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DRAFT - GREAT LAKES BEACH SANITARY SURVEY GUIDANCE

Contents

1. Overview 1-1
2. Introduction 2-1
Why is EPA doing this? 2-1
What is the Beach Sanitary Survey Tool? 2-1
Who will use the survey? 2-2
What are the benefits of the survey? 2-3
How does the survey tie into EPA's BEACH program? 2-3
Risk-Based Beach Evaluation and Classification Plan 2-4
Resource Planning 2-5
Modeling 2-5
Steps to Remediation 2-6
Great Lakes Watershed Actions and Planning 2-7
Links to Additional EPA Programs 2-7
3. Types of Beach Sanitary Surveys 3-1
Background 3-1
Survey forms 3-1
When and where beach sanitary surveys should be conducted 3-2
Routine On-site Sanitary Survey 3-2
Annual Sanitary Survey 3-2
5-year Sanitary Survey 3-2
Suspected pollution sources 3-2
Beginning of beach season 3-2
New beaches 3-2
4. Preparing to Conduct a Beach Sanitary Survey 4-1
Determine purpose and identify appropriate form 4-1
Determine how long survey should take 4-1
Use trained staff 4-1
Locate or acquire equipment and supplies 4-1
Consider health and safety 4-2
5. Data Fields 5-1
Data elements for the Routine On-Site Sanitary Survey 5-1
1. General conditions 5-1
2. Water quality 5-4
3. Bather load 5-8
4. Potential pollution sources 5-8
Data elements for Annual and 5-year Sanitary Surveys 5-11
Description of land use in watershed 5-11
Conditions 5-15
Information on sampling location 5-17
Bather load 5-18
Beach cleaning 5-19
Sampling 5-19
Modeling 5-27
Advisories/Closings 5-28
Potential pollutant sources 5-28

Description of sanitary facilities and other facilities 5-28
Constructing an Annual Survey Report 5-29
Record management 5-29
6. References 6-1

Appendix A. Routine On-Site Sanitary Survey Form A-1
Appendix B. Annual Sanitary Survey Form and Outline B-1
Appendix C. 5-Year Sanitary Survey Form C-1
Appendix D. Quality Assurance and Quality Control D-1
Appendix E. Equipment and Supplies E-1

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1. Overview

The U.S. Environmental Protection Agency (EPA) developed the Beach Sanitary Survey Tool as part of the Great Lakes Regional Collaboration (GLRC) to assist beach managers with identifying pollution sources, sharing information, and planning source remediation.

The GLRC is a wide-ranging, cooperative effort to design and implement a strategy for the restoration, protection, and sustainable use of the Great Lakes. President George W. Bush created the GLRC in May 2004 when he issued an Executive Order that recognized the Great Lakes as a “national treasure” and created a federal Great Lakes Interagency Task Force to improve federal coordination in addressing Great Lakes issues.

The GLRC identified eight priorities for Great Lakes restoration and protection. One area of concern is Coastal Health, specifically beaches. The GLRC has recommended that a standardized sanitary survey form be drafted and used by states to identify sources of contamination at the local level. The purpose of this recommendation is to get all beach program managers to use the same tool, collect and share pollution data for watershed assessments, use the data in preemptive models, and take action to remediate bacterial pollution sources to reduce public exposure to fecal bacteria contamination while swimming at the beach.

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2. Introduction

Why is EPA doing this?

Beaches are adversely affected by pollution. Usually the contaminants of concern are a small subset of microorganisms known as human pathogens, which cause human diseases. People who swim and recreate in water contaminated with fecal pollution are at risk of contracting illnesses due to their exposure to waterborne diseases spread by the fecal-oral route. These illnesses include gastrointestinal diseases; nongastrointestinal diseases, such as respiratory, ear, eye, and skin infections; and other illnesses such as meningitis and hepatitis (Rose et al. 1999; USEPA 2002).

"Indicator" bacteria such as *Escherichia coli* (*E. coli*) and enterococci are used to estimate the level of fecal contamination of the water. These bacteria generally occur in the intestinal tract of animals, including humans. When these organisms are detected at levels above corresponding federal and state recreational water quality guidelines, regional health departments issue advisories or close the beaches to bathing.

The reasons for elevated bacterial indicator concentrations that cause swimming advisories or beach closings to be issued at Great Lakes beaches are often unknown. As noted in the *Great Lakes Regional Collaboration Strategy* (GLRC 2005), according to the Natural Resources Defense Council's (NRDC's) annual survey of water quality monitoring and public notification at U.S. beaches, there were 51 percent more beach closings and advisories in 2003 than in 2002. To improve this situation at Great Lakes beaches, the Great Lakes Regional Collaboration of National Significance has identified as one of its goals achieving "a 90%–95% reduction in bacterial, algal, and chemical contamination at all local beaches" by identifying sources of indirect pollution, providing community education, and remediating "all potential indirect pollution sources through identification, estimation of relative source contribution (based on historical data and sanitary inspection), and remediation of these sources."

Sanitary surveys are useful tools for identifying sources of existing or potential contaminants to bathing beaches. The survey information can be used in developing recommendations for improving water quality that, when implemented, will decrease the amount of fecal contamination received by bathing beach waters and subsequently reduce the number of beach closings and number of persons contracting waterborne diseases at bathing beaches.

What is the Beach Sanitary Survey Tool?

Sanitary surveys have been used in shellfish and drinking water programs to identify sources of bacterial pollution that adversely affect water quality. A beach sanitary survey is an evaluation of the watershed and bathing area for existing and potential pollution sources and safety hazards that might influence the quality of bathing beach water.

Sanitary surveys are especially useful in helping to identify sources of fecal contamination affecting water quality at bathing beaches. This fecal contamination originates from many sources, including shoreline development, wastewater collection and treatment facilities, septic tanks, urban runoff, disposal of human waste from boats, bathers themselves, animal feeding operations, pet waste, and natural animal sources like wildlife.

Thus, a beach sanitary survey can be an effective tool for protecting human health at bathing beaches. It can provide information that helps in fine-tuning water quality monitoring protocols and identify needed capital improvement projects.

Three types of sanitary surveys are intended for use at bathing beaches:

1. On-site Routine Sanitary Survey. This survey can be used to collect information each time a water sample is taken during regular bacterial monitoring.
2. Annual Sanitary Survey. This form is designed to help beach managers collect the necessary information to conduct a beach sanitary survey and construct a report that will assist in determining potential problems that might need to be studied on a long-term basis.
3. 5-Year Sanitary Survey. This is also designed to help beach managers collect the necessary information to conduct a beach sanitary survey and construct a report. It includes further analysis of water quality trends, pollution sources, or other areas of concern that could be used in developing models and source tracking and remediation plans.

The results of sanitary surveys can be used to determine how a state's or county's resources can best be allocated to help improve bathing beach water quality. In addition, sanitary survey data (e.g., flow, turbidity, rainfall, number of birds) can be used in models to predict bathing beach water quality.

The level of detail and level of effort required to complete the survey increase from the Routine Sanitary Survey to the 5-Year Survey. The types of surveys are described in more detail in section 3 of this document.

Who will use the survey?

The Beach Sanitary Survey was created for state and local beach managers, sanitarians, public health officials and staff to use to identify bacterial sources of pollution impacting beaches, assess beach health, share information, and apply to watershed planning.

Beach managers will be able to better allocate resources to beach monitoring, notify the public of swimming risks, conduct remediation, do modeling, perform beach risk evaluations, and focus monitoring efforts on beaches with high pollution levels or historically high bacteria levels. Beach managers will be able to apply a risk- and watershed-based approach to their existing beach monitoring and notification programs.

Other groups of stakeholders, such as stormwater program managers, wastewater facility managers, local elected officials, local planning authorities, and academic researchers will also use the data collected by the beach sanitary surveys. Survey results will be applied to preemptive models and will assist in remediating sources of bacterial pollution at beaches.

What are the benefits of the survey?

EPA believes that periodic sanitary surveys, along with appropriate corrective measures, are indispensable for ensuring the long-term quality of bathing beach water and protecting public health. Properly conducted sanitary surveys help to reduce public exposure to fecal bacteria contamination while swimming at the beach. Sanitary surveys have many benefits for the operation and management of public beaches. They can also provide support to enforcement actions by establishing a record of conditions and operations at a point in time.

The benefits of conducting sanitary surveys include the following:

- Improve outdoor experience for beach users
- Reduce number of beach advisories and closings
- Identify factors that limit a system's ability to continually provide safe bathing conditions
- Improve system compliance with state health regulations
- Improve the quality and homogeneity of data collected from different beach programs
- Reduce monitoring requirements
- Educate operators
- Provide source protection
- Evaluate risks
- Provide technical assistance and training
- Provide information for monitoring waiver programs
- Reduce formal enforcement actions in favor of more informal action
- Reduce oversight by state monitoring and enforcement personnel
- Increase communication between state beach operators and the public
- Provide contact personnel to notify in case of emergencies or for technical assistance
- Verify data validity
- Reduce risk of waterborne disease outbreaks
- Encourage disaster response planning

How does the survey tie into EPA's BEACH program?

To be eligible for a BEACH Act grant to implement a monitoring and notification, program, a state, tribal, or local government's program must be consistence with the nine performance criteria described in EPA's *National Beach Guidance and Required Performance Criteria for Grants* (2002). Details on how the sanitary survey ties into EPA's beach program and other EPA programs are provided below.

Risk-Based Beach Evaluation and Classification Plan

Results from sanitary surveys will be especially useful to a state, tribe, or local government in developing or updating a risk-based beach evaluation and classification plan (Performance Criterion 1). This criterion requires a state or tribe to develop a risk-based beach evaluation and classification plan and apply it to state or tribal coastal recreation waters. To meet this criterion, a state or tribal government program must describe the factors used in its evaluation and classification process and explain how its coastal recreation waters are ranked as a result of the process. This process must result in the identification of a list of coastal recreation waters, including coastal recreation waters adjacent to beaches or similar points of access used by the public (EPA, 2002).

Risk-based Approach

The Great Lakes Task force is considering adopting the use of a health-risk-based beach classification scheme as a way to improve beach and coastal assessment methods. This classification scheme, known as the *Annapolis Protocol* is described below.

> *The Annapolis Protocol*
>
> In 1999, EPA and WHO jointly hosted a meeting in Annapolis, Maryland to develop a health-risk-based approach to monitoring recreational waters (the Annapolis Protocol). This approach includes employment of a beach classification scheme (based on the results of sanitary surveys), in addition to compliance monitoring based on bacterial indicators to assess health risk. The regulation of recreational waters in this manner would better reflect health risk and provide enhanced scope for effective management intervention. Enabling beach managers to respond to sporadic or limited areas of pollution, and to upgrade a beach's classification, provides a significant incentive to local management actions as well as to pollution abatement.

A large number of factors can influence the condition of a given beach. A classification system reflects this, and allows regulators to invoke mitigating approaches for beach management. Specifically, the Annapolis Protocol approach calls for the development of a health-risk based beach classification system for the Great Lakes based on bacterial indicator levels (microbial assessment) derived from routine monitoring and the results of standardized sanitary surveys.

EPA's three-tiered process

Specific requirements of the risk-based beach evaluation and classification plan include the following:

Specific requirements. A state or tribe must address the following requirements:

- Identify factors used to evaluate and rank beaches.
- Identify coastal recreation waters in the state or tribe.

- Identify beaches, or similar points of access used by the public for swimming, bathing, surfing, or similar water contact activities, adjacent to coastal recreation waters.
- Identify and review available information describing (1) the potential risk to human health presented by pathogens and (2) the use of the beach.
- Notify EPA annually when the ranking of beaches changes and alters the sampling frequency at beaches.

The goal of the state's or tribe's evaluation process is to use these requirements to evaluate coastal recreation waters adjacent to beaches or similar points of access and classify those waters in an appropriate tier on the basis of the potential risk to human health presented by pathogens and the use or uses of the waters. EPA recommends establishing an evaluation and classification process that uses a three-tiered process because this approach will enable beach managers to efficiently allocate monitoring and public notification resources to waters on the basis of use and potential disease risk. A Tier 1 classification, for example, could indicate that waters are of such high risk or receive such high usage that significant resources should be devoted to more intensive monitoring and public notification efforts for that area. Although EPA recommends this three-tiered model program, it recognizes that state and tribal programs vary. The program must, however, ultimately result in a risk-based ranking. The classification can then be used to direct appropriate resources toward monitoring and notification programs for coastal recreation waters adjacent to beaches or similar points of access.

Resource Planning

Once beaches have been classified, resources can be allocated more efficiently. Monitoring efforts can be focused on beaches that have a history of high bacteria levels with high usage. A sanitary survey can help determine the frequency of monitoring (e.g., daily, bi-weekly, weekly, monthly), the number of samples that can be collected from each beach (e.g., one sample collected every 500 meters), and type of remediation activities that should be performed at a beach (e.g., pet owner education, improved plumbing at public restrooms).

Modeling

The primary objective of any beach monitoring program is to minimize the health risk to beachgoers associated with infectious diseases caused by exposure to pathogenic microbial organisms. Notifications of elevated levels of indicator bacteria are usually based on monitoring of beach waters. Under this system, however, users of recreational waters can be exposed to waterborne pathogens because of inadequate monitoring during periods of poor water quality or delayed reporting of monitoring results. The laboratory methods commonly used to detect potentially harmful microorganisms take 24 to 48 hours; during this period, beachgoers might be exposed to harmful pathogens.

To reduce exposure to pathogens, government agencies need tools that can provide a quick, reliable indication of the water quality conditions. Predictive models are one means to provide these rapid indications. Modeling tools can be used to supplement, not replace, monitoring and provide conservative estimates when there is a lag time between sampling the water quality and obtaining results. The information provided by sanitary surveys could help to properly develop and apply models for dilution and mixing zone evaluations that can be used in making beach advisory or closing decisions.

Steps to Remediation

Sanitary surveys can be used to identify sources of pollution and to provide information on source controls and identification, persistent problems such as exceeding water quality standards, magnitude of pollution from sources, and management actions and links to controls. Sources of pollution can generally be classified as point and nonpoint. Once the source and extent of pollution is determined, appropriate remediation activities can be planned.

Point source pollution

A point source is a source of pollution that comes from a pipe or other discrete "point." Examples of point sources include combined sewer overflows (CSOs), concentrated animal feeding operations (CAFOs), and publicly owned treatment works (POTWs). Industrial, municipal, and other point sources of pollution that discharge wastewater directly to surface waters are required to obtain National Pollutant Discharge Elimination System (NPDES) permits.

