Beachwatch and Harbourwatch State of the Beaches

Sydney - Hunter - Illawarra

2008-2009

Department of
Environment, Climate Change and Water NSW

For technical information about this report contact:

Beachwatch, Department of Environment, Climate Change and Water NSW
59–61 Goulburn Street, Sydney
PO Box A290, Sydney South NSW 1232
Phone: (02) 9995 5344
Fax: (02) 9995 5913
Email: Beachwatch@environment.nsw.gov.au
Web: www.environment.nsw.gov.au/beach

Published by:

Department of Environment, Climate Change and Water NSW
59–61 Goulburn Street, Sydney
PO Box A290, Sydney South NSW 1232

Phone: (02) 9995 5000 (switchboard)
Phone: 131 555 (environment information and publications requests)
Phone: 1300 361 967 (national parks information and publications requests)
Fax: (02) 9995 5999
TTY: (02) 9211 4723
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

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Summary

About this report

This report describes the results of Beachwatch and Harbourwatch water quality monitoring and reporting activities at Sydney Metropolitan, Hunter and Illawarra ocean beaches and Sydney estuarine beaches for the period 1 May 2008 to 30 April 2009.

Discussion in this report focuses on the 2008–2009 summer swimming season, which covers the period from 1 October 2008 to 30 April 2009.

About Beachwatch and Harbourwatch

The Beachwatch program was established in 1989 and Harbourwatch in 1994. Both programs involve routine monitoring and reporting of bacterial indicator levels to determine water quality at swimming locations in the Sydney region. The State Government extended Beachwatch to the Hunter and Illawarra regions in 1996.

Measuring recreational water quality

Indicator micro-organisms

Beachwatch uses two types of indicator bacteria, faecal coliforms (also known as thermotolerant coliforms) and enterococci, to measure recreational water quality, as recommended by the National Health & Medical Research Council (NHMRC 1990) and the Australian and New Zealand Environment and Conservation Council (ANZECC 1992). These guidelines also refer to other physical and chemical parameters for the assessment of recreational water quality, such as pH, clarity and temperature. Beachwatch focuses on the use of faecal coliforms and enterococci, as these indicate the possible presence of waterborne pathogens that pose the most significant risks to human health. Results presented in this report are described in terms of faecal coliform and enterococci compliance with Beachwatch water quality criteria (Chapter 1).

This report includes an appendix describing the use of indicator micro-organisms in establishing the suitability of a waterbody for recreational use (Appendix 1). Details of recent developments in this area and discussion of the new NHMRC (2008) *Guidelines for Managing Risks in Recreational Waters* and World Health Organisation documentation are also included in Chapter 1, Chapter 7 and Appendix 1.

The use of faecal coliforms and enterococci

Faecal coliforms are now referred to as thermotolerant coliforms, as some genera within the group are not of faecal origin. However, to be consistent with previous Beachwatch reports the terminology 'faecal coliforms' is still used in this report.

Although faecal coliforms have been the traditional organisms measured to indicate the presence of faecal contamination in water used for recreation, the use of enterococci as an additional indicator of faecal contamination in marine waters is growing in favour. Faecal coliforms are generally more abundant in sewage and easier to detect in bathing waters than are enterococci, but enterococci generally survive longer in bathing waters and may be detected after most faecal coliforms have died off (Chapter 1).

Results for 2008–2009

Of the 131 swimming locations monitored in the Sydney, Hunter and Illawarra regions, 103 complied with Beachwatch guidelines 100% of the time during summer 2008–2009. This result is the second highest recorded in the 19-year history of the Beachwatch Program, just behind summer 2005–2006 when 107 sites complied 100% of the time and equal to the results from summer 2006–2007.

Significant improvements in compliance were recorded in summer 2008–2009 compared with the previous year, when extreme wet weather conditions resulted in only 61 sites complying 100%. The higher levels of compliance can be attributed to a

return to average rainfall, as well as long-term improvements in the management of stormwater and wastewater.

Improved compliance was recorded at 69 swimming sites throughout the program, with the majority of swimming sites located in Sydney Harbour, lower Georges River, Botany Bay and Port Hacking recording higher levels of compliance than in the previous summer season. Ocean beaches in the Sydney, Hunter and Illawarra regions also recorded good results, with most compliance levels either improving or showing little change.

Decreases in compliance for one or both indicators were recorded at 13 swimming sites throughout the program. Compliance fell at five ocean beaches in the Sydney region, two ocean beaches in the Illawarra region, one swimming site in both Pittwater and Botany Bay, and two swimming sites in both lower Georges River and Sydney Harbour.

Sydney metropolitan ocean beaches

The results for 2008–2009 are the equal best ever recorded, with 29 beaches complying 100% with both indicators. Twenty-nine beaches also complied 100% in summer 2004–2005 and summer 2005–2006. The results are a significant improvement from summer 2007–2008 when heavy rainfall resulted in only 23 sites complying 100% of the time.

Sydney's cleanest beaches were Palm, Whale, Avalon, Bilgola, Bungan, Mona Vale, Warriewood, Turimetta, North Narrabeen, Collaroy, Long Reef, Dee Why, North Curl Curl, South Curl Curl, Freshwater, Queenscliff, North Steyne, South Steyne and Shelly (Manly) in Sydney's north; the city beaches of Tamarama, Clovelly and Maroubra; and the southern beaches of Greenhills, Wanda, Elouera, North Cronulla, South Cronulla, Shelly (Sutherland) and Oak Park.

