DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

Protocol for assessment and management of microbial risks in recreational waters

Implementing chapter five of the National Health and Medical Research Council guidelines for managing risks in recreational waters

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This document is the second revision of the *Beachwatch Programs Protocol for Assessment and Management of Microbial Risks in Recreational Waters* compiled in 2011.

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Coastal environments are rich in natural and cultural resources and are the focus of economic, social, tourist and recreational activities. However, these environments can also pose threats to human health and safety through the presence of physical hazards, dangerous aquatic organisms and pollution.

In 2008, the National Health and Medical Research Council (NHMRC) endorsed Guidelines for Managing Risks in Recreational Water (NHMRC 2008). The 2008 guidelines supersede the Australian Guidelines for Recreational Use of Water (NHMRC 1990) and replace some sections of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000).

The NHMRC 2008 guidelines are based on the World Health Organization (WHO) Guidelines for Safe Recreational Water Environments (WHO 2003) and combine international best-practice with an understanding of Australian waters to provide guidance relevant to local conditions.

The primary aim of the 2008 guidelines is to protect human health. Unlike the earlier guidelines, which focused on water quality compliance, the new guidelines advocate a preventative, risk management approach with a focus on assessing, managing and reducing risks.

This document

This document is the second revision of the *Beachwatch Programs Protocol for Assessment and Management of Microbial Risks in Recreational Waters* compiled in 2011.

This document supports the implementation of a key component of the NHMRC 2008 guidelines: Chapter 5 – Microbial Quality of Recreational Water. It provides water resource managers in New South Wales with the practical information necessary to design and implement programs for assessing risk from microbial contamination in recreational waters and to devise effective management solutions.

This document has three key objectives:

- Raise awareness and understanding of the risks associated with microbial contamination of recreational waters
- Facilitate the adoption and consistent implementation of the NHMRC 2008 guidelines
- Increase community access to information on recreational water quality.

Risk management framework

The following is an overview of the risk management framework detailed in the NHMRC guidelines; it defines the uses and users of recreational waters and describes how to use this protocol.

Identify hazards

A hazard is a chemical, biological or physical agent that has the potential to cause harm, such as death, illness or injury (NHMRC/NRMMC 2004). There are many potential hazards in recreational waters, and the 2008 guidelines cover the following (Table 1):

- physical hazards, such as drowning, near drowning and spinal injuries
- sun, heat and cold and water temperature
- microbial contamination
- toxic algae and cyanobacteria in fresh and marine waters
- chemical contamination, pH and dissolved oxygen
- dangerous or venomous aquatic organisms
- aesthetic aspects.

Assess risk

Risk is the likelihood that a hazard or hazardous event will occur and the consequences if it does.

Hazards pose a highly diverse range of risks. Risk increases with the probability of the hazardous event occurring and the magnitude of the consequences (Figure 1).

A hazard that occurs infrequently and has little impact on human health will be assessed as low risk. In contrast, a hazard that is known to occur with some regularity and leads to serious injury will be assessed as high risk.

Table 1 Identification of hazards in recreational waters

Characteristic	Guideline	Comments
Physical hazards	Recreational waterbodies and adjacent areas should be free of physical hazards, such as floating or submerged objects that may lead to injury. Where permanent hazards exist, for example rips and sandbars, appropriate warning signs should be clearly displayed.	Injuries related to these objects may result during activities such as swimming, diving and water skiing.
Sun, heat and cold-water temperature	The temperature of recreational waterbodies should be in the range 16–34°C. Recreational water users should be educated to reduce exposure to ultraviolet radiation (UVR), particularly during the middle of the day.	Exposure to cold water (<16°C) can result in hypothermia (excessive heat loss) or a shock response. Prolonged exposure to waters >34°C may result in hyperthermia (heat exhaustion or heat stress). Levels of UVR vary throughout the day, with a maximum occurring during the 4 hours around noon.
Microbial quality	Preventive risk management practices should be adopted to ensure designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin.	The main health risks are from enteric viruses and protozoa.

Characteristic	Guideline	Comments
Cyanobacteria and algae in fresh waters	Fresh recreational waterbodies should not contain: • ≥10 µg/L total microcystins; ≥50,000 cells/mL toxic *Microcystis aeruginosa*; or biovolume equivalent of ≥4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume, or • ≥10 mm^3/L for total biovolume of all cyanobacterial material where known toxins are not present, or • cyanobacterial scums consistently present.	Two guideline values have been established based on known risks associated with known toxins and probability of health effects caused by high levels of cyanobacterial material. A situation assessment and alert levels framework for the management of algae/cyanobacteria in recreational waters has been developed that allows for a staged response to the presence and development of blooms.
Cyanobacteria and algae in coastal and estuarine waters	Coastal and estuarine recreational waterbodies should not contain: • ≥10 cells/mL *Karenia brevis* and/or have *Lyngbya majuscula* and/or *Pfiesteria* present in high numbers.	A situation assessment and alert levels framework for the management of algae/cyanobacteria in recreational waters has been developed that allows for a staged response to the presence and development of blooms.
Dangerous aquatic organisms	Direct contact with venomous or dangerous aquatic organisms should be avoided. Recreational waterbodies should be reasonably free of, or protected from, venomous organisms (e.g. box jellyfish and bluebottles). Where risks associated with dangerous aquatic organisms are known, appropriate warning signs should be clearly displayed.	Risks associated with dangerous aquatic organisms are generally of local or regional importance and vary depending on recreational activities.
Chemical hazards	Waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes.	Chemical contamination can result from point sources (e.g. industrial outfalls) or from runoff (e.g. from agricultural land). All chemical contaminants should be assessed on a local basis.
pH	6.5–8.5	A wider pH range of 5–9 is acceptable for water with a very low buffering capacity.
Dissolved oxygen	>80%	When considered with colour and turbidity, dissolved oxygen is an indicator of the extent of eutrophication of the waterbody.
Aesthetic aspects	Recreational waterbodies should be aesthetically acceptable to recreational users.	The water should be free from visible materials that may settle to form objectionable deposits, including floating debris; oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life

Source: Adapted from NHMRC 2008

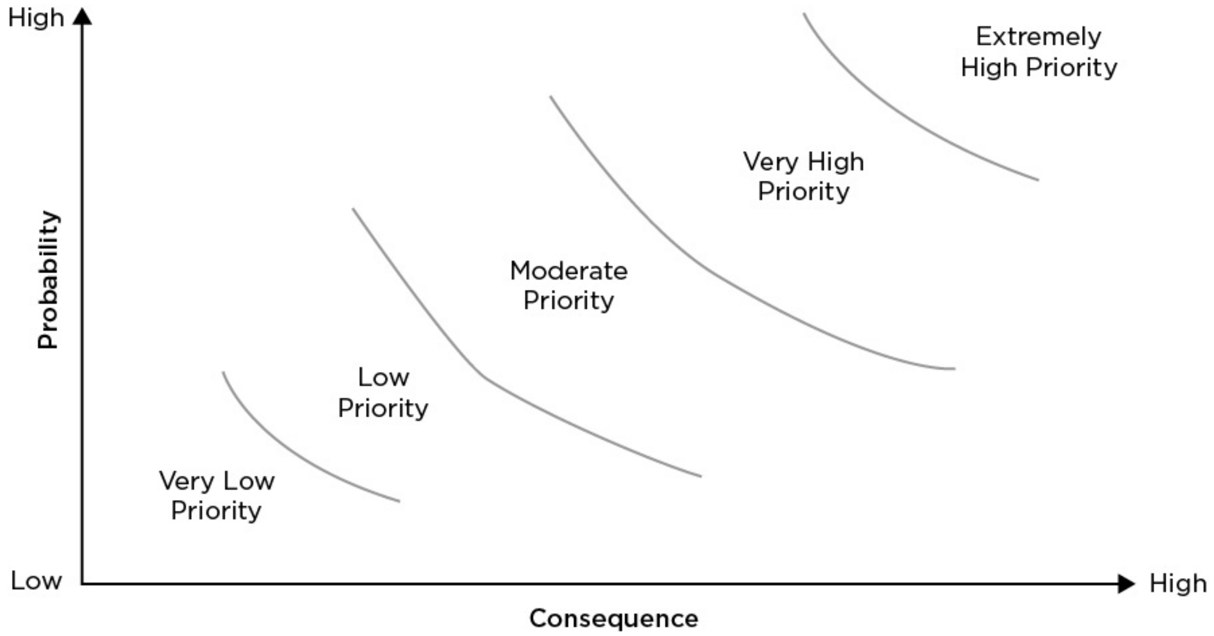

Figure 1 Schematic of risk assessment based on probability (likelihood) and consequence

Source: WHO 2003

Manage risk

Attention and resources should be focused on the level of risk rather than the existence of a hazard.

For healthy adults, recreational waters that conform to the guidelines presented in Table 1 will pose only minimal risks. The risks may be greater for susceptible groups such as small children or the elderly. While it is not possible to completely eliminate risk, it should be reduced to tolerable levels through management actions, such as those listed in Table 2.

Uses and users of recreational water

The 2008 guidelines can be applied to a wide range of recreational water environments, such as any coastal, estuarine or freshwater area used by the community for recreation.

Recreation covers a range of activities and is classified as follows (from NHMRC 2008):

- Whole-body contact (primary contact) – an activity where the whole body, face or trunk are frequently immersed, or the face is frequently wet by spray and where it is likely that water will be swallowed or come into contact with the ears, eyes, nasal passages or cuts in the skin. Examples are swimming, diving, surfing and white-water canoeing.
- Incidental contact (secondary contact) – an activity where only the limbs are regularly wet and greater contact, including swallowing water, is unusual; includes activities where occasional and inadvertent immersion may occur through slipping or wave action. Examples are boating, fishing and wading.
- No contact (aesthetic use) – an activity where there is normally no contact with the water or where water is incidental to the activity. Examples include angling from the shore and sunbathing.

Users of recreational waters include the general public as well as tourists and special interest groups such as sportspeople. Some user groups, such as children, the elderly, people with compromised immune systems, tourists and people from culturally or linguistically diverse backgrounds are most susceptible to exposure to hazards.

Table 2 Hazards and measures for reducing risks in whole-body (primary) contact recreational use

Principal risk	Potential risk reduction measures
Drowning	Where appropriate: safety rails, lifebelts/lifejackets, warning notices, broadcast weather alerts, education/legislation for lifejacket use while boating, supervision and availability of rescue services. Personal care.
Microbial infection	Avoiding body contact after heavy rain. Licensing, control and treatment of discharges of sewage, effluents, storm overflows. Improvements where indicated as appropriate due to unsatisfactory microbial quality. Personal awareness of local conditions.
Sunburn, skin damage, skin cancer, eye damage and heat illness	Generalised and localised education and publicity programs including advice to limit exposure (between 10am and 3pm), seek shade, wear protective clothing (including a hat), apply sunscreen, wear sunglasses, maintain hydration.
Cyanobacterial, marine algal toxicoses	Control of eutrophication, monitoring and reporting cyanobacterial populations, curtailing recreation during blooms, avoiding contact, washing body and equipment after recreation.
Impact injury	Notices indicating hazards. Personal awareness raising and avoidance, wearing head and body protection where appropriate. Supervision and presence of lifeguards and rescue services. Removal/mitigation of the hazard.
Injury; treading on broken glass, jagged metal waste, or needle stick injuries, infection following skin injury	Litter control, cleaning of recreational area. Provision of rubbish bins. Prohibiting use of glass on beaches, and provision of sharps disposal facilities. Cover all injuries with waterproof dressings.
Collision with or entrapment by wrecks, piers, weirs, sluices and underwater obstructions	Notices to mariners, marker buoys, posted warnings. Personal awareness. Legislation requiring boat training. Rescue services to respond to incidents and mitigate injuries. Appropriate oversight (e.g. harbour/beach patrols).
Stings from sea animals	Local awareness raising where the problem occurs.
Attack by aquatic animals (e.g. sharks, crocodiles)	Posting warnings, personal awareness raising, avoidance.
Bites of mosquitoes and other insect vectors of disease	Health warnings; avoidance of infested regions, personal protection (e.g. clothing, insect repellents).

Source: NHMRC 2008

Implementing the microbial guidelines

Implementation of a microbial quality assessment program can be broken down into seven key components (Figure 2 and Table 3). Each component is fully described in Parts 1 to 7 of the protocol.

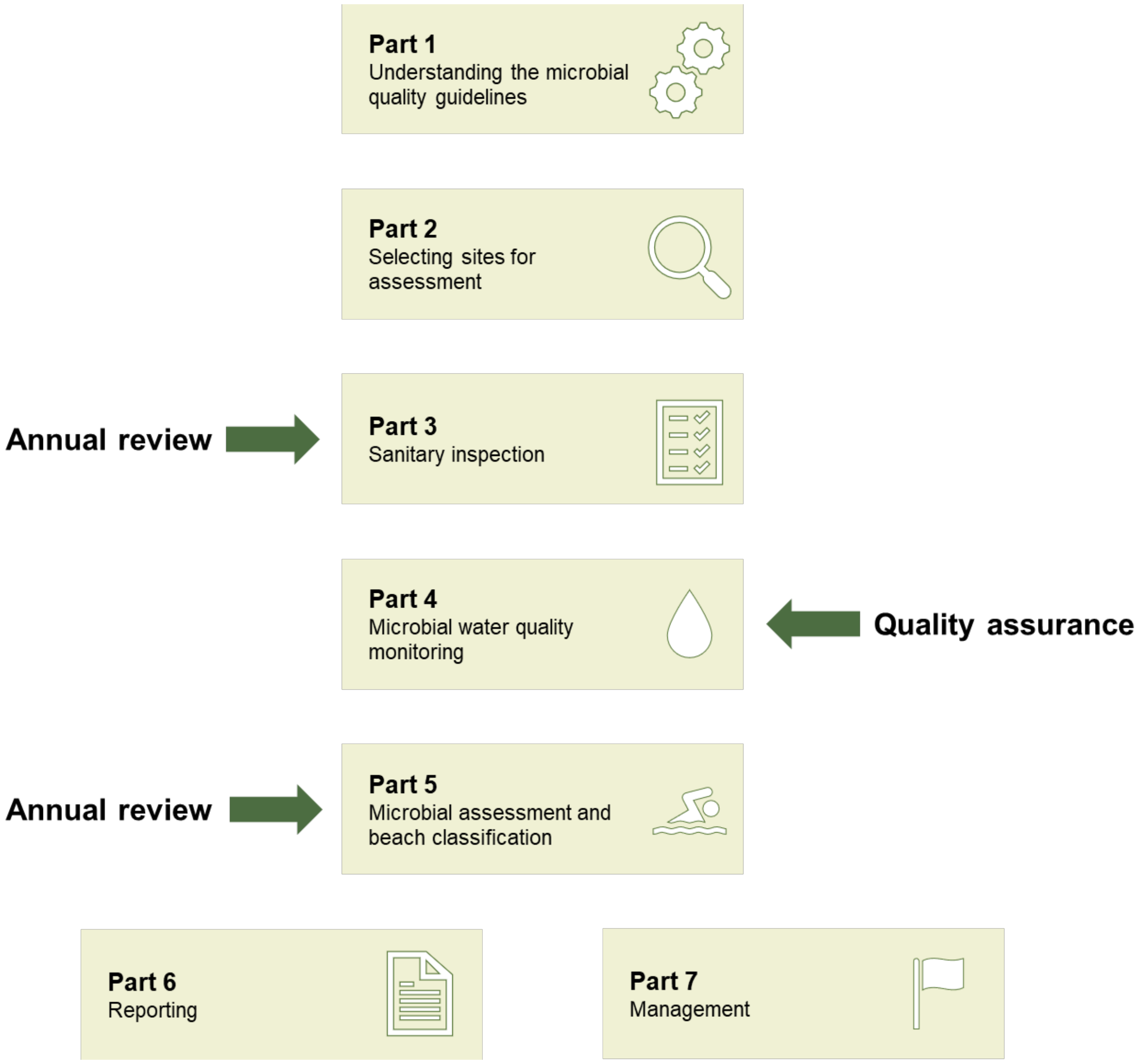

Figure 2 Framework for managing microbial risks in recreational waters

Table 3 Framework for managing microbial risks in recreational waters

Part	Description
Part 1 Understanding the microbial quality guidelines	A thorough understanding of the guidelines for microbial quality is required before commencing a microbial assessment program. This section provides an overview of Chapter 5 – Microbial Quality of Recreational Water of the NHMRC (2008) Guidelines for Managing Risks in Recreational Waters.
Part 2 Selecting sites for assessment	Assessment of water quality over a large geographic area or over a long timeframe can be prohibitively expensive. The key to minimising cost is to develop a targeted program that meets specific regional priorities and can be easily integrated with existing council activities. This section presents a simple risk-based process for prioritising beaches by assessing the likelihood and consequence of pollution at each swimming location.
Part 3 Sanitary inspection	Sanitary inspections are an integral part of the 2008 guidelines. They require identification of all sources of faecal contamination that may affect a swimming area, assessment of the risk posed by each source and grading of the overall risk into a Sanitary Inspection Category (SIC). A four-step procedure for conducting sanitary inspections and determining the SIC is presented. A copy of Beachwatch's sanitary inspection report is provided in Appendix A.
Part 4 Microbial water quality monitoring	This section shows how to design a monitoring program to meet the requirements of the 2008 guidelines including setting the scope of the study, sampling frequencies and measurement parameters. It also details how to implement the strategy with information on sampling procedures, occupational health and safety considerations, quality assurance and quality control requirements and information about laboratory requirements and data handling issues. An example of a field logsheet is provided in Appendix B.
Part 5 Microbial assessment and beach classification	Microbial water quality data is used to determine the Microbial Assessment Category (MAC). This section shows how to analyse the data to determine the MAC and how to combine the MAC and the SIC to derive a beach classification.
Part 6 Reporting	This section describes the development of a communication plan and the range of media that can be used to disseminate information on recreational water quality to the public.
Part 7 Management	This section outlines preventive risk management practices that should be adopted to ensure designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin.

