

NSW Health Guidelines for Managing Water Quality in Public Swimming Pools and Spa Pools

2026

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Glossary

Term	Definition
Acid	A liquid or dry chemical used to lower the pH of pool water.
Acidic	Having a pH below 7.0.
Alkaline	Having a pH above 7.0.
Alkalinity	Refer to 'Total alkalinity'.
Alkalinity factor (AF)	A factor derived from total alkalinity. Used to calculate the Langelier Saturation Index of water.
Ammonia	A nitrogen-containing compound that combines with free available chlorine to form chloramines or combined chlorine.
Backwash	The process of removing debris accumulated in a filter by reversing the flow of water through the filter.
BCDMH	Bromo-chloro-dimethylhydantoin. A common name bromine-based disinfectant.
Biofilm	Slime-like community of microorganisms usually attached to wet surfaces.
Breakpoint chlorination	The addition of sufficient chlorine to oxidise combined chlorine to the point where free available chlorine makes up the total chlorine and combined chlorine is oxidised to below detectable levels. Also known as 'breakpoint'.
Bromate	Bromate ions are formed when bromide ions react with ozone. It is a disinfection by-product.
Bromamine	Bromamine is formed when bromine reacts with ammonia in urine, sweat or other nitrogen-containing compounds in water. Also known as 'combined bromine'.
Buffering capacity	The number of moles of strong acid or base needed to change the pH of a litre of buffer solution by one unit.
Calcium hardness	A measure of calcium salts dissolved in pool water. Calcium hardness factor (CF) is used to calculate Langelier Saturation Index.
Carbon dioxide	A common gas found in air at trace levels. When injected into pool water it forms mild carbonic acid to lower pH.
Chloramines	Chloramines are formed when free available chlorine reacts with urine, sweat or other nitrogen-containing compounds in water.
Chlorination	The application of chlorine products for disinfection.
Chlorine demand	The amount of chlorine that will be consumed by readily oxidisable impurities in pool water.

Term	Definition
Chlorine dioxide	A secondary disinfectant. Chlorine dioxide is usually generally generated onsite and then added to the water or generated in the water itself by adding specially formulated tablets to the water.
Chlorine gas	Gaseous form of chlorine containing 100 per cent available chlorine.
Circulation rate	The flow of water in m ³ /h to and from the pool through all the pipework and treatment system.
Clarity	Degree of transparency with which an object can be seen through a given depth of pool water.
Coagulants	Chemicals, sometimes referred to as flocculants, that help clump suspended particles together into a filterable size.
Colloidal	Items of small size that are suspended in solid, liquid or gas.
Colony-forming units (CFU)	A measure of microorganisms per unit volume of water.
Combined bromine	Also known as 'bromamine'.
Combined chlorine	Combined chlorine (including chloramine) is formed when free available chlorine reacts with ammonia in urine, sweat or other nitrogen-containing compounds in water.
<i>Cryptosporidium</i>	A protozoan parasite that causes cryptosporidiosis. This is a diarrhoeal disease that in healthy people can last up to two weeks. For those with some underlying health conditions it can result in prolonged illness, severe dehydration, and in some cases death.
<i>C.t</i>	A measure of disinfection effectiveness. It is disinfection residual concentration (C, in mg/L), multiplied by contact time (t, in minutes) at the point of residual measurement.
Cyanuric acid	A stabiliser that can be added to an outdoor swimming pool to reduce chlorine loss due to ultraviolet light from the sun.
Disinfectant	An oxidising agent that is added to water and is intended to inactivate disease-causing microorganisms.
Disinfectant residual	The measurable active disinfectant present in water.
Disinfection by-product	Products of reactions between disinfectants, particularly chlorine, and naturally occurring organic material.
Drinking water	Water provided, usually from a mains supply by a drinking water supplier.
<i>Escherichia coli</i> (E. coli)	<i>Escherichia coli</i> is typically used as an indicator of faecal contamination and that disease-causing microorganisms may also be present.
Filter	A vessel or device that removes suspended particles.
Filtrate	Water that has passed through a filter.

Term	Definition
Filtration	Filtration is a treatment process that physically removes suspended particles from the water. Effective filtration is necessary for effective disinfection.
Flocculant	A substance used in treating water that promotes clumping of particles.
Flow rate	Velocity of water typically stated as litres/second (L/s) or cubic metres per hour (m ³ /h).
Free available chlorine	A measure of the chlorine that is available as hypochlorous acid and hypochlorite ion. Also known as 'free chlorine'.
Free chlorine	A measure of the chlorine that is available as hypochlorous acid and hypochlorite ion. Also known as 'free available chlorine'.
Head loss	Head loss is the reduction in water pressure or energy through a filter, caused by friction and trapped particles. It represents the resistance to flow. The pressure drops as the filter becomes clogged with contaminants indicating when to backwash.
Heterotrophic colony count	The number of colonies of heterotrophic bacteria grown on selected solid media at a given temperature and incubation period, usually expressed in number of bacteria per millilitre of sample. Also known as 'heterotrophic plate count' or 'total plate count'.
Hyperchlorination	The practice of dosing high amounts of chlorine-containing product to achieve a specific <i>C.t</i> to inactivate disease-causing microorganisms. Can also be referred to as superchlorination.
Hypochlorous acid	Formed when any chlorine-containing product is dissolved in water. The most active oxidising form of chlorine.
Interactive water feature	A water play park such as a splash pad or spray park and other recreational aquatic structures.
Inlets	Points at which water from the swimming pool or spa pool's water treatment is introduced to the water body.
Isocyanuric acid	Refer to 'cyanuric acid'.
Langelier Saturation Index	Calculation based on various factors to determine the corrosive or scale-formation nature of water. Used to determine appropriate water balance.
Log reduction	A mathematical term referring in these guidelines to logarithms to the base 10, and a 10-fold (or 90%) reduction in the quantitative value of a microbiological population. It is used in reference to physical or chemical treatment of water to remove and/or inactivate microorganisms such as bacteria, protozoa and viruses. For example, a 1-log ₁₀ reduction means the quantitative value of a microbiological population is reduced by 90% or 10-fold reduction; 3-log ₁₀ = 99.9% or 1,000-fold reduction.

Term	Definition
Make-up water	Water used to replace water lost from a swimming pool or spa pool including backwash water, evaporation, splashing, water exchange and the water users carry out. Make-up water is typically introduced from a public drinking water supply via an auto-level valve.
Maximum bather load	The maximum number of bathers in a pool or spa pool at any one time. This should be linked to the capacity of the treatment system and pool safety.
Micron	A micrometre – one millionth of a metre. Used to describe particle size.
Microorganism	Microscopic organism such as a virus, bacterium, or protozoa.
Multi-barrier approach	Water quality risks can be prevented or reduced at multiple points of the treatment process, not just relying on a single barrier in the treatment system.
National Association of Testing Authorities (NATA)	The national accreditation body for Australian testing laboratories.
Nitrogen	An element present in ammonia, sweat, urine, fertilisers and a variety of personal care products. When introduced to pools, it readily reacts with chlorine to form combined chlorine.
Oocyst	A hardy, thick-walled spore. The infective stage in the life cycle of <i>Cryptosporidium</i> .
Outbreak	More than one human case of a communicable (infectious) disease related to a common exposure.
Outlets	Points at which water exits a pool for treatment by the water treatment plant.
Ozone	A secondary disinfectant and a powerful oxidant. Ozone is a relatively unstable molecule containing three oxygen atoms. It is created on-site by-passing oxygen across a corona discharge. It has a very short life and cannot be stored for later use. It is very hazardous, especially in poorly ventilated spaces.
Pathogens	Disease-causing microorganisms.
pH	A scale used to express the acidity or alkalinity of a solution on a scale of 0–14, with 7.0 being neutral. Values less than 7.0 are acidic and values greater than 7.0 are alkaline.
Physicochemical	Relating to both physical and chemical properties of a substance.
Residual	Refer to 'disinfectant residual'.
Scale	The precipitate that forms on surfaces in contact with water when calcium hardness, pH or total alkalinity levels are too high.

Term	Definition
Shock dosing	The practice of dosing high amounts of chlorine (sometimes in excess of 10 mg/L) into a public swimming pool or spa pool to reduce combined chlorine or to remove confirmed or suspected contamination.
Sodium bicarbonate	A white powder used to raise total alkalinity in pool water. Also known as bicarb soda.
Sodium bisulfate	A granular material used to lower pH and/or total alkalinity in water. Also known as dry acid.
Sodium carbonate	A white powder used to raise pH in water.
Sodium hypochlorite	A clear liquid form of chlorine. Commercially available in bulk-delivered strengths of 10–12.5% available chlorine. Also called liquid chlorine or bleach.
Sodium thiosulfate	A chemical that can be added to water to neutralise all residual chlorine.
Source water	Water used to fill the swimming pool or spa pool and used as make-up water. Usually, mains drinking water but could also include rainwater provided it meets the <i>Australian Drinking Water Guidelines</i> .
Stabiliser	Refer to 'cyanuric acid'.
Test kit	Equipment used to determine specific water quality parameters.
Total alkalinity	A measure of the pH buffering capacity of water.
Total chlorine	A measurement of the sum of both free and combined chlorine.
Total dissolved solids (TDS)	A measure of soluble material dissolved in water.
Trihalomethanes	Disinfection by-product compounds formed by reaction between chlorine or bromine and certain organic compounds.
Turbidity	The cloudiness of water due to the presence of extremely fine particulate matter in suspension that interferes with light transmission. Generally measured using Nephelometric Turbidity Units (NTU).
Turnover time	The period of time required to circulate a volume of water equal to the pool's capacity through the treatment plant.
Ultraviolet (UV) light	A secondary disinfectant that uses wavelengths of light shorter than visible light to inactivate microorganisms.

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1

Introduction

Chapter 1 Introduction

These guidelines assist organisations and operators of public swimming pools and spa pools to manage water quality to protect public health according to relevant regulatory frameworks. It also provides advice to local and state government environmental health officers to help fulfil their regulatory and advisory roles regarding water quality in public swimming pools and spa pools.

The *NSW Public Health Act 2010* (the Act) and Public Health Regulation 2022 (the Regulation) define and detail the requirements for public swimming pools and spa pools in NSW. Refer to [Chapter 3](#) for more information.

The Act defines a public swimming pool or spa pool to be any structure that is used or intended to be used for human bathing, swimming, or diving to which the public is admitted, whether free of charge, on payment of a fee or otherwise. This includes pools:

- to which the public is admitted as an entitlement of membership of a club
- provided at a workplace for the use of employees
- provided at a hotel, motel or guest house or at holiday units, or similar facility, for the use of guests
- provided at a school or hospital
- situated at private residential premises used for commercial purposes.

A public spa pool also includes any structure (other than a swimming pool) that holds more than 680 litres of water, is used, or intended to be used for human bathing and has facilities for injecting jets of water or air into the water.

Water play parks and other recreational aquatic structures, including water slides and any interactive water feature or fountain that is intended to be bathed in for recreational purposes, are not declared to be a public swimming pool or spa pool if they use a public water supply, do not use a recirculation system and do not store water. Refer to [Appendix A](#) for more information about interactive water features such as water play parks or other recreational aquatic structures (splash pads, spray parks and water play areas).

A natural swimming pool is a swimming pool that contains only untreated water that is supplied directly to the pool from the ocean or other natural water source and does not have a circulation system. Natural swimming pools are exempt from the Regulation's operation, notification and registration requirements for public swimming pools. The Regulation provides powers for temporary closure orders and directions to take action if a natural swimming pool is a risk to public health. Organisations that manage natural swimming pools should refer to [Appendix B](#) and the latest edition of National Health and Medical Research Council's *Guidelines for Managing Risks in Recreational Water*.

Although these guidelines may be useful for domestic swimming and spa pools owners, questions about water quality or maintaining domestic pools are best directed to Swimming Pool and Spa Association of Australia (SPASA), a pool shop or a pool and spa service technician.

Outside the scope of this document are risks related to pool design (such as hydraulics), fencing, physical safety (for example, slips and falls), drowning and sun protection.

For operational matters not covered in this document, public swimming pool and spa pool operators should refer to relevant risk management guidelines and standards such as the Royal Life Saving Society Australia's *Guidelines for Safe Pool Operations*.

2

Public health hazards

Chapter 2 Public health hazards

Key points

- Poorly managed public pools can create ideal conditions for spreading disease.
- In public pools, microbiological hazards pose the greatest risk to health because they can cause outbreaks of disease.
- Chemicals can pose a risk to the health of bathers and staff.

All public swimming pools and spa pools must be properly managed to reduce microbiological, chemical, and environmental hazards. Poor management can cause harm to the health of bathers, particularly for vulnerable bathers such as young children, the elderly, and people with low immunity.

Bathers can be affected by disease-causing microorganisms that are passed on through contaminated pool water, contaminated surfaces or person-to-person contact. Certain chemicals, environmental hazards and poor water supply quality can also put the health of bathers at risk.

NSW Health recommends public swimming pools and spa pools use a water quality risk management plan to help protect public health. Refer to [Appendix C](#) for more information.

2.1 Microbiological hazards

Viruses, bacteria, protozoa, and fungi are common disease-causing microbiological hazards in public swimming pools and spa pools. Microbiological hazards are typically introduced into public swimming pools and spa pools through:

- **faecal matter** – for example, contaminated water source, faecal accidents or shedding of faecal matter from bathers
- **other contaminants** – for example, shedding from human skin, mucus, vomit or other secretions; from animals; windblown matter; stormwater runoff or microorganisms associated with warm water environments.

Table 2-1 lists examples of illnesses associated with public pools. Skin, wound and ear infections and gastroenteritis are the most common illnesses. Other conditions such as Legionnaires' disease are less common but may be associated with poorly maintained spa pools or heated water systems. It is rare for public pools to be associated with illness caused by *Acanthamoeba*, nontuberculous *Mycobacterium*, *Leptospira*, and *Naegleria fowleri*. People with low immunity may have an increased risk of developing illness associated with microbial contamination of a public pool.

Cryptosporidium is highly resistant to chlorine disinfection and is responsible for most disease outbreaks associated with public pools. *Cryptosporidium* causes cryptosporidiosis, which is a diarrhoeal disease that can last up to 30 days. A person infected with cryptosporidiosis may continue to shed *Cryptosporidium* oocysts in their faeces for several weeks after their symptoms have subsided and may continue to be infectious. A person who has diarrhoea should not swim for at least 14 days after all symptoms have resolved to prevent potential contamination of a public pool.

The risk of passing on illness increases if public pools are not properly managed. While most illnesses are associated with poor disinfection, outbreaks can occur in well maintained pools because disinfectants need time to inactivate micro-organisms. It is important to immediately close and decontaminate a pool after a potentially infectious incident (for example faecal or vomit incident).

Information on reducing microbiological hazards in natural swimming pools is included in [Appendix B](#).

Table 2-1 Examples of illnesses associated with public swimming pools and spa pools.

