe must review its program and associated List of Beaches annually to determine whether there are significant changes and, if so, must provide the public with an opportunity to review these significant program changes and discuss them with its EPA regional beach coordinators. States and tribes must submit the information to EPA in the form of a revised state List of Beaches.

3.7 Federal Beaches

The federal government is responsible for BEACH Act beaches on federal property, consistent with CWA section 406(d). BEACH Act grant funds may not be spent for monitoring or notification at federal beaches. Moreover, states do not need to report information on those beaches to EPA or include them in their List of Beaches.

3.8 Chapter 3 References

Boehm, A.B, L.C. Van De Werfhorst, J.F. Griffith, P.A. Holden, J.A. Jay, O.C. Shanks, D. Wanga, and S.B. Weisberg. 2013. Performance of forty-one microbial source tracking methods: A twenty-seven lab evaluation study. *Water Research* 47: 6812–6828.

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Stewart, J.R., A.B. Boehm, E.A. Dubinsky, T. Fong, K.D. Goodwin, J.F. Griffith, R.T. Noble, O.C. Shanks, K. Vijayavel, and S.B. Weisberg. 2013. Recommendations following a multi-laboratory comparison of microbial source tracking methods. *Water Research* 47(18): 6829–6838.

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Chapter 4: Beach Monitoring

Chapter 3 laid out a step-by-step process by which a state or tribe can conduct an evaluation and classification of its beaches, resulting in a List of Beaches that is ranked in tiers determined on the basis of potential risks to public health, beach usage, and other key factors (section 3.6).

Key changes to chapter 4 from the 2002 guidance document

- Strengthens the link between prioritizing beaches and developing a tiered monitoring plan (sections 3.5, 3.6, and 4.2).
- Adds three specific requirements to performance criterion 2 (section 4.1).
- Updates the science on beach water quality monitoring (section 4.3).
- Updates monitoring procedures to include qPCR (section 4.4.2).
- Adds a specific requirement to report monitoring data to the public on a website (section 4.5).
- Expands the discussion on integrating predictive models into a monitoring plan (section 4.6).
- Adds discussion of the beach monitoring program within the context of the 2012 RWQC, including adoption of new or revised WQS pursuant to CWA section 303(i)(1)(B) and identification and use of a beach notification threshold (section 4.7).

Monitoring has evolved to include a number of support tools, including sampling, sanitary surveys, and predictive tools. Chapter 4 describes the performance criteria and technical guidance related to beach monitoring and assessment procedures for identifying short-term increases in FIB. It also provides information on how to develop a tiered monitoring plan based on local circumstances using the risk-based classification of beaches discussed in chapter 3. The contents of the sections of this chapter are as follows:

- Section 4.1: A description of the performance criteria that relate to monitoring and assessment.
- Section 4.2: The concept of a tiered monitoring plan, including goals, considerations, and an example plan, along with requirements and recommendations for quality assurance (QA).
- Section 4.3: Detailed information on how to structure a monitoring program to assess beach water quality, including recommended monitoring and analytical procedures.
- Section 4.4: A discussion of methods and procedures, including consideration of rapid methods.
- Section 4.5: A discussion about monitoring report submission.
- Section 4.6: Ways to incorporate predictive tools into a beach monitoring and notification program.
- Section 4.7: A discussion about the 2012 RWQC and beach monitoring programs.
- Section 4.8: A discussion of delegation of monitoring responsibilities.

The chapter includes monitoring approaches appropriate for both culture and qPCR methods for determining FIB densities. Where approaches differ, the specific differences are clearly noted. Many monitoring procedures are common to both methods of water quality analysis.

Integrating sanitary surveys into beach monitoring planning, using predictive tools in beach management, and potentially using qPCR methods are valuable approaches that can be used for beach monitoring, and they are emphasized in this document. EPA encourages beach or program managers to be flexible when tailoring monitoring plans to their beach settings to optimize public health protection by using a range of these available tools.

4.1 Performance Criteria

Additions to the monitoring and assessment performance criteria pave the way for states and tribes receiving beach grants to implement significant improvements to public health protection by widespread use of sanitary surveys to identify sources of fecal pollution; the use of qPCR analysis and predictive modeling, which facilitate same-day notification of water quality exceedances; timely reporting of water quality results; and tailored WQS for site-specific public health protection.

Table 4-1 summarizes the general and specific requirements of the five performance criteria related to monitoring and to the beach assessment activities that go into forming a monitoring plan (criteria 2 through 5 and 10) and cross-references them to the sections in this chapter that discuss them. The term *assessment*, used in this context, means gathering information to serve as a basis for a monitoring plan, as distinct from the assessment activities associated with routine monitoring of ambient waters under CWA section 305(b).

Table 4-1. Summary of monitoring performance criteria

Performance criteria		Chapter section
General requirement	**Specific requirements**	
Tiered Monitoring Plan (Performance Criterion 2). Performance criterion 2 requires development of a tiered monitoring plan that can adapt to changing conditions and adequately protect public health.	• Adequately prioritize, in the tiered monitoring plan, the frequency, locations, and methods of monitoring and assessment of coastal waters based on: o A review of existing monitoring data. o Periods of recreational use of the waters. o The nature and extent of use of the waters. o The proximity to known point and nonpoint sources of pollution. o The effect of stormwater runoff on the waters. o The appropriateness of qPCR methods. o The potential use of predictive tools.	4.2 and 4.3
	• Provide for public review of the tiered monitoring plan.	2.2.11
	• Develop appropriate quality control (QC) policies and procedures and submit adequate quality management plans (QMPs) and quality assurance project plans (QAPPs) to EPA for approval.	4.2.3

Performance criteria		Chapter section
General requirement	**Specific requirements**	
Methods and Assessment Procedures (Performance Criterion 3). Performance criterion 3 requires the development of detailed methods and assessment procedures.	• Submit to EPA methods for characterizing water quality relative to human health in coastal recreation areas. • Provide documentation of the performance of methods other than those that EPA recommended or approved or validated. • Identify and submit to EPA procedures for assessing short-term increases in FIB densities that indicate risk to human health in coastal recreation waters.	4.4
Monitoring Report Submission (Performance Criterion 4). Performance criterion 4 requires development of a mechanism to collect and report monitoring data in timely reports.	• Make monitoring data available to the public, including posting on a website. • Report monitoring data to EPA at least annually or at a frequency that the EPA Administrator determines. Reported data must be consistent with the reporting requirements specified at http://water.epa.gov/grants_funding/beachgrants/datausers_index.cfm.	4.5
Delegation of Monitoring Responsibilities (Performance Criterion 5) States must describe any delegation that they have made, or intend to make, to local governments.	• If a state delegates monitoring responsibilities to local governments, the state grant recipient must describe the process that the state follows.	4.8
Adoption of New or Revised WQS and Identification and Use of a Beach Notification Threshold (Performance Criterion 10) Performance criterion 10 requires states and tribes to develop and implement schedules leading to adoption of new or revised WQS and for the identification and use of an appropriate beach notification threshold.	• Develop and implement two separate schedules: o To adopt new or revised WQS by FY 2016. o To identify and use a beach notification threshold by FY 2016. • Before identification and use of a new beach notification threshold, continue to make beach notification decisions using the existing threshold based on the currently applicable WQS, e.g., SSM.	4.7.3

Performance criterion 2 now requires states and tribes receiving beach grants to consider the following elements when developing a tiered monitoring plan:

- ***A review of existing monitoring data.*** The BEACH Act states have been implementing beach monitoring programs since at least 2000, and since that time they have amassed large amounts of recreational water quality data. These data provide a substantial characterization of water quality at monitored beaches and are likely to prove useful in formulating monitoring plans as well as in supporting model development. States and tribes must now consider these historical data when developing a tiered monitoring plan.
- ***The appropriateness of qPCR.*** The 2012 RWQC make available a number of tools to assist beach managers in implementing monitoring and notification programs. qPCR is a rapid molecular method that facilitates same-day notifications when beach water quality presents a risk to public health. It also presents challenges, including method

performance. However, given the potential for same-day notifications and the public health protection that qPCR could provide, states and tribes must now consider when developing tiered monitoring plans whether qPCR might be appropriate at specific sites.

For states and tribes that know they do not have the resources or expertise to implement qPCR, or that practical factors such as proximity to laboratory facilities would preclude its use, "consideration" of qPCR could take the form of a brief acknowledgment in the grant workplan that, at the present time, the state or tribe has determined that qPCR cannot be implemented. For states and tribes that believe there might be beaches where qPCR could be implemented, "consideration" could involve developing a plan to perform a site-specific analysis.

- ***The potential use of predictive tools.*** Another tool discussed in the 2012 RWQC is predictive modeling. Like qPCR, modeling offers the potential for same-day notification, but for a considerably smaller resource outlay than qPCR. The 2012 RWQC encourages states and tribes to use site-specific models as part of a tiered monitoring plan. Given the potential for same-day notifications and the public health protection that modeling could provide, states and tribes must now consider when developing tiered monitoring plans whether predictive models might be appropriate at specific sites.

  State level of effort in considering the use of predictive models will also be on a continuum, based on a state's or tribe's knowledge of their applicability (e.g., states with beaches with very good water quality might already know that models do not work well in those environments), local circumstances, and available resources.

The level of effort a state or tribe puts into considering the use of qPCR or predictive models may vary depending on the suitability of these tools and the state's or tribe's ability to implement them, including whether the state or tribe has sufficient resources.

Performance criterion 4 adds a requirement to post monitoring data on a website, to ensure its wide public availability.

A new performance criterion 10 requires states and tribes to develop and implement schedules to adopt new or revised WQS pursuant to CWA section 303(i)(1)(B) and to identify and use an appropriate beach notification threshold.

4.2 Developing a Tiered Monitoring Plan (Performance Criterion 2)

This section describes the required elements of a tiered monitoring plan and discusses QA requirements and recommendations. Developing the tiered monitoring plan starts with the ranked List of Beaches described in chapter 3.

4.2.1 Goal and Key Considerations

The goal of a tiered monitoring plan is to define combinations of monitoring activities that align with identified priorities (i.e., tiers), are appropriate for the level of risk and use of a given beach, effectively allocate available monitoring resources, and address site-specific circumstances. A BEACH Act grant-funded program must prioritize the use of grant funds for monitoring on the

basis of the use of the waters and the risk to human health. A beach or program manager should consider the following factors when developing a detailed tiered monitoring plan:

- EPA requirements and policy recommendations for BEACH Act grants.
- Existing and historical beach water quality.
- Sampling considerations.
- Analytical methods.
- Available funding and staffing.
- Logistical considerations.
- Potential use of predictive tools.

The specific elements of monitoring plans will vary according to these factors, local practices and policies, and the extent and nature of available resources. Regardless of the approach taken, states and tribes must demonstrate how the plan meets the performance criterion for an adequate tiered monitoring plan.

The number of tools available to states and tribes has increased in recent years. In 2002, when the first beach guidance was issued, the primary decisions involved in the development of a tiered monitoring plan included choosing which beaches to monitor and how often to monitor them. The number of potential considerations has increased. Now states and tribes should factor in information related to the following additional questions:

1. What does the history of water quality monitoring at this beach reveal about how often it requires monitoring?
2. How can sanitary survey findings be used to tailor monitoring approaches?
3. What is the most appropriate method of measuring water quality at this beach—culture or qPCR methods—relative to sources of contamination, the number and type of people visiting the beach (e.g., many families with small children), and available resources?
4. If it appears that a beach is a good candidate for qPCR, do practical factors such as proximity to laboratory facilities allow timely notification?
5. Is this beach a good candidate for a predictive model or other predictive tool in terms of observed effects from sources under varying conditions?
6. Are staff members with experience in model development available?
7. How can the use of available resources be otherwise optimized to best protect public health?

4.2.2 Tiered Monitoring Plan

Table 4-2 presents an example of how the various tools available to a beach or program manager might be incorporated into a tiered monitoring plan to maximize public health protection at a range of beach settings with varying risk and use characteristics. As chapter 3 described, in EPA's recommended tiering system, each tier shares a common level of risk (based on sources and variable water quality) and degree of use by the public. In the example in table 4-2:

- Tier 1 = high risk and high beach usage.
- Tier 2 = high or moderate use and moderate or low risk.
- Tier 3 = low use and low or very low risk.

The tools include:

- Sanitary surveys.
- Methods and indicators.
- Monitoring frequencies.
- Predictive models or other predictive tools.

Table 4-2. Example of a tiered monitoring plan

Rank # (risk/ use)	Tier	Examples of application of tiered monitoring to a range of beach settings				
		Analytical method	*Monitoring frequency*	*Model*	*Contributing factors*	*Additional information*
Program (P) beaches						
1	P-1	qPCR	5–7 days/week	No	Nearby lab with qPCR capability; high use; high risk	High-use urban beach
2	P-1	qPCR	3 days/week	Yes	Nearby lab with qPCR capability; high use; high risk; modeling experience	Use of model as a means of reducing analytical cost through targeted monitoring
3	P-1	Culture	3 days/week	Yes	Lab with culture capability only; high use; high risk; modeling experience	Timely water quality estimates daily from a model
4	P-2	Culture	Weekly	Yes	High use; moderate risk	Model reduces analytical cost
5	P-2	Culture	Weekly	Rainfall advisory	Moderate use; moderate risk	Rainfall advisory supported
6	P-2	Culture	Every 2 weeks	No	High-moderate use; low risk	Rare exceedances
7	P-3	Culture	None or infrequent	Rainfall advisory	Low use; low risk	Rare exceedances or no history of exceedances
Non-program (NP) beaches						
8	NP	None	None	Rainfall advisory	Low use; very low risk	Remote location
9	NP	None	None		Low use; very low risk	Remote location; sporadic use
10	NP	None	None		Low use; very low risk	Resource limitation

Results from sanitary surveys can help a manager classify beaches into tiers and select the most appropriate tools for the monitoring program. Not every jurisdiction will use every tool in its monitoring program. The right mix of tools for beach monitoring programs depends on the setting, the resources available, the capabilities and approaches taken by the local jurisdiction in meeting the public health protection function, and the tiered List of Beaches.

As mentioned in section 4.2.1, the local beach manager's selection of tools will likely depend in part on the capabilities and practices specific to the jurisdiction. Resource availability or public interest might influence a local beach manager to choose to develop local modeling capability as a means of stretching resources or to adopt qPCR analysis in response to local demand or the new availability of qPCR at a local public health laboratory. Section 4.4.2 includes other factors related to the selection of test methods for the applicable WQS (i.e., culture methods versus qPCR).

States and tribes must determine which beaches to monitor and which beaches not to monitor using an analysis of their recreational waters based on the degree of recreational use of the adjacent water body and risk to human health posed by known or unknown sources and historical variable water quality. According to historical data that the states and tribes submitted to EPA, some open-ocean marine beaches have never had a WQS exceedance. If the same beach has high rates of beach usage, and is an important beach to a locale or municipality, then that beach would still be considered important for continued monitoring. A beach with no exceedances and low use could be considered for reclassification as a non-program beach (i.e., a beach not subject to the monitoring and notification program). Such waters could be included in the state's or tribe's routine water quality monitoring program for CWA sections 305(b) and 303(d) (attainment and listing) purposes to confirm continued good water quality in settings where there is no history of WQS exceedances.

EPA recommends a tiered monitoring approach that prioritizes the use of funds based on beach usage and human health risk while taking into account additional relevant factors. Such a policy allows flexibility to states and tribes, recognizing that there might not be uniform monitoring requirements for all beaches. To best protect public health, the states and tribes must evaluate the trade-offs of monitoring more beaches less frequently or fewer beaches more frequently based on degree of use of the beach, risk to human health, and other considerations. For example, qPCR sampling could be used on days when a model predicted an exceedance of a WQS, and a prediction of good water quality could be confirmed after the fact with the results from a less expensive culture sample. Conversely, a model could replace sampling on some high-use days to provide timely notification. In addition, beach managers should consider all available information to reconcile or evaluate conflicting or anomalous analytical results, or results that seem inconsistent with environmental conditions. Comparing the outputs of multiple tools (e.g., monitoring results, model outputs, daily sanitary survey information), to the extent they are available, can help managers make informed assessments concerning their beaches' water quality.

4.2.3 Quality Management System Requirements for Performance Criterion 2

To meet the quality management portion of performance criterion 2 (development of an adequate tiered management plan), states and tribes must develop an appropriate QC system that includes

adequate policies and procedures and submit them to EPA for approval. States and tribes must submit documentation of the quality system for review and approval by the EPA Grants Officer and the EPA QA officer, or an approved designee, before environmental measurements (primary or secondary) are taken. States and tribes should contact the EPA regional QA officer for more detailed guidance tailored to their grants.

EPA is committed to ensuring the quality of environmental data used in its decision-making process and in activities supported by the Agency. As a result, EPA has developed an Agency-wide quality system to ensure that environmental data are of sufficient quantity and quality to support the data's intended use. EPA OW has, in turn, developed a QMP for its activities (the OW QMP; USEPA 2009c) that is consistent with the Agency-wide quality system. Furthermore, the tasks performed under BEACH Act grants involve environmentally related measurements and data generation, and thus they are covered by 40 CFR part 31 for grants and cooperative agreements to states, tribes, and local governments. To comply with 40 CFR 31.45, grant recipients must develop and implement QA practices consisting of policies, procedures, specifications, standards, and documentation necessary to produce data of sufficient quality to meet project objectives and to minimize loss of data due to out-of-control conditions or malfunctions.

