PowerWater

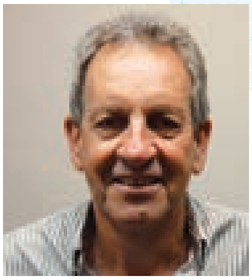
ANNUAL DRINKING WATER QUALITY REPORT **2012**


Finding Leaks
Leak Detection Van

CONTENTS

From the Managing Director

Power and Water Corporation is committed to ensuring safe, sustainable drinking water for Territorians. This commitment requires an appropriate highly skilled, trained and competent workforce capable of managing water quality to ensure consistent, high quality potable water to all Territorians.



John Baskerville

Multiple barriers against contamination are in place to maximise protection of water supplies and preserve the highest quality drinking water and Power and Water is continually investigating and implementing new ways to provide the safest and most acceptable water to our customers.

A well established and comprehensive monitoring program is in place throughout our diverse water supply systems. This annual report provides details of our water quality management system and the results of our water quality monitoring for 2011-12.

A memorandum of understanding (MoU) has been resigned with the Department of Health (DoH) defining the roles, responsibilities and obligations of both organisations with the aim of improving drinking water quality management.

Additionally, a new DoH notification protocol was finalised for reporting of incidents and events that may have public health implications. The protocol ensures that such incidents and events are reported in a consistent and timely manner so that appropriate responses can be initiated quickly to minimise the consequences of any incident or event.

To support the DoH notification protocol, complementary protocols were established during the year with laboratory service providers to promptly notify Power and Water of *Escherichia coli* detections, coliform detections and out-of-range fluoride results.

Separately, Power and Water has updated its Drinking Water Quality Policy which outlines a number of principles that ensure the effective management of drinking water supplies to provide good quality drinking water to our customers.

Sustainable water supply continues to be a priority for Power and Water with Territorians currently using twice as much water per person than comparable other Australian cities. We will continue to work with Territorians in urban centres to encourage responsible use of this precious resource.

John Baskerville
Managing Director

Section A

FRAMEWORK FOR DRINKING WATER QUALITY MANAGEMENT

The *Australian Drinking Water Guidelines* (ADWG) are the primary reference on drinking water quality in Australia. They are designed to provide an authoritative reference on what defines safe, good quality water, how it can be achieved and how it can be assured. The ADWG are concerned with both safety from a health perspective and aesthetic quality.

The ADWG are not mandatory standards, however, they provide a basis for determining the quality and safety of water to be supplied to consumers in all parts of Australia. The ADWG apply to any water intended for drinking, irrespective of the source or where it is consumed, with the exception of bottled and packaged water as these packaged waters are covered under the national Food Standards Code.

The ADWG are published by the National Health and Medical Research Council (NHMRC) in collaboration with the Natural Resource Management Ministerial Council (NRMMC). The last major revision of the ADWG occurred in December 2004 with the incorporation of the "Framework for Management of Drinking Water Quality" - a preventive risk management approach for water supplies.

There are 12 elements to the Framework, which are based on a proactive approach to ensuring the safety of drinking water by managing all steps in water supply from catchment to consumer. The 12 element are outlined in this report.

The ADWG are subject to a rolling revision process to ensure they represent the latest scientific evidence on good quality drinking water. The 2011 revision was released on 28 October 2011.

The 2011 ADWG have been developed after consideration of the best available scientific evidence addressing both the health and aesthetic quality aspects of supplying good quality safe drinking water.

The recent update of the ADWG includes:

- Additional material on pharmaceuticals and endocrine disruptors in Chapter 6;
- A rewrite of the monitoring chapters (9 and 10);
- Changes to guideline values for certain chemicals;
- Additional micro-organism fact sheets; and
- An additional 130 pesticide fact sheets.

IMPLEMENTATION OF 2011 AUSTRALIAN DRINKING WATER GUIDELINES

A secure and safe supply of drinking water maintained to the standard of current scientific knowledge is expected by customers. To meet these expectations, Power and Water, in conjunction with DoH, anticipate the endorsement of the 2011 ADWG during the 2012-13 financial year.

ASSESSMENTS MADE IN THIS REPORT

As the 2011 ADWG were introduced after the beginning of the reporting period of this report, all assessments made in this report are made against the 2004 ADWG. However, where an exceedance determined under the 2004 ADWG is inconsistent with the 2011 ADWG, comment will be made.

Commitment to drinking water quality management

Power and Water Corporation is committed to the effective management of its drinking water supplies and providing good quality safe drinking water to consumers.

This is outlined in our Drinking Water Quality Policy and Customer Contract. A copy of the Customer Contract is available at any Power and Water office or at www.powerwater.com.au

While Power and Water has a primary responsibility for providing safe drinking water through the *Water Supply and Sewerage Services Act 2000 (NT)*, a number of government agencies are also involved.

DoH has a key role in applying the 2004 ADWG and monitors compliance against them in the interest of public health. During 2011-12, collaborative work commenced between Power and Water and DoH on the implementation of the MoU which came into effect in July 2011. The MoU seeks to define the roles, responsibilities and obligations of both organisations with the aim of improving drinking water quality management.

The Department of Natural Resources, Environment, The Arts and Sport (NRETAS) also has a role in protecting water quality, including the regulation and management of water resources and the regulation of pollution control.

The Department of Resources (DoR) undertakes independent analyses of water samples in its laboratories in Darwin and Alice Springs.

The Department of Construction and Infrastructure (DCI) also has a major role in protecting water quality through appropriate land use planning.

These agencies coordinate and cooperate to ensure the highest standard of water quality is achieved and maintained.

SUMMARY OF POWER AND WATER'S DRINKING WATER QUALITY POLICY

In 2011-12 Power and Water released a new version of its *Drinking Water Quality Policy*. Power and Water is committed to effective management of its drinking water supplies to provide good quality drinking water to consumers. Power and Water, in partnership with its stakeholders, will:

- Work towards achieving compliance with the health and aesthetic guideline values set in the *Australian Drinking Water Guidelines*.
- Maintain regular monitoring of drinking water quality and establish effective reporting mechanisms to provide timely and relevant information to stakeholders, including the Chief Health Officer and the community.
- Use a risk-based approach to identify and manage any threat to drinking water quality at all points of the water supply path, from source water to the consumer.
- Advocate for source protection and primacy of drinking water supply in catchments and implement relevant catchment management activities.
- Develop and maintain a water quality incident and complaint register and where possible, engage with the community to assist in the identification, resolution and reporting of water quality issues.
- Develop and implement incident and emergency response plans.
- Participate in research and development activities to ensure continued understanding of drinking water quality issues and priorities in the Northern Territory.
- Consider needs and expectations of our stakeholders, including customers and regulators, in our planning processes.
- Review and improve our practices by assessing performance against corporate commitments, stakeholder expectations and criteria included in the *Australian Drinking Water Guidelines*.

Assessment of the drinking water supply system

Major centres have larger and usually more complex infrastructures. Power and Water provides the technical services to maintain these supplies. With these resources in place, major centres are able to extend these services to minor centres functioning both as a technical and administrative hub.

Garawa, a town camp of Borroloola, is included in this report. While the Mabunji Aboriginal Resource Centre is the custodian of the Garawa water supply infrastructure, it is operated by Power and Water's Essential Services Officer (ESO) based at Borroloola. The Borroloola ESO also collects routine water samples from the Garawa supply.

To assist the Mabunji Aboriginal Resource Centre, Power and Water monitors Garawa potable water quality by appending it to the Borroloola water quality monitoring program.

Water supply licence area

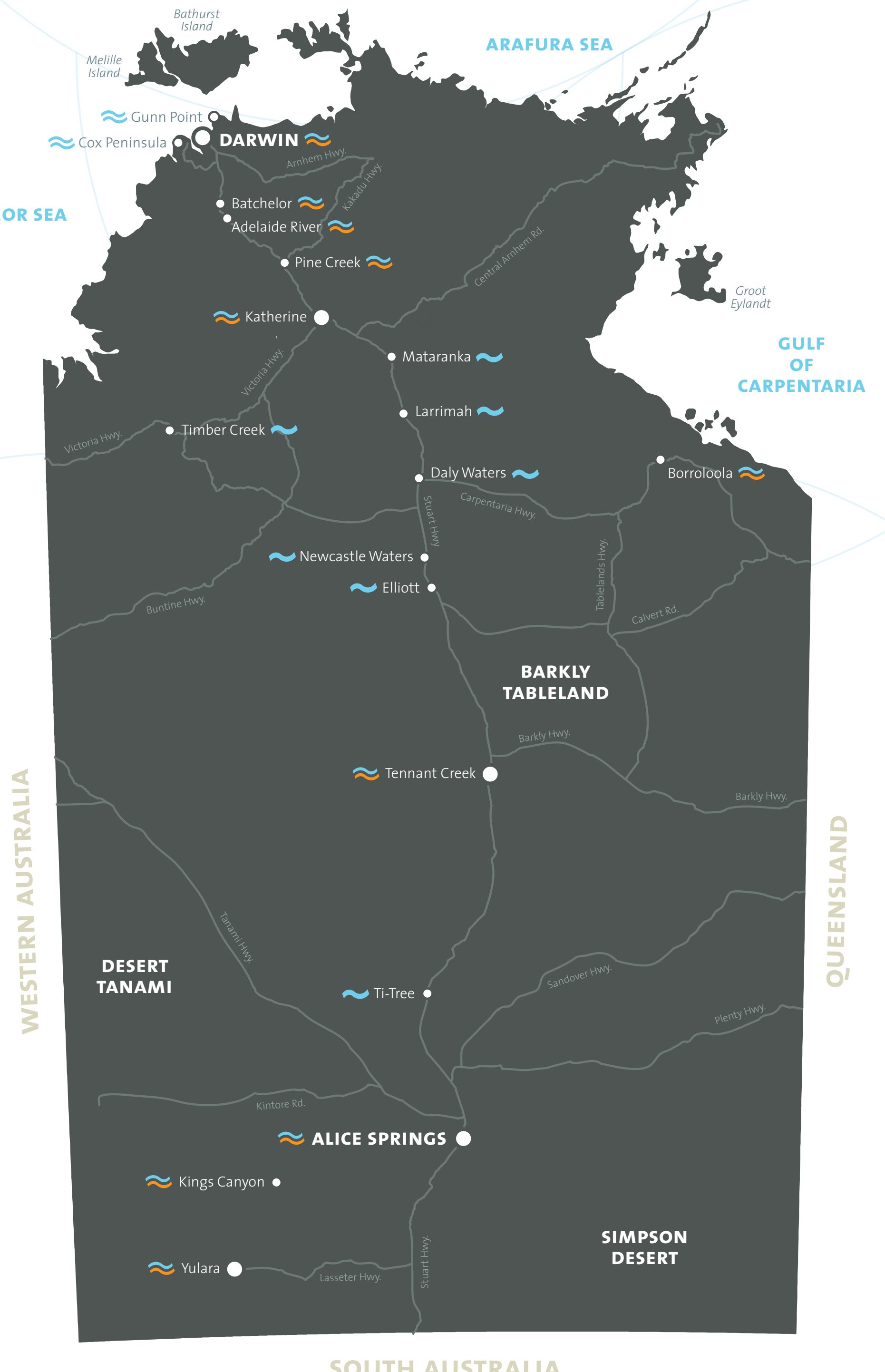
Water supply licence area
Restricted services area

Water supply and sewerage
Service licence area

Major urban

Minor urban

Figure 1 Drinking water supply system



WATER SOURCES

The primary water source for centres across the Northern Territory is ground water. Exceptions are Darwin, Katherine and Pine Creek which also access surface water. Table 1 lists existing water sources for major and minor centres in the Northern Territory.

Most of Darwin's water supply comes from Darwin River Reservoir. To ensure good quality water, no development or uncontrolled public access is permitted within the catchment. The reservoir is drawn down through the year with the majority of use in the Dry Season (May to October) with subsequent recharging during the Wet Season (November to April). The balance of supply (at least 10 per cent) is ground water from the McMinns and Howard East borefields.

DARWIN RIVER RESERVOIR ENHANCED CAPACITY

Completion of the raised spillway in 2010-11 increased the capacity of the reservoir by approximately 17 per cent. The following Wet Season and record-breaking rainfall from Cyclone Carlos caused the newly raised dam to spill for the first time on 16 February 2011. This was repeated during the 2011-12 Wet Season when the dam began overflowing on 13 March 2012 following the declaration of a cyclone watch the preceding day. Again the reservoir level rose above 105 per cent capacity deeply inundating shoreline vegetation.

The special investigation initiated in 2010-11 to monitor and assess the impact of shoreline inundation on water quality continued throughout 2011-12 (refer page 19). The 2010-11 inundation resulted in a significant proportion of shoreline vegetation dying. The 2011-12 inundation drew this dead vegetation into the reservoir. Since this event, a continuous increase in phosphorus has been measured throughout Darwin River Reservoir elevating the risk of algal blooms. Monitoring algal mass for toxins has now been increased.

The annual increase in demand for water from the Darwin water supply is currently approximately 1.6 per cent per annum (estimated to 2030). At this predicted rate water demand by 2030 will exceed current capacity by 25 per cent. To secure additional water supply capacity it is planned that Manton River Reservoir, which is currently considered as an emergency water source for the Darwin water supply, will be returned to service. Manton River Reservoir is not currently used as an operational source of water due to infrastructure constraints and water quality issues. Water quality investigations have shown that the return to service of Manton River Reservoir would require specialist water treatment to produce potable water of acceptable quality.

Table 1 Summary of existing drinking water sources in major and minor centres

Centre[1]	Source
Adelaide River	Ground water
Alice Springs	Ground water (Roe Creek borefield)
Batchelor	Ground water
Borroloola[2]	Ground water
Cox Peninsula	Ground water
Daly Waters	Ground water
Darwin	Surface water (Darwin River Reservoir) + ground water (10%)
Elliott	Ground water
Gunn Point	Ground water
Katherine	Surface water (Katherine River) + ground water (30%)
Kings Canyon	Ground water
Larrimah	Ground water
Mataranka	Ground water
Newcastle Waters	Ground water
Pine Creek	Surface water (Copperfield Reservoir) + ground water (40%)
Tennant Creek	Ground water (Kelly Well, Kelly Well West and Cabbage Gum borefields)
Timber Creek	Ground water
Ti Tree	Ground water
Yulara	Ground water

1 With local names where in common use.
2 The water source for the Borroloola town camp Garawa is groundwater and is separate from the Borroloola source.

The Darwin water supply does not currently have water treatment other than disinfection and fluoridation. Hunter Water Australia Pty Ltd has been engaged to undertake a water quality review and treatment options scoping for a new potable water treatment plant (WTP) to service the Darwin water supply.

The options for a WTP to treat the source water from Manton River Reservoir or a larger treatment plant to treat the whole region's water supply will be carefully considered.

Investigations that began in 2007-08 to improve and stabilise Manton River Reservoir's water quality by in reservoir treatment continued throughout 2011-12. In reservoir treatment and stabilisation will minimise the potential for algal blooms and iron and manganese mobilisation providing constant quality feedwater to the WTP.

3

Preventative strategies for drinking water supply

A preventative risk-based approach means that all the different risks to water quality are considered to determine what risks can reasonably be avoided and what risks need to be minimised or managed. A multiple barrier approach employs different barriers against contamination at different stages of a drinking water supply system. This approach means that the inherent risks to water quality are as low as possible.

MULTIPLE BARRIER APPROACH

The 2004 ADWG outline how to protect drinking water quality in Australia. They recommend a catchment to consumer framework that uses a preventive risk-based and multiple barrier approach. A similar approach is recommended by the World Health Organization.

The multiple barrier approach is universally recognised as the foundation for ensuring safe drinking water. Specific water treatment methods can prevent disease from being transmitted to the community. However, treating water after it leaves reservoirs and storages is not the only way to maintain water quality.