Part 1: Understanding the microbial quality guidelines

Health risks from microbial contamination

Contamination of recreational waters with faecal material from animal and human sources can pose significant health problems to beach users due to the presence of pathogens, or disease-causing micro-organisms, in the faecal material. The most common groups of pathogens found in recreational waters are bacteria, protozoans and viruses.

Bacteria

There are many thousands of species of these simple single-celled organisms. The vast majority of bacteria are harmless and perform a variety of essential roles, including the breakdown of organic material, fermentation and nitrogen fixing. Enteric bacteria live in the intestinal tracts of warm-blooded animals and help with digestion. Several groups of bacteria are pathogenic: these include Salmonella, which can cause typhoid fever, and Vibrio, which can cause cholera.

Protozoans

These single-celled organisms live as parasites in humans and animals. In the environment, they exist as dormant cysts, enabling them to survive harsh conditions such as high temperatures and salinity. When swallowed by a host, the protozoans multiply and are spread through excretion of faeces. At the height of an infection, there may be between two and 10 million cysts in every gram of faeces excreted. Approximately 300 of the 35,000 known species of protozoans are pathogenic. *Giardia lamblia* and *Cryptosporidium parvum* are two of the best known pathogenic protozoans.

Viruses

These consist of nucleic acid (RNA or DNA) surrounded by a protein shell. Viruses are not able to take in food, get rid of waste or reproduce by themselves. Viral infection does not always lead to disease. In some cases the host will have no symptoms; in others the host will become very ill. Person-to-person contact is the most common transmission route. Viruses found in water include hepatitis A and E, norovirus, coxsackie, rotavirus and adenovirus.

Exposure

Exposure to waterborne human pathogens when at the beach can occur through direct contact with polluted water while swimming, by accidental ingestion of contaminated water or by inhalation of small water droplets in the air.

Primary contact with contaminated water can cause a variety of diseases of the gastrointestinal tract, collectively known as gastroenteritis. Symptoms of gastroenteritis include vomiting, diarrhoea, stomach-ache, nausea, headache and fever.

Diseases and conditions that affect the eyes, ears, skin and upper respiratory tract can also be contracted when pathogens come into contact with small breaks and tears in the skin or ruptures of the delicate membranes in the ear or nose. Some waterborne pathogens, the diseases they cause, and their effects are listed in Table 4.

Table 4 Waterborne pathogens, diseases and effects

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

Source: USEPA 2001

Epidemiological studies

People who contract diseases as a result of swimming in contaminated water do not always associate their illness symptoms with this contact. As a result, disease outbreaks are often inconsistently reported. As the incidence of disease among swimmers is difficult to determine, numerous studies have been conducted in an attempt to establish a link between illness and the level of faecal contamination. A review of these studies by Pruss (1998) drew two conclusions:

- The relative risk of swimming in contaminated water ranged from one to three times above the risk associated with swimming in uncontaminated water.
- Symptom rates were higher in individuals with compromised immune systems.

Certain groups of users may be more exposed to the threat of microbial infection than others. Children, the elderly, people with compromised immune systems, tourists and people from culturally and linguistically diverse backgrounds are generally most at risk.

Indicator organisms

NHMRC 2008 advocates the use of enterococci as the indicator organism for assessing risks from microbial contamination in recreational waters.

Thermotolerant coliforms (also known as faecal coliforms) have traditionally been used to assess levels of faecal contamination in recreational waters; however, epidemiological studies have found no clear relationship between levels of these bacteria and disease rates in swimmers (also called the dose–response relationship). One reason for the poor correlation may be that coliform bacteria can grow in the environment and so their presence does not necessarily relate to the presence of faecal contamination and associated pathogens.

In contrast, enterococci (a sub-group of faecal streptococci) have shown a clear dose–response relationship in marine waters and are the single preferred indicator bacteria recommended by the World Health Organization (WHO 2003).

Microbial quality assessment

The NHMRC 2008 guidelines use a combination of knowledge of beach catchment characteristics (sanitary inspection) and microbiological information gathered over previous years to arrive at a Beach Suitability Grade, which is an assessment of the suitability of a site for recreational use.

Beach Suitability Grades support informed personal choice and provide guidance to the community on the relative safety of the water. Classifications can be compared to determine which sites are the most suitable for recreation.

Beach Suitability Grades also provide a basis for regulatory requirements and an assessment of compliance with such requirements. Improvements as a result of regulatory actions can be measured as a change in beach classification.

There are five Beach Suitability Grades: Very Good, Good, Fair, Poor and Very Poor. The Beach Suitability Grade for a site is determined by combining a Sanitary Inspection Category and a Microbial Assessment Category, as shown in the framework in Figure 3. More detailed information about determining Beach Suitability Grades is provided in Part 5.

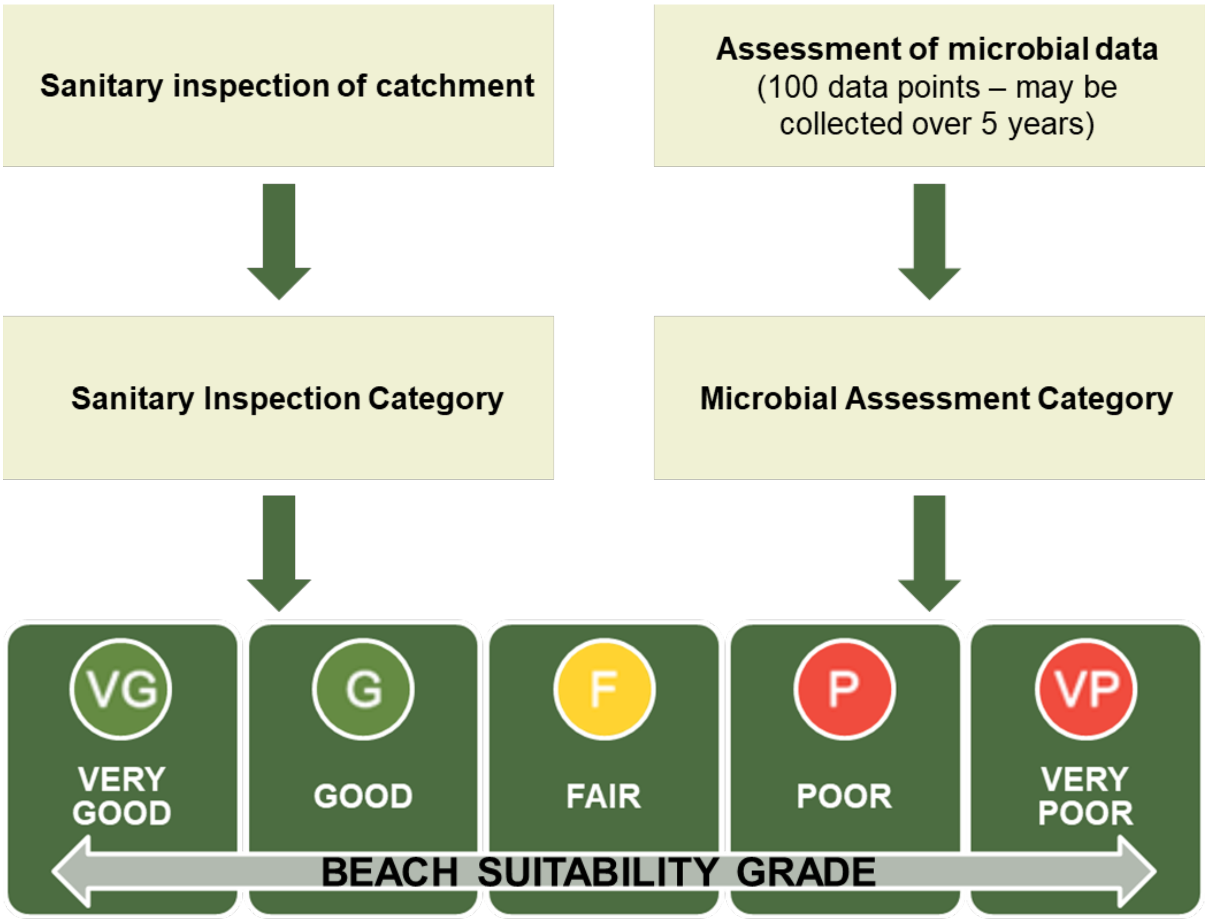

Figure 3 Framework for microbial quality assessment of recreational waters

Sanitary Inspection Category

The Sanitary Inspection Category (SIC) is derived from a sanitary inspection of the beach catchment (see Part 3 for details).

The sanitary inspection identifies all potential sources of faecal contamination at a site, with a focus on human sources. The likelihood of a pollution event occurring at the site is categorised as Very Low, Low, Moderate, High or Very High.

The likelihoods from all identified sources are then added together to give an overall likelihood, which is the SIC.

Microbial Assessment Category

The Microbial Assessment Category (MAC) is determined from the 95th percentile of the last 100 enterococci data points collected at the swimming site (see Part 5 for details).

The category levels, A, B, C or D, relate to risk of illness determined from key epidemiological studies. The MAC provides an indication of the microbial quality at the site based on long-term water quality monitoring.

Part 2: Selecting sites for assessment

The resources needed for comprehensive microbial quality assessment may not always be available. This does not mean the assessment should be neglected altogether. Programs can be tailored to meet specific local needs and available resources. The key to achieving this is to identify and prioritise swimming locations on the basis of their use, importance to the local community, and the potential for pollution to affect the site.

This section describes a priority evaluation and classification system that can assist water resource managers to determine their assessment needs. The approach is based on a qualitative risk assessment that uses readily available information on pollution sources and beach use. Swimming locations can then be graded according to priority (i.e. high, medium or low).

Prioritising beaches provides a basis for determining resource allocation. High priority swimming locations should attract more monitoring and reporting resources to ensure the greatest benefit is obtained.

As the priority evaluation is qualitative and subjective, beach classifications may not be comparable between council areas. If councils or organisations wish to pool resources and collaborate on a monitoring and reporting program, they should go through the priority evaluation process together.

The information generated in this process provides a starting point for Part 3, assigning Sanitary Inspection Categories to the beaches included in the assessment program.

The steps to prioritise sites are shown in Figure 4 and described in detail below.

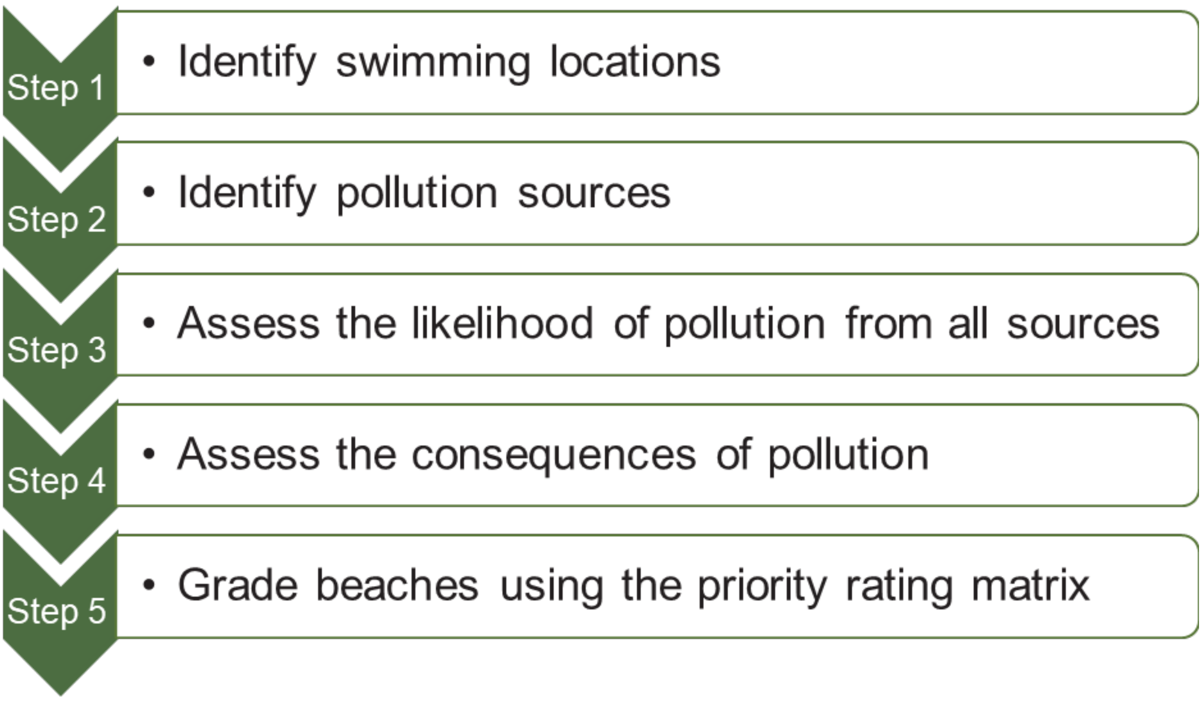

Figure 4 Framework for selecting sites for assessment

Step 1: Identify swimming locations

The first requirement of the priority evaluation process is to list all locations used by the community for swimming or other primary contact recreation activities such as surfing and diving. Areas where swimming is popular include ocean beaches, bays, harbours, estuaries, lagoons, rivers and rockpools.

In many cases there may be more than one swimming location on a beach, bay or river. Factors to consider when identifying locations include the presence of a surf club, the presence of facilities such as toilets, showers and change-rooms, access points to the water such as parks or reserves, the presence of netted swimming enclosures, and areas commonly used by the public, and in particular, small children or the elderly. Also consider other issues of public safety such as the presence of physical hazards.

Briefly describe and map the location. The map can also be used to indicate the location of pollution sources. All sites identified should be considered suitable for promotion as swimming locations by the organisation responsible for their management.

Step 2: Identify pollution sources

Only major pollution sources need to be considered in the priority evaluation:

- wastewater treatment plants (WWTPs, also known as sewage treatment plants)
- stormwater drains, creeks, rivers and lagoons (including overflows from sewerage system infrastructure). Discharges from boats and domestic and wild animals need only be considered when in large numbers.

Step 3: Assess the likelihood of pollution from all sources

The likelihood of contamination is determined as Rare, Possible or Likely according to the following definitions (adapted from *AS/NZS 4360:1999 – Risk Management* (Standards Association of Australia1999)):

- Rare – may occur only in exceptional circumstances
- Possible – might occur at some time; some opportunity, reason or means to occur
- Likely – expected to occur in most circumstances; considerable opportunity, reason and means to occur; regular reported incidents.

Assessing likelihood is a qualitative procedure. It is generally based on knowledge of a local area rather than hard data. Where data exist, they should be used to verify any assumptions made.

The methodology for assessing the likelihood of contamination from each source is outlined below.

Wastewater treatment plants

The likelihood of contamination from WWTPs can be determined using Table 5 as a guide. Information is required about the location of the WWTP outfall, the level of treatment, the frequency of treatment bypasses, and presence of visual indicators of sewage contamination at the beach. Each of these characteristics is described below.

Table 5 Assessment of likelihood for WWTPs

Likelihood	Characteristic		
	Outfall and treatment	**Bypasses**	**Visual indicators**
Rare	• Any outfall with disinfection • Offshore outfall without disinfection	• Occasional wet weather bypass or discharge always via effective outfall	• Never reported
Possible	• Short outfall without disinfection	• Occasional dry weather bypasses and frequent wet weather bypasses	• Occasional reports
Likely	• Direct outfall without disinfection	• Frequent dry and wet weather bypasses (e.g. 10 or more per year)	• Frequent reports

The combination of outfall type and level of treatment will have the greatest impact on the overall likelihood for each source. Where bypasses occur and there is visual evidence of sewage pollution at the beach, the likelihood should be increased to the appropriate category.

As an example, a WWTP that discharges disinfected effluent via a short outfall may initially be given a likelihood of ‘rare’. Frequent wet weather bypasses and occasional reports of visual indicators of sewage on the beach could increase the likelihood to ‘possible’.

Location of the outfall

Locations of WWTP outfalls can be classified as direct, short or long (offshore):

- Direct – outfalls that discharge to the shoreline or directly to a beach
- Short – outfalls that discharge within the intertidal zone, with significant probability that the sewage plume will reach the beach
- Long/offshore – outfalls that are of sufficient length and depth to ensure there is a low probability of the sewage plume reaching the beach.

Level of wastewater treatment

Primary, secondary and tertiary treatment processes remove only a small proportion of pathogens in wastewater. Greater reductions in pathogen numbers can be obtained where a disinfection step is included in the treatment process.