Aging or overburdened sewage infrastructure, which can release raw sewage to source waters in urban areas through sanitary sewer overflows (SSOs) or CSOs, still exist in many Great Lakes municipalities where storm and sanitary systems remain co-mingled. Substantial reduction of the discharge of untreated sewage into the Great Lakes will reduce health risks for bathers and bacteria load in drinking water supplies. Given the potential impact on human health, overflows of untreated human and industrial waste into Great Lakes waters must be controlled through comprehensive solutions that may include structural controls such as separating storm and sanitary sewers, constructing storage capacity or controlling infiltration/inflow; non-structural controls such as land use planning and aggressive use of best management practices to allow no net increase in storm water run-off; and regulatory controls such as issuing, updating, and enforcing National Pollutant Discharge Elimination System (NPDES) permits. Sanitary Surveys can help identify these problems when they affect water quality at beaches.

Nonpoint Source Pollution

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, or ground water. Nonpoint source pollution also can result from resuspension of bacteria-laden beach sands and hydrological modification.

The effects of nonpoint or indirect sources of contamination are diffuse and, therefore, determining their origin may require intensive investigation. For example, determining a correlation between increased bacterial level density at the bathing beach and various coastal processes, predominating weather conditions, and natural and human sources is often difficult. Remediating contamination sources responsible for indirect pollution water quality failures will reduce human health risks, increase availability/access to Great Lakes recreation, improve ecosystem health, promote sustainable practices, decrease economic loss (millions of dollars are lost each year due to beach closures), and increase commercial benefits.

Great Lakes Watershed Actions and Planning

One of the goals of the Great Lakes Regional Collaboration is to improve Great Lakes water quality by achieving a 90–95 percent reduction in bacterial, algal, and chemical contamination at all local beaches. Steps to achieve this include: identify indirect pollution sources capable of adversely impacting Great Lakes coastal health; educate communities regarding their environmental impact; and remediate all potential indirect pollution sources through identification, estimation of relative contribution (based on historical data and sanitary inspection), and remediation of these sources. This will result in 90–95 percent of all Great Lakes public bathing beaches being classified as having “good” water quality. Developing a sanitary survey for Great Lakes beaches is one means of working towards this goal.

Another goal is at the local level, where individual contamination events will occur no more than five percent of available days per bathing season, sources of these contamination events will be identified through standardized sanitary surveys, and remediation measures will be in place to address these events. By 2008 the GLCR hopes that sanitary surveys will be used to identify 90–95 percent of all indirect pollutant sources resulting in beach closures.

Links to Additional EPA Programs

As authorized by the Clean Water Act (CWA), the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. Additional information on the NPDES permit program can be accessed at http://cfpub.epa.gov/npdes/.

Congress amended the CWA in 1987 to establish the section 319 Nonpoint Source Management Program to help focus state, tribal, and local government nonpoint source efforts. Under section 319, states, territories, and Indian Tribes receive grant money which support a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects. Additional information on the section 319 Nonpoint Source Management Program can be found at http://www.epa.gov/nps/.

Many waterbodies are listed as water quality-limited or impaired to due fecal contamination. Section 303(d)(1)(C) of the CWA and its associated policy and program requirements for water quality planning, management, and implementation (40 CFR Part 130) require the establishment of a Total Maximum Daily Load (TMDL) for the achievement of state water quality standards when a waterbody is water quality-limited. A TMDL identifies the pollutant/waterbody-specific assimilative capacity, which includes an appropriate margin of safety. The focus of the TMDL is reduction of pollutant inputs to a level (or “load”) that fully supports the designated uses of a given waterbody. The mechanisms used to address water quality problems after the TMDL is developed can include a combination of best management practices and/or effluent limits and monitoring required through NPDES permits. Information on 303(d)-listed waterbodies and waterbodies for which TMDLs have been implemented is provided on state environmental agency web sites.

States are required to submit a report on their water quality to EPA pursuant to Section 305(b) of the CWA. The 305(b) report provides water quality information (including information on 303[d]-listed waters) to the general public and serves as the basis for U.S. EPA‘s National Water Quality Inventory Report to Congress. This report is the primary vehicle for informing Congress and the public about general water quality conditions in the United States. This document characterizes the water quality, identifies widespread water quality problems of national significance, and describes various programs implemented to restore and protect waters throughout the United States. Additional information on 305(b) reports can be found at http://www.epa.gov/305b/.

3. Types of Beach Sanitary Surveys

Background

Beaches are dynamic systems that are in a constant state of flux. They need to be gauged frequently for short- and long-term health risks. EPA has developed three types of beach sanitary surveys—the Routine On-site Sanitary Survey, the Annual Sanitary Survey, and the 5-year Sanitary Survey—to assist with short- and long-term assessments. The Routine On-site Sanitary Survey is performed with water quality samples, and it supports the annual and five- year surveys.

Survey forms

To create the three beach sanitary survey forms EPA, along with Great Lake state and local agencies, reviewed several existing sanitary survey forms used by states, compared data fields in those surveys, and developed a list of appropriate data elements for each survey form.

- The *Routine On-site Sanitary Survey* was designed to be used each time a water sample is collected during regular bacterial monitoring. The survey was designed to provide useful information on water quality to support the annual and 5-year surveys without taking more than an hour to complete. This daily sanitary survey is performed to supplement information collected during water quality sampling. The premise behind collecting the additional information is to try to identify what underlying conditions (e.g., wind patterns, rain, and temperature) might trigger microbiological contamination of the recreational waters and beach areas. This form is in Appendix A.

- The *Annual Sanitary Survey* is a form to help beach managers to collect the information needed for an effective beach sanitary survey and to develop a report. The Annual Sanitary Survey requires the same information collected for the Routine On-site Sanitary surveys, as well as additional information on potential sources of contamination (e.g., direct and indirect sources such as sanitary facilities, agricultural runoff), maps of potential sources, and seasonal trends, which could be useful in determining potential problems that might need to be studied over the long term. This form is in Appendix B.

- The 5-*year Sanitary Survey* is a form to help beach managers to collect the information needed for an in-depth beach sanitary survey and to produce a report. The 5-Year Sanitary Survey is the most detailed of the three survey forms. It includes further analysis of water quality trends, pollution sources, and other areas of concern that could be used in developing models, tracking sources, and developing remediation plans. This form is in Appendix C.

When and where beach sanitary surveys should be conducted

Routine On-site Sanitary Survey

This survey should be completed every time water quality sampling is performed. Over time, collecting additional data with every sample will aid those conducting trend analyses and modeling. The data will help show whether bacteria levels correlate to other conditions at a beach.

Annual Sanitary Survey

This survey should ideally be conducted at each beach once a year to determine the condition of the beach, locate potential pollution sources, and determine whether there are other issues that can affect water quality.

5-year Sanitary Survey

This survey should be conducted at a beach where further investigation is required to determine more information on pollution sources affecting the beach.

Suspected pollution sources

A sanitary survey should be conducted in suspected high-risk situations to identify or confirm the presence or absence of contamination sources and to aid in beach classification. In addition, sanitary surveys may be performed periodically during a swimming season, when a bacterial exceedance is measured, or more frequently depending on the length of the bathing season (CTDEP 1992; Figueras et al. 2000; Great Lakes-Upper Mississippi River Board of State Sanitary Engineers 1990).

Beginning of beach season

EPA recommends that at least one Routine On-site Sanitary Survey be performed before the start of the swimming season.

New beaches

A sanitary survey also should be conducted as part of any proposal to expand or develop a recreational beach area or when a newly proposed activity would significantly alter the water quality in an existing recreational beach area. The findings of the survey should receive prime consideration in any decision to proceed with development. In some states, such as Maryland, a permit for operation of a bathing beach may not be issued if a detailed sanitary survey reveals sources of pollution that affect or might affect the bathing beach (Maryland Department of Health and Mental Hygiene 1978).

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4. Preparing to Conduct a Beach Sanitary Survey

Determine purpose and identify appropriate form

Before conducting a beach sanitary survey, it is important to identify the purpose of the survey. Three types of forms (i.e., Routine On-site, Annual, and 5-year Sanitary Survey Forms) were developed to perform sanitary surveys based on how frequently the surveys would be performed and on the resources available to complete the surveys. Refer to Section 3.b of this document for a detailed description of the forms.

Determine how long survey should take

Routine On-Site Sanitary Survey: 20–60 minutes.
Annual Sanitary Survey: One week
Detailed Sanitary Survey: Two weeks

Use trained staff

EPA recommends that professional staff from state, tribal, and local agencies maintain primary responsibility for overseeing the performance of sanitary surveys. Lifeguards or citizen volunteers may be used to help complete or gather information for Routine On-site Sanitary Surveys at the same sampling stations at which they perform bacterial monitoring for a state, tribal, or local agency. A registered sanitarian should be used to perform the Annual Sanitary Survey and 5-year Sanitary Survey reports.

The staff who perform the sanitary surveys should be adequately trained in sampling procedures, equipment use, completion of forms, and health and safety precautions before they begin to perform sanitary surveys. EPA recommends that relevant quality assurance (QA) documentation (e.g., quality assurance project plan, sampling and analysis plan, standard operating procedures [SOPs]) be distributed to all participants during training. Training should stress the importance and relevance of the sanitary surveys in helping to identify potential sources of contamination, conducting quality control (QC) activities, and following the protocols specified in the SOPs. The quality of information produced by the sanitary surveys depends on the quality of the work undertaken by the field staff and others involved in the beach program. Follow-up or continuing training should be held as needed for as long as the sanitary surveys are performed. Refer to Appendix D for further information on QA/QC.

Locate or acquire equipment and supplies

Information on equipment and supplies (such as multiprobes and velocity meters) that might be used for collecting some of the data is located in Appendix E.

Consider health and safety

Health and safety should be a key consideration for all volunteers and others engaged in surveying and monitoring. The fact that surveying and sampling might focus on areas in close proximity to combined and sanitary sewer overflows and might be conducted during periods of beach closure suggests that the risk of potential exposure to pathogenic agents will be increased over that of recreational users. Heightened awareness of personal protection is the responsibility of every member of the survey team, and effective use of basic personal protective equipment and supplies can significantly limit exposure to potentially infectious waters. For instance,

- Limit exposure of *any* open wounds to survey site waters.
- Carry moisturizing hand sanitizer and use it immediately after each survey location. (Use care if samples are being collected to ensure that you make no contact with the inside of sample containers.)
- Wear latex gloves, rubber boots, and safety glasses when contact is required or during sampling to minimize the potential for direct exposure to surface waters that are potentially contaminated.
- Carry a spray bottle with dilute bleach solution as part of your survey supplies for immediate disinfection in the event of accidental exposure.
- Practice good personal hygiene.
  - Avoid direct hand-to-mouth, -nose, or -face contact in the field.
  - Avoid eating, drinking, or chewing gum during site surveys. Delay drinking or consuming snacks and meals until you have removed all personal protective equipment and washed your hands and face.
  - Promptly shower and wash clothing with hot water following a day of surveying.

Although your survey activity might not entail longer or closer contact with surface water than the exposure of bathers, fisherman, or others, surveys might be required in less desirable areas or during beach closures mandated by measured exceedances of recreational standards.

5. Data Fields

The data fields for each of the sanitary surveys are described in this section. For the data fields on the Routine On-Site Sanitary Survey, an example of the data is given followed by a detailed description and an explanation of methods that one can use to collect the data. For the Annual and 5-Year Sanitary Surveys, the data fields and collection methods are described as well, but no examples are given.

Data elements for the Routine On-Site Sanitary Survey

1. General conditions

Air temperature

Example
75 °F, 24 °C

Description
Air temperature, in combination with other conditions and situations, such as after significant rainfall or with a particular wind direction, can increase of the likelihood of higher levels of microorganisms at certain times.

Methods
Liquid-in-glass thermometers are the most common types of thermometers because they are easy to read and inexpensive to manufacture. Highly accurate electrical thermometers measure temperature by measuring the electrical resistance of some material. Because the resistance for these materials changes with temperature, the resistance can be measured and calibrated to the temperature.

Temperature measurements are typically taken at 1.5 meters above grassy surfaces. Ideally, the thermometer should be housed in an instrument shelter that is away from materials that might absorb heat and affect an accurate air temperature reading. All air temperature readings are done in the shade. This is necessary to avoid excessive warming of the liquid in the thermometer due to the absorption of solar radiation. Instrument shelters should allow air to flow through freely to ensure that the air in the shelter is not warmed locally by the shelter itself.

Report air temperature in Fahrenheit or Celsius temperature scales, specifying which one was used. If both scales are available, Celsius is preferred because this scale was developed and is most commonly used for scientific purposes.

Rainfall

Example
Yes, rainfall occurred during the past 72 hours. Rainfall amount was 1.2 inches.

Description
Bacterial contamination at bathing beaches can result from rain events. Combined sewer overflow discharges can occur during heavy rainfall events and can reach bathing beaches, causing contamination problems. In addition, nonpoint source pollution of bathing beaches can be caused by rainfall or snowmelt moving over and through the ground and carrying natural and human-made pollutants into the receiving water.

Rainfall measurements can be used in models to predict bacterial contamination at bathing beaches during rainfall events (USEPA 1999). It is also important to document whether the rain event occurred within 72 hours of a previous rain event to help differentiate between dry-weather and wet-weather contamination sources.

Methods
Record the amount of rainfall in inches or centimeters, as well as the time from the previous rainfall event, on the Routine On-site Sanitary Survey form. If rainfall is measured using a rain gauge near the sampling stations (weather station or airport), record the distance from the rain gauge in miles.

Wind speed and direction

Example
East at 10 miles per hour

Description
A description of the wind speed and direction might provide valuable information concerning the actual or potential effect of pollutant transport to the area.

Methods
Wind is difficult for forecasters to measure because wind speed and direction can quickly and abruptly vary over short distances, especially in cities and other areas with a lot of obstructions.

An anemometer is the main instrument used to measure the speed of the wind. It consists of three or four hemispheric cups, mounted one on each end of a pair of horizontal arms, which lie at equal angles to each other. A vertical axis round that the cups turn passes through the center of the arms, and a train of wheel-work counts up the number of turns the axis makes. From the number of turns made in any given period, the velocity of the wind during that time is calculated.