The grant recipients' consultation with EPA regional officials should determine what documentation is sufficient to describe the quality system used for their beach monitoring and notification programs and should consider a variety of quality management topics, including but not limited to the following:

- Ensuring that QA procedures are consistent with EPA's Policy Directive Number FEM-2012-02, Policy to Assure the Competency of Organizations Generating Environmental Measurement Data under Agency-Funded Assistance Agreements. A copy of the policy is available online at http://www.epa.gov/fem/pdfs/competency-policy-aaia-new.pdf.
- Developing a QAPP or equivalent documentation for their beach monitoring and notification programs. A QAPP is a commonly used form of documentation for primary data collection. It is a technical planning document that defines the objectives of a project or continuing operation and the methods, organization, and quality management activities necessary to meet the project or operation goals. It serves as the blueprint for implementing the data collection activity to ensure that the program's technical and quality goals are met. It also provides the necessary link between the required data quality constraints and the sampling and analysis activities to be conducted. A QAPP typically details the technical activities and QA and QC procedures that should be implemented to ensure that the data meet the specified standards. The QAPP should be implemented to ensure that data collected and analytical data generated are complete, accurate, and suitable for the intended purpose.
- Considering standard operating procedures (SOPs), which can be included as attachments to the tiered monitoring plan or QAPP and can be used to present in detail the method for a given technical operation, analysis, or action in sequential steps. An SOP includes specific sites, sampling locations, equipment, materials, and methods; QA and QC procedures; and other factors necessary to perform sampling, analysis, and notification.
- Addressing other tasks identified by EPA regional officials.

4.3 Factors to Consider When Developing a Monitoring Plan

One of the major issues a beach or program manager must confront is the significant variability inherent in beach water quality. This section provides information on how beach water quality can affect the design of a monitoring program, recommended monitoring procedures, logistical considerations for conducting a monitoring program, and recommendations for securing laboratory services and choosing appropriate analytical methods. EPA published a thorough review of scientific studies related to beach monitoring entitled *Sampling and Consideration of Variability (Temporal and Spatial) for Monitoring of Recreational Waters* (USEPA 2010c). This section summarizes the major findings. For more information see http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/P12-MonRept-final_508.pdf.

4.3.1 Variability of Beach Water Quality

4.3.1.1 Temporal Variations in Sources of Fecal Indicators and Pathogens

FIB densities in water samples are highly variable across time (temporal variability) and location (spatial variability) at a beach. Temporal variability in FIB density—at time scales ranging from minutes to months—has been observed in time series analyses of FIB density (Taggart et al. 1992). Variations with time scales on the order of minutes are important because such considerations influence the number of samples needed to accurately characterize microbial water quality and the confidence with which to ascribe the results of sampling events. Variations with time scales on the order of tens of minutes are important because they have the same time scale as that of typical recreational use episodes. Variations with time scales on the order of a day are important because knowledge of them allows comparison between samples taken at different times of the day or between samples taken on successive days. Temporal variability can also be caused by both environmental and meteorological parameters such as sunlight intensity and temperature (USEPA 2010c).

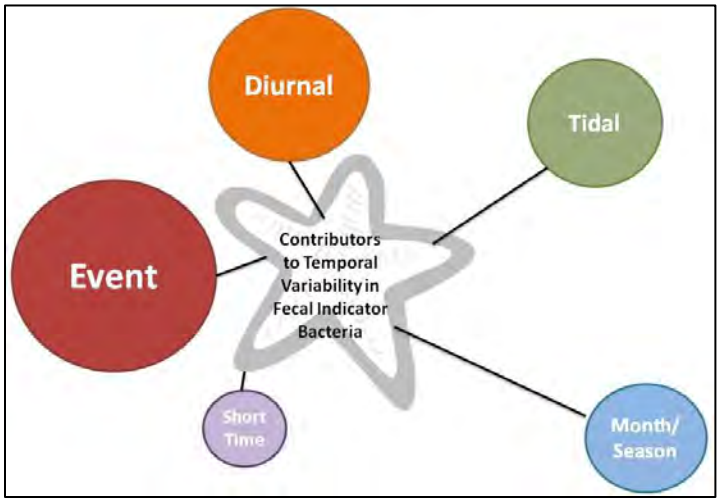

Figure 4-1. Relative contributions to temporal variations in FIB density. (Line length indicates duration of influence.)

Although there can be site-specific differences, many factors contribute to temporal variations in FIB density for both coastal and inland sites. Figure 4-1 depicts the relative level of effects on FIB densities.

4.3.1.1.1 Event-Scale Variability

Event variability refers to the change in FIB density associated with rain events. Event-scale variabilities constitute the category of greatest variability (including both temporal and spatial variabilities) in FIB density for both coastal and inland waters. Rainfall events account for a large portion of the total FIB loading into receiving water systems. In addition, among the documented temporal variations, event-scale variability is, by far, the greatest for both inland and coastal waters. FIB density can increase by several orders of magnitude during a single rainfall event. FIB loading varies significantly during rain events and is related to rainfall intensity and duration, total rainfall amount, and antecedent rainfall patterns. Because event variability is so great, beach or program managers might use alternatives to FIB densities for assessing water quality during and after rainfall or storm events. For example, the correlation between historical rainfall and FIB data might allow the estimation of the total rainfall amount over a 24-hour period above which beaches are likely to exceed existing WQS.

For inland sites and coastal sites affected by hydrologic features such as streams and drainage outfalls, FIB densities sometimes correlate poorly with rainfall amounts and stream gauges because of the dependence of FIB response on factors such as antecedent rainfall and the input of FIB from sources such as CSO discharges. In general, indicator density peaks during the rising limb of the storm hydrograph when loading to the stream is high and streams are turbulent, promoting re-suspension of sediment-associated indicators. The lag period between the beginning of rainfall events and sharp rises in indicator density varies among sites, with small, flashy streams exhibiting shorter lag periods and coastal sites exhibiting longer lag periods. Generally, indicator densities decline faster than the hydrograph because of depletion of indicators from land surfaces and other reservoirs as they are washed out. The time it takes for the indicator density in a stream or lake to recede to pre-storm levels is highly variable among drainages and even for a given drainage. Similar trends have been observed for coastal sites. Indicator densities rise quickly during storms because of loading from stormwater runoff, nearshore sands, and increased wave action and mobilization of indicators from sediments. Presumably, dilution would cause event-scale variability to be less at coastal sites than in streams, though poor mixing in the vicinity of stream mouths and stormwater outfalls appears to contribute to extreme event-driven changes in indicators.

4.3.1.1.2 Diurnal (Daily) Variability

A limitation of culture methods for the analysis of beach water samples for FIB is that the results are available a minimum of a day later. By the time the results are received, the water quality at the location sampled is likely to have changed. Leecaster and Weisberg (2001) analyzed a large set of total coliform and fecal coliform data from samples collected at Southern California beaches in an attempt to associate sample collection frequency with misidentifying exceedances of FIB WQS in coastal waters. The lag time between sampling and analysis completion was not considered. Table 4-3 presents the number of missed exceedances for four sampling frequencies. One explanation for the poor performance of the schemes considered is the frequency of exceedances of single-day duration. Approximately 70 percent of exceedances lasted for only a day. The exceedances were characterized by water quality only slightly exceeding standards. Given the variabilities and uncertainties associated with sample collection and analysis, there is a high probability for misclassification of water quality for samples with FIB densities near or within the confidence interval of the existing standard.

Table 4-3. Percent of exceedances missed for different sampling frequencies

Sampling frequency	% missed exceedances
5 days per week (weekdays only)	20%
3 times per week	45%
Once per week	75%
Once per month	95%

Source: Adapted from Leecaster and Weisberg (2001).

4.3.1.1.3 Tidal Variability

Low tides are associated in most cases with higher FIB densities at coastal sites. This association is typically a result of increased freshwater input to estuarine and coastal locations during low tide, given the direction of water flow. In a minority of circumstances, such as when rising tides cause connections with contaminated surface waters during a hurricane or tropical storm, hydrological connection of sewage and stormwater conveyance systems can occur. In general, tidal variability is minor compared with diurnal and rainfall variability.

Approaches for accounting for tidal variation of FIB density in developing sampling schemes include sampling without regard to tidal cycles and sampling at low tide or the portion of the tidal cycle during which FIB density is highest (all other factors being equal).

4.3.1.1.4 Monthly and Seasonal Variability

Most U.S. inland streams experience higher FIB densities during the spring and summer than during the winter. That phenomenon arises from generally lower precipitation and runoff during summer months combined with greater loading from sources such as wildlife and domestic animals (particularly those with seasonal access to streams) and bacteria growing in nearshore soils or sediments. In tropical locales such as Hawaii, Puerto Rico, and south Florida, differences in seasonal precipitation patterns and other climatic factors can give rise to peak indicator density in other seasons. For sites where recreational use spans only the summer months, variation in indicator density with season does not influence the design of monitoring programs. Similarly, seasonal and monthly variability of fecal indicators at coastal sites is difficult to assess and tends to be linked to the wide range of climates existing along the U.S. shoreline and its indirect consequences on indicator density (e.g., loading patterns that vary with season). At both inland and coastal settings, seasonal and monthly variability of fecal indicator organisms is of lesser significance than event-scale variability.

4.3.1.1.5 Short-Time Variability

Short-time variability describes rapid changes in FIB density occurring even when sample collection is conducted at intervals as short as 1 to 10 minutes. Variations in the density of the *Enterococcus* spp. greater than the WQS can occur between adjacent samples taken at those time scales (Boehm 2007), and certainly variations can occur more quickly than the results of previous sampling can be obtained using culture methods.

4.3.1.2 Relative Magnitude of Spatial Variation

Spatial variability relates to the alignment of sources at a beach, advection, and the distribution of mixing on the beach (USEPA 2010c). Although site variations can alter the relative dependence of indicator density on sample location, the expected general dependence of indicator density variability with location for coastal sites is shown in figure 4-2. Studies have shown that for coastal sites, there is a general trend toward decreasing indicator density with water column depth (USEPA 2010c).

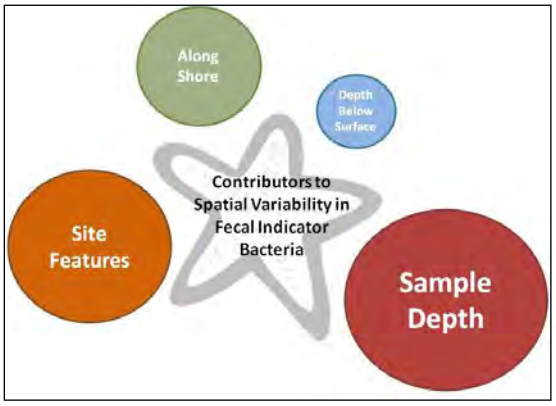

Figure 4-2. Relative contributions to spatial variation at coastal beaches.

For inland water sites, the expected variation is slightly different from that for coastal sites, as shown in figure 4-3. For inland lakes, however, there is a general trend toward higher FIB density at the bottom of the water column (USEPA 2010c).

Features that promote or inhibit mixing and point sources of fecal indicator organisms play a significant role in the distribution of indicators. These features, which can be identified during a sanitary survey, include:

- Jetties, dams, or other features that influence mixing at a site or reduce the natural flow of water and therefore can retain contamination at a beach.
- Point sources, particularly stormwater or wastewater treatment discharges, in the vicinity of the beach.
- Other diffuse sources of contamination such as small ponds and areas where wild birds and animals congregate, dog parks, and livestock and agriculture operations near beaches.

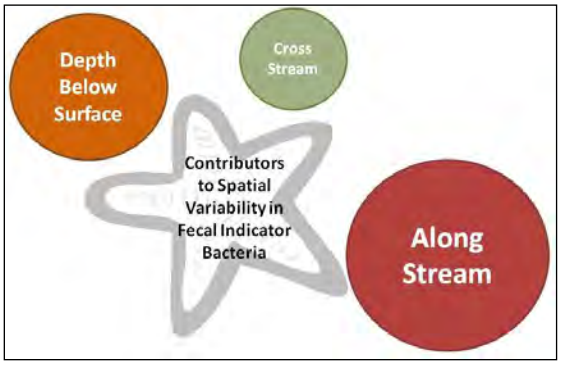

Figure 4-3. Relative contributions to spatial variation at inland beaches.

4.3.2 Recommended Monitoring

Monitoring programs range from simple to complex, depending on the setting. The range in beach settings is vast—from pristine settings to heavily used urban beaches. For every beach, there is an appropriate monitoring plan that addresses the risk and use characteristics chapter 3 described.

The following sections provide recommendations for basic sampling frequency and monitoring procedures a state should consider in developing its monitoring plan. Not all settings will call for using the range of options listed in table 4-2. This section includes an example of a basic three-tiered plan, which is one recommended approach. In addition, careful observation by beach or

program managers of circumstances under which poor water quality occurs through the use of a daily sanitary survey or other process could provide the basis for focused sampling or preemptive advisories.

4.3.2.1 Sampling Considerations

EPA recognizes that variation in indicator bacteria densities is one of the main technical challenges that beach or program managers face when designing effective monitoring programs and interpreting sampling results. FIB densities at different sites can substantially vary (spatially and temporally). Accordingly, managers should tailor monitoring plans to individual circumstances. The tiered monitoring plan should address specific monitoring procedures, including sampling time, location, and depth. Each of these is described in more detail below.

4.3.2.1.1 Sampling Frequency

EPA recommends that samples be taken one or more times per week during the swimming season at Tier 1 beaches and once per week at Tier 2 beaches, starting a month before the swimming season. Sample as close as possible to the peak swimming period of the week (usually the weekend), while still allowing time for retesting and notification on subsequent days.

Sampling frequencies should be consistent with the circumstances at a beach. For example, many agencies sample Tier 1 beaches more frequently to minimize the uncertainty in their sampling. Conversely, less frequent sampling might be appropriate for Tier 2 or greater beaches, depending on distance to suspected pollution sources, beach use, historical water quality data, and other risk factors.

For Tier 3 beaches, EPA recommends a minimum sampling frequency consistent with other ambient water quality sampling programs. However, these beaches should be reviewed periodically to determine whether they should be reclassified as Tier 1 or Tier 2 or non-program beaches. Such an assessment should include a review of beach use, an updated sanitary survey, and a review of the water quality history and resulting advisories.

When sampling for qPCR analysis, if possible, sample on every day of significant swimming activity for same-day notification. If this is not possible, sample on the peak swimming days for same-day as well as subsequent-day notification and retesting. Rapid methods can also influence the selection of sampling frequencies. Rapid methods might promote the public expectation of daily monitoring at heavily used beaches where same-day notification of exceedances has been provided on some days.

4.3.2.1.2 Sampling Frequency and Predictive Models

A predictive model can be used to complement analytical test methods for the applicable WQS (e.g., culture or qPCR methods), reducing the frequency of sampling, depending on the circumstances and setting of a beach. Data from culture samples can be used as a basis for models that provide timely results in a cost-effective manner. In addition, historical data are now available for most monitored beaches.

The time period covered by the data used to build robust models can vary in length, depending on the beach setting. According to varying trend analyses conducted by the U.S. Geological Survey (USGS), the suggested minimum data collection period is roughly two years (Gonzalez et al. 2012), whereas some EPA modeling trials obtained favorable results from data collected over 45 days (Frick et al. 2008). In addition, using a model should not completely replace monitoring (USEPA 2010c). If the locally selected threshold for predictive errors is maintained at a lower monitoring frequency (e.g., twice per week to once per week) after building a model on the basis of twice per week, the model can save scarce monitoring resources for use at another location where a model might not be appropriate.

4.3.2.1.3 Timing of Sample Collection

Collecting samples early in the morning for culture analysis appears to offer the best balance between practicality and generation of data that protect human health (USEPA 2010b). If culture methods are used for enumerating FIB, morning samples could generate results that would allow posting of health advisories the next morning.

For culture methods, FIB densities tend to be lower in the afternoon, probably because of the effects of sunlight. Diurnal (daily) variation in indicator density is observed in both inland and coastal waters. In general, when culture methods are used for FIB enumeration, the highest FIB densities are observed in the morning. Depending on the insolation on a given day and at a site, the lowest FIB density might occur between 2:00 p.m. and 3:00 p.m. These patterns suggest that early sampling might be more protective of public health when using culture methods.

The density of the FIB as determined using qPCR is not as sensitive to time of day as the density measured using culture methods because the qPCR methods quantify DNA instead of metabolically active cells (Boehm et al. 2002; Converse et al. 2012). Furthermore, many epidemiological studies include data collected and pooled from throughout the day (Wade et al. 2008).

When sampling for qPCR quantitation, however, earlier sampling means that public notification will occur earlier in the day and therefore will inform the public in a timelier manner. Nevertheless, practical limitations (such as sample transport and other factors) could delay such notifications.

4.3.2.1.4 Sample Location

There is no standard definition of *beach length*, or a standard requirement for the distance between beach monitoring stations. Sampling locations should be selected on the basis of the ability of a small number of samples to adequately describe water quality at the site. These are generally locations where FIB are most likely to be associated with a fecal pollution source.

Sampling locations in the alongshore direction should be chosen on the basis of the mixing characteristic of the beach and location of sources of fecal contamination as determined by sanitary surveys. When there are beach features that influence hydrodynamics (mixing), beach regions with different hydrology cannot be expected to have similar FIB densities, and therefore they should be sampled separately. The following suggestions can also help in structuring a sampling plan:

- Sample within 60 meters of where the greatest beach use occurs (where the people are).

- If the beach is short, take samples at a point corresponding to each lifeguard chair, or one point for every 100 to 200 meters of beach, depending on the dimensions of the beach.
- If the beach is long (more than 5 miles), take samples at the most highly used areas and spread out along the entire beach.
- Sampling location should take into account beach features (e.g., channels, streams, jetties, groins, stormwater discharge pipes) that might affect FIB density.

Sampling locations should be selected to obtain the greatest amount of information that can be used for public health protection. The variable effect from a known or potential source would be an example of such useful information. In contrast, results from sampling at the discharge point of a source that always exhibits high indicator density would likely be less instructive.