Further details of treatment levels:

- None – no treatment; raw sewage discharged
- Preliminary – screen filtration to remove large solid material
- Primary – physical sedimentation
- Secondary – primary treatment with trickling filter/activated sludge
- Secondary and disinfection – secondary treatment with disinfection
- Tertiary – secondary treatment with coagulation-sand filtration
- Tertiary – tertiary treatment with disinfection
- Lagoons – low-rate biological treatment.

History of wastewater treatment plant bypasses

The frequency of WWTP bypasses and the cause of the bypasses should be noted. The likelihood of contamination may need to be increased where bypasses occur frequently, especially when discharged close to shore (bypassing effective outfalls).

Visible signs of sewage pollution at beach

As part of the evaluation, consider any history of visible signs of sewage pollution on the beach. Visible signs of sewage pollution include grease particles or balls, cotton buds, and sewage-derived litter and plastics. Where these have been frequently recorded by council lifeguards or reported by the community, the likelihood of contamination should be increased accordingly.

Discharges from stormwater drains, creeks, rivers and lagoons

Discharges from stormwater drains, creeks, rivers and lagoons may be a significant source of faecal contamination during, and for several days following, wet weather. These discharges may also contain faecal contamination from sewage overflows and overflows from sewage pumping stations.

Note the locations of all discharge points near the swimming area. The likelihood of contamination from these sources can be determined using Table 6 as a guide. Information is required about catchment development, volume of discharge, existing water quality, and the presence of visual indicators. Each of these characteristics is described below.

Table 6 Assessment of likelihood for discharges into receiving waters

	Characteristic	
Likelihood	**Development and discharge volume**	**Visual indicators**
Rare	• Bushland, any volume	• Minor or only after large or extended wet weather events
Possible	• Rural, low volume • Urban, low volume • Sewage pumping stations present, but rarely overflow	• Significant after moderate rainfall
Likely	• Rural, medium or high volume • Urban, medium or high volume • Sewage overflows occur	• Significant and apparent after most wet weather events

Development within the catchment

Note the extent and type of development within the catchment. Discharges from urban catchments may contain faecal contamination from leaks in the sewerage system, illegal sewer connections to stormwater, sewage overflows, leaking septic tanks and domestic animals. Unless there is evidence to the contrary from comprehensive water quality records, discharges from most urban catchments should be given a rating of ‘likely’.

Discharges from rural catchments may contain faecal contamination if the catchments are used for grazing or intensive animal production. Although most human viruses are unlikely to be found in rural runoff, pathogenic protozoans such as Cryptosporidium and Giardia may be found in large numbers. Abattoirs are likely to be major sources of faecal contamination and should be considered if present. Discharges from bushland catchments are unlikely to contain significant numbers of indicator organisms or pathogens.

Volume of discharge

Estimate the discharge volumes in wet and dry weather in quantitative terms. The size and number of discharge points will need to be considered as part of this process, along with the frequency of discharge. Low-volume discharge may be defined as one or two small creeks or small drains that discharge in wet weather only. Medium-volume discharge may be defined as two or more creeks or drains of varying sizes, some of which discharge in dry weather. Large-volume discharges would include the presence of a large stormwater drain, large creek, river or lagoon that discharges in dry and wet weather.

Existing water quality data

Where stormwater, creek, river or lagoon discharges have been analysed for bacterial indicators, this information can be used in the assessment. Consider the conditions when samples were collected, including wet or dry weather flows, the quality of the data and the level of variability within the data.

Visible signs of stormwater pollution

Visible signs of stormwater pollution include discoloured water and leaves, and twigs and street litter in the water and at the high tide mark. These visual indicators can provide valuable information on the frequency, extent and duration of stormwater impacts. Where possible, relate the extent of the impact to the level of rainfall received (e.g. minor impact after 5 millimetres of rainfall, extensive impact after 20 millimetres of rainfall).

Other sources

Other sources of faecal contamination that may need to be included in the assessment of likelihood are described below.

Boats

These should be considered when large numbers are present in the vicinity of the site for extended periods. Where there is no requirement for vessels to be fitted with effluent holding-tanks, sewage may be released directly into the waterway. If boats are moored or anchored near a swimming location, these discharges may be a source of faecal contamination. Factors to consider when determining a risk rating for this source should include how close the boats are to the swimming location, the number of boats, the type of boats (e.g. houseboats will pose a greater risk than a recreational fishing boat) and for how long they are present.

Domestic and wild animals

These need only be considered when they are present at the site in large numbers. Where dogs are allowed on beaches or near other swimming locations, note the presence of their faeces on the beach. Similarly, note the type and approximate number of birds that frequent the area.

Overall likelihood

The overall likelihood of contamination is determined by considering the overall impact of all identified pollution sources. This can be done by weighting each source (as a percentage) on the basis of its estimated contribution. All weighted likelihoods can then be considered together to determine an overall likelihood of pollution. Give particular importance to WWTP discharges and runoff from urban areas (whether via stormwater drains, creeks, rivers or lagoons).

Examples of likelihood assessments for two hypothetical beaches are provided in Figures 5 and 6. These examples demonstrate how the likelihood from various pollution sources can be weighted to determine an overall risk rating.

Step 4: Assess the consequences of pollution

The health risk posed by a swimming location will depend on its level of use. The consequences of pollution are likely to be greater at a very popular beach where more people are likely to come into contact with pathogens, or at tourist beaches where reports of poor water quality may affect the local economy.

The consequences may also be greater at beaches used by people with weaker immune systems, such as small children or the elderly.

Consequences are rated as minor, moderate or major in accordance with the qualitative definitions below. As with likelihood, consequence is qualitative. The goal of the exercise is to select the category that best suits the importance of the swimming location to the local community.

- Minor – location rarely used on weekdays; location occasionally used on weekends or holidays; few beach users enter the water; location not popular with children or the elderly; of little importance to local economy
- Moderate – location occasionally used on weekdays; location frequently used on weekends or holidays; most beach users enter the water; location often used by children or the elderly; location of some importance to the local economy
- Major – location frequently used on weekdays, weekends and holidays; most beach users enter the water; location very popular with children or the elderly; location of great importance to the local economy.

Step 5: Grade beaches using the priority rating matrix

Each site should be graded as high, medium or low priority using the priority rating matrix in Table 7. This matrix uses the overall likelihood of pollution and consequence.

Table 7 Priority rating matrix for beach monitoring

		Overall likelihood		
		Rare	**Possible**	**Likely**
Consequence	**Minor**	Low priority	Low priority	Medium priority
	Moderate	Low priority	Medium priority	High priority
	Major	Medium priority	High priority	High priority

Source: Adapted from *AS/NZS 4360:1999 – Risk Management* (Standards Association of Australia 1999)

The priority rating provides a valuable insight into the assessment needs of a swimming site. A beach that has been classified as high priority is either of high importance to the community or there is likely to be faecal contamination present, or both. In any case, the high priority rating indicates that resources should be focused on the site.

The need for microbial assessment at beaches that have been classified as medium or low priority is less than for those classified as high priority. Where resources are available after the needs of high priority beaches have been met, the needs of medium and then low priority beaches can be addressed.

Swimming location: Big Basin Beach

Description: About 300 metres long, with a surf club and main swimming area located at centre of the beach. Located near the town centre with a small caravan park at the southern end.

Likelihood of contamination

Potential source	Characteristic	Likelihood
Sewage treatment plant discharges 20% contribution	• Present • Tertiary treatment with disinfection • Effective outfall • Average 1 bypass per 5 years in dry weather • Average 2 bypasses per year in wet weather • No visible sewage pollution recorded	Rare (possible in wet weather)
Stormwater drains 30% contribution	• 5 drains discharge directly to beach • Discharge during wet weather only • No monitoring data • Urban catchment • Unknown frequency of sewage overflows • Visible stormwater pollution for at least 24 hours after rain	Likely in wet weather
Lagoon discharges 50% contribution	• At northern end of beach • Discharge during wet weather only • Monitoring data indicate poor quality lagoon water • Discharges result in water discolouration	Likely in wet weather
Overall likelihood of contamination (select highest)		**LIKELY**

Consequence of contamination

Item	Characteristic	Consequence
Season	October to April	
Use (lifeguard estimates)	• 500–1000 people per day (weekend) • 100–1000 people per weekday (holiday period) • 20–50 people per weekday (non-holiday period)	MODERATE
Importance to economy	Medium	MODERATE
Overall consequence (select highest)		**MODERATE**

Risk rating: HIGH

Figure 5 Example priority evaluation sheet 1

Swimming location: Little Basin Beach

Description: Small, sheltered embayment about 100 metres long. Access by boat (mainly) or through private property (rare).

Likelihood of contamination

Potential source	Characteristic	Likelihood
Sewage treatment plant discharges 50% contribution	• Present • Tertiary treatment (no disinfection) • Short outfall • Average 2 bypasses per year in dry weather • Average 5 bypasses per year in wet weather • Visible sewage pollution occasionally recorded	Possible (likely in wet weather)
Creek discharges 40% contribution	• Southern end of beach • Flows constantly • No monitoring data • Bush catchment, no development • No sewage overflows • No visible stormwater impacts after rain events	Rare
Boats 10% contribution	• Approximately 50 boats just offshore • Weekends only	Possible
Overall likelihood of contamination (select highest)		**POSSIBLE**

Consequence of contamination

Item	Characteristic	Consequence
Season	October to April	
Use (lifeguard estimates)	• ~50 people per day (weekend) • ~50 people per weekday (holiday period) • <5 people per weekday (non-holiday period)	MINOR
Importance to economy	Medium	MINOR
Overall consequence (select highest)		**MINOR**

Risk rating: LOW

Figure 6 Example priority evaluation sheet 2

Part 3: Sanitary inspection

The aim of a sanitary inspection is to identify all sources of faecal contamination that could affect a swimming location and assess the likelihood of contamination from these sources.

The sanitary survey provides an ‘assessment of the susceptibility of an area to direct influence from human faecal contamination’ (WHO 1999, Annapolis Approach). It is a qualitative assessment of bacterial water quality at the site, and should, to some degree, correlate with the bacterial water quality results obtained through sampling.

The knowledge of the catchment, pollution sources and receiving water processes gained from the sanitary inspection provides beach managers with a good foundation for investigating pollution incidents, prioritising and implementing pollution abatement measures and providing sound advice to the community on where and when to swim.

The steps

There are five key steps to a sanitary inspection:

1. Define the swimming area and catchment.
2. Identify sources of faecal contamination and gather information on the frequency, duration and intensity of impact. Information may be sourced from:
    a. desktop study, including, maps, reports and published data
    b. field inspections
    c. reconnaissance surveys
    d. interviews with information holders.
3. Assess likelihood for each identified source of faecal contamination.
4. Determine the Sanitary Inspection Category for the site (overall likelihood).
5. Hold a workshop or meeting with stakeholders to review pollution sources and likelihood assessment.

Resources

Undertaking a sanitary survey can be resource-intensive and time-consuming. Preparation and planning can reduce these impacts by keeping the survey focused, ensuring that only accurate and relevant information is collected and minimising the need for repeat inspections or interviews.

A sanitary inspection report (a paper-based template) has been developed to assist with and standardise the risk classification process. The template is based on those developed by Bree Abbott of Western Australia Department of Health, with some modifications to the risk assessment framework and to reflect conditions in New South Wales.

The report provides a framework for the sanitary inspection and includes sections for:

- site information – type, description, location, map and responsible authority
- site use – activities, number and types of users, lifeguard services and facilities
- inventory of pollution sources and risk assessment of each
- management actions
- total risk calculation.

The sanitary inspection report used and developed by DPIE Beachwatch is in Appendix A. The sanitary inspection report is available as a fillable document on the Beachwatch website.

A sanitary inspection database has been developed to collate and electronically store initial sanitary inspection reports and annual reviews for all swimming sites monitored as part of the Beachwatch and Partnership Programs in New South Wales. The database is a Microsoft Access database.

Step 1: Define the swimming area and catchment

Defining the extent of the swimming area and the catchment provides a focus for data collection (WSAA 2003). A swimming area defined as the area between the flags might only have a subset of the pollution sources that affect the entire beach.

The following information should be collated:

- name of site
- unique site reference number
- site type: ocean, estuarine, freshwater, other
- dimensions of swimming site: length and width
- catchment area and catchment land use
- responsible authority including contact person and contact details
- site address
- GPS coordinates and projection
- site description
- level of tidal flushing
- rainfall impacts
- activities at location: swimming, surfing, water/jet skiing, canoeing/kayaking, fishing, sailing, boating, other
- groups using location: children, elderly, families, tourists
- number of users on weekends, non-holiday weekdays and holiday periods
- off-street car parking
- lifeguard services
- conditions that deter use of the site
- history of illness at the site.

This information can be sourced from maps, historical water quality data, lifeguards, user groups, community representatives, government agencies and reports.

Step 2: Identify pollution sources and gather information

Identify pollution sources

While a sanitary inspection should investigate all sources of faecal pollution affecting a swimming site, emphasis should be given to human sources as these pose the greatest risk to human health (NHMRC 2008; WSAA 2003).

Animal sources of faecal contamination, such as runoff from animal pastures or the presence of aquatic birds, may result in elevated levels of faecal bacteria at a swimming site, but because of the 'species barrier', many of the associated pathogens do not affect human health. However, animal sources should not be ignored as some human pathogens, such as Cryptosporidium parvum, Campylobacter spp. and E. coli are found in animal faeces (WHO 2003).

The main sources of faecal pollution affecting recreational waters are described in Step 3. While this list is extensive, where other, unlisted sources are present at a swimming site these must also be included in the sanitary inspection.

Gather information

A template has been developed to standardise the information gathering process (see Appendix A). The template provides a framework for the sanitary inspection and defines the information required for the assessment of each pollution source. The sanitary inspection report is available as a fillable form on the Beachwatch website.

Sourcing the information to complete the templates can be a considerable challenge. While some information will be readily available, other information will need to be researched. Identifying information sources and holders can be one of the most difficult aspects of the sanitary inspection. Where information does not exist, it will need to be generated.

Desktop study, field inspections, reconnaissance surveys and interviews are the four main sources of information for the sanitary inspection and these are outlined below.

Desktop study

Maps of the catchment area can be a very useful starting point for the sanitary inspection. Maps can show land use, catchment size, presence of creeks, rivers and lagoons, and the location of infrastructure such as sewage/wastewater treatment plants and boating facilities.

Water quality reports can provide information on the impact of rainfall, the frequency and extent of faecal pollution events, bacterial density or load from sources such as stormwater discharges or sewage overflows and the extent of tidal flushing.

Reports on the performance of sewage/wastewater infrastructure may contain information on discharge volumes, treatment levels, the frequency of bypasses, sewage overflows and chokes, and effluent quality.

Field inspections

Field inspections are an important component of sanitary inspections. They are required to:

- verify or ground-truth information obtained through desktop study
- collect a range of unpublished or unavailable information such as number of toilets and showers, GPS coordinates of the site, location and size of stormwater drains, presence of aquatic or native animals, location and number of boats, size of carparks, etc.

Field inspections can be time-consuming and require careful planning to ensure data is obtained in a systematic way.

Reconnaissance surveys

Sampling programs designed to assess the impact of sources of faecal pollution may be required in some instances. These reconnaissance surveys involve collection of water samples upstream and downstream of source input locations, and where possible, sampling of the source itself. In some cases, the source of faecal contamination may be unknown and chemical biomarkers and microbial source tracking parameters can be employed to assist source identification (NHMRC 2008).

Interviews

Information for the sanitary inspection can also be sourced from individuals or organisations with responsibilities or interest in the swimming location. For example:

- lifeguards may hold information on site use including number of visitors and user groups, pollution sources which affect the site and general conditions at the site
- sewage/wastewater system operators or regulators may have information on the sewer system and treatment system, including location and frequency of overflows
- council planners may hold information on the stormwater drainage system, land use, presence of onsite sewage treatment systems, animal exercise areas, location of wastewater re-use areas and a record of complaints or illnesses
- local residents or user groups may also be important sources of information.

As with field inspections, gathering information through interviews can be time-consuming and must be carefully planned. A list of interview questions should be drawn up in advance and reviewed to ensure completeness.

Step 3: Assess likelihood for identified pollution sources

For each identified pollution source, the likelihood of a public health event occurring must be determined. A public health event can be conservatively defined as an occasion when a pollution source could cause enterococci levels in excess of 200 cfu/100 mL[1] at a swimming site.

The likelihood categories are defined as follows:

- Very Low – event occurs only in exceptional circumstances; about once every 10 bathing seasons
- Low – event occurs infrequently; once every five bathing seasons
- Moderate – event occurs occasionally; once or twice each bathing season
- High – event occurs with some regularity; three or four times each bathing season
- Very High – event occurs frequently; several times each month.

An overview of the major sources of faecal contamination and some guidance on assessing likelihood is provided on the following pages and in Appendix A.

The likelihood matrices are not intended to be prescriptive and should be used as a guide only.

Bather shedding

Several studies have found that bathers themselves can be a source of faecal contamination in recreational waters (NHMRC 2008). The effect is greatest at sites where:

- dilution and tidal flushing are low, for example in shallow coastal lakes
- bather density is high (>0.2 people per square metre)
- small children swim or wade at the site, and
- there are no toilet facilities.

Likelihood estimation

The likelihood of contamination from bathers can be estimated from the matrix in Table 8.

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[1] Enterococci are measured in colony forming units per 100 mL of sample (cfu/100 mL).