Aerovanes are commonly used at many weather stations and airports to measure both wind direction and speed. The tail orients the instrument into the wind for direction, while the propellers measure the wind speed.

If you do not have the necessary equipment to measure wind speed and direction, you can provide data from a nearby weather station, ideally one within a 5-mile radius of the beach. If this method is used, the distance to the station should be noted in the survey.

Wind directions are always reported as the direction from which the winds are coming. In other words, a north wind pushes air from the north to the south. When reporting wind speeds, always provide the units (e.g., miles per hour [mph], kilometers per hour [kmh], knots).

Sky conditions

Example
Partly cloudy

Description
Sky conditions are used to describe the predominant/average sky condition based on octants (eighths) of the sky covered by opaque (not transparent) clouds. The National Oceanic and Atmospheric Administration (NOAA) uses the following scale:

Sky Condition	Cloud Coverage
Sunny	0/8
Mostly Sunny	1/8 to 2/8
Partly Cloudy	3/8 to 4/8
Mostly Cloudy	5/8 to 7/8
Cloudy	8/8

Method
Estimate the weather or provide information from a nearby weather station.

Longshore current speed

Example
Current is moving towards the east at approximately 5 centimeters per second.

Description
The current speed and direction are a critical parameter that helps to identify the actual or potential effect of pollutant transport to the area, as well as to predict potential unhealthy conditions based on known outfalls in the vicinity of the beach.

Methods
Accurate measurements of longshore current speed require specialty meters available for very slow currents because such currents are most likely present in recreational waters. Some more practical ways to estimate the longshore current speed and direction include using a stick that has a fishing reel on it with a water balloon on the end, or a ball on a tether.

A practical and inexpensive technique for measuring the longshore current speed and direction begins by placing a stick in the sand near the water's edge. One observer walks into the water away from the stick and places an object (e.g,, water balloon, dye tablet) into the water. The object should be able to minimize the effects of the wind. The observers on the beach stand near the stick, watch the object, and observe the direction in which the object moves. After 1 minute, the distance the object has moved is measured along the beach starting at the stick. This measurement is recorded. The measurement is made again after 2 minutes and after 5 minutes.

The distance moved after 5 minutes is used to determine the current speed in centimeters per second. The direction in which the dye moved must also be recorded. These measurements can be repeated at several different places along the beach to see if the current speed and direction are the same or whether they vary. If the object does not move much but just remains near the stick, there is no longshore current on that day.

Current direction, recorded in degrees, is the direction toward which the current is going. If a current is going from north to south, the current direction is recorded as south or south-going; similarly, a current going from east to west is recorded as west or west-going. (This is the opposite of wind direction, which is recorded as the direction from which the wind is blowing).

Wave height

Example
1–2 feet

Description
Waves are the main source of energy that causes beaches to change in size, shape, and sediment type. They also move marine debris between the beach and offshore zone. Waves are generated by the wind blowing over water. Waves formed where the wind is blowing are often irregular and are called wind waves. As these waves move away from the area where the wind is blowing, they sort themselves out into groups with similar speeds and form a regular pattern known as swell.

The three main characteristics of waves are the height, the wavelength, and the direction from which they approach. Wave height is the vertical distance from the crest of the wave to the trough. Wave period is the time, measured in seconds, between two successive wave crests. Wave direction is the direction from which the waves approach.

Method
Wave height is measured by carrying a graduated stick or a ranging pole (pole with measured sections in red and white) out into the water to just seaward of where the waves are breaking and then recording where the wave crest and the following wave trough cut the stick. The difference between the two is the wave height. Alternatively, you can estimate the wave height. Such estimates should be made in the units with which you are most comfortable. Often it is best to have two observers independently estimate wave height and then compare their results. The height of at least five separate waves should be estimated and the average taken.

2. Water quality

Bacteria sample results

Example
E. coli: 9 cfu [colony-forming units]

Description
Fecal bacteria have been used as an indicator of the possible presence of pathogens in surface waters and the risk of disease, based on epidemiological evidence of gastrointestinal disorders from ingesting contaminated surface water or raw shellfish. Contact with contaminated water can lead to ear or skin infections, and inhaling contaminated water can cause respiratory diseases. The pathogens responsible for these diseases can be bacteria, viruses, protozoans, fungi, or parasites that live in the gastrointestinal tract and are shed in the feces of warm-blooded animals.

Enterococci and *Escherichia coli* are used as the primary indicators of fecal contamination and were recommended as the basis for bacterial water quality standards in the 1986 *Ambient Water Quality Criteria for Bacteria* document (both for fresh waters, enterococci for marine waters). The standards are defined as a concentration of the indicator above which the health risk from waterborne disease is unacceptably high.

Methods
Qualified local laboratory services are a tremendous information resource. In addition to providing analytical support for monitoring recreational waters for pathogens, laboratories typically provide their own sterilized sample containers and custody documents to record dates, times, and sampling locations. Local laboratories often provide training for sampling personnel or offer laminated sampling guides to assist sampling staff in appropriately collecting samples and completing sample documentation. Sampling procedures should be developed into SOPs based on the variety of sampling requirements for the target sites. (For example, variable accessibility and sampling depths in the monitoring design might require that different techniques be employed at different locations.) In general, samples should be collected at the desired depth(s) directly into sterilized containers, sealed, labeled, and chilled for transport to the local laboratory.

If you are taking samples while wading, take care not to disturb bottom sediments or substrates as you sample. Pathogens adhere to solids, and excessive resuspension might produce results that exceed local advisory limits.

The first sample collected for the day should be a field blank. A field blank is simply a volume of reagent water or sterilized buffer solution transported to the field and transferred into a sample container to assess potential contamination from the sampling technique.

Duplicate samples, if included in the monitoring design, should be collected simultaneously, if possible (if two containers can be held at once in one hand). If two containers cannot be managed without spillage, the duplicates should be collected sequentially.

Chapter 4 and Appendix J of the *National Beach Guidance and Required Performance Criteria for Grants* (USEPA 2002) provide detailed discussions on sample collection, handling, and suggested procedures. Before developing SOPs, consult the local laboratory for recommendations because protocols that are relevant and applicable to the sampling design might already be available.

Local laboratory support is critical because laboratory analysis for pathogenic indicators should be initiated within 24 hours of collection (the measurement holding time). Samples collected for compliance purposes for the measurement of pathogen indicators must be initiated within 8 hours of collection (6 hours transport to the laboratory and 2 hour to initiate processing in the laboratory). Local laboratory resources that are qualified to perform testing can be readily identified through local departments of health. It should be noted, however, that many laboratories certified to perform analysis of pathogen indicators might not be certified for the preferred indicators for recreational waters, *E. coli* and enterococci. Part of the laboratory selection process should include reviewing and assessing laboratory certifications, which in some programs might certify by pollutant or parameter or might certify to the method level.

Analytical methods
Membrane filter tests for enterococci**:**
- EPA Method 1600 (mEI media)
- EPA Method 1106.1 (mE media)

Membrane filter tests for *E. coli*:
- Modified EPA Method 1103.1 (Modified mTEC Media)
- EPA Method 1103.1 (mTEC Agar)

Most probable number tests for *E. coli*:
- LTB EC-MUG (Standard Methods 9221B.1/9221F)
- ONPG-MUG (Standard Methods 9223B, AOAC 991.15, Colilert, Colilert-18, and Autoanalysis Colilert)
- CPRG-MUG (Standard Methods 9223B, ColisureTM)

Membrane filter tests for *E. coli*:
- mEndo, LES-Endo, or mFC followed by transfer to NA-MUG media (Standard Methods 9222B/9222G or 9222D/9222G)
- MI agar
- m-ColiBlue24 broth

Water temperature

Example
68 ºF

Description
This parameter is measured for use in taking temperature-dependent measurements such as pH and conductivity. Water temperature can also be important in assessing the quality of potential habitat for aquatic species and for some less-desirable pathogenic organisms.

Methods
You can measure water temperature by using multiprobes or other handheld electronic measurement devices, or by using simple graduated thermometers, with relative ease. The

accuracy of common, wide-scale thermometers and electronic instruments can be verified with simple ice-point (0 ºC or 32 ºF) and boiling water (100 ºC or 212 ºF) measurements. If the ice point and boiling point do not register correct temperatures, the results for the two measurements can be plotted on simple graph paper to translate field measurements to corrected values. Electronic meters can be professionally calibrated if the manufacturer's specifications do not include calibration procedures. Local and regional water temperatures for recreational beaches are also generally broadcast on NOAA Weatherband radios and local radio stations. Temperature ranges can be expected to be in the 60s, 70s, and 80s during the recreational swimming seasons.

*Multiprobe*s are electronic instruments used to measure an array of parameters (e.g., dissolved oxygen, pH, temperature, conductivity, turbidity) in situ by special sensors. Multiprobes are usually portable, handheld devices that are used to collect instantaneous water quality measurements during focused environmental investigations; however, they can also be deployed for extended periods for specialized studies to capture the diurnal (24-hour) quality cycle. Multiprobes are favored for routine environmental investigations because they can collect data for parameters like dissolved oxygen (DO) and pH, which have extremely limited holding times, and they do not call for transport and use of field chemistry test kits or necessitate the disposal of waste reagents or spent samples following measurement. (Field test kits often employ acids or other toxics that require specialized disposal or pretreatment prior to disposal.)

For larger counties or regional coordinators, using multiprobes can be a cost-effective way to garner a large amount of information relatively quickly. Depending on the background and qualifications of the monitoring teams, the cost of training might be prohibitive because multiple persons would likely require training. Because multiprobes are reasonably portable and are subject to calibration, the uncertainty and subjectivity associated with their measurement are highly controlled. Some jurisdictions or regional survey programs might already include the use of multiprobes.

Turbidity

Example
Clear, or 0 NTU [nephelometric turbidity units]

Description
Turbidity is a measure of the cloudiness of water and is also measured *in situ*. It is an aggregate property of the solution. Turbidity is not specific to the types of particles in the water. They can be suspended or colloidal matter, and they can be inorganic, organic, or biological. At high concentrations, turbidity is perceived as cloudiness or haze or an absence of clarity in the water.

Methods
The most common instrument for measuring scattered light in a water sample is a nephelometer. A nephelometer measures light scattered at a right angle (90°) to the light beam. Light scattered at other angles may also be measured, but the 90° angle defines a nephelometric measurement. The light source for nephelometric measurements can be one of two types to meet EPA or International Organization for Standardization (ISO) specifications. EPA specifies a tungsten

lamp with a color temperature of 2,200–3,000 K (Kelvin). The units of measurement for the EPA method are nephelometric turbidity units (NTU). The ISO specifies a light emitting diode (LED) with a wavelength of 860 nanometers and a spectral bandwidth less than or equal to 60 nanometers. The units of measurement for the ISO method are formazin nephelometric units (FNU). Also see the description of multiprobes in this section under Water temperature.

3. Bather load

Example
200 people at the beach, 50 people in the water

Description
For recreational areas with poor water circulation, the sanitary survey should include a discussion of the impact of bather load on recreational areas. Because of the poor water circulation, heavy bather loads can cause significant elevation in bacterial counts for total and fecal coliform bacteria and enterococcus bacteria. High-use areas with poor water circulation might also indicate a need for increased monitoring of microbiological indicator organisms and might require that attention be paid to the potential for blue-green algae blooms.

Methods
When the Routine On-site Sanitary Survey is being performed, count the number of people at the beach. If the count is performed in the morning when bather density is low or zero, note that on the form and try to obtain bather density data from the lifeguards or park gate. Lifeguards often maintain records of bather density throughout the day. You can also sometimes use gate or visitor numbers for that beach.

The following data should be recorded when counting beach attendance:

- Number of people at the beach
- Number of people in the water (swimming, diving, clamming, etc.)
- Number of people not recreating in or on the water

4. Potential pollution sources

The person performing the Routine On-Site Sanitary Survey should identify visible sources of pollution up to 500 feet from the beach boundary.

Sources of discharge

Example
River discharge is occurring at a flow rate of approximately 10 cubic feet per second.

Description
Visible sources, including rivers, ponds, and outfalls, might carry contaminants that affect bathing beach water quality. Documenting the flow of these visible sources can provide valuable information about the magnitude of the potential pollutant loads carried by these sources to the bathing beach.

Methods
Identify visible sources that are affecting the beach up to 500 feet from the sampling station. If visible sources are suspected of affecting water quality, an agency could decide to collect bacterial samples from these sources to determine what influence they might have on bathing beach water quality.

Measure flow in a straight section of the stream or another source that has a stable bottom. Flow can be measured using a flow meter. It is important to stand downstream and to the side of the flow meter when taking measurements.

Flow can also be measured using orange peels or a floating ball and a stopwatch. The measurement is the time it takes the floating object to travel downstream a pre-measured (and pre-marked) distance (e.g., 10 meters).

Document the name of each visible source and corresponding flow rate, in meters per second, on the Routine On-site Sanitary Survey form. Add additional notes, such as whether the visible sources occur only in conjunction with specific weather conditions, to the comments/observations section.

*Current velocity meter*s are available as mechanical or electronic units. A current velocity meter consists of a sensor or current meter, the support system for the sensor, and a counter. The signal from the sensors or current meter is processed or read by the counter. Many factors must be considered when selecting the proper current measuring equipment. In general, you should know if you will be measuring current from an overhead structure or while wading. It also helps to know the approximate speed of the water to be measured; there are specialty meters available for very slow currents, and those are most likely present in recreational waters.

Floatables present

Example
Yes, floatables are present in the water. Types found include trash such as aluminum cans.

Description
Floatable debris causes problems at beaches because it can easily come into contact with aquatic animals, people, boats, fishing nets, and other objects. Communities also lose money when beaches must be closed or cleaned up, and the fishing industry and recreational and commercial boaters must spend thousands of dollars every year to repair vessels damaged by floatable debris (USEPA 2002). Floatable debris also can be a source of bacterial contamination to bathing beaches.

Types of floatables present in water include street litter (e.g., cigarette butts, filters, and filter elements), medical items (e.g, syringes), resin pellets, food packaging, beverage containers, sewage-related items (condoms, tampons, applicators), pieces of wood and siding from construction projects, fishing equipment (e.g., nets, lures, lines, bait boxes, ropes, and rods), household trash, plastic bags and sheeting, and beverage yokes (six-pack rings for beverage containers) (USEPA 2002).