The first and most important barrier to protect is the catchment

Power and Water has adopted the multiple barrier approach to protect drinking water supplies. The strength of multiple barriers is that a failure of one barrier may be compensated for by the remaining barriers, minimising the likelihood of contaminants passing through the entire system. The placement of barriers in a conventional multiple barrier system is shown in Figure 2 on page 9. Barriers in place across major and minor centre water supply systems are described in Table 2, see page 9.

The catchment to consumer framework applies across the entire drinking water supply system – from the water source to consumers' tap. It ensures a holistic assessment of water quality risks and solutions to ensure the reliable delivery of safe drinking water to consumers.

HOW DO WE PROTECT PUBLIC DRINKING WATER SOURCES?

The first and most important barrier to protect is the catchment. The catchment is the primary asset of any water supply. Protection of the catchment has a flow-on effect that can result in a lower cost, safer drinking water supply. Other barriers against contamination include storage of water to help reduce contaminant levels, treating the water (e.g. chlorination to deactivate pathogens), maintenance of pipes and other infrastructure. Research and experience shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. Drinking water source protection is recognised as the most practical and significant approach to ensure protection of water quality of catchments now and for the future.

DRINKING WATER SOURCE PROTECTION PLANS

Drinking water source protection plans (DWSPPs) are designed to protect the quality and quantity of water sources from a wide range of pressures. The plans are typically developed for a specific source of drinking water supply, such as a catchment, reservoir or aquifer. They are relevant to area-based planning for both surface water and groundwater, where the threats to water quality and quantity are dispersed across a wide landscape. In the development of these plans, it is essential all potential threats to the water source are identified.

Management of water sources is a major responsibility of Power and Water. There are many risks and threats to water sources. Power and Water works both independently and in conjunction with stakeholders to ensure the security of these water sources.

Effective control requires planning, resourcing and proactive management, and an ongoing commitment to protection.

Power and Water has managed water resources and catchments through the development of risk plans, catchment management plans and other more specific land management and maintenance plans. Further development of a comprehensive framework with a focus on water source protection has been initiated in this reporting period. Power and Water's *Catchment and Water Source Protection Strategy* aims to develop this framework including individual site specific asset management plans to further protect and manage these critical assets.

Figure 2 Multiple barriers against pathogenic and chemical hazards

From catchment to consumer multiple barriers ensure safe drinking water

Table 2 Water quality barriers in major and minor centres

Centres	Catchment protection	Detention in reservoirs and aquifers	Bore head protection zone	Bore head integrity	Coagulation, filtration or membrane filtration	Disinfection	Storage tank integrity and cleaning	Maintenance of positive pressure in reticulation	Back-flow prevention in reticulation	Disinfection residual to customer's meter
Adelaide River		●	●	●		●	●	●	●	●
Alice Springs	●	●	●	●		●	●	●	●	●
Batchelor		●	●	●		●	●	●	●	●
Borroloola		●	●	●		●	●	●	●	●
Cox Peninsula	●	●	●	●		●	●	N/A	N/A	●
Daly Waters	●	●	●	●		●	●	●	●	●
Darwin -ground water	●	●	●	●		●	●	●	●	●
Darwin - surface water	●	●	●	N/A		●	●	●	●	●
Elliott		●	●	●		●	●	●	●	●
Gunn Point		●	●	●		●	●	●	●	●
Katherine - ground water		●	●	●		●	●	●	●	●
Katherine - surface water	●		●	N/A	●	●	●	●	●	●
Kings Canyon	●	●	●	●		●	●	●	●	●
Larrimah	●	●	●	●		●	●	●	●	●
Mataranka		●	●	●		●	●	●	●	●
Newcastle Waters	●	●	●	●		●	●	●	●	●
Pine Creek - ground water		●	●	●		●	●	●	●	●
Pine Creek - surface water	●	●	●	N/A	●	●	●	●	●	●
Tennant Creek		●	●	●			●	●	●	
Timber Creek		●	●	●		●	●	●	●	●
Ti Tree	●	●	●	●		●	●	●	●	●
Yulara	●	●	●	●	●	●	●	●	●	●

● Presence of Water Quality Barrier

4

Operational procedures and process control

Power and Water has documented procedures in place to ensure the uninterrupted supply of quality drinking water across the Northern Territory.

Operators have access to these procedures via Power and Water's intranet. During 2011-12 delivery of information via the intranet was redesigned to improve accessibility of information from Water Services' intranet site (Aquanet). This work will continue during 2012-13 and ultimately operational procedures will only be accessed from Aquanet.

Power and Water's systems and processes are based on International Standards Organisation (ISO) standards, Environment (AS/NZS ISO 14001:2004), Quality (AS/NZS ISO 9001:2008) and Occupational Health and Safety (AS/NZS 4801:2001). Power and Water continues to routinely review and enhance its systems and processes in accordance with Power and Water's commitment to continual improvement.

Operational monitoring is included as a component of Power and Water's monitoring program and addresses chemical, physical and biological parameters relevant to the management of water quality.

Industrial control systems (ICS) such as SCADA (supervisory control and data acquisition) are computer controlled systems that monitor and control industrial processes that exist in the physical world. SCADA systems historically distinguish themselves from other ICS systems by being large scale processes that can include multiple sites and large distances.

Power and Water's SCADA system monitors critical control points in water supplies using a range of online monitoring systems in each centre. Apart from monitoring the status and performance of infrastructure, this system provides continuous monitoring for specific water quality parameters such as chlorine, fluoride, conductivity, turbidity and pH.

In-field measurements, such as temperature and chlorine residuals help to identify performance issues and provide direction for corrective actions.

Corrective and preventative actions cover all aspects of operation and include health, safety and quality. Corrective actions specific to a procedure usually form part of that procedure. Corrective actions can be linked to operational monitoring, providing a formalised response to deviations from set point values at critical control points.

Materials used by Power and Water that contact potable water must comply with AS/NZS 4020:2005, *Testing of products for use in contact with drinking water* or other relevant standards.

Suppliers of chemicals used by Power and Water for water treatment are required to provide an analysis report of the chemical to be supplied. Chemicals must comply with the relevant ANSI/AWWA standard and the management system at the site of manufacture of the chemical must be certified to ISO 9001.

During 2011-12 an audit was initiated to identify products and materials (e.g. greases, jointing compounds etc.) that may be in contact with drinking water which fall outside the scope of AS/NZS 4020:2005 or other relevant standards. This audit also identified chemicals used for cleaning of WTP equipment and for weed control in catchments. During 2012-13 it is proposed formal schedules listing these materials, products and chemicals are created to ensure they are the only ones used by operational personnel.

5

Verification of drinking water quality

Water quality monitoring

Power and Water designs and implements 12 month water quality monitoring programs for all major and minor water supplies throughout the Northern Territory. The 2011-12 monitoring program was developed in consultation with the DoH in accordance with the principal commitments contained in the MoU between Power and Water and DoH.

Water quality monitoring undertaken by Power and Water in all centres in the Northern Territory is extensive. The *Drinking Water Monitoring Program 2011-12* details the collection of 4408 operational and verification samples. The execution of this program achieved the collection of 4232 samples or 96.0 per cent.

Water quality monitoring has a number of objectives and is therefore divided into classes with specific objectives.

OPERATIONAL MONITORING:

Used to check that the processes and equipment that have been put in place to protect and enhance water quality are working properly. The data can be used, if necessary, as a trigger for immediate short-term corrective action to improve water quality, but is generally not used for assessing conformance with the ADWG or compliance with agreed levels of service.

DRINKING WATER QUALITY (COMPLIANCE VERIFICATION) MONITORING:

Drinking water compliance monitoring aims to verify the quality of water in the distribution system and as supplied to the consumer. The data is used for assessing conformance with the ADWG or compliance with agreed levels of service and/or regulations and, if necessary, as a trigger for corrective action to improve water quality.

Power and Water's *Drinking Water Monitoring Program 2011-12* is used to verify the effectiveness of water quality management strategies. The program is based on the 2004 ADWG's recommendations, however, knowledge of specific water quality issues for a water supply may require an increase in monitoring frequency or the monitoring of additional parameters.

Microbiological samples are collected from locations closer to the point of supply to the customer, typically from within the reticulation system (e.g. from fire hydrants) or at customers' taps. Physical, chemical and radiological properties are generally subject to less variation. As a consequence, physical and chemical samples are generally collected from locations post-treatment while radiological samples are normally collected at sources.

Drinking water quality verification monitoring is the final check that the barriers and preventative measures implemented to protect public health are working effectively.

The parameters monitored in the program include:

Microbiological Parameters

Waterborne disease-causing organisms (pathogens) pose a serious risk to human health. The risk from pathogens in water supplies can vary significantly within a short period of time, therefore frequent microbiological monitoring is required to assess the potential for their presence.

The primary source of pathogens is faecal material either directly from animals or from sewage. Pathogens are difficult to detect and the analytical procedures are complex, protracted and require a specific test for each pathogen. The time taken for these analyses makes it impractical to directly test for pathogens, therefore indicator organisms are used to determine if contamination with faecal material has occurred.

The indicator organisms Power and Water monitors are:

- *Escherichia coli* (or *E. coli*): indicates faecal contamination from warm-blooded animals, including humans and hence, the potential for the presence of disease-causing micro-organisms; and
- Total coliforms: a range of bacteria found in many soil and aquatic environments. Total coliforms provide a measure of the effectiveness of the treatment system and a general indication of the cleanliness of the drinking water supply.

The 2004 ADWG require the assessment of microbiological performance:

- At least a minimum number of routine samples have been tested for *E. coli*; and
- At least 98 per cent of scheduled samples (as distinct from repeat or special purpose samples) contain no *E. coli*.

The number of routine samples collected for *E. coli* testing is defined in the 2004 ADWG and is based on the population served by each water supply.

Power and Water monitors for the presence of *Naegleria fowleri*. *N. fowleri* is a free-living ameboflagellate found in soil and aquatic environments. This amoeba causes primary amoebic meningoencephalitis (PAM), a very rapid and usually fatal infection acquired when water contaminated with *N. fowleri* enters the nasal passages.

Testing for *N. fowleri* is included separately in the monitoring program as the indicator organisms described above are not suitable indicators for the presence of *N. fowleri*. Power and Water introduced an extensive monitoring program for *N. fowleri* in all major and minor centres in 2006-07 following the detection of this organism in South Australia and Western Australia. Monitoring was continued throughout 2011-12 (refer page 32).

The 2004 ADWG recommend an action level of two *N. fowleri* organisms per litre in the treated water system.

The 2004 ADWG also recommend controlling *N. fowleri* by maintaining a minimum free chlorine level of 0.5 mg/L. Power and Water aims to maintain this level of chlorination in all distribution systems except Tennant Creek where continuous chlorination has not been implemented.

During the 2011-12 monitoring period *N. fowleri* was detected in the Darwin supply during investigational monitoring. Details are presented on page 31.

Power and Water monitors for the presence of *Burkholderia pseudomallei* in reticulated water. *B. pseudomallei* is the agent responsible for the disease melioidosis. This primarily tropical disease causes a potentially fatal human infection that generally manifests itself as a localised soft tissue infection, pneumonia, abscesses of the liver and spleen, or acute, rapid and often fatal septicaemia.

The monitoring program was developed in 2006-07 in consultation with the Department of Health and Community Services and focussed on the Tennant Creek water supply. Monitoring was continued during 2011-12 (refer page 33).

Chemical Parameters (Health)

The safe levels of chemicals in drinking water are specified in the 2004 ADWG and are based on assumptions including water consumption and potential exposure to chemicals from other sources. Power and Water monitors numerous chemical parameters to ensure that water supplied to customers is safe to drink.

The potential risk to human health increases as the levels of these chemicals increase. Monitoring by Power and Water ensures any risk to human health is identified and quickly minimised.

The results for health related chemical parameters are presented in the appendices Tables A3 and A4 pages 45-48.

Chemical and Physical Parameters (Aesthetic)

Numerous chemical and physical parameters are monitored by Power and Water in order to supply customers with aesthetically acceptable drinking water. Aesthetic parameters are the chemical and physical characteristics of water quality which pose no threat to human health but can affect drinking water appearance, taste, feel and odour. This includes total dissolved solids (TDS), hardness (calcium and magnesium carbonates and sulfates), colour, pH and a few common metals.

The aesthetic quality will affect the acceptance of drinking water by the consumer and is usually the first change in water quality observed by the consumer. Results for the annual assessment of aesthetic parameters are shown in Tables A3 and A4 pages 45-48.

Radionuclides

Low level radioactivity is occasionally detected in drinking water supplies in the Northern Territory. The radionuclides responsible for this radioactivity are natural and characteristic of the local hydrogeology.

The 2004 ADWG define corrective action responses when guideline limits are exceeded:

- If the total annual dose is less than 0.5 mSv, Power and Water will continue monitoring in accordance with 2004 ADWG;
- If the total annual dose lies between 0.5 and 1.0 mSv, results are reported to the relevant health authority (DoH). Collectively Power and Water and DoH determine the frequency of ongoing sampling (primary response level); and
- If the total annual dose exceeds 1.0 mSv intervention is required. Power and Water and DoH would assess the results and examine options to reduce the levels of exposure (secondary response level).

Details of the radiological assessment are reported on pages 34-35 and results are shown in Tables A3 and A4 pages 45-48.

Disinfection By-Products

Chlorine introduced into a water supply as a disinfectant reacts with naturally occurring organic matter such as decaying leaves and other vegetation to produce several by-products of disinfection, primarily trihalomethanes (THMs).

The concentration of THMs is typically proportional to the amount of organic material in the water. Surface water supplies have higher levels of naturally occurring organic matter than ground water supplies and hence higher THM levels after disinfection.

All major and minor centres were monitored for THMs in 2011-12 as part of the *Drinking Water Monitoring Program* (refer to Tables A3 and A4 pages 45-48).

Pesticides

The pesticide monitoring program focuses on 43 commonly used pesticides including organochlorine, organophosphate and triazine pesticides, insecticides and acidic herbicides.

Although monitored for several years, pesticides in the Northern Territory water supplies have not been detected despite limited use in some areas. From 2004 until July 2012 no sample tested for pesticides has returned a result at or above the level of detection.

Pesticides (insecticides and herbicides) are sometimes used in our catchments to control insects and weeds. DoH requires testing for pesticides where there is the potential for water supply contamination.

Results from the pesticide monitoring program revealed that pesticides had not been detected in any water supply. More precisely, the level of pesticides in all supplies was below the level of detection. In respect of these results, pesticide monitoring of drinking water supplies during 2010-12 was restricted to Darwin and Katherine supplies. The results for all samples from these supplies remain below the level of detection.

Disinfection Performance

The most commonly used disinfectant, chlorine, is used to destroy disease-causing organisms in water. Only chlorine-based disinfectants leave a beneficial residual level that remains in treated water helping to protect it during distribution and storage.

Chlorine can only be efficacious when its concentration is maintained at an effective level. This requires frequent measurement of the concentration and correction when the concentration is found to be inadequate.

Chlorine Decay

In order to achieve adequate disinfection the concentrations of both free chlorine and total chlorine must be measured. In a well performing water supply the concentrations of total chlorine and free chlorine would be near equal. A difference between these residuals indicates material in the system is reacting with the free chlorine reducing its concentration. The decline in the free chlorine concentration, through deactivation and/or combination, is referred to as chlorine decay. With the decay in free chlorine there is a corresponding increase in the difference between the free chlorine and total chlorine concentrations. The greater the chlorine decay the poorer the quality/performance of the system.

Free Chlorine Total Chlorine Ratio (FC/TC)

The free chlorine - total chlorine ratio is a measure of chlorine demand and chlorine decay and is a useful indication of the cleanliness of a distribution system. In a well operated and maintained system the free chlorine to total chlorine ratio will be 0.90 or greater. The critical limit is 0.8 (WIOA).

During 2011-12 Power and Water began monitoring of disinfection performance with the intention to provide a report of assessment to Water Operations.

6

Incident and emergency response

Appropriate and systematic responses to incidents that can compromise water quality are essential in order to protect public health and provide best service to customers. Power and Water has created a number of protocols to enable rapid dissemination of information when water quality failures and incidents occur or are identified.