Table 8 Likelihood matrix for bather shedding

		TOILETS = YES		TOILETS = NO	
		Low bather density	**High bather density**	**Low bather density**	**High bather density**
Flushing	**Low**	Low	Moderate	Low	Moderate
	Medium–High	Very Low	Low	Low	Moderate

Bather density can be calculated as:

$$\text{Bather density} = \frac{\text{Typical number of bathers}}{\text{Area of swimming site in square metres}}$$

Bather density is LOW if less than 0.2 people per square metre.

Bather density is HIGH if greater than 0.2 people per square metre.

A more accurate estimation of the likelihood of bather shedding may be obtained from existing water quality data; for example, if bacterial levels measured at a site during periods of high use are consistently low, this would indicate that bather shedding is not impacting water quality.

Alternatively, if elevated bacterial levels (>200 cfu/100 mL) are measured during periods of high use when other pollution sources are unlikely to be impacting water quality, then the likelihood of bather shedding may be High or Very High. This effect should be confirmed by comparing bacterial levels from a control site (outside of the bathing area) with results from within the bathing area.

Toilet facilities

Leaks from toilet facilities are most likely to be a source of microbial contamination when:

- they are very near to the swimming area (<50 metres)
- they are not connected to the sewer, but rely on onsite treatment
- there has been a history of discharges, leaks or odours
- they are very old and require upgrading
- there are many toilets and showers (high flow)
- they are located at a very popular beach (high use).

Likelihood estimation

The likelihood of contamination from toilet facilities can be estimated from the matrix in Table 9.

Table 9 Likelihood matrix for toilet facilities

		Distant proximity		Close proximity	
		Low use/flow	**High use/flow**	**Low use/flow**	**High use/flow**
Facility condition	**Poor**	Low	Moderate	Moderate	High
	Good	Very Low	Low	Low	Moderate

Close proximity is generally within 50 metres of the swimming site, but also consider the drainage line. Facilities located further away, but in direct line with the swimming site might also be classified as close.

Distant proximity is more than 50 metres away from the swimming site.

Use/flow may vary between weather conditions in accordance with beach use figures.

Facility condition should be described as good where there is no history of leaks, discharges or odours, the facilities are new or have been upgraded.

Facility condition should be described as poor if they have been identified as requiring upgrade or if there has been a history of leaks, discharges or odours.

There may be instances where it is appropriate to classify the likelihood of contamination from toilet facilities as Very High.

Wastewater treatment plant

This potential pollution source considers the regular discharge of effluent from wastewater treatment plants (also known as sewage treatment plants), and the less frequent discharges of untreated effluent (bypasses). When there is a history of treatment bypasses at wastewater treatment plants, the likelihood should be increased to the appropriate category.

a. Discharges from wastewater treatment plants

Discharges from sewage/wastewater treatment plants will have the greatest impact when:

- the outfall is located close to the swimming area
- the level of dilution and dispersion available in the receiving water is low
- the level of treatment at the plant is low
- the volume of effluent discharged is high.

In cases where the effluent is not treated to a high level (secondary or lower), the level of dilution in receiving waters is particularly important when assessing potential impact. The volume of effluent discharged, tidal movement, currents and depth of the receiving water should all be considered.

Likelihood estimation

The likelihood of contamination from sewage/wastewater treatment plant discharges can be estimated from the matrix in Table 10.

Table 10 Likelihood matrix for discharges from wastewater treatment plants

		Outfall type		
		Direct	**Short**	**Long (offshore)**
Treatment level	**None**	Very High	High	Low
	Preliminary	Very High	High	Low
	Primary	Very High	High	Low
	Secondary	High	High	Low
	Secondary + disinfection	Moderate	Moderate	Very Low
	Tertiary	Moderate	Moderate	Very Low
	Tertiary + disinfection	Low	Low	Very Low
	Lagoons	High	High	Low

Source: NHMRC 2008

Refer to Step 3 in Part 2 for definitions of treatment levels and outfall types.

Water quality data from the swimming location or near the ocean outfall may be used to modify the estimated likelihood.

b. Wastewater treatment plant bypasses

On occasion, sewage entering a wastewater treatment plant may not receive full treatment (also known as treatment bypass) before discharging, due to human error, mechanical malfunction or electrical malfunction. As a result, untreated or partially treated effluent will be discharged to the receiving water via the usual outfall or a different discharge point located elsewhere, such as a cliff face outfall. When there is a history of bypasses at wastewater treatment plants, the likelihood should be increased to the appropriate category.

Sewage treatment bypasses will have the greatest impact on recreational waters where the treatment plant:

- bypasses frequently because it is operating close to operational capacity, has no storage capacity and/or is subject to large peaks in flow during wet weather
- uses older technology without backup or warning systems
- is unable to disinfect bypassed effluent.

The level of dilution in receiving waters is important when assessing potential impact. The volume of effluent discharged, tidal movement, currents and depth of the receiving water should all be considered.

Likelihood estimation

The likelihood of contamination from sewage/wastewater treatment plant bypasses can be estimated from Table 11.

Table 11 Likelihood matrix for wastewater treatment plant bypasses

		Wastewater treatment plant bypass frequency (assuming effluent is not disinfected)				
		May occur in exceptional circumstances (1 in 10 years)	**Unlikely to occur but could occur at least once in a 5-year period**	**Might occur at least once or twice per bathing season**	**Will probably occur at least 3–4 times per bathing season**	**Will occur on a regular basis (once a week)**
Dilution (from discharge location)	**High**	Very Low	Very Low	Low	Moderate	High
	Low	Very Low	Low	Moderate	High	Very High

Dilution is high for long outfalls and this classification may also be appropriate for short outfalls where bypass volume is low and flushing is high.

Dilution is low for short and direct outfalls.

If there is no history of bypasses the likelihood of contamination for wastewater treatment plants is determined using Table 10; however, if there is a history of treatment bypasses at the wastewater treatment plant the likelihood is determined by using Table 11.

Designated sewage overflows

Discharges from the sewerage system can occur through designated overflow points and sewage pumping stations. Sewage overflows from these structures can flow directly into recreational waters or enter the stormwater system and then flow to recreational waters.

Sewage overflows generally occur more frequently during wet weather when the flow in the sewer has increased due to rainfall infiltration.

Sewage overflows will have the greatest impact on recreational waters when:

- they are near to the swimming location
- the sewer is old or poorly maintained, with cracks allowing rainwater to enter the pipes and increase flow beyond the design capacity
- the sewer is operating at close to capacity due to increases in serviced population
- the sewer serves a large population.

Likelihood estimation

The likelihood of contamination from sewage overflows can be estimated from Table 12.

Table 12 Likelihood matrix for designated sewage overflows

		Frequency				
		May occur in exceptional circumstances (1 in 10 years)	**Unlikely to occur but could occur at least once in a 5-year period**	**Might occur at least once or twice per bathing season**	**Will probably occur at least 3–4 times per bathing season**	**Will occur on a regular basis (once a week)**
Dilution	**High**	Very Low	Very Low	Low	Moderate	High
	Low	Very Low	Low	Moderate	High	Very High

High dilution occurs when the sewage overflow enters the waterway distant from the swimming location and the waterbody is well-flushed or well-mixed.

Low dilution occurs when the sewage overflow enters the waterway close to the swimming location and the waterbody is poorly flushed or mixed.

Sewer chokes and leaks

Discharges from the sewerage system can occur during dry weather conditions as a result of blockages in the sewer from tree roots or construction debris. These discharges are called chokes. Sewers may also leak sewage through cracks in the pipes or areas where the pipe has been damaged.

Sewer chokes and leaks will have the greatest impact on recreational waters when:

- they are near to the swimming location
- the sewer is operating at close to capacity due to increases in serviced population.

Likelihood estimation

The likelihood of contamination from sewer chokes can be estimated from Table 13.

Table 13 Likelihood matrix for sewer chokes and leaks

		Frequency				
		May occur in exceptional circumstances (1 in 10 years)	Unlikely to occur but could occur at least once in a 5-year period	Might occur at least once or twice per bathing season	Will probably occur at least 3–4 times per bathing season	Will occur on a regular basis (once a week)
Dilution	High	Very Low	Very Low	Low	Moderate	High
	Low	Very Low	Low	Moderate	High	Very High

High dilution occurs when the sewage enters the waterway distant from the swimming location and the waterbody is well-flushed or well-mixed.

Low dilution occurs when the sewage enters the waterway close to the swimming location and the waterbody is poorly flushed or mixed.

Onsite sewage treatment systems

Onsite systems, such as septic tanks, will have the greatest impact on recreational waters when:

- they are incorrectly designed or located
- they are not maintained and/or there are reports of leaks or odours
- there are many systems in the catchment
- the systems are near to the swimming area, particularly if soils are sandy and porous.

Likelihood estimation

The likelihood of contamination from onsite sewage treatment systems can be estimated from Table 14.

Table 14 Likelihood matrix for onsite sewage treatment systems

		Distant proximity		Close proximity	
		<50 systems	>50 systems	<50 systems	>50 systems
Condition	Good – no complaints	Very Low	Very Low	Low	Low
	Poor – history of odours and discharges	Low	Moderate	Moderate	High

Close proximity is generally within 100 metres of the swimming site. Distant proximity is more than 100 metres from the swimming site.

Note that the number of systems relates to household systems, commonly used by 3–4 people. Where a system services many people, such as at a caravan park or public facilities, this should not be considered as a single system, but graded up accordingly.

Wastewater re-use

Wastewater re-use, such as irrigation of treated sewage effluent on grazing land or parks or outside use in residential areas where a dual reticulation system is provided, can be a source of faecal contamination in recreational waters, particularly when:

- wastewater is not treated to a high level before re-use
- the re-use area is near to the swimming site and soils are porous or sandy
- a large volume of effluent is re-used.

Likelihood estimation

The likelihood of contamination from wastewater re-use can be estimated from Table 15.

Table 15 Likelihood matrix for wastewater re-use

		Distant proximity		Close proximity	
		Low volume	**High volume**	**Low volume**	**High volume**
Treatment level	**High – disinfected**	Very Low	Very Low	Low	Low
	Low – not disinfected	Low	Moderate	Moderate	High

Consider how the wastewater is treated before it is re-used.

Stormwater

Stormwater drains will have the greatest impact on recreational waters when:

- discharge volume from the drain is large because the catchment is large and/or the area receives high rainfall
- the catchment is densely populated
- the sewerage system is old and/or poorly maintained
- the drain discharges near the swimming area.

Likelihood estimation

The likelihood of contamination from stormwater drains can be estimated in two ways. It is recommended that the likelihood matrix in Table 16 be employed initially and if adequate water quality data is available, this finding be revised in line with the data analysis results.

Table 16 Likelihood matrix for stormwater

		Discharge area		
		Dune	**Beach, offshore or direct >50 m**	**Direct <50 m**
Land use	**High density urban**	Low	Moderate	High
	Low density urban	Very Low	Low	Moderate
	Rural – grazing	Very Low	Low	Moderate
	Rural – cropping	Very Low	Low	Low
	Bushland/reserve	Very Low	Low	Low

Discharge types:

- Dune discharge – discharges into dune area behind beach and infiltrates to groundwater
- Beach discharge – discharges onto beach and flows over sand with some filtration before entering water
- Offshore discharge – pipe runs offshore to deep water
- Direct discharge >50 metres – discharges directly to swimming area but more than 50 metres from the swimming site
- Direct discharge <50 metres – discharges directly to swimming area within 50 metres of the swimming site.

To test the assumptions in the likelihood matrix, the impact of rainfall on measured water quality at the swimming site should be assessed. It is recommended that at least one year of data be used in the analysis to ensure the less frequent, larger rainfall events are represented. A likelihood classification of Very High may be appropriate in certain instances, particularly if elevated levels of bacteria are often recorded after very low rainfall.

River discharge

Discharge from rivers can be a significant source of faecal contamination to recreational waters, particularly when:

- the volume of river discharge is high because the river catchment is large and/or the region receives high rainfall
- there is significant urban or rural development in the catchment with many sources of faecal contamination impacting river water quality
- the river discharges near to the swimming site with little dilution or dispersion.

Sources of faecal contamination in river discharge may include urban stormwater, leachate from onsite wastewater systems, agricultural runoff, intensive livestock productions and wastewater treatment plants.

Likelihood estimation

The likelihood of contamination from river discharges can be estimated from Table 17.

Table 17 Likelihood matrix for river discharge

		Distant proximity		Close proximity	
		Low discharge volume	**High discharge volume**	**Low discharge volume**	**High discharge volume**
River water quality	**Good**	Very Low	Very Low	Low	Low
	Poor	Low	Moderate	Moderate	High

Some sources of faecal contamination within river discharge may have also been considered as other sources impacting the swim site. If this is the case, adjustments may need to be made to ensure the overall likelihood is not overestimated.

Lagoons

Coastal lagoons/lakes will have the greatest impact on recreational waters when:

- discharge volumes from the lagoon are high due to large catchment area and/or the area receives high rainfall
- the outflow is near to the swimming site
- the lagoon receives urban or agricultural runoff or discharges from the sewerage system.

Many coastal lagoons are only open to the ocean following large wet weather events. Water quality in these lagoons tends to be poor due to the low levels of tidal flushing from clean ocean waters. These lagoons rarely impact recreational waters during dry weather conditions but have significant impacts when the entrance is forced following heavy rainfall.

In some cases, the lagoon entrance (outlet) has been modified and the lagoon is open to the ocean for much of the time. Water quality near the entrance of these lagoons tends to be of higher quality due to tidal flushing; however, discharges can impact recreational waters during dry weather as well as during wet weather conditions.

Likelihood estimation

The likelihood of contamination from lagoons can be estimated using Table 18.

Table 18 Likelihood matrix for lagoons

Likelihood of pollution from lagoons				
Very Low	**Low**	**Moderate**	**High**	**Very High**
May occur only in exceptional circumstances, e.g. 1 in 10 years	Unlikely to occur but could occur at least once within a 5-year period	Might occur at least once or twice per bathing season	Will probably occur at least 3–4 times per bathing season	Will occur on a regular basis, e.g. once a week

Consider the proportion of time the lagoon is open.

Boats

Disposal of human sewage from boats can contribute to faecal contamination in recreational waters, particularly when:

- there are many boats in the vicinity of the site
- boats are not required to have holding-tanks or treat effluent before disposal
- there are no or insufficient pump-out facilities for boats
- there are no onshore toilets.

Likelihood estimation

The likelihood of contamination from boats can be estimated from Table 19.

Table 19 Likelihood matrix for boats

		Number of boats		
		<20 boats	**20–50 boats**	**50–100 boats**
Waste management	**Good (holding-tanks required)**	Very Low	Very Low	Low
	Poor (holding-tanks not required)	Low	Moderate	Moderate

Consider the number of people on the boats. Boats on permanent moorings may be less important if they are not being used.

Animals

Animal faeces can impact on recreational waters, particularly when:

- large numbers of aquatic birds are present at the site
- large numbers of native animals are present at the site
- domestic animals have direct access to the water
- domestic animal exercise areas are not regularly cleaned of animal faeces.

Likelihood estimation

The likelihood of contamination from animals can be estimated using Table 20.

Table 20 Likelihood matrix for animals

Likelihood of pollution from animals				
Very Low	**Low**	**Moderate**	**High**	**Very High**
May occur only in exceptional circumstances, e.g. 1 in 10 years	Unlikely to occur but could occur at least once within a 5-year period	Might occur at least once or twice per bathing season	Will probably occur at least 3–4 times per bathing season	Will occur on a regular basis, e.g. once a week

Step 4: Determine the Sanitary Inspection Category

The Sanitary Inspection Category is the overall likelihood posed by all identified sources of faecal contamination at a site and is categorised as Very Low, Low, Moderate, High or Very High. To determine the overall likelihood, the likelihoods from all pollution sources are added together.

While the likelihood categories are qualitative, they are derived from event frequency, which is a quantitative measure. The values listed in Table 21 can be added together to determine an overall likelihood in accordance with the listed category ranges. The overall likelihood is the Sanitary Inspection Category for the site.

Due to the ‘species barrier’, the likelihood values for animal sources is reduced as many of the associated pathogens do not affect human health.

Table 21 Likelihood values and categories

Likelihood	Event frequency	Value/ Value for animal source	Category range
Very Low	1 in 10 bathing seasons	0.1 / 0.1	<0.2
Low	1 in 5 bathing seasons	0.2 / 0.1	0.2 to <1
Moderate	1 per bathing season	1 / 0.2	1 to <3
High	3 per bathing season	3 / 1	3 to <12
Very High	12 per bathing season	12 / 1	12 or greater

For example: Site A has four identified sources of pollution with associated likelihoods of Very Low, Moderate, Moderate and High. The overall likelihood would be 0.1 + 1 + 1 + 3 = 5.1 = High (range of 3 to <12). The Sanitary Inspection Category is therefore High.

Step 5: Workshop the findings

Once the sanitary inspection is complete, or almost complete, a workshop should be held to review the information, the assumptions made and the risk assessment findings of the sanitary inspection. The workshop may also be used to identify and fill gaps in the information and identify additional sources of faecal pollution.

While the objective of the workshop is to gain consensus on the sanitary inspection report and Sanitary Inspection Category, this may not always be possible. The risk assessment process is subjective and not all participants will necessarily agree on the input information or the findings. Gain consensus as far as possible, adopt a majority view where necessary and document any dissenting views.

