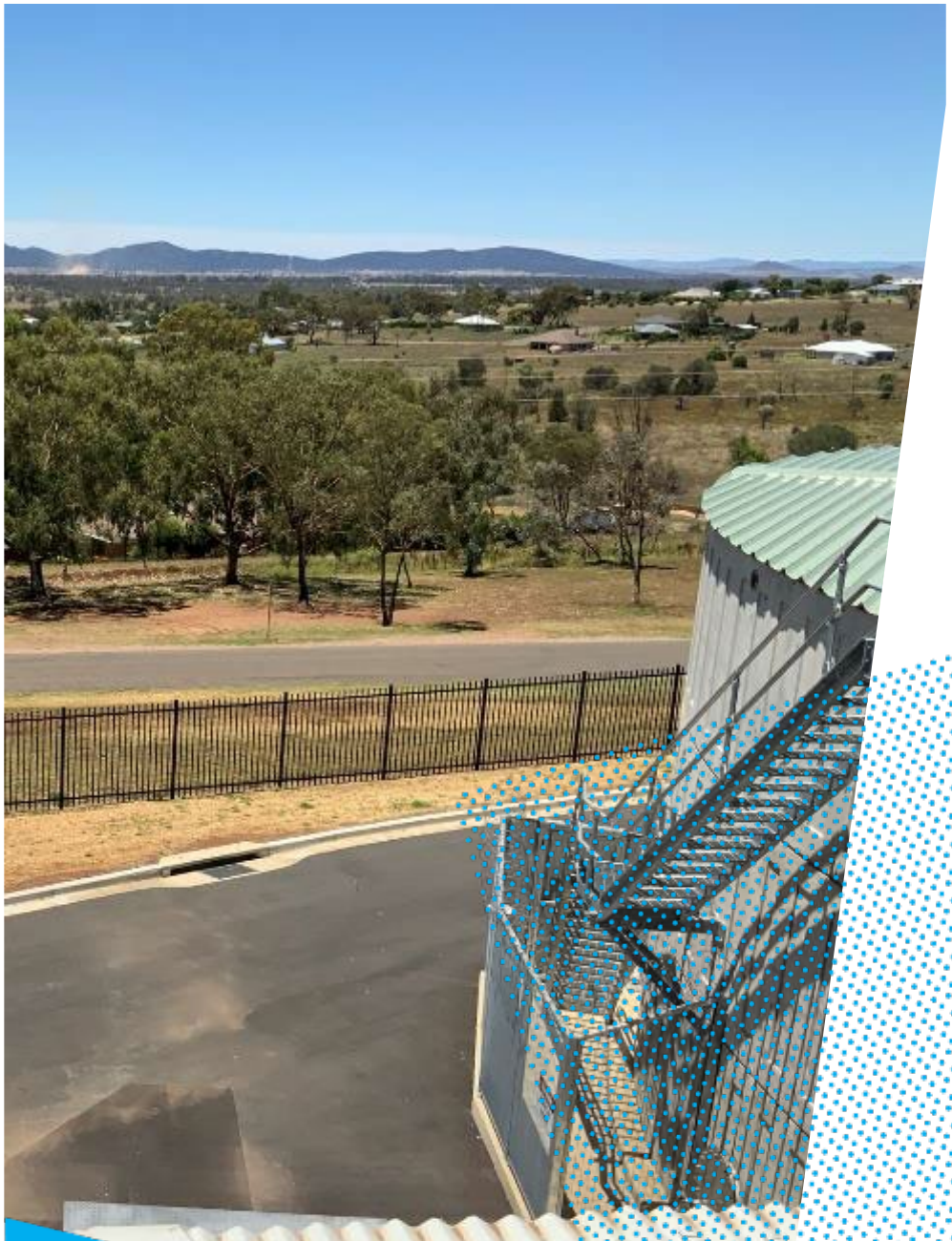

DRINKING WATER MANAGEMENT SYSTEM 2024

GUNNEDAH SHIRE COUNCIL 2024

DOCUMENT CONTROL SHEET

DOCUMENT

Drinking Water Management System 2024

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Gunnedah Shire Council

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Acknowledgement to Country

We acknowledge the Kamilaroi Aboriginal Nation as the traditional custodians of the land on which we live, work and play and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past, present and emerging.