Hazard source	Group of causal microorganisms	Causal microorganism	Type of illness	Example source of causal microorganism
Faecally derived	Virus	Adenovirus ¹	Gastroenteritis, or upper respiratory tract infections	Faecal accidents Bather shedding Vomit accidents
		Hepatitis A	Gastroenteritis	
		Norovirus		
		Echovirus		
	Bacteria	<i>Escherichia coli</i> (<i>E. coli</i>)		
		<i>Shigella</i>		
		<i>Campylobacter</i>		
	Protozoan parasite	<i>Cryptosporidium</i>		
		<i>Giardia</i>		
Non-faecally derived	Bacteria	<i>Pseudomonas aeruginosa</i>	Skin, wound or ear infections	Bather shedding in water or on wet surfaces Biofilm growth in poorly disinfected pools
		<i>Staphylococcus aureus</i>		
		<i>Legionella spp.</i>	<i>Legionella</i> pneumonia or hypersensitivity pneumonitis	Aerosols from spas and water sprays with inadequate disinfection Poorly maintained showers or heated water systems
		Nontuberculous <i>Mycobacterium</i>	Hypersensitivity pneumonitis or skin granulomas	Bather shedding in water or on wet surfaces Aerosols from spas and water sprays
		<i>Leptospira spp.</i>	Leptospirosis ²	Pool water contaminated with urine from infected animals
	Virus	Molluscum contagiosum	Skin infection	Bather shedding on wet surfaces (mainly towels or swimming aids) ³
		Papillomavirus (plantar wart)	Skin infection	Bather shedding on wet surfaces
	Fungi	Tinea pedis (athlete's foot)	Skin and nail infection	Bather shedding on wet surfaces
	Protozoan amoeba	<i>Acanthamoeba</i> ⁴	Granulomatous amoebic encephalitis Keratitis	Aerosols from warm water environments Biofilm growth
		<i>Naegleria fowleri</i>	Primary amoebic meningoencephalitis	Warm water environments that are inadequately disinfected Biofilm growth in poorly disinfected warm pools

Adapted from World Health Organization (2006).

¹ Also associated with respiratory and ocular symptoms with non-faecally derived transmission.

² Symptoms range from flu-like symptoms to severe organ disease (haemorrhagic jaundice or aseptic meningitis).

³ Transmission is predominantly from direct human-to-human contact.

⁴ Risk of illness greater in people who are immunosuppressed or wear contact lenses.

2.2 Chemical hazards

Pool chemicals are to be used and stored according to the manufacturer's instructions to reduce risks from chemical hazards. Personnel should be trained and wear appropriate personal protective equipment when handling chemicals. Safety data sheets should be available on site for all chemicals.

Disinfection by-products (DBPs) are chemical compounds that form when disinfection chemicals react with contaminants from the skin, hair, sweat, saliva, urine, and other organic matter. Trihalomethanes are the most common disinfection by-products associated with public pools.

DBPs pose a risk to water quality and air quality in indoor swimming pools and spa pools. Ventilation rates in the Australian Standard 1668 and the Australian Building Codes Board's National Construction Code should be followed for all indoor swimming pools and spa pools for bather and staff health and comfort.

2.3 Environmental hazards

Bathers introduce most of the contamination in a swimming pool or spa pool. Contamination can also be introduced from the surrounding environment and can vary seasonally. Environmental contamination can be a problem for outdoor public pools and natural swimming pools where dust, soil, sand, leaves, and grass can easily enter the pool. Birds, bats, and other animals can also contaminate the pool with their droppings.

2.4 Water supply

Water used to fill public swimming pools and spa pools (other than natural swimming pools) should meet the National Health and Medical Research Council's *Australian Drinking Water Guidelines*. The best available water supply, ideally mains drinking water, should always be used to fill a pool.

Some public drinking water supplies maintain a chloramine residual rather than a free chlorine residual. This may affect the pool's ability to manage combined chlorine. Achieving breakpoint is necessary to achieve a free available chlorine residual in pool water that is disinfected with chloramine. Refer to [Chapter 4](#) and [Appendix D](#) for more information about breakpoint.

Alternative water sources, such as rainwater or other raw water supply, could be considered if the water source complies with the *Australian Drinking Water Guidelines*. Risks associated with the use of alternative water sources should be assessed and documented in a risk assessment to ensure potential hazards are identified and managed. Chemical and microbiological quality of the rainwater or other raw water source should be monitored as it may impact treatment requirements.

Recycled water, including treated stormwater, sewage, or pool backwash water, is unlikely to be suitable for swimming pools without substantial treatment and careful ongoing management due to risks to human health from microbiological and chemical contaminants. Sydney Water, where it operates recycled water schemes, advises that recycled water must not be used for filling swimming pools and spas.

3

Regulatory framework

Chapter 3 Regulatory framework

Key points

- The *Public Health Act 2010* and Public Health Regulation 2022 outline regulatory requirements that apply to public swimming pools and spa pools.
- Local government and NSW Health Public Health Units regulate public swimming pools and spa pools including registration and inspection to check compliance with prescribed operating requirements.
- Operators must disinfect (other than natural swimming pools) and clean pools and surrounds to minimise transmission of disease, in accordance with the legislation.
- Operators must make and keep records of required testing results for at least 6 months.

3.1 *Public Health Act 2010* and Public Health Regulation 2022

Public swimming pools and spa pools are regulated under the *NSW Public Health Act 2010* (the Act) and the Public Health Regulation 2022 (the Regulation).

The Act requires occupiers of premises at which a public swimming pool or spa pool is situated must:

- give notice of the pool's existence to their local council
- comply with the prescribed operating requirements
- not allow a person to use the pool unless the water is disinfected in such a way as to minimise the transmission of disease to users of the pool
- ensure that the pool surrounds, including any toilets and change rooms, are kept clean and in such condition as to minimise the transmission of disease.

The Act provides authorised officers from NSW Health and local government with powers to determine whether there is a public health risk at a public swimming pool or spa pool. The Act also provides enforcement tools to address public health risk. The Regulation prescribes operating, testing and water quality requirements to protect public health and minimise the risk of disease transmission.

3.1.1 Definitions

A swimming pool includes any structure that is used or intended to be used for human bathing, swimming, or diving. This can include water slides, water play parks or other recreational aquatic structures including any interactive water feature or fountain that is intended to be bathed in for recreational purposes.

The Act defines a *public swimming pool or spa pool* as a swimming pool or spa pool to which the public is admitted, whether free of charge, on payment of a fee or otherwise. This includes pools:

- to which the public is admitted as an entitlement of membership of a club
- provided at a workplace for the use of employees
- provided at a hotel, motel, or guest house or at holiday units, or similar facility, for the use of guests
- provided at a school or hospital
- situated at private residential premises used for commercial purposes
- any other pool or spa pool declared by the Regulation to be a public swimming pool or spa pool.

In accordance with the Act, a spa pool includes any structure (other than a swimming pool) that holds more than 680 litres of water, is used, or intended to be used for human bathing and has facilities for injecting jets of water or air into the water.

Under the Regulation, an interactive water feature such as a water play park or other recreational aquatic structure is declared not to be a public swimming pool or spa pool if it uses a public water supply, does not use a recirculation system, and does not store water.

In accordance with the Regulation, a natural swimming pool is a swimming pool that contains only untreated water that is supplied directly to the pool from the ocean or other natural water source and does not have a circulation system. The operating, notification, and registration requirements for swimming pools under the Regulation do not apply to natural swimming pools. Powers under the Regulation providing for temporary closure orders and directions to take action if a pool is a risk to public health do apply to natural swimming pools. More information about natural swimming pools is available in [Appendix B](#).

3.1.2 Prescribed operating, monitoring and record keeping requirements

Schedule 1 of the Regulation prescribes specific operating, monitoring and record keeping requirements for public swimming pools and spa pools. All public swimming pools and spa pools must be fitted with an automated or a continuous metered disinfectant dosing system. Only chlorine or bromine can be used as a primary disinfectant. More information is available in [Chapter 4](#).

3.1.2.1 Chlorine disinfected pools

Table 3-1 outlines the Regulation's requirements for public swimming pools and spas using chlorine-based disinfectants.

Table 3-1 Requirements for swimming pools and spa pools using chlorine-based disinfectants.

Parameter	Situation		Criteria ¹
Free available chlorine²	pH ≤7.6	Outdoor pool without cyanuric acid	Min. 1.0 mg/L
		Outdoor pool with cyanuric acid	Min. 3.0 mg/L
		Indoor pool	Min. 2.0 mg/L
		Spa pool	Min. 2.0 mg/L
	pH >7.6	Outdoor pool without cyanuric acid	Min. 2.0 mg/L
		Outdoor pool with cyanuric acid	Min 4.0 mg/L
		Indoor pool	Min. 3.0 mg/L
		Spa pool	Min. 3.0 mg/L
Combined chlorine	Chlorine disinfected pool		Max. 1.0 mg/L
Total chlorine	Chlorine disinfected pool		Max. 10.0 mg/L
pH	Chlorine disinfected pool		7.0 – 7.8
Total alkalinity	Chlorine disinfected pool		80 – 200 mg/L
Cyanuric acid	Outdoor swimming pool only		Max. 50 mg/L
Ozone³	Any pool		Not present
Temperature	Any pool		Max. 38°C

¹ The unit mg/L is equivalent to parts per million or ppm.

² Free available chlorine concentration should be increased when high bather numbers are anticipated to ensure concentrations are never less than the minimum.

³ Residual excess ozone is to be quenched before circulated water is returned to the pool.

3.1.2.2 Bromine disinfected pools

Table 3-2 outlines the Regulation's requirements for public swimming pools and spas with bromine-based disinfectants.

Table 3-2 Requirements for swimming pools and spa pools using bromine-based disinfectants.

Parameter	Situation	Criteria ¹
Bromine²	Outdoor public pool	Min 2.25 mg/L
	Indoor swimming pool	Min. 4.5 mg/L
	Spa pool	Min. 4.5 mg/L
Bromine	All bromine disinfected pools	Max. 9.0 mg/L
pH	Bromine disinfected pool	7.0 – 8.0
Total alkalinity	Bromine disinfected pool	80 – 200 mg/L
Ozone³	Bromine disinfected pool	Not present
Temperature	Any pool	Max. 38°C

¹ The unit mg/L is equivalent to parts per million or ppm.

² Bromine concentration should be increased when high bather numbers are anticipated to ensure concentrations are never less than the minimum.

³ Residual excess ozone is to be quenched before circulated water is returned to the pool.

3.1.2.3 Testing of disinfectants and pH levels

Table 3-3 outlines the Regulation's monitoring requirements for public pools and spa pools. Table 6-1 summarises additional recommended pool operational monitoring frequencies.

Table 3-3 Requirements for testing.

Parameter	Frequency of testing
Disinfectant level (free available chlorine, and total chlorine; or bromine) and pH level	Swimming pools or spa pools with a continuous metered disinfectant dosing system must be tested manually once every day before the pool opens for use.
	Swimming pools or spa pools with an automated disinfectant dosing system must be: • recorded every day once before the pool opens for use by the public • recorded once during the period in which the pool is being used • tested manually once every day.
	Swimming pools or spa pools must be tested more frequently than the frequencies mentioned above if the occupier of the premises considers it necessary taking into account the following: • the number of people swimming in the pool at a particular time • the hours of operation of the pool • the depth of the pool • the effect of sunlight on disinfectant levels. See Section 6.1.1 for more guidance on increased monitoring frequencies.
Alkalinity	Daily for all swimming pools or spa pools unless liquid chlorine (sodium hypochlorite) or carbon dioxide-based pH control is used then monthly.
Cyanuric acid (may only be used in outdoor chlorine disinfected swimming pools and must not be used in a spa pool)	Weekly.
Ozone	Weekly (if used in the circulation system of the pool).

3.1.2.4 Records

All public swimming pools and spa pools must maintain a record of the results of testing required under Schedule 1 of the Regulation for at least 6 months. Monitoring logs should be filled out when samples are analysed and kept on site or held electronically and be available for inspection. Swimming pools and spa pools with automated in-line testing where results are recorded electronically should download these results monthly and keep on file with other records. The [NSW Health website](#) has an example of a monitoring log template.

All public swimming pools and spa pools should have arrangements in place for the laboratory analysing any characteristics not tested on site to immediately report the results to the person(s) responsible for managing and maintaining water quality. The responsible person should review results on receipt for compliance with the appropriate water quality requirements (Table 3-1 and Table 3-2). Appropriate corrective actions should be undertaken in instances where non-compliant results are observed.

3.2 Non-compliance with *NSW Public Health Act 2010* and *NSW Public Health Regulation 2022* requirements

Failure to comply with prescribed operating requirements is an offence and could lead to an improvement notice. Occupiers of non-compliant public swimming pools and spa pools may be served a prohibition order to close down their swimming pool or spa pool so that public health risks can be prevented or mitigated.

3.3 NSW Health and local government responsibilities

NSW Health is responsible for public swimming and spa pool public health regulation and guidelines. NSW Health also receives disease notifications, undertakes disease surveillance and management of outbreaks associated with public swimming pools and spa pools. Local government and NSW Health environmental health officers are responsible for regulating public swimming pools and spa pools through the Act and the Regulation. Authorised Officers of NSW Health and local councils inspect public pools and conduct regulatory activities. In NSW, local councils maintain a register of public swimming pools and spas pools as required by the Regulation.

3.4 Building code

Swimming pools should be designed, constructed, and installed according to the Australian Building Codes Board's National Construction Code (NCC). The NCC includes the Building Code of Australia (Volumes 1 and 2) and the Plumbing Code of Australia (Volume 3).

The *NSW Swimming Pools Act 1992*, *NSW Swimming Pools Regulation 2018* and Australian Standard 1926 prescribe requirements for designing, constructing, and installing swimming pools and spas and their safety barriers. Under Part 3A of the *NSW Swimming Pools Act 1992* pool and spa owners must register their pools and assess whether their pools comply with safety standards.

3.5 SafeWork NSW

SafeWork NSW as the workplace health and safety regulator is responsible for regulating compliance with the *NSW Work Health and Safety Act 2011* and the *NSW Work Health and Safety Regulation 2025*. They give advice on improving work health and safety, provide licences and registration for potentially dangerous work and investigate workplace incidents and enforce work health and safety laws.

Pool staff should be trained to handle pool chemicals appropriately and safely to prevent injuries. Pool chemical handlers should establish appropriate staff management and supervision, maintain good communication and document each chemical use. Staff should wear relevant personal protective equipment when handling pool chemicals. Safety instructions should be posted and visible to all staff in the chemical storage area and pump room. Chemical spills are to be responded to immediately according to a response plan and safety data sheets.

3.6 Australian Pesticides and Veterinary Medicines Authority and registered products

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is the Australian Government regulator of agricultural and veterinary chemical products and swimming pool and spa chemicals. Users and suppliers of pool and spa chemicals should always follow the safety and use directions on the label of APVMA registered products. NSW Health only supports the use of chemical products in public swimming pools and spa pools that are registered with the APVMA. The database of registered products can be searched on the [APVMA](https://www.apvma.gov.au) website.

3.7 Standards

The most recently published Australian Standards should be complied with where relevant for each facility. The [Standards](#) section of this document includes a list of Australian standards and examples of international standards that apply to public swimming pools and spa pools, which may assist pool designers and operators, where relevant.