The *Protocol for the Notification of Drinking Water Quality and Supply Reportable Incidents and Events* was established between Power and Water and DoH and was approved by DoH on 19 December 2011.

The protocol provides a series of formalised actions to be followed to ensure information of adverse changes in water quality is promptly conveyed to DoH.

This information includes analytical results where the measured value of a parameter exceeds an aesthetic or health ADWG guideline value or set trigger value. Additional information includes known details of the circumstances of the drinking water quality incident or event and actions being taken to rectify the situation.

During the 2011-12 financial year, the *Protocol for the Notification by Laboratory Service Providers of E. coli and Coliform Detections in Potable Waters V*1.0 was completed. The protocol was implemented in March 2012, following formal agreement between Power and Water and DoR microbiological laboratories.

The objective of this protocol is to ensure effective and timely communication of *E. coli* and coliform detections in potable water to both Power and Water and DoH. Trigger levels for *E. coli* and coliform detections define which nominated specific organisational positions in Power and Water, and where applicable in DoH, are notified by the laboratory service provider. Notification is by email (electronic fax) and may require reporting by phone.

Protocols covering notification of out-of-range fluoride results in potable water and pathogen detections in potable water are currently being developed.

Emergencies and incidents during 2011-12 year are reported on page 41.

7 Employee awareness and training

Power and Water ensures that all employees are appropriately trained and aware of their responsibilities. Procedures and documentation are frequently reviewed and training requirements are identified and programmed into schedules. Training is continually monitored to ensure staff knowledge and skills are current.

ON-LINE INDUCTION

Water Services' on-line induction was activated on 10 October 2011. The objective of this system is to improve safety on Water Services worksites by making the induction process consistent, site specific and up to date. The system ensures personnel and contractors are inducted to a level that meets Power and Water's legislative requirements and industry best practise.

This system:

- ensures important safety and site information is current;
- assesses competency in Water Services' safety procedures and information;
- includes site specific hazards/assembly area locations etc. and are activity specific; and
- includes a quick site familiarisation with their site contact.

TRAINING TO NATIONAL STANDARDS

Power and Water is committed to gaining industry training to either Certificate III or IV for all Water Operators. Certificates III and IV in Water Operations provide training for operators in the water industry and the opportunity for specialisations in water treatment, wastewater treatment, water supply distribution (network), trade waste, catchment operations, irrigation, dam safety, dam operations and source protection, river groundwater diversions and licensing, and construction and maintenance. Trade Technical workers continue to work towards the completion of Certificate III and Certificate IV in Water Operations.

OHS CONSTRUCTION INDUCTION WHITE CARD - WORK SAFELY IN THE CONSTRUCTION INDUSTRY

The *Northern Territory Code of Practice for Induction for Construction Work* commenced as an approved Code of Practice in the Northern Territory on 31 October 2009. Power and Water has a legal obligation under the *Work Health and Safety (National Uniform Legislation) Act 2011 (NT)* for the health and safety of its employees as well as contractors performing works at its various work sites. Power and Water initiated the identification and training of all relevant employees in relation to this legislative requirement and set an initial completion date for 1 September 2010. The majority of Power and Water's Water Services staff completed this requirement in the 2010-11 reporting period.

SEMINARS

Water Services personnel attended a one day interactive seminar on 'Water Awareness and Distribution System Management' in Darwin, April 2012. The seminar was presented by WIOA and covered the subjects of public health & water quality awareness, pathogens in distribution systems, disinfection, mains repairs, and system cleaning. At the invitation of Power and Water, representatives of DoH also attended this seminar.

8

Community involvement and awareness

The ADWG are intended to provide consumers with safe and aesthetically pleasing water but ultimately it is consumers who will be the final judges of water quality. It is vitally important that consumers are viewed as active partners in making decisions about drinking water quality and the levels of service to be adopted. Community expectations and willingness to pay must be considered. It is the responsibility of drinking water suppliers to keep the community fully informed about water quality, existing problems and needs for improvement.

Power and Water seeks community involvement in the awareness of water quality issues.

We would like the community to:

- Understand issues associated with their drinking water quality; and
- Help Power and Water ensure the security and integrity of their supply by reporting:
  - problems with water quality;
  - damage to water supply or sewage infrastructure; and
  - suspicious activity or unauthorised access to Power and Water's facilities.

Water quality specialists visit schools if requested and present classes on water science and other water-related subjects. Information on this, as well as our previous water quality reports, can be viewed at www. powerwater.com.au

Customers are informed of current and predicted water quality issues through placement of newspaper advertisements. In Darwin advertisements are placed to inform customers of predicted seasonal water quality changes that may produce discoloured water. In Tennant Creek advertisements are placed to notify customers that risks identified during routine monitoring are being remediated by manual dosing of the supply with chlorine.

Power and Water sponsors various community activities and technical events to promote awareness of water quality by:

- Sponsoring the Water in the Bush conference hosted by the Northern Territory branch of Australian Water Association (AWA);
- Providing grants as part of the annual Power and Water Melaleuca Awards;
- Staging open days at facilities such as Darwin River Dam;
- Providing presentations to school groups;
- Making presentations at major events including regional shows, the Tropical Garden Spectacular in Darwin and the Sustainability Festival in Alice Springs; and
- Publishing pamphlets and fact sheets to promote better understanding of the Territory's various water quality issues.

OUTREACH PROJECTS

The Sustainability Unit (SU) conducted a two-day workshop in Darwin on best practice in water efficient irrigation as part of Power and Water's three year Water Efficiency Plan. Participants were mainly from local shires and the Northern Territory Government. The objective was to build capacity within Northern Territory organisations involved in the irrigation of public open spaces by showcasing current best practices in water saving irrigation methods and technologies. The workshop included lectures, discussions and field visits.

SU conducted two school water audits in collaboration with the Department of Education and Children Services (DECS). The goal of these audits was to identify water saving opportunities and transfer know how to the DECS for their continued support to schools. The schools included Casuarina Senior College and Alawa Primary School. Results were presented to the respective school principals and relevant staff. A number of opportunities were identified to save water through more efficient fixtures and appliances, and fixing leaks. Overall payback periods on investment in water efficiency were less than a year.

9

Research and development

Water Quality Research Australia Limited (WQRA) is a not-for-profit company, established and funded by its members, to undertake collaborative research of national application on drinking water quality, recycled water and relevant areas of wastewater management.

The primary aims of WQRA are to coordinate and manage a structured program of collaborative research in water quality and to ensure that the knowledge generated is transferred to industry. WQRA's focus is on national issues in water quality with an emphasis on improving public health for Australians. WQRA brings together key water research groups and industry members across Australia to conduct targeted, priority research. These relationships place WQRA in a unique position to rapidly address current and emerging issues in public health and water quality.

Power and Water is an industry member WQRA and is represented by Managing Director John Baskerville.

As a member of WQRA, Power and Water plays an active role in numerous research projects including funding of relevant projects. Current Power and Water funded projects include:

- PROJECT # 1025
  Capacitive deionisation for high recovery and low energy desalination of brackish water supplies - Recent research conducted has indicated that the capacitive deionisation (CDI) has the potential to achieve good desalination at reduced energy consumption rates, relative to conventional reverse osmosis (RO) systems. In addition, CDI is simple to operate and the maintenance is low compared to RO. If demonstrated in this research to be a viable alternative, this method can be recommended to small communities where technical resources are not readily available.

WQRA projects (supported in-kind by Power and Water) and relevant to Power and Waters' current activities, especially Darwin River Reservoir, are:

- PROJECT #1006
  Implications for enumeration, toxicity and bloom formation. "Are there more toxingenes than toxic cyanobacteria?" - This project aims to establish the relationship between cyanobacterial genes, especially toxin genes, and cells using real-time polymerase chain reaction (PCR) to better forecast the growth of toxic cyanobacteria in water systems;
- PROJECT #1022
  Australian Cyanosurvey. - This project primarily investigates cyanobacteria speciation and validation of a range of analytical methods for detection of toxic species and toxin production;
- PROJECT #1031
  Ultrasound for Control of Cyanobacteria - The aim of this project is to develop a novel, ultrasound-based treatment technology for the control of cyanobacteria in reservoirs and lakes; and
- PROJECT #1033
  Optimizing conventional treatment for the removal of cyanobacteria and their toxins - Determination of the optimum conditions and coagulant type and pH for each cyanobacteria type in different source waters.

Power and Water maintains direct involvement in a range of research projects to improve water quality throughout the Territory. Power and Water has also commissioned a number of internal and external reports on water quality issues during 2011-12.

MANTON RIVER RESERVOIR RETURN TO SERVICE

Fortnightly algal and chemical monitoring in Manton River Reservoir continued during 2011-12. Tropical Water Solutions was contracted to continue this monitoring. The collection of algal data is significant to the destratification project which is in part designed to control algal growth in the reservoir. This monitoring is also required to continue the assessment of risks associated with continued recreational use of this reservoir.

DARWIN RIVER RESERVOIR MONITORING PROGRAM

Some discussion of the emerging Darwin River Reservoir water quality issues has been provided in Sections 2 and 3.

The original 12 month limnological monitoring program assessing changes in water quality arising from the increase in the spillway height is now ongoing.

Monitored water quality parameters include but are not confined to:

- Colour;
- Turbidity;
- Iron and manganese;
- Changes in the seasonal concentrations and ratios of nutrients;
- Algal biomass of dominant groups including *Botryococcus braunii;* and
- Aquatic and terrestrial weeds specifically *Olive hymenachne* and *Mimosa pigra.*

Following the 2012 inundation of shoreline vegetation, elevated levels of phosphorus were detected throughout the reservoir. In response, monitoring for cyanobacteria has been expanded. New sample collection sites have been introduced and the frequency of nutrient monitoring has been increased.

10

Documentation and reporting

The majority of Power and Water's documentation and records are stored electronically.

Power and Water's Integrated Management System (IMS) integrates all of Power and Water's systems and processes into one complete framework, enabling the organisation to work as a single unit with unified objectives.

Core components of the IMS are the maintenance of documentation and the dissemination of information through a formalised reporting system. Data generated from the drinking water quality monitoring program is maintained in a purpose-specific Oracle database. Operational data from the online monitoring SCADA is made available to operators through a data historian application. This process information system (PI System) allows operators to record, analyse, and monitor the real-time status of water supply infrastructure and water quality.

Power and Water has progressively rolled out additional access to the PI system to all relevant users in the Water Services business unit to enhance monitoring and system understanding.

Research and development data is maintained in Power and Water's electronic data management system (TRIM). Technical and operational details of the water supply system including technical drawings and maps are contained in the Facilities Information System (FIS).

All of the above information is accessible through the Power and Water intranet.

Aquanet is a Water Services business unit specific subunit of Power and Water's intranet. Aquanet has been developed to improve ease of access to many components held in other systems by bringing these components together under a single interface.

As stated in the previous year's report, an Asset Management Capability project is underway to replace FIS and the Work Information Management System (WIMS) with IBM's asset management system, Maximo. Development and testing was undertaken during 2010-12 with implementation planned for the second half of the 2011-12 financial year. Implementation was delayed and Maximo was launched in August 2012.

The Asset Management Capability Project is critical to Power and Water to ensure:

- There is a consistent approach to managing assets;
- Data is accurate, complete and regularly updated;
- The current outdated and inflexible systems WIMS and FIS are replaced; and
- Greater focus on maintenance planning and reporting is needed.

Maximo officers systematically record customer queries and complaints. Power and Water's Water Quality section has constructed call scripts that will ensure correct categorisation of complaints received from customers and simplify the collation of this data in preparation for submission to the *National Performance Report (NPR)*.

Power and Water provides information to the public via its website. This includes technical information, guides to water conservation and media releases. Power and Water reports to the National Water Commission and the information reported forms part of the NPR and provides the Northern Territory and Australian public a reliable and transparent source of information on urban water utilities.

Power and Water's *Annual Drinking Water Quality Report 2012* provides an objective account of the quality of Northern Territory potable water supplied to consumers, regulatory bodies and stakeholders.

The intrinsic relationship between potable water and public health means Power and Water and DoH share common responsibilities and are required to work together to resolve water quality health-related issues. Protocols are in place to ensure any exceedance of the 2004 ADWG is reported promptly to DoH by Power and Water.

11

Evaluation and audit

The evaluation and audit of Power and Water's Water Quality Management System ensures successful management of water quality data and processes. Routine auditing is essential and Power and Water maintain a programmed schedule of internal audits.

Audits ensure that operational procedures and processes are in place so that accurate water quality data is collected and appropriate management systems are maintained.

The Drinking Water Quality Management System was internally audited in April 2012 and corrective actions are being addressed. The main issue highlighted by the audit was the lack of progress with the 'Aquality Tool' and therefore the assessment of the implementation of the ADWG's "Framework for Management of Drinking Water Quality" across Power and Water's water supply systems.

Scheduled for 2012-13, the "Water Quality Monitoring Program" will be audited with emphasis on compliance and obligations.

Power and Water's certifications to ISO 9001 (Quality Endorsed Company), AS/NZS 4801 (Occupational Health and Safety) and ISO 14001 (Certified Environmental Management) require six monthly independent external audits.

The management systems recertification audit was conducted in May 2012 by SAI Global Limited. Power and Water's quality, safety and environment management systems have been recertified until 2015.

12

Review and continual improvement

Power and Water is committed to developing and improving its drinking water quality management system and the safety of drinking water supplies.

In early 2011, the new position of Water Quality Information Management Officer (WQIMO) was recruited to the Water Quality section. This position has ensured water quality results from laboratories are scrutinized and validated prior to transfer into the database. The WQIMO also reports on the execution of the monitoring program by monitoring sample collections and submissions. The systematic recording of sample collections and associated documentation has significantly reduced 'failure to collect samples' events, and provides timely monitoring on the execution of the monitoring program.

The WQIMO is also responsible for the development of the *Water Quality Monitoring Data Management Manual*. This manual was created to address an area of concern raised by SAI Global in their audit of Water Services in 2011.

The audit identified there was no procedure or guidance on the manner in which data should be managed. It was acknowledged that Power and Water was awaiting the introduction of the Maximo system before committing to documenting a procedure. However, it was stated there should be an interim procedure (as a minimum) to ensure that critical data is managed effectively.

The manual provides instruction for the use of the Water Quality Front End Application (WQFA) in regard to uploading and downloading data. It sets out a basic naming convention for records that will be stored in TRIM simplifying the identification of other related documents stored in TRIM.

Information obtained from these audits and data gathered and assessed in annual reports such as this one leads to more comprehensive and targeted reforms to the drinking water quality monitoring program providing a valuable contribution to our program of continual improvement.

Power and Water has formed a Water Quality Network with SA Water (South Australia) and Water Corporation (Western Australia). The network provides a forum to share information and knowledge and discuss emerging issues. This allows us to benchmark our performance and identify other ways to improve drinking water quality.

A Water Quality Network workshop was held in Darwin in November 2011 and in Perth in June 2012.

Numerous topics were addressed at this meeting, however the major focus was on:

- Source protection;
- Cross connection and backflow;
- Toxin producing cyanobacteria;
- Iron and manganese removal; and
- 2011 ADWG Implementation.

REVIEW OF DRINKING WATER QUALITY SYSTEM

This annual drinking water quality report provides a role in identifying issues and facilitating improvements.

The recently published 2011 ADWG will provide guidance for further enhancements to Power and Water's management system and framework.

MICROBIOLOGICAL WATER QUALITY

Microbiological water quality is assigned the highest precedence and is assured by assessing the number and effectiveness of barriers that prevent the introduction of disease-causing organisms.

Table 2 shows Tennant Creek has the least number of protective barriers. It is therefore necessary to ensure this supply is monitored more frequently to capture any sudden decline in microbiological water quality.

Chlorination is the water industry's standard defence against microbiological contamination. Continuous chlorination is the preferred method to disinfect drinking water and without it there exists an elevated and unnecessary level of risk to public health. The Tennant Creek water supply does not operate a continuous chlorine disinfection system.