Excellent results were also recorded at Bondi, Bronte, Coogee, Little Bay and Boat Harbour beaches, which complied at least 90% of the time for both bacterial indicators.

The only beach with compliance of less than 80% was Malabar Beach with 75% for faecal coliforms and 56% for enterococci.

Hunter region ocean beaches

The good news from previous summer seasons continued for the Hunter region beaches during summer 2008–2009. Once again they were among the cleanest group of beaches monitored under the Sydney, Hunter and Illawarra Beachwatch Program.

All 17 Hunter beaches (Zenith, Box, Fingal, One Mile, South Stockton, Nobbys, Newcastle, Bar, Merewether, Glenrock Lagoon, Dudley, Redhead, Blacksmiths, Swansea Heads Little, Caves Beach and Burwood North and Burwood South) complied 100% with Beachwatch swimming water quality guidelines for both bacterial indicators.

Illawarra region ocean beaches

The Illawarra region had excellent results, with 16 of the 18 beaches monitored for both faecal coliforms and enterococci recording 100% compliance with Beachwatch criteria for both indicators during the 2008–2009 summer season. Illawarra's cleanest beaches were Austinmer, Thirroul, Bulli, Woonona, Bellambi, Corrimal, Wollongong City, Coniston, Fishermans, Port Kembla, Warilla, Shellharbour, Boyd's Jones, Bombo, Surf Beach (Kiama) and Werri.

North Wollongong beach performed very well, achieving more than 90% compliance for each indicator. Entrance Lagoon Beach recorded 100% compliance with faecal coliform guidelines and 52% compliance with enterococci guidelines.

This result is an improvement on the previous summer season when only 13 beaches complied 100% of the time for both bacterial indicators.

Sydney metropolitan harbour and bay swimming sites

Forty-one of the 59 harbour swimming sites complied 100% with Beachwatch criteria for faecal coliforms and enterococci during the 2008–2009 summer season. This is among the highest level of compliance ever recorded at the harbour beaches and a vast improvement on the previous season when heavy rainfall resulted in only 10 harbour swimming sites complying 100%.

Harbour swimming sites that complied 100% of the time with both bacterial indicators during summer 2008–2009 were:

- **Pittwater** – Barrenjoey Beach, Paradise Beach Baths, Clareville Beach, Salt Pan Cove Baths, Winji Jimmi Bay, North Scotland Island, South Scotland Island, Elvina Bay, The Basin and Great Mackerel Beach.
- **Sydney Harbour** – Little Sirius Cove, Clifton Gardens, Rose Bay Beach, Nielsen Park, Parsley Bay, Watsons Bay, Forty Baskets Pool, Fairlight Beach, Manly Cove, Little Manly Cove, Gurney Crescent Baths, Northbridge Baths, Clontarf Pool, Chinamans Beach, Edwards Beach, Balmoral Baths, Tambourine Bay, Woodford Bay, Woolwich Baths, Cabarita Beach, Henley Baths, Chiswick Baths, Dawn Fraser Pool and Greenwich Baths.
- **Lower Georges River** – Dolls Point Baths.
- **Botany Bay** – Monterey Baths, Congwong Bay and Silver Beach.
- **Port Hacking** – Gunnamatta Bay Baths, Lilli Pilli Baths and Jibbon Beach.

Excellent results were also recorded at Davidson Reserve and Sangrado Baths in Middle Harbour, Sandringham Baths in lower Georges River, Ramsgate Baths, Brighton Le Sands Baths and Kyeemagh Baths in Botany Bay, and Gymea Bay Baths and Horderns Beach in Port Hacking, which all complied more than 90% of the time.

Actions to improve beach and harbour water quality

Stormwater

Funding for sustainability projects is provided under the NSW Government's Environmental Trust $80 million Urban Sustainability Program. Grant funding is targeted at local councils working with the community and business to protect and improve the urban environment. Some funded projects have specifically addressed urban water management issues, including stormwater management, reducing urban runoff and improving water quality.

In 2008, $30 million in grant funding was made available through the Urban Sustainability Major Projects and Urban Waterways Initiative for up to three years. The priority catchment areas for the Urban Waterways funding stream are the Cooks River, Georges River, Hawkesbury Nepean River, Central Coast/Lower Hunter catchments and Sydney Harbour.

From 2006 to 2008 the Environmental Trust provided over $19.8 million for 26 projects to improve the condition of degraded urban waterways through rehabilitation and restoration activities. The projects implemented include initiatives such as stormwater reuse schemes, implementation of water-sensitive urban design, and activities to restore streams and creeks in various local government areas, improving local water quality and overall catchment health. These projects have also included the implementation of education and engagement programs to maintain the health of urban catchments.

In addition, the NSW Government has developed a state-wide Diffuse Source Water Pollution (DSWP) Strategy to reduce diffuse source pollution inputs into all NSW surface and ground waters. Diffuse source water pollution is the contamination of water bodies by pollutants (such as pathogens, chemicals and salinity) from urban and rural land-use activities in the catchment. The DSWP Strategy will contribute towards the NSW water quality objectives and state-wide natural resource management targets listed in the State Plan. The DSWP Strategy will bring together Catchment Management Authorities (CMAs), relevant NSW government agencies and local councils to jointly manage and address these issues.

Sydney Water manages 5% of Sydney's stormwater network, mainly the lower reaches of catchments where the stormwater channels are large and cross a number of council boundaries. This includes 65 stormwater quality improvement devices such as litter booms, sediment traps, gross pollutant traps and a wetland.

