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National Beach Guidance and Required Performance Criteria for Grants

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Acronyms

AFO	Animal feeding operation
ANSI	American National Standards Institute
AOAC	Association of Official Analytical Chemists International
APHA	American Public Health Association
ASQC	American Society for Quality Control
ASTM	American Society for Testing Materials
ATP	Alternate Test Procedure
AWWA	American Water Works Association
BEACH Act	Beaches Environmental Assessment and Coastal Health Act
CAFO	Concentrated animal feeding operation
CFU	Colony-forming units
COC	Chain of custody
CSO	Combined sewer overflow
CWA	Clean Water Act
MF	Membrane filtration
mL	Milliliter
MPN	Most probable number
MTF	Multiple-tube fermentation
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
ORD	Office of Research and Development
PBMS	Performance-based measurement system
POTW	Publicly owned treatment works
QA	Quality assurance
QAPP	Quality assurance project plan
QMP	Quality management plan
SOP	Standard operating procedure
SSO	Sanitary sewer overflow
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WEF	Water Environment Federation

Chapter 1: Introduction

This document outlines the performance criteria that an eligible coastal or Great Lakes state, tribal, or local government must meet to receive grants to implement coastal recreation water monitoring and public notification programs under the Beaches Environmental Assessment and Coastal Health (BEACH) Act. The coastal recreation waters covered under the grant program are defined in section 3.2.3 of this document. 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.

1.1 Program and Document Overview

Fecal contamination of our nation's recreation waters originates from many sources, including coastal and shoreline development, wastewater collection and treatment facilities, septic tanks, urban runoff, disposal of human waste from boats, bathers themselves, animal feeding operations, and natural animal sources such as wildlife. People who swim and recreate in water contaminated with fecal pollution are at an increased risk of becoming ill because of pathogens from the fecal matter. For example, people could contract gastrointestinal diseases; nongastrointestinal diseases, such as respiratory, ear, eye, and skin infections; or other illnesses such as meningitis or hepatitis (Rose et al., 1999).

In response to these concerns, the U.S. Environmental Protection Agency (EPA) announced its BEACH Program in 1997. The goal of the program was to assist states, tribes, and local government environmental and public health officials in reducing the risk of disease to users of U.S. recreation waters. The BEACH Program focused on four key objectives:

- Strengthening water quality standards for bathing beaches
- Improving state, tribal, and local government beach programs
- Providing better information regarding beach water quality to the public
- Promoting scientific research to better protect the health of beach users

EPA also started its annual voluntary survey of state and local agencies that monitor water quality at beaches. The *National Health Protection Survey of Beaches* collects information to determine which local beaches are monitored and what agencies are responsible for beach programs. The survey also collects detailed information about advisories and closures at specific beaches. In March 1999 EPA published the *Action Plan for Beaches and Recreational Waters* (Beach Action Plan), a multiyear strategy that describes the Agency's programmatic and scientific research efforts to improve beach programs and research. The Beach Action Plan was published jointly by EPA's Office of Water and Office of Research and Development (ORD), and it can be accessed at <http://www.epa.gov/ORD/WebPubs/final/> Printed copies of the document (EPA 600/R-98-079) can be ordered through the National Service Center for

Environmental Publications (NSCEP), at <http://www.epa.gov/ncepi> or by telephone at 1-800-490-9198.

1.1.1 BEACH Act

The BEACH Act was passed on October 10, 2000, and amended the Clean Water Act (CWA) by adding section 406. The BEACH Act addresses pathogens and pathogen indicators in coastal recreation waters and contains three significant provisions, summarized as follows:

1. The BEACH Act amended the CWA to add section 303(i), which requires states and tribes that have coastal recreation waters to adopt new or revised water quality standards by April 10, 2004, for pathogens and pathogen indicators for which EPA has published criteria under CWA section 304(a). The BEACH Act amendments further direct EPA to promulgate standards for states and tribes that fail to adopt such standards for such pathogens and pathogen indicators.
2. The BEACH Act amended the CWA to include section 104(v), which requires EPA to study issues associated with pathogens and human health and to publish (by 2005) new or revised CWA section 304(a) criteria for pathogens and pathogen indicators based on that study. Within 3 years after EPA's publication of the new or revised section 304(a) criteria, states and tribes that have coastal recreation waters must adopt new or revised water quality standards for all pathogens and pathogen indicators to which EPA's new or revised section 304(a) criteria apply.
3. The BEACH Act amended the CWA to add section 406, which authorizes EPA to award grants to states and tribes to develop and implement a program to monitor and assess, for pathogens and pathogen indicators, coastal recreation waters adjacent to beaches or similar points of access that are used by the public and to notify the public if applicable water quality standards for pathogens and pathogen indicators are exceeded. EPA may award an implementation grant only if the applicant meets all of the statutory requirements for implementation grants. One of these requirements is that the applicant must implement a monitoring and public notification program that is consistent with performance criteria published by EPA under the act. The BEACH Act also requires EPA to implement a monitoring and notification program for coastal recreation waters for states and tribes that do not have a program consistent with EPA's performance criteria, using grant funds that would otherwise have been available to those states and tribes. The BEACH Act and an associated fact sheet are included in appendix C. In addition, a complete copy of the BEACH Act can be found at <http://www.epa.gov/waterscience/beaches/technical.html>.

1.1.2 How This Document Should Be Used

This document 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 attainment of applicable water quality standards for pathogen indicators and (2) promptly notifying the public of any exceedance or likelihood of exceedance of applicable water quality standards for pathogen indicators for coastal recreation waters. EPA is required to publish such performance criteria under CWA section 406(a). Section 406(b) authorizes EPA to award grants to states and tribes to implement a monitoring and notification program, but only if the program meets certain requirements. (See CWA section 406(b)(2)(A)(i)-(v).) One of these requirements is that the monitoring and notification programs must be consistent with EPA's performance criteria. Excerpts from section 406(b)(2)(A) are included in chapter 2.

The performance criteria provide the basis for EPA's evaluation of grant applications when deciding whether to award monitoring and notification program implementation grants under section 406(b). This document is intended to be used by potential grant recipients to implement effective monitoring and notification programs that will be eligible for grants under section 406.

This document also includes EPA's recommendations for implementing programs consistent with the performance criteria. In addition, this document can serve as a reference guide for how and when to conduct preliminary beach assessments because it outlines protocols for water sample collection, sample handling, and laboratory analysis. It also provides information about using predictive models to estimate indicator levels and includes procedures for notifying the public about beach advisories, closings, and openings.

1.1.3 Organization of Document

The chapters in this document cover the following topics:

- **Chapter 1** discusses human health concerns associated with exposure to pathogens and discusses the establishment of water quality standards for bacteria.
- **Chapter 2** summarizes the basic requirements that an applicant must meet to receive a program implementation grant. The chapter 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** describes the risk-based evaluation process that EPA recommends for states and tribes to classify and prioritize their recreation beaches. This step-by-step approach allows states and tribes to assess the relative human health risks and usage of their beaches and to assign an appropriate management ranking to each of them.

- **Chapter 4** discusses the performance criteria related to monitoring and assessment and provides detailed technical guidance.
- **Chapter 5** describes the performance criteria and technical guidance related to the public notification and risk communication portions of a beach program.