During the 2011-12 period, the Tennant Creek water supply suffered nine separate *E. coli* contamination incidents. All of these incidents were remediated by manual chlorination of the supply. In 2004, the Northern Territory Government (NTG) directed Power and water not to install continuous chlorination to the Tennant Creek water supply following a referendum by the community. In light of recent microbiological failures and potential risks, Power and Water is reviewing options in consultation with the NTG.

Microbiological Risks

N. fowleri presents a significant health risk to consumers. To control this risk, Power and Water has set a minimum free chlorine residual of 0.5 mg/L to be maintained in all supplies at all times. The effectiveness of this control can be assessed by monitoring the free chlorine residual and recording all incidents where the free chlorine residual falls below 0.5 mg/L.

Maintaining a minimum free chlorine residual of 0.5 mg/L has the inevitable consequence that the free chlorine level will frequently exceed the aesthetic guideline value of 0.6 mg/L. Free chlorine has therefore been excluded as an aesthetic parameter in the risk assessment.

In the absence of a continuous disinfection system, the Tennant Creek supply is unacceptably vulnerable to microbial contamination. Power and Water continues to work with DoH to review disinfection practice in Tennant Creek and routinely publishes a monthly public notice highlighting manual chlorine dosing events. Ongoing discussions between Power and Water, DoH and Northern Territory Government are still limited by the 2004 public referendum.

Infrastructure Development

Septic systems located within the protection zone of the original Elliott borefield are suspected to be the primary cause of numerous microbiological water quality failures in the Elliott supply. A new borefield was established for Elliott and four new production bores were drilled. The drilling was completed in July 2010. This new water source also addressed the issues of elevated hardness and iodide in the original source. These bores were scheduled to be commissioned in December 2012.

Elevated levels of iron and manganese in the Adelaide River water supply are an ongoing source of customer dissatisfaction. Complaints relating to discoloured water, in particular staining of laundry, increased during the 2010-11 period. Sequestration of iron and manganese with sodium silicate is currently used to prevent the iron and manganese precipitating out of the water at consumers' taps. This has been partly effective and is reflected in a decrease in complaints during 2011-12.

Power and Water has commissioned a consultant to design a water treatment plant for the Adelaide River supply that will remove iron and manganese prior to water entering the distribution system. This new WTP is scheduled for delivery during the 2013-14 financial year.

CHEMICAL, PHYSICAL AND RADIOLOGICAL RELATIVE RISK ASSESSMENT

Relative Risk Assessment Model

A major component of this annual report involves the evaluation of chemical, physical, radiological and microbiological data collected from the analysis of thousands of water samples. This data is used to calculate an annual statistical value for each parameter which is assessed against the corresponding 2004 ADWG value. When the annual value of a parameter is greater than the ADWG guideline value, it is reported as an exceedance.

Power and Water has developed a semi-quantitative risk assessment to rank the water quality of supplies according to the scale of these exceedances. Exceedances for each centre are summed and these totals or scores are used to rank centres according to the number and magnitude of the exceedances. Only exceedances are used in the risk assessment.

This ranking system is used to allocate resources to reduce the risks. The higher the rank the greater the risks and therefore the greater the requirement for resources. Results are shown in Table 3 on page 25.

Review of the Relative Risk Assessment Model

In the context of the model described above, risk is the probability a parameter will exceed its ADWG guideline value. However, when an exceedance occurs it is no longer a risk as it becomes an issue. An exceedance is therefore an issue that represents a problem. A risk can become an issue, but an issue is not a risk as it has already happened.

The original risk assessment procedure jointly developed between DoH and Power and Water aimed to prioritise needed improvements in chemical, physical and radiological water quality in all centres. It focused on a system numerically ranking exceedances of the 2004 ADWG values for one or more chemical, physical or radiological parameters.

The standard risk assessment model which combines likelihood and consequences to assess risk is poorly suited to this task as the consequences are assigned values arbitrarily. The likelihood of a parameter resulting in a problem becomes irrelevant as the assessment only considers known problems i.e. exceedances. This model assumes the magnitude of the problem can be expressed as the ratio of the annual value to the 2004 ADWG guideline value. For example, where the annual measured value exceeds a guideline value by double, the magnitude of the problem is given a value of two. Although very simple, this approach does provide a basic means to rank water supplies according to water quality problems.

Power and Water has established a protocol which defines the reporting of numerous events, incidents and exceedances to DoH. The *Protocol for the Notification of Drinking Water Quality and Supply Reportable Incidents and Events* prioritises events and incidents. Priority 2 requires the reporting of analytical results for health related parameters that exceed 80 per cent of the ADWG guideline value and is in part driven by the adoption of a risk based approach to water quality management.

This protocol requires the reporting of analytical results for health related parameters when they exceed 80 per cent of the guideline value but only actual exceedances of the guideline value are used in the current risk assessment model.

In the original procedure, the consequence of an exceedance is created by assigning a weighting according to a parameter's effect on human health. Weightings were developed in conjunction with DoH’s predecessor, Department of Health and Community Services, and are as follows:

- Relatively significant health impact: 10;
- Relatively minor health impact: 5; and
- Relatively significant aesthetic impact: 3.

For example, under this system, arsenic (a health related parameter) is given a weighting of 10 and salinity (TDS) (an aesthetic parameter) is given a weighting of 3.

There are two reasons for concern to this approach. Firstly, each health related parameter has significantly different health effects.

A one-size-fits-all approach to weighting is poorly conceived. Secondly, the act of combining health and aesthetic parameters biases the final score. A water supply with several aesthetic quality issues will be ranked above a supply with a single health related issue.

The procedure then follows that for each water supply, the risk (problem) contributed by each parameter exceeding the 2004 ADWG guideline value is converted to a consequence value by application of its weighting. The values of each of these risks (actually hypothetical consequences) are then summed and presented as the total risk value for each water supply.

This model was originally developed to provide a means to determine priorities for further action such as collection of additional water quality data, more detailed studies, or investigation into alternative sources of supply and water treatment options. Although this model falls short of its objective, the results of the assessment are reported here while an appropriate replacement model is developed.

Power and Water is committed to the development of a procedure that will accurately and systematically prioritise issues specific to each water supply and assist in the direction of funding to resolve these issues.

Chemical and Radiological Exceedance 2011-12

Table 3 shows Kings Canyon and Daly Waters have the highest risk scores. The primary water quality issue for Kings Canyon is iodide which is greater than four times the 2004 ADWG health guideline value. For the 2011-12 period, the level of iodide reported for the Kings Canyon's water supply is 0.43 mg/L. Four of the other 19 water supplies have slightly elevated levels of iodide.

The primary water quality issue for Timber Creek is barium which is approximately twice the 2004 ADWG health guideline value.

Table 3 Relative risk scores for all water supplies 2011-12

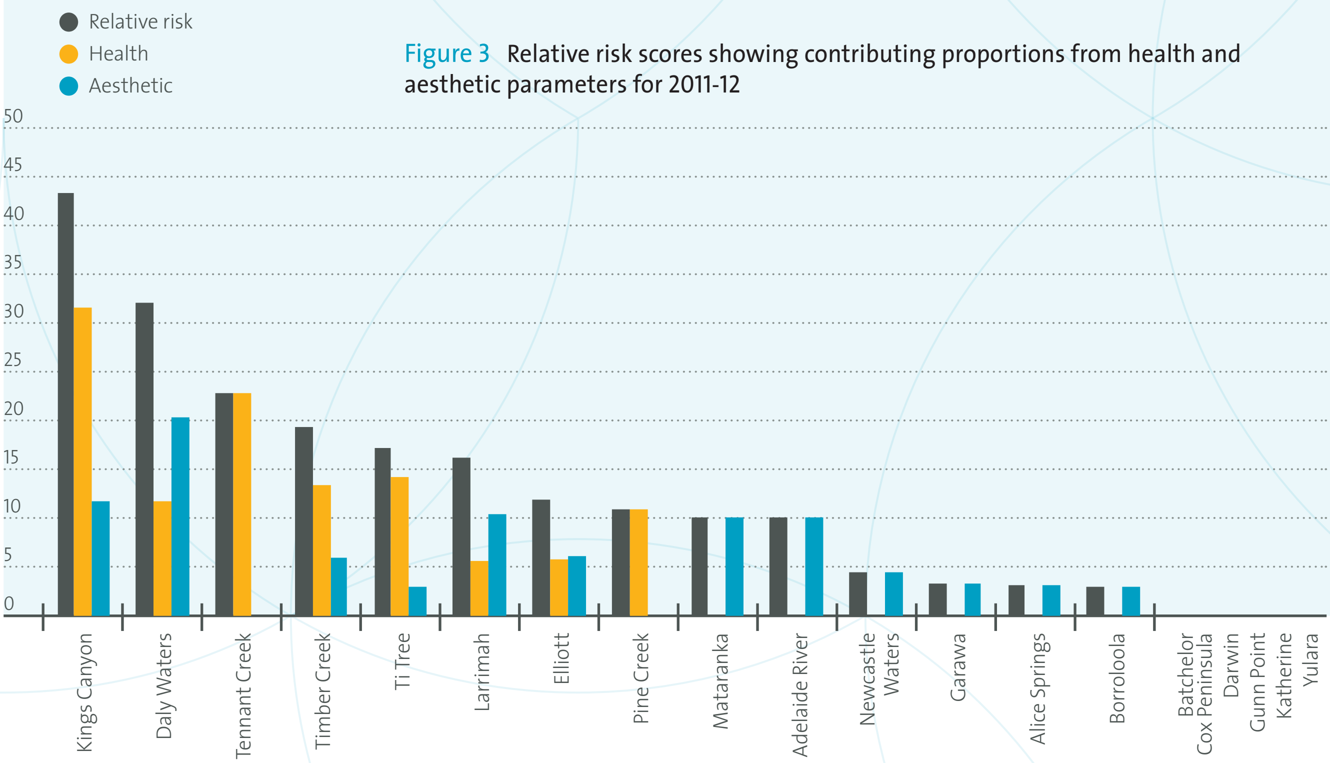
Rank	Centre	Relative Risk Score	Parameters Exceeding 2004 ADWG and DoH TDS Value 2011-12
1	Kings Canyon	43.5	Iodide Radiological Chloride Hardness TDS
2	Daly Waters	32.2	Iodide Chloride Hardness Sodium TDS
3	Tennant Creek	22.9	Fluoride Iodide
4	Timber Creek	19.4	Barium Hardness
5	Ti Tree	17.2	Iodide Nitrate Hardness
6	Larrimah	16.3	Iodide Hardness TDS
7	Elliott	11.9	Iodide Hardness
8	Pine Creek	11.0	Arsenic
9	Mataranka	10.2	Hardness TDS
10	Adelaide River	10.1	Iron Manganese
11	Newcastle Waters	4.5	Hardness
12	Garawa	3.4	pH
13	Alice Springs	3.1	Hardness
14	Borroloola	3.0	pH
15	Batchelor	0	None
16	Cox Peninsula	0	None
17	Darwin	0	None
18	Gunn Point	0	None
19	Katherine	0	None
20	Yulara	0	None

In the 2011 ADWG, the health guideline value for iodide has been raised from 0.1 mg/L to 0.5 mg/L. Many of the water supplies with iodide exceedances determined under the 2004 ADWG will not have these exceedances under the 2011 ADWG. More information is provided in Table 4.

The 2004 ADWG set a guideline value for iodide, however, most laboratories report iodine as iodide as Induction Coupled Plasma Mass Spectrometry is the preferred method of analysis. As this method does not distinguish between different forms of iodine in water samples, it is only a conservative measure of iodide concentration.

In Figure 3, the data used in Table 3 is presented to show health and aesthetic parameters separately.

Figure 3 Relative risk scores showing contributing proportions from health and aesthetic parameters for 2011-12



The 2011 ADWG includes changes to guideline values for several chemical parameters. Beryllium is now included as a health parameter and silica as an aesthetic parameter. The raising of the guideline value for iodide from 0.1 to 0.5 mg/L has the affect of eliminating iodide exceedances for all centres. The raising of the guideline value for barium from 0.7 to 2.0 mg/L eliminates this parameter as an exceedance in the centre of Timber Creek. Changes affecting specific centres are shown in Table 4.

Table 4 Centres and chemical parameters affected by the introduction of the 2011 ADWG

Centres Affected	Health Parameter	ADWQR 2012 Reported Value mg/L	2004 ADWQR Value mg/L	2011 ADWQR Value mg/L
None. No centre has a value greater than 0.001 mg/L	Beryllium	0.001	None	0.060
Daly Waters	Iodide	0.24	0.10	0.50
Elliott	Iodide	0,12	0.10	0.50
Kings Canyon	Iodide	0.43	0.10	0.50
Larrimah	Iodide	0.11	0.10	0.50
Pine Creek	Arsenic	0.0077	0.0070	0.0100
Tennant Creek	Iodide	0.35	0.10	0.50
None. No centre has a value greater than 0.00942 mg/L	Uranium	0.00942	0.02000	0.01700
Ti Tree	Iodide	0.17	0.10	0.50
Timber Creek	Barium	1.88	0.70	2.00

Centres Affected	Aesthetic Parameter	ADWQR 2012 Reported Value mg/L	2004 ADWQR Value mg/L	2011 ADWQR Value mg/L
Tennant Creek	Silica	82	None	80
Ti Tree	Silica	96	None	80

Section B

DRINKING WATER QUALITY AND PERFORMANCE

Microbiological Results Summary

Bacteria

MICROBIOLOGICAL MONITORING OBJECTIVE

Tests of microbial quality are a valuable adjunct to assessing source water protection, treatment, and the integrity of the barriers through to the consumer's tap. Microbiological monitoring under the risk management approach is used as a final check to verify water quality. Monitoring of drinking water quality is effectively the final check that all barriers and preventative measures implemented to protect public health are working effectively.

Chlorination provides a major barrier against microbiological hazards. Although the measurement of chlorine residuals is used to determine the state of this barrier, it is not an assessment of the effectiveness of the barrier. An assessment requires measurement of the control of microorganisms. Microbial indicators are used for verifying the effectiveness of disinfection, treatment and for assessing system cleanliness.

MONITORING PROGRAM

Operational monitoring provides information to maintain a treatment process within defined parameters (process control). Verification monitoring is performed deeper into the distribution system to determine the quality of water received by consumers (quality compliance). Verification or compliance monitoring is performed routinely but less frequently than operational monitoring.

The possibility for water quality to diminish increases the further into the distribution system it travels. A treatment system may be operating within required parameters but this is not a guarantee that quality can be maintained to the farthest points of the distribution system at all times. Occasionally, unsatisfactory water quality is encountered. On occasions, as a consequence of a supply breach or through loss of adequate disinfection, water containing microorganisms can be delivered to consumers.

LIMITATIONS OF MONITORING

Power and Water's *Drinking Water Monitoring Program 2011-12* requires that samples are representative of the quality of water supplied to consumers be collected and analysed for *E. coli* at a minimum frequency determined by the population served by the supply. The results from this monitoring provide an appraisal of the status and effectiveness of the disinfection system and in the extreme case whether this barrier has been compromised. The confidence provided by this appraisal diminishes as the number of samples collected decrease every time *E. coli* is detected.

Although the objective of disinfection is to eradicate microorganisms, it is unrealistic to expect results from a monitoring program to show a water supply system to have zero indicator bacteria at all times.

It is common in most water supplies that:

- At times *E. coli* may be detected and remedial action required;
- There is no absolute certainty disinfection is 100 per cent effective; and
- Human error may result in sample contamination and laboratory mistakes.

The complete absence of *E. coli* detections in any water supply system is an unreasonable expectation. The 2004 ADWG allows one failure (*E. coli* detection) in 50 samples or that 98 per cent of samples contain no *E. coli*.

COMPLIANCE PERFORMANCE

Performance can be regarded as satisfactory if over the preceding 12 months:

- At least the minimum number of programmed samples have been tested for *E. coli*;
- Samples tested are representative of the quality of water supplied to consumers; and
- At least 98 per cent of programmed samples contain no *E. coli* (excludes repeat or special purpose samples).