Methods
Record the types and amount of floatable debris on the Routine On-site Sanitary Survey form. Depending on the types of floatables present, it might be appropriate to describe the corresponding amounts by quantity (e.g., number of cigarette butts, number of aluminum cans) or area (e.g., 20 square feet of sewage materials). For further guidance on measuring floatable debris, refer to EPA's *Assessing and Monitoring Floating Debris* (2002), which can be accessed at http://www.epa.gov/owow/oceans/debris/floatingdebris/pdf.html.

Amount and type of beach debris/litter on beach

Example
Low (1%–20%) amount of beach has litter present

Description
Beach debris or litter can cause problems similar to those caused by floatable debris described above because they can easily be washed into the bathing beach water and affect wildlife. In addition, the presence of certain materials on the beach, such as medical waste and sewage-related items, can pose an immediate health hazard to beachgoers and can be a source of bacterial contamination to the bathing beach.

Methods
Record the type of beach debris or litter observed, along with the percentage of the beach length that has each type of debris or litter, on the Routine On-site Sanitary Survey form. Describe additional types of debris or litter not already provided on the form next to "Other."

Amount of algae in nearshore water/beach

Example
Low (1%–20%) amount of beach has litter present

Description
Algae can be a nuisance at Great Lakes bathing beaches when it reaches the beach. Decaying algae can produce a foul odor that might deter people from visiting affected bathing beaches. Algae also have been suspected of harboring *E. coli* that can lead to beach closures (Pfeiffer 2005; see http://www.wnrmag.com/stories/2005/jun05/algae.htm).

Methods
Record the amount of algae found in the nearshore water and covering the beach on the Routine On-site Sanitary Survey form. There are separate fields for algae in the nearshore water and

algae on the beach itself. The types of algae present, if known, should be recorded in the comments and observations section of the form.

Presence of wildlife and domestic animals

Example
20 gulls seen on the beach and in the water

Description
The presence of wildlife and domestic animals at bathing beaches affects water quality. Waste from these animals, whether entering the water directly from waterfowl droppings or indirectly from runoff carrying waste from dogs and other animals, can cause bacterial concentrations to be elevated to the point where recreational standards are exceeded, resulting in beach closure. Data like the types and numbers of animals present at the bathing beach could be used to help identify major sources of bacterial contamination and potential best management practices (e.g., pet owner education, better trash management to reduce available food sources at the beach) that could be used to reduce the amount of animal waste reaching the bathing beach.

Methods
Determine the presence of animals at the bathing beach through visual observation. Binoculars and a handheld counter can be used to keep track of the number of animals present.

Record both the types and number of animals present at the beach on the Routine On-Site Sanitary Survey form. Note the presence of any types of animals not already listed on the form next to “Other.” Also note the number of each type of animal present in the water, on the beach, and in the air in the comments and observations section.

Data elements for Annual and 5-year Sanitary Surveys

This section includes descriptions of the types of data you should consider collecting if you are conducting an Annual Sanitary Survey or a 5-year Sanitary Survey.

Description of land use in watershed

Current land use in watershed and overall development

As described in EPA’s 2002 *National Beach Guidance and Required Performance Criteria for Grants*, you can use beach characterization data, including surrounding land uses, to evaluate potential risk and rank beaches. Pollutant loadings into nearby bathing beaches and other surface waters generally increase as a watershed becomes more developed and more impervious surfaces are created. Using environmentally sound land use planning techniques and implementing controls can help reduce the impacts of development on bathing beaches.

Land use maps or aerial photographs of the watershed can usually be obtained through a city, county, or state planning department. In addition, some land use and land cover (LULC) data are available from the U.S. Geological Survey (USGS) for the coterminous United States and Hawaii, although coverage is not complete for all areas. The Web site for LULC information is http://edc.usgs.gov/products/landcover/lulc.html.

The information provided by these sources can be used to estimate the percent of various land uses, including residential, industrial, commercial, and agricultural, in the watershed. In addition, this information can be used to determine the overall percentages of developed and undeveloped area in the watershed.

Uses

Beach use information can be used to identify potential sources of pollution. For example, if small oil or gasoline spills are often noted, nearby motorized boats could be investigated as a potential source of the contamination. You can determine beach uses through direct observations of activities that occur at the beach and services offered at the beach (e.g., boat rentals).

Mapping

You can obtain topographic maps from USGS directly or through a retailer. Information on ordering these maps is provided on USGS's Web site at http://topomaps.usgs.gov/ordering_maps.html. Topographic maps provide an indication of geographic boundaries and contours that influence stormwater flow and, ultimately, pollutant loads to recreational waters.

Detailed maps of survey areas are valuable to the understanding of the annual surveys, and to ensure consistency in the continuity of the annual survey program. Maps assist in the documentation of specific conditions with respect to development of waterfront and adjacent properties that might include potential sources, or pollution management controls. Graphic representations of key features assist future surveyors in verifying and documenting the impacts of nearshore development activities and pollution control or sanitation enhancements from one year to the next.

Local governments maintain maps of their jurisdictions in their planning and zoning offices. Such maps should be amended as required to indicate key features identified in the survey, including primary (central) global positioning system (GPS) locations for survey reaches or sub-reaches (permanent structural markers such as buildings [addresses], light poles, or utility poles might serve as reference to the location of GPS measurements because some GPS measurement devices have greater resolution than others); water sampling and physical measurement locations; location and direction of any digital photographs (to serve as an index); significant potential sources (e.g., CSO/SSO or other discharge conveyances or apparent stormwater runoff, marinas, docks with recreational watercraft); surrounding development and land use, including any active construction; and permanent or temporary sanitary facilities for swimmers and beach patrons. A map of sufficiently small scale should provide opportunity to make notations regarding most features and/or perspectives for most of the detailed observations on the Annual Sanitary Survey Form.

Erosion/accretion measurements

To determine whether a beach is eroding or accreting over time, you can take measurements from a fixed object behind the beach, such as a building or parking lot, to the high watermark. The high watermark is the highest point that waves reach on the day the measurement is taken. It can usually be identified as the “line” on the beach between where it is wet and where it is dry or by a line of debris (e.g., seaweed, shells). If there is more than one line of debris on the beach, use the line closest to the waterbody because other debris lines farther from the beach might be the result of previous storms (UNESCO 2005).

Two people are needed to perform this measurement. For beaches at least 1 mile long, choose at least three points along the beach for the erosion/accretion measurements. Additional points can be added as needed. For instance, measurements can be taken directly in front of and adjacent to man-made bounding structures to study their impacts (UNESCO 2005).

At the first point (point A), select the fixed object and record a description of it on the sanitary survey form. In addition, take pictures of both the high watermark location and corresponding fixed object, and record a description of these photographs on the sanitary survey form. One person should stand at the high water mark and lay the tape measure on the ground. The other person should stretch the tape measure to the fixed object and pull the tape measure taut. One of the field personnel should record the distance in feet or meters on the sanitary survey form. Field personnel should then proceed to the next point and repeat the measurement and record corresponding information on the sanitary survey form. Finally, field personnel should measure the distances between sampling points (UNESCO 2005) and record them on the sanitary survey form.

Examples of some best management practices that may be used to reduce erosion at beaches are provided on the University of Minnesota Extension Service’s Web site at http://www.extension.umn.edu/distribution/naturalresources/components/DD6946g.html.

Bounding structures

Alterations of the coastal environment can occur from the installation of man-made bounding structures like jetties, groins, and seawalls. Alterations affect coastal dynamics and have far-reaching effects on coastal ecosystems, hydrodynamic and tidal regimes, and sediment transport rates. Usually, bounding structures are placed in environments to counteract erosion in sediment-deficient areas, or to deter accretion in dynamic areas such as inlets. Adjacent downdrift areas typically experience increased erosion after these structures have been installed (NPS 2006).

Groins are perpendicular structures used to maintain updrift beaches or to restrict longshore sediment transport. Jetties are another type of perpendicular hard structure; they are normally placed adjacent to tidal inlets to control inlet migration and to minimize sediment deposition within the inlet. Seawalls, bulkheads, and revetments are shore-parallel structures designed to protect the beach in front of a particular property or properties. Structures like breakwaters, headlands, sills, and reefs are designed to alter the effects of waves and stop or alter natural coastal changes (NPS 2006). Refer to http://www2.nature.nps.gov/geology/coastal/human_impact.cfm.

Take photographs of bounding structures. Record corresponding descriptions of the pictures on the sanitary survey form.

Beach materials/sediments

Beaches can be characterized by the types of materials/sediments present. Changes in the types of materials/sediments present over time (e.g., from fine-grain to coarse sand) can indicate erosion problems. If beach nourishment projects are undertaken, the grain size of the replacement sand should match the existing sand grain sizes as closely as possible to avoid problems like beach narrowing.

Simple, subjective observations (e.g., sandy, soft, very mucky) may be used to describe the materials/sediments present at a beach. Alternatively, a sand card (officially known as a "sand-gauge," by W.F. McCollough) may be used to help discern between silt/clay, very fine sand, fine sand, medium sand, coarse sand, and very coarse sand. Sand cards can be obtained through Forestry Suppliers (http://www.forestry-suppliers.com) for approximately $15.00 per card. When different sizes of beach materials/sediments are present at a beach, several (up to 10) transects may be selected to better characterize the beach, in which a total of 10 particles are measured at evenly spaced intervals (e.g., every 10 feet for a 100-foot long transect). The transects should run perpendicular to the shoreline. To the extent possible, they should include some measurements at all habitat types (e.g., dunes, wetlands, open water) present at a beach.

Habitat

Changes in the types of habitats present at a beach over time can indicate erosion problems. For example, if dunes are starting to disappear, beach restoration efforts might be needed to slow the erosion process. Also, special measures might be needed to maintain critical habitat for a threatened species, such as the piping plover (*Charadrius melodus*), at a beach.

Record the types of habitat present at a beach (e.g., dunes, wetlands, open water) on the sanitary survey form. In addition, note whether critical habitat for endangered or threatened species is present at a beach. Record the names of these species on the sanitary survey form. Information on threatened and endangered species and habitats is provided on the U.S. Fish and Wildlife Service's Web site at http://www.fws.gov/endangered/wildlife.html.

Historical weather conditions

The results of the Routine Sanitary Survey from previous years can be used to calculate the average, typical, or maximum measurements of air temperature, water temperature, and wind speed and direction during beach season. If those values are not available, the National Weather

Service Web site or other Web sites might be a source of data. The following is a list of sources on the Web that could be used to access historical weather data.

NOAA
http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Great%20Lakes%20Water%20Level%20Data&sort=A.STATION_ID&state=&id1
Major airport weather stations have data from 1996 to the present available for purchase at this site. The data include daily temperature extremes, precipitation, and winds. Data come in the form of monthly or annual records and cost $4 per record.

NCDC–NOAA
http://www7.ncdc.noaa.gov/IPS/getcoopstates.html
This Web site contains records for weather stations in the United States ranging from the year 1800 to 2 or 3 months ago. The database is searchable by state and then city. It gives results as pdf files showing scanned monthly logs with a daily account of temperature extremes (participating locations) and precipitation, snow, and snow depth. Data are available for the thousands of sites that are a part of the cooperative observing network in the United States. This information is free, but if certified copies are necessary, they cost about $1 to $4 per monthly data sheet ordered.

NOAA–Great Lakes Environmental Research Laboratory
http://www.glerl.noaa.gov/data/precip/precip.html
This site compiles historical rainfall precipitation data from all the weather stations in the states surrounding the Great Lakes in the form of one zipped file for each state. The stations are subfiles that can be opened in Excel.

NOAA-National Weather Service
http://www.nws.noaa.gov/
This National Weather Service site provides locations of weather stations and weather radio information. Archived data are available for the previous year.

Typical sky conditions

If sky conditions were observed using the Routine Sanitary Survey, the survey results should be examined to determine the typical sky condition for this beach. In addition, sky conditions from the routine survey can be examined with the bacterial sampling results to determine whether there is any correlation between the sky conditions and the sampling results.

Conditions

Beach length or dimensions

Comparing beach dimensions over several years can provide information on how local development might be affecting the beach. For instance, uncontrolled development near the beach can prevent natural dune restoration, which in turn can decrease the width of the beach.

Beach length measurements can be used to help identify sampling locations and other features. Beach dimensions can also be useful in calculating how much sand will be needed for a beach nourishment project.

Two people are needed to measure the length of the section of beach to which the sanitary survey applies. Note the fixed objects or beach formations that will be used as boundaries (e.g., beach chair to beach chair, edge of building to inlet) for the length of beach on the sanitary survey form. In addition, take pictures of the boundaries and record a description of these photographs on the sanitary survey form. One person should stand at one end of the beach and lay the tape measure on the ground. The second person should stretch the tape measure to the other end of the beach or as far as the tape measure will allow. If the beach is longer than the length of the tape measure, it will be necessary to take incremental beach length measurements in a field notebook. Add the incremental measurements, and record them on the sanitary survey form.

Enter the previously taken three beach width measurements (distance from fixed object to high watermark) taken for the erosion/accretion measurements on the sanitary survey form for width (Z1), width (Z2), and width (Z3). Average the three measurements, and enter the value on the form for width (average) (UNESCO 2005).

Water level variation

Variations in Great Lakes water levels affect beach widths; if low water levels are experienced, beach widths expand. During 1998 and 1999, low precipitation and warm water temperatures (leading to increased evaporation) contributed to lower-than-normal lake levels. Several marinas needed to extend their docks during this time to reduce boater maintenance problems experienced in shallow waters. Algae blooms were also more common during this time because of the high water temperatures (MDEQ 2006).

Comparisons of daily Great Lake water levels with prior levels measured at reference gauges on each lake can be found on the NOAA Great Lakes Environmental Research Laboratory's Web site at http://www.glerl.noaa.gov/data/now/wlevels/levels.html. Real-time water level data for additional gauges can be found on the Great Lakes Information Network at http://www.great-lakes.net/envt/water/levels/hydro.html.

Longitudinal dispersion coefficient and lateral dispersion coefficient

Longitudinal and lateral dispersion coefficients are used in water quality models to estimate mixing rates. This information can be used to develop mixing zones for water quality standards. For example, a mixing zone of 200 feet might be allowed before an *E. coli* water quality standard needs to be met.

Dispersion coefficients can also be used in water quality models to help predict *E. coli* concentrations during wet-weather and dry-weather events.