4

Treatment process

Chapter 4 Treatment process

Key points

- All public swimming pools and spa pools must be disinfected using an automated or continuous metered dosing system with either chlorine or bromine.
- Effective circulation and filtration of pool water is essential to maintain good disinfection.
- Secondary disinfection can provide extra protection against *Cryptosporidium*.

All public swimming pools and spa pools are expected to have effective treatment barriers in place to maintain suitable water quality and prevent the spread of illness. This is particularly important in reducing harmful microorganisms including viruses, bacteria, protozoan parasites and fungi.

All public swimming pools and spa pools should adopt a multi-barrier approach that involves two or more types of treatment processes to address pathogen risk. Each barrier (treatment process) on its own may not be able to completely remove or prevent contamination. Having multiple barriers provides greater assurance that the water will be safe for use. Treatment processes need to be operated, monitored and maintained in accordance with manufacturer's instructions to minimise variability in performance.

4.1 Filtration

Filtration is a treatment process that physically removes suspended particles from the water. Effective filtration is necessary for effective disinfection. It is recommended that disinfectants are added after the filtration system to lessen the formation of disinfection by-products.

Filters are often categorised according to their allowable operating flow rates. The flow rate is expressed as cubic metres per hour per square metre ($\text{m}^3/\text{h}/\text{m}^2$), also described as the filtration flux (flowrate per unit area). Generally, filtration is more efficient the slower the flow of water through the filter, but this can also prolong turnover time. For effective filtration, operational flow rates of public swimming pools and spa pools should be maximised according to the filtration system and turnover periods.

Filtration systems should be designed to remove *Cryptosporidium*. *Cryptosporidium* is very small (4–6 microns), highly chlorine resistant, and may persist in the pool water for days. Filters should ideally be validated for *Cryptosporidium* removal and operated according to manufacturer instructions. Filters capable of removing particles 4 microns in diameter and consistently achieving a filtrate turbidity of no more than 0.5 Nephelometric Turbidity Units (NTU) will provide additional protection against *Cryptosporidium* (National Health and Medical Research Council 2011). Secondary disinfection systems such as ultraviolet (UV) light could be used in conjunction with filters to manage *Cryptosporidium* risk.

Continuous turbidity monitoring can help ensure filter performance by signalling potential issues with filtration and flow rates, filter breakthrough or backwash routines. Turbidity of filtered water should be consistently below 0.2 NTU and not above 0.5 NTU to maximise *Cryptosporidium* removal. Turbidity should be below 1 NTU to ensure effectively disinfected water.

Facilities with several different pools or water attractions should ideally have an individual filtration system for each body of water. This allows pools to be closed for cleaning while other pools remain open.

Each filtration system should ideally have multiple filter units to allow backwashing of one filter while maintaining filtration of the recirculating pool water. This flexibility also allows planned inspection and maintenance to be performed, which is essential for filter efficiency. Filtration types differ in terms of the media, coagulant, process configuration and the operational conditions applied. Each filter type should be operated in accordance with the manufacturer's specified operating parameters including filtration rates and run times, head loss and backwash rates.

The following processes make filtration more effective:

- **Coagulation.** Using coagulants and flocculants according to manufacturer's instructions can assist with removing fine, dissolved, colloidal or suspended material and pathogens in swimming pools or spa pools that use media filtration (such as a granular filter).
- **Backwashing.** Backwashing is the process of reversing the flow of water back through the filters to flush trapped material to waste. It should take place whenever the difference between the filter inlet pressure and the filter outlet pressure (differential pressure, pressure drop or head loss) reaches a level identified by the manufacturer or based on a maximum filtration timeframe (run time). Backwash water should always be sent to waste (sewerage system) or disposed of appropriately as approved by council and/or the NSW Environment Protection Authority. The concentration of contaminants in backwash water may make it unsuitable for re-use without further treatment.
- **Filter to waste.** Media filters should discard filtrate immediately after backwashing until the filtrate runs clear. This will help minimise the breakthrough of particulates following a backwash.
- **Air scouring.** Air scouring of media filters before backwashing can significantly improve filter cleaning because it breaks up sediment from the filtering media, allowing it to be backwashed out more easily.
- **Filter cleaning.** Remove and clean cartridge filters according to the manufacturer's instructions and ensure that wastewater is sent to waste.

The operational monitoring program for filtration system effectiveness should include the coagulation dosing process, flowrate, filtration cycle (including filter-to-waste times), triggers for backwashing and turbidity. Turbidity should be monitored immediately after filtration.

4.2 Disinfection

Effective disinfection of the water in public swimming pools and spa pools is the best way to protect bather health. Disinfection is the process of inactivating disease-causing microorganisms through either physical (for example, by UV light) or chemical destruction (for example, by chlorine or bromine). Filtration of pool water is needed to remove particles and allow the chemicals to have direct contact with the microorganisms. Disinfection systems should be located after filtration and treat all the filtration flow.

Only disinfectants approved by APVMA for use in swimming pools or spa pools should be used.

Ideally, a disinfectant should:

- be able to inactivate all disease-causing microorganisms
- be fast-acting
- maintain lasting residual effectiveness
- be dosed easily, accurately and safely
- be non-toxic at levels required for effective disinfection
- not cause damage to infrastructure
- be able to be measured accurately and simply on site.

In practice, no single disinfectant can meet all these criteria. The most suitable type of disinfectant will depend on a range of factors including:

- indoor or outdoor situation
- the type of swimming pool or spa pool – such as general pool or specialised hydrotherapy
- the chemical characteristics of the water supply
- the number of people who use the swimming pool or spa pool
- circulation capacity and pool design
- chemical handling and safety issues

- supervision and maintenance requirements
 - pool water temperatures.
-

4.2.1 Primary disinfectants

Primary disinfectants such as chlorine and bromine must be capable of inactivating disease-causing microorganisms and persist in the water to provide ongoing disinfection. Primary disinfectants provide the greatest overall level of disinfection and must be used at all public swimming pools and spa pools. Schedule 1 of the Regulation requires all public swimming pools and spa pools to be disinfected with either chlorine or bromine.

These disinfectants are generally effective at inactivating viruses and bacteria that can cause disease. Neither chlorine nor bromine is effective against *Cryptosporidium* at levels that are acceptable for general use when the pool is operational.

4.2.1.1 Chlorine-based disinfectants

Refer to Table 3-1 for the requirements for swimming pools and spa pools using chlorine-based disinfectants. Chlorine-based chemicals approved by the APVMA for swimming pools or spa pools include:

- elemental chlorine gas
- liquid chlorine (sodium hypochlorite)
- granular chlorine (calcium and lithium hypochlorite)
- electrolytic generation of chlorine from a salt solution (salt chlorination)
- stabilised chlorine granules/tablets (dichloroisocyanurate and trichloroisocyanurate).

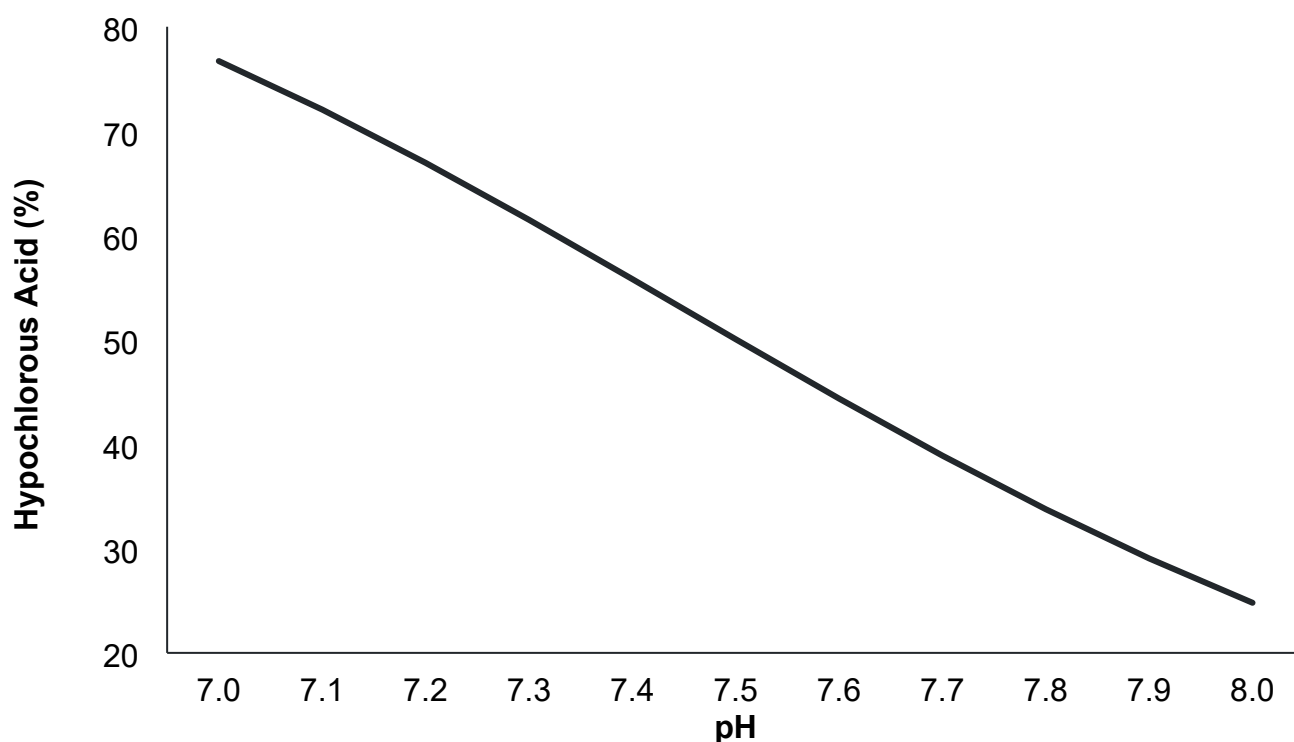
Improper storage can quickly degrade the concentration of stock chlorine solutions. Chlorine should be stored in accordance with the label instructions.

Chlorine exists in two forms in swimming pools and spa pools: free available chlorine and combined chlorine (Table 4-1). The total of these is known as total chlorine.

Table 4-1 Forms of chlorine.

Form	Description
Free available chlorine	Free available chlorine is the main form of chlorine that is responsible for most of the disinfection in a swimming pool and spa pool. Adding chlorine to water produces free available chlorine, which is a mixture of hypochlorous acid (a strong disinfectant) and hypochlorite ions (a weaker disinfectant). Hypochlorous acid is the active component of the free available chlorine and is responsible for most disinfection. Its formation in water is sensitive to pH. Increasing pH reduces the formation of hypochlorous acid and the disinfection power of the free available chlorine (Figure 4-1), whereas a lower pH may cause bather discomfort. Maintaining the pH of the pool water between 7.0–7.8 is required by the Regulation (Table 3-1) and ensures that free available chlorine remains most effective. The minimum free available chlorine concentrations required by the Regulation in public swimming pools or spa pools are listed in Table 3-1.
Combined chlorine (for example, chloramines)	Combined chlorine (including chloramine) is formed when free available chlorine reacts with contaminants in the water, particularly nitrogen compounds such as ammonia. Combined chlorine is a weaker disinfectant form compared to free available chlorine. Some types of combined chlorine can affect air quality in indoor venues and may cause skin or eye irritation, produce a strong and offensive chlorine odour, as well as corrode fabrics and fittings. Pool operators must remove or minimise presence of both organic and inorganic forms of combined chlorine in public swimming pools and spa pools. Combined chlorine must not exceed 1.0 mg/L in a chlorine disinfected public swimming pool or spa pool (Table 3-1). More information on combined chlorine in this chapter and in Appendix D.
Total chlorine	Total chlorine is a measurement of the sum of free available chlorine and combined chlorine and must not exceed 10.0 mg/L (Table 3-1).

Figure 4-1 Percentage of hypochlorous acid determined by pH.



Adapted from Pool Water Treatment Advisory Group (2017).

Chlorine demand

Chlorine demand reflects the amount of chlorine that is used up through reactions with microorganisms and other contaminants in the water. It is the difference between the amount of chlorine added to the water and the amount of free available chlorine or combined chlorine remaining at the end of a specified period. Chlorine demand is often relative to the number of bathers but is ultimately related to the total amount of contaminants in the water (for example, ammonia, organic matter, leaves, dirt, cosmetics, sunscreen).

The greater the chlorine demand, the greater amount of chlorine that needs to be added to the pool water to maintain the required minimum free available chlorine levels (Table 3-1). Chlorine demand can be reduced by encouraging bathers to shower before they enter the water, maintaining effective filtration and turnover of pool water, and minimising environmental contamination through public swimming pools and spa pools design.

Controlling combined chlorine

Reducing the amount of nitrogen compounds introduced into the water will help to reduce combined chlorine. Recommending bathers shower with soap and rinse well before swimming or entering the water and strongly encouraging regular toilet breaks can help achieve this.

Combined chlorine can be controlled by achieving breakpoint chlorination. Breakpoint chlorination is a process where enough chlorine is added to a pool to oxidise combined chlorine in the water to ensure effective free available chlorine residual is produced. Breakpoint chlorination can be achieved by continual or shock chlorine dosing. Regular shock dosing of chlorine to a concentration of at least 10 times the combined chlorine concentration can control combined chlorine. Shock dosing must only occur when the swimming pool or spa pool is closed to prevent harming bathers. The public swimming pool or spa pool must not be re-opened until the total chlorine level is less than 10 mg/L.

Combined chlorine can be controlled in public swimming pools and spa pools with secondary disinfection systems such as medium-pressure UV disinfection and ozone. Alternatively, APVMA approved oxidisers such as hydrogen peroxide, chlorine dioxide and potassium monopersulfate can be used.

In instances where shock dosing does not reduce combined chlorine, exchanging a proportion of the

pool or spa's water with drinking water may reduce the level of combined chlorine present. This could help where drinking water supplies maintain a free available chlorine residual. The effect may be limited in drinking water supplies that maintain a chloramine residual. Contact your water utility for more information on the type of disinfectant used in your drinking water supply.

Refer to [Appendix D](#) for more information on controlling combined chlorine.

Cyanuric acid and chlorine (stabilised chlorine)

Sunlight breaks down chlorine in outdoor swimming pools, which can lead to significant loss of free available chlorine. Stabilised chlorine (chlorine with cyanuric acid added to it) can be used to address this issue because cyanuric acid bonds loosely to the free available chlorine to minimise the impact of UV light. It can be purchased as granules and tablets or can be formed by adding cyanuric acid to water containing free available chlorine.

The Regulation requires that cyanuric acid only be used in outdoor chlorine disinfected pools and must not be used in spa pools. The concentration of cyanuric acid in an outdoor pool must not exceed 50 mg/L (Table 3-1). Cyanuric acid reduces the disinfection power of hypochlorous acid, so the minimum free available chlorine level must be maintained as per Schedule 1 requirements of the Regulation (Table 3-1).

Outdoor public swimming pool operators need to consider cyanuric acid concentrations in the event of a diarrhoeal incident or *Cryptosporidium* contamination incident. Using stabilised chlorine can impact the effectiveness of hyperchlorination procedures. Cyanuric acid concentration levels should be dropped to equal or less than 15 mg/L for hyperchlorination (Murphy et al. 2015). This may involve partially draining the pool and adding drinking water. Refer to the [NSW Health website](#) for more information on incident response protocols.

