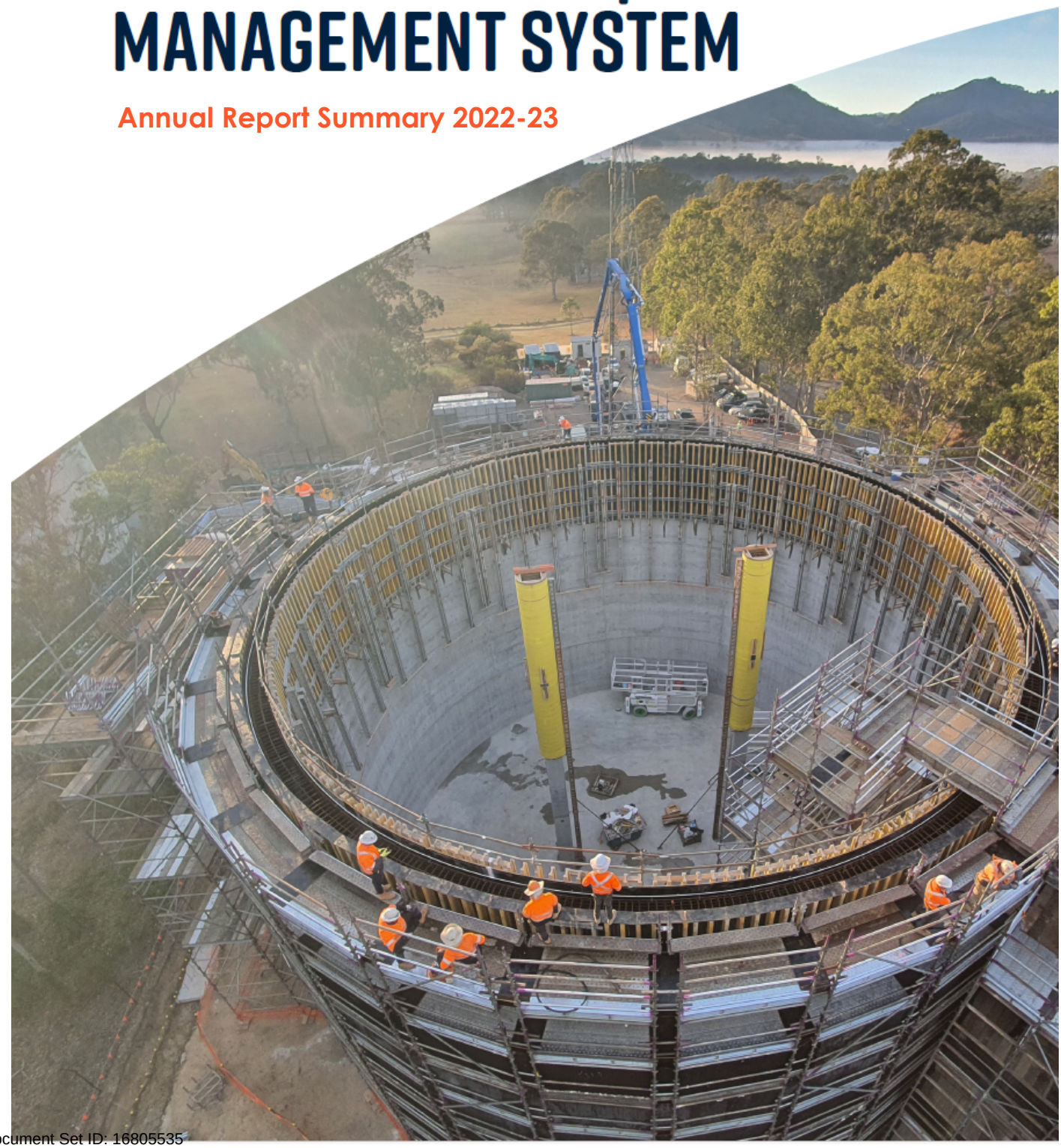
MIDCOAST council

DRINKING WATER QUALITY MANAGEMENT SYSTEM

Annual Report Summary 2022-23



Document and Version Control

Photograph on the front cover: Construction of new reservoir in the Gloucester Water Supply Scheme

Document and Version Control

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Executive Summary

MidCoast Council (Council) is responsible for water and sewerage services across the local government area, operates under the Local Government Act 1993, and is governed by a board of 11 elected councillors. This report provides a summary of the report provided to NSW Health on the implementation and status of the Council's Drinking Water Quality Management System (DWQMS) during 2022-23. DWQMS is a proactive, risk-based approach to managing the quality of drinking water supplies. It measures performance against the Australian Drinking Water Guidelines (ADWG).

Extensive water quality monitoring is undertaken for council's water supply systems following the requirements of ADWG. Overall, all water supply systems have performed well this reporting period with very few water quality results outside ADWG. All water supply schemes achieved 100% of microbiological and physical water testing results within ADWG for samples collected at customers' taps.

Combined chemical results within ADWG were 99.56% compared to 98.48% during 2021 - 2022. Results outside ADWG for total Trihalomethanes (THMs) at Tea Gardens Water Supply are the main reason for the chemical parameters not meeting 100%.

THMs are produced during the disinfection of water as a by-product. A project to remove THMs from treated water at the Tea Gardens Water Supply was undertaken last year and was successful in reducing THMs below ADWG values without compromising disinfection. The project was completed in November 2022. There have been no THM exceedances since the completion of the above project.

A critical control point (CCP) is defined as "a point, step or procedure at which control can be applied and a hazard can be prevented, eliminated or reduced to acceptable levels." CCPs are used to monitor the effectiveness of the water treatment process applied to supply safe drinking water. Bulahdelah, Gloucester, and Stroud Water Supply Schemes achieved all results within CCP limits.

There was one occasion of CCP exceedance in the Manning Water Supply Scheme, which related to the disinfection of a small service reservoir. Water from this reservoir is only supplied to customers when there is a major failure of the main supply reservoir. Customers were not supplied from the service reservoir during the CCP breach. As such, there was no risk to customers. The exceedance was reported to regulators and rectified as soon as possible.

There was one occasion where a positive *E.coli* detection was recorded in a service reservoir within the Tea Gardens Water Supply Scheme. However, investigations determined that this was related to weather conditions during sampling, which potentially contributed to the contamination of the sample. The quality of water supplied to customers was not compromised at any time during the above incident as indicated by water quality results from customers' taps.

There has been major progress in the strategic planning area for the Council this reporting period. The Integrated Water Cycle Management Strategy (IWCM) was adopted by the council and work on a catchment management program for the southern regions is underway. Both these programs are interwoven with water quality and the Drinking Water Quality Management System (DWQMS) catchment to tap multiple barrier approach of providing safe drinking water

to customers. Council's DWQMS was also formally updated and adopted by the Council during this reporting period.

Major upgrades and system improvements were undertaken in the Manning and Gloucester Water Supply Schemes. Construction to increase the capacity of the Nabiac Water Treatment Plant (WTP) is progressing and will increase water security for the Manning Water Supply Scheme.

Major capital works that were underway last year are progressing within the Gloucester Water Supply. This includes the construction of two new reservoirs with an onsite chlorination facility, a new dedicated rising main, and new reticulation pipework in the network. Benefits to the community will include improved water security, water pressure, and water quality.

Asset renewals and system improvements continued across all schemes on a priority basis.

Council’s DWQMS is periodically reviewed and audited by external and internal stakeholders. The improvement actions recommended during these reviews are managed through the continuous improvement plan and the corrective actions database.

Five actions from the above database were completed this year (2022-2023),17 actions are in progress and three new actions were also added to the database.

The reservoir integrity program focused on the protection of water quality continued. Two new reservoirs are being constructed to replace reservoirs requiring repairs in the Gloucester Water Supply Scheme. Routine maintenance was also undertaken by operators during inspections as required.

In conclusion, all the water supply systems have performed well this reporting period with very few water quality results outside ADWG and only two CCP exceedances. Furthermore, the significant resources invested this year in water security, system improvements, and upgrades together with achievements in the strategic planning area will be of enormous benefit to drinking water quality management for the future.

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1. Report purpose

The purpose of this report is to present progress on the implementation of the Drinking Water Quality Management System (DWQMS) during the 2022 - 2023 (July 2022 - June 2023) reporting period. This report is a summary of the full report presented to NSW Health which fulfills MidCoast Council's responsibilities stated in; the Memorandum of Understanding between NSW Health and MidCoast Council, and the NSW Guidelines for Drinking Water Management Systems, produced by NSW Health and NSW Department of Planning and Environment (NSW DPE).

Water supply performance is measured against the Australian Drinking Water Guidelines (ADWG).

This summary document has been prepared to provide information to the community on water supply performance over the 12-month reporting period.

2. Scheme summary

MidCoast Council supplies drinking water to just over 40,000 properties in the local government area. This is achieved through the operation of five drinking water supply systems; Manning, Bulahdelah, Gloucester, Stroud, and Tea Gardens. Bulk water is purchased from Hunter Water for distribution to residents of North Karuah.

The largest of these supplies is the Manning Water Supply Scheme. It serves a population of approximately 70,000 across the Manning and Great Lakes districts which accounts for 90% of our drinking water customers. The Manning Water Supply is serviced by Bootawa and Nabiac Water Treatment Plants (WTP).

Water is extracted from the Manning River, stored at Bootawa Dam, and treated at Bootawa WTP which includes membrane filtration.

Nabiac WTP supplements the Manning Supply. Water extracted from the Nabiac Inland Dune Aquifer is treated at Nabiac WTP. Treatment includes membrane filtration.

The Bulahdelah Water Supply Scheme serves a population of approximately 1,500 in the town of Bulahdelah. Source water comes from Crawford River and is treated at a small conventional WTP located at Bulahdelah.