EXECUTIVE SUMMARY

This Drinking Water Management System was developed to be consistent with the Australian Drinking Water Guidelines (ADWG) framework for ensuring the ongoing safety of the drinking water supplies in Gunnedah, Curlewis, Mullaley and Tambar Springs.

In 2023, the risk assessment for these schemes was updated to consider all recent changes to the schemes, and to reflect the maturing of the Drinking Water Management System (DWMS). In conjunction, assumptions were challenged, and preventive measures reassessed to ensure that best practice guidance from the ADWG was being implemented. This resulted in the adjustment of some Critical Control Point (CCP) procedures and the creation of a new CCP for the new fluoridation plant in Gunnedah. The CCP procedures ensure that risks to public health are managed appropriately.

Risks to the system were documented, including the management actions that are currently used to lower the risks to acceptable levels. Where risks were identified as being unacceptable, a risk improvement plan was developed, and will be implemented to reduce risks in the future. At present the highest risks to safe drinking water comes from bacteria and viruses through contamination caused by reservoir integrity (Tambar Springs and Links Road) and backflow into the reticulation network.

The ADWG advocates for multiple robust barriers to manage risks. In the case of the Gunnedah Shire Council water supplies, the key barriers are:

- Bore integrity to protect the water source
- Chlorination
- Integrity of reticulation (Reservoir integrity, backflow prevention, sanitary main break repairs)

These barriers are effectively monitored and maintained by implementing Critical Control Point procedures, and other internal Standard Operating Procedures.

Water quality is monitored through operational monitoring, and the effectiveness of treatment confirmed through verification monitoring. These programs are also detailed in the DWMS.

This document is intended to be a dynamic management system that changes over time. Safe drinking water is essential to our community, and a key function of Council.

GLOSSARY

Term	Definition
ABS	Australian Bureau of Statistics
ADWG	*Australian Drinking Water Guidelines 2011*, published by the National Health and Medical Research Council (NHMRC). Primary guidance for drinking water quality and management within Australia
barrier	A treatment process step that is effective at mitigating a risk
chlorination	use of chlorine as a means of disinfection
consumer	an individual or organisation that uses drinking water
corrective action	procedures to be followed when monitoring results indicate a deviation occurs from acceptable criteria
critical control point (CCP)	An activity, procedure or process at which control can be applied and which is essential to prevent or eliminate a hazard or reduce it to an acceptable level
critical limit	a prescribed tolerance that must be met to ensure that a critical control point effectively controls a potential health hazard; a criterion that separates acceptability from unacceptability
GSC	Gunnedah Shire Council
C.t.	the product of residual disinfectant concentration (C) in milligrams per litre determined before or at taps providing water for human consumption, and the corresponding disinfectant contact time (t) in minutes
DISPLAN	Local Disaster Management Plans, often prepared by Councils in compliance with the State Emergency and Rescue Management Act, 1989.
DWMS	Drinking Water Management System
disinfection	The method used to kill or inactivate pathogenic (disease-causing) microorganisms. This is achieved by chlorination by Gunnedah Shire Council
distribution system	a network of pipes, pumps and reservoirs leading from a treatment plant to customers' plumbing system
drinking water	water intended primarily for human consumption
EPA	Environment Protection Authority
groundwater	water contained in rocks or subsoil
guideline value	the concentration or measure of a water quality characteristic that, based on present knowledge, either does not result in any significant risk to the health of the consumer (health-related guideline value), or is associated with good quality of water (aesthetic guideline value).
HU	Hazen Unit (colour)
hazard	a biological, chemical, physical or radiological agent that has the potential to cause harm
hazard identification	the process of recognising that a hazard exists and defining its characteristic
hazardous event	an incident or situation that can lead to the presence of a hazard (what can happen and how)
Improvement Plan	A Drinking Water Quality Management Improvement Plan as required under Element 12 of the Framework