The appendices include detailed technical information associated with the topics discussed in the five chapters:

- Appendix A: Beach Guidance Review Team
- Appendix B: EPA Grant Coordinators
- Appendix C: BEACH Act and Fact Sheet
- Appendix D: Indicator Organisms
- Appendix E: Data Elements
- Appendix F: Beach Evaluation and Classification List
- Appendix G: Conducting a Sanitary Survey
- Appendix H: Data Quality and Sampling Design Considerations
- Appendix I: Training
- Appendix J: Sample Collection
- Appendix K: Predictive Tools

1.2 Pathogen Groups

Pathogens are defined as disease-causing microorganisms. Microorganisms are ever-present in all terrestrial and aquatic ecosystems. Many types are beneficial, functioning as agents for chemical decomposition, food sources for larger animals, and essential components of the nitrogen cycle and other biogeochemical cycles. Some microorganisms reside in the bodies of animals and aid in the digestion of food; others are used for medical purposes such as providing antibiotics. The small subset of microorganisms that cause human diseases are known as human pathogens. If taken into the body, such pathogens can cause gastrointestinal illness or even death. The source of these microorganisms is usually the feces of humans and other warm-blooded animals. The pathogens most commonly identified and associated with waterborne diseases can be grouped into three general categories: bacteria, protozoans, and viruses.

Bacteria are unicellular organisms that lack an organized nucleus and contain no chlorophyll. They contain a single chromosome and typically reproduce by binary fission, during which a single cell divides to form two new cells. A primary source of concern to EPA is feces from warm-blooded animals, including fecal waste associated with farming and the discharge of domestic sewage. Feces can contain many types of bacteria found in waterbodies, including the coliform group, streptococcus, lactobacillus, staphylococcus, and clostridia. It is important to note, however, that most bacteria are not pathogenic.

Protozoans are unicellular organisms that reproduce by fission and occur primarily in the aquatic environment. Pathogenic protozoans, which constitute almost 30 percent of the 35,000 known species of protozoans, originate in the feces of warm-blooded animals. They can exist in the environment as cysts that hatch, grow, and multiply after ingestion, causing associated illness. Encystation of protozoans facilitates their survival by protecting them from harsh conditions like high temperature and salinity. Two protozoan species of major concern as waterborne pathogens are *Giardia lamblia* and *Cryptosporidium parvum*.

Viruses are a group of infectious agents that require a host in which to live. They are composed of a sequence of nucleic acids—either DNA or RNA, depending on the virus—that is covered by a protein shell for protection. The most significant virus group affecting water quality and human health grows and reproduces in cells of the gastrointestinal tract of infected animals. These enteric viruses are excreted in feces and include hepatitis A, rotaviruses, caliciviruses (Norwalk-like viruses), adenoviruses, enteroviruses, and reoviruses.

1.3 Health Concerns

The main route of exposure to disease-causing organisms in recreation waters is contact with polluted water while swimming, including accidental ingestion of contaminated water. In waters that contain fecal contamination, potentially all the waterborne diseases spread by the fecal-oral route could be contracted by bathers. These illnesses include diseases resulting from the following:

- Bacterial infection (such as cholera, salmonellosis, shigellosis, and gastroenteritis).
- Viral infection (such as infectious hepatitis, gastroenteritis, and intestinal diseases caused by enteroviruses).
- Protozoan infections (such as amoebic dysentery and giardiasis).

Swimming in contaminated water most frequently causes gastroenteritis. Gastroenteritis is the inflammation of the gastrointestinal tract, usually caused by a microorganism. Symptoms include chills, nausea, diarrhea, and fever.

Although bathing in contaminated water most often results in contracting diseases that affect the gastrointestinal tract, diseases affecting the eye, ear, skin, and upper respiratory tract can be contracted as well. Infection often results when pathogenic microorganisms come into contact with small breaks and tears in the skin or ruptures in delicate membranes in the ear or nose resulting from the trauma associated with diving into the water. Table 1-1 provides a list of diseases that can result from contact with water contaminated with anthropogenically introduced or naturally occurring bacterial, viral, and protozoan pathogens.