Figure 4 shows for 2011-12 all major centres, with the exception of Tennant Creek, achieved the 98 per cent *E. coli* free target. Tennant Creek was the only major centre to record *E. coli* detections.

Figure 4 Percentage of samples taken in major centres in which no *E. coli* were detected from 2008 to 2012

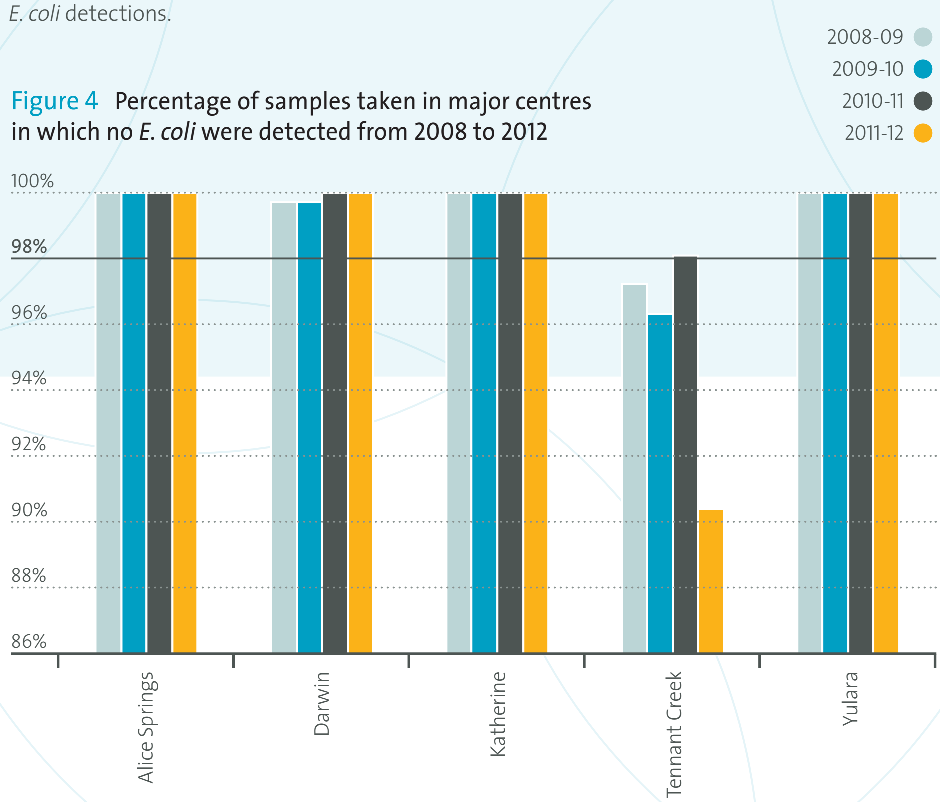
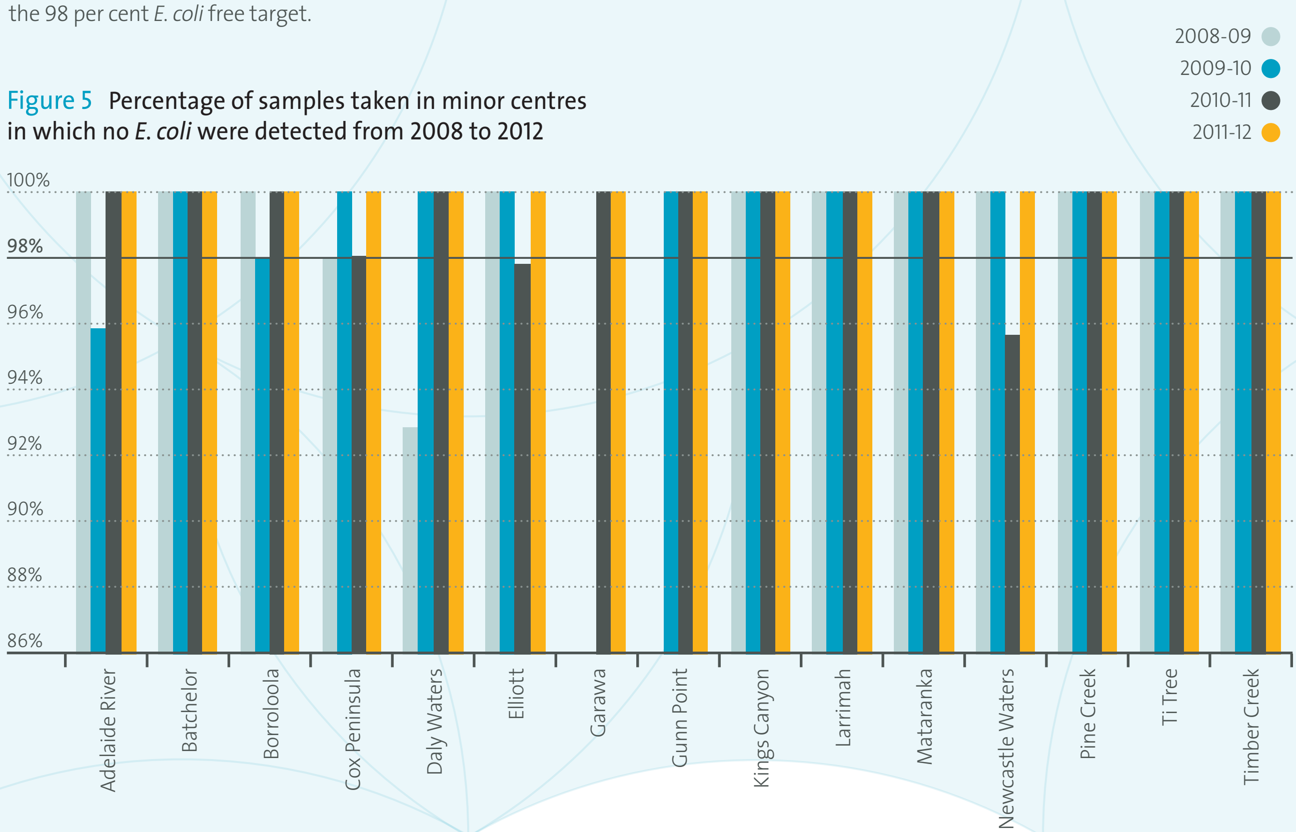


Figure 5 presents results for the minor centres in the Northern Territory. No *E. coli* detections were recorded in minor centres. All minor centres met the 98 per cent *E. coli* free target.

Figure 5 Percentage of samples taken in minor centres in which no *E. coli* were detected from 2008 to 2012



Power and Water's *Drinking Water Monitoring Program 2011-12* scheduled *1438* drinking water samples to be collected for bacteriological assessment from 19 centres across the Northern Territory. The collection and assessment of all programmed samples was not achieved. Bad weather, communication failure and logistical issues contributed to only 98.2 per cent, 25 samples less than required, of these samples being collected. Some centres were more successful than others. Details of the performance of individual centres are presented in Tables A1 and A2. (refer page 44)

NAEGLERIA FOWLERI

The detection of *N. fowleri* in the Darwin distribution system in 2005 prompted Power and Water to undertake extensive monitoring of water supplies and to implement procedures to control this amoeba.

An effective chlorine residual maintained throughout the distribution system can provide protection against contamination and limit the regrowth of *N. fowleri*. Free chlorine at 0.5 mg/L or higher will control *N. fowleri*, provided the disinfectant persists at that concentration throughout the water supply system. Power and Water now requires all continuously chlorinated water supplies to maintain a minimum free chlorine residual not less than 0.5 mg/L throughout the entire supply.

During the 2011-12 period, a total of 535 routine samples were collected from source waters and distribution systems of water supplies across the Territory. An investigation was also undertaken during tank cleaning in Darwin. Samples of sediment and water were collected from several storage tanks in the Darwin distribution system. Samples were also collected from the Adelaide River and Tennant Creek water supplies.

Table 5 shows the results from 2011-12 *N. fowleri* monitoring program.

N. fowleri was only detected in the Darwin distribution system and only during hydrant flushing to remove iron and manganese sediments. All other distribution systems and sources monitored during the 2010-11 period were free of *N. fowleri*.

N. fowleri is the amoeba of primary concern but the detection of any thermophilic amoeba is considered significant. The detection of thermophilic amoeba indicates conditions in the water supply are conducive for the growth of *N. fowleri* and further investigation or remedial action maybe warranted. *Naegleria* spp. other than *N. fowleri* were detected in the Darwin, Gunn Point and Tennant Creek distribution systems and Darwin groundwater. *Naegleria* spp. were not detected in surface waters.

Last year's investigations during sediment removal from Darwin distribution storage tanks found *N. fowleri* present in the sediment of four tanks. This year, during tank cleaning, no *Naegleria* spp. were detected. This finding supports the long term strategy to control *N. fowleri* growth in tanks by increasing the frequency of tank cleaning and minimising sediment accumulation.

Table 5 Thermophylic amoeba detections, monitored supplies and investigation 2011-12

Centre Routine Monitoring	Samples Collected	Acanthamoeba group III	Amoebae Total	Amoebae Total (solids)	*Hartmannella*	*Naegleria* Total	*Naegleria* Total (solids)	*Naegleria fowleri*	*Naegleria lovaniensis*	*Willaertia magna*
		Positive Samples								
Alice Springs Distribution Totals	10	0	0	NA	0	0	NA	0	0	0
Cox Peninsula Distribution Totals	19	0	1	NA	1	0	NA	0	0	0
Darwin Source Bores and Reservoir Total	25	0	6	NA	2	5	NA	0	5	0
Darwin Distribution Totals	211	0	43	NA	43	3	NA	0	3	0
Gunn Point Distribution Totals	25	0	1	NA	0	1	NA	0	1	0
Katherine Distribution Totals	29	0	2	NA	2	0	NA	0	0	0
Tennant Creek Distribution Totals	208	0	29	NA	2	28	NA	0	28	0
Yulara Source Bore Totals	2	0	1	NA	1	0	NA	0	0	0
Yulara Distribution Totals	6	0	0	NA	0	0	NA	0	0	0
Total Samples	535									

Centre Investigational Monitoring	Samples Collected	Acanthamoeba group III	Amoebae Total	Amoebae Total (solids)	*Hartmannella*	*Naegleria* Total	*Naegleria* Total (solids)	*Naegleria fowleri*	*Naegleria lovaniensis*	*Willaertia magna*
		Positive Samples								
Adelaide River Totals	1	0	NA	1	0	NA	1	0	1	0
Darwin Storage Tank Sediments Totals	9	1	NA	8	8	NA	0	0	0	1
Darwin Hydrant Flushing	3	0	3	NA	2	1	NA	2	0	0
Tennant Creek non-routine Totals	1	0	NA	1	1	NA	0	0	0	0
Total Samples	14									

Several detections of *N. fowleri* in the potable water supply at Manton Dam Park Tap over the past few years have required Power and Water to increase the free chlorine residual at this site. This has been achieved in part by:

- The installation of an automatic irrigation system at Manton Dam Park that routinely draws water through the pipeline preventing the accumulation of chlorine depleted water; and
- Changing the booster pump feeding the mains that supples the park to a higher capacity pump.

There has also been a significant increase in the number of consumers connected to this main increasing water turnover through the mains and reducing the retention time of water in it. These three factors together have improved the quality of water supplied to the area in the vicinity of the Manton Dam Park Tap sampling site. During the 2011-12 reporting period, no *Naegleria* spp. were detected in the potable water supply at Manton Dam Park Tap sampling site.

BURKHOLDERIA PSEUDOMALLEI

Burkholderia pseudomallei is the agent responsible for melioidosis and despite being ubiquitous throughout the tropics its ecology is poorly understood. Epidemiological evidence has established melioidosis can be contracted by exposure to contaminated soil or water where the bacteria enter via skin cuts and lesions. Human infections have a high mortality rate. The latent phase between infection and disease can be extremely long, up to months or even years, and relapse is quite common. Other routes of transmission, specifically gastrointestinal, have not been confirmed. Despite its apparent ubiquity there have been few waterborne outbreaks.

Power and Water's *Drinking Water Monitoring Program* 2010-2011 includes *B. pseudomallei* as an investigative and research activity. Initially monitoring sites and frequency were in response to the identification of clusters of melioidosis cases. During 2011-12, Power and Water continued working closely with Menzies School of Health Research (MSHR) to identify water supplies likely to be at risk of colonisation by *B. pseudomallei*.

Recent research has confirmed an association between *B. pseudomallei* and bore water which has low salinity, high iron levels, low pH and low hardness. This finding aids in identifying water supplies at risk of contamination from this pathogenic bacterium. Borroloola source waters have pH values as low as 5.1, iron levels as high as 12.2 mg/L, very soft water with hardness measured as low as 4.5 mg/L ($CaCO_3$) and low salinity EC = 50μS/cm (2010-11 values) and was therefore considered vulnerable to *B. pseudomallei* colonization. Water samples collected from the Borroloola water supply during 2010-11 were negative for *B. pseudomallei*. Samples collected from the Borroloola supply during 2011-12 were also negative for *B. pseudomallei*.

Clinical literature documents *B. pseudomallei* infection by the inhalation of contaminated dust suggesting water supplies open to the environment are at risk. Components of the Katherine WTP, particularly the aerator and reactivator, are uncovered, unsealed and therefore susceptible to dust. Samples were collected from points within the Katherine WTP and distribution system. In 2010-11, *B. pseudomallei* was detected in the WTP filter sand and WTP clarifier sludge but not in water leaving the WTP. During 2011-12, samples collected from Katherine water storage tanks were negative for *B. pseudomallei*.

As the Tennant Creek water supply is a non-chlorinated supply it lacks a crucial barrier against bacterial contamination. Power and Water has continuously monitored this supply for the past five years. As in previous years, *B. pseudomallei* was not detected in the Tennant Creek water supply.

Chemical and Physical Results Summary

All chemical and physical results presented in this report are reported as statistical values. Where statistically adequate data is available, health-related water quality parameters are reported as the 95th percentile. If data is limited, values are reported as the maximum value. Aesthetic parameters are reported as an average as specified in the 2004 ADWG.

Details of the health and aesthetic parameters for each major and minor centre are shown in Tables A3 and A4. (refer pages 45-48).

RADIOLOGICAL

All water supplies are examined to gain an initial measure of gross alpha and gross beta activity concentrations.

The 2004 ADWG recommend further radiological measurements be undertaken to determine the total annual radiation dose if the gross activities are higher than 0.5 Bq/L. The 2004 ADWG recommend the total annual radiation dose not exceed 1 mSv/year. To precisely calculate the annual radiological dose (ARD), all radioactive species in the water supply must be identified and their activity concentrations determined. Generally, radium-226 (an alpha emitter) and radium-228 (a beta emitter) are the major radionuclides contributing to the gross alpha and beta values. When radium-226 and radium-228 do not account for all gross alpha and beta values, other radionuclides present must be identified and their levels determined.

The likely worst case leading to the highest exposure is where the gross alpha and gross beta activities are due entirely to radium-226 and radium-228. If the analysis fails to include all radionuclides, the total annual radiation dose is calculated by treating the gross alpha value as if it were due entirely to radium-226 and the K40 corrected gross beta value as if it were due entirely to radium-228. As described previously, this treatment of the assessment calculates the maximum possible exposure. This approach derives its validity from the knowledge that radium-226 and radium-228 are the most consequential radionuclides present in water and on a concentration based comparison, contribute more to the annual dosage than any other radionuclide. The annual radiation dose calculated by this method is a conservative solution and produces a total annual radiation dose estimate in excess of the true value. An estimation of the total annual radiation dose cannot be made without values for gross alpha and gross beta activities.

To comply with 2004 ADWG, radiological data used in the calculation of the total annual radiation dose must be no more than two years outside the reporting period for ground water supplies and no more than five years for surface water.

ANNUAL ASSESSMENT

When a water supply passes both the gross alpha and potassium-40 corrected gross beta screening assessment or the estimated annual dose is below 0.5 mSv/year, sampling can be less frequent – every two years for groundwater supplies and every five years for surface water supplies. All water supplies included in this report draw some water from ground water sources. As radiological data from groundwater is valid for two years, supplies monitored during 2010-11 may not have been required to be monitored during 2011-12. The radiological results presented in this report therefore cover the period 2010-12. Fifteen water supplies were sampled during 2011-12.