Term	Definition
L/s	litres per second
mg/L	milligrams per litre
ML	megalitre
maximum risk	a risk in the absence of preventive measures
NTU	Nephelometric Turbidity Units
operational monitoring	the planned sequence of measurements and observations used to assess and confirm that individual barriers and preventative strategies for controlling hazards are functioning properly and effectively
pathogen	an organism capable of eliciting disease symptoms in another organism
pH	value taken to represent acidity or alkalinity of an aqueous solution
point of supply	the physical location of the outlet of the water supply scheme at the consumers' tap
preventive measure	any planned action, activity or process that is used to prevent hazards from occurring or reduce them to acceptable levels
raw water	the water entering the first treatment process of a water treatment plant; water in its natural state, prior to any treatment
residual risk	the risk remaining after implementation of existing preventive measures
risk	the likelihood of a hazard causing harm in exposed populations in a specified time frame, including the magnitude of that harm
risk management	the systematic evaluation of the water supply system, the identification of hazards and hazardous events, the assessment of risks, and the development and implementation of preventive strategies to manage the risks
SCADA	Supervisory Control and Data Acquisition system used to monitor, control and alarm water treatment plants
service reservoir	a storage for drinking water, generally within the distribution system, used to meet fluctuating demands, accommodate emergency requirements and/or equalise operating pressures
turbidity	the cloudiness of water caused by the presence of fine suspended matter
validation	A method of demonstrating that processes are effective
verification monitoring	Retrospective monitoring of the quality of water that was supplied to consumers

1 INTRODUCTION

1.1 Overview

NSW Health has provided funding to support Gunnedah Shire Council (GSC) develop a risk-based drinking water management system (DWMS) to fulfil its obligations under Division 1 Section 25 of the NSW *Public Health Act 2010* and Part 5 Section 34 of the *Public Health Regulation 2012*. The *Public Health Act 2010* sets out the requirement for drinking water suppliers to develop and adhere to a quality assurance program also known as a drinking water management system, consistent with the *Australian Drinking Water Guidelines 2011* (ADWG) (NHMRC, NRMMC, 2011).

The ADWG provides the framework for the good management of drinking water supplies that, when implemented, assures safety at point of use. The framework was developed to guide a structured and systematic approach for the management of drinking water quality from catchment to consumer. It incorporates a preventive risk approach or quality assurance program developed specifically for the water industry, and includes elements of HACCP, AS/NZS ISO 9000:2015 and AS/NZS ISO31000:2009.

1.2 Objective

This document aims to support both the Council to provide, and the community to access, a safe quality drinking water supply. Access to safe water is a basic need and is one of the most important contributors to public health.

The overall approach is to provide drinking water system operators and managers with a user-friendly document that supports Council in its management of a safe drinking water supply. It provides an overview of the system and a summary of all relevant documentation and supporting requirements.

This DWMS and its supporting documentation are living documents. They should be reviewed and updated in line with Council's monitoring and reporting procedures and when new processes or changes are introduced.

2 COMMITMENT

Council is committed to managing its drinking water supply systems to provide a safe, high quality drinking water which consistently meets the ADWG, consumer expectations and regulatory requirements.

Council has a published drinking water policy that can be found on our website at:

https://gunnedah.nsw.gov.au/index.php/council/council-information/council-policies under Policy - Drinking Water Quality Policy.

2.1.1 Regulatory and Formal Requirements

The regulatory and formal requirements relating to drinking water quality in the Gunnedah Shire have been identified and detailed in the table below.