Gloucester Water Supply Scheme serves a population of approximately 3,500 residents of Gloucester and Barrington. Source water comes from Barrington River and water is treated at a conventional WTP at Gloucester.

Stroud Water Supply Scheme draws source water from the Karuah River. The water is treated at a small conventional WTP, including an off-river storage. The scheme serves a population of approximately 1,000 in the villages of Stroud and Stroud Road.

Approximately 3,800 residents of Tea Gardens and Hawks Nest are supplied with drinking water from Tea Gardens WTP which includes membrane filtration. Source water for this scheme is groundwater from the Viney Creek Aquifer northeast of Tea Gardens.

Bulk water is purchased from Hunter Water for distribution to residents of North Karuah. Monitoring of water quality in the reticulation system of North Karuah is included in the Council's drinking water quality monitoring. Water treatment and monitoring through the treatment process is the responsibility of Hunter Water.

These water supply systems vary in size and complexity. A general description of each system is presented in the table below.

Table 1: Description of water supply systems

Water Supply System	Source Water/Catchment	Treatment Process	Towns Supplied	Population Served
Manning (north & south)	Manning River	Selective pumping, retention, and sedimentation in Bootawa Dam, screening, water stabilisation, coagulation, microfiltration, ozonation, BAC filtration, chlorination, fluoridation.	Taree, Forster, Tuncurry, Hallidays Point, Wingham, Pacific Palms, Old Bar, Harrington, Coopernook, Crowdy Head, Cundletown, Krambach, Nabiac, Lansdowne, Manning Point, Tinonee, and Green Point.	70,000
	Nabiac Inland Dune Aquifer	Water stabilisation, aeration, coagulation, microfiltration, chlorination, fluoridation.		
Tea Gardens	Viney Creek Aquifer	Water stabilisation, aeration, coagulation, microfiltration, pH correction, chlorination, fluoridation.	Tea Gardens and Hawks Nest	3,800
Gloucester	Barrington River	pH correction, coagulation, sedimentation, sand filtration, chlorination, fluoridation.	Gloucester and Barrington	3,500
Bulahdelah	Crawford River	pH correction, coagulation, sedimentation, sand filtration, chlorination, fluoridation	Bulahdelah	1,500
Stroud	Karuah River	Selective pumping, coagulation, sedimentation, off-river storage, secondary coagulation, sand filtration, chlorination, fluoridation.	Stroud and Stroud Road	1,000
North Karuah	Bulk water supplied by Hunter Water – Tomago bore fields	Aeration, coagulation, filtration, pH correction, fluoridation, chlorination. Treated by Hunter Water at the Lemon Tree Passage WTP.	North Karuah	100

3 Strategic Planning

There has been major progress in the strategic planning area for the Council this reporting period. This includes work on the Integrated Water Cycle Management Strategy, and catchment management programs. Both these programs are interwoven with water quality and the DWQMS catchment to tap, multiple barrier approach of providing safe drinking water to customers.

3.1 Catchment Management Program for the southern waterways.

The scoping study was completed in June 2022 for the southern catchments as the first step in developing a Catchment Management Program. Funding has also been secured for the above program and the implementation of this program will consider key risks to water quality in the lower Crawford (Bulahdelah WTP), Tea Gardens, and Nabiac Bore Fields. Since the program is funded by the Coastal Management funds it does not include the upper catchment.

3.2. Integrated Water Cycle Management Strategy

MidCoast Council's Integrated Water Cycle Management Strategy (IWCM), Our Water Our Future 2050, is our 30-year plan for sustainable and affordable urban water services. Work on the strategy was in the Options Phase during the last reporting period with the establishment of the Our Water Our Future group, consisting of community members and representatives from government agencies, council, local industries, and environmental groups. The Options and Scenarios Phase has now been completed and the final strategy was adopted by the council in August 2023. During the options phase, options to action on each of the strategic issues were identified and investigated by a quadruple bottom-line assessment. These options were then packaged together into scenarios during the Scenarios Phase and each scenario was financially modelled and reduced to a Typical Residential Bill or TRB.

The IWCM Strategy was adopted by council following various forms of stakeholder consultation including workshops, public exhibition of the strategy for submissions, and online engagement.

4. Upgrades and system improvements

Major upgrades and system improvements were concentrated on the Manning and Gloucester Water Supply Schemes with some smaller projects in other water supply schemes. Significant resources have been invested in improving water security, quality, and supply.

4.1 Manning Water Supply major upgrades

Upgrading of the Nabiac WTP (Stage two) is underway with the main construction contract now executed. The site works began in August 2023 and will take approximately 18 months to complete. This will increase the capacity of the plant from 12ML/d to 18ML/d improving water security for the Manning region. It will enable additional raw water extraction during drought situations and offer redundancy and operational flexibility. Nabiac Bore Field stage two to install five new bores with a target of an additional 100L/s raw water extraction is progressing as part of this upgrade. The project is targeted to be completed by early 2024.

Figure 1: Provision for two new membrane racks at Nabiac WTP

Figure 2: Installation of new bores at Nabiac Water Supply System

Figure 3: sub-base pavement and compaction completed for Nabiac Water Treatment Plant pre-treatment tank

4.2. Gloucester Water Supply major upgrades

Major capital works which commenced during the last reporting period on the Gloucester Water Supply to improve operational performance and water security have progressed further. The works include the construction of two new reservoirs, a new rising main from the WTP, and additional reticulation works within the township. A booster chlorine gas dosing system has also been incorporated into the design. Benefits to the community will include improved water security, water pressure, and water quality.

The 0.5ML steel high-pressure reservoir is completed and the 8ML concrete reservoir is now over 50% completed. The pump station and dosing buildings are under construction and some site pipe works are now in progress. All the reticulation pipework has been done and the project is expected to be completed in early 2024.

Figure 4: New steel and concrete reservoirs in Gloucester Water Supply System

Figure 5: Construction of concrete reservoir in Gloucester Water Supply System

Figure 6: Laying of new rising main in Gloucester Water Supply System

4.3 System improvements – all regions

The water mains renewals program is continuing to replace mains to address issues including breaks, aging mains, and upsizing to suit future growth demand. The program also aims to ascertain high-quality installation standards set within the council's Water Main Asset Class Management Plan.

Some of the work completed during this reporting period includes Manning River Drive Taree and Cundletown project within the Manning Water Supply, and Forbesdale to Gloucester main upgrade in the Gloucester Water Supply System.

Installation of the new modified fluoride dosing system for Gloucester WTP is complete and awaiting commissioning.

A project initiated as part of the drought resilience measures from the 2019/20 drought response to install bulk water meters at reservoirs and critical trunk mains for leak detection is continuing at various sites.

Other asset renewals have taken place across all regions on a priority basis. Work was undertaken on the Comboyne communications tower, and switchboards across multiple sites including water pump stations.

As well as system improvements for water supplies, Council has also committed significant resources to improve environmental performance and public health outcomes throughout the sewerage systems.

4.4 Process improvements

4.4.1 Tea Gardens WTP Trihalomethane removal project

The Australian Drinking Water Guideline (ADWG) limit for total Trihalomethane (THMs) is 250 ug/L. The THMs level in the Tea Gardens Water Supply Scheme has been historically high, with only intermittent exceedances of the ADWG limit of 250 ug/L. However, since December 2020, the THMs results have increased, with results often exceeding 250 ug/L.

Council explored a range of options to address this issue in 2021. THMs removal via aeration was assessed to be both the financially and technically preferred option as it would seamlessly integrate into the treatment process. In late 2021, a benchtop aeration trial utilising diffused air was conducted, this trial successfully achieved THMs removal in the range of 70-85%. A full-scale plant trial in one of the treated water storage tanks at the WTP was initiated in April 2022 and was expanded to the second storage tank in August 2022. As shown in Figure 7 the trial was successful in reducing the THMs to below ADWG limits without compromising disinfection. Furthermore, a secondary aeration system was installed in November 2022 at the offsite storage reservoirs which has further reduced the THMS levels.