Water from 10 minor centres and three major centres complied with the 2004 ADWG screening level, with radioactivity levels below 0.5 Bq/L. Eighteen of the 19 centres passed annual radiological assessment.

Kings Canyon was the only water supply to exceed the annual guideline limit of 1.0 mSv/year.

Garawa source water has not been assessed for radiological characteristics in the three year period preceding this report. However, as Borroloola and Garawa draw water from the same aquifer, and have very similar chemistry, it is reasonable to assume these supplies share similar radiological characteristics.

Eight bores supplying Alice Springs passed annual radiological assessment at the screening level. Nine bores exceeded either 0.5 Bq/L for gross alpha or 0.5 Bq/L for K-40 corrected gross beta. No bore exceeded the annual guideline limit of 1.0 mSv/ year. The ADR is reported as 0.38 mSv/year, the 95th percentile of all the 17 bores combined.

Kings Canyon's water supply has higher levels of radionuclides than other Northern Territory water supplies and is intensely monitored. Two hundred and thirty three samples were collected from the Kings Canyon supply during 2010-12. Thirteen of these samples exceeded the 1.0 mSv/ year limit with the highest value, 1.46 mSv/year, recorded at the ground level tank outlet (same sample location as last year's highest level). This is an increase from the previous year where four samples exceeded the 1.0 mSv/ year limit and the highest value was recorded at 1.24 mSv/year. Kings Canyon's ADR for the two year monitoring period is 1.04 mSv/year (95th percentile).

The ARD is calculated only for supplies which had one or more samples failing the screening level. The ARD's for Borroloola, Darwin and Mataranka are calculated from small data sets and reported as maximum values. Results for the radiological assessment of all supplies are shown in Tables A3 and A4. (refer pages 45-48)

UNCERTAINTY IN RADIOLOGICAL MEASUREMENT

No measurement is exact. When a quantity is measured, the outcome depends on the measuring system, the measurement procedure, the skill of the operator, the environment, and other effects. Uncertainty is the quantitative estimation of error present in data. All measurements contain some uncertainty generated through systematic error and/or random error.

The expression of the value of the result of a measurement is incomplete without a statement of its evaluated uncertainty. This characterises the range in which the true value is estimated to lie with a given level of confidence.

Total uncertainty for radiological measurements is quoted at the 2 sigma (95%) confidence interval but may not be symmetrical around the measured value. Radiological measurements are therefore reported with an upper and lower uncertainty. The ARD calculated for Kings Canyon using the upper and lower uncertainties indicates the true value is within the range 0.93-1.14 mSv/year.

TRIHALOMETHANES

The baseline data set for trihalomethanes (THMs) in Power and Water supplies was initially determined in 2002-03. Values ranged from less than 0.004 mg/L in Alice Springs to less than 0.08 mg/L in Darwin. These concentrations were well below the 2004 ADWG level of 0.25 mg/L.

During the 2011-12 monitoring period, all water supplies except Tennant Creek were assessed for THMs. The concentration of THMs for these water supplies ranged from <0.004 to 0.097 mg/L. Tennant Creek is not included in this assessment as it is not a continuously chlorinated supply.

Long term THM levels (2007-2012) are shown in Tables A3 and A4 (refer pages 45-48). THMs in all water supplies remain at levels similar to those measured in previous years and appear to be stable. The low levels of THMs measured in Northern Territory water supplies is due to the low level of total organic carbons (TOC), the precursors of THMs, in these waters. The highest levels of THMs are in Darwin, Katherine and Pine Creek supplies, all of which use surface water.

HERBICIDES AND PESTICIDES

From 2004 until July 2012, no sample tested for pesticides has returned a result at or above the level of detection of the test method.

The pesticide monitoring program focuses on 43 commonly used pesticides including organochlorine, organophosphate and triazine pesticides, insecticides and acidic herbicides. Monitoring is generally undertaken on water supplies where local pesticide usage suggests a water supply may be at risk. Good management of surface water sources and bores reduce the risk of drinking water becoming contaminated with pesticides. Bores are required to be constructed to standards that guarantee bore head integrity and prevent surface water (potentially containing pesticides) from entering the bore. Surface waters (reservoirs and rivers) are managed to strictly control pesticide use in their catchments.

Occasionally, weed problems in reservoirs and catchments can only be managed effectively through the use of herbicides. Dicamba (Banvel, 3,6-dichloro-2-methoxybenzoic acid) is a moderate to low toxicity herbicide used to control weeds and mimosa in the Darwin River Reservoir catchment. Dicamba is moderately persistent in soil and breaks down to very simple substances such as carbon dioxide and water. The reported half-life of Dicamba in soil ranges from one to six weeks. This herbicide is applied two to three times a year as part of the mimosa control program.

Although monitored for several years, pesticides have not been detected in the Northern Territory water supplies despite limited use in some areas. In consideration of these results, pesticide monitoring during 2010-12 has been restricted to Darwin and Katherine water supplies. These supplies are considered potentially vulnerable to pesticide contamination due to agricultural activities close to production bores and surface water sources. Results for all samples collected from these supplies were below the level of detection.

The 2011 ADWG list more than one hundred new pesticides which have the potential to find their way into drinking water sources.

Pesticide management and monitoring will form an integral part of the DWSPPs for each drinking water source. These management plans are currently being developed by the Catchments and Water Sources group under the *Catchment and Water Source Protection Strategy.*

GOOD WEEDS IN DARWIN RIVER RESERVOIR

In the past few years, Olive hymenachne has been detected in Darwin River Reservoir requiring the use of herbicides to control its growth and spread. This year small patches of Azolla have been found in Darwin River Reservoir. Although Azolla is found throughout the Northern Territory, this is the first report of it in Darwin River Reservoir.

What is Azolla?

Red Azolla is a small, native, free-floating, aquatic fern species. It grows from 1 cm to 2.5 cm wide and its colour changes from bright green to deep red when exposed to the sun. From a distance, Azolla can be confused with Salvinia, a noxious aquatic weed, or the scum of a blue-green algal bloom.

Water quality benefits of Azolla

Mats of Azolla can actually discourage blue-green algal blooms by restricting the penetration of sunlight into the water and reducing availability of nutrients. Azolla also impedes the growth of exotic aquatic plants, including Salvinia and Water Hyacinth.

Customer Satisfaction

WATER QUALITY CUSTOMER COMPLAINTS

Appearance, taste and odour are monitored as they are generally the characteristics by which customers judge water quality. Power and Water records all water quality complaints made by customers and reports them to the National Water Commission for publication, as do other Australian water utilities.

Table 6 shows the total number of water quality specific complaints received during 2011-12.

Table 6 Water quality complaints 2007 to 2012

Location	Properties (2011-12)	2007-08	2008-09	2009-10	2010-11	2011-12
Adelaide River	107[A]	DNA	1	1	3	3
Alice Springs	11524[B]	1	4	5	22	24
Darwin	51828[B]	373	355	123	134	336
Katherine	2076[A]	DNA	DNA	1	48	4
Tennant Creek	1146[A]	DNA	DNA	DNA	0	1
Total	**6668[1]**	**374**	**360**	**130**	**207**	**368**
Complaints per 1000 properties (all NT)		6.13	5.77	2.44	3.15	5.52

A Properties based on number of meters.
B As reported to WSAA in 2008-09 NPR.
DNA Data not available.

The pattern of complaints made about the Darwin water supply is largely governed by changes in water quality associated with the seasonal variation in reservoir water quality and customer demand.

As with many water supply reservoirs, Darwin River Reservoir is subject to stratification. Stratification is the development of distinct layers of water of different temperature or density at various depths in a water body and the subsequent restriction of mixing between these layers. Stratification develops when the upper layers of the reservoir are heated by solar radiation faster than the heat can disperse into the lower depths of the reservoir. The generated difference in the surface and bottom water densities limit circulation between these layers and can lead to these layers having significantly different water qualities.

Atmospheric oxygen is absorbed by water at the interface between air and water. Algal photosynthesis near the surface also supplies oxygen to the water. Oxygen at the bottom of a reservoir is consumed by the decomposition of organic material. As water circulation is restricted due to stratification, oxygen consumed in the lower layers is not replenished from the surface resulting in oxygen depletion at the bottom of the reservoir.

The decomposition of organic material under anaerobic conditions lowers the pH and encourages production of hydrogen sulphide. This process reduces iron and manganese in the sediments to soluble forms.

Once the reservoir has stratified, a large amount of energy is required to disrupt the layered structure and mix the reservoir again.

De-stratification occurs with a decrease in surface temperature, in-flow and wind-induced mixing processes that cause the layers to mix and bring low quality anoxic water from the bottom of the reservoir to the surface where it is drawn into the supply. Soluble iron and manganese entering the distribution system can be oxidized and will precipitate out of solution creating discoloured water resulting in customer dissatisfaction and complaints. During the Wet Season, as water demand drops and flow rates are reduced, oxidised iron and manganese can settle out in the distribution system. At the beginning of the next Dry Season, as flows in the distribution system increase, the settled iron and manganese are mobilised by the higher velocity water and become the cause of further customer complaints.

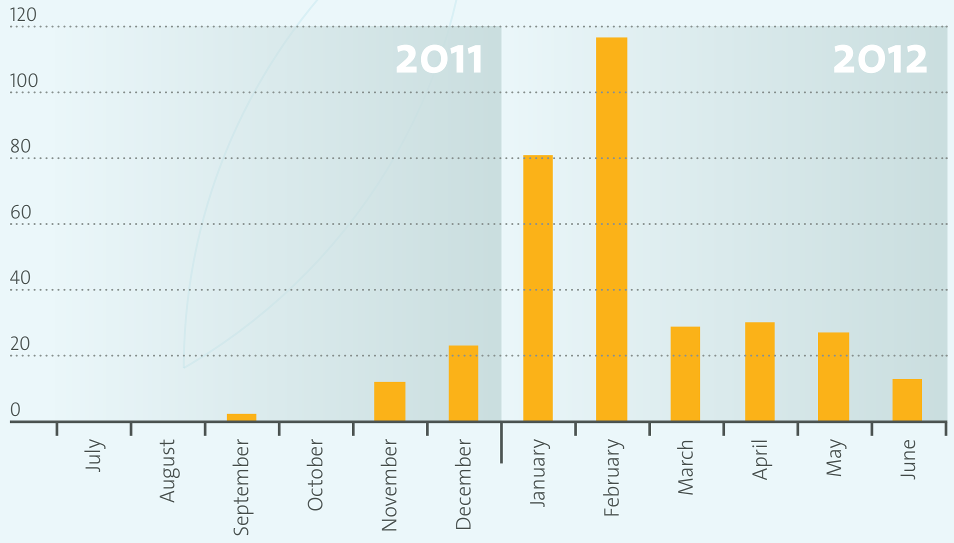
The levels of iron and manganese in the drinking water do not constitute a health risk due to the relatively short duration of the discoloured water events.

The frequency of drinking water complaints for the Darwin water supply during 2011-12 is shown in Figure 6.

Power and Water works to minimise the frequency and the magnitude of these events primarily through a mains flushing program in major centres where customers frequently report discoloured water. Mains are flushed before anticipated increased demands associated with seasonal changes. If a customer reports discoloured water, Power and Water flushes the mains supplying the customer's residence.

In addition to this, water quality is monitored at a number of locations in the Darwin water supply to gauge the extent of discoloured water and determine when routine flushing is required.

Figure 6 Number of monthly drinking water quality complaints for Darwin 2011-12



Customers have also complained about cloudy water, floating particles, and high chlorine levels.

High chlorine levels manifest themselves as chlorinous taste and odour complaints.

Figure 7 shows a breakdown of customer complaints for 2011-12.

Taste and odour complaints often relate to varying chlorine levels due to changing water demand. The chlorine residual in the reticulation network is regularly monitored and adjusted as required. Online water quality monitoring units have been installed in most centres to improve monitoring across the entire network.

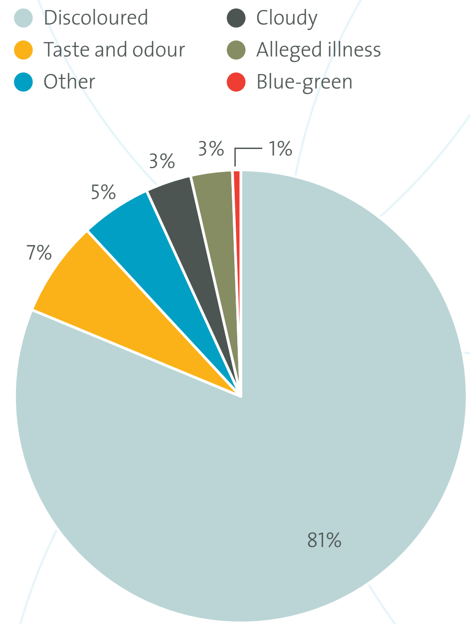
Objectionable tastes and odours can also result from compounds produced by certain types of algae, cyanobacteria (blue-green algae), bacteria and sometimes protozoa. A number of organic compounds causing tastes and odours can be produced as by-products when water is disinfected with chlorine.

Sometimes a customer will report cloudy or milky water. This is generally due to the presence of dissolved air in the water. Milkiness or cloudiness most commonly occurs after water mains repairs and repressurising of water mains causes trapped air to be dissolved. When a tap is turned on, minute air bubbles are released causing the water to appear milky. When left to stand, this cloudy water will clear rapidly. Other causes of cloudy water are tap aerators and hot water systems.

Occasionally, harmless white algae can be observed in the Darwin water supply. These algae grow naturally in Darwin River Reservoir and their original green colour is lost during the disinfection process.

If there is doubt as to the cause of a water quality problem, an investigation is carried out and, when necessary, water samples are taken and analysed.

Figure 7 Breakdown of customer complaints for Darwin 2011-12 showing major water quality issues



As a response to the detection of *N. fowleri* in some Northern Territory water supplies, free chlorine residuals are now maintained at a minimum of 0.5 mg/L. This level of chlorine is objectionable to some customers who have complained about the chlorinous taste.

A significant increase in discoloured water complaints for Darwin occurred during 2011-12 compared with the previous year. The majority of these complaints were received in January and February 2012 following a mixing event in Darwin River Reservoir. This mixing occurred after a long period of strong stratification. The longer the reservoir remains stratified the lower the quality of the water that develops in the hypolimnion. This mixing event in January 2012 distributed the low quality water in the hypolimnion throughout the reservoir which was then drawn into the distribution system.

The number of water quality related complaints received for Alice Springs was the same as the previous year. The number of complaints received for Katherine decreased approximately 90 per cent compared with the previous year. The previous years high number of complaints was attributable to a chlorination control failure event and major water mains repairs.

Recorded Emergencies / Incidents

In the 2011-12 year, there were nine incidents in which *E. coli* was detected (refer Table 7). All of these occurred in the Tennant Creek water supply.

Table 7 *E. coli* incidents in 2011-12

Supply	Samples with *E. coli* Detections	Collection Date	Number of *E. coli* Detected in Sample (MPN/100 mL)
Tennant Creek	1	7 November 2011	1
Tennant Creek	1	21 November 2011	4
Tennant Creek	1	12 December 2011	6
Tennant Creek	1	9 January 2012	2
Tennant Creek	1	24 January 2012	2
Tennant Creek	1	6 February 2012	1
Tennant Creek[1]	2	20 February 2012	3 and 1
Tennant Creek	1	12 March 2012	1
Tennant Creek	1	26 March 2012	2

1 Single Incident

INCIDENT

Newcastle Waters loss of supply and inaqequate chlorination - October 2011

The Elliott power station supplies electricity to Newcastle Waters. In late October 2011, an electrical fault at the Elliott power station disrupted supply to Newcastle Waters. The disruption caused automatic control equipment essential to the Newcastle Waters water supply to fail. The water supply could only be operated manually requiring personnel to be on site to provide manual chlorination of the elevated tank and operate pumps to fill storage tanks. As there is no resident ESO in Newcastle Waters, personnel had to travel from Elliott.