4.3.2.1.5 Sample Depth

Taking a sample in an area parallel to the shore where the water depth is approximately knee deep or greater appears to offer some advantages. Indicator density tends to vary less in deeper waters than in shallower zones (USEPA 2005). The indicator density in shallower water is higher than that in deeper areas because of the re-suspension of indicator organisms growing or sheltered in sediments. Re-suspended indicators might not indicate fresh fecal pollution, and therefore samples with a high number of re-suspended organisms might not provide a good means to assess water quality. Other considerations, such as a steep beach face or safety concerns, can also play a role in selecting the appropriate sample depth zone.

EPA's general recommendation for all beaches has been that samples be taken at knee depth. However, local conditions will dictate the sampling depth selected for a beach. For instance, in high-energy environments, sampling is often conducted at ankle depth because it is safer and easier for the sampler. In California marine waters, for example, samples are taken at ankle depth in part to protect the safety of the sampler from the threat posed by incoming waves. In more quiescent waters, sampling can be conducted at up to waist depth. The data analysis conducted for the 2012 RWQC was based on the pooling of data from shin depth to waist depth (0.3–1.0 meter) (Wade et al. 2010), which corresponds to the sampling depth in the NEEAR study, which was found to have high correlation with risk. The 2012 RWQC STVs and BAVs are based on the 90th and 75th percentile, respectively, in shin- to waist-deep water.

qPCR results in shin-deep water were over 40 percent higher than those in waist-deep water (93 versus 65 qPCR-CCE (calibrator cell equivalents)/100 mL, respectively) among NEEAR Great Lakes beaches (Wade et al. 2008). Differences were consistent throughout the day at Great Lakes beaches (unpublished EPA data). Differences between waist and shin depths were greater among marine beaches (320 versus 190 CCE) and tended to be greatest in the morning (unpublished EPA data).

The most important aspect of sample depth is consistency from sampling event to sampling event (Wymer 2007). Sampling at the same depth ensures the consistent representativeness of the sample. Therefore, EPA encourages states, tribes, and localities to sample at the same depth at a given beach to ensure consistency and comparability between sampling events.

The depth for the sample container (i.e., distance below the water surface) appears to be less critical than the depth zone (e.g., knee depth) where sampling is conducted (Le Fevre and Lewis 2003). The depth below the water surface, however, should also be consistent. At waist to knee depth, this should be 0.5 to 1.0 foot below the water surface. At any depth more shallow than knee depth, mid-water column would be appropriate while avoiding introducing sand or sediment into the sample. A sampling depth of 0.3 meter below surface represents water to which swimmers receive maximum exposure with their faces under water. This was also the sampling depth used in NEEAR and other studies to establish risk relationships. However, variation in qPCR densities with respect to depth of sample collection has not been studied. An EMPACT (Environmental Monitoring for Public Access and Community Tracking) study (Wymer 2007) saw no consistent difference in colony forming units versus depth for culture methods.

4.3.2.2 Sample Collection Techniques

Although EPA has no requirements for sample collection, adherence to specific, state-defined procedures for sampling is critically important for a successful beach monitoring program. This can be accomplished by implementing a detailed plan or written SOP for obtaining samples and submitting them for analysis. Proper collection, preservation, and storage of water samples are critical to ensuring the accuracy of the results of water quality analyses for FIB at swimming beaches, and to satisfy the QA/QC requirements of state certification programs. Section 4.3.3.2 discusses the basic equipment and techniques that can be used to obtain water samples. Appropriate sampling procedures should be determined for a beach monitoring program on the basis of the sampling design, the availability of facilities and equipment, and how the samples will be processed. In addition, it is important to use consistent procedures and take careful notes in the field when collecting samples. Additional information about EPA-recommended SOPs for sample collection, handling, and subsequent analysis can be found in *Standard Methods for the Examination of Water and Wastewater* (APHA 1998).

4.3.2.3 Sampling after an Exceedance

When a water quality sample exceeds a beach notification threshold, a state must promptly issue a beach notification or resample if there is reason to doubt the accuracy, certainty, or representativeness of the first sample. This applies whether the method used to determine the exceedance was culture-based or qPCR-based.

- If a sample result is determined to be accurate and representative and exceeds a beach notification threshold, the state agency must issue a beach notification. The notification should remain in effect until resampling indicates that the beach notification threshold is no longer being exceeded and approved QA/QC requirements are being met. When the beach notification threshold is no longer being exceeded, the basic sampling approach may be resumed. If in the meantime heavy rainfall or other pollution events have occurred as listed below, refer to guidance for that instance.
- If there is reason to doubt the accuracy, certainty, or representativeness of the first sample collected, based on QA/QC measures, resampling should be considered. This might be the case if sampling results at the beach have shown that, historically, water quality has consistently met acceptable beach water quality thresholds and no known or potential sources of fecal contamination affect beach water quality. EPA recommends that additional samples be taken as soon as possible if the first sample exceeds water quality thresholds.

If possible, the resampling should be completed immediately after detection of a beach notification threshold exceedance. If culture methods are used, the results should be obtained as expeditiously as sample collection and analysis can occur after the routine monitoring results indicate an exceedance. If qPCR is used, resampling results could be available later the same day. If the second sample indicates that a water quality threshold has been exceeded, the state or local government must promptly notify the public.

Chapter 5 discusses notification procedures (beach advisories, postings, and closings) in more detail. BEACH Act grant QAPPs typically describe state training plans.

4.3.2.3.1 After a Sewage Spill or Pollution Event

For all beaches, EPA recommends sampling immediately after a sewage spill or other significant pollution event for which FIB densities might be expected to exceed standards. EPA also strongly recommends that beach managers consider a preemptive beach closure (with or without confirmatory sampling) when there is suspicion of a sewage spill or major leak. Chapter 5 discusses beach closures in more detail. Beach or program managers should complete additional sampling of closed beaches to ensure mitigation of the spill before reopening the beaches.

4.3.2.3.2 After an Advisory or Closing

After an exceedance, additional sampling should be conducted to determine whether a beach notification can be lifted. Because an advisory imposed on the basis of sampling results should not be lifted without subsequent sample results showing that the applicable WQS have been met, prompt resampling is preferable to waiting until receipt of the next routine sampling results. Beach advisories issued on the basis of the output of a predictive model can be lifted if the output from an additional model run estimates that water quality conditions have improved to within acceptable parameters or, alternatively, that the results of a water quality sample indicate that indicator densities once again meet the applicable standard. Section 5.2.1.2 discusses preemptive advisories in more detail.

4.3.2.3.3 After a Heavy Rainfall Event

EPA recommends that managers develop and follow a protocol for a variety of rain events and consider such protocols at all recreational beaches. Many states, tribes, and local governments have protocols in place. At beaches with stream and storm drain discharges, previous sampling has established that water quality is often poor after a substantial rain, justifying a preemptive advisory without confirmatory sampling results. A beach or program manager should consider local circumstances and evaluate whether additional monitoring or a formal protocol for preemptive beach notification advisories is appropriate.

4.3.2.3.4 Other Circumstances

When routine monitoring at a sample location indicates elevated FIB densities, additional sampling can be done to determine the extent of the water quality problem. Defining the extent of the poor water quality more effectively protects public health and might provide valuable information for source identification and mitigation.

4.3.3 Administering a Monitoring Program

4.3.3.1 Staffing Monitoring Programs

A monitoring plan should include an adequate staffing plan that accommodates periods of peak beach use. EPA recommends that professional staff from state and local agencies maintain primary responsibility for the design and oversight of beach monitoring. Citizen volunteers can also be used to perform supplemental beach monitoring program functions. For example, volunteers can be used to provide more intensive monitoring at high-priority beaches or to help with monitoring at low-priority beach areas where regular staff might not be available. Additional information on volunteer monitoring programs is available on EPA's website at http://water.epa.gov/type/rsl/monitoring/index.cfm.

Once the monitoring plan has been developed, the staff who will implement the program should receive training. Whether drawn from the ranks of professional staff, other municipal employees, or volunteers, the personnel responsible for sample collection and environmental measurements at the beach and those performing the bacterial indicator analyses should be trained for those activities. The quality of information produced by a monitoring program depends on the quality of the work done by field and laboratory staff. Separate training programs should be developed for field staff, laboratory staff, and others involved in the monitoring program. Laboratory training and analyst qualifications are generally evaluated as part of a laboratory accreditation program. The training for field staff should include a review of applicable SOPs, sampling locations, sampling equipment and containers, field forms and labels to be completed on-site (e.g., chain-of-custody forms, sample collection forms, sample labels), sample preservation information, personal protection equipment, coordination with the analytical laboratory, and important contact information. Follow-up training should continue for as long as the monitoring program is active. QAPPs should describe the content of training plans in BEACH Act grant QAPPs.

Early in each swimming season, it is advisable to conduct procedural reviews with each field sampling crew. Such reviews afford program oversight staff an opportunity to observe the techniques and procedures being used to collect samples, provide any necessary clarification, and immediately address any departures from program requirements. Reviews also evaluate whether program procedures are applicable to potentially changing conditions, and they offer an opportunity to solicit field staff opinions regarding procedure refinements or enhancements that could continue to improve the quality of the data.

4.3.3.2 Field Sample Collection Methods

The monitoring plan should also include the following elements on field sample collection methods:

- ***Selecting sampling locations (e.g., maps, names of sampling locations).*** The beach manager should survey the site to become familiar with its physical and hydrologic features, in addition to or as part of a sanitary survey. The reconnaissance site visits should include collecting the following information:
  - Most convenient and safest point of access to the site.
  - Potential sampling locations.

  - Necessary equipment.
  - Directions to sampling locations relative to access point.
  - Justification for the selection of each sampling location.
  - Other information necessary for preparing for sampling at a site (e.g., health and safety requirements).

- ***Chain-of-custody forms, field forms, bottle labels.*** A sampler should record a detailed description of each sample collected and record it on a chain-of-custody form. The form should document the sampling location (site ID), time of collection, date of collection, collector's name and signature, agency, laboratory to which the samples were delivered or sent, and other notes or comments. Field sampling staff should document on a field form basic on-site measurements and observations, such as weather conditions, general characteristics about the water, time of sample collection, name of sampler, and number of sample bottles filled. A field log (notebook) can also be used to record observations and notes not recorded on the field forms.

  A sample identification label (to be placed on the sample container) should be completed to accompany each sample throughout the chain of custody. The label should document the information for each sample, including sampling trip number, sample number, analyte for analysis, and date of sample. All entries should be made in indelible ink and coincide with sample information on the field form and chain-of-custody form.

- ***Equipment, sample container needs.*** Sampling for recent EPA epidemiological studies was conducted consistent with recommendations on microbiological sampling in *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al. 1998). Those studies used capped 1,000-mL, pre-sterilized polypropylene bottles for sample collection. EPA, in its *Microbiological Methods for Monitoring the Environment, Water and Wastes* (USEPA 1978), suggests wide-mouth borosilicate glass bottles with screw caps or ground-glass stoppers; however, glass bottles can break, causing loss of the sample. Polysulfone (Nalgene) containers of appropriate size are also used. Heat-resistant polypropylene bottles may be used if they can be sterilized without producing toxic materials when autoclaved, or pre-sterilized disposable containers may be employed. Sufficient coolers and ice should be available to place samples promptly on ice for transport to the laboratory. Other equipment needs will vary according to local sampling practices and/or state protocols.
- ***For qPCR use,*** pre-sterilized, single-service plastic containers are optimal because of the potential for DNA fragments to persist after sterilization. Otherwise, if used, reusable containers should be constructed of polysulfone or other similar plastic material, soaked in 5 percent bleach solution, and then rinsed with distilled water before each use.
- ***Health and safety concerns.*** Any field team member who participates in sample collection at the beach should know how to swim. Sample collection should be postponed if conditions are dangerous (e.g., bad weather, rough water).
- ***Laboratory availability and scheduling of sample deliveries.*** Samples are usually transported to the laboratory by the person collecting the sample or picked up by laboratory personnel. Because of holding time limitations, the laboratory should be conveniently near the sampling site and notified a few days before the sampling effort so

that it is prepared to process the samples promptly. Chain-of-custody procedures should be followed at the laboratory for all samples.

- ***Communication with the lab.*** Open communication and collaboration with your laboratory service provider will greatly benefit your monitoring program. Laboratories work with a variety of clients from various backgrounds and with different levels of experience. Laboratories also routinely provide sampling kits (bottleware, labels, and custody records), assist in training sampling staff, and provide additional sampling instructions or responses to frequently asked questions about their bottleware. When selecting a laboratory, if multiple laboratory service providers are available in the vicinity of the beach, consider value-added services. In addition to the services above, many laboratories offer courier services to drop off supplies and pick up samples, and some provide preprinted chain-of-custody forms and bottle labels that require only the samplers' initials and the date and time of sample collection.

4.3.3.3 Managing Data

One of the most important aspects of a monitoring program is data management, from the collection process through the data analysis. Data management activities include documenting the nature of the data and subsequent analyses so that the data from different sites are comparable. Data management also includes handling and storing both hard copies and electronic files containing field and laboratory data. It is important to understand and comply with all state agency policies and standards regarding data collection and generation.

The operation of the data management system should include QA oversight and QC procedures. If changes in hardware or software become necessary, the data manager should obtain the most appropriate equipment and test it to verify that the equipment can perform the necessary jobs. Appropriate user instructions and system documentation should be available to all staff using the database system. Developing spreadsheet, database, and other software applications involves performing QC reviews of input data to ensure the validity of computed data.

EPA requires beach managers to add their monitoring data to the Agency's STORage and RETrieval (STORET) database at http://www.epa.gov/storet/wqx/index.html. Each sampling result in STORET is accompanied by information describing where the sample was taken (latitude, longitude, state, county, hydrologic unit code, and brief site identification); when the sample was gathered; the medium sampled; and the name of the organization that sponsored the monitoring. Additional information on STORET is available at http://www.epa.gov/storet.

States, tribes, and local governments can submit their data using a database provided by the beach program, create a state or local STORET database, or create an alternative data system. The beach program's monitoring database can be accessed at http://water.epa.gov/grants_funding/beachgrants/datausers_index.cfm#monitor. These databases submit monitoring data to EPA's Water Quality eXchange (WQX), which accumulates data that are copied into the STORET repository on a weekly cycle. Staff working with the database should have expertise and training in the software and in the procedures for data transport, file transfer, and system maintenance.

4.3.3.4 Program Implementation and Oversight

States and tribes should regularly assess the effectiveness of their monitoring programs. The purpose of assessments (such as surveillance, readiness reviews, technical system audits, performance evaluations, and audits of data quality) is to determine whether the established QC procedures are being used and how the program is operating. Checklists or reviews of program documentation and reports can be used to evaluate different aspects of the program. The types and number of assessments to be performed can be documented in the monitoring program oversight plan. In addition, the program should clearly provide for the authority of the assessor (e.g., a QA officer) to stop work and should identify under what conditions that might occur.

The QA program should include procedures for identifying and defining a problem, assigning responsibility for investigating the problem, determining the cause of the problem, assigning responsibility for implementing corrective action, and assigning responsibility for determining the effectiveness of the corrective action and verifying that the corrective action has eliminated the problem. Supervision is important during the program. To provide advice and identify problems when they occur, personnel providing oversight to technical staff should be well-versed in the procedures they are performing. Such proficiency is needed whether in the field performing the sampling or in the laboratory performing the microbiological analyses.

4.3.3.5 Public Comment

Public review of the monitoring plan is part of the overall public review and comment criterion described in section 2.2.11 (performance criterion 11). States or local governments must submit documentation of the public review to EPA.

4.4 Methods and Assessment Procedures (Performance Criterion 3)

Performance criterion 3 requires the states and tribes to document methods and assessment procedures. States and tribes must:

- Submit to EPA methods for characterizing water quality relative to human health in coastal recreation areas.
- Provide documentation of the performance of methods other than those that EPA approved or validated.
- Identify and submit to EPA assessment procedures for identifying short-term increases in FIB densities that indicate risk to human health in coastal recreation waters.

4.4.1 EPA-Approved or Validated Analytical Methods

EPA recommends a number of analytical methods for use in testing recreational waters. These are methods that EPA has approved and codified at 40 CFR part 136 or validated in single- or multi-lab validation studies. These methods, with their associated indicators, are used to determine whether the water quality at a beach exceeds or is likely to exceed the applicable WQS. EPA has established relationships through epidemiological studies between FIB density in the water and levels of illness.

Sections 4.4.1.1 and 4.4.1.2 discuss EPA's approved culture and validated qPCR methods. Section 4.4.2 provides information on selecting the appropriate analytical method—culture (4.4.2.1) or qPCR (4.4.2.2). Subsections of 4.4.2.2 discuss the analysis of site-specific performance that EPA encourages for qPCR methods.

4.4.1.1 Culture Methods

In July 2003 EPA promulgated testing procedures in *Guidelines Establishing Test Procedures for the Analysis of Pollutants; Analytical Methods for Biological Pollutants in Ambient Water; Final Rule* (Office of the Federal Register 2003). The 2003 rule revises 40 CFR part 136 to add analytical methods for *Escherichia coli*, enterococci, *Cryptosporidium*, and *Giardia* in ambient waters. It includes methods published in the *Official Methods of Analysis of AOAC International* (AOAC International 1995), the 20th edition of *Standard Methods for the Examination of Water and Wastewater* (APHA 1998), and the 2000 edition of the A*nnual Book of ASTM Standards* (volumes 11.01 and 11.02; ASTM 2000). It also includes methods developed by EPA and commercial vendors, including Hach Company, IDEXX Laboratories, and others. This ruling was updated in a final ruling in March 2012, which provided updated versions of EPA methods (see FR [*Federal Register*] 77(97):29758).