The workshop should include representatives from stakeholders such as user groups, environment groups, lifeguards, beach managers, local council, wastewater managers and state government. Where a large number of sanitary surveys need to be reviewed, more than one workshop may be needed.

To ensure the workshop is focused and effective, it should be facilitated by someone with a good understanding of the sanitary inspections under consideration and the risk assessment process. Preliminary sanitary inspection reports should be distributed to all workshop participants in advance.

In cases where the sanitary inspection is simple and includes few sources of pollution, an external review of the sanitary inspection report may be all that is required.

Part 4: Microbial water quality monitoring

Microbial water quality monitoring collects information on levels of faecal contamination over time. This data is used to calculate the Microbial Assessment Category (MAC) which, in conjunction with the Sanitary Inspection Category (SIC), is used to determine the suitability of a swimming site for recreation, also known as the Beach Suitability Grade.

This section outlines the strategy for monitoring recreational water quality and should be implemented until sufficient water quality data have been collected to adequately assess site performance. In most cases this may be for at least three swimming seasons or 100 samples. A provisional MAC can be determined and used in reporting until 100 samples are reached.

Sampling design

Sampling location

Samples for microbial water quality assessment should be collected at locations where swimming occurs. At patrolled beaches, this is likely to be between the flags, so the actual sampling location may move from day to day according to surf conditions.

For unpatrolled beaches and other waterways, select the location where the majority of people swim. Access points to the water and the presence of facilities may provide a good indication of areas most commonly used by swimmers. Identify areas that might be used by small children such as shallow, calm waters with minimal flushing or areas of ponded stormwater, which could contain high levels of faecal contamination.

Samples should be collected at knee depth within the ‘swash zone’ (the area of low waves near the shore). This has two distinct advantages. First, this is the area used by small children. Secondly, sampling near the shore reduces the risk to field samplers, who may have to sample on days when the beach or swimming location is closed because of dangerous conditions.

Sampling frequency

Samples should be collected during the bathing season, or the period the waterbody is used for swimming. In the Sydney region, the season begins on 1 October and ends on 30 April.

The time of day when samples are collected should also be considered. Factors such as tides, winds, waves, pollution inputs and the number of swimmers present can all affect bacterial levels. There is also reported evidence that diurnal UV exposure affects bacterial levels. Where possible, the time of sampling should coincide with the time of highest risk. For example, if a pollution source operates only in the morning, take samples in the morning; if afternoon winds are likely to drive pollution onshore, collect samples in the afternoon.

Where there is unlikely to be a daily pattern in bacterial levels, sampling times should be randomised. This can be achieved by commencing sampling at different times of the day or by varying the order in which locations are sampled.

Sampling on a six-day roster is recommended (although this is not mandatory) as this ensures all days of the week are sampled. The popularity of sites on weekends, the additional cost of weekend sampling, and the availability of laboratories for weekend sample analysis are also important factors to be considered.

To collect the 100 data points needed to calculate the Microbial Assessment Category, samples should initially be collected as frequently as possible over the range of conditions when the site is in use.

Once the 100 data points have been collected and sanitary inspections show no change over several years, the recommended monitoring schedule in Table 22 can be adopted.

Table 22 Recommended monitoring schedule

Sanitary Inspection Category	Monitoring schedule	Frequency of review of sanitary inspection
Very Low or Low	Minimum of five samples per year during swimming season	Annual
Moderate or High	20 samples at regular intervals during the swimming season Additional sampling if abnormal results are found	Annual
Very High	Minimum of five samples per year, but nil if the site is closed to use	Annual

Indicator bacteria

Indicator organisms are used as fundamental monitoring tools for assessing the potential presence of pathogenic organisms. An indicator organism should:

- be easily detectable using simple laboratory tests
- generally, not be present in unpolluted waters
- appear in concentrations that can be correlated with the extent of the contamination
- survive under similar conditions as the pathogens of concern.

NHMRC (2008) advocates the use of enterococci as the single preferred faecal indicator in marine waters. These bacteria are excreted in faeces and are rarely present in unpolluted waters. Enterococci have shown a clear dose–response relationship to disease outcomes in marine waters in the northern hemisphere; however, because of the lack of epidemiological information, it is not known if the same relationship exists under Australian conditions.

Direct detection of pathogens in recreational waters is generally not undertaken due to the difficulty of this analysis. Where reliable laboratory methods exist, they generally require the collection of large volumes of water; analysis is costly, and it can take a week or more to obtain a result. In addition, decisions about how many and which specific pathogens to test for need to be made.

Documentation

Field manual

Comprehensive and accurate documentation of sampling protocols is an essential component of the monitoring program. A field manual should document the procedures used for collecting, labelling, transporting and storing samples; taking field measurements; taking field notes; and the types and numbers of quality control procedures used. The field manual should also contain detailed information on site location, access issues, work, health and safety (WH&S) considerations, contact numbers for the office, laboratory and any other relevant personnel, and copies of field logsheets.

Field logsheets

Field logsheets record the conditions at the time water samples are collected. Field sheets must include date and time of sample collection, name of sampler, sample site names and/or codes. Field logsheets can be paper-based or forms created to use on electronic devices such as tablets and phones.

Important field observations to record include the weather, tides, stormwater, creek or lagoon flows, number of swimmers, surface scum, leaf litter, litter, weed, bluebottles and visual turbidity. Ensure any other observations are noted in the comments section, which may include strong odours, discolouration in the water, or presence of birds or dogs in the vicinity of the sampling location. Consider recording water temperature and conductivity measurements (if you have access to water quality meters).

Ensure field sheet data is stored securely in a database so the information can be referred to later if needed.

Conductivity

Conductivity is the property of a substance that enables it to serve as a channel or medium for electricity. Salty water conducts electricity more readily than purer water. Therefore, electrical conductivity is routinely used to measure salinity. Significant changes in conductivity may indicate that a discharge or some other source of contamination has entered recreational waters.

Each waterbody tends to have a relatively consistent range of electrical conductivity values that, once known, can be used as a baseline against which to compare regular measurements of conductivity. Marine waters have a higher conductivity than freshwater and therefore a reduction in conductivity can indicate freshwater influence from stormwater.

Gradients in conductivity can also be measured from stormwater drains to assess the extent of impact from this pollution source on a specific swimming location.

Chain of custody

It is important to be able to track all samples from collection through to the laboratory. Chain of custody documentation serves this purpose and is recommended. Chain of custody forms can be included on field logsheets or may be a separate form entirely. This will depend on the laboratory's requirements. An example of a chain of custody form is included as part of the field logsheet in Appendix B.

Equipment

The following list of equipment is the minimum required for conducting a sampling run. The required number of specific items such as sample containers, eskies and field sheets will vary depending on the number of sites to be sampled and the number of samples collected at each site for quality control (QC) purposes.

Table 23 Equipment needed for a sampling run

Equipment	Key considerations
Bacterial sample containers	• Sample containers must be sterile. • Re-usable containers can be used and re-sterilised. These bottles must be able to withstand the high-temperature sterilising conditions. • Wide-mouthed glass bottles with screw caps are frequently used, but they can break, causing loss of samples and injury to the sampler. • Sample containers should have a capacity of at least 250 mL. • Consult the laboratory doing the analyses to determine their exact requirements for container type and volume of water.
Labels for sample containers	• Labels are important for sample identification, and should include the name of the site, date collected and other relevant information (check requirements with the laboratory). • Labels should be clean, secure, waterproof and non-smearing. • Labels can be pre-printed (which can reduce time in the field) or handwritten (ensure the pen used is non-smearing). • Ensure the labels do not become detached during storage and transport.
Sterile water	• To use for trip blanks.
Small bucket	• To collect water to measure water temperature, and other variables (e.g. conductivity) if desired.
Esky and ice or ice-bricks	• Esky large enough to store and transport bacterial water samples. • Use ice or ice-bricks (or a refrigerated esky if available) to ensure water samples are kept cool between 2°C and 8°C.
Soft esky bag/clean box	• Pack empty sample containers into a clean box or esky bag.
Sampling pole *(optional)*	• Ensure the sampling pole is suited to holding the sampling containers. • Use the pole when it is difficult or unsafe to access a site by hand, or when you suspect contamination in the water.
Thermometer	• Basic thermometer to monitor the esky temperature during the sampling run.
Personal disinfectant or handwash and sterile gloves	• Disinfect/wash hands and use sterile gloves as required while collecting samples, particularly when you suspect water may be polluted.
Disinfectant spray and paper towel	• Routinely disinfect eskies used for carrying water containers and samples.
Water quality meter *(optional)*	• Water quality meters to measure water temperature and conductivity (plus other parameters if desired). • Water quality instruments (for pH, conductivity and temperature) must be calibrated and used as per the manufacturer's instructions. Correct instrument use and calibration ensures the reliability and credibility of water quality data.
Documentation (field manual and logsheets)	• The field manual and logsheet provide sampling officers with the necessary information for water sampling. • This documentation should be regularly reviewed, and accessible to sampling officers at all times.
First aid kit	• First aid kit should be kept nearby when sampling and be suited to the work environment.
Mobile phone	• Charged mobile phone for work, health and safety.

Equipment	Key considerations
Vehicle	• Access to a vehicle for regular use during the sampling season and suitable for carrying sample equipment and travelling to the sampling locations.
Personal protective equipment (PPE)	• Suitable PPE should be worn to prevent and minimise risks to identified hazards. This may include sun protective clothing such as a hat and long-sleeve shirt, sunscreen and appropriate footwear.

Sampling procedure

Sample collection, storage and transport

At each site, the location, time of sample collection, condition of the waterbody and weather conditions should be noted on the field logsheet. An example of a field logsheet is provided in Appendix B. This information is based on Australian Standard AS2031:2012 (Standards Australia 2012).

The sample container should be labelled with a waterproof, non-smearing label indicating the location and date of sample collection.

Samples for bacterial analysis must be collected using aseptic sampling technique to avoid sample contamination. To do this:

1. Move to the sampling location and try to avoid stirring up bottom material.
2. Remove the lid from the bottle immediately before taking the sample from the pre-determined sample site, no sooner.
3. Avoid contact with the inside of the bottle, the neck of the bottle and inside of the lid.
4. Fill the bottle by plunging it into water, mouth downward, to a depth of 30 centimetres below the surface. If there is a current, position the mouth of bottle into the current. If the water is still, sweep the bottle horizontally through the water.
5. Remove the bottle and tip out a small portion of the sample to allow an air space of 1–2 centimetres.
6. Immediately replace the lid tightly.
7. Place the sample in a chilled esky (using ice, ice-bricks or refrigerated) and position so it cannot fall over or roll around. The sample should be stored or refrigerated at 2–8°C and delivered to the laboratory as soon as possible, ideally within 8 hours. Take care to ensure samples are not immersed in water (from ice melt) in the esky during transport. It is recommended samples are stored for a maximum of 12 hours; however, 18 hours from time of collection is acceptable. The integrity of samples may be compromised if tested more than 18 hours after collection.

When sampling, ensure quality control procedures are in place, including taking blanks (field, trip and duplicates), monitoring esky temperature, and ensuring equipment and the sampler are free from contaminants. See Table 24 for more information.

Important points to remember:

- If there is any doubt about the integrity of a sample, discard it and collect another sample in a new container.
- Samples should be collected from the most frequently used section of the beach, usually within the flagged area or in front of the surf club (if present), so the sample location may move slightly from day to day.

- Do not use sample containers that have chips, cracks, etched surfaces or misshaped or misplaced lids, or if a container is suspected to be contaminated. Sample container closures should be watertight.
- Try to collect water samples for analysis of other parameters in separate containers at the same time and try to avoid stirring up the bottom material.
- Take physical water quality measurements after bacterial samples have been collected. This prevents contamination of bacterial samples.
- Many laboratories will specify a time by which the samples must be delivered to ensure analysis can begin immediately. If you are going to be late, call the laboratory. Samples must be refrigerated upon receipt in the laboratory.
- Ensure the chain of custody procedure is in place. This will ensure the collection, storage, transportation and analysis of water samples can be traced at each stage. The person conducting the sampling must complete the chain of custody form.
- If when sampling you suspect waters are polluted, wash hands, arms and footwear with disinfectant to reduce exposure to potentially harmful bacteria or other micro-organisms.

Reporting suspected algae or pollution incidents

At times samplers may observe or suspect algae or pollution impacting swimming sites while sampling. All potential pollution incidents should be reported to ensure government agencies can respond effectively and efficiently.

If a potential pollution incident is suspected (such as irregular discharge from a stormwater drain to the beach), follow the procedure below:

- Record accurate notes on the sample collection field sheet. The notes should include the suspected pollutant affecting the beach or waterbody, the area affected by the pollutant, the velocity of flow (if applicable), the time of observation and any odour present.
- Call or email the Environment Line on 131 555 and info@environment.nsw.gov.au. Provide them with as much information as possible, including all details that were recorded on the field sheet. Environment Line staff will then forward the details to the relevant authorities to initiate further action if necessary.

If algal bloom is suspected (which may appear as red or brown discolouration in the water, foamy or having a strong odour), follow the procedure below:

- Record accurate notes on the sample collection field sheet. The notes should include a description of the appearance, the area affected by the pollutant, the time of observation and any odour present.
- Call or email the Environment Line on 131 555 and info@environment.nsw.gov.au, and email Water NSW’s Regional Algal Coordinator at RACC@waternsw.com.au. Provide as much information as possible and ideally photos. Environment Line staff will then forward the details to the relevant authorities to initiate further action if necessary. Water NSW usually responds and advises if there have been other algal bloom sightings or if anything else is required.

Sampling for algae or suspected pollution

After reporting suspected algae or pollution in the water, field samplers may need to collect additional water samples for identification. Follow your organisation's policies and procedures as to whether this sampling is undertaken. Consult standard methods relevant to collecting of these samples. Suspected algal blooms or pollution should be reported.

Laboratory analysis

Laboratory accreditation

The analytical laboratory must be of a suitable standard. A good indication whether a laboratory has met a suitable minimum standard is its compliance with Australian Standards 3901, 3902, 3903, 3904, ISO 9000 ISO/IEC 17025 for biological testing accreditation or NATA (National Association of Testing Authorities) accreditation for the relevant analyses performed. Such laboratories have proved their performance to independent assessors and can ensure quality performance for their clients. Carefully assess any variation from recognised standard analysis procedures.

Other considerations

For analyses that must be undertaken within a short timeframe, such as analysis of enterococci, the location of the laboratory is an important factor in the selection process. Ideally, the laboratory should be within two hours' drive of the last sample collection point. If the laboratory is outside this range, consider employing a courier to deliver samples to prevent driver fatigue in samplers.

The working hours of the laboratory must also be considered. As bacterial samples must be processed immediately, many laboratories will require delivery of samples by 4pm or earlier. This may not be practical if there are a large number of sites to be sampled or if the distance from the study area to the laboratory is great. Where later sample delivery times are required, these will need to be negotiated with the laboratory and may incur additional cost.

The laboratory's opening days will affect not only whether samples can be collected and submitted on the weekend, but also whether they can be collected later in the week. As the process for bacterial analysis takes several days, analysis of samples collected on Thursday or Friday will need to be completed on the weekend. If a laboratory is closed on weekends, sampling is usually restricted to Monday, Tuesday or Wednesday.

Methods

Enterococci density should be analysed by using the membrane filtration method in accordance with Australian/New Zealand Standards (AS/NZS 4276.9:2007) or another NATA accredited method suited to intestinal enterococci analysis. This method does not require a confirmation step (unless the plate is crowded) and results are available within 26 hours. Where the standard method is modified or another standard used, evidence is needed that similar results can be obtained.

The detection limits for samples submitted for bacterial analysis will vary, and appropriate limits will need to be decided on. As a guide, the DPIE Beachwatch program requires that original analyses are able to detect between 1 and 10,000 cfu/100 mL, and that retest analyses are able to detect between 1 and 1,000,000 cfu/100 mL.

Quality control and quality assurance

Microbial water quality programs should include several quality control procedures and quality assurance checks during the sampling, laboratory analysis and data management phases of water quality monitoring programs. These are put in place to ensure a high level of reliability and accuracy in the data, and the overall integrity of the program. The definitions for quality control and quality assurance are:

- Quality control – devising and implementing safeguards to minimise corruption of data. These safeguards are required at every step of the process to ensure the data collected are valid
- Quality assurance – tests to check the effectiveness of these safeguards.

Sampling

Quality control and quality assurance should be implemented at all stages of sampling, from the preparation of sampling equipment, collecting of water samples and the storage and transport of samples to the laboratory (Table 24).

Blank or control samples are commonly used as a quality assurance measure to check samples are not contaminated during the sampling process. Water quality programs may use all or some of these depending on their program's set-up. Types of blanks samples are:

- Container blanks – These are used to detect contamination from the container. Sample containers are randomly selected and filled with sterilised water. The sample is analysed and should return a zero value for enterococci. If sample containers are re-usable, it is likely the laboratory has a similar process in place to check sample containers are sterilised.
- Field blanks – These will detect contamination by the sampler. The field blank is prepared in the field. Sterilised water is taken into the field and the sample container is filled, handled and stored as if it were a real sample.
- Trip blanks – These are collected on each sampling run and can be used to assessed cross-contamination of samples during storage and transport. Sample containers are filled with sterilised water, taken into the field, and stored and transported as if they are a real sample.