The improvement devices target litter and sediment hotspots and remove these pollutants from nearly 46% of the stormwater runoff in Sydney Water's infrastructure. In 2007–2008, 2,465 cubic metres of litter and 11,000 tonnes of silt were removed.

Previous funding for stormwater projects was provided under the NSW Government's Urban Stormwater Program. Between 1997 and 2006 a total of $82 million in seed funding was provided to address stormwater quality hotspots and to give the stormwater industry and stormwater managers opportunity to develop new ways of addressing poor stormwater quality and ameliorating its impact on receiving waters.

The major outcomes of the Urban Stormwater Program included stormwater project grants to councils totalling $67 million, additional contributions of $40 million by councils, stormwater harvesting projects, and the construction of almost 100 artificial wetlands. One important project was an independent evaluation of the $7 million Urban Stormwater Education Program that showed that one person in five has changed their behaviour to reduce stormwater pollution as a result of the program.

The Urban Stormwater Program has proven to be a successful, integrated, state-wide program that has made a difference to stormwater quality. It has raised the community's knowledge of stormwater pollution, shown people how to make a difference, improved attitudes and changed the behaviour of people in NSW.

Actions to reduce sewage overflows

Sydney Water is required by DECCW Environment Protection Licence conditions to manage sewerage treatment systems efficiently, to protect and minimise harm to the environment and public health. The licences aim to minimise the frequency and volume of overflows and sewage treatment plant bypasses by identifying limits and targets for sewage overflows as well as measures to require further overflow abatement.

Northside Storage Tunnel

The Northside Storage Tunnel was constructed to capture wet weather overflows from the four major overflow sites at Lane Cove, Quakers Hat Bay, Tunks Park and Scotts Creek. The Tunnel was designed to reduce the number of overflows at the four major wet weather overflow points from more than 150 to less than 20 in an average 10-year period. Since coming on-line the Tunnel has prevented more than 37 billion litres of diluted sewage from entering Sydney Harbour (Sydney Water 2009a).

SewerFix

SewerFix is Sydney Water's 20-year program for maintaining and improving the sewer system. Key works include:

- In consultation with DECCW, Sydney Water is targeting overflows that occur in the vicinity of beaches and other sensitive locations. Where poor performance is identified, works will be conducted to reduce the overflows and improve beach water quality.
- Sydney Water's wet weather overflow abatement program includes amplification, storage and sewer lining. Works completed (Hotspots 1) will benefit Darling Harbour on Port Jackson, Oatley Bay Baths and Jew Fish Bay Baths on the Georges River, and Gunnamatta Bay Baths, Shelly Beach and Oak Park on Port Hacking. Other works (Hotspots 2) will benefit Hayes St Beach on Port Jackson and the Sydney ocean beaches of Queenscliff and North Curl Curl.
- Sydney Water's dry weather overflow abatement program addresses discharges due to sewer blockage and leakage. A large proportion of the $20 million spent in 2008–2009 addressed discharges to waterways. The work to reduce discharges due to blockage targeted small-diameter sewer mains that carry high flows. These sewers have been found to cause the majority of the dry weather overflows to waterways. The work to reduce leakage monitored stormwater catchment outlets for indicator organisms and when levels

exceeded a threshold a detailed investigation was done across the catchment to find and fix the source of faecal contamination. Further funding has been allocated for 2009–2010 to ensure that discharge targets for waterways are met.

- Sydney Water is working on its Avoid Fail program which aims to rehabilitate the aging sewerage system, particularly in the Sydney region. The program focuses on priority areas, assesses the structural integrity and makes repairs where necessary. Sewers in Botany, Coogee and the Berkeley area of the Illawarra have had repairs. Repairs are planned for completion by 2010 on sewers in Warriewood, Manly, Bondi and Padstow and at Warrawong in the Illawarra.

Upgrades have been completed to 250 sewage pumping stations to minimise the risk of dry weather sewage overflows. Telemetry systems have been upgraded at all of the 664 operating stations to provide warnings of failure. The upgraded telemetry system improves response times and reduces the likelihood and severity of overflows to the environment.

Actions to upgrade Sydney's cliff-face sewage outfalls

The State Government's upgrade of the Cronulla Sewage Treatment Plant was commissioned in April 2001. The upgrade involved the addition of secondary biological treatment, tertiary sand filtration, ultraviolet disinfection and chlorination of recycled water. The treatment scheme allows for use of the treated wastewater by local industry, thereby reducing the volume of discharge from the plant and saving potable water. The capacity of the plant was also increased (Sydney Water 2001).

Pipelines were constructed under Port Hacking to connect residents of Bundeena and Maianbar to the Cronulla Sewage Treatment Plant. A total of 1,251 properties in the Bundeena and Maianbar areas are now connected to the sewerage system. An unknown number of properties in the Bundeena and Maianbar area may still rely on on-site systems such as septic tanks.

Upgrades to Sydney's ocean outfall sewage treatment plants

Works as part of the $95 million Bondi Sewage Treatment Plant Reliability Improvement and Modernisation Program (RIAMP) were completed in January 2007. The works included new ventilation and scrubbing systems, devices to control wastewater flow, and fitting of pipework. The installation of a wastewater recycling system at the plant enables the reuse of 3 million litres of treated wastewater daily. The program ensures that plant reliability and performance are maintained to meet environmental protection licence conditions set by DECCW and provide a safe working environment.