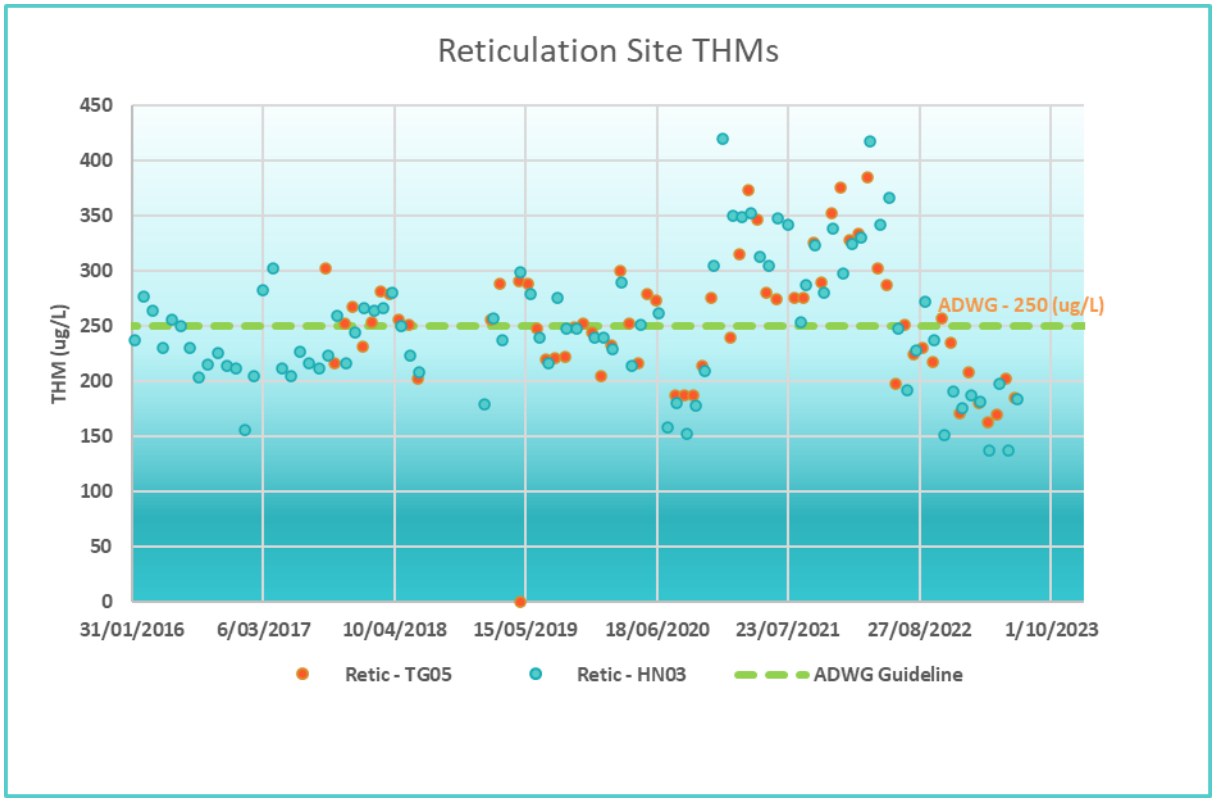

Figure 7: Tea Gardens THMs results

5. Water quality

5.1 ADWG and monitoring programs

The ADWG has been developed by the National Health and Medical Research Council and Natural Resource Management Ministerial Council of the Australian Government. The ADWG is intended to provide a framework for good management of drinking water supplies that, if implemented, will assure good quality water at the point of supply. Exceedance of a guideline value is a trigger for further investigation.

The ADWG recognises that it is impossible to test every water supply for every parameter listed in the guidelines, therefore monitoring programs need to be structured effectively to capture, analyse and interpret water quality data. Selecting parameters and frequency of monitoring should be based on system analysis and risk assessment to ensure safety at the point of use. The ADWG recognises that the most likely and serious form of contamination risk comes from microbiological contamination. The council's drinking water quality monitoring program has been designed based on these principles.

Operational monitoring is used to confirm that preventive measures to reduce hazards are in place and performing effectively. These preventive measures are applied throughout all stages of the water supply system, from catchment to tap, and need to be checked regularly. CCPs are included in operational monitoring.

Verification monitoring is the final check of water quality which confirms the effectiveness of preventive measures and barriers throughout the system. Samples are collected throughout the reticulation system at customers' taps or public reserves for water quality monitoring.

Council's Drinking Water Quality Monitoring Plan underwent an annual review in June 2023. During the annual review, changes were made to operational and verification monitoring to improve the efficiency of the program and to assist in the investigation of results outside ADWG.

A summary of the water quality parameters tested at the point of supply is provided below.

MICROBIOLOGICAL PARAMETERS

- *E. coli*

PHYSICAL PARAMETERS

- pH
- turbidity
- true colour
- hardness
- total dissolved solids

CHEMICAL PARAMETERS

- iron
- manganese
- aluminium
- arsenic and other metals
- fluoride
- disinfection by-products
- chlorine

Figure 8: Operational monitoring

Figure 9: Verification monitoring

5.2 Reticulation water quality results

All water supply schemes achieved 100% of microbiological results within ADWG over the 12-month reporting period (2022–2023) for samples collected at customers' taps. This is consistent with results over the past nine years. The combined results of physical parameters were 100% within ADWG which is higher than the previous year. Combined results of chemical parameters were 99.56% within ADWG compared to 98.48% last year. Results outside ADWG for Trihalomethanes (THMs) at Tea Gardens Water Supply are the main reason for the chemical parameters not meeting 100%.

Trends in water quality results over the past five years are shown in Figure 10 below and detailed water quality data for each supply system is provided in Appendix 1 Water quality data summary.

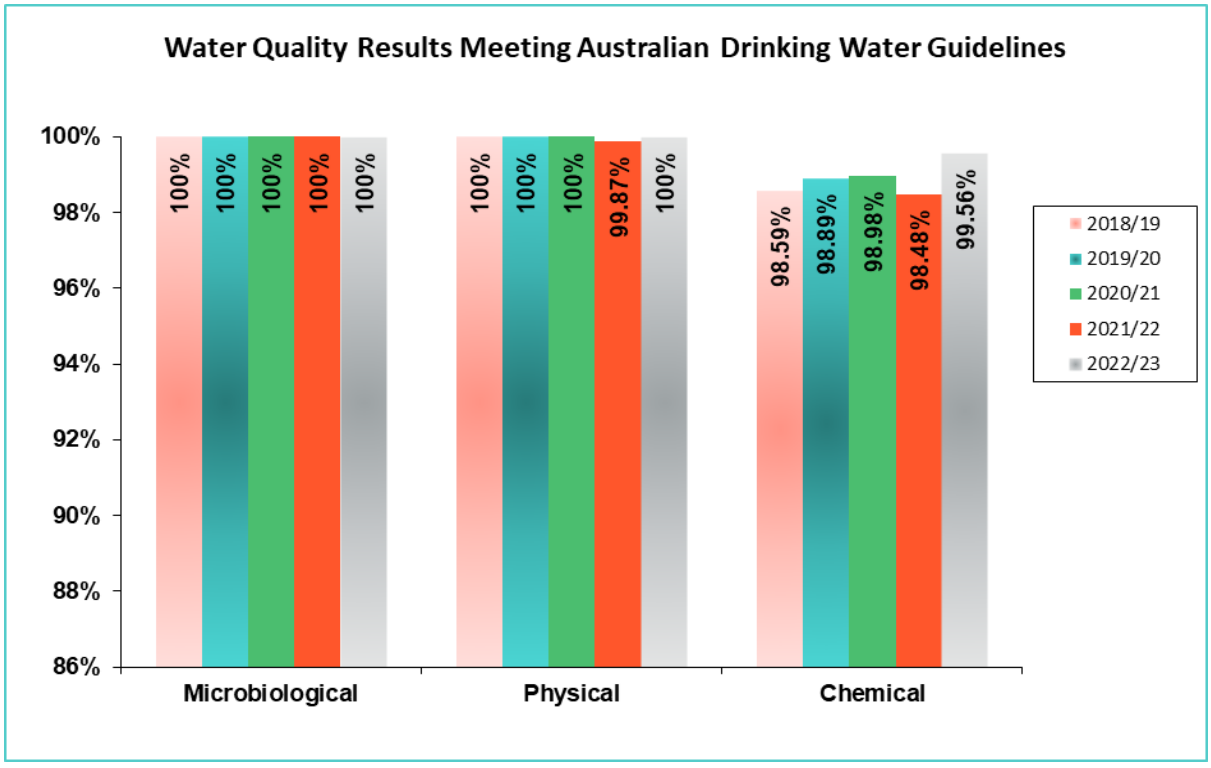

Figure 10: Water quality results meeting ADWG

5.2.1 Manning Water Supply

Manning Water Supply System achieved 100% of water quality results meeting ADWG for samples collected from customers taps during the 2022 - 2023 reporting period. There were 2692 analytes tested for verification monitoring in the Manning System.

5.2.2 Tea Gardens Water Supply

Tea Gardens Water Supply System achieved 98.00% of water quality results for samples collected in the reticulation system (customer taps) within ADWG during the 2022 - 2023 reporting period compared to 92.74% during 2021 - 2022. A total of 351 analytes were tested for verification monitoring in the Tea Gardens Water Supply System.

Results outside ADWG were for disinfection by-products; THMs on three occasions and dichloroacetic acid on four occasions compared to 24 occasions for THMs and two occasions for dichloroacetic acid last reporting period. Disinfection by-products are formed when organic matter reacts with chlorine. Raw water at Tea Gardens is high in Dissolved Organic Carbon (DOC). The composition of the DOC might have changed after the drought, bushfires and flood within the catchment making it increasingly difficult to remove during the treatment process. Chlorine cannot be boosted throughout the reticulation system at Tea Gardens therefore, the dose rate at the end of treatment needs to be adequate to ensure sufficient residual chlorine throughout the entire reticulation system. The long detention time in reservoirs and reticulation systems, partly due to low water usage outside holiday periods also contributes to these elevated readings. In response to this, water levels are reduced in reservoirs when appropriate, and monitoring frequency has been increased.

Action to reduce THMs is encouraged, but must not compromise disinfection, as non-disinfected water poses a significantly greater risk than THMs (Australian Drinking Water Guidelines 2011).

A project that was undertaken in the last reporting period to reduce the THMs by the aeration of water in the treated water reservoirs was completed in this reporting period (November 2022). The result of this project shows that the THM levels can be reduced to below ADWG values without compromising disinfection. This is reflected in the percentage of chemical compliance for Tea Gardens Water Supply System this reporting year. Refer to section 4.4.1 *Tea Gardens WTP Trihalomethane removal project* for details.

5.2.3 Bulahdelah Water Supply

Bulahdelah Water Supply achieved 100% of water quality results for samples collected in the reticulation system (customer taps) meeting ADWG during the 2022 – 2023 reporting period. There were 303 analytes tested for verification monitoring within the Bulahdelah System.

5.2.4 Stroud Water Supply

Stroud Water Supply System achieved 100% of water quality results for samples within ADWG collected in the reticulation system (customer taps) during the 2022 – 2023 reporting period compared to 99.35 % during the 2021 – 2022 reporting period. A total of 303 analytes were tested in the Stroud Water Supply for verification monitoring in this reporting period.