For beach testing, EPA recommends that states and tribes use the EPA-recommended culture methods mentioned above. The methods identified at 40 CFR part 136 are also acceptable. States and tribes that want to use culture methods other than the currently approved methods at 40 CFR part 136 must go through EPA's Alternate Test Procedure (ATP) program, which requires submission of their method, along with validation data, to EPA. To meet performance criterion 3, documentation supporting the validity of methods other than those EPA has approved must be provided. Detailed descriptions of culture methods are included in http://water.epa.gov/scitech/methods/cwa/methods_index.cfm. Vendor method descriptions can be obtained from the various vendor websites (see FR 77(97):29758 for details).

4.4.1.2 qPCR Methods

EPA Methods 1611 (USEPA 2012a) and 1609 are EPA-validated qPCR *Enterococcus* spp. methods (see http://water.epa.gov/scitech/methods/cwa/bioindicators/upload/Method-1611-Enterococci-in-Water-by-TaqMan-Quantitative-Polymerase-Chain-Reaction-qPCR-Assay.pdf). Method 1609 has internal amplification control (IAC). EPA expects to validate qPCR methods for *E. coli* and *Bacteroidales* in the near future. Because at present only culture methods are included at 40 CFR part 136 as approved methods, the ATP protocol may not be used to qualify these qPCR methods for adoption into state or tribal WQS or for use in beach monitoring. Consistent with the 2012 RWQC, EPA encourages states and tribes that want to use EPA-validated qPCR methods to conduct a site-specific analysis of the method's performance before use in a beach notification program or adoption of WQS based on the method. Documentation of the site-specific analysis has two parts: method performance (4.4.2.3.1) and site-specific acceptability (4.4.2.3.2). In addition, section 4.4.2.3.3 discusses logistical and other practical considerations for implementing a qPCR method.

4.4.2 Selection of Analytical Methods: Culture versus qPCR

4.4.2.1 Culture Methods

Analyzing water samples for the enumeration of FIB by culture methods such as membrane filtration, multiple-tube fermentation, or defined substrate technology has been the standard for decades. Although refined, the culture methods in use today still require bacterial growth in specific selective media for quantification. Culture methods require at least 18 to 48 hours to produce results, with the densities of the target organism reported in colony-forming units (CFU) or most probable number (MPN) per 100 mL. Previous research (e.g., Boehm 2007; Griffith et al. 2007; Noble et al. 2003; Taggart et al. 1992) has shown that FIB density exhibits a high degree of methodological and temporal variability. Culture results, nevertheless, are economical and reproducible, and they can serve as a source of information for managing waters and developing predictive models (section 4.5) to provide timely estimates of FIB density.

Culture results are also effective in characterizing long-term water quality and variability at beaches. If, over the course of a season, weekly water quality monitoring fails to identify any occasions when the WQS were exceeded, it can be assumed that water quality is generally good. That can be expressed numerically by calculating a GM of the results or, more simply, by reviewing the number of exceedances or viewing data displayed graphically. Such results might suggest a reduced monitoring frequency at that location. Conversely, if weekly culture results produce a range of values including WQS exceedances, the results would indicate that sources of contamination exist, that the water quality is variable, and that conducting more intensive monitoring—or using a predictive model or qPCR analytical methods for more timely public notification—might be appropriate for the site.

4.4.2.2 qPCR Methods

Determining water quality by quantifying the DNA of FIB is a well-established methodology (e.g., Haugland et al. 2005, Noble et al. 2010). Unlike culture-based methods, qPCR methods quantify all forms of FIB, whether viable cells, injured cells not capable of growing on selective culture media, dead cells, or fragments of free DNA. The premise is that like the viable cells, the molecular material indicates the presence of fecal material from humans or other vertebrates and an associated risk of illness, likely from human enteric viruses also found in sewage and wastewater treatment plant effluent (Colford et al. 2012; Wade et al. 2008). Results of the epidemiological studies conducted for the 2012 RWQC demonstrated a significant association between gastrointestinal illness in swimmers and both culture and qPCR enumeration methods for *Enterococcus*; the association observed with qPCR enumeration was the stronger of the two.

The 2012 RWQC discuss using EPA's qPCR *Enterococcus* spp. method (Method 1611) as a tool for beach management and potential inclusion in WQS. The primary advantage of qPCR methods compared to culture methods is that analytical results can be available in as few as three hours after receipt of the sample in the lab. This means that the qPCR results are much more likely to reflect water quality on the day when recreators are exposed to the water that was sampled. However, using a qPCR method might pose challenges for the beach or program manager, including method performance, site-specific acceptability, and practical considerations. Before deciding to use qPCR methods at local beaches, a beach manager should assess the

acceptability and feasibility of applying qPCR methods in light of these potential challenges. Section 4.4.2.3 discusses this in more detail.

4.4.2.3 Assessing the Use of qPCR on a Site-specific Basis

A primary message of this document is that beach and program managers should develop tiered monitoring plans that reflect beach-specific use and risk. The decision whether to use qPCR-based methods will require weighing the potential advantages of more timely public notification against the site-specific characteristics of the beach and resource and logistical constraints. This analysis will help a beach or program manager determine whether using a qPCR-based method is feasible for local waters before investing in capital equipment and ancillary supplies, repurposing lab space, and providing the method-specific staff training required to implement qPCR for beach water quality analyses.

The 2012 RWQC recommend criteria for *Enterococcus* or *E. coli* as measured by culture methods. Although the 2012 RWQC recognize the value of qPCR for beach monitoring, the RWQC only provided supplementary information on qPCR and did not base EPA's national RWQC recommendation on it given EPA's limited knowledge regarding the performance of qPCR methods under varied water body conditions. EPA encourages state and tribal beach programs that want to use qPCR as a method for beach monitoring to conduct a site-specific analysis of the method's performance and to assess the method's site-specific acceptability before using it in a beach notification program or adopting WQS based on the method. These two assessments are described below.

4.4.2.3.1 Assessing Site-specific Method Performance

States and tribes undertake beach water quality sampling to identify WQS exceedances to issue beach advisories or closures. As discussed in the 2012 RWQC, the state of knowledge regarding the performance of qPCR methods under varied water body conditions is limited. EPA Methods 1611 (USEPA 2012a) and 1609 (USEPA 2013b) are two EPA-validated qPCR enterococci methods. Method 1611 was released simultaneously with the RWQC. Method 1609 is an improved version of Method 1611. It uses a newer formulation of PCR reagent (environmental master mix) that has shown enhanced inhibition control compared to the reagent used in Method 1611 (universal master mix). In addition, Method 1609 includes a competitive IAC assay (i.e., a control for inhibition) to help specifically identify false negative reactions (i.e., test results that wrongly show an effect to be absent) or reduced amplification efficiency due to Taq DNA polymerase inhibition (Haughland et al. 2012). Although either method is acceptable for use, EPA recommends using Method 1609 because of these enhancements.

Both Method 1611 and Method 1609 quantify the number of copies of *Enterococcus* DNA in surface water. For states and tribes interested in using either method to make site-specific beach notification decisions, the 2012 RWQC provide qPCR-based beach notification thresholds. If local beach managers are considering using EPA Method 1611 or 1609, the method documentation (USEPA 2012a; USEPA 2013b) provides information on identifying method limitations in specific waters, such as interference, and procedures for correcting method problems.

The performance acceptability criteria of EPA Method 1609 or 1611 are stated in the method document. The acceptability criteria are based on a nationwide validation of the method (see section 14 in Methods 1609 and 1611). The method document assumes that the testing laboratory has been able to perform the method within the acceptance criteria and that the beach or program manager wants to determine whether the method would be acceptable for use at a particular site.

4.4.2.3.2 Assessing Site-specific Acceptability

The analysis for site-specific acceptability of qPCR analysis should include the following elements, which are more fully described in *Acceptability of the EPA qPCR Test at Your Beach* (USEPA 2013a):

- At least 10 samples should be taken on different days for site evaluation before using the method for beach notification decisions. Sampling for a longer period, however, will provide data that are more representative. Among these samples, a maximum of 10 percent can fail the Salmon DNA sample processing control (SPC) assay criterion (see section 9.12 in Method 1611) or the SPC and IAC assay criteria (see sections 9.12 and 9.13 in Method 1609). For any samples that fail the initial analysis, one or both of the interference mitigation approaches—extract dilution (see section 9.12 in Methods 1609 and 1611) or higher Salmon DNA (see reference 17.5 in Method 1609)—can be used to assess for mitigation of the interference. If mitigation by one of these approaches is successful (i.e., samples now pass the control assay criteria specified above), these samples can be considered as not having failed in the site evaluation.
- Particularly if beach advisories or closures are not mandated by local standards after a heavy rain event, site evaluation sampling should include a representative number of samples collected after such events.
- Sites should be reevaluated every year, preferably before using the method for beach action decisions, because water characteristics, including the appearance and disappearance of inhibitors to the method, have been shown to change over time.

Some localities might be inclined to compare the frequency of beach advisories based on the qPCR test versus the culture test. EPA neither encourages nor discourages such comparisons; however, if used, the results should be interpreted carefully. Comparisons between exceedances do not reflect their respective method performance when all the controls in the methods are performing properly. In addition, a higher rate of exceedances does not necessarily reflect greater health protection when evaluating qPCR and culture approaches because such comparisons do not take into account the relative severity of the total health risks on the days of exceedance. In all cases, however, the same-day notification potential for qPCR more accurately reflects water quality for beachgoers compared with methods where results are not available until the following day.

4.4.2.3.3 Logistical and Other Practical Considerations

Although the results from qPCR sampling can be obtained in a few hours, a number of factors can affect a state's or tribe's ability to deliver same-day notification. Besides having a laboratory that is close enough to the beach to allow samples to be quickly transported, prepared, and analyzed, beach or program managers should consider cost, configuring laboratory facilities for

qPCR use, choosing an appropriate instrument, providing adequate staff training, selecting reagents and controls, and documenting QA/QC protocols.

The Southern California Coastal Water Research Project (SCCWRP) conducted a pilot study in which the participating jurisdictions used qPCR to make health protection decisions at nine beaches in Orange County (Griffith and Weisberg 2011). The authors determined on the basis of the study results that cost and temporal logistics are the biggest challenges to initial use of rapid methods, and that would likely limit qPCR initially to heavily used beaches or those with highly variable water quality. They also found that to post notifications by noon, they needed to modify every step in the process, from sample collection to posting advisories. See the text box for more details.

Southern California Coastal Water Research Project (SCCWRP) Pilot Study

During their pilot study, SCCWRP found they had to modify every step—from sampling to posting signs—to provide notifications by noon. The modifications included:

- Sample collection routine.
  - Started sampling earlier in the morning.
  - Limited sites sampled to high-priority beaches (i.e., heavily used or with highly variable water quality).
  - Used a second crew for qPCR sites.
- Laboratory procedures.
  - Used a faster method (i.e., one with a shorter cycling time).
  - Did not use a DNA extraction kit with multiple pipetting steps.
  - Completed all preparation steps before samples arrived at the lab.
- Communication with the beach manager.
  - Automated the data analysis and QA using Excel macros.
  - Used electronic signs that could be controlled remotely.

4.4.3 Using Other Methods or Indicators for Developing Site-specific WQS

Previous sections of this document discuss using EPA-approved culture methods or validated qPCR methods for assessing water quality at recreational beaches. Relationships have been established through epidemiological studies between the density of FIB in the water measured by these methods and levels of illness. There are three scenarios states and tribes might present; they are discussed briefly below.

- ***The state or tribe wants to use a method that is not EPA-approved or validated but has a predictable and consistent relationship with an approved or validated EPA method.*** The state or tribe should consult *Site-Specific Alternative Criteria Technical Support Materials for Alternative Indicators and Methods* (in press-c). In this case, the relationship between the alternative method and the EPA method can be correlated with the illness rates associated with the EPA method and used to establish site-specific alternative water quality criteria to be adopted into site-specific WQS based on the alternative method.
- ***The state or tribe wants to use an approved and validated EPA method and wants to account for local-scale, non-human sources of fecal contamination.*** The health studies that substantially informed EPA's 2012 RWQC recommendations were conducted at beaches contaminated by secondary treated and disinfected wastewater effluent. Beaches affected by other fecal sources could pose different, potentially much lower, human health risks at the same level of water quality recommended in the 2012 RWQC. In this instance, a state or tribe would use QMRA to estimate the human health risks posed by

the pathogens coming from the specific sources of fecal contamination affecting a site and to calculate site-specific water quality criteria that would provide a level of public health protection equivalent to the health goals discussed in the 2012 RWQC. Once adopted into site-specific WQS, these criteria would provide a basis for identifying beach notification thresholds. States and tribes wishing to establish site-specific water quality criteria accounting for nonhuman sources of fecal contamination should consult *Site-Specific Alternative Criteria Technical Support Materials for Alternative Fecal Sources* (USEPA in press-b).

- ***The state or tribe wants to use a method that does not have a predictable and consistent relationship with an approved or validated EPA method but is demonstrated to be associated with health.*** In this instance, the state or tribe would establish a site-specific health relationship between the indicator and human health effects at the site by performing a scientifically defensible epidemiological study and/or QMRA at the site. The documented association between the indicator and health would serve as the basis for site-specific criteria to be adopted into site-specific WQS. These WQS would provide a basis for identifying beach notification thresholds in the waters where the relationship was established. States and tribes wishing to establish a site-specific health/indicator relationship should consult *Alternative Health Relationships Technical Support Materials* (USEPA in press-a).

4.5 Monitoring Report Submission (Performance Criterion 4)

The fourth performance criterion requires development of mechanisms to collect relevant monitoring information, provide timely communication of water quality to the public, and submit reports to EPA.

States and tribes must report their monitoring data to the public in a timely manner, including posting the data on a publicly available website. A publicly available website is one that:

- Has its address included on grantee websites and in published materials (e.g., news releases, advisories, beach program documents) as a source of additional information about the state's or tribe's beach program.
- May be a dedicated beach water quality website or a general state or tribal news website.
- Is reliably operational, at least during the beach season.
- Does not require access credentials.

Posting all monitoring data to EPA's STORET would also meet the requirement for a publicly available website. If a state or tribe uses STORET as its "publicly available website," related state or tribal websites must include a link to STORET and an explanation of the type of data posted.

In this context, "timely" means posting monitoring data associated with an exceedance concurrently with or shortly after the issuance of a notification action. States and tribes must report all other monitoring data to EPA's STORET and to their publicly available website, if not STORET, at least annually or at a frequency the EPA Administrator requires. Reported monitoring data must be consistent with section 4.3.3.3.

4.5.1 Data Validation and Verification Recommendations

EPA recommends that managers use procedures to verify whether the microbiological sample collection and analyses have correctly estimated the densities of indicator bacteria, to ascertain whether requirements for a specified use of the results have been fulfilled, and to determine how the data should be interpreted for decision making. This section discusses some of the important aspects of such procedures. These should be included in the monitoring program design to ensure that the data obtained are usable and defensible. Several iterations through these procedures might be necessary to ensure that the data and their interpretation are correct.

4.5.1.1 Data Validation Methods

Single laboratory validation refers to the confirmation that data quality objectives (DQOs) for a specified intended use have been fulfilled. Thus, once beach or program managers have confirmed that the data meet standards and contract requirements, they can systematically examine the data to determine the technical usability with respect to the planned objectives. This activity can also provide a level of overall confidence in reporting the data on the basis of the methods used. For example, if the wrong medium was used or the incubation temperature limit was exceeded, managers would assign a qualifier to the data indicating their uncertainty and reject the data from further analyses. The managers should then prepare a report that provides an assessment of the usability of the data, a summary of environmental sample results, and a summary of QC and QA results. The report should discuss any discrepancies between the DQOs and the data collected and any effects such discrepancies might have on the ability to meet the DQOs.

Finally, managers should assess the data to evaluate whether they are of the right type, quality, and quantity to support their intended use. The assessment could include reviewing the DQOs and sampling design, conducting a preliminary data review, selecting the statistical test, verifying the assumptions of the statistical test, and drawing conclusions from the data.

4.5.1.2 Data Verification Methods

The laboratory service provider should provide the procedures for verifying whether the bacterial indicators were correctly determined for any method used. Verification involves performing additional tests to identify those colonies found on the membrane filter that provided information. A false positive rate is calculated as the percent of colonies that reacted (were identified as the indicator) but were not actually the indicator. A false negative rate is calculated as the percent of colonies that did not react as anticipated (and so were not identified as the indicator) but were in fact that indicator. False positive and false negative rates for the media used in EPA Methods 1600 (USEPA 2009a) and 1603 (USEPA 2009b) are provided in those methods. Verification procedures should be used in establishing QC limits on initial use of the procedure, when using a new technician to perform the procedure to ensure that method requirements can be met, whenever any changes are made in how the procedure is performed or in the materials used in the procedure, and always when the results are to be used in evidence for legal proceedings.

The laboratory service provider should review the sample records, chain-of-custody records, and sample tracking records to verify that all the samples collected were analyzed so that the data set

will be complete. It should also verify data entries and analyses and, for large quantities of data, perform spot-checking to detect potential data entry errors. Additional checks could include graphically displaying data to visually inspect for potential errors, using statistical methods to detect invalid data, and checking for duplicate data entries. Input data should be reviewed for accuracy, bias, completeness, precision, representativeness, and uncertainty. In addition, the data reductions and transformations should be reviewed (audited) to ensure that they have been correctly performed. The calculation review could include rechecking the computations, reviewing the assumptions used and the selection of input data, and checking the input data against the original sources to be sure there are no transcription errors. The EPA methods provide the types of calculations that might be performed on bacterial indicator filter counts to estimate bacterial densities per sample. *Standard Operating Procedure for Recreational Water Collection and Analysis of* E. coli *in Streams, Rivers, Lakes and Wastewater* (IITF 1999) provides more examples.