Slope

Beaches exposed to high-energy waves tend to have a steeper slope than those exposed to low-energy waves. Steep, man-made, structure-induced slopes can be vulnerable to erosion when the structure is removed during beach nourishment operations if this fact is not recognized in design (NOAA 2003).

Slope can be measured at one or more of the locations selected for erosion/accretion measurements. The equipment needed for slope measurements includes two poles tied together with several meters of string and a tape measure.

Choose a fixed object behind the beach, such as a building or tree. The fixed starting point should be used when future slope measurements are taken so that any changes in slope over time can be measured. Take photographs of the fixed starting point, and record corresponding information on the sanitary survey form (UNESCO 2005).

Field personnel should place a pole at the fixed starting point and place the second pole down-gradient of the first pole and pull the string taut. The field personnel should move the string up or down on the poles until the string is level. One of the field personnel should measure the distance between the first and second poles and record the data in a field notebook. Field personnel should move the first pole up to the second pole and repeat the process at each break of slope. The end of the profile should be the water’s edge (Paraska 1999). Percent slope can be calculated for sections of the beach for a beach profile, or an overall percent slope can be calculated using the start and endpoint measurements.

Date and description of last major rehabilitation

Beach rehabilitation can help restore major habitats and reduce pollution sources. Major rehabilitation could include projects such as planting beach grass and erecting fences to protect dune ecosystems, removing litter, and constructing bathroom facilities.

Information on sampling location

Sampling location

EPA recommends that water quality samples be taken in the middle of a typical bathing area. Samples may be taken at a point corresponding to each lifeguard chair, or every 500 meters. If a beach is more than 5 miles long, samples should be taken at the most populated/used areas of the beach and spread out along the length of the beach (USEPA 2002).

Measurements and landmarks can be used to identify specific locations and to ensure future consistency in sample collection. A handheld GPS device can also be used to determine precise locations previously sampled if such data are available, or it can be used to mark specific locations for future sampling (MCHD 2000).

Collect samples in the morning if possible to ensure that the holding times are met and that the laboratory has the maximum time to process the samples. Note the name of the laboratory and distance from the sampling sites to the lab on the sampling form to determine the best time for collecting samples.

Sampling plan, equipment maintenance and calibration procedures

Before each sampling event, review the sampling plan and the equipment maintenance and calibration procedures. Any maintenance or calibration of instruments should be performed per the protocols for the particular instrument before the sampling event.

Bather load

For the annual and detailed surveys, collect bather load data during times of the day when people are most likely to be at the beach to indicate average and peak usage for the swimming season. Lifeguards in many counties routinely collect daily counts during swimming season and therefore might have data that are of use in the survey. County Health Departments or beach program managers might also have historical beach attendance data that could be of use in the annual or detailed surveys. The following data should be recorded when counting beach attendance:

- Number of people at the beach
- Number of people in the water (swimming, diving, clamming, etc.)
- Number of people non recreating in or on the water

The following are some examples of methods for estimating bather load:

- Count by hand the number of people at the beach. Count the total number of people and estimate the number of people in the water as a percentage of the total number of people at the beach. If the beach is large, choose a representative area to use to count the number of people and extrapolate the number to the entire beach based on the size of the area as it compares to the total size of the beach.
- Take photographs of the beach and count the number of people in the photographs. Make sure to note how much of the beach area the photograph covers. If possible, try to cover the entire beach using photographs, but make sure the photographs do not overlap and that people are not double counted.
- Count people or take photographs from a helicopter or plane flying over the beach.
- Count the number of cars at parking lots used for beach parking and use that number to estimate bather load.
- Use a laser counting device like that used in Encinitas, California. The devices cost about $500 each, and they can be installed alongside stairwells leading to the beaches. To tally visitors, the counters use a laser beam that is directed across the stairwells or narrow paths leading to a beach. Each person walking through the beam registers 0.5 on the counter. That way, a person arriving and departing counts as one visitor. However, calculating beach attendance with the lasers is not an exact science.

Some beach entrances might not have a counter. People who walk past several times are counted as more than one person. Staff members use their judgment to calculate total beach attendance, factoring in such things as parking lot size at different beaches, beach width, and past trends. Laser counters would not work at a beach where the main beach entrance is several blocks long or where visitors can access the beach from several other areas or side streets. Also, laser counters might need to be hidden so they are not vandalized.

Beach cleaning

Cleanup activities

Beaches are typically cleaned with the use of mechanical cleaners, volunteers (e.g., Adopt-a-Beach programs, county- or city-sponsored beach cleanup days), or both. Mechanical beach cleaners groom the sand by mechanically raking and sifting sand, and they can remove both large and small pieces of debris. This process might or might not be followed by leveling of the sand. Beach grooming without leveling has been shown to significantly reduce the amount of bacterial contamination during dry-weather events (Northeast–Midwest Institute 2005). Mechanical beach cleaning can be performed daily during early morning or late evening hours.

Manual beach cleaning can be performed by volunteers in year-round Adopt-a-Beach programs, which require participants to clean a designated area of beach at least five times a year and include litter monitoring, cleanup, and simple monitoring activities. (Alliance for the Great Lakes 2004). Municipalities or counties might also sponsor beach cleanup events one or more times a year.

Sampling

Biological survey results

Since the 1800s more than 160 nonindigenous aquatic species have invaded the Great Lakes ecosystem, causing severe economic and ecological impacts. These species include zebra mussel, round goby, sea lamprey, Eurasian ruffe, purple loosestrife, Eurasian watermilfoil, and spiny and fishhook waterfleas. The Great Lakes Commission has made the prevention of the introduction and spread of aquatic nuisance species a priority (GLC 2004).

Pictures and descriptions of exotic invasive species commonly found in the Great Lakes region are provided on the Minnesota Sea Grant Web site at http://www.seagrant.umn.edu/exotics/fieldguide.html and http://www.seagrant.umn.edu/exotics/index.html.

Duration and identification of species of algae blooms

Algae can be a nuisance at Great Lakes bathing beaches. *Cladophora* species have been found in the nearshore water and on beaches themselves. *Cladophora* species have been reported to have a foul odor that might deter people from visiting affected bathing beaches. Algae also have been suspected of harboring *E. coli*, which can lead to beach closures (Pfeiffer 2005; see http://www.wnrmag.com/stories/2005/jun05/algae.htm).

- Field personnel can reference the following NOAA Web site, an electronic field guide to algae found in the Great Lakes: http://www.glerl.noaa.gov/seagrant/GLWL/Algae/Algae1.html.

- In addition, taxonomic guides like *Freshwater Algae of North America: Ecology and Classification (Aquatic Ecology)* by John D. Wehr and Robert G. Sheath, published in 2003 by Elsevier Science, can be used to identify algae observed in the nearshore water and on the beach.

Current and/or historical amounts of algae

- Record the amount of algae found in the nearshore water on the Routine On-site Sanitary Survey form. Record the type of algae present, if known, in the comments and observations section of the form.

- Record the amount of algae found covering the beach on the Routine On-site Sanitary Survey form. This should be measured as the percentage of the length of the beach that has algae present. Record the type of algae present, if known, in the comments and observations section of the form.

- Review the results of the Routine On-site Sanitary Survey for previous years and summarize them on the Annual and 5-year Sanitary Surveys to determine whether there are any long-term issues and whether there is a correlation between the presence of algae and bacterial sample results.

Historical presence of wildlife and domestic animals

The presence of animals at the bathing beach can be determined through visual observation, which should be performed routinely (during the Routine Sanitary Survey). Binoculars and a handheld counter can be used to keep track of the number of animals present. Record both the types and number of animals present at the beach on the Routine On-Site Sanitary Survey form. Note the presence at the beach of any types of animals in addition to those listed on the form next to “Other.” Also note the number of each type of animal present in the water, on the beach, and in the air in the comments and observations section. The results from the Routine On-site Sanitary Survey conducted during prior seasons should be summarized on the Annual and 5-year Sanitary Surveys. If routine surveys were not performed and there are no historical data, note the current presence of any wildlife and domestic animals.

Bacterial samples collected

EPA's *Ambient Water Quality Criteria for Bacteria–1986* (EPA, 1986) recommends the use of *E. coli* and enterococci as the preferred pathogen indicators in freshwater systems, and enterococci as the preferred indicator in marine waters. EPA's identification of these two indicators was based on epidemiological analysis, and examination of results for these indicators as they correlate to the incidence of illness in recreational bathers.

Methods of sample collection

Qualified local laboratory services are a tremendous resource of information. As well as providing analytical support for the monitoring of recreational waters for pathogens, laboratories generally provide their own sterilized sample containers and custody documents to record dates, times, and sample locations. Local laboratories often provide training for sampling personnel, or laminated sampling guides to assist sampling staff in appropriately collecting samples and completing sample documentation. Sampling procedures should be developed into standard operating procedures (SOPs) based on the variety of sampling requirements for the target sites (e.g., variable accessibility and sampling depths in the monitoring design may require different techniques be employed at different locations.) In general, samples should be collected at the desired depth(s) directly into sterilized containers, sealed, labeled and chilled for transport to the local laboratory.

The first sample collected for the day should be a field blank. The field blank is simply a volume of reagent water or sterilized buffer solution that was transported to the field and transferred into a sample container to assess potential contamination from the sampling technique.

Duplicate samples, if included in the monitoring design, should be collected simultaneously, if possible (i.e., if 2 containers can be held at once in one hand). If two containers cannot be managed without spillage, the duplicates should be collected sequentially.

Chapter 4 and Appendix J of the *National Beach Guidance and Required Performance Criteria for Grants* (EPA 2002) provide detailed discussions on sample collection, handling, and suggested procedures. Prior to development of SOPs, the local laboratory should be consulted for recommendation, as protocols may already be available which are relevant and applicable to the sampling design.

Local laboratory support is critical, as laboratory analysis for pathogenic indicators should be initiated within 24 hours of collection (the measurement holding time). Samples collected for compliance purposes for the measurement of pathogen indicators must be initiated within 8 hours of collection (6 hours transport to the laboratory and 2 hour to initiate processing in the laboratory). Local laboratory resources that are qualified to perform testing are readily identified through local departments of health. It should be noted, however, that many laboratories certified to perform analysis of pathogen indicators might not be certified for the preferred indicators for recreational waters, *E. coli* and enterococci. Part of the laboratory selection process should include review and assessment of laboratory certifications which, in some programs may certify by pollutant or parameter or may certify to the method-level.

Methods of Analysis

Based on the potential for other data uses, and the critical need to protect human health, EPA recommends use of established, reproducible methods described at 40 CFR Part 136 for measurement of pathogenic indicators, E. coli, enterococci, and any additional indicators of interest. The methods identified at Part 136 include methods published in the 1995 Offical Methods of Analysis of AOAC International, the 20th edition of Standard Methods, the 2000 Edition of the Annual Book of ASTM Standards (Vols. 11.01 and 11.02), and additional methods of analysis developed by commercial vendors including Hach and IDEXX Laboratories. In addition, Part 136 describes a program for laboratories to gain approval of alternative test procedures (ATP). A number of methods have been proposed for the update of Table 1A of Part 136 to exploit advances in measurement systems and technology toward a faster, more reliable assessment of bacterial indicators. Consultation with local laboratory resources will reveal the analytical options available locally for use in the monitoring of recreational waters.

Analytical methods for analysis for microbiological analysis of pathogens and pathogen indicators generally consist of introducing or exposing samples to a growth medium (or more than one media) followed by incubation and examination of the number and type of biological colonies grown. Sample introduction may include inoculation of a sample into a liquid media or filtration of a sample through a filter, which is placed in its entirety onto a media for incubation. Different media are selectively fortified with nutrients most beneficial to different target organisms, thus between selection of media and incubation temperatures, different conditions assist in isolation of different target organisms or classes of organisms.

In general, methods of analysis are described as membrane filtration (MF) and most probable number (MPN) for reporting E. coli and enterococci in aqueous samples. MF is a direct-plating method in which sample dilutions/volumes are filtered through membrane filters and transferred to petri plates containing selective media. A second substrate medium is used in the two-step MF procedures to differentiate the target organisms. In MPN tests, a series of test tubes containing growth media will be inoculated with sample or sample dilutions, and the number of test tubes or wells producing a positive reaction provides an estimate of the original, undiluted density (concentration) of target organisms in the sample. This estimate of target organisms, based on probability formulas, is termed the most probable number. MPN tests can be conducted in multiple-tube fermentation (MTF), multiple-tube enzyme substrate, or multiple-well enzyme substrate formats.

Chapter 4 of the *National Beach Guidance and Required Performance Criteria for Grants* (EPA 2002) provides a number of EPA and other methods within these two categories. Among them are the four preferred membrane filter methods of analysis described in detail as follows:

Membrane Filter Tests for Enterococci
EPA Method 1600 (mEI media). Method 1600 is a single-step MF procedure that provides a direct count of enterococci in water based on the development of colonies on the surface of a filter when placed on selective mEI agar (USEPA, 1997). This medium, a modification of the mE agar in EPA Method 1106.1, contains a reduced amount of 2-3-5-triphenyltetrazolium

chloride, and an added chromogen, indoxyl-ß-D-glucoside. This change in ingredients allows for results in 24 hours rather than 48 hours, and it eliminates the second filter transfer step from mE to EIA. In this method, a water sample is filtered, and the filter is placed on mEI agar and incubated at 41 ± 0.5 °C for 24 hours. Following incubation all colonies with a blue halo, regardless of colony color, are counted as enterococci. Results are reported as enterococci per 100 mL.

EPA Method 1106.1 (mE media): EPA Method 1106.1 is a two-step MF procedure that provides a direct count of enterococci in water, based on the development of colonies on the surface of a membrane filter when placed on a selective medium (USEPA, 1985b). A water sample is filtered through a 0.45-µm membrane filter, and the filter is placed on a plate containing selective mE agar. After the plate is incubated at 41 ± 0.5 °C for 48 hours, the filter is transferred to an Esculin Iron Agar (EIA) plate and incubated at 41 ± 0.5 °C for 20 to 30 minutes. After incubation, all pink to red colonies on the mE agar that form a black or reddish-brown precipitate on the underside of the filter when placed on EIA are counted as enterococci. The organism density is reported as enterococci per 100 mL.