On several occasions, the supply ran dry and the required level of chlorination in the distribution was not achieved. Chlorination of the ground level storage tank was commenced in an attempt to maintain a satisfactory level of chlorine in the distribution system. *E. coli* was not detected in water samples collected for bacteriological analysis in early November. In mid November repairs to the electrical supply and water supply equipment were completed and the Newcastle Waters supply was retuned to automatic operation. An investigation has been conducted to determine the causes of the incident and identify what is required to prevent a reoccurrence.

The DoH was notified of the incident and kept up-to-date during corrective actions, repairs and investigations.

INCIDENT

Tennant Creek 'boil water' notice - November 2011

On 23 November 2011 *E. coli* was detected in samples from two locations in the Tennant Creek water supply collected on 21 Novemeber 2011. Operations personnel were notified immediately. To ensure public safety, DoH issued a water boil alert notice to the residents of Tennant Creek. Power and Water immediately isolated the tank that was suspected as being the source of the contamination. Both the storage and distribution system were manually chlorinated. The entire system was purged with chlorinated water. Samples were collected to assess the effectiveness of the remedial action. To ensure the supply of safe drinking water, Power and Water maintained manual daily chlorination while investigations continued. Following tank inspections and minor repairs to storage tank roofs and access hatches, daily chlorination was suspended on 27 November 2011. Samples collected after remedial actions were free of *E. coli*. Investigations suggested the contamination was attributed to frogs entering the tank via damaged hatches.

E. coli was again detected in samples collected on 12 December 2011. A water boil alert notice was not issued by DoH. The standard response was actioned. Storage and distribution systems were chlorinated and purged. Initial repairs to access hatches were inadequate requiring more appropriate repairs. Daily chlorination was maintained until the completion of repairs.

Further *E. coli* detections were reported on 9 January 2012, 24 January 2012, 6 February 2012, 20 February 2012, 12 March 2012 and 26 March 2012. In each case, temporary rectification was achieved with manual chlorination. Daily manual chlorination of the 5 ML tank has been maintained through to the end of this reporting period.

The total replacement of tank access hatches is planned during 2012-13. However, in the absence of the primary barrier, continuous disinfection, the Tennant Creek water supply remains unnecessarily vulnerable to microbiological contamination.

APPENDICES

Table A1 Bacteriological monitoring in major centres 2011-12

Centre	Parameter (MPN/100 mL)	Target Level	Total No. of Samples Required	Total No. of Samples Collected*	Total Exceedances (No.)	Samples Passing Reporting Level (%)
Alice Springs	*E. coli*	<1 in 98% of samples	104	104	0	100.0
	Total Coliforms	<10 in 95% of samples	104	104	0	100.0
Darwin	*E. coli*	<1 in 98% of samples	468	468	0	100.0
	Total Coliforms	<10 in 95% of samples	468	468	5	98.9
Katherine	*E. coli*	<1 in 98% of samples	104	104	0	100.0
	Total Coliforms	<10 in 95% of samples	104	104	0	100.0
Tennant Creek	*E. coli*	<1 in 98% of samples	104	104	10	90.4
	Total Coliforms	<10 in 95% of samples	104	104	15	85.6
Yulara	*E. coli*	<1 in 98% of samples	52	**51**	0	100.0
	Total Coliforms	<10 in 95% of samples	52	**51**	0	100.0

*Numbers in bold indicate samples collected are less than specified in the monitoring program

Table A2 Bacteriological monitoring in minor centres 2011-12

Centre	Parameter (MPN/100 mL)	Target Level	Total No. of Samples Required	Total No. of Samples Collected*	Total Exceedances (No.)	Samples Passing Reporting Level (%)
Adelaide River	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Batchelor	*E. coli*	<1 in 98% of samples	52	52	0	100.0
	Total Coliforms	<10 in 95% of samples	52	52	0	100.0
Borroloola	*E. coli*	<1 in 98% of samples	24	**22**	0	100.0
	Total Coliforms	<10 in 95% of samples	24	**22**	0	100.0
Gunn Point	*E. coli*	<1 in 98% of samples	26	26	0	100.0
	Total Coliforms	<10 in 95% of samples	26	26	0	100.0
Cox Peninsula	*E. coli*	<1 in 98% of samples	52	**50**	0	100.0
	Total Coliforms	<10 in 95% of samples	52	**50**	1	98.0
Daly Waters	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Elliott	*E. coli*	<1 in 98% of samples	104	**89**	0	100.0
	Total Coliforms	<10 in 95% of samples	104	**89**	3	96.6
Garawa	*E. coli*	<1 in 98% of samples	24	**22**	0	100.0
	Total Coliforms	<10 in 95% of samples	24	**22**	0	100.0
Kings Canyon	*E. coli*	<1 in 98% of samples	104	104	0	100.0
	Total Coliforms	<10 in 95% of samples	104	104	0	100.0
Larrimah	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Mataranka	*E. coli*	<1 in 98% of samples	24	**23**	0	100.0
	Total Coliforms	<10 in 95% of samples	24	**23**	0	100.0
Newcastle Waters	*E. coli*	<1 in 98% of samples	24	**22**	0	100.0
	Total Coliforms	<10 in 95% of samples	24	**22**	0	100.0
Pine Creek	*E. coli*	<1 in 98% of samples	24	24	0	100.0
	Total Coliforms	<10 in 95% of samples	24	24	0	100.0
Timber Creek	*E. coli*	<1 in 98% of samples	24	**23**	0	100.0
	Total Coliforms	<10 in 95% of samples	24	**23**	0	100.0
Ti Tree	*E. coli*	<1 in 98% of samples	52	52	0	100.0
	Total Coliforms	<10 in 95% of samples	52	52	0	100.0

*Numbers in bold indicate samples collected are less than the number specified in the monitoring program.

Table A3 Health, aesthetic and other parameters in major centres 2011-12

Parameter/Centre	Guideline Value[1]	Units	Alice Springs	Darwin	Katherine	Tennant Creek	Yulara
HEALTH PARAMETERS - 95TH PERCENTILE VALUES							
Antimony	0.003	mg/L	0.0004	<0.0002	<0.0002	0.0004	<0.0002
Arsenic	0.007	mg/L	<0.0005	<0.0005	0.0006	0.0026	0.0006
Barium	0.7	mg/L	0.10	<0.05	<0.05	<0.05	0.06
Boron	4	mg/L	0.14	<0.02	<0.02	0.52	0.83
Cadmium	0.002	mg/L	<0.0002	<0.0002	<0.0002	0.0009	0.0007
Chlorine (free)	5	mg/L	0.88	1.27	0.73	NA	0.64
Chromium	0.05	mg/L	<0.005	<0.005	<0.005	0.006	0.006
Copper	2	mg/L	0.22	0.29	0.05	0.07	0.16
Fluoride	1.5	mg/L	0.5	0.8	0.8	**1.6**	0.1
Iodide	0.1	mg/L	0.09	0.02	<0.01	**0.35**	0.04
Lead	0.01	mg/L	0.005	0.002	0.002	<0.001	0.002
Manganese	0.5	mg/L	0.031	0.057	0.013	0.006	0.006
Mercury	0.001	mg/L	0.0002	<0.0001	<0.0001	0.0002	<0.0001
Molybdenum	0.05	mg/L	0.005	0.005	0.005	0.006	0.006
Nickel	0.02	mg/L	0.005	<0.002	0.002	<0.002	0.003
Nitrate	50	mg/L	8	2	<1	47	49
Radiological	1.0	mSv/yr	0.38	0.12	PASS	PASS	PASS
Selenium	0.01	mg/L	0.002	<0.001	<0.001	0.005	<0.001
Silver	0.1	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	500	mg/L	66	9	12	55	330
THMs	0.25	mg/L	<0.004	0.097	<0.065	<0.004	<0.017
Uranium	0.02	mg/L	0.00893	0.00008	0.00023	0.00870	0.00005
AESTHETIC PARAMETERS - MEAN VALUES							
Aluminium	0.2	mg/L	0.02	<0.02	0.04	<0.02	<0.02
Chloride	250	mg/L	77	11	8	101	72
Chlorine (free)	0.6	mg/L	**1.14**	**2.01**	**0.92**	**NA**	**0.86**
Copper	1	mg/L	0.07	0.05	0.02	0.02	0.07
Hardness	200	($CaCO_3$) mg/L	**208**	45	121	172	29
Iron	0.3	mg/L	<0.05	0.09	0.05	0.06	<0.05
Manganese	0.1	mg/L	0.007	0.027	0.006	<0.005	<0.005
pH	6.5-8.5	pH	7.9	7.5	7.8	7.8	7.6
Sodium	180	mg/L	79	3	5	122	59
Sulfate	250	mg/L	53	2	6	45	66
TDS	800	mg/L	444	59	140	610	215
Zinc	3	mg/L	0.02	<0.01	<0.01	<0.01	0.06
OTHER PARAMETERS - MEAN VALUES							
Alkalinity		($CaCO_3$) mg/L	237	44	120	278	<20
Beryllium		mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bromide		mg/L	0.27	0.02	0.02	0.72	0.31
Calcium		mg/L	46	9	28	27	7
Electrical conductivity		µS/cm	805	101	264	976	371
Magnesium		mg/L	24	5	12	25	3
Potassium		mg/L	5.9	0.5	0.9	29.3	6.9
Silica		mg/L	18	12	18	82	14
Tin		mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

[1] 2004 ADWG value for health and aesthetic parameters. TDS value set by DoH.

Table A4 Health, aesthetic and other parameters in minor centres 2011-12

Parameter/Centre	Guideline Value[1]	Units	Adelaide River	Batchelor	Borroloola	Cox Pennisula	Daly Waters
HEALTH PARAMETERS - 95TH PERCENTILE VALUES							
Antimony	0.003	mg/L	0.0012	<0.0002	<0.0002	<0.0002	0.0004
Arsenic	0.007	mg/L	0.0045	0.0006	0.0006	<0.0005	0.0012
Barium	0.7	mg/L	<0.05	0.06	0.06	<0.05	0.07
Boron	4	mg/L	<0.02	<0.02	0.05	<0.02	0.44
Cadmium	0.002	mg/L	<0.0002	<0.0002	<0.0002	0.0003	0.0003
Chlorine (free)	5	mg/L	0.87	0.85	0.69	0.66	0.82
Chromium	0.05	mg/L	<0.005	0.006	0.006	<0.005	0.007
Copper	2	mg/L	0.43	0.14	0.63	0.13	0.33
Fluoride	1.5	mg/L	0.4	0.2	<0.1	<0.1	0.5
Iodide	0.1	mg/L	<0.01	<0.01	<0.01	<0.01	**0.24**
Lead	0.01	mg/L	0.002	<0.001	0.003	0.003	0.003
Manganese	0.5	mg/L	0.307	0.007	0.036	0.008	0.172
Mercury	0.001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
Molybdenum	0.05	mg/L	<0.005	0.006	0.006	<0.005	0.006
Nickel	0.02	mg/L	<0.002	<0.002	0.003	0.003	0.006
Nitrate	50	mg/L	6	2	<1	7	12
Radiological	1.0	mSv/yr	PASS	PASS	0.37	PASS	PASS
Selenium	0.01	mg/L	<0.001	<0.001	<0.001	<0.001	0.007
Silver	0.1	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	500	mg/L	4	2	3	26	227
THMs	0.25	mg/L	<0.017	<0.004	0.013	<0.004	<0.019
Uranium	0.02	mg/L	0.00006	0.00043	0.00027	0.00003	0.00774
AESTHETIC PARAMETERS - MEAN VALUES							
Aluminium	0.2	mg/L	0.0213	<0.02	<0.02	<0.02	0.0255
Chloride	250	mg/L	30	10	11	10	**347**
Chlorine (free)	0.6	mg/L	**1.53**	**1.32**	**0.81**	**0.97**	**1.14**
Copper	1	mg/L	0.08	0.03	0.11	0.04	0.07
Hardness	200	($CaCO_3$) mg/L	99	**200**	22	9	**517**
Iron	0.3	mg/L	**0.64**	0.06	0.14	0.03	0.20
Manganese	0.1	mg/L	**0.122**	<0.005	0.012	<0.005	0.038
pH	6.5-8.5	pH	7.4	7.5	**6.4**	6.7	7.5
Sodium	180	mg/L	28	5	7	7	**213**
Sulfate	250	mg/L	3	1	1	10	192
TDS	800	mg/L	202	221	53	51	**1297**
Zinc	3	mg/L	0.03	0.02	0.03	0.05	0.02
OTHER PARAMETERS - MEAN VALUES							
Alkalinity		($CaCO_3$) mg/L	109	213	34	20	435
Beryllium		mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bromide		mg/L	0.06	0.01	0.02	0.01	1.58
Calcium		mg/L	17	29	7	3	124
Electrical conductivity		µS/cm	334	411	78	53	2105
Magnesium		mg/L	14	34	1	0	59
Potassium		mg/L	1.1	0.3	1.1	0.9	25.2
Silica		mg/L	45	31	14	22	38
Tin		mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

[1] 2004 ADWG value for health and aesthetic parameters. TDS value set by DoH.

Table A4 (cont.) Health, aesthetic and other parameters in minor centres 2011-12

Parameter/Centre	Guideline Value[1]	Units	Elliott	Garawa[2]	Gunn Point	Kings Canyon	Larrimah
HEALTH PARAMETERS - 95TH PERCENTILE VALUES							
Antimony	0.003	mg/L	0.0005	<0.0002	<0.0002	0.0005	0.0005
Arsenic	0.007	mg/L	<0.0005	<0.0005	0.0010	0.0044	0.0008
Barium	0.7	mg/L	0.17	<0.05	0.30	0.06	<0.05
Boron	4	mg/L	0.34	0.04	<0.02	0.36	0.22
Cadmium	0.002	mg/L	<0.0002	<0.0002	<0.0002	0.0003	<0.0002
Chlorine (free)	5	mg/L	0.98	0.55	1.09	0.59	0.65
Chromium	0.05	mg/L	<0.005	<0.005	<0.005	0.013	<0.005
Copper	2	mg/L	0.03	0.05	0.02	0.48	0.08
Fluoride	1.5	mg/L	0.8	<0.1	0.6	0.5	0.2
Iodide	0.1	mg/L	**0.12**	<0.01	<0.01	**0.43**	**0.11**
lead	0.01	mg/L	0.003	<0.001	0.003	0.006	<0.001
Manganese	0.5	mg/L	<0.005	<0.005	0.045	0.006	<0.005
Mercury	0.001	mg/L	0.0002	<0.0001	<0.0001	0.0004	0.0002
Molybdenum	0.05	mg/L	<0.005	<0.005	<0.005	0.006	<0.005
Nickel	0.02	mg/L	0.004	<0.002	0.004	0.013	0.004
Nitrate	50	mg/L	20	<1	<1	9	5
Radiological	1.0	mSv/yr	PASS	DNA	PASS	**1.040**	PASS
Selenium	0.01	mg/L	0.003	<0.001	<0.001	0.009	0.003
Silver	0.1	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	500	mg/L	245	1	3	196	132
THMs	0.25	mg/L	<0.004	DNA	0.019	<0.005	<0.007
Uranium	0.02	mg/L	0.00626	0.00011	0.00109	0.00269	0.00266
AESTHETIC PARAMETERS - MEAN VALUES							
Aluminium	0.2	mg/L	<0.02	<0.02	<0.02	0.0202	<0.02
Chloride	250	mg/L	158	18	17	**265**	197
Chlorine (free)	0.6	mg/L	**1.67**	**0.66**	**2.00**	**0.81**	**0.88**
Copper	1	mg/L	<0.01	0.05	0.02	0.09	0.03
Hardness	200	($CaCO_3$) mg/L	**407**	4	169	**371**	**482**
Iron	0.3	mg/L	0.08	<0.05	0.10	0.20	0.08
Manganese	0.1	mg/L	<0.005	<0.005	0.045	0.004	<0.005
pH	6.5-8.5	pH	8.0	**5.8**	8.5	6.9	7.6
Sodium	180	mg/L	93	13	7	117	121
Sulfate	250	mg/L	90	1	3	176	111
TDS	800	mg/L	779	58	150	**816**	**883**
Zinc	3	mg/L	<0.01	0.02	0.18	0.06	0.04
OTHER PARAMETERS - MEAN VALUES							
Alkalinity		($CaCO_3$) mg/L	362	<20	190	131	420
Beryllium		mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bromide		mg/L	0.70	0.04	0.02	1.38	0.83
Calcium		mg/L	91	0.34	24	73	118
Electrical conductivity		µS/cm	1309	88	370	1401	1456
Magnesium		mg/L	44	1	26	44	53
Potassium		mg/L	22.1	1.1	4.1	23.6	12.1
Silica		mg/L	57	15	11	21	43
Tin		mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

[1] 2004 ADWG value for health and aesthetic parameters. TDS value set by DoH.
[2] Although Garawa is not a Power and Water minor centre it is included in this table for convenience.