Many projects are in progress at North Head Sewage Treatment Plant, with a number completed. These include a recycled water plant (RWP) constructed in 2005 which reuses 1.5 million litres of wastewater per day in plant processes, reducing the demand on potable water supplies (a saving of 550 million litres per year). The projects will improve the reliability, operability and maintainability of various plant processes.

Actions to upgrade Hunter region sewage treatment and transport systems

Hunter Water Corporation has prepared detailed studies called Upgrade Management Plans for each of its reticulation systems relating to its Wastewater Treatment Works. The upgrades and actions from these plans are focused on reducing impacts on customers and the environment during wet weather periods and will cater for new growth in each catchment.

Upgrade works being undertaken or planned as part of these Upgrade Management Plans include those in the coastal areas of Lake Macquarie, Newcastle and Port Stephens. Significant work is programmed for the Newcastle System wastewater catchment draining to Burwood Beach Wastewater Treatment Plant, including works to reduce wet weather impacts in Mayfield, Adamstown and New Lambton over the next five years.

An upgrade of Belmont Wastewater Treatment Works (WWTW) has been completed to cater for population growth on the eastern side of Lake Macquarie.

Work will commence late in 2009 on upgrades of both Burwood Beach and Boulder Bay Wastewater Treatment Plants to improve the reliability of the plants to meet current license requirements and provide capacity for growth. Further investigations are under way to determine the longer term sustainable strategy for both plants.

Actions to upgrade the Illawarra region sewage treatment and transport systems

The Illawarra Wastewater Strategy has been commissioned to deliver water quality improvements at a number of Illawarra beaches, particularly those near the Bellambi, Wollongong and Port Kembla sewage treatment plants.

The Strategy has ended dry weather discharge from the Bellambi and Port Kembla treatment plants and through water recycling reduces total ocean discharge and saves about 7.3 billion litres of fresh water each year.

The Illawarra Wastewater Strategy involved:

- construction of a water recycling plant at Wollongong sewage treatment plant that produces at least 20 million litres of effluent treated by reverse osmosis to a high standard of quality each day. Under a 15-year agreement the recycled water is used at nearby BlueScope Steel.
- building a pipeline to transfer wastewater from the Bellambi and Port Kembla catchments to Wollongong sewage treatment plant for high-level (tertiary and ultraviolet) treatment and disinfection
- working to improve swimming conditions at Wollongong beaches by stepping up to tertiary treatment and significantly upgrading the existing ocean outfall
- converting Bellambi and Port Kembla sewage treatment plants to specialised storm sewage treatment plants (SSTPs) that store and treat wastewater during prolonged wet weather.

The Strategy is now largely commissioned.

Other components of the Illawarra Wastewater Strategy included the amplification of the Shellharbour Sewage Treatment Plant to meet the demands of population growth within the Albion Park and Shellharbour areas up to 2025. Works included the construction of additional grit and primary tanks to allow for increased flows, improvements in sewage treatment processes and modifications to the ocean outfall to improve effluent dispersion. The amplified sewage treatment plant and the ocean outfall works were completed in 2006.

Beachwatch quality assurance program

The Beachwatch quality assurance (QA) program is undertaken to ensure that the data collected and presented are accurate and reliable. This includes QA of field sampling, microbiological analysis of beach water samples and reporting to the community. Results indicate that Beachwatch samples are collected according to established protocols, the microbiological data are reliable and Beachwatch information reported to the community is both accurate and timely.

New recreational water quality guidelines

In February 2008 the National Health and Medical Research Council (NHMRC) released new *Guidelines for Managing Risks in Recreational Waters*. The new guidelines are largely based on the World Health Organization guidelines (WHO 2003) and supersede the NHMRC (1990) and ANZECC (1992) guidelines on which the Beachwatch guidelines are based.

Under the new NHMRC guidelines, there are major changes to the way recreational waters are assessed for suitability for swimming. Recreational water quality at swimming sites is no longer reported as percent compliance based on microbial data. Instead, beaches will be given a 'suitability for swimming' grading using a classification matrix based on sanitary inspection and microbial assessment categories. This approach provides information on possible sources of pollution and numerical data on the likely level of faecal pollution.

The new guidelines are not mandatory but are provided as a tool for State and Territory Governments to develop relevant programs. On this basis, Beachwatch has reviewed its monitoring and reporting protocols to commence implementation of the new guidelines from 1 May 2009.

An overview of the new NHMRC guidelines, as well as preliminary beach suitability grades for Beachwatch and Harbourwatch sites, is provided in Chapter 7.

Appendixes

There are three appendixes to this report:

- Appendix 1 describes the use of indicator micro-organisms in establishing the suitability of a body of water for recreational use.
- Appendix 2 presents the detailed results of the microbiological quality assurance program.
- Appendix 3 is intended to point the reader towards other information sources relating to bacterial pollution of waterways used for recreation and human health risks.

A list of references, a glossary and a beach index are also provided at the end of this report.

Chapter 1 Introduction

Introduction

This report describes the results of Beachwatch and Harbourwatch water quality monitoring and reporting activities at Sydney Metropolitan, Hunter and Illawarra ocean beaches, and Sydney estuarine beaches for the period 1 May 2008 to 30 April 2009. Discussion in this report focuses on the 2008–2009 summer season, which covers the period from 1 October 2008 to 30 April 2009.

Chapter 2 outlines sources of bacterial contamination in waterways and the ways in which State and local governments, community groups and individuals are tackling the problem.

Chapters 3 and 4 present overviews of each beach in the Beachwatch and Harbourwatch programs respectively, and present the data collected in the water quality monitoring programs.