5.2.5 Gloucester Water Supply

Gloucester Water Supply System achieved 99.72% of water quality results within ADWG for samples collected from the reticulation system during the 2022 - 2023 reporting period. There were 370 analytes tested for verification monitoring in the Gloucester Reticulation System. There was one aluminium result that was outside ADWG from the samples collected and tested in the reticulation system (customer taps). An investigation was performed in response, the system was flushed to remove aluminium, and repeat samples were collected and analysed for aluminium. The repeat samples were within ADWG for the above parameter. NSW Health was notified.

5.2.6. North Karuah Water Supply

North Karuah Reticulation System achieved 100% of water quality results within ADWG during the 2022– 2023 reporting period. A total of 148 analytes were tested in this reticulation system during the reporting period.

There was one occasion when free chlorine was below the recommended level of 0.2 mg/L in the reticulation system. This was notified to Hunter Water. Corrective actions were put in place, including flushing until chlorine levels were back within target. Although chlorine levels below 0.2 mg/L are not specified as outside guideline values in ADWG, these results are outside operational control points in reticulation systems, and NSW Health and DPE recommendations. There has been considerable improvement in the chlorine readings after the new reservoir dosing regime was implemented by Hunter Water in January 2020.

Water quality data is shared regularly between the Council and Hunter Water. Investigations and data sharing have helped to better understand the supply system and to plan and optimise water quality outcomes in the future. A summary of these investigations at North Karuah is provided in Section 5.4.1 *North Karuah water quality investigations*.

5.3 CCP performance

Bulahdelah, Gloucester, and Stroud water supplies achieved all results within CCP requirements.

There was one occasion of CCP exceedance in the Manning Water Supply System. This was for disinfection at a service reservoir and details are provided in Table 2: *Critical limit exceedance.* This reservoir supplies 25 residential properties with a daily turnover of 0.45ML when in operation and is only used for supply when there is a major failure of the main service reservoirs. Customers were supplied from the main service reservoir during the CCP exceedance. Chlorine concentration at the reservoir was boosted in response and preventative actions were programmed to improve the turnover in the reservoir. The notification was made to NSW Health.

Table 2: Critical limit exceedance

Date	Supply system	CCP exceedance	CCP limit	Details of exceedance	Corrective action	Preventative action
26/09/2022	Manning	Disinfection in service reservoir (Bungay Road).	Free chlorine= 0.20 mg/L	Free chlorine =0.05 mg/L.	Chlorine tablets were added to the reservoir to increase chlorine levels. Extra monitoring at the reservoir and reticulation system.	Improved monitoring program for this reservoir and investigated options to improve turnover.

5.4 Investigative monitoring

There were no large-scale investigative projects undertaken this year. North Karuah water quality comparison and the aboriginal community pesticide and radiological monitoring continued. Two other projects commenced this year which include the pesticide project for Bulahdelah, Gloucester, Stroud and Tea Gardens Water Supply Systems and an investigation into the history of total coliform detections in the reticulation system and risk assessments of sample collection taps.

5.4.1 North Karuah water quality investigations

Investigations performed during the last reporting period to compare water quality parameters before and after the point of handover from Hunter Water indicated that although North Karuah water quality data followed the general trend of Karuah data (HW reticulation site) there is a considerable difference between absolute data for the two sites. Specifically, chlorine levels were lower and turbidity levels were slightly higher in North Karuah reticulation. As a continuation of last year's investigations water quality parameters for the HW reticulation site in Karuah were compared with MidCoast Councils' reticulation data for North Karuah. The results confirm previous trends. However, the difference between the two sites for chlorine is trending up and the difference between the two sites for turbidity is trending down. These investigations and data sharing has helped to better understand the supply system and to plan and optimise water quality outcomes in the future. The council has also initiated a project to investigate and determine whether the difference between the water quality parameters before and after the handover point is related to water usage patterns.

5.4.2 Aboriginal communities' pesticide and radiological project

Pesticide and radiological monitoring were undertaken for the Purfleet and Tobwabba Aboriginal Communities as part of the Aboriginal communities' pesticide and radiological monitoring program from January 2022 to December 2022. NSW Health financially supported the program. Bootawa WTP and Nabiac WTP source water samples were analysed for pesticides monthly. Biannual radiological samples were collected from the reticulation system from Purfleet and Tobwabba Community sampling sites. All results for samples collected were within ADWG.

5.4.3 Pesticide monitoring

The council is currently undertaking a pesticide monitoring program for Bulahdelah, Gloucester, Stroud, and Tea Gardens Water Supplies. NSW Health financially supports the program. Samples will be collected monthly from the source water extraction points of the above WTPs for the duration of a year (July 2023 – July 2024).

5.4.4 Risk assessments of sampling taps and historic data review of total coliform numbers

The presence of total coliforms in the absence of *E.coli* is not considered an indicator of enteric pathogens in the water supply distribution systems according to the ADWG. The presence of total coliforms in the distribution and storage system, when water tested immediately post-treatment is free of total coliforms, indicates water quality degradation, possibly via bacterial regrowth or post-treatment contamination due to, breakdowns in system integrity (leaks, fractures, or repair work), or the release of coliforms from biofilms. Investigating total coliform detections therefore can be used to prevent water quality incidents, especially in the distribution system. Council has initiated a project to review historical data on total coliform recordings in the reticulation system to set specific targets for using the above as an indicator of post-treatment contamination. Associated with this project council is also reviewing the sampling taps at sample sites to preserve sample integrity during sampling and prevent false positive results of microbiological analysis. The results of this investigation will be presented in next year's annual report.

6. Water quality complaints

Recording and analysing the number and nature of customer notifications and complaints can provide useful information on potential water quality issues, which can assist with timely response and rectification. Any rapid or noticeable change in conditions including water quality, pressure etc. may be detected by customers. All notifications and complaints are registered and investigated. This monitoring forms part of the verification of water supply performance. Any health or illness-related notifications and complaints are treated seriously and investigated thoroughly, by collecting, and testing samples and discussing with NSW Health where appropriate.

Australian Standards define a complaint as an 'expression of dissatisfaction made to an organisation, related to its products, or the complaints handling process itself, where a response or resolution is explicitly or inexplicitly expected' (AS ISO 10002-2006). Council records all customer requests relating to poor water quality as a complaint.

Water quality complaints are reported in the following categories; taste, dirty, odour, chlorine and other. The category 'other' covers complaints such as scaling or illness. These categories and definitions are consistent with NSW DPE requirements for NSW Water Utilities Performance Monitoring. Details of complaints for each water supply are provided in Table 3: *Summary of water quality complaints 2022 -2023 and Figure 11 Trends in customer complaints for all water supply systems during 2022-2023.*

Table 3: Summary of water quality complaints 2022-2023

Water supply	Taste	Dirty	Odour	Chlorine	Other	TOTAL
Manning	1	32	0	7	1	41
Bulahdelah	0	0	0	0	0	0
Stroud	0	0	0	0	0	0
Tea Gardens	0	0	0	0	0	0
Gloucester	1	0	1	0	0	2
North Karuah	0	0	0	0	0	0
TOTAL	2	32	1	7	1	43

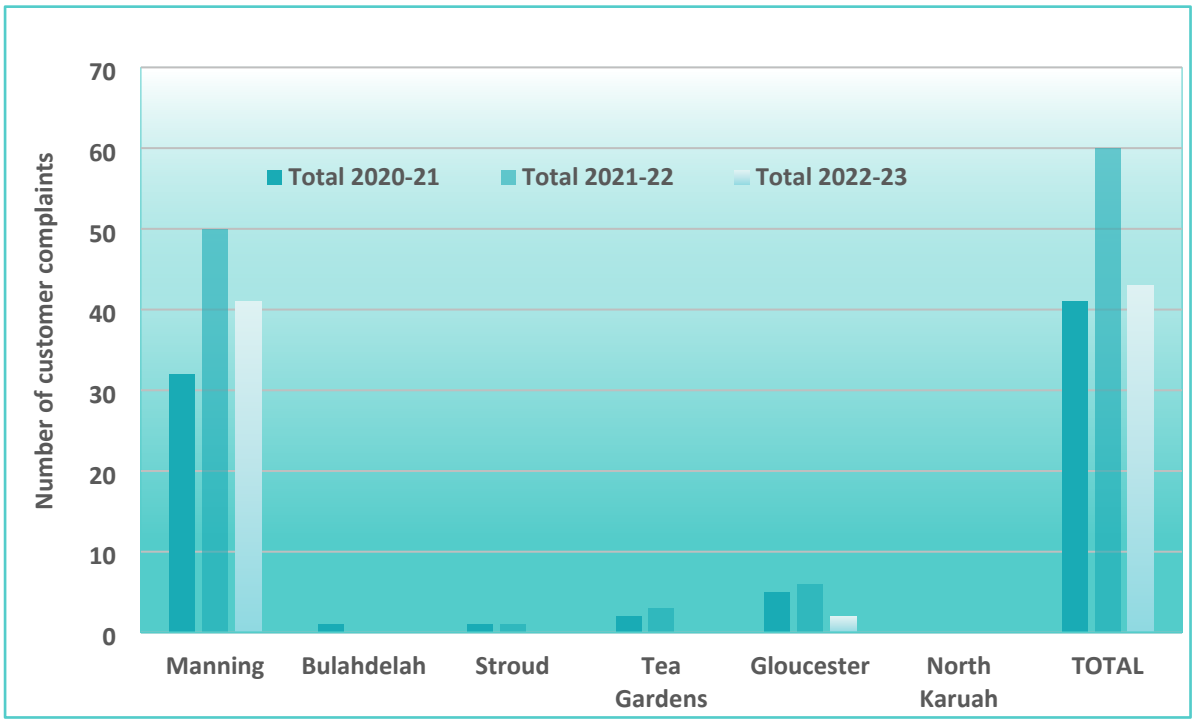

Figure 11: Trends in customer complaints for all water supply systems during 2022-2023

The total number of customer complaints has decreased in all water supply schemes. This is mainly due to the process improvements at the above WTPs during the past and current reporting periods.