Regular field audits of sampling procedures are recommended to ensure samples are collected in line with procedures (which should be outlined in a field manual). To do this, a field sampler is observed collecting samples at several monitored sites. The audit assesses field sampling techniques (sample collection, sample handling and field observations) and competency. Where necessary, guidance should be given to correct any areas that might compromise sample or data integrity.

Laboratory analysis

The objective of quality control and quality assurance in a laboratory is to minimise errors that may occur during analysis and reporting and thus ensure that data are accurate and reliable (refer to Table 24).

A system of tracing results is part of good laboratory practice and an essential requirement for accreditation. For each analysis, the laboratory should keep records of the samples analysed, the person doing the analysis, the equipment used, original data and calculations, any manual data transfers, and standards preparation.

Quality assurance of laboratory results can be achieved through a range of measures. For bacterial analyses, laboratories commonly use interlaboratory comparisons and duplicate samples:

- Interlaboratory comparisons – These are a form of proficiency testing. Replicate samples are sent to the regularly used laboratory and to two or more additional laboratories. The results from all laboratories are combined to generate a consensus mean. The results from the regularly used laboratory are then compared against this value to determine the accuracy of its results. Although the consensus mean is not necessarily the true value, the more laboratories that are included in the program, the less the consensus mean will be affected by outlying values.
- Duplicate samples – These are used for assessing laboratory precision. At least 5% of samples should be analysed in duplicate. Duplicate samples are obtained by collecting a sample in a sterilised one-litre container, shaking vigorously for 1 minute to homogenise the sample, and then decanting this into two sterile sampling containers. The analysis of duplicate samples is standard procedure in laboratories. Due to the variability of bacterial levels in environmental samples, duplicate samples within a halving or doubling of density of each other (equivalent to 0.3 log-units) are considered acceptable.

Data management

Data management is crucial to reporting reliable information to stakeholders and the community. Data includes any information collected, such as field observations recorded on logsheets and results received from the laboratory. Examples of quality control measures are detailed in Table 24.

Clear and detailed procedure documents for managing data should include step-by-step instructions for data entry, screening, importing and archiving, and the mandatory quality assurance checks. The procedures should also outline the process for dealing with data that are below the detection limit or are considered not to be of high quality.

Laboratory reports should include the name and address of the laboratory, tabulated samples and analysis data, identification of analytical methods used, date of analysis, name of the technician, and a quality assurance statement. Check laboratory results to identify any anomalous data, such as unexpectedly high or low results. Cross-check the field sheets to identify any reason for the result; for example, discharges to the beach or pollution evident in the water. If the result cannot be explained, ask for a retest of the sample. So that retests can be done, the laboratory should store residual sample waters at 4°C for seven days after results have been provided. For bacterial analyses, test membranes and plates should also be stored at 4°C for two days after the results have been issued.

Quality assurance results (such as container blanks, field blanks, trip blanks and duplicates) should be regularly reviewed to identify and rectify problems quickly, if they occur. These results should be stored in a database.

Table 24 Quality control and quality assurance procedures for microbial water quality programs

Step	Quality control	Quality assurance
Equipment preparation	• Clean sampling containers in accordance with laboratory and standard procedures. • Discard cracked, discoloured or damaged sample containers. • Store sample containers in a clean and dry environment. • Clean eskies regularly using disinfectant.	• Collect a container blank for one in every 10 containers.

Step	Quality control	Quality assurance
Sample collection and field notes	• Provide training in sampling technique and procedure. • Provide a field manual that clearly marks site locations and sampling procedures. • Use a field logsheet to record field notes. • Include a signoff point on each field logsheet to promote double-checking of completeness and accuracy.	• Collect a field blank for one in every 10 samples collected. • Do a regular field audit of sampling procedures.
Storage and transport	• Include methods of sample preservation in the field manual. • Store samples in an esky and kept chilled at 2–8°C (using ice, ice-bricks or refrigerated) after collection. Ensure samples are not immersed in melted ice water. • Transport samples to the laboratory for analysis within 18 hours, and preferably within 8 hours.	• Collect a trip blank on each sampling run. • Monitor and record esky temperature during the sampling run to ensure samples are kept within the required temperature range.
Laboratory analysis	• Submit samples with appropriate documentation (field logsheet, chain of custody) in accordance with laboratory procedures. • Ensure the laboratory meets essential requirements for accreditation, or keeps records of samples analysed, the person doing the analysis, equipment used, original data and calculations and standards preparation to enable effective tracing of results. • Ensure laboratory staff are competent in the analysis of water samples for enterococci.	• Laboratory participates in regular accredited proficiency testing programs, or other similar programs such as interlaboratory comparisons. • Collect a duplicate sample on each sampling run. •
Data management	• Develop a procedure manual and provide training for managing data. • Check laboratory reports for anomalous data and follow up when required. • Store data in a central location to avoid multiple datasets. • Restrict user access to the database. • Ensure data are double-checked by another person. • Ensure the database is secure and backed up periodically to prevent data loss.	• Complete regular data checks of the database to identify any anomalies • Evaluate blank samples (container, field, trip, duplicates) for unexpected results and follow up when required. • Check the performance of the NATA accredited laboratory or interlaboratory comparison program, and follow up if needed.

Work health and safety

Work health and safety (WHS) is a major issue that needs to be carefully considered when you are implementing any water quality monitoring program.

All employers should consult with their employees on health, safety and welfare matters. The following information is a guide to some of the hazards that may be encountered while sampling and some of the ways in which risk can be controlled.

Identifying hazards

A hazard is a source of potential harm or a situation with potential to cause loss or injury. Hazards or risks involved with field sampling should be assessed by the field staff and their managers and fully documented. Hazards that may be encountered in a program for monitoring recreational water quality are likely to include, but are not limited to, those listed in Table 25.

In addition, staff undertaking sampling should be physically and mentally able to do field work. Training is an essential risk management strategy and should cover environmental hazards, sampling protocols, use of equipment, safety procedures, first aid and use of vehicles.

Risk minimisation plans, job safety analyses or safe work method statements

Once all hazards have been identified, field officers and their managers should develop a risk minimisation plan. Ideally, risks should be eliminated. If this is not reasonably practicable, risks must be controlled by implementing measures to lessen the risk of harm to the lowest possible level. Examples of risk minimisation measures for various hazards are provided in Table 25.

Once appropriate risk minimisation measures have been identified they should be documented in a job safety analysis (JSA), also called a safe work method statement (SWMS). These should be reviewed on a routine basis (e.g. annually) or schedule, to ensure the plan is being implemented and any deficiencies are identified and addressed in a timely manner.

Table 25 Risk minimisation measures for identified hazards

Hazard	Risk minimisation measures
Motor vehicle accidents	Advanced driver training; regular breaks to avoid fatigue; maintaining vehicles in good order at all times, procedure for reporting and repairing defects promptly; reporting all traffic infringements to manager for identification of repeat offenders; reading organisation’s motor vehicle user’s handbook.
Exposure to elements (UV, cold)	Provision of PPE such as sunscreen, broad-brimmed hats, collared shirts, sunglasses, wetsuits for winter and rain jackets for wet weather; vehicles air-conditioned and heated; showers provided; officers encouraged to undergo skin cancer checks each year.
Foot injury (cuts, needle stick)	Provision of PPE such as booties or thick-soled rubber sandals.
Contact with viral pathogens	Training to identify water that may be affected by sewage or stormwater; provision of PPE such as gloves or antibacterial handwash; sample collection by sample pole in contaminated waters; recommendations for hepatitis vaccinations.

Hazard	Risk minimisation measures
Injuries from carrying esky	Ensuring eskies are in good condition with secure handles; training in manual handling; field officers encouraged to seek assistance in unloading and carrying eskies.
Working in remote areas	Field officers to work in pairs; carry mobile phones or radios where coverage is poor; establish check-in procedures.
Dangerous surf conditions, drowning	Encourage officers to check in with local lifeguard before entering water; collect samples at knee depth; training of officers in surf awareness; sample collection by sample pole in rough or deep waters.

Resource and planning issues

Experience shows that resource requirements are often underestimated. When planning the monitoring program, consider how long the sampling run will take to complete; the frequency, number and type of samples collected; as well as time and resources needed for data entry, data analysis and reporting.

Part 5: Microbial assessment and beach classification

Beach Suitability Grades provide the primary means to assess suitability of a swimming location for recreation over time and are based on a combination of sanitary inspection (identification and rating of potential pollution sources at a beach) and water quality measurements gathered over previous years. This section describes how to calculate the Microbial Assessment Category, assign a Beach Suitability Grade and provides information on interpretation of the grades.

Microbial Assessment Categories

The Microbial Assessment Category is determined from the 95th percentile of a dataset of at least 100 data points. The four categories (A to D) relate to levels of risk of illness determined from key epidemiological studies (Table 26).

The NHMRC recommends Microbial Assessment Categories be calculated from a rolling five-year dataset, with at least 20 samples collected each year.

The threshold enterococci levels for each of the four Microbial Assessment Categories were determined by the World Health Organization from a dose–response relationship applied to enterococci data collected at swimming locations across Europe. These thresholds will represent different levels of illness if the distribution of enterococci data from swimming locations in New South Wales differs from the European distribution.

In recognition of this problem Dr Richard Lugg (WA Department Health) has developed Enterotester, a Microsoft Excel® tool for calculating a modified 95th percentile that takes into account differences in distribution of the data in Australian conditions. The Enterotester template with instructions is available for download from the WA Health Environmental waters publications webpage.

Table 26 Microbial Assessment Categories

Category	95th %ile of enterococci (cfu/100 mL)	Basis of derivation	Estimation of probability
A	≤40	No illness seen in most epidemiological studies	GI* illness risk: <1% AFRI** risk: <0.3%
B	40–200	Upper threshold is above the threshold of illness transmission reported in most studies	GI illness risk: 1–5% AFRI risk: 0.3–1.9%
C	201–500	Represents a substantial elevation in the probability of adverse health outcomes	GI illness risk: 5–10% AFRI risk: 1.9–3.9%
D	>500	Above this level there may be significant risk of high levels of illness transmission	GI illness risk: >10% AFRI risk: >3.9%

* GI = gastrointestinal ** AFRI = acute febrile respiratory illness

Source: NHMRC 2008

Determination of Beach Suitability Grades

Swimming locations are graded from Very Good to Very Poor according to the beach classification matrix, using the Sanitary Inspection Category and Microbial Assessment

Category (Table 27). Where information from the sanitary survey and water quality sampling do not correlate, 'follow up' is indicated and requires a review of both the sanitary survey and water quality data.

Table 27 Beach Suitability Grade matrix

		Microbial Assessment Category (MAC)			
		A (≤40)	**B (41–200)**	**C (201–500)**	**D (>500)**
Sanitary Inspection Category (SIC)	**Very Low**	Very Good	Very Good	Follow up	Follow up
	Low	Very Good	Good	Follow up	Follow up
	Moderate	Good	Good	Poor	Poor
	High	Good	Fair	Poor	Very Poor
	Very High	Follow up	Fair	Poor	Very Poor

Explanation of grades

The beach grades are a long-term assessment of the susceptibility of a site to faecal pollution. They are based on long-term water quality monitoring data and reflect the poorest water quality measured during the period rather than the average water quality.

The classifications do not represent water quality on a particular day. A beach may be graded as Poor but still be suitable for swimming for a good proportion of the time. The explanations include advice on when to swim and when swimming should be avoided. The five Beach Suitability Grades are described in Table 28.

Table 28 Beach suitability descriptions

Beach Suitability Grade	Description
Very Good	Site has generally excellent microbial water quality and very few potential sources of faecal pollution. Water is considered suitable for swimming almost all of the time.
Good	Location has generally good microbial water quality and water is considered suitable for swimming most of the time. Swimming should be avoided during and for up to one day following heavy rain at ocean beaches and for up to three days at estuarine sites.
Fair	Microbial water quality is generally suitable for swimming, but because of the presence of significant sources of faecal contamination, extra care should be taken to avoid swimming during and for up to three days following rainfall or if there are signs of pollution such as discoloured water, odour or debris in the water.
Poor	Location is susceptible to faecal pollution and microbial water quality is not always suitable for swimming. During dry weather conditions ensure the swimming location is free of signs of pollution, such as discoloured water, odour or debris in the water, and avoid swimming at all times during and for up to three days following rainfall.
Very Poor	Location is very susceptible to faecal pollution and microbial water quality may often be unsuitable for swimming. It is generally recommended to avoid swimming at these sites

Provisional beach grades

There will be occasions when there is a need to issue advice on the classification of a recreational water environment even though the information required for calculating the Beach Suitability Grade is incomplete. This may occur where:

- there are no microbial water quality data available or no information on risks of faecal contamination (e.g. new developments)
- the data available for the microbial water quality assessment, the sanitary inspection, or both, are incomplete
- there is reason to believe the existing classification no longer accords with changed circumstances, but the data required for completing classification are insufficient.

In these circumstances it may be necessary to issue a provisional classification. It should be made clear that the advice is provisional and subject to change. A provisional classification should be time limited and there should be a commitment to obtaining the necessary data to provide a definitive classification as soon as possible.

Modifying a beach grade

Beach grades may be modified where management interventions can be demonstrated to effectively discourage recreational use during occasional and predictable contamination events such as wet weather conditions; for example, when a swimming location is closed to the public during rainfall events and the closure is enforced.

The modified grade should reflect the water quality conditions to which the public are usually exposed, in this case in dry weather conditions.

Data analysis

Weekly assessment

Weekly assessment of microbial water quality is useful as an early indication of when and where further investigation may be required. Unexpected elevated results can be used to trigger appropriate management actions to reduce risk to public health. Further information on trigger levels is provided in Part 7.

Weekly assessment of enterococci results also allows for regular reporting to the community. The information can be reported as a star rating on websites or in local papers, which are easily accessed by the community. Beaches can be graded from one star to four stars on a weekly basis using the most recent microbial result. Methods for calculating star ratings are provided in Part 6.

A limitation of weekly assessments is the small number of data (single data point for each location) available for interpretation.

Annual assessment

The Beach Suitability Grade is determined annually. Each year, the sanitary inspection must be reviewed, with the Sanitary Inspection Category updated to reflect any changes in pollution sources or their likelihood, and the Microbial Assessment Category recalculated from the most recent 100 enterococci data points.

Part 6: Reporting

Reporting and information dissemination are important tools for managing risks in recreational waters. They are essential for raising community awareness and increasing understanding of the potential pollution sources and health risks associated with recreational water use.

Beach managers should aim to provide beach users with general advice on beach water quality, in conjunction with annual classifications. This information facilitates informed decisions about where and when to swim and greatly reduces risks to public health.

Daily predictions and weekly star ratings can also be developed to provide the community with more immediate indications of beach water quality. While these are not mandatory, they are effective tools to support general advice and beach classification.

Reports on microbial water quality should be kept as simple as possible and results presented in clear and easy-to-interpret formats. Care should be exercised when interpreting data and clearly state whether the NHMRC (2008) guidelines on recreational water quality were followed.

This section outlines ways to report recreational water quality and how to develop a communication plan.

Annual classifications

The minimum level of reporting required by the NHMRC 2008 guidelines is an annual Beach Suitability Grade (see Part 5).

For councils participating in the Beachwatch Partnership Program, this information is reported in the State of the Beaches report issued after 1 October each year. This information can also be released as a press release at the start of the following swimming season or holiday period, as well as displayed on signs at the beach, on websites or in a flyer with rates notices.

The beach classifications include general information that can assist the general public to determine when it is safe to swim (Table 29), and this information should also be included when reporting the beach classifications to the community.

Table 29 General advice for each beach classification

Classification	Advice
Very Good	Water is considered suitable for swimming almost all of the time
Good	Water is considered suitable for swimming most of the time. Swimming should be avoided during and for up to one day following heavy rain at ocean beaches and up to three days at estuarine sites
Fair	Water is generally suitable for swimming. Avoid swimming during and for up to three days following rainfall or if there are signs of pollution such as discoloured water or odour or debris in the water
Poor	Water is not always suitable for swimming. Avoid swimming at all times during and for up to three days following rainfall or if there are signs of pollution such as discoloured water, fast flowing or strong-smelling drains or street litter floating in the water or on the tide line
Very Poor	Water is often unsuitable for swimming. Avoid swimming at all times

General advice can also relate to certain situations that may increase the likelihood of pollution at the swimming site:

- Avoid swimming if the lagoon is open.
- Avoid swimming if there is discoloured water, fast flowing or strong-smelling drains or street litter floating in the water or on the tide line.

Weekly star ratings

Star ratings allow more frequent reporting of water quality results than a single report at the end of the bathing season and require fewer resources for production than daily bulletins. The ratings provide the community with an assessment of water quality each week and can be reported in local newspapers and/or on websites.

Star ratings are based on a single enterococci data point from the most recent sampling occasion. To allow the star ratings to be updated each week, samples must be collected at a minimum frequency of once per week.

The star rating categories are derived from the Microbial Assessment Categories used in the NHMRC (2008) guidelines. Beaches are graded from one to four stars according to Table 30.

Table 30 Star rating categories

Rating	Enterococci (cfu/100 mL) category	Description
★★★★	≤40	Good
★★★	41–200	Fair
★★	201–500	Poor
★	>500	Bad

Calculating star ratings

Each beach is assigned a star rating based on the enterococci result from the latest sampling run; for example, a beach with a result of 51 cfu/100 mL would fall into the '41–200' enterococci category and be assigned three stars and a 'Fair' rating.