Table A4 (cont.) Health, aesthetic and other parameters in minor centres 2011-12

Parameter/Centre	Guideline Value[1]	Units	Mataranka	Newcastle Waters	Pine Creek	Ti Tree	Timber Creek
HEALTH PARAMETERS - 95TH PERCENTILE VALUES							
Antimony	0.003	mg/L	0.0005	0.0004	<0.0002	<0.0002	0.0002
Arsenic	0.007	mg/L	<0.0005	<0.0005	**0.0077**	0.0010	0.0010
Barium	0.7	mg/L	<0.05	0.29	<0.05	0.10	**1.88**
Boron	4	mg/L	0.26	0.28	<0.02	0.37	0.13
Cadmium	0.002	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
Chlorine (free)	5	mg/L	0.62	1.08	0.66	0.90	0.58
Chromium	0.05	mg/L	<0.005	<0.005	<0.005	<0.005	0.006
Copper	2	mg/L	0.13	0.03	0.08	0.11	0.04
Fluoride	1.5	mg/L	0.4	0.9	0.7	0.8	1.4
Iodide	0.1	mg/L	0.09	0.09	0.08	**0.17**	0.03
Lead	0.01	mg/L	0.002	<0.001	0.003	0.009	0.002
Manganese	0.5	mg/L	0.007	<0.005	0.163	<0.005	0.163
Mercury	0.001	mg/L	0.0002	0.0002	<0.0001	<0.0001	<0.0001
Molybdenum	0.05	mg/L	<0.005	<0.005	<0.005	<0.005	<0.006
Nickel	0.02	mg/L	0.003	0.007	<0.002	<0.002	<0.007
Nitrate	50	mg/L	3	10	<1	**58**	1
Radiological	1.0	mSv/yr	0.31	PASS	0.21	PASS	PASS
Selenium	0.01	mg/L	0.003	0.002	<0.001	0.002	<0.001
Silver	0.1	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Sulfate	500	mg/L	140	119	90	81	6
THMs	0.25	mg/L	<0.011	<0.004	<0.035	<0.005	<0.007
Uranium	0.02	mg/L	0.00334	0.00522	0.00024	0.00942	0.00219
AESTHETIC PARAMETERS - MEAN VALUES							
Aluminium	0.2	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Chloride	250	mg/L	172	53	14	69	30
Chlorine (free)	0.6	mg/L	**0.85**	**2.24**	**0.97**	**1.15**	**0.80**
Copper	1	mg/L	0.04	0.02	0.03	0.03	0.02
Hardness	200	($CaCO_3$) mg/L	**462**	**303**	129	**201**	**398**
Iron	0.3	mg/L	0.15	<0.05	0.12	<0.05	0.05
Manganese	0.1	mg/L	<0.005	<0.005	0.051	<0.005	0.018
pH	6.5-8.5	pH	7.7	7.9	7.1	8.0	7.2
Sodium	180	mg/L	128	56	33	65	22
Sulfate	250	mg/L	116	43	36	39	5
TDS	800	mg/L	**865**	543	232	514	459
Zinc	3	mg/L	0.02	0.02	0.02	0.04	0.02
OTHER PARAMETERS - MEAN VALUES							
Alkalinity		($CaCO_3$) mg/L	468	377	148	211	441
Beryllium		mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Bromide		mg/L	0.69	0.20	0.05	0.38	0.12
Calcium		mg/L	112	68	21	45	61
Electrical conductivity		µS/cm	1512	901	385	786	873
Magnesium		mg/L	50	33	19	21	62
Potassium		mg/L	17.3	28.8	1.4	18.4	6.7
Silica		mg/L	40	58	44	96	22
Tin		mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

[1] 2004 ADWG value for health and aesthetic parameters. TDS value set by DoH.

Legend (Table A3 and A4)

Radiological	Results are reported as 'Pass' if screening levels of gross alpha and gross beta (K corrected) are less than 0.5 Bq/L. Water supplies passing the screening level do not require an annual dosage assessment. Where assessment is required, data used is not more than two years older than the starting date of the reporting period for bores and five years for surface water. Annual dosage is reported as 95th percentile for large data sets and maximum value for small data sets. Data covers the period 2007-12.
THMs	Reported as the maximum values as data sets are small.
Health parameters	Assessments are reported as the 95th percentile. Data covers the period 2007 to 2012. Exceedances are shown in bold.
Aesthetic parameters	Assessments are reported as the mean. Data covers the period 2007 to 2012. Exceedances are shown in bold.
N/A	Not applicable.
Other parameters	Assessments are reported as the mean. Data covers the period 2007 to 2012. No guideline value applicable.
DNA	Data not available - supplies for which there is insufficient data, incomplete data or where the only data available is outdated are reported as data not available (DNA).
<	All values reported preceded with "<" indicate the value is below the level of detection of the analytical method.
Iodide	2004 ADWG set a guideline value for iodide, however, most laboratories report iodine as iodide as Induction Coupled Plasma Mass Spectrometry is the preferred method of analysis. As this method reports all forms of iodine in water samples as iodide it is not a true measure of iodide concentration.

Table B1 Five year trend of exceedances

Parameters	HEALTH PARAMETERS								AESTHETIC PARAMETERS						
	Arsenic	Barium	Fluoride	Iodide	Lead	Nitrate	Radiological	Selenium	Chloride	Hardness	Iron	Manganese	pH	Sodium	TDS
Centre/ ADWG 2004 (mg/L)	0.007	0.70	1.5	0.10	0.010	50	1.00	0.010	250	200	0.30	0.100	6.5-8.5	180	800
Adelaide River 07-08											**0.89**	**0.123**			
Adelaide River 08-09											**0.80**	**0.121**			
Adelaide River 09-10											**0.62**	**0.120**			
Adelaide River 10-11											**0.74**	**0.118**			
Adelaide River 11-12											**0.64**	**0.122**			
Alice Springs 07-08				**0.15**			0.38			**220**					
Alice Springs 08-09				**0.10**			0.37			**220**					
Alice Springs 09-10				0.09			**1.32**			**220**					
Alice Springs 10-11				0.09			0.43			**210**					
Alice Springs 11-12				0.09			0.38			**208**					
Batchelor 07-08										**201**					
Batchelor 08-09										**214**					
Batchelor 09-10										160					
Batchelor 10-11										191					
Batchelor 11-12										**200**					
Borroloola 07-08							DNA						**6.3**		
Borroloola 08-09							DNA						**6.5**		
Borroloola 09-10							**1.06**						**6.3**		
Borroloola 10-11							0.37						**6.5**		
Borroloola 11-12							0.37						**6.4**		
Daly Waters 07-08				**0.26**				**0.010**	**348**	**587**				**218**	**1339**
Cox Peinsula 07-12															
Daly Waters 08-09				**0.27**				**0.010**	**346**	**580**				**215**	**1337**
Daly Waters 09-10				**0.25**				0.008	**342**	**528**				**216**	**1321**
Daly Waters 10-11				**0.25**				0.007	**358**	**526**				**215**	**1310**
Daly Waters 11-12				**0.24**				0.007	**347**	**517**				**213**	**1297**
Darwin 07-12															
Elliott 07-08				**0.12**						**381**					
Elliott 08-09				**0.13**						**412**					
Elliott 09-10				**0.12**						**396**					
Elliott 10-11				**0.12**						**396**					
Elliott 11-12				**0.12**						**407**					
Garawa 07-08													DNA		
Garawa 08-09													DNA		
Garawa 09-10													DNA		
Garawa10-11													DNA		
Garawa 11-12													**5.8**		
Gunn Point 09-12															
Katherine 07-12															
Kings Canyon 07-08				**0.40**	0.008		0.88	**0.010**	243	**348**					**815**
Kings Canyon 08-09				**0.41**	**0.010**		0.89	**0.010**	248	**360**					**821**
Kings Canyon 09-10				**0.41**	**0.010**		**2.37**	0.009	243	**363**					**811**
Kings Canyon 10-11				**0.43**	**0.011**		0.99	0.009	**261**	**365**					**809**
Kings Canyon 11-12				**0.43**	0.006		**1.04**	0.009	**265**	**371**					**816**

Table B1 (cont.) Five year trend of exceedances

Parameters	HEALTH PARAMETERS								AESTHETIC PARAMETERS						
	Arsenic	Barium	Fluoride	Iodide	Lead	Nitrate	Radiological	Selenium	Chloride	Hardness	Iron	Manganese	pH	Sodium	TDS
Centre/ ADWG 2004 (mg/L)	0.007	0.70	1.5	0.10	0.010	50	1.00	0.010	250	200	0.30	0.100	6.5-8.5	180	800
Larrimah 07-08				**0.12**						**513**					**892**
Larrimah 08-09				**0.13**						**522**					**900**
Larrimah 09-10				**0.12**						**490**					**901**
Larrimah 10-11				**0.10**						**487**					**914**
Larrimah 11-12				**0.11**						**482**					**883**
Mataranka 07-08				**0.13**						**512**	**2.12**				**937**
Mataranka 08-09				0.09						**515**	0.19				**920**
Mataranka 09-10				0.09						**479**	0.17				**892**
Mataranka 10-11				0.09						**470**	0.17				**862**
Mataranka 11-12				0.09						**462**	0.15				**865**
Newcastle Waters 07-08				**0.11**						**318**					
Newcastle Waters 08-09				**0.10**						**320**					
Newcastle Waters 09-10				0.09						281					
Newcastle Waters 10-11				0.09						293					
Newcastle Waters 11-12				0.09						**303**					
Pine Creek 07-08	**0.008**			DNA											
Pine Creek 08-09	**0.008**			**0.10**											
Pine Creek 09-10	**0.008**			**0.10**											
Pine Creek 10-11	**0.008**			0.09											
Pine Creek 11-12	**0.008**			0.08											
Tennant Creek 07-08			**1.8**	**0.35**											
Tennant Creek 08-09			**1.6**	**0.36**											
Tennant Creek 09-10			**1.6**	**0.36**											
Tennant Creek 10-11			**1.6**	**0.36**											
Tennant Creek 11-12			**1.6**	**0.35**											
Ti Tree 07-08				**0.11**		**52**				**206**					
Ti Tree 08-09				**0.18**		**67**				**208**					
Ti Tree 09-10				**0.17**		**64**				**200**					
Ti Tree 10-11				**0.17**		**58**				**202**					
Ti Tree 11-12				**0.17**		**58**				**201**					
Timber Creek 07-08		**1.26**	**1.50**							**430**					
Timber Creek 08-09		**1.76**	**1.60**							**428**					
Timber Creek 09-10		**1.79**	1.40							**398**					
Timber Creek 10-11		**1.85**	1.40							**395**					
Timber Creek 11-12		**1.88**	1.40							**398**					
Yulara 07-08						38									
Yulara 08-09						41									
Yulara 09-10						**52**									
Yulara 10-11						**52**									
Yulara 11-12						49									

GLOSSARY OF ACRONYMS

ADI	Acceptable Daily Intake
ADWG	Australian Drinking Water Guidelines (2004). Referred to in this report as "2004 ADWG"
ANSI	American National Standards Institute
ARD	Annual Radiological Dose
AS/NZS	Australian/New Zealand Standards
AWA	Australian Water Association
AWWA	American Water Works Association
Bq	Becquerel
CDI	Capacitive deionisation
CGA	Cooperative and Government Affairs
CRC	Cooperative Research Centre
DCI	Department of Construction and Infrastructure (from 4 December 2009)
DECS	Department of Education and Children Services
DHCS	Department of Health and Community Services (until 1 July 2008)
DNA	Data not available
DoH	Department of Health
DoR	Department of Resources
DRD	Darwin River Dam
EC	Electrical conductivity
EMS	Electronic management system
ESO	Essential service operator
FC/TC	Free chlorine/Total chlorine ratio
FIS	Facilities Information System
IBM	International Business Machines
ICS	Industrial control system
IMS	Information Management System
ISO	International Organization For Standardization
ML	mega litres
MSHR	Menzies School of Health Research
N/A	Not applicable
NF	*Naegleria fowleri*
NHMRC	National Health and Medical Research Council
NPR	National Performance Report
NRETAS	Natural Resources, Environment, the Arts and Sport
NRMC	National Resources Management Council
NT	Northern Territory
NTG	Northern Territory Government
NWC	National Water Commission
OHS	Occupational Health and Safety
PAM	Primary amoebic meningoencephalitis
PCR	Polymerase chain reaction
PI System	Process information system for the management of real time data and events
PWC	Power and Water Corporation
RO	Reverse Osmosis
ROP	Reverse Osmosis Plant
SA	South Australia
SAI Global	Standards Australia International (Global)
SCADA	Supervisory, Control and Data Acquisition
SU	Sustainability Unit
TDS	Total dissolved solids
THMs	Trihalomethanes
TOC	Total organic carbons
TRIM	Power and Water's electronic document management systems
UV	Ultra violet
WIMS	Work information management system
WIOA	Water industry Operators Association
WQFA	Water Quality Front-end Application
WQIMO	Water Quality Information Management Officer
WQRA	Water Quality Research Australia
WSAA	Water Services Association of Australia
WTP	Water treatment plant

UNITS OF MEASUREMENT

Bq/L	Becquerel per litre
µg/L	micrograms per litre
mg/L	milligrams per litre
MPN/100mL	Most probable number per 100 millilitre
mSv/yr	millisieverts per year
ML	mega litres
µS/cm	microsiemens per centimetre
pH	Log measurement of acidity
$CaCO_3$ mg/L	Equivalent concentration of calcium carbonate

Standards

AS/NZS ISO 14001:2004

Environmental management systems – Requirements with guidance for use

The objective of this Standard is to specify requirements for an environmental management system (EMS) to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects.

AS/NZS ISO 9001:2008

Quality management systems – Requirements

This Standard promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements.

For an organization to function effectively, it has to determine and manage numerous linked activities.

An activity or set of activities using resources, and managed in order to enable the transformation of inputs into outputs, can be considered as a process. Often the output from one process directly forms the input to the next.

AS/NZS 4801:2001

Occupational health and safety management systems – Specification with guidance for use

The objective of this Standard is to set auditable criteria for an occupational health and safety management system.

The Standard is a specification that aims to encompass the best elements of such systems already widely used in Australia and New Zealand.

AS/NZS 4020:2005

Testing of products for use in contact with drinking water

This Standard specifies requirements for the suitability of products for use in contact with drinking water, with regard to their effect on the quality of water.

These products include all items such as pipes, fittings, components, and materials used in coating, protection, lining, jointing, sealing and lubrication applications in the water supply and plumbing industry.

Chemicals and media used directly for treating raw water to provide a suitable drinking water supply (e.g. lime, coagulants, activated carbon, ion-exchange resins) are not covered by this Standard.

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Quality System – Quality Endorsed Company ISO 9001 Lic22599 SAI Global

OHS System – Occupational Health and Safety AS/NZS 4801 Lic20234 SAI Global

Environmental System – Certified Environmental Management ISO 14001 Lic20341 SAI Global