Most of the water quality complaints were related to dirty water which were rectified by investigating and flushing.

There was one health-related complaint recorded during this reporting period. This complaint was from Wingham in the Manning Water Supply Scheme where the customer had issues with the taste of the water and claimed that was also affecting her/his mouth. Water samples were collected from the customers residence, and a comprehensive analysis was performed. All the results complied with ADWG. The customer was notified of the results and assured that the water was safe to drink.

7. Water quality incidents

There was one occasion where *E.coli* was detected in a service reservoir in the Tea Gardens Water Supply System. NSW Health was notified immediately, and a full investigation was conducted.

The investigation showed that the cause of the issue may have been a combination of weather conditions on the day and the type of sampling tap used contributing to the contamination of the sample. Opportunities for improvement from the root cause analysis included replacing the sampling tap at Tea Gardens Reservoir and risk assessment of other sampling taps. A project has been initiated for the above and is being conducted currently to identify opportunities for improvements.

A comprehensive report on the outcomes of the investigation was also submitted to NSW Health.

The incident did not affect any customers. The water supplied to customers was within ADWG and there was no boil water alert issued.

8. Continuous improvement plan

MidCoast Council's DWQMS improvement plan is managed by implementing recommendations from internal and external reviews, system audits and water quality incidents reviews. These are captured in a corrective actions database. Each corrective action is ranked according to risk to the quality of drinking water. Accountability for each corrective action is delegated to a manager and is closed when completed. There are 197 actions listed in the data base to date. These also include the actions which have been closed out.

8.1. Progress during 2022 – 2023

Considerable progress has been made on the implementation and improvement of the quality system during 2022 – 2023. Five items were closed out in this reporting period and 17 items are in progress currently. In total 87% of the actions in the data base have been completed to date.

Significant actions which have been completed or have progressed during 2022 – 2023 include;

- Filtration CCP improvements to ensure the removal of chlorine resistant pathogens at WTPs and to effectively monitor the performance of filtration process
- Our Water Our Future Strategic Business Plan IWCM
- Water security, system resilience and water quality issues addressed by IWCM
- Drought management activities including aquifer condition assessments at Nabiac WTP and upgrades to increase capacity
- Gloucester water supply improvements and upgrades
- Process improvements at Bulahdelah and Tea Gardens WTP
- Water filling stations project to minimise risk to the reticulation system and improve water carting during drought
- Review and implementation of backflow prevention policy and procedure
- Scoping study for the Catchment Management Program of the Southern catchments to minimise risks to source water quality
- New readily available and searchable data base for water quality data management

9. Reservoir condition

The reservoir integrity program to minimise risks to drinking water includes ten types of routine reservoir inspections conducted on all service reservoirs. Details of scheduled inspections are provided in Table 4: *Reservoir inspection program* below.

Table 4: Reservoir inspection program

Frequency	Type of inspection	Inspected by	Process of inspection/reporting
Monthly	External integrity check, vermin proofing, grounds, fencing, inspection hatches	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding.
Monthly	Online chlorine analysers	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding.
Monthly	Chlorine booster stations	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding.
Annually	Electrical	Electrician	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding.
Annually	Major site inspection: ensure roof is secure from birds, vermin, pass/fail. windborne contaminants, check rainwater cannot enter reservoir, drainage, signage, security of site	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in the work order system; Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding. In accordance with DPI Water Circular LWU 18.

In addition to these inspections, operators monitor reservoir integrity and chlorine levels in accordance with critical control point requirements.

Repair works are undertaken according to priority. The initial focus is to rectify roof issues which may affect water quality.

Two new reservoirs are being constructed in the Gloucester Water Supply System to replace reservoirs requiring repairs. Reservoir repairs necessary to protect water quality, maintenance, and other routine repairs were completed, as necessary.

Five reservoirs have been identified for repairs within the next five years and two reservoirs within the next 10-15 years.

9. Conclusion

Significant resources have been invested this year in the implementation of the risk-based DWQMS. These include capital investments to improve water security and water quality in the Manning and Gloucester Water Supply System, investigations, upgrades, and enhancements to improve system and product compliance in all the water supply systems.

Considerable progress has been made on the DWQMS improvement plan with five items closed out in this financial year and 17 items in progress.

The main feature this year is the success of the THMs project at the Tea Gardens Water Supply Scheme. This will address the long-standing issue of THMs in the above scheme and will improve water quality compliance and customer satisfaction in the Tea Gardens Water Supply.

There has been considerable progress in strategic planning including IWCM, Drought Management Plan, and an updated version of DWQMS being adopted by Council this year. There has also been initial work done for the Catchment Management Plan of the southern catchments.

The strategic planning milestones, capital works investment, process improvements, and the implementation of DWQMs improvement plan will set drinking water quality and water security well into the future.

Acknowledgements: Tracey Hamer for the section on IWCM and Patrick Duiveman on THMs Investigations.

APPENDIX 1 CRITICAL CONTROL POINTS SUMMARY

Summary of CCPs – Manning Water Supply System

CCP number and description	Monitoring parameter	Target criterion	Adjustment limit	Critical limit
1: Filtration (Bootawa)	Turbidity NTU	< 0.1	> 0.3	> 0.5
	Pressure decay test	PDT completed every day	PDT not complete every day every 8 operating hours	> 20 kPa per minute
2: Disinfection (Bootawa)	Free chlorine mg/L	1.4 – 2.6	< 1.4 or > 2.6	< 1.0
3: Fluoridation (Bootawa)	Fluoride mg/L	1.0	< 0.9 or > 1.1	> 1.5
4: Filtration (Nabiac)	Turbidity NTU	< 0.1	> 0.3	> 0.5
	Membrane integrity test	MIT completed every day	MIT not complete every day	> 8 kPa per 5 minutes
5: Disinfection (Nabiac)	Free chlorine mg/L	3.0	< 1.4 or > 2.6	< 1.0 or > 5
6: Fluoridation (Nabiac)	Fluoride mg/L	1.0	< 0.9 or > 1.1	> 1.5
7: Manning Reservoirs	Free chlorine mg/L *and* reservoir integrity	> 0.5 Secure and vermin proof	< 0.2 Evidence of breach	< 0.2 Breach not rectified or serious breach
8: Lantana Chlorine Booster Station	Free chlorine mg/L	2.0	< 1.5 or > 2.5	< 0.5 or > 4.0
9: Kolodong and Forster Chlorine Booster Stations	Free chlorine mg/L	1.5	< 1.0 or > 2.0	< 0.5

Summary of CCPs – Bulahdelah Water Supply System

CCP number and description	Monitoring parameter	Target criterion	Adjustment limit	Critical limit
1: Filtration	Turbidity NTU Online clear water tank	< 0.2	> 0.4	> 1.0
	Turbidity grab sample individual filter	<0.2	>0.4	>0.5
2: Disinfection	Free chlorine mg/L	2.5 – 5.5	< 2.5 or > 5.5	< 1.5
3: Fluoridation	Fluoride mg/L	0.9 – 1.1	< 0.9 or > 1.1	> 1.5
4: Reservoirs	Free chlorine mg/L *and* reservoir integrity	> 1 Secure and vermin proof	< 0.8 Evidence of breach	< 0.2 Breach not rectified or serious breach

Summary of CCPs – Stroud Water Supply System

CCP number and description	Monitoring parameter	Target criterion	Adjustment limit	Critical limit
1: Filtration	Turbidity NTU	< 0.4	> 0.7	> 1.0
	Turbidity grab sample individual filter	<0.2	>0.4	>0.5
2: Disinfection	Free chlorine mg/L	1.5-4	< 1.5 or > 4.0	< 1.0 or
3: Fluoridation	Fluoride mg/L	0.9 – 1.1	< 0.9 or > 1.1	> 1.5
4: Reservoirs	Free chlorine mg/L *and* reservoir integrity	> 0.5 Secure and vermin proof	< 0.3 Evidence of breach	< 0.2 Breach not rectified or serious breach

Summary of CCPs – Tea Gardens Water Supply System

CCP number and description	Monitoring parameter	Target criterion	Adjustment limit	Critical limit
1: Filtration	Turbidity NTU	< 0.1	> 0.3	> 0.5
		MIT completed every day	MIT not completed every day	>5 KPa per 5 minutes
2: Disinfection	Free chlorine mg/L	3.0	< 1.4 or > 4.3	< 1.0
3: Fluoridation	Fluoride mg/L	0.9 – 1.1	< 0.9 or > 1.1	> 1.5
4: Reservoirs	Free chlorine mg/L *and* reservoir integrity	> 1.0 Secure and vermin proof	< 0.8 Evidence of breach	< 0.2 Breach not rectified or serious breach

Summary of CCPs – Gloucester Water Supply System

CCP number and description	Monitoring parameter	Target criterion	Adjustment limit	Critical limit
1: Filtration	Turbidity NTU	< 0.4	> 0.7	> 1.0
	Turbidity grab sample individual filter	<0.2	>0.4	>0.5
2: Disinfection	Free chlorine mg/L	3.0	< 2.0 or > 4.0 Nov-Feb < 1.5 or > 3.5 Mar-Oct	< 1.0
3: Fluoridation	Fluoride mg/L	0.9 – 1.1	< 0.9 or > 1.1	> 1.5
4: Reservoirs	Free chlorine mg/L *and* reservoir integrity	> 0.5 Secure and vermin proof	< 0.3 Evidence of breach	< 0.2 Breach not rectified or serious breach

APPENDIX 2 WATER QUALITY DATA SUMMARY

Water quality data for each scheme is presented in the following tables. Raw water quality is measured before water enters the treatment plant. Final treated water quality is measured as water leaves the treatment plant and is sent to reticulation. Water quality in the reticulation system is measured at customers' taps or public sites throughout the distribution system. The water quality data summary includes samples tested at National Association of Testing Authorities (NATA) laboratories including MidCoast Council Environmental Laboratory and the NSW Forensic and Analytical Service Science (FASS) Laboratory as part of NSW Health Drinking Water Quality Monitoring Program. This does not include samples collected and tested by operators at WTP laboratories.