A 'Good' rating indicates bacterial levels are generally safe for bathing according to National Health & Medical Research Council guidelines.

A 'Fair' rating indicates an increased risk of illness to bathers, particularly those with lower immune function such as the elderly and young children.

'Poor' and 'Bad' ratings indicate bacterial levels pose a substantially increased risk of illness to bathers.

Reporting star ratings

Star ratings can be reported in tables or on maps of the region. It is important to include the date of sampling, recent rainfall in the area, as well as general advisories such as to avoid swimming during and for at least one day after heavy rain and if there are signs of stormwater pollution. A contact number should also be provided for further enquiries. This information can be presented on a website or in local papers.

For councils participating in the Beachwatch Partnership Program, star ratings can be calculated by Beachwatch and presented on the Beachwatch website.

Advisories

A limitation with the use of bacterial indicators is that results are not available for up to 48 hours after sampling. During this time, bathers may be exposed to pathogens. To reduce the risk to public health, beach users need to be notified when pathogens may be present in recreational waters and tools are needed that provide a quick, reliable and conservative estimate of the level of faecal contamination.

Rainfall is the major driver of poor water quality generating stormwater runoff and triggering discharges from the sewerage system. Water quality at each beach has a different response to rainfall depending on the catchment area, the extent and stage of development, and the condition of the sewerage system. In general, faecal contamination increases with increasing rainfall, but some beaches appear to reach a rainfall threshold above which faecal contamination rises rapidly, whereas others exhibit an apparent log-linear response. Others appear to be largely unaffected by rainfall.

Advisories are a useful tool and can be developed once there is sufficient data to analyse the relationship between rainfall and bacterial levels. These include:

- advisory statements about when water quality is usually safe or unsafe for swimming
- daily beach pollution forecasts to provide beach users with ‘real time’ predictions on the likelihood of pollution at a beach. In exceptional circumstances beach managers can use this information to close beaches and minimise the risk to public health.

Advisory statements

The relationship between rainfall and bacterial levels can be used to generate advisory statements by determining the minimum amount of rainfall that causes elevated bacterial levels at a swimming site. This information can inform general statements about water quality and when it is not suitable to swim, such as:

- Water quality at ocean beaches can be impacted during and for up to 24 hours after rainfall.
- Avoid swimming after, during and for up to one day after heavy rain at ocean beaches.
- Swimming is not recommended during and for up to 3 days at estuarine swimming locations, due to the possibility of pollution.
- As a precaution, it is recommended swimming at lake and lagoon swimming sites is avoided during and for up to three days after rainfall, due to the possibility of pollution.

Daily beach pollution forecasts

Beach pollution can be predicted using a rainfall-based model derived from a statistical relationship between the amount of rainfall at representative rainfall gauges in a catchment and the bacterial levels measured at a swimming location. Although the model does not specifically account for pollution sources, the fate of pollutants or transport processes, these factors are indirectly included within the statistical relationship.

By modelling the data, the site-specific rainfall threshold (the amount of rain required to trigger poor water quality), and the recovery time (the amount of time for bacterial water quality to return to safe swimming levels) are determined. This information can then be applied to predict the expected water quality based on recent rainfall.

The model should be updated in response to changes in pollution sources; for example, where remediation actions have reduced the level of faecal contamination contributed by several large stormwater drains, the relationship between rainfall and bacterial levels is likely to be altered.

Although predictive models are effective tools for supplementing actual sampling, it is important to remember that models do not provide perfect predictions of actual conditions, only estimates of current conditions based on what has happened in the past.

Developing a communication plan

Audience identification

The potential target audience for information on beach water quality must be identified and characterised. The characteristics of beach users will define the mode of communication you select; for example, a sign posted at a beach entrance may be suitable if most beach users live locally, whereas an additional message on a website or telephone line may be necessary where the beach is used by those living farther away.

A survey of the public is a useful means of identifying the audience and gaining an understanding of public behaviour, knowledge, beliefs and the sources people use to obtain information.

Methods of communication

The method of communication chosen will largely depend on the needs of the target audience and the objectives of the monitoring program. The methods most commonly used are beach signs, the mass media, websites, reports and social media.

Beach signs

Signs are an effective way to communicate advice to the community on when not to swim. A permanent sign displaying the advice can be erected at the access points to the beach. Alternatively, lifeguards can erect temporary signs warning of pollution on particular days or can close the beach if necessary.

Signs should be simple and consistent throughout the council area. They should also be large enough to be noticed, legible and easily understood. Graphics and bright colours such as red or yellow are a good way to get attention. There may be legal implications in using some beach signs. Seek legal advice for specific signs and locations.

Mass media

Newspapers, television and radio are effective means for communicating that swimming is not advisable. These forms of communication enable you to provide more detailed information to the public than a sign at a beach; for example, you can provide information for more than one beach and explain the reason for the warning or beach closure.

Notifying the public through mass media targets a larger audience than a sign at a beach. It also has the advantage of advising the community before they arrive at the beach and can be updated regularly. A media release at the beginning of the swimming season is a good way to advise the community that water quality assessment is being undertaken and how they may access the information. Similarly, a media release at the start of the holiday period may be used to advise the local community, tourists and other visitors about beach suitability.

Websites

Providing beach water quality information on the council's website is a good way to reach many people in the community. This medium can be used to present information on beach classifications, general warnings on when it is not advisable to swim, and daily predictions of water quality.

The contents of the website can also include sampling results, maps of the area, information on the monitoring program, photographs of the beach, contact numbers for reporting pollution incidents or inquiries, information on how the community can help reduce levels of pollution at their beach, and promotion of council actions to improve water quality.

View the Beachwatch website as an example of online communication.

Technical reports

Technical reports provide comprehensive information to the community and can include details of the monitoring program, site locations, findings from the sanitary inspections, Microbial Assessment Categories, the impact of rainfall or pollution sources on water quality, and any remediation works undertaken or planned at the site.

Annual reports

Beachwatch publishes the annual State of the Beaches report at the start of the summer swimming season in October each year. The report summarises Beachwatch activities over the previous year and the water quality at all monitored swimming sites in New South Wales. All reports are made available on the Beachwatch website.

Social media

Social media can be an effective tool to communicate and engage with the community. Water quality information can be rapidly updated, particularly in response to pollution incidents, with little effort by beach managers. Channels such as Twitter, Facebook and Instagram can be easily accessed on mobile devices ensuring any updates on beach water quality are readily available.

Evaluation of your communication plan

Evaluate your communication plan regularly to ensure it meets the needs of the public and the objectives of the council. Perform a summary evaluation at the end of the swimming season or holiday period.

A survey of the community and tourists could include questions on their knowledge of the health risks associated with swimming in contaminated water, recollection of advice, awareness of websites, and their level of media use and preferred media for communication.

Part 7: Management

Management actions

Management of risks from microbial contamination is a critical component of the NHMRC 2008 guidelines. Ideally, identified risks should be eliminated entirely; however, this is rarely ever possible, and most management actions focus on reducing the risk. Risk can be reduced in two ways:

- reduce the likelihood of a public health event occurring
- reduce the consequence of the public health event.

In many cases, a combination of both approaches can be used.

Actions to reduce likelihood

Pollution abatement actions aim to contain or reduce the release of sewage or faecal contamination into the environment and include:

- relining sewers and stormwater pipes, fixing sewage pumping stations and reducing sewer inputs to reduce the potential for overflows, such as by re-using wastewater
- using sewage retention tanks or tunnels that discharge during periods when water is not being used recreationally or that act as buffers during storms by retaining sewage for future treatment (these are costly and may be impractical for large urban areas, but examples exist, such as the Northside storage tunnel in Sydney)
- transporting sewage to locations distant from recreational areas via piped collection systems or effective outfalls, and
- disinfection (ozone, chlorine, peracetic acid or UVR), which may not be effective against all hazards.

Many of the above actions require major capital expenditure and may not be readily justifiable, especially in rural communities where the cost is borne by a smaller population. Sources requiring pollution abatement measures can be prioritised according to likelihood, with resources focused on sources rated as Very Likely or Likely.

In some cases, elevated bacterial levels will be measured during routine monitoring and the source will be unknown. Inputs may come from human sewage, farm animals, native birds and animals or domestic pets. Understanding the origin of faecal pollution is essential in assessing associated health risks as well as the actions necessary to remedy the problem. Microbial source tracking (MST) techniques have been developed over the last decade to identify the sources and origins of faecal pollution. Some of these procedures are simple and can be done in situ, while others are more complex, requiring specialist laboratory techniques.

Technical reports describing MST in NSW coastal habitats are available on the Environment, Energy and Science Water quality investigation webpage.

Actions to reduce consequence

The impact of a faecal contamination incident can be greatly reduced by restricting public use of the site during the period of increased risk.

Beach closures

Council lifeguards routinely close beaches in response to dangerous surf conditions and may also do so when water pollution is clearly visible; for example, when there are grease balls on the sand, turbid stormwater or lagoon discharges or extensive surface scum or slicks. Beach closures may also be initiated as part of an incident response procedure.

It is recommended that swimming locations rated as Very Poor be permanently closed (NHMRC 2008).

Informed personal choice

Reporting of Beach Suitability Grades and other water quality information enables the community to make informed personal choices about where and when to swim.

Daily advisories provide an assessment of the likelihood of faecal contamination at a swimming location and can be used to warn the community about periods of increased risk, such as following rainfall. These can be placed on websites, sent as RSS feeds, posted on social media, recorded on telephone information lines, issued by local radio or posted on signs at beach entrance points or on surf club notice boards.

Weekly star ratings provide regular reports on water quality and raise the community's awareness about when to avoid swimming. These can be placed on websites, advertised in the local press or posted on signs and noticeboards at the beach.

Media releases can be issued at the start of the swimming season, at peak holiday periods, in response to pollution incidents or to report Beach Suitability Grades.

Part 6 of this protocol provides further information on reporting.

Triggers for management actions

Water quality monitoring

Elevated enterococci results may be recorded during routine monitoring over the summer season. These elevated results can signify a significant deterioration in water quality. When detected, they should trigger a response to investigate the cause of faecal contamination. If sampling results remain elevated, the source or cause must be identified, and appropriate action taken. This may include signage at the site to advise the public on the safety of the recreational waterbody.

Site-specific trigger levels allow a response to unanticipated deterioration in water quality that is unusual for a specific site rather than using a generic trigger that is applied for all sites. The guidelines do not provide specific guidance as to what level of elevated microbial count represents a trigger level for action; however, when sampling data is entered into the Enterotester spreadsheet, a trigger level will be automatically calculated for the sampling location.

Incidents or exceptional circumstances

Incidents such as sewage overflows can greatly increase the risk to human health. All agencies need to be aware of their roles and responsibilities to ensure the incident is managed in a rapid, coordinated and effective manner to prevent or minimise impacts to public health. While individual agencies may have their own risk management plans, it is essential that a coordinated approach is developed to ensure effective management and communication between relevant authorities.

Development of incident response plans

Incident response plans should include:

- Definition of the incident – When should the plan be applied? Include definitions of any general terms, such as ‘recreational waterbody’.
- Roles and responsibilities – Identify all agencies that have a role in managing the incident including initial assessment, containment and clean-up of contamination, installation, management and removal of warning signs, issuing of public health advisories, providing advice on risks, collection of samples, media and stakeholder liaison and determining when the area is again safe for swimming.
- Notification process – Detail the notification process, including when and how to contact each agency.
- Response process – Detail the actions each agency must undertake when notified of an incident. This expands on the agencies’ responsibilities and includes specifications for signage, barriers, sampling, public notifications and the decision framework for re-opening a beach.
- Contact details – Include during and after hours contact details for principal and secondary contacts in all agencies.
- Review procedures – How often or under what circumstances should the plan be reviewed?

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Appendix A: Sanitary inspection report

Sanitary inspection report

+ Determination of Beach Suitability Grade

Version 11

Summary of findings

Site name: ________________________________ Site reference number: __________

Site visit date:______________ Council meeting date:______________

Sanitary Inspection Category (SIC): ______________ Determined on: ______________

Microbial Assessment Category (MAC): ___________ Calculated on: _______________

Matrix for determining the Beach Suitability Grade

Sanitary Inspection Category (SIC)	Microbial Assessment Category (MAC) (95th percentiles – enterococci cfu/100 mL)			
	A ≤40	**B 41–200**	**C 201–500**	**D >500**
Very Low	Very Good	Very Good	Follow up	Follow up
Low	Very Good	Good	Follow up	Follow up
Moderate	Good	Good	Poor	Poor
High	Good	Fair	Poor	Very Poor
Very High	Follow up	Fair	Poor	Very Poor

Beach Suitability Grade: _______________ for the year: __________

Entered into database on: _______________

This template can be used as a field sheet for the Beachwatch Sanitary Inspection Database or on its own as a sanitary inspection report. The template is available as a fillable form on the Beachwatch website.

For further guidance in determining the likelihood of pollution from each pollution source contact Beachwatch – beachwatch@environment.nsw.gov.au

Contents of the sanitary inspection report

1. Site information

Site name: ________________________________ Site reference number: __________

Type of site: ☐ Ocean ☐ Estuarine ☐ Freshwater

☐ Other ______________________________

Sandy beach? ☐ Yes ☐ No

Swimming dimensions: Length (m): ________ Width (m): _______ = Area (m^2): ________

Catchment area: __________ square kilometres

Catchment land use: Bushland: ________% Rural: ________% Urban: ________%

Contact details

Responsible authority: ___________________________

Name: ____________________________ Position: ____________________________

Landline: _______________ Mobile: ________________ Fax: _________________

Email: _____________________________

Site location

Address: ____

Latitude: __________________________ Longitude: __________________________

Site description: ____

____

Diagram of site

1. Site information, cont.

Level of flushing:
- ☐ High (e.g. coastal beach)
- ☐ Medium (e.g. estuarine)
- ☐ Low (e.g. lagoon)

Elevated enterococci (>40 cfu/100mL):
- ☐ After light rain (5 mm in 24hrs)
- ☐ After moderate rain (10 mm in 24hrs)
- ☐ After heavy rain (20 mm in 24hrs)
- ☐ After very heavy rain (50 mm in 24hrs)

2A. Site use

Activities at site: ☐ Swimming ☐ Surfing ☐ Jet skiing ☐ Canoeing/kayaking

☐ Fishing ☐ Sailing ☐ Boating ☐ Diving

☐ Other ________________________________

Groups using site: ☐ Young children (<7yrs) ☐ Elderly (>60yrs)

☐ Adults & older children ☐ Tourists

Number of users: ________ to ________ people per day on weekends

________ to ________ people per weekday (non-holiday period)

________ to ________ people per weekday (holiday period)

Off-street parking? ☐ No ☐ Yes, number of bays: __________

Lifeguards: ☐ Unpatrolled ☐ Weekends ☐ Weekdays (non-holiday)

☐ Summer/School holidays

Do conditions deter people from entering?

☐ No ☐ Yes, details: ____

Any complaint of illness recorded?

☐ No ☐ Yes, details: ____

Consequence

☐ Minor

- Rarely used on weekdays
- Occasionally used on weekends or holidays
- Few people enter the water
- Location not popular with children or the elderly
- Location of minimal importance to the local economy

☐ Moderate

- Occasionally used on weekdays (e.g. <100 people per day for non-holiday period)
- Frequently used on weekends or holidays
- Most people enter the water
- Location very popular with children or the elderly
- Location of some importance to the local economy

☐ Major

- Frequently used on weekdays, weekends and holidays
- Most people enter the water
- Location very popular with children or the elderly
- Location of great importance to the local economy

2B. Pollution sources

Pollution source inventory

Pollution sources that could affect the water quality at the swimming site:

- ☐ Do **bathers** use the site?
- ☐ Are **toilet facilities** located within close proximity to the site?
- ☐ Are **wastewater treatment plants (including outfalls)** located within 2 km of the site?
- ☐ Do **designated sewage overflows** occur in the catchment (or within approximately 1 km radius of the site)?
- ☐ Do **sewer chokes or leakages** occur in the catchment (or within approximately 1 km radius of the site)?
- ☐ Do surrounding properties use **onsite sewage disposal systems**?
- ☐ Does **wastewater re-use** occur within 100 m radius of the site?
- ☐ Does **stormwater** discharge within 500 m of the site?
- ☐ Do **rivers** discharge within 1 km of the site?
- ☐ Do **lagoons** discharge within 500 m of the site?
- ☐ Are **boats** located in the vicinity of the site?
- ☐ Are **animals** (wildlife or domestic animals) present at the site?

Bather shedding

☐ Applicable ☐ Not applicable, details:________________________________

Number of bathers at busy times: ________

Toilets available? ☐ No ☐ Yes, location: ______________________________

Bather density calculation

Use **area** as defined on the *Site details* sheet.

Use **number at busy times** as defined above.