Chapter 5 describes the quality assurance (QA) programs undertaken by Beachwatch to ensure that the data collected and presented are accurate and reliable. This includes QA of field sampling, microbiological analysis of water samples and reporting to the community.

Chapter 6 reports on special studies conducted by Beachwatch in its effort to gain a better understanding of water quality in specific areas. A study of water quality in Darling Harbour is included in this chapter.

Chapter 7 describes the new guidelines for managing risks in recreational waters. Provisional beach classifications have been made for each swimming site in the Beachwatch and Harbourwatch programs to enable comparisons between the old and new guidelines, highlighting the fact that beach water quality has not changed, just the way it is reported.

There are three appendixes to this report. Appendix 1 describes the use of indicator micro-organisms in establishing the suitability of a body of water for recreational use. Appendix 2 presents the detailed results of the microbiological quality assurance program. Appendix 3 is titled Further Reading and is intended to direct interested readers to other sources of information relating to bacterial pollution of waterways used for recreation and the potential risks to human health.

About Beachwatch and Harbourwatch

The Beachwatch and Harbourwatch programs are conducted by Beachwatch Programs, a section of the Sustainability Programs Division of the Department of Environment, Climate Change and Water (DECCW), in collaboration with local councils, Sydney Water Corporation and Hunter Water Corporation.

Program objectives

Both programs have the following objectives:

- to provide the public with daily assessments of pollution levels at major swimming areas within the Sydney Metropolitan area, or other areas as required
- to provide regular information to the public and other stakeholders on the cleanliness of coastal swimming areas, and the impact of pollution sources and incidents on their recreational use
- to closely monitor scientific developments that improve monitoring and reporting techniques. This will give better information and guidance to the community about the suitability of ocean beaches and estuarine swimming areas for recreational use.

Beachwatch

The Beachwatch program was established in 1989. It involves monitoring of ocean waters for bacterial contamination. Water samples are collected from between the bathing flags (or at the most frequently used part of the

beach if there are no flags) at least five times each month. In November 1996 the Beachwatch program was extended to include the Hunter and Illawarra regions.

Harbourwatch

The Harbourwatch program, which commenced in November 1994, complements the Beachwatch program and extends the monitoring to estuarine areas of Sydney Harbour, Botany Bay, Georges River and Port Hacking and, since October 1995, Pittwater. Water samples are typically collected at swimming baths and other recognised swimming locations.

Beachwatch Partnership Program

The Beachwatch Partnership Program provides those local councils undertaking Beachwatch-style programs with technical advice, quality assurance and assistance with community reporting. During summer 2008–2009 12 coastal councils in regional NSW participated in the program, monitoring 143 sites. A report detailing the results of the programs will be issued at the start of the 2009–2010 summer season. Twelve councils participated in the program in summer 2007–2008 and 2006–2007, and nine councils participated during the 2004–2005 and 2005–2006 summer seasons (DECC 2008, DECC 2007, DEC 2006a and 2006b).

Daily bulletins

The daily Beachwatch and Harbourwatch bulletins provide information to the community on the potential risk of bacterial contamination in bathing waters. They are based primarily on rainfall data and also include reports of sewage treatment bypasses and other pollution incidents as they occur.

The daily Beachwatch and Harbourwatch bulletins are available at (www.environment.nsw.gov.au/beach) and on a recorded telephone information line (1800 036 677); they are also sent by fax to relevant authorities such as local councils, State Government agencies and most major print, radio and television media.

Weekly reports

In 1996 Beachwatch introduced a weekly community information service for beach users in the Illawarra. A beach 'star rating' is published in local newspapers in the Illawarra during summer and is based on the results of water sampling by Sydney Water at 18 Illawarra beaches.

A weekly beach 'star rating' is also published in local papers in the Hunter region during summer and is available on the Hunter Water website all year round. The rating is based on the results of water sampling by Hunter Water at 17 beaches in the Hunter region.

The sample collection techniques and laboratory analysis of water samples collected by Hunter Water and Sydney Water are included in the Beachwatch quality assurance program (Chapter 5).

Monthly media release

A news release is issued each month for Beachwatch and Harbourwatch monitoring undertaken in the Sydney Metropolitan region. The monthly reports summarise the results of water quality analyses, compare these with rainfall and may also include reported visual pollution or information from telemetered sewage overflows. The reports are released to the media and other interested parties and are available on the Beachwatch website.

Annual State of the Beaches report

The annual State of the Beaches report is issued each October and provides a comprehensive summary of Beachwatch activities and results of water quality monitoring for the summer season (October to April). It also includes the results of the winter season (May to September). Beachwatch uses a rolling median (see page 4) to calculate compliance for each beach. The raw data for the entire year are presented for each beach, along with comparisons of aggregated data between beaches.

Bacterial water quality analyses

Beachwatch collects water samples for the Sydney Metropolitan area at all sites once every six days as part of the long-term monitoring program. The sampling frequency is in accordance with national health guidelines for recreational use of water (see below). Samples are transported to a commercial laboratory and analysed for the presence of two indicator organisms,

faecal coliforms and enterococci, which may indicate that sewage pollution is present in the water.

In recent years, faecal coliforms have been renamed thermotolerant coliforms, as some genera within the group are not of faecal origin. However, to be consistent with previous Beachwatch reports the terminology 'faecal coliforms' is used in this report.

Faecal coliforms generally survive in marine waters for between 24 and 48 hours. When elevated faecal coliform levels are detected in a water sample it indicates the presence of recent sewage contamination at the swimming site.