Table 1 Regulatory and Formal Requirements for Supply of Drinking Water

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
Commonwealth Legislation		
Water Act 2007	Provides for the management of the ground and surface water resources of the Murray-Darling Basin, with particular focus on managing extractions to "protect, restore and provide for the ecological values and ecosystem services of the Murray-Darling Basin".	Murray Darling Basin Authority
Competition and Consumer Act 2010	Replaces the Trade Practices Act 1974 and incorporates Schedule 2 - The Australian Consumer Law. As a "seller" of water, the local council is subject to provisions of Consumer transactions and Consumer guarantees, which guarantees that the goods supplied are reasonably fit for purpose.	Australian Competition and Consumer Commission
NSW Legislation		
Catchment Management Authorities Act 2003	Natural resource management, from planning to operations, is to be undertaken at the catchment level. State-wide standards are to be applied. Catchment Action Plans are used to define key themes for each catchment, each with specific catchment and management targets.	Border Rivers - Gwydir Local Land Services (LSS) Natural Resources Commission
Environmental Planning & Assessment Act 1979	Requires that the environmental impacts of projects be studied at all stages on the basis of scale, location and performance. Under Part 3 of the Act, Local Environmental Plans (LEPs) are developed to establish what forms of development and land use are permissible and/or prohibited.	NSW Department of Planning. Industry and Environment (Water)
Local Government Act 1993	Local councils have the responsibility for the provision of water supply to consumers, in accordance with the NSW Regulatory and Assurance Framework for local water utilities (2022).	NSW Government Division of Local Government
NSW Groundwater Quality Protection Policy 1998	Manages groundwater resources for sustainable economic, social and environmental uses, with a specific principle to protect town water supplies against contamination. A key recommendation is to develop wellhead protection plans.	NSW Department of Planning. Industry and Environment (Water)
Protection of the Environment (Operations) Act 1997	Requires licences for activities with potentially significant environmental impacts. Prosecution may be carried out under this act for any chemical leakage, spill, and disposal of wastes or similar.	NSW EPA

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
Public Health Act 2010 *Public Health Regulation 2022*	Requires all water authorities to develop Drinking Water Management Systems. Bestows certain powers on NSW Health with respect to provision of safe drinking water, including ability to enter treatment facilities, order mandatory testing or obtain information about the drinking water and powers to close a water supply. Council is required to issue public advice regarding the water supply when directed by the Chief Health Officer of NSW Health.	NSW Health
Water Management Act 2000	Provides the basis for water planning, the allocation of water resources and water access entitlements. Licences for extraction for the three systems are governed by the provisions of this Act.	NSW Department of Planning. Industry and Environment (Water)
Work, Health & Safety Act 2011	Specifies conditions for storage and handling of chemicals on-site at water treatment plants.	WorkCover Authority of NSW
Guidelines and Programs		
Australian Drinking Water Guidelines 2011 (Updated Sep. 2022)	Ensures the accountability of drinking water managers and operators and health authorities and auditors for the supply of safe, good quality drinking water to consumers.	NSW Health
NSW Regulatory and Assurance Framework for local water utilities,2022	Provides for appropriate, affordable and cost- effective services to meet community needs while protecting public health and the environment and making best use of regional resources. Requires a Strategic Business Plan (SBP), including a Financial Plan and associated asset management plans, reviewed and updated every four years; a 30-year Integrated Water Cycle Management (IWCM) plan. Council has an IWCM, but not yet an SBP for their water business.	NSW Department of Planning. Industry and Environment (Water)
NSW Health Drinking Water Monitoring Program 2005	NSW Health provides analysis of drinking water samples for water utilities, providing an independent analysis of water at point of supply.	NSW Health
NSW Health Response Protocol for management of microbial quality of drinking water	Guides Public Health Units and water utilities in their joint response to rapidly changing source water quality, treatment failure or microbial contamination. https://www.health.nsw.gov.au/environment/water/Pages/nswhrp-microbiological.aspx	NSW Health
NSW Health Response Protocol for management of physical and chemical quality	Guides Public Health Units and water utilities in their joint response following the detection of physical and chemical water characteristics that exceed the Guidelines. Aesthetic and health related guideline values are considered. https://www.health.nsw.gov.au/environment/water/Pages/nswhrp-chemical.aspx	NSW Health
National Partnership Agreement on Water for the Future	The COAG Strategy on Water and Wastewater Services in Remote Communities in New South Wales aims to provide water infrastructure and build the capacity of the Council to improve the management and overall security of water in remote communities.	Australian Government NSW Department of Planning. Industry and Environment (Water)
Plumbing Code of Australia	Specifications for plumbing in drinking water systems, to be complied with by administrators, plumbing Licensees, developers and property owners/occupiers.	Office of Fair Trading
Water Sharing Plan for the Great Artesian Basin (2020)	Governs the licensing of groundwater extraction in the Great Artesian Basin	NSW Department of Planning. Industry and Environment (Water)