Beach program managers should obtain a report from the laboratory service provider documenting the results of the data verification. To verify conformance of the data collection effort with the plan, data should pass the specified numerical QC tests (precision and bias limits); the plans should be followed and calculations should be performed correctly; all samples should be treated consistently; and the necessary quantity of data and information relative to the stated DQOs should be obtained (completeness). Staff should address data concerns, if possible, or managers should reject the data and not use them to make the decision.

4.6 Use of Predictive Tools in Beach Monitoring Programs

EPA encourages states and tribes to use predictive tools to make timely beach notification decisions and to deliver same-day notifications. Although using qPCR can provide results sooner than using culture methods, qPCR might not be a viable option for all settings. To reduce exposure to pathogens, agencies operating beach monitoring and notification programs need tools that can provide a quick, reliable indication of the water quality conditions. Predictive models and other predictive tools are another means to provide rapid estimates. These tools are used to supplement, not replace, monitoring; they provide timely estimates when a lag time exists between performing sampling and obtaining results.

Predictive tools might also be useful in developing or adapting routine monitoring programs to focus efforts when conditions favor high FIB levels. The predictive tools examined in *Predictive Tools for Beach Notification, volume 1* (USEPA 2010b) include statistical models, rain threshold levels, notification protocols, and deterministic models. Information from that report is briefly summarized below. The report is available on EPA's website at http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/P26-Report-Volume-I-Final_508.pdf.

Significant development and implementation of statistically based models have occurred recently, especially in the Great Lakes (Lake Erie and Lake Michigan), where many predictive tools were proven reliable and cost-effective (Francy 2009; Nevers and Whitman 2005). EPA believes such predictive tools could be applicable in many other settings as well, including marine and inland beaches. These tools develop statistical relationships or models between FIB densities (dependent variables) and various observations that describe the environmental conditions at the beach (independent variables). The models use recent and historical FIB densities and independent variables that include other water quality, hydrodynamic, and meteorological data to predict current FIB levels and to forecast near-future FIB levels or the likelihood of exceeding a WQS. Statistical models and other predictive tools can be run as frequently as data are available for measured independent variables and as long as models are producing reliable predictions that protect public health.

Chicago's Modeling Project

The Chicago Park District (CPD) has developed predictive models for water quality to provide more current and accurate information to the public.

CPD selected five public beaches in Chicago for modeling, from the largest in size (Montrose Beach) to one of the city's most popular (Oak Street Beach).

All the beaches are primarily affected by nonpoint sources and have a history of between 8 and 15 percent exceedance rates (percent of days when the mean of two samples exceeds 235 CFU *E. coli* per 100 mL of water).

USGS helped CPD develop empirical models using multivariate regression. They modeled *E. coli* levels using results from both the current culture-based method and a qPCR-based method.

CPD initially anticipated the need for two years of data to have working models developed because results depend strongly on the weather. The Chicago area has very different beach seasons from year to year; therefore, a larger data set would help improve the model's accuracy.

CPD began using the model in 2012 to make management decisions about notification actions. They monitor all beaches every weekday. CPD runs the models at 9:00 a.m. and issues advisories by 9:30 a.m. If the model shows no exceedance, CPD posts a green flag; however, the public can view both model results and sampling values by visiting the beach, viewing the website, or calling a hotline.

Rainfall-based beach notifications have been widely used at marine and freshwater beaches for decades. Rainfall-based beach notification thresholds are issued at some beaches on the basis of an analysis of historical data. At such beaches, it has been shown that after a certain amount of rainfall, a beach is likely to have high FIB densities (USEPA 1999). Similar notification protocols could be developed in which a certain combination of conditions has been shown to result in high FIB levels.

Information on these and other types of predictive tools is provided below.

4.6.1 Statistical Models

Statistical model is a general term for any type of statistical modeling approach that predicts or forecasts beach water quality. Statistical models are also called statistically based models and include most *predictive models* currently in use. Linear regression models assume a linear relationship between factors, or combinations of factors, and FIB densities (Boehm et al. 2007; Nevers and Whitman 2005; Olyphant and Whitman 2004; USEPA 2007). The most highly developed and currently used statistical modeling approaches for beach water quality

management are multivariable linear regression models. These types of models couple combinations of important independent variables to FIB densities. The most common model outputs are estimated FIB levels or a probability of exceedance of the adopted state WQS for FIB. Typical, easy-to-measure environmental and water quality variables that are predictive of FIB density can include:

- Meteorological conditions (e.g., solar radiation, air temperature, precipitation, wind speed and direction, dew point).
- Water quality (turbidity, pH, conductivity/salinity, ultraviolet/visible spectra).
- Hydrodynamic conditions (freshwater discharge, magnitude and direction of water currents, wave height, tidal stage).
- Other factors such as presence and number of birds or people.

Statistical models are especially useful at some beaches and less useful at others. According to Francy (2006), statistically based modeling can effectively predict water quality in situations where nonpoint or unidentified sources dominate and in settings where discrete sources have been identified (Nevers and Whitman 2005). If a beach rarely has high bacteria densities or, conversely, chronically exceeds a bacterial WQS, it is unlikely that a statistical predictive model would significantly improve timely decision making and notification. If a beach occasionally exceeds the WQS or if bacteria levels are highly variable, statistical models can help by providing a timely prediction of whether FIB are likely to exceed the WQS according to parameters that are easier and faster to measure than FIB densities.

Developing and using a statistical predictive model is a dynamic process based on data collected from beach monitoring. Statistical modeling uses a retrospective correlation of measured water quality (FIB levels) with conditions observed at the time of sample collection to produce a timely estimate of water quality for recreational water management and use by the public. Model developers can create Internet-based systems that provide model predictions (similar to weather forecasts) to the public for the current period, as compared to other Internet-based systems that alert the public to exposure that might have occurred a day or two earlier. However, models require periodic validation and refinement to improve predictions.

EPA has developed a very effective tool for building freshwater statistical models—Virtual Beach. Virtual Beach is a versatile and user-friendly statistical tool that links past water quality data to observed variables to produce real-time estimates of water quality at freshwater beaches (USEPA 2010a). EPA is expanding Virtual Beach for marine beaches. Visit http://www2.epa.gov/exposure-assessment-models/virtual-beach-vb for more information.

Although USGS, the National Oceanic and Atmospheric Administration (NOAA), and other agencies and Internet sources are available to provide much of the data necessary for developing multivariable linear regression models, many modeling efforts have been shown to be site-specific. Therefore, beach water quality managers can expect to need to analyze their own historical FIB data in relation to mined data from other agencies to develop models specific to their own locations. To make this process simpler, there is a newly available version of Virtual Beach, V.3.0.

Other useful references for information on statistical models include Predictive Modeling at Beaches, volume 2 (USEPA 2010a), *Temporal Synchronization Analysis for Improving Regression Modeling of Fecal Indicator Bacteria Levels* (Cyterski et al. 2012), *Partial Least Squares for Efficient Models of Fecal Indicator Bacteria on Great Lakes Beaches* (Brooks et al. 2013), and A*pplication of Empirical Predictive Modeling Using Conventional and Alternative Fecal Indicator Bacteria in Eastern North Carolina Waters* (Gonzalez et al. 2012).

4.6.2 Rainfall-based Beach Notification Threshold

The objective of a rain threshold level is to identify the level of rainfall at which FIB levels are likely to trigger a beach notification. That is achieved if a statistical relationship—a simple regression or a frequency of exceedance analysis—between rainfall amount, intensity, and duration and FIB densities can be observed or if a level of rainfall and rainfall conditions is consistently shown to be associated with increased FIB densities. With that information, many beach managers and public health officials commonly issue a preemptive rain threshold advisory after a rain event of a predefined intensity or duration. Beachgoers are familiar with routine, wet-weather closures in locations where they are implemented. The beach notification threshold can then serve as a management tool for developing notification protocols or predicting WQS exceedances that require a beach notification.

4.6.3 Notification Protocols

Notification protocols are based on a set of decision criteria that trigger beach notifications in anticipation of poor water quality or other potentially hazardous conditions (e.g., rough waves, strong rip currents, red tide). The protocol can rely on sampling results, other information, or beach characteristics either alone or in addition to sampling results. Such evaluations are designed to supplement bacteria data with characteristics of the beach that can influence the related bacteria levels (e.g., proximity to pollution sources, stormwater runoff, current, or wind direction).

4.6.4 Deterministic Models

Deterministic models use mathematical representations of the processes that affect FIB densities to predict exceedances of WQS. They include a range of simple to complex modeling techniques, such as fate and transport and hydrodynamic models. EPA believes that many models developed for general purposes might have potential use for understanding beach processes. However, at this time, no specific examples of easy-to-implement deterministic models exist (unlike with predictive statistical models). In contrast to the statistical models described earlier, deterministic models typically require specialized knowledge and expertise for successful implementation. It would likely be challenging for local beach managers to set up, calibrate, and run certain types of deterministic models with sufficient reliability and validity to protect public health.

In the future, beach managers and modeling practitioners might want to further develop deterministic modeling tools to support beach monitoring and notification programs. Blending the performance of multiple types of models, a process known as *stacking* models, can help to account for complex variations in aquatic systems and improve accurate and timely predictions of WQS exceedances. A complex pattern of WQS exceedances was resolved by combining

hydrodynamic and statistical modeling at a popular beach in Florida (Zhu 2009). In the Great Lakes, water current, wind, and water level outputs of deterministic models are generated and can be used as independent variables in statistical models for predicting water quality at beaches, as well as for other purposes (NOAA 2012; Schwab and Bedford 1994). EPA's FRAMES model combines the functions of multiple process models to estimate water quality. For information on FRAMES visit http://www.epa.gov/extrmurl/research/3mra.html.

4.6.5 Determining Exceedances Using Predictive Models

Predictive models use past water quality data and current observed hydro-meteorological data as a basis for estimating water quality at a given time, as described in section 4.5. Models need a data set of observations that can vary in length, and ongoing calibration with periodic water quality determinations that can vary in frequency, to maintain a model's calibration. Beach or program managers should assess their predictive models by correlating estimates of water quality with analytical results, the percentages of both Type I (false positive) and Type II (false negative) errors, or other methods that characterize water quality (e.g., Francy 2009, Gonzalez et al. 2012).

The water quality estimates should be compared with beach notification thresholds. Beach or program managers can use beach notification thresholds that provide an adequate basis for public health protection. As stated in section 5.3, actions imposed based on the output of a predictive model can be lifted when the model is run again and new estimates indicate water quality conditions have improved to within acceptable parameters or, alternatively, when the results of a water quality sample show that FIB densities once again meet the applicable standard.

Future directions that EPA considers likely for predictive tools for beach notification include forecasting beach water quality conditions a day or more into the future. Researchers are also attempting to develop models that would apply to more than one beach or to a region of shoreline.

4.7 The 2012 RWQC Provide Context for Beach Monitoring Programs

This section summarizes relevant elements of the 2012 RWQC (section 4.7.1) and describes key considerations for beach monitoring programs (section 4.7.2). Section 4.7.3 discusses a new performance criterion—*Adoption of New or Revised WQS and Identification and Use of a Beach Notification Threshold*, Performance Criterion 10.

4.7.1 2012 Recreational Water Quality Criteria

On November 26, 2012, EPA released its revised RWQC. It is beyond the scope of this document to discuss the details of the RWQC. The criteria and associated information are available at http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/index.cfm.

The 2012 RWQC, if adopted as recommended into state or tribal WQS, would be the applicable WQS in CWA programs, including issuing NPDES permits, assessing waters to determine whether they are attaining WQS, developing TMDLs, and conducting beach monitoring and notification programs funded under CWA section 406. However, the water quality distribution

on which a state's or tribe's WQS is based could also be the basis for selecting a beach notification threshold value to trigger beach notification actions (i.e., advisories and closures).

EPA recommends that WQS based on the 2012 RWQC include the following values:

- ***Magnitude.*** Magnitude is the numeric expression of the maximum amount of the pollutant that might be present in a water body that supports the designated use.
- ***Duration.*** Duration is the period of time over which the magnitude is calculated.
- ***Frequency.*** Frequency of excursion[7] describes the maximum number of times the pollutant might be present above the magnitude over the specified time period (duration).

Criteria in a WQS should consist of a combination of magnitude, duration, and frequency of exceedance to protect the designated use (in this case, primary contact recreation).

As summarized below and described in greater detail in the 2012 RWQC document (USEPA 2012b), EPA determined that the primary contact recreation designated use would be protected if the state or tribe adopted one of the sets of criteria values (table 4-4), consisting of a GM and an STV, into its WQS and EPA approved it. Note that EPA's criteria recommendations are for a GM and an STV (rather than just a GM or just an STV) because, used together, they indicate whether the water quality is protective of the designated use of primary contact recreation. Using the GM alone would not protect for spikes in water quality because the GM alone is not sensitive to them.

The 2012 RWQC provide both GM values and STVs as upper-bound values (table 4-4). EPA recommends that the criteria magnitude be expressed as a GM value and an STV. These values correspond to the 50th and the 90th percentiles, respectively, of the same water quality distribution, and thus they are associated with the same level of public health protection.

Table 4-4. Recommended 2012 RWQC

Criteria elements	Estimated illness rate (NEEAR GI): 36 NGI per 1,000 recreators			Estimated illness rate (NEEAR GI): 32 NGI per 1,000 recreators	
	Magnitude			Magnitude	
Indicator	**GM (CFU/100 mL)***	**STV (CFU/100 mL)***		**GM (CFU/100 mL)***	**STV (CFU/100 mL)***
Enterococci – marine and fresh water	35	130	**OR**	30	110
OR					
E. coli – fresh water	126	410		100	320
Duration: The water body GM and STV should be evaluated over a 30-day interval. **Frequency:** The selected GM magnitude should not be exceeded in any 30-day interval, nor should there be greater than a 10 percent excursion frequency of the selected STV magnitude in the same 30-day interval.					

*EPA recommends using EPA Method 1600 (USEPA 2009a) to measure culturable enterococci, or another equivalent method that measures culturable enterococci, and using EPA Method 1603 (USEPA 2009b) to measure culturable *E. coli*, or any other equivalent method that measures culturable *E. coli.*

[7] The frequency of excursion describes how often water quality sample values may surpass the combined magnitude and duration components before an exceedance of the WQS occurs and the water body is considered impaired.

4.7.1.1 Geometric Mean

EPA is recommending that the GM of a water body be calculated in the same way as recommended in the 1986 criteria by taking the $\log_{10}$ of sample values, averaging those values, and then raising 10 to the power of that average.

4.7.1.2 Statistical Threshold Value

The STV is derived in a similar manner to the 1986 criteria SSM, by estimating the percentile of the expected water quality distribution around the GM criteria value. EPA recommends an STV that approximates the 90th percentile of the water quality distribution; it is intended to be a value that should not be exceeded by more than 10 percent of the samples measured over a 30-day period used to calculate the GM. EPA selected the estimated 90th percentile as the STV. The 90th percentile accounts for the expected variability in water quality measurements, while limiting the number of excursions above the STV. It encourages additional monitoring because using the 90th percentile reduces the number of samples that could exceed the criteria value (i.e., STV) within the 30-day duration period. This approach also encourages monitoring because it allows no excursion of the STV unless at least 10 samples are taken over the 30 days during which the magnitude component of the criteria is calculated.

In a departure from the 1986 criteria, EPA no longer recommends the concept of multiple *use intensity* values of the SSM. EPA's 2012 RWQC include both the GM and STV, used together to adequately protect the designated use of primary contact recreation. Therefore, EPA recommends that states and tribes adopt both the GM and STV into their WQS.

4.7.2 Threshold Values for Beach Notification Actions

4.7.2.1 Selection of Beach Notification Thresholds for States and Tribes Receiving Grants under CWA Section 406

The BEACH Act requires that states and tribes receiving grants under the act notify the public of any exceedance of or likelihood of exceedance of applicable WQS. When FIB levels at a beach exceed the applicable threshold, the responsible state or tribal agency issues a beach notification. Agencies generally issue beach advisories but, in some cases, might issue a beach closure notice. The purpose of these public notices is to inform the public of the potential risks associated with primary contact recreation in waters that exceed or are likely to exceed the applicable WQS.

States and tribes must identify a beach notification threshold. This threshold does not need to be adopted into a state's or tribe's WQS. In the 2012 RWQC EPA suggests use of a specific value, the Beach Action Value (BAV), which is the 75th percentile value of the water quality distributions for the CWA section 304(a) recommended criteria (i.e., the 75th percentile values for 32 NGI per 1,000 recreators or 36 NGI per 1,000 recreators for one of the two indicator-method combinations (enterococci or *E. coli* by culture) or qPCR (on a site-specific basis and with the appropriate analyses (see section 4.4.2.3)) as the threshold value for determining

whether to take a beach notification action.[8] EPA selected the 75th percentile value because it corresponds to the percentile of the SSM values many states currently use as beach notification thresholds.

In state and tribal programs funded by EPA grants under CWA section 406, it is critical that the selected beach notification threshold be based on the same water quality distribution as the state's or tribe's WQS. Any single sample above the threshold value would trigger a beach notification until collection of another sample below that value. EPA suggests a BAV at the 75th percentile level in order to trigger an advisory at a lower FIB density than the STV. Because this BAV is a more conservative point on the same water quality distribution, states and tribes using this value will satisfy the statutory requirement for a notification action on an exceedance or likely exceedance of the WQS.

EPA expects that states and tribes receiving beach grants under CWA section 406 will select as their beach notification threshold the BAV based on the 75th percentile value that corresponds to the indicator and illness rate in their adopted their WQS. (See table 4-5). However, they do have the option to submit a written justification to use a different value. The alternative value should be selected from the same statistical distribution as the illness rate and corresponding values adopted into state WQS, and the justification should explain why this value is preferable to the EPA-preferred 75th percentile value. This is discussed further in section 4.7.3.