4.2.1.2 Bromine-based disinfectants

Refer to Table 3-2 for the requirements for public swimming pools and spa pools using bromine-based disinfectants.

Bromine is another primary disinfectant that works in a similar way to chlorine. Bromine-based chemicals approved by the APVMA for use in swimming pools and spa pools include:

- **Bromo-chloro-dimethylhydantoin (BCDMH) tablets.** A broad-spectrum disinfectant containing a mixture of bromine and chlorine. It causes skin and eye irritations if not properly maintained. Avoid the use of ozone with BCDMH as it may produce bromate, a harmful disinfection by-product.
- **Sodium bromide (NaBr) with an activator (hypochlorite or ozone).** Also known as a bromine bank system. Operators of pools with sodium bromide systems should ensure that there is always more sodium bromide than the oxidising activator (for example, hypochlorite, ozone or potassium monopersulfate). Systems using ozone to generate bromine need skilled designers and trained operators to ensure performance and safety. Operators of these systems need to maintain the required bromine concentration (Table 3-1), ensure the continual supply of bromide ions, prevent ozone de-gassing, quench ozone from the water before use, and keep bromate at a safe level. The *Australian Drinking Water Guidelines* guideline value for bromate is 0.02 mg/L.

Bromine is more stable at higher temperatures but is slightly a less effective disinfectant than chlorine. Bromine is commonly used in indoor spa pools and is rarely used in larger outdoor public swimming pools and spa pools because it decays in sunlight. Cyanuric acid does not stabilise bromine against UV light like chlorine and should not be used in outdoor bromine-treated swimming pools.

Bromine is less affected by pH than chlorine, which means additional bromine is not required at pH levels greater than 7.6 (Table 4-2). Maintaining the pH of the pool water between 7.0 to 8.0 is required by the Regulation (Table 3-2) to ensure bromine remains effective.

Table 4-2 Percentage of hypobromous acid determined by pH.

pH	Percentage of free bromine as	
	Hypobromous acid (HOBr) (strong disinfectant)	Hypobromite ion (OBr ⁻) (weak disinfectant)
6.0	100	0
7.0	98	2
7.2	96	4
7.5	94	6
7.6	91	9
7.8	87	13
8.0	83	17

Bromamines

Like chloramines, bromamines are formed when bromine reacts with ammonia. Bromamines do not produce irritating odours like chloramines. While some pool and spa operating manuals state that disinfection with bromamine is as effective as with free bromine further research is needed to better understand this and the impact of bromamines to bather skin irritation (U.S. Centers for Disease Control 2024a). To reduce bromamine formation, bathers should shower with soap and rinse well before entering the pool water and have regular toilet breaks.

4.2.2 Secondary disinfectants

Secondary disinfectants generally boost or support primary disinfection and are recommended for all swimming pools and spa pools, particularly for facilities where there is a need for extra protection against *Cryptosporidium*. Secondary disinfectants cannot be used alone as they do not provide a long-lasting disinfection. Commonly used secondary disinfection systems include UV disinfection systems and ozone.

4.2.2.1 Ultraviolet disinfection

UV light is a powerful disinfectant, particularly against bacteria and protozoa such as *Cryptosporidium*. The UV light inactivates these microorganisms by destroying their nucleic acid. UV light does not provide a lasting disinfectant residual, so it is only recommended for secondary disinfection in swimming pools and spa pools.

UV disinfection systems should be validated and designed for full flow (not side stream) to achieve a minimum of 3–log₁₀, or 99.9%, inactivation of *Cryptosporidium* for interactive water features (splash pads, spray parks and water play areas) and a minimum of 2–log₁₀, or 99%, reduction for all other types of public swimming pool and spa pools (U.S. Centers for Disease Control and Prevention 2024b).

UV disinfection systems typically have one or more UV lamps installed in the pipework where the pool water circulates. The ‘sleeves’ that protect the UV lamps must be cleaned regularly so the lamps continue to emit the correct dose. The clarity and flow rate of the water can also impact the effectiveness of UV lamps, so the operational limits set by the manufacturer should be complied with. Some UV disinfection systems have self-cleaning lamp sleeves and provide for real-time monitoring of the dose rate.

The maximum and minimum levels required for chlorine (Table 3-1) and bromine (Table 3-2) remain the same when using UV disinfection. UV disinfection systems should be positioned before any chlorine or bromine dosing points because the UV light can reduce the concentration of disinfectant residual in the water.

4.2.2.2 Ozone

Ozone is a highly reactive gas that can be dissolved in water to act as a powerful disinfectant. It can also be used to control disinfection by-products and combined chlorine that may be responsible for tastes, odours and eye irritation in pool water. Ozone is not considered a primary disinfectant because no lasting residual can be provided.

Ozone is typically used with chlorine as a secondary disinfectant. It provides greater disinfection power and can inactivate *Cryptosporidium*. Ozone systems should be designed to achieve a 3-log₁₀, or 99.9%, inactivation of *Cryptosporidium* for interactive water features (splash pads, spray parks and water play areas) and a minimum 2-log₁₀, or 99%, reduction for all other types of swimming pools or spa pools (U.S. Centers for Disease Control and Prevention 2024b).

Ozone can cause respiratory irritation. Ozone must be removed from the water ('quenched') before the water is returned to where bathers are exposed. The treatment system should include an activated carbon bed or ozone destructor for quenching ozone. An ozone sensor should be installed after the activated carbon bed or ozone destructor to shut down and raise an alarm if ozone is detected.

The maximum and minimum levels required for chlorine (Table 3-1) and bromine (Table 3-2) must be maintained when using ozone. Ozone systems should be located before any chlorine and bromine dosing points because the activated carbon bed or ozone destructor will also remove any chlorine or bromine in the water. Public pool operators need to monitor and control the ozone level to maintain required disinfection concentrations.

Avoid the use of ozone with bromo-chloro-dimethylhydantoin (BCDMH) because it may produce bromate, a disinfection by-product. These treatment systems require a highly skilled designer and operator to ensure safe operating conditions.

4.2.2.3 Chlorine dioxide

Chlorine dioxide (ClO₂) is a useful secondary disinfectant for shock treatment for control of *Cryptosporidium* and biofilm. It is not a primary disinfectant as it does not produce free available chlorine. When combined with hypochlorite it reduces the contact time required for control of *Cryptosporidium* and reduces the time required to close a pool for shock treatment. Table 4-3 provides required contact times for 3-log₁₀ inactivation of *Cryptosporidium*. Chlorine dioxide does not form combined chlorine and can be used to manage combined chlorine and faecal contamination incidents in pools.

Table 4-3 Free available chlorine and chlorine dioxide concentrations and contact time combinations for 3-log₁₀ inactivation of *Cryptosporidium*.

Chlorine dioxide concentration (mg/L)	Free available chlorine concentration (mg/L)	Contact time	pH
0	20.0	12 h 45 min	7.5
1.4	3.6	4 h 54 min	7.6
5.0	2.6	1 h 45 min	7.5

¹ Adapted from Murphy et al. (2014).

Chlorine dioxide should not be used with ozone or an activated carbon filter as this may increase disinfection by-product formation.

Iron and manganese are naturally occurring metals that may be present in water. Chlorine dioxide can oxidise these metals to form iron hydroxides and manganese dioxide precipitates. These precipitates can cause aesthetic problems such as coloured water, turbidity, and staining. They do not pose a health issue. Sedimentation and filtration can help reduce and remove precipitates once formed.

Chlorine dioxide may affect the operation of automated dosing equipment, seek specialist advice before use.

4.3 Disinfectant dosing system

All public swimming pools and spa pools must use an automated or continuous metered disinfectant dosing system. Automated dosing systems can be programmed with a set range of values that ensure optimal disinfection. Automated dosing systems will range in complexity. Dosing systems should dose chemicals within the set point range to always maintain required disinfectant levels in the public swimming pool or spa pool. More advanced automated dosing systems allow for 'proportional dosing' where the dose rate varies according to the magnitude of the deviation from the set point.

Oxidation reduction potential (ORP) systems can be used as an automated disinfectant dosing system. However, disinfectant levels (chlorine or bromine) and monitoring must still comply with Schedule 1 requirements of the Regulation. Maintaining an ORP millivolt measurement of 720 mV is no longer required by the Regulation. ORP systems can be set at an appropriate millivolt to achieve the required disinfectant level in the individual pool or spa.

4.4 Disinfection by-products

Disinfection by-products (DBPs) are unwanted chemical compounds that form when disinfection chemicals react with organic matter including contaminants from the skin, hair, sweat, saliva, urine and other organic matter.

Public health risks from disinfection by-products in public swimming pools and spa pools are likely to be low. By contrast, microbiological risks are significant if disinfection is inadequate. Disinfection should never be compromised or reduced over concerns relating to disinfection by-products.

Reducing DBPs in swimming pools and spa pools is important for bather comfort and safety. The level of DBPs can be minimised by getting bathers to shower using soap and rinsing thoroughly before entering the water.

4.5 Treatment validation

Treatment validation is an important consideration in designing new public swimming pools and spa pools. Treatment system manufacturers have a responsibility to demonstrate the efficacy of their processes to achieve specific water treatment objectives. Pre-validated treatment systems should be chosen, if available, and operated according to validated operating parameters.

5

Bather load, water circulation and turnover times

Chapter 5 Bather load, water circulation and turnover times

Key points

- All swimming pools and spa pools should strike a realistic balance between the number of bathers it allows and the capacity of the pool or spa and treatment plant.
- Effective water circulation ensures treated water reaches all areas of the swimming pool or spa pool and that contaminated water is removed efficiently.
- The highest level of protection is provided by short turnover times combined with filters that can remove *Cryptosporidium* and/or secondary disinfection systems that can inactivate *Cryptosporidium*.

5.1 Bather load

Maximum bather load (MBL) is the maximum number of bathers (persons) allowed at any one time. Professional pool designers should be engaged to calculate a pool's MBL considering factors such as the pool water's surface area and depth, the type of activity and water treatment plant capability. Table 5-1 should be used as a guide where MBL requirements have not been specified by a professional pool designer. The pool's MBL should be recorded.

Bather numbers should be monitored regularly so the MBL is not exceeded to maintain water quality, bather safety and comfort. If the MBL is approached, then operators may need to:

- implement strategies to reduce bather numbers (for example, sectioning off parts of the pool or limiting patron entry)
- increase the treatment plant capability
- further dilute the pool water with drinking water
- ensure additional treatment such as ozone or UV disinfection is working effectively.

Issues with bather load should be considered and addressed in a water quality risk management plan. For more information on water quality risk management plans, refer to [Appendix C](#).

Table 5-1 Recommended bather load.¹

Water depth	Maximum Bather Load (MBL)
< 1.0 m	1 bather per 2.2 m ²
1.0 – 1.5 m	1 bather per 2.7 m ²
> 1.5 m	1 bather per 4.0 m ²

¹ Adapted from Pool Water Treatment Advisory Group (2017) and World Health Organization (2006).

5.2 Water circulation

Efficient water circulation in public swimming pools and spa pools is important in supporting contaminant removal and allowing treated water to reach all areas of the swimming pool or spa pool. Circulation systems should be operated while the pool or spa is open, before opening and after closing so that adequately disinfected water is present throughout the pool or spa pool.

Most of the pool water should ideally be taken from the surface of the pool for treatment and recirculation because it contains the highest concentration of contaminants. The remainder should be drawn from the bottom to remove grit and other matter. Dye testing is a reliable way of assessing water circulation. It should be conducted during the commissioning of new swimming pools or spa pools, after any changes to the filtration or hydraulic system, and repeated routinely to check water circulation remains effective.

Maintaining low pool turbidity indicates effective circulation and filtration systems. The effectiveness of these systems depends on the pool's bather load, circulation rate, turnover time, and filtration system.

The circulation rate is the flow of water to and from the pool through all the pipe work and treatment system. The circulation rate can be calculated using the Pool Water Treatment Advisory Group (2017) formula:

$$\text{Circulation rate (m}^3\text{/h)} = \text{Maximum Bather Load (MBL)} \times 1.7 \text{ (a constant).}$$

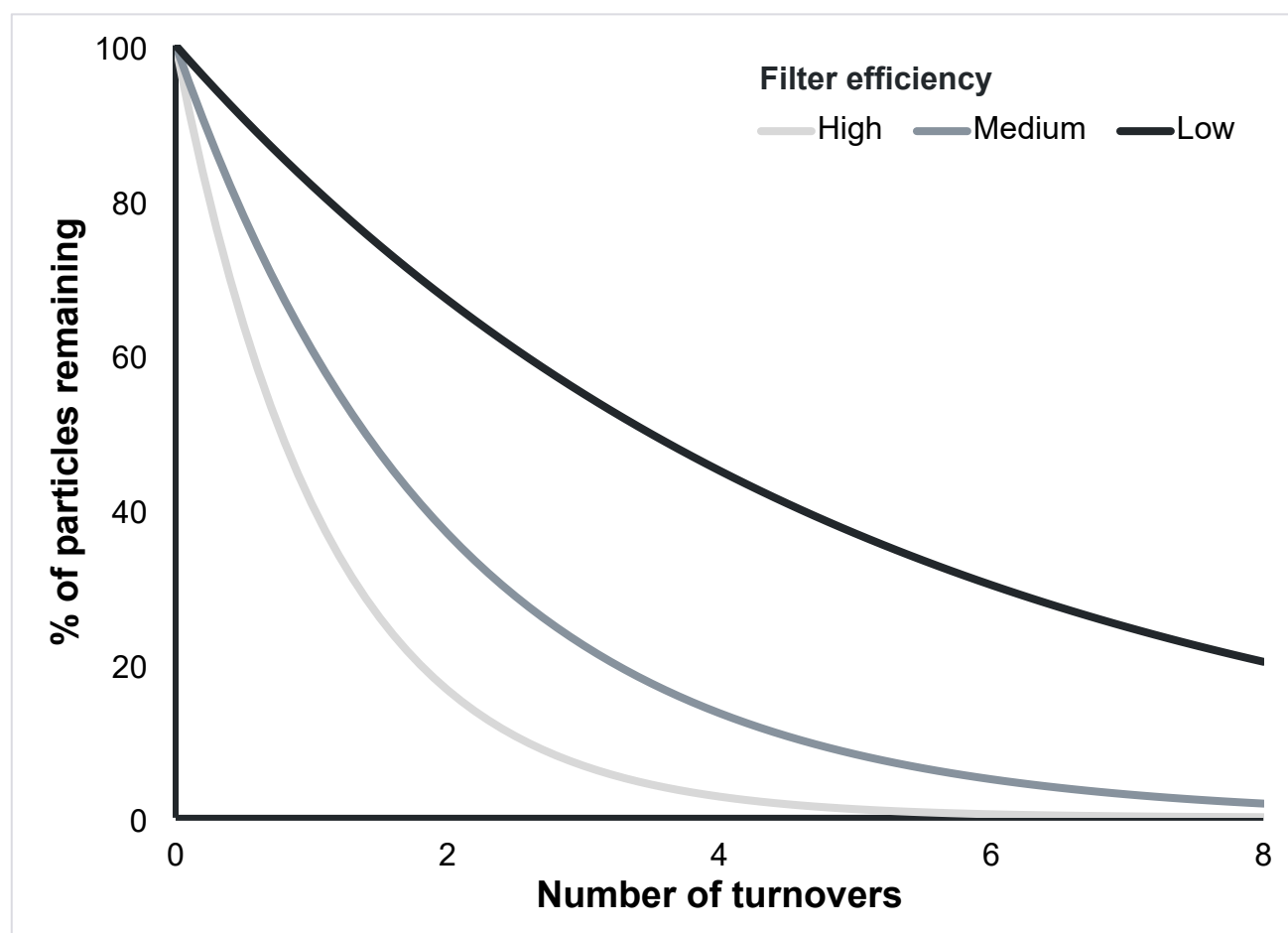
5.3 Turnover times

Turnover time is the time taken for water equivalent to the volume of water in a public swimming pool or spa pool to pass through the filtration system.