2.1.2 Engaging Stakeholders

Stakeholders involved in the provision of a safe reliable drinking water supply have been identified and are listed in Table 2. NSW Health Water Unit, Local Public Health Unit and NSW DPE (Water) participated in the development of this DWMS.

Table 2 Key stakeholders

Organisation	Name	Role	Contact
Gunnedah Shire Council	Michael Ludlow	Manager Water Services	michaelludlow@infogunnedah.com.au 0427 837 868
	Keshan Dharmasena	Water Services Engineer	keshandharmasena@infogunnedah.com.au 0467 421 850
	Brendon Lemon	Water Services Coordinator	brendonlemon@infogunnedah.com.au 0427 936 717
Chemical Supply	Ixom	Chlorine Gas Supply	zarif.yazid@ixom.com 0456 948 172
Bore contractors	ACS Equip	Bore Cleaning	lukewoods@acsequip.com 1300 859 010
Electrical	Thomson Electrical	Switchboard Maintenance	adam@thomsonelectrical.net 0412 633 338
Aqualift	Aqualift Project Delivery Pty Ltd	Reservoir Inspections and Cleaning	brett@aqualift.com.au 0428 682 347
NSW Department of Planning, Industry and Environment (Water)	Trent Betts	Regional Inspector	trent.betts@dpie.nsw.gov.au 0417 458 247
NSW Health Hunter New England Local Health District	Fidelis Jaravani Environmental Health	Environmental Health Officer	HNELHD-PHEnvironmentalHealth@health.nsw.gov.au> 0249246477
Environmental Protection Agency		Environmental Issues	131 555

3 DRINKING WATER SUPPLY SYSTEMS

3.1 Overview

Gunnedah Shire Council operates three drinking water supply systems in Gunnedah, Mullaley and Tambar Springs. All schemes use bore water as the raw water supply, and all schemes are chlorinated. There was previously a separate drinking water scheme in Curlewis, however, there is now a pipeline from Gunnedah, and Curlewis is now considered as part of the Gunnedah scheme.

A summary of these drinking water systems is detailed below.

Table 3 Overview of Gunnedah Shire Water Supply Systems

Scheme	# bores	Disinfection	Fluoridation	Reservoirs	Tot. Res volume	Connections
Gunnedah WTP	9	Cl_2 (gas)	Yes		2x 1ML	
Gunnedah Retic	-			Links 1 and 2 Apex 1 and 2 Gallens South St	2.3 & 9.1 ML 1.0 & 4.0 ML 2.0 ML 3.1 ML	4725
Curlewis Retic	-	Cl_2 (gas)		Curlewis 1 and 2	2x 0.5 ML	297
Mullaley	2	NaOCl	No	Mullaley Tank	186 kL	56
Tambar Springs	2	NaOCl	No	High St Quarry St	3x 50 kL 20 kL	92