Table 4-5. Beach Action Values (BAVs)

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

[a] Enterococci measured using EPA Method 1600 (USEPA 2009a), or another equivalent method that measures culturable enterococci.
[b] *E. coli* measured using EPA Method 1603 (USEPA 2009b), or any other equivalent method that measures culturable *E. coli.*
[c] EPA *Enterococcus* spp. Method 1611 for qPCR (USEPA 2012a).

Before selecting any new beach notification threshold, states and tribes will continue to make notification decisions using the existing beach notification thresholds. In most states the existing beach notification values are SSM values from EPA's 1986 RWQC document. These SSM values corresponded to the 75th percentile values of the 1986 RWQC statistical distribution.

[8] All BEACH Act states and tribes that have not revised their WQS as directed in CWA section 303(i)(1)(A) were required by section 303(i)(1)(A) to have WQS as protective of human health as EPA's 1986 bacteria criteria. Because EPA's 1986 bacteria criteria recommendations were for the same fecal indicator bacteria in the 2012 RWQC (enterococci and *E. coli*), the BAV in the 2012 RWQC have the requisite relationship with the applicable WQS in states that have not yet revised their WQS under CWA section 303(i)(1)(B).

4.7.2.2 Alternative Beach Notification Thresholds

For beach programs ***not*** funded by EPA grants under CWA section 406(b), there are additional alternatives for states and tribes to consider. As with the BEACH Act states, neither use of the BAV nor any of the alternatives requires adoption into a state or tribal WQS.

States and tribes that do not receive funding under CWA section 406 could choose to use any exceedance of the applicable STV as a threshold for notification for the purposes of their beach notification program, even without adopting it as a "do not exceed value" into their WQS. Alternatively, states and tribes that do not receive funding under CWA section 406 could choose to continue to use their current beach notification value; however, EPA encourages these states and tribes to use the BAV based on the 75th percentile value from the water quality distribution of their WQS.

4.7.2.3 Preemptive Advisories

A state or tribe might have in place a preemptive advisory that automatically takes effect when conditions in the advisory (e.g., amount of rainfall) are met. The advisory is developed based on an analysis of monitoring data that shows the conditions under which the applicable WQS will be exceeded or is likely to be exceeded. The preemptive advisory would take effect and would end based on those predetermined conditions. Such an advisory might need to be recalibrated if the state's or tribe's beach notification threshold changes.

4.7.2.4 Exceedances for EPA Enterococcus qPCR Methods

The 2012 RWQC document provides information on a qPCR *Enterococcus* spp. method (EPA *Enterococcus* spp. qPCR Method 1611; USEPA 2012a), discussed in section 4.4.2.2. EPA supports state use of qPCR methods for beach notification decisions in lieu of culture methods because it presents an opportunity to improve public health protection by enabling beach managers to take more timely notification actions at recreational beaches.

Because of EPA's limited experience with qPCR performance across a broad range of environmental conditions, EPA encourages a site-specific analysis of the method's performance before using the method in a beach notification program or adopting WQS based on the method. Section 4.4.2.3 describes a process for assessing the feasibility of using qPCR on a site-specific basis, including confirming that inhibition does not affect the method's ability to accurately characterize water quality.

For states considering using qPCR Method 1611 or 1609, the 2012 RWQC provides the following GM, STV, and BAV values (table 4-6) for both the 36/1,000 and 32/1,000 primary contact recreators' illness rates. Consistent with section 4.7.2.1, states and tribes using qPCR may also select a beach notification threshold that is other than the 75th percentile value, with appropriate justification.

Table 4-6. Values for qPCR

Element	36 NGI per 1,000 primary contact recreators			OR	32 NGI per 1,000 primary contact recreators		
	GM (CCE per 100 mL)	STV (CCE per 100 mL)	BAV (CCE per 100 mL)		GM (CCE per 100 mL)	STV (CCE per 100 mL)	BAV (CCE per 100 mL)
qPCR (site-specific)*	470	2,000	1,000		300	1,280	640

*EPA *Enterococcus* spp. Method 1611 for qPCR (USEPA 2012a).

4.7.3 Implementation Requirements for Adopting the 2012 RWQC into State and Tribal WQS and Identifying and Using a Beach Notification Threshold (Performance Criterion 10)

EPA is adding a new performance criterion, *Adoption of New or Revised WQS and Identification and Use of a Beach Notification Threshold*, Performance Criterion 10. The purpose of the criterion is to ensure that BEACH Act states and tribes adopt new or revised WQS as directed in CWA section 303(i)(1)(B); that is, within three years after EPA issues new or revised RWQC. The performance criterion also requires selection and use of an appropriate beach notification threshold. The specifics of performance criterion 10 will change from year to year.

4.7.3.1 FY 2014 Overview

The prerequisite for receiving an FY 2014 BEACH Act grant is to agree to a grant condition requiring the development of two schedules. BEACH Act states and tribes must include in the grant workplan for their FY 2014 grants a commitment to develop these schedules within 60 days of grant award:

- Adopt new or revised WQS by FY 2016.
- Select and use an appropriate beach notification threshold by FY 2016.

Additionally, states and tribes must commit to begin following the schedules by the end of the grant year. If a state or tribe believes that it will be unable to develop either or both schedules within the allotted time frame, the state or tribe may request from the regional grant project officer an extension of up to 30 days for submitting the schedule(s).

The schedules should contain milestones consistent with any relevant aspect of state or tribal law or custom that could affect the time frame for adopting new or revised WQS and identifying and using an appropriate beach notification threshold. Milestones might include, for example, drafting regulations, interagency coordination, public outreach and public comment periods, and legislative review. Where different state or tribal agencies must collaborate in order to develop and implement the two schedules, milestones might include creating and convening an interagency workgroup.

4.7.3.2 FY 2014: Adopting New or Revised Water Quality Standards

The new or revised WQS anticipated by the schedule must have RWQC expressed as a magnitude, duration, and frequency for the indicator, and an illness rate consistent with the CWA

section 304(a) recommendations in the 2012 RWQC or alternative criteria that are scientifically defensible and protective of the primary contact recreation use.

In 2004, EPA promulgated WQS for 21 states. Since then, only six of those states have revised their WQS. The other states continue to use the WQS in the federal promulgation to make beach notification decisions. One purpose of this schedule is to ensure that such states update their underlying state regulations.

All BEACH Act states and tribes must develop this schedule except those that have received an affirmative statement from EPA waiving the requirement. States and tribes that have RWQC that are consistent with EPA's CWA section 304(a) 2012 RWQC recommendations may be eligible for such a waiver. EPA will expect the schedule to address specifically those elements that are not consistent with the 2012 RWQC.

4.7.3.3 FY 2014: Identifying and Using a Beach Notification Threshold

The second schedule is for the state or tribe to identify and use an appropriate beach notification threshold. The state or tribe must commit to identify the indicator, illness rate, and value the state or tribe will use as its beach threshold at the completion of the second schedule. EPA expects that states and tribes will use BAVs as their notification thresholds (i.e., the 75th percentile value of the water quality illness rate from their new or revised WQS). States and tribes that want to use an alternative threshold must submit a written justification to EPA based in science, local water quality data, or monitoring experience.

The 2012 RWQC explicitly did not recommend adoption of a beach threshold as part of the CWA section 304(a) recommendations for state and tribal WQS. However, some states and tribes may be required under state or tribal law to use only the values in their WQS as their beach notification threshold, and those WQS might not include an appropriate not-to-exceed threshold. In those situations, the state or tribe would need to change any legal requirement that precludes the state or tribe from using a value consistent with the requirements of this document.

States and tribes must continue to use their existing beach notification thresholds based on the currently applicable WQS, e.g., SSM, until the state or tribe adopts new or revised WQS. When the state or tribe adopts new or revised WQS, it must have a beach notification threshold that can be used.

4.7.3.4 FY 2015 and Beyond

Grant workplans for FY 2015 and beyond must include a commitment to continue to implement the schedules for adopting the WQS and identifying and using a beach notification threshold until the state or tribe has met all the milestones in both schedules. The workplans must also identify the indicator, illness rate, and value the state or tribe will use as its beach notification threshold and commit to making beach notification decisions as described.

4.7.4 Use of RWQC in Identifying CWA Section 303(d) Impaired Waters

States that have EPA-approved WQS consistent with EPA's 2012 RWQC recommendations must use the GM and STV (with corresponding duration and frequency) when identifying CWA

section 303(d) impaired waters. EPA expects that beach water quality monitoring data from the beach program, and any other ambient monitoring, would be evaluated as part of a state's or tribe's data set to calculate the GM and STV for attainment purposes.

States also have the option to consider use of beach notification actions (advisories and closures in a recreational season) when determining whether the waters demonstrate nonattainment of their primary recreation use. In general, EPA recommends that states and tribes consider information about beach notification actions as a supplement to the GM and STV calculations.

4.8 Delegation of Monitoring Responsibilities (Performance Criterion 5)

If a state delegates monitoring responsibilities to local governments, performance criterion 5 requires the state grant recipient to describe the process by which the state may delegate these responsibilities to local governments and document any specific delegated responsibilities. States must notify EPA annually if there are any changes in delegated responsibilities.

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Chapter 5: Public Notification and Risk Communication

This chapter describes the performance criteria and technical guidance related to public notification and risk communication. It includes information on developing and implementing a plan that describes measures to notify the public of an exceedance or likely exceedance of the applicable WQS and inform them of the potential risks associated with water contact activities in recreation waters that do not meet applicable WQS. Assessing the information needs of stakeholders, developing message content, and selecting communication methods are key elements of the plan. This chapter discusses a variety of communication options, such as beach signs, news releases, websites, and social networking. The chapter also covers BEACH Act requirements for notifying EPA and local agencies when WQS are exceeded and reporting notification activities.

To the extent possible, states and tribes should be moving toward same-day notification of exceedances and prompt reporting by using tools that provide rapid results (i.e., rapid analytical methods and predictive models) and tools that facilitate rapid communication of those results (e.g., electronic notification and real-time reporting).

This guidance reflects those goals in the addition of three new specific requirements under the performance criteria. These requirements apply to states and tribes that receive grants under CWA section 406 after this document becomes final:

- Performance criterion 2, Tiered Monitoring Plan, now requires that states and tribes consider the potential use of predictive tools when developing a tiered monitoring plan.
- Performance criterion 2, Tiered Monitoring Plan, now requires that states and tribes consider the appropriateness of qPCR methods when developing a tiered monitoring plan.
- Performance criterion 4, Monitoring Report Submission, now requires that states and tribes make monitoring data available in a timely manner to the public on a website.

5.1 Performance Criteria

Performance criteria 6 through 9 describe the four requirements for a public notification and risk communication program:

- Public Notification and Risk Communication Plan (performance criterion 6).
- Actions to Notify the Public (performance criterion 7).
- Notification Report Submission (performance criterion 8).
- Delegation of Notification Responsibilities (performance criterion 9).

Key changes to chapter 5 from the 2002 guidance document

- More clearly ties notification to the tiered monitoring plan (section 5.2).
- Adds a specific requirement to identify measures to inform the public of the risks of swimming in contaminated water (section 5.2).
- Adds information about risk communication objectives, notification content, and notification methods (sections 5.2 and 5.4).
- Discusses new beach notification and communication tools, such as social media, email, and text messages (section 5.4).
- Provides guidance on when to issue or remove a notification (section 5.3).
- Combines performance criteria 5 through 7 into performance criterion 6 to eliminate duplication (section 5.2).
- Divides performance criterion 8 into two criteria—performance criteria 8 and 9—to separate disparate activities (sections 5.5 and 5.6).

Table 5-1 provides details on the general and specific requirements of the performance criteria and cross-references them to the sections in this chapter where they are discussed. As explained in chapter 2, monitoring and notification programs funded with BEACH Act implementation grants must be consistent with the performance criteria.

Table 5-1. Performance criteria details

Performance criteria		Chapter section
General requirements	**Specific requirements**	
Public Notification and Risk Communication Plan (Performance Criterion 6). States and tribes must develop public notification and risk communication plans.	• Identify measures to notify EPA and local governments (if applicable) when indicator bacteria levels exceed a beach notification threshold. • Identify measures to notify the public when a beach notification threshold has been exceeded by posting a sign or functional equivalent. • Identify measures that inform the public of the potential risks associated with water contact activities in the coastal recreation waters that do not meet applicable WQS. • Provide for public review of the public notification and risk communication plan.	5.2
Actions to Notify the Public (Performance Criterion 7). States and tribes must give notice to the public that the coastal recreation waters are not meeting or are not expected to meet applicable WQS or the beach notification threshold for pathogens and pathogen indicators.	• Promptly issue a public notification for exceedance of the beach notification threshold when there is no reason to doubt the accuracy of the sample. • If there is a reason to doubt the accuracy of the first sample, the state agency may resample before issuing a notification.	5.4
Notification Report Submission (Performance Criterion 8). States and tribes must compile their notification actions in timely reports submitted to EPA.	• States and tribes must report to EPA at least annually, or at a frequency the EPA Administrator determines, on the occurrence, nature, location, pollutants involved, and extent of any exceedances of any WQS for pathogens and pathogen indicators.	5.5
Delegation of Notification Responsibilities (Performance Criterion 9). States must describe any delegation of notification responsibilities that they have made, or intend to make, to local governments.	• States must identify any local governments to which they have delegated responsibility for implementing a notification program and describe the process by which the state may delegate such authority.	5.6

5.2 Public Notification and Risk Communication Plan (Performance Criterion 6)

Performance criterion 6 requires states and tribes to develop a public notification and risk communication plan. The plan must describe the state's or tribe's public notification efforts; identify measures used to inform the public of an exceedance or likely exceedance of the applicable WQS; and address a new requirement to identify measures to inform the public about the potential risks associated with water contact activities in coastal recreation waters that do not meet the applicable beach notification thresholds. Below are the key steps of creating a public notification and risk communication plan:

- Creating a risk communications strategy.
- Assessing needs and establishing trust.
- Crafting beach notifications.
- Evaluating outcomes.

EPA recognizes that states and tribes usually have such plans in place. States and tribes should review and evaluate their plans periodically to keep them current with the information needs of the community, conditions associated with a contamination problem, and resources and personnel available to the responsible agency. Importantly, careful evaluation will help to determine to what extent the public notification and risk communication program is achieving its objectives and what components should be revised and improved.

5.2.1 Creating a Risk Communication Strategy

5.2.1.1 Risk Communication Partners

Public notification and risk communication are primarily information-sharing processes among three key groups of people:

- ***Stakeholders***—the target audiences that receive and respond to beach advisory and closing information. They include swimmers and other people (such as seashore vendors) who might be affected by beach actions. Government agencies that have an interest in beach actions or must be notified if a beach action is issued are included in this category. State agencies should consider the stakeholders' beliefs, attitudes, and backgrounds when developing notification content and appropriate ways to distribute it. Stakeholders can provide valuable feedback that helps the responsible agency achieve the greatest positive impact in the community.
- ***Agency technical experts***—the people responsible for beach monitoring and research activities; setting policy and procedures in response to violations of WQS; and generating, interpreting, and assessing water quality data. They provide the scientific foundation for the notification and risk communication program.
- ***Risk communicators***—the people responsible for designing and implementing the notification and risk communication program. They typically rely on a two-way communication process with the other partners to define program objectives, assess information needs, and develop communication strategies.

Those three groups should work toward the common objective of reducing the risk of disease to users of recreational waters.

5.2.1.2 Types of Public Notifications

When indicator bacteria levels at a beach exceed the beach notification threshold, the responsible agency issues an advisory or closure to inform the public of an exceedance or likely exceedance of the applicable WQS and the potential risks associated with swimming and other water contact activities.

- ***Beach advisories*** (or *postings* in California) are recommendations to avoid swimming at the beach, or beach area, because of an increased risk of contracting a water-related illness. The action does not, however, officially close a beach to the public. Types of advisories include:
  - Water quality exceedance advisories, which notify the public of an exceedance of applicable beach notification thresholds on the basis of water quality sampling or the likelihood of an exceedance on the basis of modeling.
  - Permanent advisories, which notify the public of a continuing potential human health risk associated with use of the water. These might be issued because of the presence of naturally occurring organisms or human influences that cause a continuous or reoccurring exceedance of a WQS.
  - Preemptive advisories, which notify the public of the likelihood of higher FIB levels at certain times. Preemptive advisories are typically based on having done sufficient monitoring in the past to support an assumption that water quality will exceed the beach notification threshold for a certain period of time after a defined event. An event might be significant rainfall that typically results in flushing bacteria from the land into the water, high-temperature conditions that stimulate bacterial productivity, or prevailing wind conditions that cause the transport of contaminated water from known polluted areas.
- ***Beach closing*** typically means that the beach, or a beach area, is officially closed to the public. Whether to close a beach is a local decision; EPA does not set beach closure requirements or conditions. States and tribes have the flexibility to close the entire beach or just the recreational water adjacent to the beach. For some jurisdictions, closure is a recommendation; for others, it might be enforced. EPA recommends, however, that a closing be issued if a clear public health hazard, such as a sewage line break or other high-risk contamination source, is present. During such a closing, no one should be in the water. Lifeguards might not be present at the beach. The beach could be closed to the public temporarily or for an extended period.

A public notification is also issued when a beach action is lifted or suspended.

5.2.1.3 Risk Communication Objectives

A complete set of clear, concise, and measurable objectives helps to guide the development of a public notification program and serves as a set of measuring tools for program evaluation. In the case of beach closings, the objective is usually clear-cut—the public is prohibited from swimming because a public health hazard (such as a sewage line break or other high-risk

contamination source) or a safety issue (such as dangerous rip tides) is present. The closing message is usually presented in a commanding tone that leaves no doubt that the message should be followed. An advisory, on the other hand, sends a different message because it suggests that the beachgoer consider the information in determining whether to follow the recommendations.