Swimming pools and spa pools with high bather load and low water volume (such as shallow wading pools and spas) need short turnover times because they are more likely to have a higher load of contaminants than other pools (for example, diving pools). A shorter turnover time means there is less time between when contaminants are introduced into the water and when that water passes through the treatment plant, allowing for greater control over disinfectant levels and turbidity. Shorter turnover times and using a secondary disinfection system or a filter that can remove *Cryptosporidium* reduces the risk to bathers.

Not all swimming pool or spa pool water will be filtered during one pool turnover. The first flows at the start of filtration will be dirty water and, as this water is filtered and returned to the pool, it mixes with and dilutes the remaining dirty water. The removal of filterable material during the first turnover depends on filter efficiency. Contaminants are also continually being introduced while the pool is in use. Figure 5-1 shows how effective filtration is accomplished by consecutive dilution which relies on continuous turnover and dilution to remove and reduce contaminants.

Figure 5-1 Consecutive dilution in relation to the effectiveness of swimming pool filtration.



Adapted from Simmonds et al. (2021).

Operators may have limited control over the turnover time for an existing water treatment system. Turnover times should consider specific aspects of pool operational management including bather numbers, pool volume, bather hygiene and pool circulation (including location and capacity of inlets and outlets). Some recommended maximum turnover times for different types of public swimming pools and spa pools are shown in Table 5-2.

Site-specific turnover times should be used when retrofitting, upgrading, or constructing a new public swimming pool or spa pool. The inlets and outlets should be positioned to provide the best water circulation and contaminant removal. Due to pool design differences, it is highly recommended that a professional pool designer is used to specify the turnover time of public swimming pools and spa pools.

There are several approaches to calculating site-specific turnover times. These include the formulas in Chapter 6 of the Swimming pool water – treatment and quality standards for pools and spas (Pool Water Treatment Advisory Group 2017), Chapter 4 of the 2024 Annex to the Model Aquatic Health Code (U.S. Centers for Disease Control 2024a) and the formulas derived by Stevenson and Associates (pers comm.).

Some swimming pool designers recommend that the turnover time can be increased by 15% and 10% if ultrafine filtration (2 micron or less) is used for indoor and outdoor swimming pools, respectively. This is reflected in the Stevenson formulas for pool turnover times (Table 5-3), which are derived from Pool Water Treatment Advisory Group (1999) and World Health Organization (2006) recommendations. The Stevenson formulas in Table 5-3 do not apply to pool water features, bubble pools, waterslide splash pools, beach pools, pools with moveable floors, spa pools, shallow leisure pools, wave pools, and hydrotherapy pools. The turnover times for these pools should instead be specified by a professional pool designer.

Table 5-2 Recommended maximum turnover times for different types of public swimming pool and spa pool.

Maximum turnover time	Pool type
20 min	Spa
20 min	Interactive water features
30 min	Hydrotherapy
1 hour	Waterslide, wading, indoor learn-to-swim pools
2 hours	Outdoor learn-to-swim, lazy rivers and wave pools
2 hours	School, 25 m and 50 m leisure pools
6 hours	Retirement village pool (not used for organised exercise activities), residential apartment, gym, resort, holiday park and motel pools
8 hours	Diving pool

Adapted from Pool Water Treatment Advisory Group (2017), World Health Organization (2006) and U.S. Centers for Disease Control (2024b).

Table 5-3 Calculating pool turnover time using the Stevenson formulas.

Pool type	Filter type	Turnover Time Calculation*
Indoor	Granular	$(1.3 \times \text{depth}) + 0.2 \text{ hours}$
	Ultrafine	$[(1.3 \times \text{depth}) + 0.2 \text{ hours}] \times 1.15$
Outdoor	Granular	$(1.8 \times \text{depth}) + 0.2 \text{ hours}$
	Ultrafine	$[(1.8 \times \text{depth}) + 0.2 \text{ hours}] \times 1.10$

Source: Stevenson and Associates (pers comm.)

* Depth is in metre units. Pools deeper than 4 metres are to be calculated as a 4-metre depth pool.

Operators should consider the following strategies if turnover times cannot be met:

- develop a water quality risk management plan to minimise public health risk
- automate disinfection and pH processes
- limit bather numbers
- increase minimum disinfectant concentrations
- improve filtration system.

6

Monitoring

Chapter 6 Monitoring

Key points

- Operational monitoring should be the focus for pool monitoring activities.
- Automated operational monitoring is recommended for all public swimming pools and spa pools.
- Manual testing of public swimming pools must be conducted at least once per day.

Monitoring public swimming pools and spa pools helps maintain water quality. There are two types of monitoring:

- **operational** – manual or automated monitoring of the performance of the treatment process and the chemical and physicochemical parameters of the pool water (for example, disinfectant level, pH and temperature). It provides pool operators with an opportunity to address water quality issues immediately and should be the focus of monitoring activities.
- **verification** – usually involves sending water samples to a laboratory to verify water quality criteria have been met.

6.1 Operational monitoring

Operational monitoring is essential for all public swimming pools and spa pools. Swimming pool and spa pool operators should test the water regularly to check that the water treatment systems are operating as expected. Operational monitoring of certain parameters is required under the Regulation. Table 3-1, Table 3-2 and Table 3-3 provide detail on parameters that must be monitored and monitoring frequency.

6.1.1 Frequency of operational monitoring

Table 3-3 summarises the minimum monitoring requirements that all public swimming pools and spa pools must meet for disinfectant, pH, alkalinity, cyanuric acid and ozone levels (where relevant) in accordance with Schedule 1 of the Regulation. The occupier of the premises must conduct more frequent monitoring considering the number of people swimming in the pool at a particular time, the hours of operation, the depth of the pool and the effect of sunlight on disinfectant levels.

Parameters that are reliably and of immediate operational health relevance such as residual disinfectant, pH and turbidity should be monitored most frequently and in all pool types. Management should regularly assess operational monitoring data and test systems to ensure that pool operators have taken appropriate and timely remedial action.

The frequency of operational and verification monitoring should be increased in the following circumstances:

- pH greater than 7.6 in a chlorinated pool
- consistently poor disinfection
- high turbidity
- poor pool circulation or filtration
- high bather loads
- presence of algae
- regular use by birds
- easy access of foreign material (for example, rubbish)
- presence of biofilms
- poor water quality (for example, high in combined chlorine)
- infrequent testing of disinfectant concentration
- no automated disinfection and pH control and infrequent pool water quality testing (particularly for microbiological testing).

Table 6-1 contains recommended and required minimum operational monitoring frequencies.

Table 6-1 Operational monitoring frequencies.

Test	Frequency
Continuous metered disinfectant dosing system	
Free available chlorine or bromine	Must test manually once every day before the pool opens for use by the public* Recommend testing every four hours after opening during the period in which the pool is being used
Total chlorine	
pH	
Automated disinfectant dosing system	
Free available chlorine or bromine	Must record once every day before the pool opens for use by the public* Must record once during the period in which the pool is being used*
Total chlorine	
pH	Must test manually once every day* Recommend checking and logging hourly automated operational monitoring readings
Must increase operational monitoring* when the occupier of the premises considers it necessary, taking into account the following: - the number of people swimming in the pool at a particular time - the hours of operation of the pool - the depth of the pool - the effect of sunlight on disinfectant levels. See Section 6.1.1 for more guidance on increased monitoring frequencies.	
Free available chlorine or bromine	Recommend testing manually every two hours after opening or every hour when bather load nears or meets design capacity
Total chlorine	
pH	
Other tests	
Total alkalinity	Must test daily for all swimming pools and spa pools unless liquid chlorine (sodium hypochlorite) or carbon dioxide-based pH control is used then monthly*
Ozone	Must test weekly (if used in the circulation system of the pool)*
Cyanuric acid	Must test weekly (outdoor chlorine disinfected pools)*
Turbidity and/or clarity	Recommend daily testing
Water balance	Recommend weekly testing
Total dissolved solids	Recommend monthly testing
Dimethylhydantoin (BCDMH systems)	Recommend monthly testing

* Mandatory testing required by the NSW Public Health Regulation 2022.

6.1.2 Automated operational monitoring

Automated operational (or 'online') monitoring is recommended along with the manual monitoring required by the Regulation so operators can determine if the treatment systems are operating as they should. It generally involves using monitoring probes or instruments to provide real-time information about water quality parameters. These probes require periodic calibration in accordance with manufacturers recommendations.

Automated operational monitoring is needed when automated dosing systems are used (such as automated chlorine dosing) but may also be used to monitor other water quality parameters or treatment steps. Treatment processes should have online instrumentation to monitor their performance and trigger alarms and corrective actions to operate within specification and in accordance with the manufacturer's recommendations.

Online instrumentation for filtration systems may include coagulant dosing control, online filtrate turbidity, pressure differential and flowrate. For UV disinfection systems online instrumentation may include UV transmissivity, flowrate, UV lamp age and UV lamp sensor. Online instrumentation for chlorination systems may include chlorine setpoint dose, chlorine residual monitoring, pH and temperature. Where ozone is used in the recirculation system online instrumentation should include an ozone detection sensor and alarm system. Public swimming pools and spa pools using an automated disinfectant dosing system must record online operational monitoring results as required by the Regulation (Table 6-1). NSW Health recommends that any additional online monitoring results are recorded electronically. The automated monitoring system should be configured to alert operators whenever operational parameters are not within acceptable limits.

6.1.3 Manual operational monitoring

Manual operational monitoring is required by the Regulation at least once per day and should be used to confirm accuracy of the results from the automated systems. Manual operational monitoring provides spot checks of chemical and physicochemical parameters. NSW Health recommends that manual samples are taken from a location furthest from the inlets and at a depth of 5 – 30 cm. It is good practice to include as a routine sampling point the area of the pool where the disinfectant residual is generally lowest because of the hydraulics. Occasionally samples should be taken from other parts of the pool and circulation system. Taking samples for ozone is an exception; these samples should be taken once a week for the presence of ozone close to an inlet to confirm ozone has been removed or 'quenched' (see [Section 4.2.2.2](#)).

6.2 Test kits

All public swimming pools and spa pools should use appropriately calibrated test instruments for manual operational monitoring. Domestic pool kits and test strips are not recommended for public swimming pools and spa pools because they are not as accurate.

6.3 Verification monitoring

Verification monitoring checks that the required water quality criteria have been met but should not be used as a substitute for operational monitoring. Verification monitoring typically involves taking a water sample and sending it to an external laboratory for analysis. Verification monitoring usually focuses on microbiological parameters but can also include certain chemical criteria that cannot be easily analysed by pool operators.

Verification monitoring frequency may need to be increased in some circumstances such as after a significant change in pool operations, chemicals or treatment, during high use periods and

commissioning, or if there is uncertainty about the effectiveness of a treatment process. Sampling frequency for relevant parameters should be increased until results stabilise.

6.3.1 Taking a verification sample

When taking verification samples, follow procedures provided by testing laboratory as incorrect sampling may give misleading information on water quality. Verification samples should be taken from a location furthest from the water inlets where the disinfectant residual is generally lowest. Samples should also be taken from other parts of the pool and circulation system. Do not use the same sample as that used for operational monitoring for microbiological analysis. Some key considerations include:

1. It is important that the laboratory knows the sample is from public swimming pools or spa pools with disinfected water, so the correct containers are provided and sampling results are representative. For microbiological analysis, use an appropriate sterile sodium thiosulfate treated sample container. Samples should be maintained in the conditions and sample submission timeframes specified by the laboratory.
2. Keep the bottle closed until the sample is taken and only take off the lid long enough to collect the sample. The container lid should not touch anything that will contaminate it.
3. The sample should be taken without rinsing the container. Plunge the bottle, neck down in the water, to a depth (for example, 25-50 cm). The container should then be tilted to face horizontally away from the hand and moved horizontally until the container is full before being lifted out of the water. The lid should then immediately be replaced.
4. Write on the label and place in an insulated cooler (such as an Esky) with enough freezer bricks to keep the sample cool (but not frozen) during transport, or as specified by the laboratory.
5. Submit verification samples to a laboratory that the National Association of Testing Authorities (NATA) has accredited to perform the requested analysis.
6. Submit samples within laboratory timeframes. Deliver microbiological samples to the laboratory as soon as possible for analysis within six hours of collection (or 24 hours if kept between 2-10°C in the dark).

6.4 Microbiological parameters

Microbiological parameters that should be included in a verification monitoring program and contamination response program (for example, post faecal incident) for public swimming pools and spa pools include heterotrophic colony count (HCC), *Escherichia coli* and *Pseudomonas aeruginosa*. Guideline values for each of these parameters are provided in Table 6-2. Provided the Regulation's water quality requirements are met (Table 3-1 and Table 3-2) frequent sampling for microbiological contamination should not be necessary. Monthly microbiological samples collected when the swimming pool or spa pool has a high bather load are recommended. More frequent microbiological sampling is recommended when water quality has deteriorated, there has been a significant change to operations, for pools that are heavily used (such as for teaching) or when a new swimming pool or spa pool is commissioned.

Table 6-2 Microbiological criteria for all swimming pools and spa pools.

Parameter	Guideline value
<i>Escherichia coli</i>	0 CFU/100 mL or 0 MPN/100 mL
<i>Pseudomonas aeruginosa</i>	0 CFU/100 mL or 0 MPN/100 mL
Heterotrophic colony count (HCC)	Less than 100 CFU/mL

6.4.1 Heterotrophic colony count

Heterotrophic colony count (HCC), sometimes referred to as 'heterotrophic plate count' or 'total plate count', provides a basic indication of the general microbiological quality of a water sample. HCC does not differentiate between harmless and potentially harmful bacteria. It provides a simple indication of the number of bacteria present in the water and can give important information that can help determine if the filtration and disinfection processes are operating effectively. HCC results greater than 100 CFU/mL suggest disinfection systems are not operating as required and the performance of the treatment processes should be checked. If a treatment deficiency is found, actions should be taken to correct it. If no treatment deficiencies are found, a resample should be taken to verify there are no ongoing issues. If ongoing issues are found, the treatment process or management of the public swimming pool and spa pool may need to be improved, such as through enhancing cleaning, adjusting water chemistry, reviewing water turnover, reducing bather numbers or treatment upgrades.