Table 1-1. Waterborne Pathogens

Pathogen		Disease	Effects
Bacteria	<i>Escherichia coli</i> (enteropathogenic)	Gastroenteritis	Vomiting, diarrhea, death in susceptible populations
	<i>Helicobacter pylori</i>	Gastritis	Diarrhea. Peptic ulcers are a long-term sequela.
	<i>Legionella pneumophila</i>	Legionellosis	Acute respiratory illness
	<i>Leptospira</i>	Leptospirosis	Jaundice, fever (Weil's disease)
	<i>Pseudomonas</i>	Infections in immunocompromised individuals	Urinary tract infections, respiratory system infections, dermatitis, soft tissue infections, bacteremia, and a variety of systemic infections
	<i>Salmonella typhi</i>	Typhoid fever	High fever, diarrhea, ulceration of the small intestine
	<i>Salmonella</i>	Salmonellosis	Diarrhea, dehydration
	<i>Shigella</i>	Shigellosis	Bacillary dysentery
	<i>Vibrio cholerae</i>	Cholera	Extremely heavy diarrhea, dehydration
	<i>Yersinia enterocolitica</i>	Yersiniosis	Diarrhea
Protozoans	<i>Balantidium coli</i>	Balantidiasis	Diarrhea, dysentery
	<i>Cryptosporidium</i>	Cryptosporidiosis	Diarrhea
	<i>Entamoeba histolytica</i>	Amebiasis (amoebic dysentery)	Prolonged diarrhea with bleeding, abscesses of the liver and small intestine
	<i>Giardia lamblia</i>	Giardiasis	Mild to severe diarrhea, nausea, indigestion
	<i>Naegleria fowleri</i>	Amoebic meningoencephalitis	Fatal disease; inflammation of the brain
Viruses	Adenovirus (31 types)	Respiratory disease	Eye infections, diarrhea
	Astroviruses	Gastroenteritis	Vomiting, diarrhea
	Enteroviruses (67 types, e.g., polio, echo, and Coxsackie viruses)	Gastroenteritis	Diarrhea. Heart anomalies and meningitis are long-term sequela and are very rare.
	Hepatitis A and E	Infectious hepatitis	Jaundice, fever
	Caliciviruses (Norwalk- and Sapporo-like viruses)	Gastroenteritis	Vomiting, diarrhea
	Reovirus	Gastroenteritis	Vomiting, diarrhea
	Rotavirus	Gastroenteritis	Vomiting, diarrhea

Source: USEPA, 2001.

People who acquire an illness from bathing in contaminated water do not always associate their illness with swimming. As a result, disease outbreaks often are inconsistently recognized. Because disease surveillance cannot determine the incidence of disease among bathers, several studies have attempted to establish a link between the concentration of indicators of fecal contamination in bathing waters and the incidence of swimming-associated disease symptoms. Even at properly monitored beaches that have very low concentrations of fecal indicators, there is a risk of contracting a swimming-related illness.

EPA began to study the relationship between the quality of bathing water and the resultant health effects in 1972. Studies in the 1970s and 1980s examined the differences in symptomatic illness between swimming and nonswimming beachgoers at marine and freshwater bathing beaches. The studies found the following (USEPA, 1999):

- Swimmers who bathe in water contaminated with sewage are at greater risk than nonswimmers of contracting gastroenteritis.
- The swimming-associated illness rate increases as the quality of the bathing water degrades.
- The illness rate in marine swimmers is greater than that in freshwater swimmers when indicator densities are equivalent in marine and fresh waters.
- Most swimmer-related illnesses are of undetermined etiology (cause).

In 1995 researchers launched a large-scale study in the Santa Monica Bay area to assess both the effectiveness of bacterial indicators in predicting health risks to bathers and the relative health risk associated with bathing near storm drains. In this study approximately 15,000 beachgoers who bathed and immersed their heads were interviewed. Approximately 13,000 of the beachgoers were contacted for follow-up interviews designed to assess the occurrence of symptoms such as fever, chills, nausea, and diarrhea. The major findings of the study suggest that there is a significant correlation between swimming in water with high densities of indicator bacteria and the incidence of adverse health effects. In addition, the study confirmed that people who swim in front of flowing storm drains are twice as likely to exhibit adverse health effects as people who swim 400 yards away from storm drains (Haile et al., 1996).