Enterococci survive for much longer than faecal coliforms in marine waters (Sieburth and Lessard 1983). Thus, the detection of elevated enterococci levels, in conjunction with low levels of faecal coliforms, indicates the presence of aged sewage contamination.

Additional information on the indicator organisms is presented in Appendix 1.

As Beachwatch collects samples every sixth day, in accordance with national guidelines, we are more likely to detect aged sewage contamination than fresh sewage contamination. Accordingly, enterococci compliance levels at many sites are lower than faecal coliform compliances.

As the laboratory analyses take up to 48 hours to complete (APHA 1998), results of the water quality monitoring are not available for inclusion in the Beachwatch daily bulletin.

Quality assurance program results

To ensure that data collected by Beachwatch are accurate and reliable, a quality assurance program covering field sampling, analysis of samples and community reporting is undertaken. The results of this program are detailed in Chapter 5.

Recreational water quality guidelines

Recreational water quality guidelines are based on the probability of swimmers developing illnesses derived from the water, but the actual risk depends on many factors. These factors include the ratio between the bacterial indicator and the actual pathogens in the water, which varies with time and is usually unknown.

The recreational water quality guidelines used by the Beachwatch Program are based on, but not identical to, guidelines published by NHMRC (1990). Accordingly, the guidelines in this report are not referred to as NHMRC (1990) guidelines, but as the Beachwatch guidelines.

The NHMRC (1990) and Beachwatch guidelines contain identical criteria for faecal coliforms and require the calculation of the median (the middle value when ranked) and second-highest value of five consecutive samples (the 80th percentile).

For enterococci, the NHMRC (1990) guidelines contain a criterion based on a geometric mean of sample values. Beachwatch has modified this criterion to bring it in line with the method used for faecal coliforms, that is, a median and second-highest value of five samples (the 80th percentile).

A study comparing compliance under the NHMRC (1990) and Beachwatch guidelines found that seasonal enterococci compliance under the Beachwatch approach were, on average, five percentage points lower than those under the NHMRC (1990) approach. The Beachwatch guidelines are therefore slightly more stringent than the NHMRC (1990) guidelines.

In February 2008, NHMRC released new recreational water quality standards, called *Managing Risks in Recreational Waters*. These guidelines are largely based on the World Health Organisation guidelines, published in October 2003 (WHO 2003). They are not mandatory but are provided as a tool for State and Territory Governments to develop relevant programs.

On this basis, Beachwatch has revised its monitoring and reporting protocols to implement the new guidelines from 1 May 2009. Further information on the new guidelines is provided in Chapter 7.

Water samples collected by Beachwatch are analysed for faecal coliform and enterococci density by using internationally recognised membrane filtration methods (APHA 1998). The management of the data has also taken account of guidelines published by the

Australian and New Zealand Environment and Conservation Council (ANZECC 2000) and the United States Environmental Protection Agency (USEPA 1983 and 1986). The water quality assessment criteria for this report are listed below.

Compliance results are based solely on the long-term monitoring program, even where additional samples have been routinely collected for special studies. This allows for valid comparisons to be made between sites, as the analysis is then performed on equivalent datasets.

Water quality assessment criteria for this report

Beachwatch considers that waters are suitable for swimming if, for the five samples collected each month:

1. the median faecal coliform density is equal to or less than 150 colony forming units per 100 millilitres (cfu/100 mL), and
2. the second-highest sample contains less than 600 cfu/100 mL (faecal coliforms), and
3. the median enterococci density is equal to or less than 35 cfu/100 mL, and
4. the second-highest sample contains less than 100 cfu/100 mL (enterococci) for five samples taken at regular intervals not exceeding one month.

Beachwatch uses a rolling median (and rolling second-highest sample) to calculate the seasonal compliance estimates for each beach.

Rolling medians

The NHMRC (1990) guidelines for recreational water quality require that results be presented as a 'pass' or 'fail' for each 30-day period. Beachwatch employs this approach when reporting compliance in our monthly reports.

The national guidelines do not provide a method for calculating seasonal compliance. Although it is possible to present the results as the percentage of months that have passed within a season (a static monthly assessment), this approach creates an artificial boundary between calendar months, and a pollution event may not be captured by the criteria if the event occurs across the boundary of two months.

Beachwatch has adopted a 'rolling' 30-day assessment to avoid the artificial boundary of calendar months. The rolling median and second-highest value (80th percentile) are calculated from five successive data points (based on sampling every sixth day, resulting in five samples per month). The median and second-highest value are initially calculated from the first five data points in the data set. The next median and second-highest value (80th percentile) are calculated by shifting forward to the next sample day and using these five data points in the calculation. Shifting forward to the next sample day continues for the entire data set, giving successive median and second-highest (80th percentile) values using overlapping groups of five data points. Each median and second-highest (80th percentile) value calculated by the rolling method uses data from a 30-day period, not a single sample.

This method gives five median and five second-highest (80th percentile) values over the month, as opposed to a single median and second-highest (80th percentile) value using the static method. The advantages of using a rolling median are:

- it overcomes artificial boundaries between months
- it provides a greater number of values for interpretation
- results are more responsive to, and representative of, environmental events.

Although Beachwatch believes that the advantages of using the rolling method outweigh those of using a static approach, the rolling method does have its limitations. A pollution event can be included in a number of successive medians (rather than by one median), thus artificially extending the pollution event.