6.4.2 *Escherichia coli*

Escherichia coli (*E. coli*) is a bacterium found in large numbers in the faeces of warm-blooded mammals. Most strains of *E. coli* are harmless, but some can cause serious illness. *E. coli* is typically used as an indicator of faecal contamination and that disease-causing microorganisms may also be present.

A sample result showing the presence of *E. coli* indicates deficiencies in disinfection or filtration and should trigger an investigation into the performance of the treatment process. If a treatment deficiency is found, appropriate remedial actions should be taken and a resample taken to verify the effectiveness of the remedial action. If no treatment deficiencies are found, a resample should be taken to verify there are no ongoing issues.

6.4.3 *Pseudomonas aeruginosa*

Pseudomonas aeruginosa is a bacterium that can cause a range of infections in humans. It can be introduced to the water from bathers or from the surrounding environment. *Pseudomonas* in the water can mean that disinfection systems are not operating as they should, and appropriate remedial actions should be taken.

7

Managing water balance

Chapter 7 Managing water balance

Key points

- Appropriately balanced water is essential for effective disinfection, bather comfort and protecting the infrastructure of public swimming pool and spa pools.
- A common method for checking the water balance is to use the Langelier Saturation Index, which takes account of the water's pH, total alkalinity, calcium hardness, total dissolved solids and temperature.

The pH, total alkalinity, calcium hardness, total dissolved solids and temperature of public swimming pool and spa pool water should be balanced to aid disinfection, and prevent swimmer discomfort, scale forming or fittings corroding. A common method for checking the balance of water is the Langelier Saturation Index (LSI). For more information, refer to [Appendix E](#).

7.1 pH

The pH of water is a measure of how acidic or alkaline the water is. The pH of water in all public swimming pools and spa pools must be maintained within the range required by the Regulation (Table 3-1 and Table 3-2) to ensure effective disinfection and bather comfort. Automatic pH control is recommended for all public swimming pools and spa pools.

If the pH is too high, it can be reduced by adding strong acids such as hydrochloric (muriatic) acid or sodium bisulfate (dry acid). Acid should always be diluted into water before being added slowly to the balance tank. Lowering the pH also lowers total alkalinity, so take care when adding acid to ensure the water stays in balance. Carbon dioxide can also be used to lower pH but because it is a weak acid, the pH change will be slower than when using strong acids.

If the pH is too low, sodium carbonate (soda ash) can be used to raise it quickly. Sodium bicarbonate (bicarb soda) can be used to raise pH more slowly. Increasing the pH in this way also increases total alkalinity.

7.2 Total alkalinity

Total alkalinity is a measure of the ability of water to withstand changes to pH (also referred to as its buffering capacity). Total alkalinity must be maintained within 80–200 mg/L as required by the Regulation (Table 3-1 and Table 3-2).

If the total alkalinity is too low, the pH can change rapidly. If the total alkalinity is too high, it will be difficult to adjust the pH. Total alkalinity can be reduced by adding strong acids or raised by adding chemicals such as bicarb soda, though adding these chemicals will also affect pH.

7.3 Calcium hardness

Calcium hardness is the amount of calcium dissolved in the water. Balanced water should contain enough calcium, so the water does not damage concrete surfaces or tile grout but not so much that it causes scale to form.

If calcium hardness needs to be raised, it can be increased by adding calcium chloride. If it needs to be reduced, exchange water from the public swimming pool and spa pool with make-up water containing lower levels of calcium hardness.

A pool consultant should be engaged in determining the most suitable pool treatment system according to your water supply's calcium hardness.

7.4 Total dissolved solids

Total dissolved solids (TDS) is the measure of soluble material dissolved in water. The level of TDS in water can increase as bathers introduce contaminants or when water treatment chemicals are added. TDS above 1500 mg/L can indicate bather overloading or lack of dilution and can reduce the effect of disinfectants and increase the potential of algal growth and corrosion (U.S. Centers for Disease Control and Prevention 2024a). TDS should not be a significant problem in a well-designed and well-operated public swimming pool and spa pools with regular backwash and routine exchange of water. High TDS is generally managed by exchanging swimming pool or spa pool water with fresh make-up water.

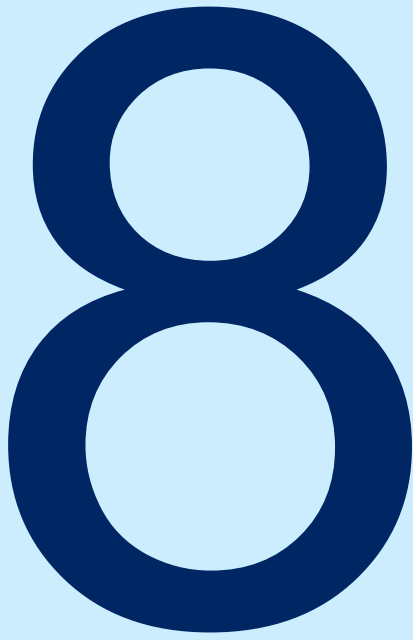
7.5 Temperature

The water temperature will affect its balance, although it is the least important of the water balance factors. Higher water temperatures can increase bacterial growth in the water, increase scaling and affect the comfort of bathers. Lower temperatures allow the pool water to absorb more calcium and cause etching of pool surfaces.

The temperature of any swimming or spa pool must not exceed 38°C. It is important to consider how temperature may vary throughout the day and within the swimming or spa pool. Consider when and where temperature is measured to ensure representative results. Sampling should include locally warmer or cooler parts of the pool for example, near lamps or heaters or after cooler water has topped up the pool or heaters have been off for some time. Samples should be taken, or temperature monitoring devices installed and monitored, to capture the warmest temperatures experienced in the pool during its use.

7.6 Langelier Saturation Index

Langelier Saturation Index (LSI) is a common method for determining the water's balance, whether it is likely to be corrosive or scale-forming. [Appendix E](#) describes the formula and provides an example LSI calculation. The ideal LSI is 0, or slightly positive, but within a range of -0.3 to 0.3 (U.S. Centers for Disease Control and Prevention 2024a). A negative LSI typically indicates that the water is corrosive and may damage pool fixtures and fittings. A positive LSI means that scale is more likely to form and interfere with normal pool operations. However, a neutral or slightly positive LSI is still preferred as scaling is less harmful than corrosion, which damages mechanical and structural components.



Healthy swimming

Chapter 8 Healthy swimming

Key points

- Do not swim if you have diarrhoea and do not swim for 14 days after symptoms have stopped.
- Shower and wash with soap, especially your bottom, before swimming.
- Wash your hands with soap after going to the toilet or changing a nappy.
- Change nappies in nappy change areas only.
- Avoid swallowing pool water.

Bather hygiene and design of public swimming pools and spa pools are important factors in keeping swimming pools clean and to prevent disease-causing microorganisms and environmental contaminants being introduced.

8.1 Exclusion periods following illness

Bathers can introduce large numbers of disease-causing microorganisms into the water such as from their faeces. The period during which disease-causing microorganisms are excreted varies from person to person. Once the pool water is contaminated with these microorganisms, disease can spread to other people, even when only small amounts of water are swallowed.

In the case of an infection with *Cryptosporidium*, an infected person typically excretes *Cryptosporidium* while they have symptoms and up to 14 days after symptoms (such as diarrhoea) have stopped. Infected people with no symptoms and have showered may still contaminate pools. *Cryptosporidium* is resistant to the levels of chlorine or bromine typically used for pool disinfection. This means it can survive in the water for long periods and potentially make others sick.

Signs should be displayed at every public access point advising bathers who have recently had a diarrhoeal illness to not swim for at least 14 days after symptoms resolve. The signs should also advise parents to exclude their children for at least 14 days if their children have had a diarrhoeal illness. Staff who have any contact with water in public swimming pools and spa pools should also adhere to these exclusion periods. However, these staff may still undertake tasks that do not involve contact with the water.

Operators of public swimming pools and spa pools can encourage parents to prevent ill children from attending swim lessons by promoting exclusion periods of at least 14 days and providing refunds or 'catch-up' swim lessons for children who have recently had a diarrhoeal illness.

8.2 Showering

Some people can carry disease-causing microorganisms without becoming ill ('asymptomatic' infections). These people, like all other bathers, may have small amounts of faecal material on their bottom, which can transfer disease-causing microorganisms into the water. For this reason, it is important that all bathers shower and wash with soap before entering the water.

Pre-swim showering is a difficult requirement to enforce for many existing public swimming pools and spa pools. Bathers can be prompted to shower and wash with soap before using the swimming pool or spa pool via strategically placed signage at public access points, by providing soap dispensers in the shower facilities and by ensuring change rooms are kept hygienic. Verbal reminders to encourage bathers to shower before using public swimming pools and spa pools can help to change behaviour,

reduce chlorine demand and reduce the rate at which disinfection by-products are created.

Showers should be designed to be easily accessible and strategically located in public swimming pool and spa pool facilities. Consider designs that require bathers to enter the change rooms before they can enter the public swimming pools and spa pools to encourage showering before entering the water.

8.3 Toileting and handwashing

Encourage proper toileting behaviour among bathers to help minimise public health risks. Parents and the guardians of children should be encouraged to ensure their young children use the toilet before entering public swimming pools and spa pools as well as take regular toilet breaks. Toilets should include signs to encourage bathers to wash their hands with soap before returning to the water. Always provide enough soap for handwashing. Toilets should be designed to be easily accessible and positioned close to the swimming area(s) in public swimming pools and spa pools.

8.4 Nappy change areas

Nappy change areas should be provided in an easily accessible location, kept clean, sanitised regularly, and always be supplied with soap for handwashing. Washdown water from nappy change areas should not be allowed to flow to the pool or stormwater. Bins should be provided for dirty nappies and emptied regularly.

Infant 'aqua nappies' and swim pants are commonly used and while effective at containing solids may give a false sense of security as faecal particles can still leak into the pool (Amburgey and Anderson 2011; Maas, Patch, Berkowitz and Johnson 2004). Regular nappy changing and frequent trips to the toilet can reduce the chance of a faecal accident. Staff should let patrons know that nappies can only be changed in nappy change areas rather than near the water's edge.

8.5 Avoid swallowing pool water

Many illnesses associated with public swimming pools and spa pools occur after swallowing contaminated water, so all bathers should be discouraged from swallowing pool water. Children should also be supervised and discouraged from 'whale spitting' because this can often lead to accidentally swallowing water. If possible, locate bubblers (drinking fountains) at convenient locations within the public swimming pool and spa pool facility, particularly near areas used for exercise.

8.6 Signs

Appropriate signs can help ensure bathers practise good hygiene. It is best to display signage at each public access point that says:

- If you currently have, or have had, diarrhoea you should not enter the water. You should not swim for at least 14 days after symptoms have resolved.
- Parents/guardians of children who have had diarrhoea in the past 14 days should ensure their children do not enter the water.
- Please shower, with your swimwear (bathers) removed, using soap and rinsing thoroughly before entering the water.
- Avoid swallowing the pool water.
- Parents/guardians should ensure young children use the toilet before entering the water and regularly while at this facility.
- Do not change nappies beside the pool or rinse off your child in the pool. Use the change room provided.
- Wash your hands thoroughly after using the toilet or changing nappies. Please use the soap provided.
- Do not urinate in the pool. This contaminates the pool water.
- Faecal accidents can happen. If you or your child doesn't quite make it to the toilet, please tell our staff immediately. Confidentiality will be respected.

Resource material, including posters and brochures, that promote healthy swimming behaviours are available online. Refer to the Healthy swimming resources on the [NSW Health website](#).

8.7 Minimising the likelihood of environmental contamination

Environmental contamination (for example, dirt and vegetation) can affect water quality in many ways. Public swimming pools and spa pools should be designed to reduce the likelihood of environmental contaminants being introduced into the water.

For outdoor swimming pools and spa pools, the surfaces around the swimming pool and spa pool should be sloped to direct stormwater away from the water body. Nearby trees should have overhanging branches removed. Any play equipment should be designed to discourage birds from roosting on it, and barriers (fences) are recommended to exclude animals.

For indoor public swimming pools and spa pools, environmental contamination is also a concern and is predominantly caused by bathers carrying microorganisms and organic matter into poolside wet areas. Consider installing mats at the entry and exit points to public swimming pools and spa pools to capture dirt and additional environmental contaminants carried in on footwear.

8.8 Assistance animals

Assistance animals (such as guide dogs) are permitted to enter public facilities but should not be permitted to enter the water.

9

Incident response

Chapter 9 Incident response

Key points

- Incidents that adversely affect water quality can occur at any public swimming pool and spa pool.
- Operators should have documented procedures for responding to incidents.
- Staff should be trained to respond to incidents appropriately.
- Incident response protocols are detailed on the [NSW Health website](#).

9.1 Response procedures

Types of incidents that may occur at a public swimming pool or spa pool that could affect public health include:

- diarrhoeal incident
- formed stool and vomit contamination
- microbiological parameters exceedance
- contamination of surfaces.

The water in public swimming pools and spa pools may become contaminated or a water treatment failure may occur despite operators' best efforts. These incidents often present a real risk to the health of bathers, and it is necessary for the operator(s) to respond appropriately.

Operators should have documented and readily accessible procedures for responding to incidents and be trained to carry out these procedures.

Taking the correct action during incident response is important. It must be done correctly to prevent illness and the need for temporary closure of the pool. Refer to incident response protocols on the [NSW Health website](#) for more information. The protocols provide guidance on responding to water quality incidents or treatment failures that may affect public health. These incident response procedures are primarily for larger public swimming pools and spa pools with large volumes of water. For smaller public swimming pools and spa pools, it may be easier to empty the affected water body, remove any accumulated contaminants retained in the filter, refill and re-establish the necessary water balance and disinfectant residual.

9.2 C.t value (disinfection effectiveness)

All public swimming pools and spa pools operators should be familiar with the concept of disinfection when responding to incidents. *C.t* is a measure of disinfection effectiveness.

C.t is expressed as milligrams (mg) of chlorine per litre (L) times the number of minutes for which this concentration of chlorine is maintained (for example, 15 mg.min/L). The formula is as follows:

$$C.t = C \times t$$

Where: *C.t* is the disinfection contact time value in mg.min/L,

C is the disinfection residual concentration in mg/L, and

t is the time in minutes required to inactivate a particular microorganism of concern.

Different *C.t* values are required to inactivate different pathogens. Table 9-1 shows the contact times to achieve the *C.t* values needed to inactivate a range of pathogenic organisms.

Table 9-1 Disinfection times to inactivate selected pathogens in pools

Contaminant ¹	Disinfection time ² (1 mg/L chlorine at pH 7.5 and 25°C, without cyanuric acid)
<i>E. coli</i> bacteria	< 1 minute
Hepatitis A virus	5-20 minutes
<i>Giardia</i> parasite	45 minutes
<i>Cryptosporidium</i> parasite	15,300 minutes (10.6 days)

Source: U.S. Centers for Disease Control and Prevention (2024a).

¹ In practice, only the *Cryptosporidium* value is relevant to most circumstances since that is the most resistant pathogen.

² These disinfection times relate to the given pH, temperature and disinfectant concentration, and are influenced by other factors such as turbidity and cyanuric acid. For instance, required contact times will increase as pH rises and decrease as temperature rises, and vice versa.