Water quality results supplied for North Karuah supply are from the reticulation system only. Hunter Water is responsible for treating and monitoring water before it is sent to the reticulation system.

MANNING WATER QUALITY

Raw water quality summary- Bootawa

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.7	8.0	8.7	26
Turbidity	NTU	0.85	2.5	15	26
True colour	Colour units	6	13.58	25	26
Alkalinity	mg/L	48	62	74	26
Calcium hardness	mg/L	28.5	36.53	51.5	52
E. coli	orgs/100ml	1	12	140	52
Total coliforms	orgs/100ml	19	393	>2400	52
Total aluminium	mg/L	0.005	0.060	0.648	26
Total iron	mg/L	0.044	0.156	0.866	26
Total manganese	mg/L	0.005	0.0227	0.086	26
Total cadmium	mg/L	<0.0001	<0.0001	<0.0001	2
Total strontium	mg/L	0.0625	0.0765	0.0904	2
Total silver	mg/L	<0.0001	<0.0001	0.0001	2
Total cyanide	mg/L	<0.005	<0.005	<0.005	2
Total chromium	mg/L	0.0002	0.0002	0.0002	2
Total copper	mg/L	0.0005	0.0007	0.0008	4
Fluoride	mg/L	<0.1	<0.1	<0.1	1

Final treated water quality summary– Bootawa

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.3	7.5	7.7	52
Turbidity	NTU	0.05	0.056	0.15	52
True colour	Colour units	<2	<2	3	13
Total dissolved solids	mg/L	110	127.31	150	52
Alkalinity	mg/L	61	74.62	86	52
Calcium hardness	mg/L	40	53.08	69	52
Free chlorine	mg/L	1.60	2.25	2.8	52
Total chlorine	mg/L	2.01	2.51	3	52
E. coli	orgs/100ml	<1	<1	<1	52
Total coliforms	orgs/100ml	<1	<1	<1	52
Total aluminium	mg/L	0.016	0.028	0.049	26
Total iron	mg/L	<0.005	<0.005	0.01	13
Total manganese	mg/L	<0.0005	<0.0005	<0.0005	10
Total copper	mg/L	<0.0005	0.0010	0.0046	12
Fluoride	mg/L	0.90	0.97	1.03	12

Raw water quality summary – Nabiac

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	5.6	5.9	6.3	23
Turbidity	NTU	0.05	0.12	0.2	23
True colour	Colour units	9	19.39	32	23
Alkalinity	mg/L	6	16.95	30	24
Calcium hardness	mg/L	2	8.81	15.5	13
E. coli	orgs/100ml	<1	<1	1	41
Total coliforms	orgs/100ml	<1	19	160	41
Total aluminium	mg/L	0.14	0.198	0.268	24
Total iron	mg/L	0.460	0.927	1.14	24
Total manganese	mg/L	0.0033	0.0091	00905	24
Total sulphide	mg/L	0.282	0.413	0.506	13
Dissolved organic carbon	mg/L	3.2	4.941	18.4	24

Final treated water quality summary– Nabiac

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.1	7.4	7.7	54
Turbidity	NTU	0.05	0.06	0.25	54
True colour	Colour units	<2	<2	4	13
Total dissolved solids	mg/L	95	110	140	13
Alkalinity	mg/L	24	38	47	24
Calcium hardness	mg/L	21	43	54	54
Free chlorine	mg/L	1.52	2.62	3.9	54
Total chlorine	mg/L	1.67	2.84	4	54
E. coli	orgs/100ml	<1	<1	<1	54
Total coliforms	orgs/100ml	<1	<1	<1	54
Total aluminium	mg/L	0.06	0.0898	0.14	26
Total iron	mg/L	0.01	0.017	0.03	13
Total manganese	mg/L	0.0043	0.0077	0.01	13
Total sulphide	mg/L	<0.002	<0.002	<0.002	13
Dissolved organic carbon	mg/L	2.5	3.373	4.8	26

Reticulated water quality summary – Manning

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.3	7.6	8.6	494
Turbidity	NTU	0.05	0.09	1.3	494
True colour	Colour units	<0.05	1.47	2	44
Free chlorine	mg/L	0.37	1.31	2.15	473
Total chlorine	mg/L	0.44	1.43	2.60	473
E. coli	orgs/100ml	<1	<1	<1	470
Total coliforms	orgs/100ml	<1	<1	2400	470
Total aluminium	mg/L	0.009	0.020	0.04	44
Total iron	mg/L	0.005	0.01	0.028	44
Total manganese	mg/L	0.00030	0.0013	0.005	44
Total antimony	mg/L	0.0001	0.0002	0.0023	44
Total arsenic	mg/L	0.0001	0.00050	0.002	44
Total barium	mg/L	0.0070	0.0093	0.0133	24
Total boron	mg/L	0.003	0.0180	0.036	44
Total cadmium	mg/L	<0.0001	<0.0001	0.0009	24
Total calcium	mg/L	15.3	18.9	21.4	13
Total chloride	mg/L	17	20.2917	26	24
Total chromium	mg/L	<0.0001	0.0006	0.0015	44
Total copper	mg/L	0.006	0.0989	0.823	44
Total iodine	mg/L	<0.02	<0.02	<0.20	24
Total lead	mg/L	<0.0001	0.00053	0.0028	44
Total magnesium	mg/L	3.14	5.65	6.95	13
Total mercury	mg/L	<0.0008	<0.0008	<0.0008	24
Total molybdenum	mg/L	<0.0001	0.0001	0.0002	24
Total nickel	mg/L	<0.0001	0.00036	0.0022	44
Nitrate	mg/L	0.05	0.5982	1	44
Nitrite	mg/L	<0.0005	0.02553	<0.10	44
Total selenium	mg/L	<0.0001	0.004	<0.007	44
Total silver	mg/L	<0.002	<0.002	<0.002	24
Total sodium	mg/L	11	12.08	15	24
Total sulphate	mg/L	4	6.0416	10	24
Total uranium	mg/L	<0.0001	<0.0001	<0.001	24
Total zinc	mg/L	0.001	0.0090	0.03	44
Total hardness	mg/L	60	82	108	24
Total dissolved solids	mg/L	82	96	102	24
Chloroacetic acid	ug/L	1	1.9	10	65
Dichloroacetic acid	ug/L	2	19	69	65
Trichloroacetic acid	ug/L	1	16	75	65
Total trihalomethanes	ug/L	23	65	208	65
Bromate	ug/L	0.002	0.0068	0.03	26
Fluoride	mg/L	0.66	0.98	1.16	24

BULAHDELAH WATER QUALITY

Raw water quality summary - Bulahdelah

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	6.3	6.63	6.9	27
Turbidity	NTU	3.5	18.17	60	27
True colour	Colour units	47	152	260	27
Alkalinity	mg/L	6	19.55	40	27
Calcium hardness	mg/L	8	20.96	37.5	27
E. coli	orgs/100ml	<1	149	2900	55
Total coliforms	orgs/100ml	49	3356.86	13000	55
Total aluminium	mg/L	0.096	1.22	6.98	27
Total iron	mg/L	0.35	1.42	2.83	27
Total manganese	mg/L	0.016	0.132	1.06	27

Final treated water quality summary - Bulahdelah

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.4	7.7	8	51
Turbidity	NTU	0.05	0.08	0.30	51
True colour	Colour units	<2	2.08	3	13
Total dissolved solids	mg/L	150	204	270	13
Calcium hardness	mg/L	10.5	18.4	31.5	13
Free chlorine	mg/L	2.7	3.7	4.9	51
Total chlorine	mg/L	3	4.1	5.4	51
E. coli	orgs/100ml	<1	<1	<1	51
Total coliforms	orgs/100ml	<1	<1	<1	51
Total aluminium	mg/L	<0.005	0.027	0.142	22
Total iron	mg/L	<0.005	0.0051	0.007	13
Total manganese	mg/L	<0.0005	0.0013	0.007	13
Fluoride	mg/L	0.84	0.92	0.97	12