Number at busy times:_________ *divided by* site area: ________ = _________ (people/m^2)

☐ Low (bather density <0.2)

☐ High (bather density ≥0.2)

Likelihood of pollution from bathers (select from the following matrix)

		Toilets available = YES		Toilets available = NO	
		Low bather density	**High bather density**	**Low bather density**	**High bather density**
Flushing	**Low**	Low	Moderate	Low	Moderate
	Medium	Very Low	Low	Low	Moderate
	High	Very Low	Low	Low	Moderate

Likelihood of pollution from bathers is: ______________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** _______________

Comments/Justification: ____

____

____

Toilet facilities

☐ Applicable ☐ Not applicable, details:______________________________

Distance from toilets to site (m): __________

Total number of toilets: _________

Total number of showers: ________

Type of sewerage system: ☐ Sewered

☐ Onsite system, how often serviced?_______________

Discharges/odours recorded? ☐ No, details: ____________________________

☐ Yes, details: ____________________________

____

Likelihood of pollution from toilet facilities (select from the following matrix)

		Distant proximity		Close proximity	
		Low use/flow	**High use/flow**	**Low use/flow**	**High use/flow**
Facility condition	**Poor**	Low	Moderate	Moderate	High
	Good	Very Low	Low	Low	Moderate

Likelihood of pollution from toilet facilities is: ________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** _________________

Comments/Justification: ____

____

____

Wastewater treatment plant (within 2 km)

☐ Applicable ☐ Not applicable, details:____________________________________

Name of outfall: ______________________________

Distance from site (m):__________

a. Discharges from wastewater treatment plants

Outfall type: ☐ Direct ☐ Short ☐ Long (offshore)

Treatment level: ☐ None ☐ Preliminary ☐ Primary ☐ Secondary + disinfection

☐ Tertiary ☐ Tertiary + disinfection ☐ Lagoon

Likelihood of pollution for discharges from wastewater treatment plants (select from the following matrix)

		Outfall type		
		Direct	**Short**	**Long (offshore)**
Treatment level	**None**	Very High	High	Low
	Preliminary	Very High	High	Low
	Primary	Very High	High	Low
	Secondary	High	High	Low
	Secondary + disinfection	Moderate	Moderate	Very Low
	Tertiary	Moderate	Moderate	Very Low
	Tertiary + disinfection	Low	Low	Very Low
	Lagoons	High	High	Low

b. Wastewater treatment plant bypasses

Average discharge volume per bypass event (mL):___________

Dilution of bypass effluent: ☐ High ☐ Low

Minimum treatment level of bypassed effluent:

☐ None ☐ Primary ☐ Secondary ☐ Tertiary/lagoon

Bypassed effluent disinfected: ☐ Never ☐ Sometimes ☐ Always

Bypass discharge location: ☐ Direct ☐ Short ☐ Long (offshore)

Wastewater treatment plant (within 2 km), cont.

Likelihood of pollution for wastewater treatment plant bypasses (select from the following matrix)

		Wastewater treatment plant bypass frequency (assuming effluent is not disinfected)				
		May occur in exceptional circumstances (1 in 10 years)	**Unlikely to occur but could occur at least once in a 5-year period**	**Might occur at least once or twice per bathing season**	**Will probably occur at least 3–4 times per bathing season**	**Will occur on a regular basis (once a week)**
Dilution (from discharge location)	**High**	Very Low	Very Low	Low	Moderate	High
	Low	Very Low	Low	Moderate	High	Very High

If there is no history of bypasses the likelihood of contamination for wastewater treatment plants is determined using the likelihood of pollution from wastewater treatment plant discharge matrix (a); however, if there is a history of treatment bypasses at the wastewater treatment plant the likelihood is determined by using likelihood of pollution for wastewater treatment plant bypasses matrix (b).

Likelihood of pollution from the wastewater treatment plant is:________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ________________

Comments/Justification: ____

____

____

Designated sewage overflows

☐ Applicable ☐ Not applicable, details:______________________________

For each overflow in the catchment (or 1 km radius), list:

Name	Address	Frequency/10yrs	Volume

Dilution: ☐ High ☐ Low

Likelihood of pollution from designated sewage overflows (select from the following matrix)

		Frequency				
		May occur in exceptional circumstances (1 in 10 years)	**Unlikely to occur but could occur at least once in a 5-year period**	**Might occur at least once or twice per bathing season**	**Will probably occur at least 3–4 times per bathing season**	**Will occur on a regular basis (once a week)**
Dilution	**High**	Very Low	Very Low	Low	Moderate	High
	Low	Very Low	Low	Moderate	High	Very High

Likelihood of pollution from designated sewage overflows is:________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ________________

Comments/Justification: ____

____

____

Sewer chokes and leakages

☐ Applicable ☐ Not applicable, details:______________________________

For each overflow in the catchment (or 1 km radius), list:

Date	**Address**

Dilution: ☐ High ☐ Low

Likelihood of pollution from sewer chokes and leakages (select from the following matrix)

		Frequency				
		May occur in exceptional circumstances (1 in 10 years)	**Unlikely to occur but could occur at least once in a 5-year period**	**Might occur at least once or twice per bathing season**	**Will probably occur at least 3–4 times per bathing season**	**Will occur on a regular basis (once a week)**
Dilution	**High**	Very Low	Very Low	Low	Moderate	High
	Low	Very Low	Low	Moderate	High	Very High

Likelihood of pollution from sewer chokes and leakages is: ________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ________________

Comments/Justification: ______________________________

____

____

Onsite sewage disposal systems

☐ Applicable ☐ Not applicable, details:______________________________

Approximate number of systems in catchment:__________

Distance to site from nearest system (m): _________ (not including onsite toilet facilities identified under 'Toilets facilities')

Discharges/odours recorded? ☐ No, details: ______________________________

☐ Yes, details: ______________________________

____

Likelihood of pollution from onsite sewage disposal systems (select from the following matrix)

		Distant proximity		Close proximity	
		<50 systems	**≥50 systems**	**<50 systems**	**≥50 systems**
Condition	**Good – no complaints**	Very Low	Very Low	Low	Low
	Poor – history of odours and discharges	Low	Moderate	Moderate	High

Likelihood of pollution from onsite sewage disposal systems is: ______________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ______________

Comments/Justification: ______________________________

____

____

Wastewater re-use

☐ Applicable ☐ Not applicable, details:____

Location of wastewater re-use area: ____

Distance from site to re-use area: _____________

Wastewater treated prior to use? ☐ No ☐ Yes, details: __________________________

____

Likelihood of pollution from wastewater re-use (select from the following matrix)

		Distant proximity		Close proximity	
		Low volume	**High volume**	**Low volume**	**High volume**
Treatment level	**High – disinfected**	Very Low	Very Low	Low	Low
	Low – not disinfected	Low	Moderate	Moderate	High

Likelihood of pollution from wastewater re-use is: ________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** _________________

Comments/Justification: ____

____

____

Stormwater

☐ Applicable ☐ Not applicable, details:____________________

Total number of drains at swimming site: _________

Pick the **two drains** that have the most influence on your sampling site (or if there is only one drain, enter its details).

Drain 1

Location: ____________________ Authority: ____________________

____________________ ____________________

Distance from site (m):__________

Type of drain: ☐ Box culvert ☐ Creek ☐ Pipe

Discharge area: ☐ Dune ☐ Beach ☐ Offshore ☐ Direct <50m ☐ Direct ≥50m

Drain 2

Location: ____________________ Authority: ____________________

____________________ ____________________

Distance from site (m):__________

Type of drain: ☐ Box culvert ☐ Creek ☐ Pipe

Discharge area: ☐ Dune ☐ Beach ☐ Offshore ☐ Direct <50m ☐ Direct ≥50m

Primary land use: ☐ High density urban ☐ Low density urban ☐ Rural – grazing

☐ Rural – cropping ☐ Bushland/reserve

Likelihood of pollution from stormwater (select from the following matrix – choose the highest likelihood if you have two different drains)

		Discharge area		
		Dune	**Beach, offshore or direct ≥50 m**	**Direct <50 m**
Land use	**High density urban**	Low	Moderate	High
	Low density urban	Very Low	Low	Moderate
	Rural – grazing	Very Low	Low	Moderate
	Rural – cropping	Very Low	Low	Low
	Bushland/reserve	Very Low	Low	Low

Stormwater, cont.

Likelihood of pollution from stormwater drains is: ________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ________________

Comments/Justification: ____

____

____

River discharge

☐ Applicable ☐ Not applicable, details: ______________________________

Name of river: ______________________________

Distance from discharge point to site (m): __________

Pollution sources in river discharge:
☐ Urban stormwater
☐ Leachate from onsite wastewater systems
☐ Agricultural runoff
☐ Intensive livestock production
☐ Other, details: ______________________________

____

Likelihood of pollution from river discharge (select from the following matrix)

		Distant proximity		Close proximity	
		Low discharge volume	**High discharge volume**	**Low discharge volume**	**High discharge volume**
River water quality	**Good**	Very Low	Very Low	Low	Low
	Poor	Low	Moderate	Moderate	High

Likelihood of pollution from river discharge is: ________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ________________

Comments/Justification: ____

____

____

Lagoons

☐ Applicable ☐ Not applicable, details:________________________________

Name of lagoon:____________________________

Distance from site (m):__________

Area of lagoon (sq. km):__________

Catchment area (sq. km): __________

Sources of pollution to lagoon: ☐ Urban stormwater ☐ Agricultural runoff

☐ Other, details:____________________________

____

% time open to ocean (recent average): ________

Entrance managed or modified?

☐ No ☐ Yes, details:____

Likelihood of pollution from lagoons (select from the following matrix)

Likelihood of pollution from lagoons				
Very Low	**Low**	**Moderate**	**High**	**Very High**
May occur only in exceptional circumstances, e.g. 1 in 10 years	Unlikely to occur but could occur at least once within a 5-year period	Might occur at least once or twice per bathing season	Will probably occur at least 3–4 times per bathing season	Will occur on a regular basis, e.g. once a week

Likelihood of pollution from lagoons is: ______________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ______________

Comments/Justification: ____

____

____

Boats

☐ Applicable ☐ Not applicable, details:________________________________

What is located near the site?

☐ Marina ☐ Permanent moorings

☐ Harbour ☐ Temporary moorings

☐ Anchorage ☐ Jetty

☐ Boat ramp ☐ Ferry berth

Distance from site to nearest boat (m): __________

Number of boats near site:___________

Pump-out facilities provided?

☐ No ☐ Yes, details:________________________________

Complaints of boat discharges?

☐ No ☐ Yes, details:________________________________

Onshore toilets provided?

☐ No ☐ Yes, details:________________________________

Likelihood of pollution from boats (select from the following matrix)

		Number of boats		
		<20 boats	**20–50 boats**	**50–100 boats**
Waste management	**Good (holding-tanks required)**	Very Low	Very Low	Low
	Poor (holding-tanks not required)	Low	Moderate	Moderate

Likelihood of pollution from boats is: ______________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:**______________

Comments/Justification: ________________________________

____

____

Animals

☐ Applicable ☐ Not applicable, details:____________________________________

Aquatic birds? ☐ Yes ☐ No

Density: ☐ Low ☐ Medium ☐ High

Roosting structures present? ☐ Yes ☐ No

Native animals? ☐ Yes ☐ No

Density: ☐ Low ☐ Medium ☐ High

Domestic animal exercise area? ☐ Yes ☐ No

Type: ☐ Dogs ☐ Horses ☐ Other, details: __________________________

Dog waste bags available? ☐ Yes ☐ No

Animals directly access water? ☐ Yes ☐ No

Area regularly cleaned? ☐ Yes ☐ No

Likelihood of pollution from animals (select from the following matrix)

Likelihood of pollution from animals				
Very Low	**Low**	**Moderate**	**High**	**Very High**
May occur only in exceptional circumstances, e.g. 1 in 10 years	Unlikely to occur but could occur at least once within a 5-year period	Might occur at least once or twice per bathing season	Will probably occur at least 3–4 times per bathing season	Will occur on a regular basis, e.g. once a week

Likelihood of pollution from animals is: ________________

Is this likelihood appropriate? ☐ Yes ☐ **No, revised likelihood:** ________________

Comments/Justification: ____

____

____

2C. Management

Which management controls are in place to warn people of periods of increased risk?

☐ None ☐ Permanent onsite signage ☐ Temporary onsite signage

☐ Media releases ☐ Beach closures ☐ Website

☐ Other, details: ____

Provide details of advisories: ____

____

____

Do management controls effectively prevent people from entering the water during these periods?

☐ No ☐ Yes, details: ____

____

____

Is there a management response plan in place to deal with exceptional events such as sewage overflows and bypasses?

☐ No ☐ Yes, details: ____

____

____

3. Calculating the Sanitary Inspection Category

On the **form on the next page** complete the following steps:

STEP 1: Fill out the likelihood for each of the pollution sources in the top part of the form (leave blank if pollution source is not applicable).

STEP 2: By referring to the table below, fill out the numerical likelihood values for these pollution sources.

Likelihood	Numerical likelihood
Very Low	0.1
Low	0.2
Moderate	1
High	3
Very High	12

STEP 3: Sum the numerical likelihoods.

STEP 4: By referring to the table below, fill out the numerical likelihood for animal pollution source (if applicable) in the second part of the form and sum the total numerical likelihood.

Likelihood	Numerical likelihood
Very Low	0.1
Low	0.1
Moderate	0.2
High	1
Very High	1

STEP 5: Using the total numerical likelihood, identify the Sanitary Inspection Category using the table below.

Total numerical likelihood	Sanitary Inspection Category
0–0.19	Very Low
0.2–0.99	Low
1–2.99	Moderate
3–11.99	High
>12	Very High

Pollution source	Likelihood		Numerical likelihood
Bathers	____________________	…………	= _______
Toilet facilities	____________________	…………	= _______
Wastewater treatment plant	____________________	…………	= _______
Designated sewage overflows	____________________	…………	= _______
Sewer chokes and leakages	____________________	…………	= _______
Onsite sewage disposal systems	____________________	…………	= _______
Wastewater re-use	____________________	…………	= _______
Stormwater	____________________	…………	= _______
River discharge	____________________	…………	= _______
Lagoons	____________________	…………	= _______
Boats	____________________	…………	= _______
	Sum of numerical likelihoods		= _______

Pollution source	Likelihood		Numerical likelihood
Animals	____________________	…………	= _______
	Sum of numerical likelihoods from previous table		= _______
	Total numerical likelihood		= _______

The **Sanitary Inspection Category** for this site is: ________________________

Appendix B: Field logsheet for collection of recreational water quality samples

Field logsheet

Date: _______________ **High tide (am):**_______________

Weather: ☐ Sunny OR ☐ Overcast AND ☐ Fine OR ☐ Wet

Officer: __________________________ **Run:**____________________________

Location	Site code	Time	Drain/ lagoon flow (Y/N)	Water temp. (°C)	Conductivity (µS/cm)	No. of swimmers	Surface scum/ foam (Y/N)	Leaf litter (Y/N)	Litter (Y/N)	Marine debris (Y/N)	Blue-bottles (Y/N)	Weed (Y/N)	Visual turbidity (Clear/ Low/ Medium/ High)	Comments

Location	Site code	Time	Drain/ lagoon flow (Y/N)	Water temp. (°C)	Conductivity (µS/cm)	No. of swimmers	Surface scum/ foam (Y/N)	Leaf litter (Y/N)	Litter (Y/N)	Marine debris (Y/N)	Blue-bottles (Y/N)	Weed (Y/N)	Visual turbidity (Clear/ Low/ Medium/ High)	Comments

Sample chain of custody

Relinquished by: ______________________ **Date:**___________ **Time:** ________

Received by:__________________________ **Date:**___________ **Time:** ________

Appendix C: Checklist for establishing a recreational water quality monitoring program

Stage	Considerations	Beachwatch support
Site selection	• Identify sites popular for swimming • Prioritise swimming sites to monitor using priority matrix	DPIE Protocol* (Part 2)
Sanitary inspection	*For all monitored swimming sites:* • Investigate potential pollution sources • Complete the sanitary inspection to identify potential sources of faecal contamination	DPIE Protocol* (Part 3) Sanitary inspection report (DPIE Protocol*, Appendix A)
Microbial water quality monitoring	*Sampling* • Determine sampling season and frequency (recommend weekly testing during the summer season, aiming for 20 samples per site per year) • Develop water quality monitoring procedure guide and field data sheet • Train staff in microbial water sampling • Get field equipment including sample jars, eskies, ice, thermometer and personal protective equipment (e.g. gloves, hats, booties) • Implement quality control and assurance measures	DPIE Protocol* (Part 4)
	Laboratory • Identify laboratory for samples to be tested for enterococci (nearby commercial laboratory or in-house) • Check laboratory undertakes regular proficiency testing programs • Consider laboratory opening days and hours when planning sampling runs. Ideally samples are analysed within 8 hours of collection (but must be analysed within 18 hours of collection) • Identify method of enterococci analysis, detection level and turnaround time for results • Determine the chain of custody information for submitting samples for laboratory analysis	Beachwatch QA program
Data management	• Develop a data management procedure • Field data – collection (how) and storage (where) • Microbial data – delivery (how) and storage (where) • Store all water quality data in centralised database	DPIE Protocol* (Part 4) Beachwatch bacteriological database
Reporting	• Determine how and who will report water quality results • Develop some key messages for informing stakeholders about recreational water quality	DPIE Protocol* (Part 6) Data downloads Weekly star ratings Annual report
Management response	• Develop a management response if poor water quality is identified • Notify stakeholders of poor water quality (how, when) • Identify existing notification procedures in response to pollution incidents such as sewage overflows	DPIE Protocol* (Part 7)

*DPIE *Protocol for Assessment and Management of Microbial Risks in Recreational Waters*