During an incident response, a *C.t* value of 15,300 mg.min/L is required for 3–log₁₀ inactivation of *Cryptosporidium*. This can be achieved with a free available chlorine concentration of 20 mg/L for 13 hours or 10 mg/L for 26 hours for public swimming pools and spa pools that use chlorine without cyanuric acid.

Calculation:

$$15,300 \div 20 = 765 \text{ minutes or } \sim 13 \text{ hours}$$

$$15,300 \div 10 = 1,530 \text{ minutes or } \sim 26 \text{ hours}$$

A higher *C.t* applies to public swimming pool that use chlorine with cyanuric acid. For more information on hyperchlorination during an incident, refer to the incident response protocols on the [NSW Health website](#).

Elevated levels of chlorine may damage the pool and its components. If required, consult a pool treatment specialist to determine a suitable combination of concentration and time for the affected pool(s).

Hyperchlorination may not be needed if a swimming pool or spa pool has a system that is validated to treat *Cryptosporidium* risk (for example, UV disinfection) provided that the system is operating within the validated parameters and adequate turnover of the water occurs before the pool is re-opened.

10

Operator training

Chapter 10 Operator training

Key points

- All staff involved in operating public swimming pools and spa pools should undertake appropriate training for their role.

Public swimming pool and spa pool managers should ensure they have adequately trained staff who understand the treatment processes and know how to maintain water quality. Managers and operators of public swimming pools and spa pools should be committed to training and continuous professional development. Industry bodies provide professional development opportunities for their members.

The NSW Office of Local Government *Practice Note No. 15 - Water Safety* guides NSW councils to strengthen their water safety functions and responsibilities. The Practice Note recommends qualifications and competencies relevant to public swimming pool and spa pool staff including the Aquatic Technical Operator skill set (SISSS00131). NSW Health recommends public swimming pool and spa pool staff that manage water quality complete the Aquatic Technical Operator skill set through a registered training organisation. Completion of the skill set provides credit towards a Certificate IV in Sport, Aquatics and Recreation (SIS40122).

Operator training in responding to water quality incidents should be included in inspections of public swimming pools and spa pools carried out by local government or Public Health Units.

11

Appendices

Appendix A Interactive water features (water play parks and recreational aquatic structures)

Interactive water features such as water play parks or other recreational aquatic structures have been associated with a number of disease outbreaks in Australia (de Gooyer et al. 2017). Interactive water features are public swimming pools. An interactive water feature is declared by the NSW Public Health Regulation 2022 (the Regulation) not to be a public swimming pool or spa pool if it uses a public water supply, does not use a recirculation system and does not store water. The information provided below will help operators of all interactive water features to minimise the risk to public health.

A.1 Risk management

NSW Health recommends that all interactive water features have a site-specific water quality risk management plan (refer to [Appendix C](#)).

A.2 Location

As interactive water features are often located within public open spaces, it is important to consider surrounding area since it may affect the water quality. It is recommended that interactive water features are:

- located far from sand pits, garden beds and trees as these will increase the volume of physical contaminants
- located near toilet and/or shower facilities, ideally including nappy changing facilities and waste bins, to reduce contamination
- graded to avoid stormwater runoff or seepage into underground water storage tanks/reservoirs
- surrounded with fencing to keep out animals during and outside operating hours (if not possible, providing bag dispensers can prompt owners to collect and dispose of animal faeces).

A.3 System design

Full system design plans (as installed) and operating manuals should be maintained so they can be reviewed by an environmental health officer if requested.

The following factors should be considered when designing an interactive water feature:

- **source water quality and availability** – only potable water should be used
- **containment structures and drainage** – include upstream interceptor drains to prevent stormwater runoff entering the interactive water feature
- **water circulation system** – recirculating water (subject to treatment and re-use) versus non-recirculating water (passes through the interactive water feature only once)
- **treatment plant** – appropriately sized to achieve effective water circulation, turnover, filtration, and disinfection targets
- **materials and system components** – fit for purpose (slip resistant, anti-entrapment) and able to withstand ongoing exposure to the surrounding environment including varying disinfection concentration levels (such as during periodic shock dosing)
- **water flow** – engineered to prevent both water stagnation and water pooling
- **spray plume height and velocity** – plumes may expose people who may not be directly using the interactive water feature and in young children may result in accidental or intentional water consumption
- **backflow prevention** – this ensures water supply lines are protected from contamination. Any backflow device should be installed and commissioned to comply with the relevant plumbing and drainage legislation.

A.4 Recirculating systems

A.4.1 Water storage and circulation

Water should be stored and circulated to allow adequate water turnover and distribution of disinfectant throughout all parts of the system. Water tanks should be accessible for cleaning and inspection and be capable of complete draining. Storage capacity, including both the size and number of tanks required, must maintain an adequate residual of disinfectant in the system.

Water temperature is an important consideration when sizing water storage tanks. Small volumes of water will heat rapidly when exposed to external surfaces during interactive water feature operation, increasing the risk of microbiological growth. A maximum water turnover rate of 20 minutes is recommended due to the relatively small volumes of water and high contaminant load associated with interactive water features. A flow gauge should be fitted to the system to demonstrate an adequate flow rate within the interactive water feature.

A.4.2 Treatment

A.4.2.1 Filtration

Filtration systems should be fitted to remove particulate matter (soils, leaves, etc.) and help control potential disease-causing microorganisms. The filtration system should run constantly while the interactive water feature is open to users.

Ideally filtration systems should be designed and operated to remove *Cryptosporidium*. Filters should ideally be validated for *Cryptosporidium* removal and operated according to manufacturer instructions. Filters capable of removing particles 4 microns in diameter and consistently achieving a filtrate turbidity of no more than 0.5 NTU (Nephelometric Turbidity Units) will provide additional protection against *Cryptosporidium* (National Health and Medical Research Council 2011).

A.4.2.2 Disinfection

Interactive water features that meet the definition of a public swimming pool must be fitted with an automated or continuous metered disinfectant dosing system and must be disinfected with chlorine or bromine. Refer to Table 3-1 and Table 3-2 for water quality requirements. Using cyanuric acid is unlikely to be beneficial as most of the water is contained in a balance tank for most of the time and is not exposed to direct sunlight for long periods. In addition, using cyanuric acid in such instances may reduce the effectiveness of chlorine disinfection.

A.4.2.3 Secondary disinfection

Secondary disinfection is recommended for all interactive water features, usually in the form of UV disinfection. UV disinfection can inactivate *Cryptosporidium* and can help control combined chlorine while improving the water quality (including the odour from combined chlorine). A UV disinfection system should be installed in a location prior to the chlorine dosing point and run constantly while the interactive water feature is open to effectively control the combined chlorine levels. UV disinfection systems should be validated and designed for full flow (not side stream) to achieve a minimum of 3–log₁₀, or 99.9%, inactivation of *Cryptosporidium* (U.S. Centers for Disease Control 2024b).

A.4.3 Monitoring

A.4.3.1 Operational monitoring

Daily on-site operational monitoring of interactive water features is required for interactive water features considered to be public swimming pools under the Regulation and is recommended for all other interactive water features. Since interactive water features are typically located in open public spaces and may be accessible after-hours, on-site operational monitoring is important to understand water quality and verify the accuracy and reliability of remote monitoring.

Schedule 1 of the Regulation prescribes specific operating, water quality, monitoring and record keeping requirements for interactive water features that are considered to be a public swimming pool or a spa pool. Operational monitoring frequency must be increased if the occupier of the premises considers it necessary,

taking into account the number of people using the interactive water feature, the hours of operation of the interactive water feature and the effect of sunlight on disinfectant levels. The Regulation also requires that monitoring records are maintained for at least 6 months.

A.4.3.2 Online monitoring

To enable real-time, online monitoring of free available chlorine levels, pH and water temperature, interactive water feature operators may install probes for free available chlorine, pH and temperature. The system should be configured to allow automatic shutoff of the interactive water feature when automated online monitoring shows that the free available chlorine levels, pH levels or water temperature are out of specification.

Interactive water features considered to be public swimming pools under the Regulation are required to conduct manual operational monitoring at least once per day even where automated online operational monitoring is used. Manual sampling confirms that the results from the automated systems are accurate. These samples should be taken from a location just before the monitoring probes. Daily manual operational monitoring is recommended for all other interactive water features.

If online monitoring is used, the probes should be correctly calibrated and maintained (in accordance with manufacturers recommendations) so that results are reliable. Results should be accessible to operators and available during inspections.

A.5 Signage

Safety signage should be provided in a conspicuous location(s) and include:

- contact details for reporting issues/faults with the interactive water feature
- advice to not swallow the water
- advice not to use the interactive water feature if someone has diarrhoea, and for 14 days after symptoms have stopped
- advice for babies and toddlers to wear tight-fitting swim nappies
- the location of the nearest public toilets/change rooms and nappy change facilities
- advice that animals are prohibited from accessing the interactive water feature.

A.6 Seasonal operation

Seasonally operated interactive water features should be drained to remove any stagnant water before closing for the season to minimise water quality risks. Prior to re-opening, the system should be cleaned and disinfected.

A.7 Operator skills and knowledge

The owner or operator of an interactive water feature should take reasonable care to ensure the person(s) responsible for managing the interactive water feature has the appropriate skills, knowledge and experience. Further information on operator training is provided in [Chapter 10](#).

Appendix B Natural swimming pools

A natural swimming pool is a swimming pool that contains only untreated water that is supplied directly to the pool from the ocean or other natural water source and does not have a circulation system. The operating, notification and registration requirements for swimming pools under the Public Health Regulation 2022 (the Regulation) do not apply to natural swimming pools. There are powers under the Regulation for temporary closure orders and directions to take action if a natural swimming pool is a risk to public health.

NSW Health recommends that natural swimming pools are managed through the preventive risk management approach recommended by the National Health and Medical Research Council's *Guidelines for Managing Risk in Recreational Water*. NSW Health recommends that the risk management approach is documented in a recreational water risk management plan.

B.1 Hazards specific to natural swimming pools

The following hazards are associated with natural swimming pools:

- **Physical** – such as floating or submerged objects.
- **Sun, heat and cold** – exposure to ultraviolet radiation particularly during the middle hours of the day, exposure to water >34°C can result in heat exhaustion or heat stress, where exposure to water <16°C can result in hypothermia.
- **Microbiological** – viruses, bacteria, protozoa, and fungi from contamination with faecal pollution from human or animals. Microbiological quality may be strongly influenced by rain events. Also, microbiological organisms such as *Naegleria fowleri* commonly found in warm drinking water and *Vibrio vulnificus* commonly found in warm marine and estuary water can cause serious disease and in some cases death.
- **Cyanobacteria and algae** – Some types of cyanobacteria (blue-green algae) produce toxins that can cause adverse health effects.
- **Dangerous aquatic organisms** – such as venomous organisms such as box jellyfish, blue ringed octopus and bluebottles.
- **Chemical-industrial, agricultural and other pollution sources** – could cause chemical contamination.

These hazards are discussed in further detail in the National Health and Medical Research Council's *Guidelines for Managing Risk in Recreational Water* and natural swimming pool operators should consider these hazards in a risk assessment and in the development of a recreational water risk management plan.

B.2 Risk management

NSW Health recommends that the operator develops and implements a recreational water risk management plan in consultation with NSW Health and authorised officers of local government that considers and documents strategies for managing public health risks.

The recreational water risk management plan should identify and assess risks; detail the process to categorise water quality (including sanitary inspection and monitoring programs) and operating, maintenance and notification activities (which could include regular cleaning programs and signs); and an incident response plan.

Strategies may include warning signs that inform people that the water is not treated and recommend avoiding head immersion and showering before and after use to help reduce risks from pathogens.

B.3 Incident response

Operators should consult with NSW Health and authorised officers of local government during the development of a natural swimming pool incident response plan. There may be times when the water in natural swimming pools will become contaminated. As incidents can present a risk to the health of bathers it is important that the incident response plan allows for operator awareness and appropriate response. The recreational water risk management plan should include protocols for responding to incidents, and triggers for closure and notifying the public during times of increased risk such as during and after periods of heavy rain and flooding. NSW Health recommends that swimming in oceans is avoided for 24 hours and in rivers, lagoons or estuaries for 3 days after heavy rain.

Appendix C Water quality risk management plan

NSW Health recommends all public swimming pools and spa pools use a water quality risk management plan to help protect public health. This is particularly important if using a water supply other than mains drinking water.

A water quality risk management system should:

- document staff roles and responsibilities, competencies, and training requirements
- describe the swimming pool or spa pool, its source water and treatment systems
- describe water quality targets and treatment objectives
- describe the process of risk assessment, including hazard identification, control measures and improvement plans
- describe operational and verification monitoring plans
- describe incident management and response procedures
- document processes for data recording and reporting.

The NSW Health Guide for developing a swimming pool water quality risk management plan and a supporting template can be found on the [NSW Health website](#).

Public swimming pool and spa pool operators can also use their own water quality risk management plan template if they prefer. Special consideration should be made for vulnerable groups (for example, children, people with low immunity, pregnant or elderly bathers) when making water quality risk management plans.

Appendix D Controlling combined chlorine

Combined chlorine is formed when chlorine reacts with nitrogen compounds introduced by bathers (mostly urine and sweat). Combined chlorine can cause skin and eye irritation and have a strong smell that bathers often incorrectly associate with high levels of free chlorine. Combined chlorine affects disinfection, and some types may corrode fabrics, fittings and cause irritation to the skin, eyes and respiratory tract.

Combined chlorine can also affect air quality in indoor venues. As such, adequate ventilation is essential. Indoor public swimming pools and spa pools should be designed to ensure continuous air circulation throughout the entire space. This will help eliminate stagnant areas, prevent temperature and humidity stratification, and maintain consistent air quality, temperature, relative humidity and pressure throughout the facility.

D.1 Reducing combined chlorine

The NSW Public Health Regulation 2022 (the Regulation) requires that combined chlorine not exceed 1 mg/L in any public swimming pool and spa pool. Reducing the amount of nitrogen compounds introduced into the water will help reduce combined chlorine. Recommending bathers shower with soap and rinse well before swimming or entering the swimming pool or spa pool and encouraging regular toilet breaks could help reduce organic compounds introduced by bathers and the production of combined chlorine.

Besides encouraging healthy hygiene and swimming practices, techniques such as shock dosing, breakpoint chlorination, ultraviolet (UV) light systems and dilution with drinking water help reduce combined chlorine concentrations in pools.

D.1.1.1 Shock dosing

Shock dosing is the practice of dosing large quantities of chlorine or other oxidisers into the pool water to reduce combined chlorine or to break down organic wastes, contamination and bacteria in the pool. Regular shock dosing of pools helps lower combined chlorine concentration, increases the chlorine's disinfection power and can restore clarity to the pool. Shock dosing of chlorine to a concentration of at least 10 times the combined chlorine concentration can control combined chlorine.

Chlorine dioxide, potassium monopersulfate and hydrogen peroxide are common oxidisers used for shock dosing. However, the use of some non-chlorine oxidisers, particularly potassium monopersulfate, can result in falsely elevated total and combined chlorine measurements (U.S. Centers for Disease Control, 2024a).