Membrane Filter Tests for E. coli

Modified EPA Method 1103.1 (Modified mTEC Media): Modified EPA Method 1103.1 is a single-step MF procedure that provides a direct count of E. coli in water, based on the development of colonies on the surface of a filter when placed on a selective modified mTEC medium (USEPA, 1985a). This is a modification of the standard mTEC media that eliminates bromcresol purple and bromphenol red from the medium, adds the chromogen 5-bromo-6-chloro-3-indolyl- ß -D-glucuronide, and eliminates the transfer of the filter to a second substrate medium. In this method, a water sample is filtered through a 0.45-µm membrane filter. The filter is placed on modified mTEC agar, incubated at 35 ± 0.5 °C for 2 hours to resuscitate injured or stressed bacteria, and then incubated for 23 ± 1 hours in a 44.5 ± 0.2 °C water bath. Following incubation, all red or magenta colonies are counted as E. coli.

EPA Method 1103.1 (mTEC Agar): EPA Method 1103.1 is a two-step procedure that provides a direct count of E. coli in water based on the development of colonies on the surface of a membrane filter when placed on a selective nutrient and substrate medium (USEPA, 1985a). EPA originally developed this method to monitor the quality of recreation waters. This method also was used in health studies to develop the bacteriological ambient water quality criteria for E. coli. In this method, a water sample is filtered through a 0.45-µm membrane filter, the filter is placed on mTEC agar (a selective primary isolation medium), and the plate is incubated first at 35 ± 0.5 °C for 2 hours to resuscitate injured or stressed bacteria and then at 44.5 ± 0.2 °C for 23 ± 1 hours in a water bath. Following incubation the filter is transferred to a filter pad saturated with urea substrate medium. After 15 minutes all yellow or yellow-brown colonies (occasionally yellow-green) are counted as positive for E. coli.

The beach guidance continues to describe and recommend an EPA video, “Improved Enumeration Methods for the Recreational Water Quality Indicators: Enterococci and Escherichia coli,” demonstrates the four methods currently recommended by EPA, including the mEI and the mE agar methods for enterococci and the modified mTEC and mTEC agar methods for E. coli. The purpose of the video is to introduce and demonstrate the improved methods.

Accompanying the video is a laboratory manual having the same name that explains all four methods in a step-by-step format (USEPA, 2000b). The laboratory manual also contains color photographs of the target colonies on all media to aid in identification. The video and methods manual are now available to all interested laboratories. Requests for copies of the manual (EPA 821R-97-004) or videotape (EPA 822V-99-001) should be directed to EPA's National Service Center for Environmental Publications (http://www.epa.gov/ncepihom/ or phone 513-489-8190). The manual is also available at http://www.epa.gov/waterscience/beaches or http://www.epa.gov/microbes.

Other Methods Proposed in Part 136 Rule
In the Part 136 proposed rule (*Guidelines Establishing Test Procedures for the Analysis of Pollutants; Analytical Methods for Biological Pollutants in Ambient Water; Proposed Rule*), EPA outlined several additional methods to be used to enumerate E. coli and enterococci. Additional information on these methods can be found at http://www.epa.gov/waterscience/methods/.

Most probable number tests for E. coli:
- LTB EC-MUG (Standard Methods 9221B.1/9221F)
- ONPG-MUG (Standard Methods 9223B, AOAC 991.15, Colilert, Colilert-18, and Autoanalysis Colilert)
- CPRG-MUG (Standard Methods 9223B, ColisureTM)

Membrane filter tests for E. coli:
- mEndo, LES-Endo, or mFC followed by transfer to NA-MUG media (Standard Methods 9222B/9222G or 9222D/9222G)
- MI agar
- m-ColiBlue24 broth

Most probable number tests for Enterooccci:
- Azide Dextrose/PSE/BHI (Standard Methods 9230B)
- MUG media (ASTM D6503-99, Enterolert)

These alternative method descriptions are followed by a cautionary statement that beach managers "should be aware of the methods that may be used for analyzing the water samples from beaches to meet particular monitoring program objectives."

The single step methods are preferred overall in light of the speed of the analysis, and the opportunity to make decisions and take rapid action in the event of elevated results or water quality exceedences (i.e., resampling, swimmer advisories, or beach closures).

Data interpretation

Data interpretation and determination of attainment for pathogen indicator criteria are discussed in Section 5.3.2 of the implementation guide (EPA 2002x), and they depends on the number and type of sampling events that were conducted, and on the criterion established locally for issuance of advisories or for beach closures. EPA recommended in its 1986 water quality criteria, and in its 2002 draft implementation guidance (EPA 2002x), that rather than a prescriptive concentration standards of colony forming units of E. coli and enterococci per unit volume (100-mL), local standards be established based on a maximum acceptable predictive risk stated in illnesses per 1,000 bathers. Calculation of criteria for selected illness rates are included in the tables in Appendix C of the implementation guide along with the formulae from which they are derived.

EPA recommends establishment of local sample maximum and geometric mean criteria based on the monitoring frequency and frequency of use for recreational waters. So too, should the local action plans be developed to define what sample measurement values dictate what corrective measures. These actions should consider not only the measurement data collected during routine monitoring, but the seasonality and the frequency of use during the sampling periods. For instance, more remote or infrequently used beaches are likely to be subject to lesser monitoring priorities, thus they are not as likely to issue advisories or closures based on moderately elevated results. Similarly, consideration of seasonality should be included in both monitoring and assessment plans to ensure that criteria for advisories or closures are less stringent during non-swimming seasons and that they do not suggest the need for unnecessary additional treatment in local POTWs. Excessive disinfection can cause formation of disinfection by-products (like trihalomethanes) themselves an environmental concern and potential health hazard.

Geometric means are widely used because they incorporate a rolling average, thereby limiting the impact of sample variability common in pathogenic indicators. Pathogens have been observed to exhibit significant variability based on time of day, as well as in light of prevailing weather conditions. Geometric mean criterion also generally include a stipulated minimum number of samples included in the assessment, commonly 5 samples over 30 days, however this criteria may be unrealistic for smaller monitoring jurisdictions, or for more remote, lesser utilized waters. Table 5-1 in the draft implementation guide explores monitoring approaches and assessments for less frequently used primary contact waters. Frequency of monitoring must always be considered in the adaptation of criteria, and in determinations of attainment.

Water temperature

- Water temperature can be measured with relative ease using one of the following:
  - A multiprobe
  - Other handheld electronic measurement device
  - Graduated thermometer

  The accuracy of common, wide-scale thermometers and electronic instruments can be verified with simple ice point (0 °C or 32 °F) and boiling water (100 °C or 212 °F) measurements. If the ice point and boiling point do not register correct temperatures, results for the two measurements can be plotted on simple graph paper to translate field measurements to corrected values. Electronic meters can be professionally calibrated if the manufacturer's specifications do not include calibration procedures (Wilde 2006).

See the description for multiprobe in the previous section under the methods listed for water temperature.

- Local and regional water temperatures for recreational beaches are also generally broadcast on NOAA Weatherband radios and local radio stations. Temperature ranges can be expected to be in the 60s, 70s, and 80s during the recreational swimming seasons.

pH

- Measurement of pH can be conducted using one of the following:
  - Simple pH strips
  - Field test kits
  - Handheld electronic meters (see the description for multiprobe in the previous section under the methods listed for water temperature)

- Common pH strips of a range expected for recreational waters are generally accurate enough for routine surveys. Their cost is usually less than $0.15 per strip.

Rainfall

- Rainfall can be measured using a rain gauge located near the sampling station(s). Some relatively inexpensive rain gauges ($50.00 to $150.00) that can also provide historical rainfall records can be purchased through vendors like Ben Meadows Company (http://www.benmeadows.com) and Weather Connection (http://www.weatherconnection.com).

- Alternatively, rainfall measurements can be obtained from a local airport. The distance from the airport to the sampling station should be noted. Record the amount of rainfall in inches or centimeters, as well as the time from the previous rainfall event, on the Routine On-site Sanitary Survey form. The Web sites listed under Historical Weather Conditions might also be a source of rainfall data.

Turbidity

- Simple, subjective observations (e.g., slightly turbid, clear) may be used to describe the turbidity of nearshore waters.

- Alternatively, test kits (using either a visual or titrimetric test method) such as the LaMotte test kit for turbidity, can be used for interpreting turbidity results. The results from using this method are reported in Jackson Turbidity Units (JTU). Visual methods use reagents to react with a substance in the sample, causing a change in color. Using the included color comparators or color sheets, the concentration of the substance can be determined. Titrimetric methods use a titrant solution that is added to the sample in precise quantities until a color change indicates a completed reaction. The amount of titrant added is used to determine concentration.

- There are two common methods for instruments to measure turbidity.

  1. Instruments can measure the attenuation of a light beam passing through a sample. In the attenuation method, the intensity of a light beam passing through turbid sample is compared with the intensity passing through a turbidity-free sample at 180° from the light source. This method is good for highly turbid samples.
  2. Instruments can measure the scattered light from a light beam passing through a sample. The most common instrument for measuring scattered light in a water sample is a nephelometer. A nephelometer measures light scattered at a right angle (90°) to the light beam. Light scattered at other angles may also be measured, but the 90° angle defines a nephelometric measurement. The light source for nephelometric measurements can be one of two types to meet EPA or ISO specifications. EPA specifies a tungsten lamp with a color temperature of 2,200–3,000 K. The units of measurement for the EPA method are nephelometric turbidity units (NTU). The ISO specifies a light-emitting diode (LED) with a wavelength of 860 nanometers and a spectral bandwidth less than or equal to 60 nanometers. The units of measurement for the ISO method are formazin nephelometric units (FNU) (APHA 1998).

- Portable turbidimeters are available for use in the field. Bathing beach water is first collected in the vial provided in the turbidimeter kit and then placed in the turbidimeter to obtain measurements. Results are provided in nephelometric turbidity units (NTUs) and are based on comparisons to known turbidity standards (also provided in the kit) through instrument calibration. Also, see the information on multiprobes given in the previous section under the methods for water temperature.

Conductivity

- Conductivity is measured electronically primarily, using a device called the Wheatstone Bridge, which measures the conductance across two electrodes. Also, see the information on multiprobes given in the previous section under the methods for water temperature.

Modeling

Water quality models also can assist in evaluating and classifying beaches. Predictive models can be used to estimate bacterial indicator levels during rainfall events to help reduce the risk of swimmers' exposure to contaminants between normal sampling periods. Selection of the appropriate model for helping to determine beach advisories and closings depends on the site conditions of the waterbody of concern. Some of these site-specific considerations are the types of sources (point source/nonpoint source), waterbody types, transport and circulation patterns, severity of impairment, and frequency of indicator criteria exceedances (USEPA 2002).

Additional information on beach water quality models can be found on EPA's Web site at http://www.epa.gov/waterscience/beaches/technical.html and USGS's Web site at http://oh.water.usgs.gov/reports/Abstracts/wrir02-4285.html.

Advisories/Closings

Compiling and comparing advisory and closing data from previous beach seasons and from the current beach season provides useful information about water quality and potential sources of contamination. Beach managers should have records of this information in a central file.

By comparing the number of days the beach was under advisory or closed during a season, a beach manager can determine whether overall water quality at a bathing beach is improving or declining. In addition, a beach manager can determine whether the dates the beach was under advisory or closed during a season correlate with other beach conditions, such as rain events, elevated water temperatures, pollution discharges, high winds, or high wildlife counts. The beach manager should be able to obtain notes on the beach conditions during sample collection on corresponding Routine On-site Sanitary Survey forms.

Potential pollutant sources

The beach manager should compile potential pollutant information (e.g., numbers of wildlife and domestic animals, sources of discharge) from previously conducted Routine On-site Sanitary Surveys. The beach manager should also review the topographic map and the detailed map developed for the Annual Sanitary Survey to determine what nearby sources (e.g., landfills, marinas, bathhouses) might be impacting bathing beach water quality and add this information with corresponding latitude and longitude data to this section of the Annual Sanitary Survey form. The beach manager should then estimate the percent annual contribution and peak contribution amounts for each potential pollutant source. This information will be very useful for prioritizing the potential sources for further investigation.

Description of sanitary facilities and other facilities

The sanitary facilities should be examined to determine whether they could be a source of pollution to the beach. Note the number of toilets, showers, sinks, and so forth to determine whether the facilities are adequate to accommodate the average and peak bather loads. Note their condition, as well as their general location and their distance from the beach and water line.

If other facilities, such as restaurants, play areas, parking lots, or other facilities that could be a source of pollution, are present at the beach, examine them as well.

Constructing an Annual Survey Report

The Annual Survey Report Outline is a standard format for compiling a report to assess a beach area and the surrounding watershed for potential sources of bacterial pollution that impact the beach and recreation water quality (See Appendix B). This report format will allow for consistency among Great Lakes beach managers for sharing beach pollution source information on beaches and swimmer health risk.

The Annual Sanitary Survey Form (See Appendix B) accompanies the Annual Survey Report Outline to serve as a guide in collecting the necessary information to adequately conduct an annual beach sanitary survey, assess the beach, and construct a report.

Record management

EPA suggests printing Routine On-Site Sanitary Survey forms on write-in-the-rain or waterproof paper. If waterproof paper is used, data should be recorded on the forms in pencil to avoid losing data that has been recorded. After forms are completed, they should be stored together so that data can later be entered electronically into a database. For the Annual Sanitary Survey and 5-year Sanitary Survey, the person(s) completing the form might want to enter the data electronically using a PDA.