A review of studies conducted during the past several decades has provided the following overall conclusions (Pruess, 1998):

- A causal dose-response relationship exists between bacterial indicator counts in recreational waters and gastrointestinal symptoms in bathers.
- A strong relationship between bacterial indicator counts and symptoms not related to the gastrointestinal tract could not be established.
- The relative risk of swimming in contaminated versus uncontaminated waters ranged from one to three times above the risk associated with swimming in uncontaminated water.
- Symptom rates were usually higher in individuals with compromised immune systems.
- The indicators showing the best correlation with adverse health effects were enterococci (marine and fresh water) and *Escherichia coli* (fresh water).

1.4 Indicator Organisms

Indicator organisms are a fundamental monitoring tool used to measure both changes in environmental (water) quality or conditions and the potential presence of hard-to-detect target pathogenic organisms. An indicator organism provides evidence of the presence or absence of a pathogenic organism that survives under similar physical, chemical, and nutrient conditions. Indicator organisms should have the following characteristics (Sloat and Ziel, 1992; Thomann and Mueller, 1987):

- Be easily detected using simple laboratory tests.
- Generally not be present in unpolluted waters.
- Appear in concentrations that can be correlated with the extent of contamination.
- Have a die-off rate that is not faster than the die-off rate of the pathogens of concern.

Because it is difficult to directly detect the many different pathogens or parasites that may be present in surface waters, the presence of fecal bacteria has long been used as an indicator of the possible presence of disease-causing organisms.

This document discusses the bacterial indicators that are used in current water quality criteria and standards. The term “pathogens and pathogen indicators” (from the BEACH Act) can refer to individual pathogens and a broad range of indicators. However, because bacterial indicators are the only indicators adopted as water quality standards, this document generally refers to bacterial indicators.

Other potential indicators are the subject of ongoing research and will be addressed in future updates to this guidance.

Figure 1-1 provides a summary of the relationships between bacterial indicator organisms for fecal contamination. Appendix D provides additional information on the organisms that can indicate fecal contamination and EPA's review of epidemiology studies.