3.2 Water Allocations

Water access licences have been issued for the Gunnedah, Tambar Springs and Mullaley schemes under the Water Management Act 2000. These are saved on file under Legal Doc - Property - Certificate of Title - Water Access License Certificate – WAL, but are also available on https://waterregister.waternsw.com.au/water-register-frame

Curlewis:

Upper Namoi Zone 3, Mooki Valley (Breeza To Gunnedah) Groundwater Source

- WAL 12543 - 198 ML/annum

Gunnedah:

Upper Namoi Zone 4, Namoi Valley (Keepit Dam To Gin'S Leap) Groundwater Source

- WAL 12605 - 3900 ML/annum

Tambar Springs:

Upper Namoi Zone 9, Cox'S Creek (Up-Stream Mullaley) Groundwater Source

- WAL 12958 - 42 ML/annum

Mullaley:

Upper Namoi Zone 2, Cox'S Creek (Mullaley To Boggabri) Groundwater Source

- WAL 12513 - 59 ML/annum

Individual bore details can be accessed from the Water NSW website https://realtimedata.waternsw.com.au/ by selecting the "All Groundwater Map" and selecting individual bores where the location is known. Relevant specifications for the GSC bores are summarised in Table 4.

3.3 Gunnedah Drinking Water Supply System Analysis

The Gunnedah drinking water scheme consists of 9 bores (see Table 4) that feed into the Gunnedah Water Treatment Plant (WTP). At the central WTP the bore water is chlorinated and fluoridated prior to the entry to the reticulation network. Chlorination, with chlorine gas, of the moderately protected bore water ensures effective disinfection through inactivation of bacteria and viruses (if present). Fluoride addition is undertaken to provide dental health benefits associated with drinking fluoridated water. From the WTP water is pumped to a series of reservoirs in Gunnedah and two in Curlewis. There is a chlorine booster station using chlorine gas at the Curlewis reservoirs providing a top-up dose as required. A schematic representation of the Gunnedah Scheme with the configuration of reservoirs is presented overleaf.

All bores are controlled by telemetry to ensure Reservoir volumes are maintained.

Bores 1 and 2 are decommissioned and they will be capped off in January 2024. Both bores are not operational.

Table 4 Gunnedah Bore Specifications

Bore Name	Bore Depth (m)	Established Static Water level from top of casing	Established Draw Down level from top of casing	Flow Rate (l/s)	Casing Diameter (mm)	Casing type
Bore 3	39.29	10.2	15.9	14.5	312	PVC
Bore 4	31	11.21	16.1	15.3	276	Steel with S/S sleeve
Bore 5	40	14.5	21.1	26.1	250	PVC
Bore 6	41.5	11.29	21.8	45.8	355	Steel
Bore 7	77	11.3	15.4	35	300	PVC
Bore 8	131.5	15.8	21.5	135	461	Stainless Steel
Bore 9	132	16	34.4	100	457	Steel with S/S sleeve
Bore 10	under construction					
Bore 11	21.5	10.2	13.9	17.5	324	PVC