Reticulated water quality summary – Bulahdelah

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.6	7.77	7.9	54
Turbidity	NTU	0.05	0.13	0.35	54
True colour	Colour units	<1	1.755	2	4
Free chlorine	mg/L	0.35	1.25	1.96	52
Total chlorine	mg/L	0.46	1.401	2.12	52
E. coli	orgs/100ml	<1	<1	<1	52
Total coliforms	orgs/100ml	<1	<1	<1	52
Total aluminium	mg/L	0.01	0.039	0.088	4
Total iron	mg/L	0.001	0.026	0.05	4
Total manganese	mg/L	0.0011	0.002	0.034	4
Total antimony	mg/L	<0.0001	<0.001	<0.0003	4
Total arsenic	mg/L	<0.0002	<0.001	<0.001	4
Total barium	mg/L	0.013	0.016	0.0182	2
Total boron	mg/L	0.018	0.021	0.0222	4
Total cadmium	mg/L	<0.0001	<0.0001	<0.0001	2
Total calcium	mg/L	7.5	9.6	11.7	2
Total chloride	mg/L	76	77	78	2
Total chromium	mg/L	<0.0002	0.0006	<0.001	4
Total copper	mg/L	0.0101	0.011	0.013	4
Total iodine	mg/L	<0.02	<0.02	<0.02	2
Total lead	mg/L	0.0004	0.001	0.001	4
Total magnesium	mg/L	4.7	5.37	5.96	1
Total mercury	mg/L	<0.0008	<0.0008	<0.0008	2
Total molybdenum	mg/L	<0.0001	<0.0001	<0.0001	2
Total nickel	mg/L	<0.0002	<0.0003	<0.0004	4
Nitrate	mg/L	<1	<1	<1	4
Nitrite	mg/L	<0.1	<0.1	<0.1	4
Total selenium	mg/L	<0.0002	0.004	<0.007	4
Total silver	mg/L	<0.0002	<0.0002	<0.0002	2
Total sodium	mg/L	54	58	68	2
Total sulphate	mg/L	3	4	5	2
Total uranium	mg/L	<0.0001	<0.0001	<0.0001	2
Total zinc	mg/L	0.003	0.007	0.01	4
Total hardness	mg/L	27	32	38	2
Total dissolved solids	mg/L	159	162	166	2
Chloroacetic acid	ug/L	1	1.9	3	12
Dichloroacetic acid	ug/L	8	20	31	13
Trichloroacetic acid	ug/L	8	21	53	13
Total trihalomethanes	ug/L	82	154	214	13
Fluoride	mg/L	0.95	0.982	1.03	12

STROUD WATER QUALITY

Raw water quality summary - Stroud

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.0	7.5	7.7	26
Turbidity	NTU	3.5	23.381	100	26
True colour	Colour units	27	63.615	130	26
Alkalinity	mg/L	13	41.96	68	26
Calcium hardness	mg/L	13	29.12	37.5	13
E. coli	orgs/100ml	17	510	9200	52
Total coliforms	orgs/100ml	230	3748	16000	52
Total aluminium	mg/L	0.143	1.104	3.08	13
Total iron	mg/L	0.587	1.402	3.14	13
Total manganese	mg/L	0.0162	0.0418	0.1123	13
Soluble reactive phosphorus	mg/L	0.006	0.0166	0.054	26
Dissolved organic carbon	mg/L	3	6.15	17	26
Total cadmium	mg/L	<0.0001	<0.0001	<0.0001	2
Total chromium	mg/L	0.0006	0.0009	0.0012	2
Total strontium	mg/L	0.0834	0.0947	0.106	2
Total silver	mg/L	<0.0001	<0.0001	<0.0001	2
Total cyanide	mg/L	<0.005	<0.005	<0.005	2

Final treated water quality summary - Stroud

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.6	7.9	8.2	52
Turbidity	NTU	0.05	0.08	0.15	52
True colour	Colour units	<2	<2	2	13
Total dissolved solids	mg/L	120	133	160	13
Alkalinity	mg/L	25	30	39	13
Calcium hardness	mg/L	22.5	27	32	13
Free chlorine	mg/L	1.85	2.21	2.6	52
Total chlorine	mg/L	2	2.45	2.9	52
E. coli	orgs/100ml	<1	<1	<1	52
Total coliforms	orgs/100ml	<1	<1	<1	52
Filtered aluminium	mg/L	0.01	0.06	0.15	26
Total aluminium	mg/L	0.03	0.09	0.17	26
Total iron	mg/L	<0.005	<0.005	0.005	13
Total manganese	mg/L	<0.0005	<0.0005	<0.0005	13
Dissolved organic carbon	mg/L	0.90	1.28	1.6	13
Fluoride	mg/L	0.86	0.97	1.14	14

Reticulated water quality summary – Stroud

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.4	7.8	8.2	54
Turbidity	NTU	0.05	0.209	1.7	54
True colour	Colour units	<1	1.5	<2	4
Free chlorine	mg/L	0.75	1.31	1.9	52
Total chlorine	mg/L	0.85	1.42	2.08	52
E. coli	orgs/100ml	<1	<1	<1	52
Total coliforms	orgs/100ml	<1	<1	<1	52
Total aluminium	mg/L	0.05	0.111	0.159	4
Total iron	mg/L	<0.01	0.02	0.03	4
Total manganese	mg/L	<0.005	0.00285	0.0102	4
Total antimony	mg/L	<0.0001	<0.0002	<0.0003	4
Total arsenic	mg/L	<0.0002	<0.0006	<0.001	4
Total barium	mg/L	0.003	0.003	0.004	2
Total boron	mg/L	0.013	0.014	0.016	4
Total cadmium	mg/L	<0.0001	<0.0001	<0.0001	2
Total calcium	mg/L	13.8	14	14.2	2
Total chloride	mg/L	48	51.5	55	2
Total chromium	mg/L	<0.0002	0.0006	<0.001	4
Total copper	mg/L	0.0020	0.0025	0.0030	4
Total iodine	mg/L	<0.02	<0.02	<0.02	4
Total lead	mg/L	0.0001	0.0002	0.0002	4
Total magnesium	mg/L	6.06	6.06	6.06	1
Total mercury	mg/L	<0.0008	<0.0008	<0.0008	2
Total molybdenum	mg/L	0.0001	0.0001	0.0001	2
Total nickel	mg/L	<0.0002	0.0003	<0.0004	4
Nitrate	mg/L	0.01	0.505	<1	4
Nitrite	mg/L	<0.002	<0.0125	<0.01	4
Total selenium	mg/L	<0.0002	<0.0036	<0.007	4
Total silver	mg/L	<0.0002	<0.0002	<0.0002	2
Total sodium	mg/L	48	52	55	2
Total sulphate	mg/L	4	4.5	5	2
Total uranium	mg/L	<0.0001	<0.0001	<0.0001	2
Total zinc	mg/L	<0.002	0.006	0.01	4
Total hardness	mg/L	40	48	56	2
Total dissolved solids	mg/L	99	104	109	2
Chloroacetic acid	ug/L	1	1	1	13
Dichloroacetic acid	ug/L	6	8	12	13
Trichloroacetic acid	ug/L	1	4	7	13
Total trihalomethanes	ug/L	23	48	71	13
Fluoride	mg/L	0.97	1.02	1.04	12

TEA GARDENS WATER QUALITY

Raw water quality summary – Tea Gardens

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	5.4	5.538	6.1	26
Turbidity	NTU	0.05	0.255	2.2	26
True colour	Colour units	15	16.84	20	26
Alkalinity	mg/L	7	8.23	10	26
Calcium hardness	mg/L	3.5	4.08	4.5	13
E. coli	orgs/100ml	<1	<1	<1	52
Total coliforms	orgs/100ml	<1	<1	<1	52
Total aluminium	mg/L	0.229	0.298	0.388	26
Total iron	mg/L	0.845	1.18	1.46	26
Total manganese	mg/L	0.0046	0.0056	0.0065	26
Total chromium	mg/L	0.0002	0.0003	0.0005	26
Total arsenic	mg/L	<0.0002	<0.0002	0.0014	26
Total sulphide	mg/L	<0.494	0.782	0.942	13
Dissolved organic carbon	mg/L	4.8	5.09	5.6	13

Final treated water quality summary – Tea Gardens

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.4	7.6	7.7	55
Turbidity	NTU	0.05	0.054	0.10	55
True colour	Colour units	<2	<2	4	13
Total dissolved solids	mg/L	120	131	160	14
Alkalinity	mg/L	27	29	43	14
Calcium hardness	mg/L	27	29	32	14
Free chlorine	mg/L	2.4	3.34	4.0	55
Total chlorine	mg/L	2.9	3.91	4.7	55
E. coli	orgs/100ml	<1	<1	<1	55
Total coliforms	orgs/100ml	<1	<1	<1	55
Total aluminium	mg/L	0.05	0.077	0.12	27
Total iron	mg/L	0.013	0.035	0.084	14
Total manganese	mg/L	0.0014	0.0028	0.0045	14
Total sulphide	mg/L	<0.002	<0.002	0.0080	14
Dissolved organic carbon	mg/L	3.1	3.75	7.8	26
Fluoride	mg/L	0.71	0.94	1.04	13

Reticulated water quality summary – Tea Gardens

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.4	7.74	7.9	53
Turbidity	NTU	0.05	0.0764	0.4	53
True colour	Colour units	<1	<1	<2	4
Free chlorine	mg/L	54	1.07	1.66	52
Total chlorine	mg/L	0.76	1.26	1.93	52
E. coli	orgs/100ml	<1	<1	<1	52
Total coliforms	orgs/100ml	<1	<1	<1	52
Total aluminium	mg/L	0.007	0.06	0.08	4
Total iron	mg/L	0.03	0.04	0.05	4
Total manganese	mg/L	0.002	0.0027	0.0035	4
Total antimony	mg/L	<0.001	<0.002	<0.003	4
Total arsenic	mg/L	<0.0002	<0.002	0.001	4
Total barium	mg/L	0.0077	0.0086	0.0095	2
Total boron	mg/L	0.0176	0.0197	0.02210	4
Total cadmium	mg/L	<0.0005	<0.0005	<0.0005	2
Total calcium	mg/L	10.7	10.7	10.7	1
Total chloride	mg/L	24	34	44	2
Total chromium	mg/L	<0.0002	0.0006	<0.001	4
Total copper	mg/L	0.0023	0.0068	0.015	4
Total iodine	mg/L	0.03	0.03	0.03	2
Total lead	mg/L	<0.0001	0.0002	<0.0004	4
Total magnesium	mg/L	2.7	2.7	2.7	2
Total mercury	mg/L	<0.0008	<0.0008	<0.0008	2
Total molybdenum	mg/L	<0.0001	<0.0001	<0.0001	2
Total nickel	mg/L	<0.0002	0.0003	<0.0005	4
Nitrate	mg/L	0.06	0.53	<1	4
Nitrite	mg/L	<0.001	0.0505	<0.1	4
Total selenium	mg/L	<0.0002	0.0003	<0.007	4
Total silver	mg/L	<0.002	<0.002	<0.002	2
Total sodium	mg/L	24	34	44	2
Total sulphate	mg/L	8	8.5	9	2
Total uranium	mg/L	<0.0001	<0.0001	<0.0001	2
Total zinc	mg/L	0.002	0.007	0.01	4
Total hardness	mg/L	39	43	47	2
Total dissolved solids	mg/L	96	97	99	2
Chloroacetic acid	ug/L	4	15	31	25
Dichloroacetic acid	ug/L	46	71	115	25
Trichloroacetic acid	ug/L	3	33	73	25
Total trihalomethanes	ug/L	138	200	272	25
Fluoride	mg/L	0.90	0.96	1.02	12