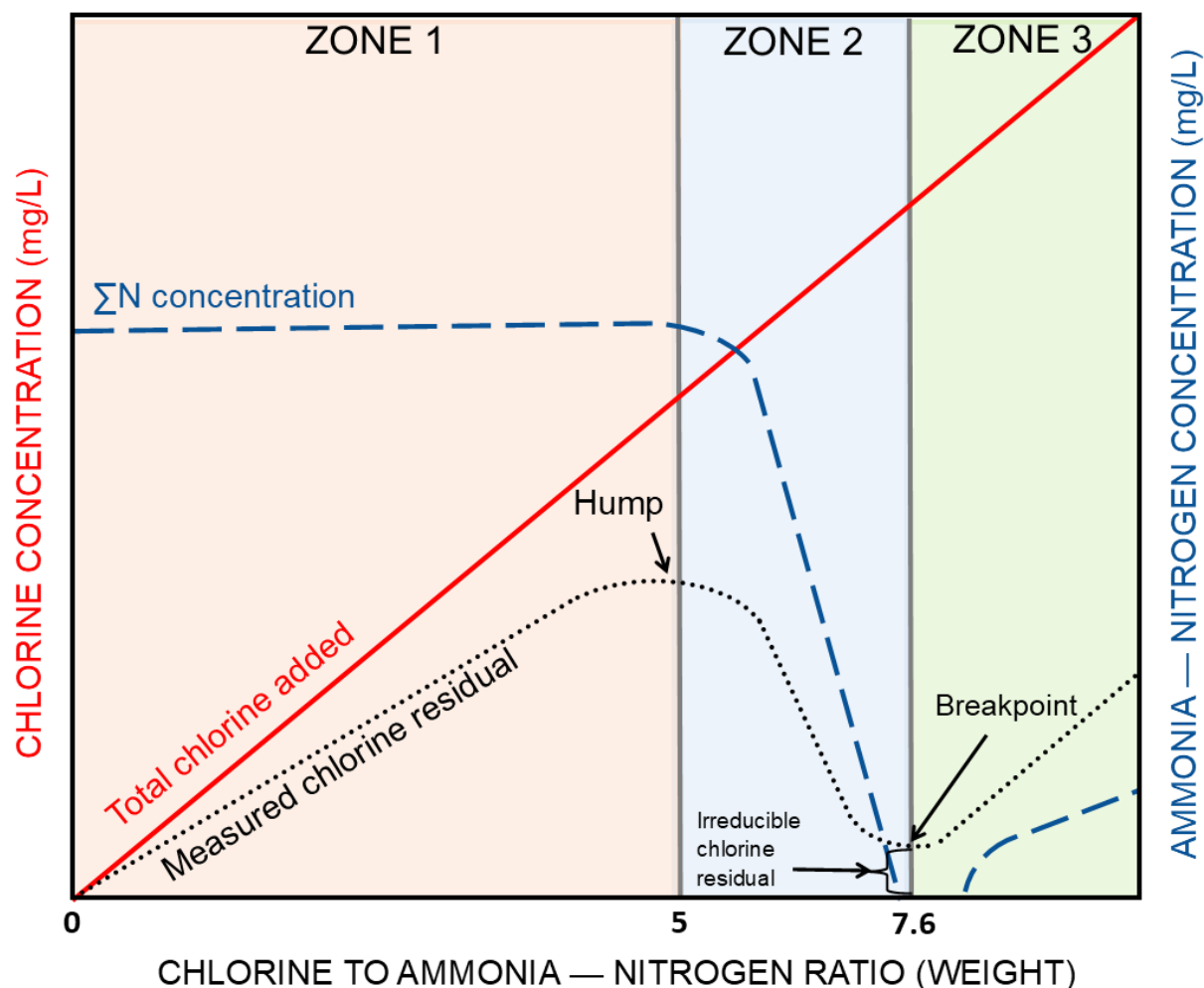
Shock dosing must only occur when the swimming pool or spa pool is closed to prevent harming bathers. Pool operators must also ensure that the total and combined chlorine and bromine measurements are within the requirements of Schedule 1 of the Regulation (Table 3-1 and Table 3-2) before re-opening the pool to the public.

D.1.1.2 Breakpoint chlorination

Breakpoint chlorination is the addition of sufficient chlorine to oxidise combined chlorine to the point where all chlorine that is present in the water is free available chlorine. There are two types of breakpoint chlorination: shock and continual. Shock breakpoint chlorination occurs by adding a dose (or slug) of chlorine into the pool that is large enough (at least ten times the combined chlorine concentration) to oxidise combined chlorine so total chlorine exists as all free available chlorine. Continual breakpoint chlorination oxidises combined chlorine by continually adding more chlorine into the pool until total chlorine exists as all free available chlorine.

The breakpoint chlorination curve (Figure D-1) demonstrates the theory of continuous breakpoint chlorination. The shape of the curve is affected by contact time, temperature, concentration of chlorine and ammonia, and pH. Higher concentrations of the chemicals increase the speed of the reactions. Swimming pools and spa pools that receive source water from chlorinated or chloraminated public drinking water supplies can be taken through breakpoint.

Figure D-1 Breakpoint chlorination curve.



Adapted from: Randtke (2010).

The breakpoint curve (Figure D-1) is a graphical representation of the chemical relationship that exists with constant addition of chlorine to swimming pool water containing a small amount of ammonia-nitrogen. This graph represents a swimming pool where bathing has ceased and no further ammonia-nitrogen is introduced into the pool. During an overnight period, chlorine (such as sodium hypochlorite) is added at a constant rate.

The left vertical axis of Figure D-1 is the chlorine concentration in mg/L, which is zero at the bottom of the axis and increases with height. On the right vertical axis is the ammonia-nitrogen concentration in mg/L (i.e., ammonia measured as nitrogen), which is zero at the bottom of the axis and increases with height. The bottom horizontal axis represents the ratio of chlorine (Cl_2) to ammonia (NH_2) by weight, which is zero on the left and increases to the right. The bottom horizontal axis also represents time and increases from left to right. There are three inter-related lines on Figure D-1:

- **ΣN CONC** – (sigma ammonia-nitrogen concentration) represents the concentration of the sum of all forms of ammonia-nitrogen in the pool
- **total chlorine added** – the constant dose of chlorine being introduced into the pool
- **measured chlorine residual** – the measured total chlorine residual in the pool.

The curve has three zones.

Zone 1

Starting from the left side of the graph, there is some ammonia-nitrogen (ΣN CONC) in the pool from bathers. Chlorine has been allowed to fall to zero. The total chlorine added and measured chlorine residual are both zero. Chlorine is then added at a constant rate. The principal reaction in Zone 1 is the reaction between chlorine and the ammonia. This reaction results in all measured total chlorine being present as monochloramine. The hump occurs, theoretically, at chlorine to ammonia-nitrogen weight ratio of 5:1. This ratio indicates the point where the reacting chlorine and ammonia-nitrogen molecules are present in solution in equal numbers. Monochloramine does not readily degrade.

Zone 2

The breakpoint occurs in this zone, which is also known as the chloramine destruction zone. As the weight ratio exceeds 5:1, some of the monochloramine starts reacting with further addition of chlorine to form dichloramine. A pure dichloramine residual has a noticeable disagreeable taste and odour, while monochloramine does not. Total chlorine added is still increasing and both the concentration of ammonia-nitrogen and measured chlorine residual decrease rapidly. This rapid decrease occurs because the dichloramine is reacting immediately with additional hypochlorous acid (the active component of free available chlorine ions) in a series of destruction reactions to form volatile compounds and other by-products such as nitrogen gas, nitrate and chloride. Ammonia and chlorine are consumed in the reactions and lost from the pool. Additional chlorine is required to destroy ammonia and chloramines.

The breakpoint is the point of the lowest concentration of measured chlorine residual where irreducible chlorine residuals remain and where ammonia-nitrogen is not detected. The irreducible chlorine residuals are mainly organic chloramines which cannot be oxidised any further by reacting with hypochlorous acid.

Zone 3

Zone 3 is to the right of the breakpoint and is where free available chlorine residual will appear. The total residual consists of the irreducible chlorine residuals plus free available chlorine. If trichloramine is formed, it will appear in this zone. In practice, the most pleasant bather comfort is achieved when free available chlorine accounts for the majority of the total chlorine.

Ammonia-nitrogen does not stay static but is continually introduced by bathers while the pool is open to the public. To achieve breakpoint chlorination, chlorination must continue after the pool has been closed to the public to ensure oxidation of the additional chloramines.

A.5.1.3 Ultraviolet light systems

Ultraviolet (UV) light systems can be effective at destroying combined chlorine. UV systems must have a wavelength of 254 or 282 nanometres to reduce combined chlorine such as monochloramines, dichloramines, and trichloramines (U.S. Centers for Disease Control and Prevention 2024a).

Most modern UV systems have in-built wiping systems that regularly clean the UV lamps to optimise pool disinfection. Otherwise, the UV lamp sleeve needs to be manually cleaned to remove oils, grease and dirt that may affect its disinfection efficiency. UV lamps typically last for 12 to 18 months and should be replaced according to the manufacturer's recommendations.

A.5.1.4 Dilution with drinking water and other water sources

Exchanging a proportion of the swimming pool or spa pool's water with drinking water may reduce the level of combined chlorine present. This could help where drinking water supplies maintain a free available chlorine residual, however the effect will be limited where drinking water supplies maintain a chloramine residual. The incoming supply water should be tested for combined chlorine before using it for dilution.

Diluting the pool with rainwater can be considered because it does not contain combined chlorine. It is important to have first flush systems and controls in place to protect public health and ensuring the rainwater complies with the National Health and Medical Research Council's *Australian Drinking Water Guidelines* before using rainwater for pool dilution.

Appendix E Langelier Saturation Index

Langelier Saturation Index (LSI) is a common method for determining the water's balance, whether it is likely to be corrosive or scale-forming.

The ideal LSI is 0, or slightly positive, but within a range of -0.3 to 0.3. A negative LSI typically indicates that the water is corrosive and may damage pool fixtures and fittings. A positive LSI means that scale is more likely to form and interfere with normal pool operations. A neutral or slightly positive LSI is still preferred as scaling is less harmful than corrosion, which damages mechanical and structural components.

If the LSI is outside the optimal range, it can be corrected by adjusting:

- pH to 7.2–7.6, and
- total alkalinity to 60–180 mg/L, and
- calcium hardness to
 - 200–400 mg/L for a masonry pool or spa, or
 - 80–200 mg/L for a vinyl or fiberglass pool or spa.

Lowering total alkalinity will usually lower pH. Lowering calcium hardness is not always possible due to the composition of the fill water. If calcium hardness is high then the pH or total alkalinity should be lowered, although they may not be able to be optimised due to the nature of dissolved minerals. Of these, pH is more important and is ideally 7.2–7.6 (noting the NSW Public Health Regulation 2022 Regulation allows a broader range of pH, see Table 3-1 and Table 3-2). LSI is calculated using the following equation:

$$\text{LSI} = \text{pH} + \text{'temperature factor'} + \text{'calcium hardness factor'} + \text{'total alkalinity factor'} - \text{'total dissolved solids factor'}$$

Table E-1 provides the conversions for pool and spa measurements for the first three of these factors. The total dissolved solids (TDS) factor should be 12.1 if the TDS is less than 1,000 mg/L, or 12.2 if the TDS is over 1,000 mg/L. If the pool is outdoors and uses cyanuric acid to stabilise the chlorine, 30% of the cyanuric acid reading should be deducted from the total alkalinity test result to get a more accurate LSI.

As an example, a pool with a pH of 7.6, calcium hardness of 200 mg/L, total alkalinity of 75 mg/L and TDS of 943 mg/L at 29°C. As per Table E-1 the temperature factor is 0.7, calcium hardness factor is 1.9, total alkalinity factor is 1.9 and TDS factor is 12.1. The LSI calculation for this pool is as follows:

$$\begin{aligned}\text{LSI} &= \text{pH} + \text{'temperature factor'} + \text{'calcium hardness factor'} + \text{'total alkalinity factor'} - \text{'total dissolved solids factor'} \\ &= 7.6 + 0.7 + 1.9 + 1.9 - 12.1 \\ &= 0\end{aligned}$$

This pool water is ideally balanced.

If the pool's calcium hardness was 1,000 mg/L, then the calcium hardness factor would be 2.6 and the LSI would be 0.7. At this LSI, scale may form including on heater elements and filter components, affecting pool operation.

Table E-1 Langelier Saturation Index conversion factors.

Measured temperature	Temperature factor	Measured calcium hardness	Calcium hardness factor	Measured total alkalinity	Total alkalinity factor
0°C	0.0	5 mg/L	0.3	5 mg/L	0.7
3°C	0.1	25 mg/L	1.0	25 mg/L	1.4
8°C	0.2	50 mg/L	1.3	50 mg/L	1.7
12°C	0.3	75 mg/L	1.5	75 mg/L	1.9
16°C	0.4	100 mg/L	1.6	100 mg/L	2.0
19°C	0.5	150 mg/L	1.8	150 mg/L	2.2
24°C	0.6	200 mg/L	1.9	200 mg/L	2.3
29°C	0.7	300 mg/L	2.1	300 mg/L	2.5
34°C	0.8	400 mg/L	2.2	400 mg/L	2.6
41°C	0.9	800 mg/L	2.5	800 mg/L	2.9
53°C	1.0	1000 mg/L	2.6	1000 mg/L	3.0
		1300 mg/L	2.7		
		1600 mg/L	2.8		
		2000 mg/L	2.9		
		2500 mg/L	3.0		

Source: U.S. Centers for Disease Control (2024a).

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Standards

Australian standards

Australian Standards that may be relevant to public swimming pools and spa pools are available at [Intertek Inform website](#) (previously SAI Global Standards)

Relevant standards include

AS 1668.2:2024 The use of ventilation and airconditioning in buildings, Part 2: Mechanical ventilation in buildings

AS 1926.1-2024 and Sup 1:2025 Swimming pool safety – safety barriers for swimming pools

AS 1926.2-2007 (R2016) Swimming pool safety – location of safety barriers for swimming pools

AS 1926.3-2010 (R2016) Swimming pool safety – water recirculation systems

AS 2560.2-2021 Sports lighting – specific applications

AS 2610.1-2007 (R2016) Public spas

AS 3633 – 1989 Private swimming pools – Water Quality

AS 3634:2022 Solar heating systems for swimming pools

AS 3780-2023 The storage and handling of corrosive substances

AS 3979-2006 Hydrotherapy pools

AS 5348:2022 Pool covers

AS 5352:2022 Swimming pool heat pump systems

AS ISO 31000:2018 Risk management – Guidelines

AS/NZS 2865-2009 Confined spaces

AS/NZS 3000:2018 Electrical installations (Australian/New Zealand Wiring Rules)

AS/NZS 60335.1-2022 Household and similar electrical appliances-Safety General requirements

AS/NZS 60335.2.60-2018 Household and similar electrical appliances-Safety General requirements-spas

Examples of international standards

ANSI/APSP/ICC-11 2019 American National Standard for Water Quality in Public Pools and Spas

DIN 19643 2023 Treatment of water of swimming pools and baths swimming pools

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