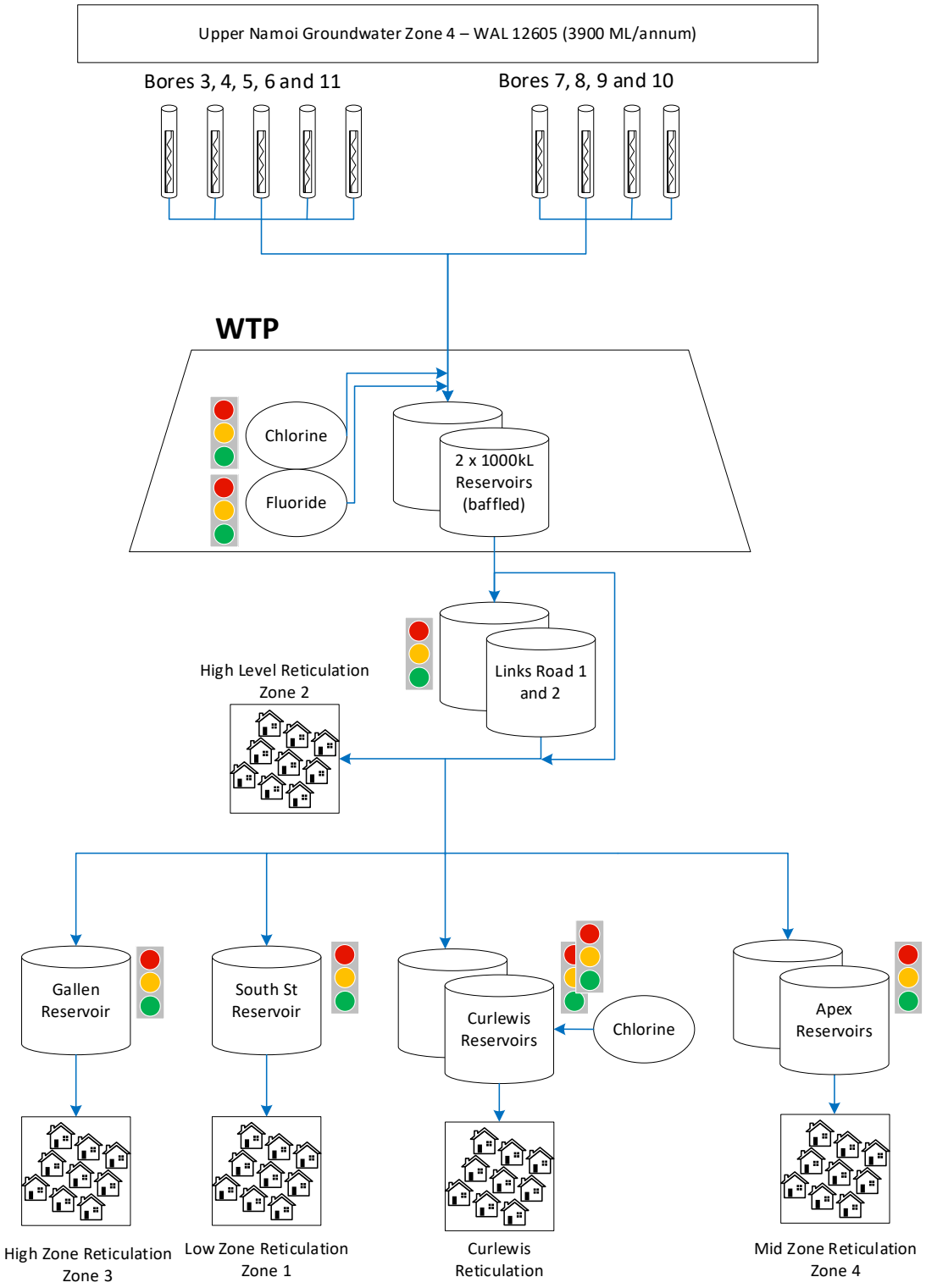

Figure 1 Gunnedah Treatment Plant Schematic

3.3.1 Gunnedah Water Quality

3.3.1.1 Raw water quality

There is minimal raw water data for the individual quality of the bores.

3.3.1.2 Treated water quality

The following graphs represent the typical chlorine, pH and turbidity for drinking water entering the reticulation network. There is also data for the reticulation sites, and these have very similar chemistry (not shown). Figure 2 shows that the average chlorine remains above the circular LWU 18 reticulation lower limit of 0.2 mg/L at all reticulation monitoring sites. pH is consistently less than 7.5 with very few results greater than this, indicating that chlorine will be highly effective. From March 2023 the new WTP was commissioned which saw a decrease of variation in free chlorine. The control point going forward is at the WTP post the treated water reservoirs with the limits provided in the CCP. For the purposes of this DWMS, the data gathered at the Entry Point is assumed to be reflective of the water quality at the new CCP monitoring location(s). In future versions of this DWMS, the data will be updated with sample results taken from the new monitoring location(s). More operational data can be found in the relevant annual reports and collided in the risk briefing document in Appendix B.