Risk communicators typically take two basic approaches with advisories (USEPA 2011):

- ***Informing*** the public of the potential risk of swimming in contaminated water so that people can make their own judgments and risk management decisions. Communication usually has a straightforward, matter-of-fact tone.
- ***Influencing*** the public by presenting a convincing argument why they should follow recommendations that safeguard their health. The message usually has a cajoling tone.

Selecting a communication approach depends on the beliefs and attitudes of the stakeholders. Beliefs and attitudes, in turn, are shaped by many factors, including the credibility, accessibility, and adequacy of the information sources. Lifestyle, perceptions, and the opinions of others also play roles in behavior choices. Gaining an understanding of the beliefs and attitudes of stakeholders is key when choosing a communication approach.

To keep the program dynamic and relevant, periodically updating objectives is one of the most important ongoing tasks of the risk communication partnership.

5.2.2 Addressing Needs and Establishing Trust

5.2.2.1 Assessing the Information Needs of Stakeholders

A majority of beach actions issued by states and tribes are beach advisories. Unlike official beach closings, cooperation is voluntary; people must make up their own minds about following advisories.

At one extreme, some in the community will accept the advisory recommendations, no questions asked. Perhaps they deem the issuing agency trustworthy and committed to looking out for their welfare. Perhaps they experienced sickness after swimming in contaminated water and do not want to repeat the unpleasant episode. Whatever the motivation, these people need no further information to convince them to follow an advisory recommendation.

At the other extreme, some will reject the advisory recommendations outright. They might think the issuing agency is untrustworthy or simply mistaken. They might believe they are immune to waterborne disease because they have never become sick from swimming. Perhaps they feel the benefits associated with their water recreation activities are worth the risk of getting sick. Whatever the reason, these people will likely never change their beach-going behavior because of an advisory notification.

Most stakeholders fall somewhere between those two extremes. They are open to the recommendations but need more background information or rationale to convince them to follow the recommendations. For that reason, it is important to study the target audiences and assess both their informational needs and the best methods for delivering information to them. Such assessments are critical for establishing trust.

5.2.2.2 Establishing Trust

Usually risk communication messages are judged primarily on the basis of whether the source can be trusted, and only secondarily on the basis of the message itself (USEPA 2011). EPA developed the *Seven Cardinal Rules of Risk Communication* (USEPA 1988) to help risk communicators foster credibility and trust within a community:

1. ***Accept and involve the public as a legitimate partner,*** identifying stakeholder groups and incorporating their concerns and perspectives in communication strategies.
2. ***Plan carefully and evaluate communication efforts,*** establishing clear objectives and developing two-way communication.
3. ***Listen to the public's concerns,*** making no assumptions about what people know, think, or want done about risks.
4. ***Be honest, frank, and open,*** not minimizing or exaggerating the level of risk and discussing data uncertainties, strengths, and weaknesses.
5. ***Coordinate and collaborate with other credible sources,*** releasing information through other credible organizations as appropriate.
6. ***Meet the needs of the media,*** being open and accessible to reporters.
7. ***Speak and write simply and clearly,*** using nontechnical language.

5.2.3 Crafting Beach Notifications

Performance criterion 1 in chapter 3 addresses the process for evaluating beaches and classifying them into a tiered ranking system on the basis of potential risks to human health and beach usage. The tiered ranking system helps grantee agency administrators efficiently allocate monitoring and public notification resources among the beaches they manage.

This approach, however, does not absolve agencies from their mandated responsibility to communicate potential health risks in a timely manner at any beach that has exceeded or is likely to exceed a beach notification threshold. Therefore, at a minimum, states and tribes must post notification of an advisory or closure (signs or their functional equivalent). Beyond this minimum requirement, states and tribes may choose to direct additional resources to beach notifications.

5.2.3.1 Developing Notification Content

The content of a beach advisory refers to the complete set of information in an advisory (USEPA 1995). Most advisories include the following:

- ***Core recommendations,*** which state the specific actions beachgoers should take to protect and preserve their health.
- ***Supplemental information,*** which supports the core recommendations. Depending on the approach, the information can be designed to inform or influence stakeholders to follow the core recommendations.

The content of core recommendations is derived from the state, tribal, and EPA risk assessment and management processes in conjunction with the established policy and procedures of the responsible agency. A core recommendation should be simple, clear, and authoritative. For example:

- For beach closings:
  - Beach Closed—No Swimming—No Wading.
  - Stay Out of the Water.
  - Keep Out—Contaminated Water.
- For beach advisories:
  - Warning—Water Contact Might Cause Illness.
  - Caution—Water Quality Advisory.
  - Water Quality Today Is Rated Poor.

Supplemental information, on the other hand, is crafted considering several factors, including the objectives of the communication program, the informational needs of the stakeholders, the communication approach (informing or influencing), and the type and limitations of the dissemination method. Most supplemental information fits into one of four broad categories:

- Information about the current action.
  - Location or beach length affected by the action.
  - Reason for the beach action (e.g., high levels of fecal bacteria).
  - Duration of the beach action (e.g., resampling and conditions to be met before the action is lifted).
  - Cause or source of the contamination (e.g., untreated sewage, sewer line break, and high runoff).
  - Scales of risk (e.g., high, medium, and low).
- Information about the monitoring program and action policies.
  - Water quality sampling (e.g., schedule, indicator bacteria, and pathogens).
  - Monitoring results that trigger an action (e.g., instantaneous criterion and rolling average criterion).
  - Monitoring limitations (e.g., lag between sampling and lab results).
  - Water quality trends (e.g., past notification actions).
- Behavior modification and instructions.
  - List of unsafe activities (e.g., swimming and wading).
  - Potential consequences of swimming in contaminated water (e.g., gastritis and ear infection).
  - Reporting a beach-related illness (e.g., hotline).
- Agency information.
  - Contact information.
  - Sources of additional information (e.g., website and other outreach efforts).
  - Agency follow-up to address the problem.

5.2.3.2 Selecting Notification Methods

State beach program managers typically use a combination of notification methods to reach the diversity of stakeholders in the community and the nonresidents that might travel to the beach. Whatever methods are selected, they should be designed so that they complement and reinforce each other (USEPA 2011). For example, beach signs, which are necessarily limited in size and scope, should reference a website or source with more detailed information.

The basic challenges for the risk communicator are to identify the various stakeholder groups and match them with effective notification methods given the constraints of agency resources. States and tribes might choose to direct additional resources to higher-priority beaches. For example, a state or tribe might determine that low-cost tools, such as news releases (discussed in section 5.4.2) and notices on a website (discussed in section 5.4.3.1) are appropriate for Tier 2 and 3 beaches and that, in addition, social media tools (discussed in section 5.4.4.3) and electronic signs are appropriate for Tier 1 beaches.

Divergent groupings of stakeholders might be best reached through different methods of communication:

- ***Older versus younger beachgoers.*** Younger people are more likely to use social media (e.g., Facebook and Twitter) than are older beachgoers, who typically prefer newspapers, radio, television, and other traditional media for their news.
- ***Active versus inactive information seekers.*** Some people are more willing than others to actively seek out water quality information before deciding to go to the beach.
- ***Tourists versus locals.*** Residents are more familiar with local information outlets, whereas nonresidents tend to rely on large-scale public media outlets such as state websites.
- ***Differing cultural backgrounds and practices.*** Often different cultures use completely different information outlets, a problem compounded if language barriers also exist. In this case, messages should be translated.
- ***People who receive information before visiting the beach versus people at the beach.*** For some beachgoers, the only time to communicate information to them is while they are at the beach. They do not seek out information before their trip to the beach.

Example of Notice in Spanish

Aviso! Corriente de agua/agua del drenaje de tormenta puede causar enfermedades. Evite contacto con agua de desague y con el area donde desemboca al oceano.

Division de Salud Ambiental del Condado de Orange. Para mas informacion llamar al 714-667-3752.

English Translation

Warning! Runoff or storm drain water may cause illness. Avoid contact with ponded or flowing runoff and the area where runoff enters the ocean.

Orange County Environmental Health Division. For further information, call 714-667-3752.

5.2.4 Evaluating Public Notification and Risk Communication Plans

Evaluations of both new and established public notification and risk communication plans are useful to ensure that the plans continue to meet the needs of the public and the objectives of the state agency. A state or tribe should conduct periodic evaluations to document the short- or long-term results of its public notification and risk communication plan and to evaluate whether objectives were achieved. These evaluations determine whether the beach advisories and closings have been effective in communicating health risks to the public.

States and tribes do not need to wait until the end of a beach season to evaluate plan implementation. Evaluation activities can include regular contacts with communication partners (media personnel, website owner, and stakeholders) to evaluate the timing and adequacy of advisory information. It can also be useful to interview stakeholders or focus groups or conduct mail and telephone surveys to assess how well the advisory information is reaching the target audience and how receptive they are to that information. A large sample size is often needed for the plan evaluators to measure statistically significant outcomes and effects in large regions (e.g., statewide).

Before developing a public notification and risk communication plan, or while evaluating or updating the plan, a state or tribe can mail surveys or conduct them over the telephone to obtain feedback from a subset of the target audience. The state or tribe can use the survey to determine the public's knowledge about the following:

- Human health risks of swimming in contaminated water.
- Specific advisory recommendations.
- The advisory process.

Questions to ask include:

- Did people receive enough information to make an informed decision?
- Were people protected from bacterial contamination? Did the public respond positively to the advisory and closing program?
- Are signs, press releases, websites, and social media presenting appropriate and accurate information?
- How many people pay attention to communication methods such as beach signs and physical barriers?
- How many people actually contact a telephone hotline, visit a website, sign up on Facebook or Twitter, or choose to receive text messages to obtain water quality information for a beach?

A state can design a survey to assess the following:

- The public's reaction to advisories and closings.
- The public's willingness to adhere to advisory and closing recommendations.
- The public's suggestions for better communication methods.

5.2.5 When to Notify EPA and Local Governments

As part of performance criterion 6, states and tribes must develop public notification and risk communication plans that identify measures to notify EPA and local agencies with jurisdiction over the land adjoining the beach of water quality exceedances. The annual reporting under performance criterion 8 satisfies this requirement to notify EPA. States must notify local agencies whenever they issue a notification action.

5.3 When to Issue and Remove a Notification

A public notification and risk communication plan should establish clear policies and procedures for each type of notification the responsible agency uses. As general guidance, EPA recommends that as soon as the lab analyzes and reviews sampling data, the lab should report them to the beach or program manager. In addition to how and when to issue a beach advisory or closing, the plan should include the conditions that must be met to lift the advisory or closing. It should cover all the methods the state or tribe might use to issue an advisory, including sampling results, preemptive advisories, and predictive tools.

5.3.1 When to Issue a Notification

As soon as the data reviews and data quality assessment are completed, based on sampling, modeling, or preemptive advisories, concentrations for the specified bacterial indicators should be reported to the beach manager. If a sample indicates that there is an exceedance or a likely exceedance of a WQS or other notification threshold value, the state or tribe must immediately issue a public notification according to the policy and procedures established in the public notification and risk communication plan unless there is a reason to doubt the accuracy of the first sample. If there is doubt (based on predefined QA measures), the responsible agency should resample.

If the decision is to resample, the resampling should be done in accordance with the discussion in section 4.3.2.3. If the decision is to notify the public, EPA recommends the following actions:

- ***Prompt notification of the owner, manager, or operator and/or the lifeguards.*** When sample results indicate an exceedance of a beach notification threshold, the appropriate agency must promptly notify the beach manager/operator and appropriate staff members (e.g., lifeguards). This approach ensures that the responsible authorities know that action should be taken to ensure the safety of the beach employees.
- ***Prompt public notification.*** The appropriate agency must promptly notify the public of an exceedance of a beach notification threshold—by either a sign or functional equivalent (see section 5.4). Notification typically should occur at the point of beach access. States and tribes must promptly issue a notification when there is an exceedance of a beach notification threshold based on modeling results or a preemptive threshold.

5.3.2 When to Remove a Notification

EPA recommends that states and tribes follow these procedures at all beaches before lifting an advisory or closing:

- For advisories based on sampling results, sample and compare the bacterial concentrations with the applicable WQS or other applicable thresholds to determine whether the levels no longer exceed the threshold.
- In the case of a preemptive advisory, remove an advisory or reopen a beach after the number of hours or days identified in the advisory has elapsed after the event or condition. A state or tribe could also sample before lifting a preemptive advisory. Best professional judgment could also be used to supplement the decision to reopen a beach. A state or tribe should develop protocols for preemptive advisories.
- Beach advisories imposed on the basis of a predictive model could be lifted when an additional model run estimates that water quality conditions have improved to within acceptable parameters or, alternatively, when the results of a water quality sample show that indicator densities once again meet the applicable threshold.

5.4 Actions to Notify the Public (Performance Criterion 7)

Programs funded with BEACH Act grants must notify the public (i.e., post signs or use functionally equivalent communication measures) of an exceedance of a beach notification threshold. Functionally equivalent communication measures are those that effectively communicate to the target audience the potential health risk in a manner at least as timely as posting signs at the beach.

A functionally equivalent measure at the point of access could be a visual notice such as a flag at a beach or personal interaction with beach or park personnel. Other functionally equivalent measures not provided at the point of access include mass media (newspapers, television, and radio), websites, telephone hotlines, and Internet tools.

Historically, traditional forms of mass media such as newspapers, television, and radio were commonly used to communicate notification information to stakeholders. Although such traditional forms of mass media remain important information sources for many segments of the community, the development of the Internet and electronic media has eroded their importance to other segments. Consequently, risk communicators should identify the various stakeholder groups and then match the notification methods to the way each group gets its news.

A beach or program manager should consider the type of beach and its tier when selecting the appropriate notification measures. The measures chosen should be consistent with the risk and use of the beach, as described in chapter 3.

5.4.1 Beach Signs

Beach signs are the most direct way to communicate a notification action to people at the beach. The signs should be where people are most likely to see and read them; beach entrances, access points, and lifeguard stations are common choices. It is important that the core message content

(see section 5.2.3.1) is large enough to be read from a distance, and the sign itself should have design qualities that attract the eye. Electronic signs can also be used, as they are in Huntington Beach, California, and other places.

Emphasize and enhance core content by using the following:

- Capital letters, boldface fonts, and exclamation points.
- Vivid colors for the text or background; red, orange, and yellow are the most common.
- Images or icons, such as a stop sign or the universal "no" symbol (figure 5-1).
- Eye-catching sign shape.
- Attention-grabbing graphics.

Figure 5-1. The universal symbol for "No."

Because signs have limited space, any supplemental content should be brief and to the point. (See the New York City Department of Health and Mental Hygiene case study in the text box below.) EPA recommends that signs include a reference to where further information can be obtained.

In addition to posted beach signs, notification information can often be displayed at other locations at the beach, such as parking lots, bathhouses, and lifeguard stands. Permanent posters in those locations that provide more in-depth information about the beach program, water quality monitoring, and other issues can also be developed.

The Centers for Disease Control and Prevention's Healthy Swimming and Recreational Water website contains excellent health promotion materials such as brochures, fact sheets, and graphic (funny and eye-catching) posters about healthy swimming behaviors. The website is at http://www.cdc.gov/healthywater/swimming/resources/index.html.

Tips to Improve the Effectiveness of Signs

- Use a standard format for notification signage throughout the state so it is familiar and easily recognizable to beachgoers.
- Change signage promptly when bacteria levels change.
- Provide signage in other languages if non-English-speaking people use the beach.
- Use a scale to communicate the severity of the risk. For example, a green, yellow, and red scale is often used to indicate low, medium, and high levels of bacteria.
- Make the sign as sturdy and vandal-proof as possible.
- Avoid small print and technical jargon.

New York City Department of Health and Mental Hygiene New Texting Program

In 2013 the New York City Department of Health and Mental Hygiene (DOHMH) conducted focus groups and intercept surveys of beach patrons in an effort to improve risk communication to the public when beach water quality exceeds acceptable standards. In response to public input on several beach signs, DOHMH developed new public notification signs for its beach water quality warnings. These signs communicate the core recommendations clearly and directly and provide supplemental information on the basis for the advisory or closure.

DOHMH also developed a free texting service for the 2014 beach season so you can "Know Before You Go" if your beach is open, under advisory, or closed. Beachgoers can enroll by texting the word "beach" to 877-877 to receive on-demand updates on the status of a beach by texting the name of the beach.

OPEN:

BEACH NAME is OPEN. To learn more about water quality sampling and the DOH Beach Program, go to: http://maps.nyc.gov/beach/.

ADVISORY;

WARNING: Swimming and wading at *BEACH NAME* is NOT recommended at this time. Water is contaminated with sewage or storm runoff. For more info, text WHY.

CLOSED:

BEACH NAME is CLOSED. By Order of the Health Department, swimming and wading are not considered safe at this time. For more info, visit: http://maps.nyc.gov/beach/.

This texting service was accompanied by a media and advertising strategy to promote the texting service. Other jurisdictions might wish to consider incorporating texting services into their public communication strategies.

5.4.2 Traditional Mass Media

The news release is the key mechanism for providing notification information to newspapers, radio, television, and other traditional media outlets. Some local jurisdictions include beach conditions in their weather reports. Risk communicators should treat the news media as another target audience to assess and cultivate. The objective is to have the notification content promptly published or announced over the air. This is more likely to happen if relationships and protocols are established before a beach action. Communicators should learn the informational needs and preferences of each media outlet they plan to use, including how it wants the news release formatted and delivered to it. That groundwork will help to ensure that notifications are published correctly and in a timely manner.