GLOUCESTER WATER QUALITY

Raw water quality summary– Gloucester

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.4	7.5	7.6	26
Turbidity	NTU	1.9	3.88	9.7	26
True colour	Colour units	10	18.34	37	26
Alkalinity	mg/L	15	32.15	39	26
Calcium hardness	mg/L	14.5	24.07	29	13
E. coli	orgs/100ml	47	406	1600	51
Total coliforms	orgs/100ml	1200	3376	>9700	51
Total aluminium	mg/L	0.02	0.124	0.411	13
Total iron	mg/L	0.06	0.214	0.434	13
Total manganese	mg/L	0.0018	0.00734	0.02227	13
Total cadmium	mg/L	<0.0001	<0.0001	<0.0001	2
Total chromium	mg/L	0.0003	0.00035	0.0004	2
Total strontium	mg/L	0.0369	0.04905	0.0612	2
Total silver	mg/L	0.0001	0.0001	0.0001	2
Total cyanide	mg/L	<0.005	<0.005	<0.005	2

Final treated water quality summary – Gloucester

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.8	8.18	8.4	50
Turbidity	NTU	0.05	0.079	0.40	50
True colour	Colour units	<2	2.5	3	12
Total dissolved solids	mg/L	68	86	130	12
Alkalinity	mg/L	26	34.99	45	12
Calcium hardness	mg/L	16	23	29	12
Free chlorine	mg/L	1.5	2.38	3.3	50
Total chlorine	mg/L	1.55	2.61	3.5	50
E. coli	orgs/100ml	<1	<1	<1	50
Total coliforms	orgs/100ml	<1	<1	<1	50
Total aluminium	mg/L	0.011	0.065	0.68	25
Total iron	mg/L	<0.005	<0.005	0.14	12
Total manganese	mg/L	0.0008	0.0017	0.0035	12

Reticulated water quality summary – Gloucester

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.8	8.19	8.5	80
Turbidity	NTU	0.05	0.228	2.2	80
True colour	Colour units	<1	1.5	<2	4
Free chlorine	mg/L	0.76	1.68	2.5	78
Total chlorine	mg/L	0.99	1.75	2.33	78
E. coli	orgs/100ml	<1	<1	<1	78
Total coliforms	orgs/100ml	<1	<1	<1	78
Total aluminium	mg/L	0.01	0.62	2.8	4
Total iron	mg/L	<0.01	0.011	0.027	4
Total manganese	mg/L	0.001	0.002	0.002	4
Total antimony	mg/L	<0.001	<0.001	0.004	4
Total arsenic	mg/L	<0.0002	0.0006	<0.001	4
Total barium	mg/L	0.0049	0.0056	0.0063	2
Total boron	mg/L	0.009	0.032	0.101	4
Total cadmium	mg/L	<0.0001	<0.0001	<0.0001	2
Total calcium	mg/L	4.6	4.6	4.6	2
Total chloride	mg/L	16	17.5	19	2
Total chromium	mg/L	0.0002	0.0006	0.001	4
Total copper	mg/L	0.0284	0.0415	0.062	4
Total iodine	mg/L	<0.02	<0.02	<0.02	2
Total lead	mg/L	0.0001	0.0025	<0.0004	4
Total magnesium	mg/L	1.49	1.49	1.49	2
Total mercury	mg/L	<0.0008	<0.0008	<0.0008	2
Total molybdenum	mg/L	<0.0002	<0.0004	<0.0006	2
Total nickel	mg/L	<0.0002	0.0007	<0.002	4
Nitrate	mg/L	0.05	0.58	1	4
Nitrite	mg/L	0.002	0.0515	<0.1	4
Total selenium	mg/L	<0.0002	<0.002	<0.007	4
Total silver	mg/L	<0.0002	<0.0002	<0.0002	2
Total sodium	mg/L	18	18.5	19	2
Total sulphate	mg/L	4	5	6	2
Total zinc	mg/L	0.005	0.0125	0.03	4
Calcium hardness	mg/L	28	29	31	2
Total dissolved solids	mg/L	65	65.5	66	2
Chloroacetic acid	ug/L	1	1	1	13
Dichloroacetic acid	ug/L	4	11	22	13
Trichloroacetic acid	ug/L	4	11	19	13
Total trihalomethanes	ug/L	18	39.6	68	13

NORTH KARUAH WATER QUALITY

Reticulated water quality summary – North Karuah

Parameter	Unit	Minimum	Average	Maximum	No. samples
pH	pH units	7.4	8.0	8.1	27
Turbidity	NTU	0.1	0.53	2.2	27
True colour	Colour units	<1	<1	<1	2
Free chlorine	mg/L	0.19	0.74	1.58	26
Total chlorine	mg/L	0.32	0.88	1.76	26
E. coli	orgs/100ml	<1	<1	<1	26
Total coliforms	orgs/100ml	<1	<1	<1	26
Total aluminium	mg/L	0.02	0.042	0.06	2
Total iron	mg/L	0.02	0.09 6	0.17	2
Total manganese	mg/L	<0.005	0.0011	0.05	2
Total antimony	mg/L	<0.001	<0.001	<0.001	2
Total arsenic	mg/L	<0.001	<0.001	<0.001	2
Total barium	mg/L	0.0141	0.0141	0.0141	2
Total boron	mg/L	0.146	0.149	0156	2
Total cadmium	mg/L	<0.0001	<0.0001	<0.0001	2
Total calcium	mg/L	25.6	5.8	26	2
Total chloride	mg/L	29	30	31	2
Total chromium	mg/L	<0.001	<0.001	<0.001	2
Total copper	mg/L	0.03	0.0545	0.08	2
Total iodine	mg/L	<0.02	<0.02	<0.02	2
Total lead	mg/L	<0.0006	<0.001	<0.001	2
Total magnesium	mg/L	1.5	1.63	1.76	2
Total mercury	mg/L	<0.0008	<0.0008	<0.0008	2
Total molybdenum	mg/L	<0.0001	0.0015	<0.0002	2
Total nickel	mg/L	<0.0004	<0.0004	<0.0004	2
Nitrate	mg/L	<1	<1	<1	2
Nitrite	mg/L	<0.1	<0.1	<0.1	2
Total selenium	mg/L	<0.007	<0.007	<0.007	2
Total silver	mg/L	<0.002	<0.002	<0.002	2
Total sodium	mg/L	14	14	14	2
Total sulphate	mg/L	4	4	4	2
Total uranium	mg/L	<0.0001	<0.0001	<0.0001	2
Total zinc	mg/L	0.01	0.01	0.01	2
Fluoride	mg/L	0.93	0.97	1.01	2

APPENDIX 3 RESERVOIR INSPECTION PROGRAM

Routine reservoir inspection program

Frequency	Type of inspection	Inspected by	Process of inspection/reporting
Monthly	External integrity check, vermin proofing, grounds, fencing, inspection hatches	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding
Monthly	Online chlorine analysers	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding
Monthly	Chlorine booster stations	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding
Annually	Electrical	Electrician	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding
Annually	Major site inspection: ensure roof is secure from birds, vermin, windborne contaminants, check rainwater cannot enter reservoir, drainage, signage, security of site	Operator	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding. In accordance with DPI Water Circular LWU 18.
Annually	Roof structure	Engineer. External engineer if required.	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding
Every 2 years	Valve exercising	Mechanical technician	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding
Every 2 years	Major electrical	Electrician	Work order sent to relevant staff through maintenance schedule. Findings recorded in work order system; pass/fail. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding

Frequency	Type of inspection	Inspected by	Process of inspection/reporting
Every 2 years	Instrumentation checks and calibration (level indicators)	Electrician. External instrument technician where required.	Work order sent to relevant staff through maintenance schedule. Calibration certificates issued.
Every 2 years	Structural integrity and internal inspection by divers	External contractors	Detailed reports provided by contractor with recommendations for repairs where necessary. Issues rectified or sent to failures and issues register for further consideration including prioritisation and funding.

APPENDIX 4 Abbreviation

Abbreviation	
ADWG	Australian Drinking Water Guidelines
BAC	Biologically activated carbon
CCP	Critical control point
DPE	Department of Planning and Environment
DOC	Dissolved organic carbon
DWQMS	Drinking water quality management system
FASS	Forensic and Analytical Science Service
IWCM	Integrated Water Cycle Management
NATA	National Association of Testing Authorities
OCP	Operational control point
THM	Trihalomethanes
WTP	Water treatment plant