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Appendix A. Routine On-Site Sanitary Survey Form

GREAT LAKES BEACHES ROUTINE ON-SITE SANITARY SURVEY

Name of Beach:	Date and Time of Sample Collection and Survey:
Sampling Station(s)/ID:	Surveyor Name(s):

PART I – GENERAL BEACH CONDITIONS

Air Temperature: _______ °C or °F Wind Speed and Direction (e.g., E or 90° at 15 mph): _____________

Rainfall: ☐ <24 hours ☐ <48 hours ☐ <72 hours since last rain event and _______ inches or _______ cm rainfall measured

Weather Conditions: ☐ Sunny ☐ Mostly Sunny ☐ Partly Cloudy ☐ Mostly Cloudy ☐ Overcast ☐ Rainy

Longshore current speed and direction (cm/sec, S or 180°): ___________ Wave Height: _______ ft ☐ Estimated or ☐ Actual

Comments/Observations

PART II – WATER QUALITY

Bacteria Sample Results

Type	E. coli	Enterococcus	Other (specify):
Concentration (CFU/100 mL)			

Water Temperature: _______°C Change in Color? ☐ yes ☐ no If yes, describe________________________________

Odor: ☐ None ☐ Septic ☐ Algae ☐ Sulfur ☐ Other________________________________

Turbidity: ☐ Clear ☐ Slightly Turbid ☐ Turbid ☐ Opaque or NTU:_______

Comments/Observations

PART III – BATHER LOAD

Total number of people at the beach: _________ Total number of people in the water: _________

Number of People Non-bathing/Non-swimming

Type	Boating	Fishing	Surfing	Windsurfing	Diving	Clamming	Other (specify):
Number							

Comments/Observations

PART IV – POTENTIAL POLLUTION SOURCES

Sources of Discharge:

Type	River(s)	Pond(s)	Wetland(s)	Outfall(s)	Other (specify):
Name(s) of Source(s)					
Flow Rate (M/sec)					
Volume					
Characteristics					

Floatables present: ☐ yes ☐ no Describe type and amount ________________________________

Amount of Beach Debris/Litter on Beach: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Type of Debris/Litter Found: ☐ Tar ☐ Oil/Grease ☐ Trash ☐ Plastic ☐ Medical Waste

☐ Other (describe)________________________________

Amount of Algae in Nearshore Water: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Amount of Algae on Beach: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Presence of Wildlife and Domestic Animals

Type	Geese	Gulls	Dogs	Other (specify):
Number				

Comments/Observations (continue on back if necessary):

Appendix B. Annual Sanitary Survey Form and Outline

APPENDIX B1. ANNUAL SANITARY SURVEY

1. BASIC INFORMATION

Name of Beach:	Date(s) of Sample Collection and Survey:
Beach ID:	Name of Waterbody:
Town/City/County/State:	
Sampling Station(s)/ID:	Name(s) of Surveyor(s):

2. DESCRIPTION OF LAND USE IN WATERSHED

Current Land Use in Watershed

Type	Residential	Industrial	Commercial	Agricultural	Other (specify):
Percentage					

Development: _______% undeveloped and _______% developed (describe): ______________________________

____

____

Uses: ☐ Boating ☐ Fishing ☐ Surfing ☐ Windsurfing ☐ Diving ☐ Other (specify):

Topographic map of area attached to Annual Sanitary Survey form: ☐ yes ☐ no
Detailed map of area attached to Annual Sanitary Survey form: ☐ yes ☐ no

Does detailed map include locations of:

Pollutant sources ☐ yes ☐ no (explain):
Boat traffic ☐ yes ☐ no (explain):
Marinas ☐ yes ☐ no (explain):
Boat dockage ☐ yes ☐ no (explain):
Canoeing ☐ yes ☐ no (explain):
Fishing ☐ yes ☐ no (explain):

Erosion/Accretion Measurements

High Watermark Location Identification	Fixed Object Description (e.g., tree, building)	Distance From Fixed Object to High Watermark (feet or meters?)	Distance Between High Watermark Locations (feet or meters?)
A			A↔B:
B			B↔C:
C			C↔D:
D (Optional)			D↔E:
E (Optional)			E↔F:
F (Optional)			

Bounding Structures

Bounding Structure	Number	Location on Beach Map? (Yes or No)
Jetty		
Groin		
Seawall		
Natural formation		
Other (specify):		
Other (specify):		

Beach Materials/Sediments

	Grabs									
Transect	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Or Beach Materials/Sediments: ☐ Sandy ☐ Soft ☐ Very mucky

Description of Photographs Taken (Specify date, roll, picture number, and subject of photograph)

Picture Number	Date/Time	Roll Number	Subject of Photograph (Include Pictures of High Watermark Locations and Corresponding Fixed Objects)

Habitat: ☐ Dunes ☐ Wetlands ☐ Open water

☐ Critical habitat for endangered or threatened species (describe critical habitat and endangered or threatened species): ___________

____

Average air temperature during beach season: _______ °C Average water temperature during beach season: _______ °C

Average wind speed and direction during beach season (e.g., E or 90° at 15 mph): ______________

Weather conditions: ☐ Sunny ☐ Mostly sunny ☐ Partly cloudy ☐ Mostly cloudy ☐ Overcast ☐ Rainy

Comments/Observations:

3. CONDITIONS

Dimensions of Waterbody

Beach length or dimensions

Length (m): _________ Width (average – m): _________

Width Z1 (m): _________ Width Z2 (m): _________ Width Z3 (m): _________

Water level variation: _______feet _______inches. Hydrographic influences (e.g., seiches): ________________________________

Longitudinal dispersion coefficient: _________m^2/sec. Lateral dispersion coefficient: _________m^2/sec. [Note that these coefficients can be calculated using velocity, width, mean depth, and shear velocity]

Slope: ________%

Date of last major rehabilitation: __________

Description of last major rehabilitation: ____

Comments/Observations:

4. INFORMATION ON SAMPLING LOCATION

Name of laboratory: ____________________________ Distance to laboratory: _________miles

Description of sampling location(s): ____

Typical time of sample collection: _____________

Sampling plan reviewed: ☐ yes ☐ no (explain):

Equipment maintenance and calibration procedures reviewed: ☐ yes ☐ no (explain):

Description of hydrometric network [note that this is a network of monitoring stations that collect data such as rainfall and flow]

Dimensions of waterbody

Comments/Observations:

5. BATHER LOAD

Beachgoer Category	Number of People							
	Historical Average	Current Average	Peak	Seasonal Average	Holiday Average	Weekend Average	Weekday Average	Off Season Average
Total beach users								
People in the water								
People boating								
People fishing								
People surfing								
People windsurfing								
People diving								
People clamming								
Other (specify):								
Frequency of measurements (e.g., biweekly, weekly, monthly)								

Describe how beachgoer numbers are calculated: ______________________________________

Comments/Observations:

6. BEACH CLEANING

Beach cleaning dates during season: ____

Description of clean up activities

	Leveling of Sand	Mowing of Vegetation	Small Scale Hand Pulling of Vegetation	Grooming of Soil	Construction and Maintenance of a Temporary Pathway Directly to Open Water	Other (specify):
Frequency						

Do cleanup activities meet the requirements of Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451, as amended (NREPA), and Part 325, Great Lakes Submerged Lands, of the NREPA : ☐ yes ☐ no (explain):____

Amount of beach debris/litter on beach: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Types of debris/litter found: ☐ Tar ☐ Oil/Grease ☐ Trash ☐ Plastic ☐ Medical waste
☐ Other (describe):

Comments/Observations:

7. SAMPLING

<u>Biological Survey Results:</u>

Invasive/nonnative species present:

____

Have algae blooms been observed during the beach season? ☐ no ☐ yes (specify duration and algae species):______________________

Amount of algae in nearshore water: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Amount of algae on beach: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Infectious snails

Dangerous aquatic organisms

Presence of Wildlife and Domestic Animals

Type	Geese	Gulls	Dogs	Other (specify):
Number				

Samples Collected

Parameter	Sample Type (Grab or Composite)	Analytical Method	Name of Laboratory Performing Analysis
Escherichia coli			
Enterococcus			
Fecal coliform			
Other (specify):			
Other (specify):			
Other (specify):			
Other (specify):			
Other (specify):			

Describe when, where, and how samples are collected: ____

____

How and when are sample results obtained? ____

____

Are advisories ever issued? ☐ no ☐ yes (describe when and how): ____

____

Water Quality

Parameter	Temperature (°C)	pH (s.u.)	Rainfall (inches)	Turbidity (NTU)	Conductivity (mhos/cm)
Average concentration					

Water quality annual trend data attached to Annual Sanitary Survey form? ☐ yes ☐ no (explain):

Comments/Observations:

8. MODELING

Are models being used? ☐ yes ☐ no

If yes, provide kinds of models being used and a brief description of the models: ____

____

Comments/Observations:

9. ADVISORIES/CLOSINGS

Advisory or Closing (specify one)	Start Date	End Date	Length of Advisory or Closing (Days)

Total number of closings issued:___________ Total number of advisories issued: __________

Comments/Observations:

10. POTENTIAL POLLUTANT SOURCES

Type	Number	Latitude	Longitude	Annual Contribution (%)	Peak Contribution (%)
Wastewater discharges					
Sewage overflows					
Septic systems					
Subsurface sewage disposal					
Stormwater outfalls					
Natural outfalls					
CAFOs or AFOs					
Wildlife					
Agriculture runoff					
Urban runoff, industrial waste					
Marinas, harbors					
Mooring boats					
Domestic animals					
Unsewered areas					
Erosion-prone areas					
Landfills, open dumps					

Groundwater seepage					
Bathhouse leakage					
Drains and pipes nearby					
Stream or wetland drainage					
Vacant areas					
Other (specify):					
Other (specify):					
Other (specify):					

Have potential pollutant sources identified above been included on the detailed map? ☐ yes ☐ no (explain):

Comments/Observations:

11. DESCRIPTION OF SANITARY FACILITIES

Facility Type	Number	Condition (Good, Fair, or Poor)	Location	Distance From Beach (feet)
Toilets				
Showers				
Sinks				
Water fountains				
Changing area				
Baby-changing area				
Litter bins				
Other (specify):				

Comments: ______________________________

Comments/Observations:

12. DESCRIPTION OF OTHER FACILITIES

Facility Type	Number	Condition (Good, Fair, or Poor)	Location	Distance From Beach (feet)
Restaurants				
Bars				
Designated bathing areas				
Diving areas				
Children's play area				
Car parks				
Other (specify):				

Comments:______________________________

Comments/Observations:

Appendix B2. Annual Sanitary Survey Report Outline

Outline for Performing a Beach Sanitary Survey Report

The first outline describes the beach sanitary survey for individual properties for pollution sources. The second outline contains the outline for a Beach Sanitary Survey Report.

Outline of Document/List of Data Elements for Assessing a Pollution Source Impacting a Beach/Recreational Swimming Area

(NOTE: See both Annual and 5-Year Beach Sanitary Survey Forms for a full, comprehensive checklist)

Survey Assignment:

- Each survey area should be assigned a unique designation.

Examination of Individual Properties for Pollution Sources:

- The boundaries of the shoreline survey area will be determined. All areas must be examined, and all potential discharges of wastes must be evaluated.
- Location (latitude/longitude) of pollution sources
- Pollution sources located on map and proximity to beach
- Properties of pollution sources
  - Volume
  - Frequency
  - Direct contribution (having an immediate impact on the beach)
  - Indirect contribution (having a delayed impact on the beach)
- Animal farms evaluated
- Marinas evaluated
- Flocks of waterfowl, wild animal populations evaluated
- Drainage ditches evaluated
- Any potential sources the surveyor feels might influence water quality
- Summation and comprehensive map of area identified as pollution source

Outline of Document/List of Data Elements for Beach Sanitary Survey Report

I. Executive Summary

II. Description of Beach/Swimming Area
   A. Location map or chart showing beach/swimming area
   B. Description of beach/swimming area
   C. History of beach water quality and beach advisories
      Date of last survey
      1. Previous assessment(s)
      2. Beach map(s)

3. Other factors, e.g. tiering or classification

III. Pollution Source Survey
   A. Summary of sources and location
      Map or chart showing the location of major sources of actual or potential pollution
      Table of sources of pollution cross referenced to the map
   B. Identification and evaluation of pollution sources
      1. Domestic wastes (discussion and maps)
      2. Stormwater
      3. Agricultural waste (farms, feedlots, and slaughterhouse operations)
      4. Wildlife areas
      5. Birds, number and type
      6. Industrial wastes
   C. Contribution of source(s)
      1. Volume
      2. Frequency
      3. Direct contribution (having an immediate impact on the beach)
      4. Indirect contribution (having a delayed impact on the beach)

IV. Hydrographic and Meteorological Characteristics
   A. Tides
      1. Type
      2. Amplitude
      3. Direction
   B. Rainfall
      1. Amount
      2. When
      3. Frequency of significant rainfalls
      4. Rainfall history
   C. Winds
      1. Seasonality and effects on pollution dispersion
      2. Direction
   D. River discharges
      1. Volumes
      2. Seasonal
   E. Summary discussion concerning actual or potential effects of transport on pollution to the harvest area

V. Water Quality Studies
   A. Map of sampling stations
   B. Sampling plan and justification
      1. Existing plan with location, frequency, proximity to source
      2. Adverse condition sampling
      3. Random sampling

C. Sample data analysis and presentation–tables containing the basic statistics (number of samples, single sample value, median or geometric mean, and the respective variability factors)
   1. Station-by-station array–adverse condition or systematic random sampling
   2. Daily sampling results and number of samples collected for survey
   3. Overall compliance with bacteria criteria

VI. Bather Load
   A. Bather density data
      Data analysis and presentation – tables containing basic statistics (total bathers, daily average, maximum, holiday, weekday, weekend values)

VII. Interpretation of Data in Determining Beach/Swimming Area Risk–discussion of how actual or potential pollution sources, wind, tide, rainfall, etc. affect or might affect water quality that addresses the following:
   A. Effects of meteorologic and hydrographic conditions on bacterial loading
   B. Variability in the data and causes

VII. Conclusions:
   A. Map or chart showing beach/swimming area in relation to sources (plume extent, hot spots)
   B. Legal description
   C. Steps for remediation and coordination with other watershed management programs
   D. Management plan (if conditionally approved or conditionally restricted)
   E. Recommendations for sanitary survey improvement
      1. Monitoring schedule, stations, etc.
      2. Comments

Appendix C. 5-Year Sanitary Survey Form

5-YEAR SANITARY SURVEY

1. BASIC INFORMATION

Name of Beach:	Date(s) of Sample Collection and Survey:
Beach ID:	Name of Waterbody:
Town/City/County/State:	
Sampling Station(s)/ID:	Name(s) of Surveyor(s):

2. DESCRIPTION OF LAND USE IN WATERSHED

Describe significant changes since previous annual survey, including new developments and improvements to wastewater structure:

___

___

___

___

___

Current Land Use in Watershed

Type	Residential	Industrial	Commercial	Agricultural	Other (specify):
Percentage					

Graphical depiction of historical trends in land use in watershed attached to form: ☐ Yes ☐ No (explain):___

Development: _______% undeveloped and _______% developed (describe):___

___

___

Uses: ☐ Boating ☐ Fishing ☐ Surfing ☐ Windsurfing ☐ Diving ☐ Other (specify):

Topographic map of area attached to Annual Sanitary Survey form: ☐ yes ☐ no
Detailed map of area attached to Annual Sanitary Survey form: ☐ yes ☐ no

Does detailed map include locations of:

- Pollutant sources ☐ yes ☐ no (explain):
- Boat traffic ☐ yes ☐ no (explain):
- Marinas ☐ yes ☐ no (explain):
- Boat dockage ☐ yes ☐ no (explain):
- Canoeing ☐ yes ☐ no (explain):
- Fishing ☐ yes ☐ no (explain):

Erosion/Accretion Measurements

High Watermark Location Identification	Fixed Object Description (e.g., tree, building)	Distance From Fixed Object to High Watermark (feet or meters?)	Distance Between High Watermark Locations (feet or meters?)
A			A↔B:
B			B↔C:
C			C↔D:
D (Optional)			D↔E:
E (Optional)			E↔F:
F (Optional)			

Graphical depiction of historical trends in erosion/accretion attached to form: ☐ Yes ☐ No (explain):___

Bounding Structures

Bounding Structure	Number	Location on Beach Map? (Yes or No)
Jetty		
Groin		
Seawall		
Natural formation		

Other (specify):		
Other (specify):		

Beach Materials/Sediments

	Grabs									
Transect	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Or Beach Materials/Sediments: ☐ Sandy ☐ Soft ☐ Very mucky

Description of Photographs Taken (Specify date, roll, picture number, and subject of photograph)

Picture Number	Date/Time	Roll Number	Subject of Photograph (Include Pictures of High Watermark Locations and Corresponding Fixed Objects)

Habitat: ☐ Dunes ☐ Wetlands ☐ Open water
☐ Critical habitat for endangered or threatened species (describe critical habitat and endangered or threatened species): ___________
____

Average air temperature during beach season: _______ °C Average water temperature during beach season: _______ °C
Average wind speed and direction during beach season (e.g., E or 90° at 15 mph): ______________
Weather conditions: ☐ Sunny ☐ Mostly sunny ☐ Partly cloudy ☐ Mostly cloudy ☐ Overcast ☐ Rainy

Comments/Observations:

3. CONDITIONS
Dimensions of Waterbody

Beach length or dimensions
Length (m): _________ Width (average – m): _________
Width Z1 (m): _________ Width Z2 (m): _________ Width Z3 (m): _________

Water level variation: _______feet _______inches. Hydrographic influences (e.g., seiches): ___________________________
Graphical depiction of historical trends in water level and water level variation attached to form: ☐ Yes ____________ ☐ No (explain):_____

Longitudinal dispersion coefficient: _________m^2/sec. Lateral dispersion coefficient: _________m^2/sec. [Note that these coefficients can be calculated using velocity, width, mean depth, and shear velocity]
Slope: ________%
Date of last major rehabilitation: __________

Description of last major rehabilitation: ____

Comments/Observations:

4. INFORMATION ON SAMPLING LOCATION

Name of laboratory: ____________________ Distance to laboratory: ________miles

Description of sampling location(s): ____

____

Typical time of sample collection: __________

Sampling plan reviewed: ☐ yes ☐ no (explain):

Equipment maintenance and calibration procedures reviewed: ☐ yes ☐ no (explain):

Description of hydrometric network [note that this is a network of monitoring stations that collect data such as rainfall and flow]

Dimensions of waterbody

Comments/Observations:

5. BATHER LOAD

Beachgoer Category	Number of People							
	Historical Average	Current Average	Peak	Seasonal Average	Holiday Average	Weekend Average	Weekday Average	Off Season Average
Total beach users								
People in the water								
People boating								
People fishing								
People surfing								
People windsurfing								
People diving								
People clamming								
Other (specify):								
Frequency of measurements (e.g., biweekly, weekly, monthly)								

Describe how beachgoer numbers are calculated: ____

____

Comments/Observations:

6. BEACH CLEANING

Beach cleaning dates during season: ____

Description of clean up activities

	Leveling of Sand	Mowing of Vegetation	Small Scale Hand Pulling of Vegetation	Grooming of Soil	Construction and Maintenance of a Temporary Pathway Directly to Open Water	Other (specify):
Frequency						

Do cleanup activities meet the requirements of Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451, as amended (NREPA), and Part 325, Great Lakes Submerged Lands, of the NREPA : ☐ yes ☐ no (explain):____

Amount of beach debris/litter on beach: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Types of debris/litter found: ☐ Tar ☐ Oil/Grease ☐ Trash ☐ Plastic ☐ Medical waste

☐ Other (describe):

Comments/Observations:

7. SAMPLING

<u>Biological Survey Results:</u>

Invasive/nonnative species present:

Have algae blooms been observed during the beach season? ☐ no ☐ yes (specify duration and algae species):______________________________

Amount of algae in nearshore water: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Amount of algae on beach: ☐ None ☐ Low (1-20%) ☐ Moderate (21-50%) ☐ High (>50%)

Infectious snails

Dangerous aquatic organisms

Presence of Wildlife and Domestic Animals

Type	Geese	Gulls	Dogs	Other (specify):
Number				

Samples Collected

Parameter	Sample Type (Grab or Composite)	Analytical Method	Name of Laboratory Performing Analysis
Escherichia coli			
Enterococcus			
Fecal coliform			
Other (specify):			
Other (specify):			
Other (specify):			
Other (specify):			
Other (specify):			

Describe when, where, and how samples are collected: ______________________________

How and when are sample results obtained? ______________________________

Are advisories ever issued? ☐ no ☐ yes (describe when and how): ______________________________

Bacterial concentration 5-year trend data attached to annual sanitary survey form? ☐ yes ☐ no (explain): ____________________

Water Quality

Parameter	Temperature (°C)	pH (s.u.)	Rainfall (inches)	Turbidity (NTU)	Conductivity (mhos/cm)
Average concentration					

Water quality 5-year trend data attached to Annual Sanitary Survey form? ☐ yes ☐ no (explain):

Comments/Observations:

8. MODELING

Are models being used? ☐ yes ☐ no

If yes, provide kinds of models being used and a brief description of the models: ____

____

Comments/Observations:

9. ADVISORIES/CLOSINGS

Advisory or Closing (specify one)	Start Date	End Date	Length of Advisory or Closing (Days)

Total number of closings issued in past 5 years:__________ Total number of advisories issued in past 5 years: __________

Average length of closure in past 5 years:_____________

Comments/Observations:

10. POTENTIAL POLLUTANT SOURCES

Type	Number	Latitude	Longitude	Annual Contribution (%)	Peak Contribution (%)
Wastewater discharges					
Sewage overflows					
Septic systems					
Subsurface sewage disposal					
Stormwater outfalls					
Natural outfalls					
CAFOs or AFOs					
Wildlife					
Agriculture runoff					
Urban runoff, industrial waste					

Marinas, harbors					
Mooring boats					
Domestic animals					
Unsewered areas					
Erosion-prone areas					
Landfills, open dumps					
Groundwater seepage					
Bathhouse leakage					
Drains and pipes nearby					
Stream or wetland drainage					
Vacant areas					
Other (specify):					
Other (specify):					
Other (specify):					

Have potential pollutant sources identified above been included on the detailed map? ☐ yes ☐ no (explain):

Describe historical trends in potential pollutant sources (e.g., number of sewage overflows decreased in the last 2 years, erosion-prone areas have been seeded within the last year and are no longer erosion-prone):

Comments/Observations:

11. DESCRIPTION OF SANITARY FACILITIES

Facility Type	Number	Condition (Good, Fair, or Poor)	Location	Distance From Beach (feet)
Toilets				
Showers				
Sinks				
Water fountains				
Changing area				
Baby-changing area				
Litter bins				
Other (specify):				

Comments: ______________________________

Describe historical trends in the condition of sanitary facilities (e.g., number of overflowing litter bins has continued to decrease in the last 2 years; number of operational sinks has decreased in the past year):

Comments/Observations:

12. DESCRIPTION OF OTHER FACILITIES

Facility Type	Number	Condition (Good, Fair, or Poor)	Location	Distance From Beach (feet)
Restaurants				
Bars				
Designated bathing areas				
Diving areas				
Children's play area				
Car parks				
Other (specify):				

Comments:

Describe historical trends in the condition of other facilities (e.g., use of covered garbage cans at outdoor restaurants has increased over the past 3 years; littering at car parks has increased over the past 2 years):

Comments/Observations:

Appendix D. Quality Assurance and Quality Control

States, tribes, and local agencies should use the information in this guidance document and follow their agency-specific QA/QC procedures for data collection, entry, and analysis when performing sanitary surveys.

Most agencies should already have QA/QC procedures for performing beach monitoring because such procedures are required to obtain BEACH grants in accordance with the EPA regulations at 40 CFR 31.45 governing grants to states, tribes, and local governments. Specifically, the regulations require the following:

> If the grantee's project involves environmentally related measurements or data generation, the grantee shall develop and implement quality assurance practices consisting of policies, procedures, specifications, standards, and documentation sufficient to produce data of quality adequate to meet project objectives and to minimize loss of data due to out-of-control conditions or malfunctions.

An agency's QA/QC procedures should be updated, as needed, to include QA/QC procedures for performing the sanitary surveys described in this guidance document. An agency's QA/QC procedures are generally documented in quality management plans (QMPs), quality assurance project plans (QAPPs), and SOPs. If an agency needs to develop additional quality documentation for performing sanitary surveys, it should refer to the documents below (available on EPA's quality Web site at http://www.epa.gov/quality/qa_docs.html) for requirements and guidance:

- *EPA Requirements for Quality Management Plans* (QA/R-2)
- *EPA Requirements for QA Project Plans* (QA/R-5)
- *Guidance for Quality Assurance Project Plan*s (QA/G-5)
- *Guidance for Preparing Standard Operating Procedures* (QA/G-6)

Typically, the written quality documentation takes the form of a QAPP. A QAPP typically details the technical activities and QA and QC procedures that should be implemented to ensure that data meet the specified standards. The QAPP should identify who will be involved in the project and their responsibilities; the nature of the study or monitoring program; the questions to be addressed or decisions to be made based on the data collected; where, how, and when samples will be taken and analyzed; the requirements for data quality; the specific activities and procedures to be performed to obtain the requisite level of quality, including QC checks and oversight; and how the data will be managed, analyzed, checked to ensure that it meets the project goals, and reported. The QAPP should be implemented to ensure that data collected and analytical data generated are complete, accurate, and suitable for the intended purpose.

States, tribes, and local agencies should also document their methods and assessment procedures in their quality system documentation. For routine implementation of these methods, SOPs, which can be referenced in and provided with the quality system documentation, provide a tool to assist the person(s) performing the activities. An SOP typically presents in detail the method for a given technical (not administrative) operation, analysis, or action in sequential steps. It includes specific facilities, equipment, materials and methods; QA and QC procedures; and other factors necessary to perform the operation, analysis, or action. If the SOP is followed, the operation should be performed the same way every time; that is, the operation is standardized. The activities being performed might include field sampling and database management. The format and content requirements for an SOP are flexible because the content and level of detail vary according to the nature of the procedure. SOPs should be revised when new equipment is used, when comments by personnel indicate that the directions are not clear, or when a problem occurs. States, tribes, and local agencies should ensure that obsolete documents are removed and that the revised SOPs are used in subsequent tasks.

EPA recommends that a registered sanitarian supervise the first few Routine On-site Sanitary Surveys performed by volunteers or lifeguards. In addition, as Routine On-site Sanitary Survey forms are completed, the registered sanitarian or designee should review the forms for any problems (e.g., incomplete answers, questionable responses). The registered sanitarian should provide some guidance to the volunteers or lifeguards to ensure that problems are remedied. The following are some additional quality considerations that should be followed:

- Make sure a second person checks the sanitary survey form to be sure it has been filled out correctly.
- Follow the calibration procedures for each instrument carefully. Flow meters have been factory-calibrated, but they must be checked regularly to ensure that they are working properly prior to use. The calibration of pH, conductivity/salinity, DO, temperature, and turbidity probes should be checked (at a minimum) once daily, prior to initial deployment, or as deemed necessary by the equipment manufacturer, using the standard solutions.
- Contact the laboratory at least 8 to 10 hours (24 hours is ideal) before the start of the sampling event to determine whether additional volumes of samples must be collected for QC analyses in the laboratory. Field blanks, trip blanks, and field duplicates must be collected as specified by the lab, although they usually are not required. If a sampling trip is cancelled, notify the lab immediately.
- Prevent contamination of samples at all times. Take care with respect to equipment handling, container handling/storage, decontamination, and record keeping. Rinse and clean sample collection equipment as necessary before and after each sampling episode, with the exception of pre-preserved containers. Wear clean powder-free gloves or make sure your hands are clean.

In addition to the general quality considerations, it is recommended that SOPs be developed for each activity or piece of equipment. Because completing the survey and performing sampling generally require the application of best professional judgment in addition to following predetermined steps, it is recommended that only persons who have received training in the operation of each type of equipment, and have experience in monitoring streams, be responsible for completing the sanitary survey.

Appendix E. Equipment and Supplies

A list of potential vendors to help you locate beach water quality supplies can be found in the *Minnesota Pollution Control Agency Volunteer Surface Water Monitoring Guide*, available at http://www.pca.state.mn.us/water/monitoring-guide.html.

Expenses

The overall potential cost of a sanitary survey ranges from tens to thousands of dollars. For the purposes of this evaluation, the expense assessment is associated with monitoring equipment and health and safety equipment for the survey teams. Health and safety are not considered optional; however, there are some cost-control opportunities in the selection and use of safety equipment. For the purpose of this analysis, the minimum safety requirements are safety glasses, gloves, and rubber boots.

As mentioned, safety equipment is not an option. Therefore, the overall expense variable lies primarily with the sampling and water quality testing equipment and supplies. Some or most of this might already be covered by a beach monitoring program. Critical to these are (1) what capital equipment might be available in the survey sponsorship organizations, (2) what data are most important to the sponsors, (3) the overall qualifications of the sampling team staff, (4) how many survey stations or locations are identified within a sponsor's jurisdiction, and (5) the timeframe for completing the surveys. A significant number of stations or reaches to be surveyed might dictate the need for a more expensive monitoring option, but the number of stations will ultimately drive down the cost per survey. As a basic estimate of some of the costs of field measurement equipment, a single-parameter nepholometer/turbidimeter runs between $700 and $1,000 and multiprobe instruments that can measure temperature, pH, conductivity, and dissolved oxygen are in the $1,700–$2,000 range (without turbidity probe). Portable digital thermometers range from less than $100 to $300 for a high-quality, National Institute of Standards and Testing (NIST) traceable calibration.