News releases should be factual, accurate, and carefully proofread. News releases should be written with short sentences, using no jargon, and in the active voice. Generally, they should be no longer than one page. Where possible, risk communicators should emphasize that a beach notification news release is an urgent matter involving public safety. Consider, for example, having the local public health agency issue the release instead of a beach administrative office. Writing "NEWS RELEASE FOR PUBLIC HEALTH AND SAFETY" and "FOR IMMEDIATE RELEASE" in large, bold letters at the top of the news release also helps to emphasize its importance.

Some media outlets will publish or announce the news release content exactly as written. Others might use only the first one or two paragraphs. Consequently, it is crucial to have the core content appear at the beginning of a release, saving the least important information for the end.

As with a beach sign, risk communicators should present the core content in a style that is authoritative and attention-grabbing; for example, "(Named Beach) Closed Because of High Bacteria Levels." The most important secondary content should immediately follow the core content. The news release should conclude with the name, title, and contact information of a person the media outlet can reach for additional information or clarification.

5.4.3 Methods that Allow Stakeholders to Anonymously Seek Out Information

Motivated stakeholders who want to learn the current status of a beach should be able to look up the information themselves. Websites and hotlines are examples of tools that fulfill this function while allowing stakeholders to remain anonymous. Passive information sources like these, however, require the risk communicator to develop a marketing effort to publicize and promote their use and a plan for continually updating them to keep them current.

Actively marketing the availability of risk communication resources such as websites and hotlines is critical for their success. Stakeholders will need to know the Web address or telephone number to use them. That information should be publicized and promoted in as many locations as practicable, including the following:

- All outreach material, such as brochures and newsletters, for the beach program.
- Beach signs and posters.
- Media outlets, especially those that will receive notification news releases.

5.4.3.1 Websites

Increased use of the Internet over the past decade has resulted in a corresponding rise in the importance of using websites to convey information to the public. All the Great Lakes and coastal states, two tribes, and many local jurisdictions maintain websites with beach advisory and closing information. The job of the risk communicator is to ensure that a stakeholder seeking beach status information can navigate to the beach status page quickly and easily. That can be done in several ways, but perhaps the simplest is to provide an eye-catching link on the home page that leads directly to a beach status page.

The beach status page should be designed with the idea that readers want to quickly find the information they are seeking. Similar to drafting news releases, the core content of any beach notification should be up front and prominent. Supplemental information should be less prominent but available to support the core content and inform or influence the reader to follow the recommendations.

Of all the notification methods, a website provides the best opportunity to present extended supplemental information about topics related to beach water quality, public notification, and risk communication. For example, on the "Where You Live" Web page (http://www2.epa.gov/beaches/state-and-local-beach-programs), each jurisdiction's name is a hotlink to its Web page. Another recommended link is to EPA's BEACON website at http://watersgeo.epa.gov/beacon2/.

5.4.3.2 Hotlines

For stakeholders who do not use or have access to a computer, a toll-free telephone number (hotline) is a method that allows people to quickly and easily obtain information about a beach's status. Like a sign, the recorded content should be brief and to the point. In most cases, only the core message can be relayed to the caller, along with where to find more information.

5.4.3.3 Smartphone Applications

Stakeholders who have smartphones might be able to download an application (app) that will give them instant access to water quality conditions at a beach. This technique is being used in the Great Lakes states, where an app provides real-time information on public beach conditions, including advisories and closures. Beachgoers can identify the beaches closest to them and save information on their favorite beaches for future reference. For information about and to download the BeachCast app, go to http://glin.net/beachcast/.

5.4.4 Methods that Rely on Stakeholders to Provide Contact Information to Receive Information

Several methods allow a risk communicator to send beach-related messages directly to a stakeholder's computer, email, text inbox, or social networking site. For that to happen, the stakeholder should become aware of the service and then take an action to link into the system. In addition to marketing the service, the communicator should develop and maintain a distribution or subscription list and implement a plan for continually keeping outreach efforts current and relevant to stakeholder needs. Emails, text messages, RSS (Real Simple Syndication)

feeds, Facebook posts, and Twitter feeds are examples of this form of communication. The link to EPA's BEACON website (http://watersgeo.epa.gov/beacon2/rss.html) is an example of this form of communication.

5.4.4.1 Email

Email is the most popular method of rapidly sending messages through the Internet to designated recipients. Recipients can access the message at a time convenient to them and save it if they desire. A challenge for the risk communicator is developing and maintaining a list of current email addresses. In general, emails should be sent only when there is an important message to communicate to stakeholders, such as a beach action. Frequent emails of lower importance might cause recipients to routinely ignore them or classify them as spam.

The email message itself should be designed similar to a news release, with the core content up front. Other tips include the following:

- Put the core message in the subject line.
- Keep supplemental messages concise.
- Include the program website address and encourage recipients to visit it for more information.
- Incorporate eye-catching graphics and photos to further enhance or illustrate the message.

5.4.4.2 Text Messages

The use of mobile phones, especially smartphones, is growing every year. Because people keep them nearby at almost all times, these devices are becoming popular as an alert system tool. Beach notifications, because of their health and safety ramifications, can be perceived as important information worthy of a special alert from the beach program. Creating a text-messaging list is similar to creating an email list. Thus, a challenge for the risk communicator is to develop a marketing plan to publicize and promote beach action notification through a text message alert system.

The text message itself should be concise and focused on core content. Because many phones have Internet capability, the message can also provide a link to the beach website, where the recipient can get additional information. See the New York City DOHMH case study.

5.4.4.3 Social Networks

Social networking is an evolving phenomenon that allows people to easily communicate with others who have similar interests.

Twitter is a free Web application that allows a user to send messages of up to 140 characters (called tweets) to the email addresses or mobile phone numbers of people who have signed up to follow the user's feed. Twitter is versatile, and messages can be composed and sent from computers, mobile phones, and other devices.

Facebook is another social networking tool that lets individuals or organizations communicate with one another. Basically, risk communicators can create a beach program profile page and use

it to send beach status and other relevant information to a network of Facebook friends. The messages show up as newsfeeds on the Facebook pages of recipients.

As always, to make social media effective as a communication tool, risk communicators should undertake a marketing campaign to get stakeholders to sign up for the beach program input.

Chicago uses a multifaceted approach to communicate with beachgoers—flags, signs, phone hotline, website, and social media. Details are provided in the text box below.

5.4.4.4 RSS Feeds

RSS is a quick and easy way to alert stakeholders of breaking news at a beach. Basically, when new information, such as a beach notification, is added to the beach website, the risk communicator would also add it to a list on the site's RSS feed page. People who subscribe to the RSS feed would be alerted that new information has been added on the site. They can then access it directly by clicking a link that takes them to the appropriate Web page.

5.5 Notification Report Submission (Performance Criterion 8)

Performance criterion 8 requires grant recipients to compile their notification activities and report them in a timely manner. States and tribes must report their notification data to EPA at least annually. Reported data must be consistent with the database schema for PRAWN found at http://water.epa.gov/grants_funding/beachgrants/datausers_index.cfm#notify. The data elements include beach description data, beach program data, station and method identification data, and beach advisory and closing data. For more information about data submission, see EPA's website at http://water.epa.gov/grants_funding/beachgrants/datausers_index.cfm.

5.6 Delegation of Notification Responsibilities (Performance Criterion 9)

Performance criterion 9 requires state grant recipients to describe any delegation of notification responsibilities to local governments. States must notify EPA, at least annually, of changes in any delegation of responsibilities. EPA encourages states to coordinate with local governments and to delegate to local governments, as appropriate, responsibilities for monitoring and notification programs. Local governments have traditionally played a lead role in administering beach protection programs.

People at the local level take responsibility for protecting recreational waters for many reasons. For example, local citizens and officials often are more familiar with local problems and needs and might be in a better position to address local issues and formulate solutions. Also, many of the benefits of protecting natural resources—in this case coastal recreation waters—accrue at the local level.

Chicago: Using a Multifaceted Approach to Communicate with Beachgoers

The Chicago Park District (CPD) is responsible for managing 31 beaches in the Chicago area, which receive an average of 20 million visitors each summer. CPD launched a multifaceted communications campaign for its beach program to better reach a diversity of stakeholders to effectively communicate current beach conditions and ways to keep the beach clean.

Flags and signs

For beachgoers already at the beach, CPD uses colored flags to notify the public of water quality and weather-related beach conditions. Green indicates no issue reported, yellow indicates that a swim advisory is in effect (swimming with caution), and red indicates that swimming is prohibited because of severe weather or water conditions that might be hazardous. A sign at the beach explains the meaning of the flag color.

Phone hotline and website

CPD uses other methods to notify beachgoers of beach conditions before they go to the beach, including a phone hotline (which might reach older beachgoers) and a website (a good source for nonresidents).

Social media

Social media were added to CPD's communications campaign in 2009 as a way to reach out to younger beachgoers. The CPD Facebook wall (http://www.facebook.com/ChicagoParkDistrict) provides daily beach status updates, posts announcements for events at beaches, and allows the public to interact with CPD staff by asking questions or communicating their likes and dislikes. The interactive nature of the Facebook site seems to have been well received by the public. CPD also sends out announcements using Twitter (http://twitter.com/chicagoparks). In 2010 CPD launched a new texting service that allows users to receive beach notification messages about one or more of the city's beaches.

Park-and-display service boxes

To reach beachgoers who might otherwise miss or not have access to the various notification methods, CPD posts the beach status at the entrance to the beach (before paying for parking) with park-and-display service boxes.

CPD has received considerable media attention for its use of novel approaches to reach the public. The use of Facebook, Twitter, and the texting service received wide coverage in Chicago media, which might have helped raise awareness of the program. Another potential factor influencing public interest in the social media tools is the combination of information that CPD communicates. For example, CPD's continuing to post cultural events of interest to the public on its Facebook page during winter months when beaches are closed might encourage people to continue to receive or sign up for the updates. As of January 2011, CPD had more than 4,000 Facebook friends and nearly 2,000 Twitter followers. Between June 7, 2010, when the service was launched, and the end of the swimming season in September, about 15,000 text messages were delivered to beachgoers at their request. About as many people (12,000 to 15,000) visited the CPD website weekly.

In addition to communicating current beach conditions, CPD performs outreach to educate beachgoers about how to keep beaches clean. The park staff performs direct outreach by going on-site at Chicago's most popular beaches, encouraging people not to feed gulls and teaching them how to properly dispose of litter. The District has also developed a 30-minute cable episode to provide similar information.

Information for this case study was obtained from the report *Assessing the Effectiveness of the Beaches Environmental Assessment and Coastal Health (BEACH) Act Notification Program* (USEPA 2011), which can be found on EPA's website at http://www.epa.gov/evaluate/pdf/beach-act-evaluation-final-report.pdf.

5.7 Chapter 5 References

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Glossary

B

Beach Action Value (BAV) – The beach notification threshold derived from the 75th percentile value on the illness risk distribution for the recommended 304(a) criteria: 32 NGI per 1,000 recreators and 36 NGI per 1,000 recreators. It is a conservative value used for making beach notification decisions (i.e., advisories or closures), and it was introduced in EPA's 2012 Recreational Water Quality Criteria.

Beaches Environmental Assessment and Coastal Health (BEACH) Act – An amendment to the CWA passed in 2000. The Act authorizes EPA to provide grants to coastal and Great Lakes states, territories, and eligible tribes to monitor their coastal beaches for bacteria that indicate the possible presence of disease-causing pathogens and to notify the public when there is a potential risk to public health.

BEACH Act beaches – Coastal and Great Lakes beaches or similar points of access used by the public for swimming, bathing, or other such activities.

Beach advisory – Recommendation to avoid swimming at a beach or beach area because of an increased risk of contracting a waterborne illness.

Beach Advisory and Closing Online Notification (BEACON) – Database of pollution occurrences and notification actions for coastal recreation waters developed and maintained by EPA.

Beach closing – Official closure to the public by a state or tribe of a beach or beach area.

Beach use – A factor used to rank beaches in the BEACH Act grant-funded program that refers to the usage of the beach by the public.

Beach notification – An action, such as an advisory or closing, that an agency issues to notify the public when a beach has exceeded (or is likely to exceed) an applicable WQS or other beach notification threshold.

Beach notification threshold – A water quality value selected by a state or tribe that is used to "trigger" a beach notification.

C

Clean Water Act (CWA) – Establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the act was significantly reorganized and expanded in 1972. "Clean Water Act" became the act's common name with amendments in 1972.

Coastal recreation waters – Great Lakes and marine coastal waters (including coastal estuaries) designated under CWA section 303(c) by a state or tribe for use for swimming, bathing, surfing, or similar water contact activities.

Code of Federal Regulations (CFR) – A codification of the final rules published in the *Federal Register*. Title 40 of the CFR contains the environmental regulations.

Colony-forming unit (CFU) – A viable cell grown on or in a non-liquid medium culture method, where each distinct colony is assumed to be derived from a single viable cell.

Combined sewer overflow (CSO) – A discharge of untreated wastewater from a combined sewer system at a point prior to the headworks of a publicly owned treatment works. CSOs generally occur during wet weather (rainfall or snowmelt). During periods of wet weather, these systems become overloaded, bypass treatment works, and discharge directly to receiving waters.

Combined sewer systems – A wastewater collection system that conveys sanitary wastewaters (domestic, commercial, and industrial wastewaters) and stormwater through a single pipe to a publicly owned treatment works for treatment prior to discharge to surface waters.

D

Data quality objective (DQO) process – A process used to establish performance or acceptance criteria.

F

Fecal indicator bacteria (FIB) – Bacterial groups or species that are naturally found in the guts of warm-blooded animals and excreted in high densities in the feces. They indirectly indicate the presence and quantity of fecal pathogens in ambient water.

G

Geometric mean (GM) – The mean of the logarithms of recreational water bacterial indicator densities in modeling risk attributable to swimming in contaminated waters.

N

National Epidemiologic and Environmental Assessment of Recreational (NEEAR) Water Study – A collaborative research study between two laboratories of EPA and the Centers for Disease Control and Prevention that investigated human health effects and rapid water quality methods associated with recreational water use. This study provided real-time water quality measurements and helped better understand the link between water pollution, swimming at the beach, and peoples' health. A main goal of the NEEAR study was to determine how new ways of measuring water pollution can be used effectively to protect swimmers' health.

National Pollutant Discharge Elimination System (NPDES) – A national program under CWA section 402 for regulation of discharges of pollutants from point sources to waters of the United States. Discharges are illegal unless authorized by an NPDES permit.

NEEAR GI – A case of gastrointestinal illness within 10 to 12 days of swimming with any of the following symptoms: (a) diarrhea (three or more loose stools in a 24-hour period); (b) vomiting; (c) nausea and stomachache; or (d) nausea or stomachache and impact on daily activity. NEEAR GI is the definition associated with EPA's 2012 *Recreational Water Quality Criteria*.

Non-program beaches – BEACH Act beaches not in a state's or tribe's current monitoring and notification program, including beaches not monitored because of fiscal constraints.

P

Pathogen – Microorganisms that have the potential to cause disease in a host.

Pathogen indicator – A substance that indicates the potential for human disease as defined by the BEACH Act (33 U.S.C. 1362(23). Pathogen indicator is a broad category of entities (including chemical and biological parameters) that can be used to indicate the presence of pathogens in water.

Predictive tools – Statistical regression models, rainfall-based notifications, decision trees or notification protocols, deterministic models, or any combination of these tools used to predict an exceedance or likely exceedance of a WQS or other notification threshold value.

Primary contact recreation – Recreational activities where immersion and ingestion are likely and there is a high degree of bodily contact with the water, such as swimming, bathing, surfing, water skiing, tubing, skin diving, water play by children, or similar water-contact activities.

Program beaches – BEACH Act beaches subject to a state's or tribe's BEACH Act monitoring and notification program, consistent with the performance criteria.

Publicly owned treatment works (POTWs) – Wastewater treatment works owned by a state or municipality (as defined by CWA section 502(4)) that include any devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes sewers, pipes, and other conveyances only if they convey wastewater to a POTW.

Q

Quantitative microbial risk assessment (QMRA) – A formal process, analogous to chemical risk assessment, for estimating human health risks due to exposures to selected infectious pathogens.

Quantitative polymerase chain reaction (qPCR) – A genetic test used to quantitatively determine the amount of DNA template in a sample relative to a standard.

R

Recreational Water Quality Criteria – CWA sections 304(a) and 304(a)(9) recommendations issued by EPA as guidance to states, territories, and authorized tribes in developing WQS to protect swimmers from exposure to water that contains organisms that indicate the presence of fecal contamination.

Risk – A factor used to rank beaches in the BEACH Act grant-funded program that refers to the susceptibility of a beach to fecal contamination.

S

Sanitary sewer overflows – Untreated or partially treated sewage overflows from a sanitary sewer collection system.

Sanitary survey – Detailed site characterization that compiles information on pollution sources (such as streams or stormwater outfalls) at a beach, physical features on or near a site, land use in adjacent areas and in the watershed that drains to the site, and other sources that could regularly influence water quality.

Statistical Threshold Value – Approximates the 90^{th} percentile of the water quality distribution for the 2012 RWQC and is intended to be a value that should not be exceeded by more than 10 percent of the samples taken for assessment and listing purposes.

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Tier 1 beaches – Highest priority beaches because of high risk and/or high use.

Tier 2 beaches – Beaches with high or moderate use and moderate or low risk.

Tier 3 beaches – Beaches with low use and low or very low risk.

Tiered monitoring plan – Plan that addresses the frequency and location of monitoring and the assessment of coastal recreation waters on the basis of the periods of recreational use, the nature and extent of use during certain periods, the proximity of recreational waters to known point and nonpoint sources of pollution, and the effect of storm events.