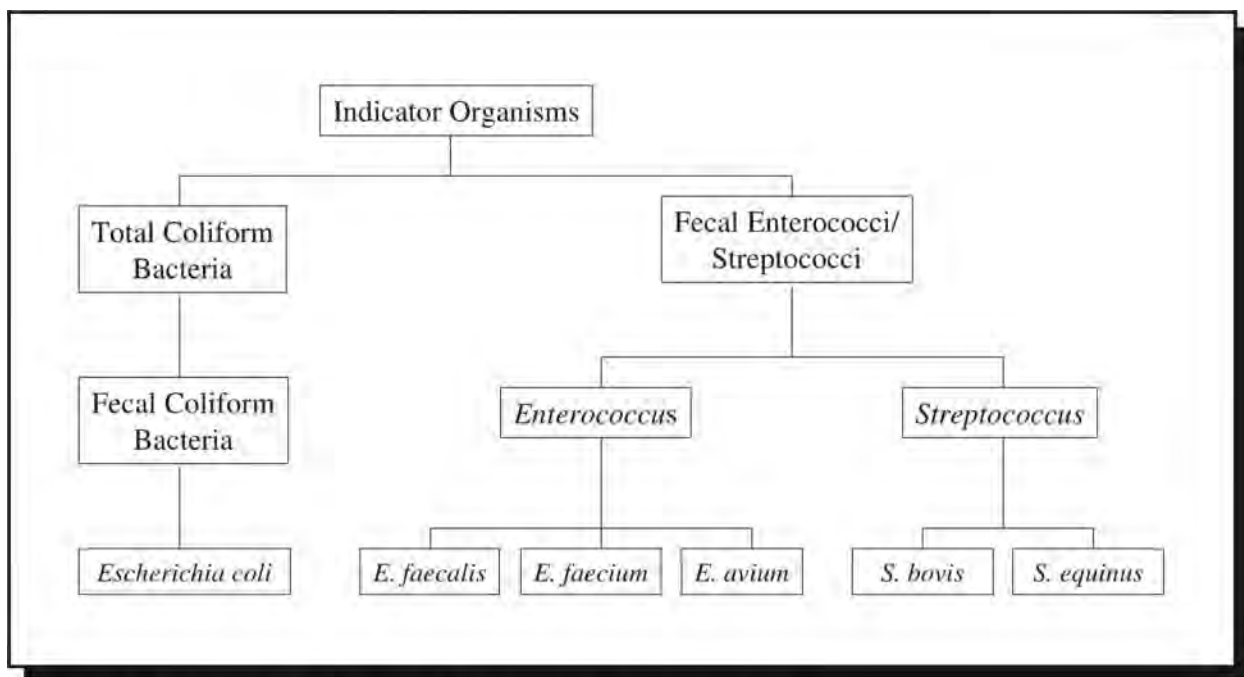


Figure 1-1. Relationship between bacterial indicator organisms.

1.5 Water Quality Criteria and Standards for Bacteria

Water quality standards define a designated use for a waterbody (e.g., primary contact recreation) and set specific water quality criteria to achieve that use. They are the foundation of the nation's water quality management program and are the goals by which success is ultimately measured for a given waterbody or watershed.

EPA's *Ambient Water Quality Criteria for Bacteria–1986* was developed for the protection of waters designated for recreational uses. Under CWA section 304(a), EPA is required to publish water quality criteria that accurately reflect the latest scientific knowledge for the protection of human health and aquatic life. The scientific foundation of the 1986 criteria is studies conducted by EPA demonstrating that for fresh water, *E. coli* and enterococci are best suited for predicting the presence of pathogens that cause illness, and that for marine waters, enterococci are most appropriate. The transition to *E. coli* and enterococci bacterial indicators (from total and fecal coliforms) continues to be an Agency priority for states' triennial reviews of their water quality

2004, EPA's recommended water quality criteria for bacteria or other criteria demonstrated to be as protective as EPA's recommended water quality criteria for Great Lakes, marine, and estuarine waters. The BEACH Act amendments further direct EPA to propose and promulgate such standards for states that fail to do so.

Implementation Guidance

It is beyond the scope of this document to provide an in-depth discussion of water quality standards and associated technical issues. However, EPA has released the document *Implementation Guidance for Ambient Water Quality Criteria for Bacteria—1986* regarding the implementation of EPA's recommended bacteriological criteria. The implementation guidance provides extensive information about the 1986 criteria document and associated issues. It should assist states, territories, and authorized tribes in adopting the most recent Ambient Water Quality Criteria for Bacteria (1986) and making the transition to monitoring for EPA's recommended *E. coli* and enterococci indicators, rather than total or fecal coliforms.

Readers are strongly encouraged to review this document because it addresses several issues that are important to beach managers. Issues addressed in the guidance document include calculating geometric mean densities from small data sets; implementing the geometric mean and single-sample maximum in various contexts, including National Pollutant Discharge Elimination System (NPDES) permits and CWA section 303(d) listing; options for application of criteria in waters contaminated by human sources; and beach public notification. This document can be found at <http://www.epa.gov/waterscience>.

1.6 Assessing and Monitoring Floatable Debris

The BEACH Act also directs EPA to provide technical assistance to states, tribes, and local governments in assessing and monitoring their floatable debris. It is beyond the scope of this document to provide an in-depth discussion of these issues. To address this requirement, however, EPA has published the guidance document *Assessing and Monitoring Floatable Debris*. For more information on the document, please contact: U.S. Environmental Protection Agency, Office of Water, Oceans and Coastal Protection Division (4504T), 1200 Pennsylvania Avenue, NW, Washington, DC 20460, or visit <http://www.epa.gov/owow/oceans/debris/floatingdebris/>.

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