However, static medians and second-highest values that are calculated for each individual month may fail to detect a pollution event at all if it occurs across the artificial boundary between two months.

Explanation of compliance calculations and beach ranking

Compliance calculations

Compliance with the water quality assessment criteria has been calculated for each bacterial indicator for summer 2008–2009 (1 October 2008 to 30 April 2009) as follows:

% compliance = (number of rolling 30-day periods passing criteria ÷ total number of 30-day periods) × 100.

The number of rolling 30-day periods during the summer season was 31 and, during winter, 22.

Ranking methodology

A beach-ranking system was introduced in 1999–2000 with the aim of giving the reader a simple indication of which beaches are the most suitable for primary contact recreation relative to the other beaches in the Beachwatch and Harbourwatch program. As this is a relative ranking, the results do not imply a measure of health risk: that is, the lowest-ranked beach may still comply with health guidelines for some of the time.

The percentage compliance for faecal coliform and enterococci data for the 2008–2009 summer season was summed to obtain a single figure that is equally weighted between the two indicators. All sites were ranked according to this method.

Several sites had the same summed total, and these were given an equal ranking. For example, a summed total of 200 (that is, 100% faecal coliform compliance and 100% enterococci compliance) resulted in an equal first ranking for 103 swimming sites. To maintain perspective, the next best swimming site or sites were ranked second, not 104th.

Ranking was done for all sites in the Beachwatch and Harbourwatch program to enable comparisons between all of the monitored sites.

Explanation of graphs

Beachwatch believes that firm conclusions about beach water quality cannot be made on the basis of a single bacterial result, owing to the inherent variability in bacterial data. However, trends in bacterial density over a season can provide useful information. Consequently, bacterial density data are presented throughout this report in two graphical formats:

- box plots, which summarise the distribution of all the data
- season graphs, in which the data are presented on a time line.

An understanding of the graphical formats will help the reader to interpret the data.

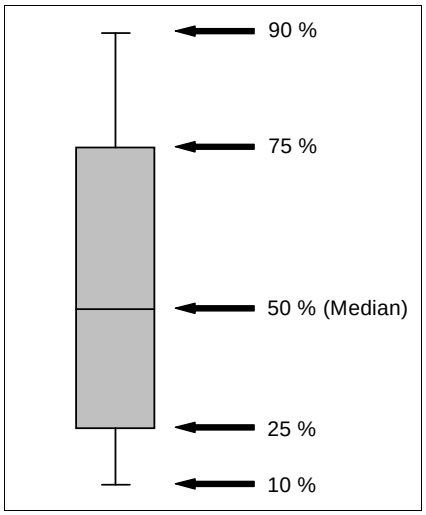
Box plots

Throughout this report, data are often aggregated for analysis. These analyses are presented graphically as a box plot, except when there are fewer than five data points, in which case only the individual data points are shown (Figure 3). A typical example of a box plot is illustrated in Figure 1.

At sites where a significant number of samples return results below the detection limit, only the upper portion of the box plots will be visible.

The box plot gives a clear representation of the spread, skew and distribution of the data.

Figure 1: Example of a Box Plot



Each part of the box plot represents a significant percentile value of the sample population:

- 10% of the samples lie below the bottom whisker
- 25% of the samples lie below the bottom of the box
- half the samples are on each side of the middle line of the box (median)
- 75% of the samples lie below the top of the box
- 90% of the samples lie below the top whisker.

Rainfall graphs

An example of the use of box plots in this report are the graphs used to represent the relationship between rainfall and bacterial density at each beach. The information is based on data from the last three years. Typical examples are illustrated in Figures 2 and 3.

Rainfall data were obtained from those rain gauges situated closest to the sample site. The next-closest rain gauge in the catchment was used if data were missing on any day. Rainfall data are presented as a range and are for the 24 hours to 9 am on the day of sampling. If there are fewer than five bacterial data points for a rainfall range, a box plot is not generated and individual data points are presented as black dots (Figures 2 and 3).

One of the criteria for passing the recreational water quality guideline is that the median value (the middle bar in the box plot) should not exceed 150 cfu/100 mL for faecal coliforms or 35 cfu/100 mL for enterococci. Figure 2 demonstrates that the guideline median value is not exceeded for any of the rainfall ranges, but the median for the more than 20 mm rainfall category starts to approach the median guideline limit.

Only the median guideline limit is shown on these graphs, but Beachwatch guidelines also require four out of five samples (80th percentile) to be below the criteria specified. That is, the 80th percentile should not exceed 600 cfu/100 mL for faecal coliforms, or 100 cfu/100 mL for enterococci. The 80th percentile criteria limit is not shown; the graphs are intended to represent a trend showing the response of bacterial density to rainfall rather than a pass or fail of the guidelines.

Figure 2: Example of Response to Rainfall — Faecal Coliforms

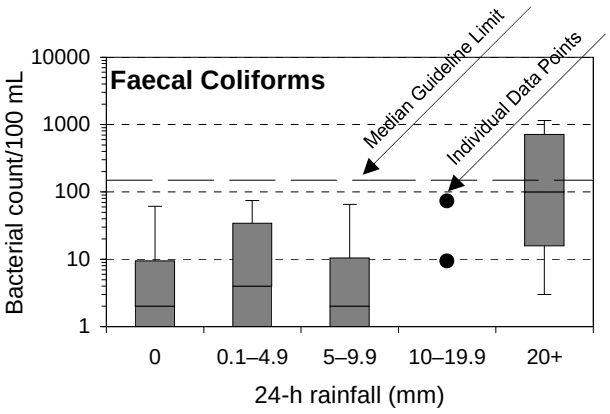
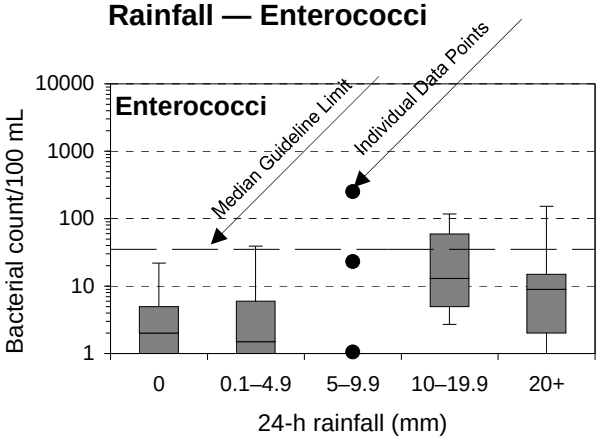


Figure 3: Example of Response to Rainfall — Enterococci



Season graphs

Figure 4 illustrates the key points of the graphical representation of the water quality monitoring data presented in Chapters 3 and 4. In accordance with the NHMRC (1990) guidelines, water samples are collected approximately every sixth day, giving a minimum of five samples each month. Faecal coliform results are presented in the left graph and enterococci results are in the right graph. The scales for bacterial count and daily rainfall are the same for both graphs.

Explanation of maps

Maps have been provided to indicate the locations of beaches and swimming sites, sample sites, surf clubs, stormwater drains, coastal sewage treatment plants and major

sewage overflow points. The council region maps include land-use classifications such as national parks and open spaces, thus providing an indication of developed and undeveloped areas in each council region.

Sewage overflow locations

Sewage overflow points on the maps have been identified as the overflows that may potentially affect areas used for primary contact recreation. This information was obtained from the 27 sewer overflow environmental impact statements covering the entire sewerage system for the Sydney and Illawarra regions. Sydney Water submitted these to DECCW in June 1998 (with updates provided as the sewerage system is upgraded).

Sewage overflow locations are not yet shown on the maps for the Hunter Region. Hunter Water has completed a detailed program of studies to investigate sewage overflows and impacts in Newcastle and Lake Macquarie.

Many of the sewage overflows shown on the maps are designed structure overflows. These overflow points have been incorporated into the sewer system to release excess wet weather flows and prevent overflows in residential areas. They generally discharge directly into waterways or the stormwater system.

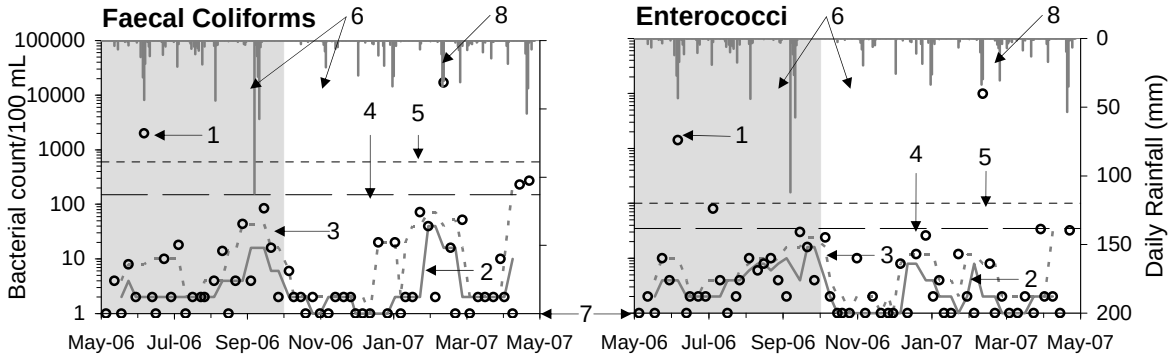
The remaining sewage overflow points are undirected overflows, and these occur from non-design overflow points such as access chambers within the sewer system. Chokes caused by tree root intrusion or debris in the sewerage system can also result in overflows. As many potential undirected overflow points exist within the sewerage system, criteria were developed for including these on the maps. Undirected overflow points have been included only if they overflow more frequently than once a year and are located in areas that may affect primary contact recreation.

Stormwater system

Sewage overflows can flow into the stormwater system and in some cases may contaminate recreational waterways. Because of its detailed nature, the stormwater system has not been shown on the maps in this report.

The maps include the locations of stormwater drain outlets, coded according to size and type, including small, medium, large and open drains. Major creeks and rivers have also been included on the maps.

Figure 4: Example of Season Graph



Numbers have been added in bold type to explain the graph. The numbers represent:

1 Individual sample results (o)

2 Rolling median based on the nearest five sample results (—)

3 Rolling second-highest (80th percentile) sample based on five nearest sample results (- - -)

4 Recreational water quality compliance threshold that should not be exceeded by the rolling median (150 cfu/100 mL for faecal coliforms and 35 cfu/100 mL for enterococci) (— —)

5 Recreational water quality compliance threshold that should not be exceeded by the rolling second-highest sample (the 80th percentile) (600 cfu/100 mL for faecal coliforms and 100 cfu/100 mL for enterococci) (- - -)

6 The shaded area is the previous winter season and the unshaded area is the previous summer season.

7 Data plotted along the baseline represent a bacterial density of 1 or < 1 cfu/100 mL.

8 Daily rainfall (mm) (|)