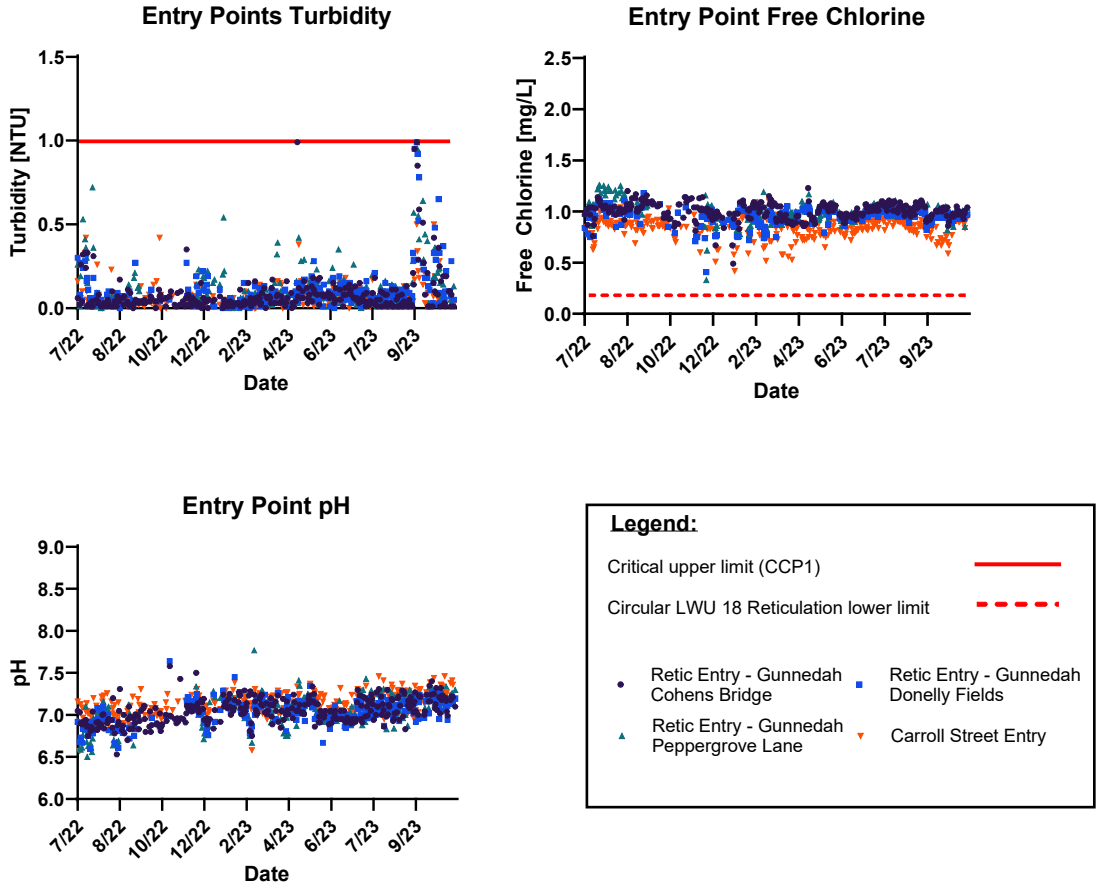

Figure 2 Water Quality entering Gunnedah Reticulation

3.3.1.2.1 Treated water quality – NSW Health water quality monitoring data.

The NSW Health water quality database was queried from 2018-2023. As can be seen in the table below, there are no ADWG (Health) exceedances of chemical parameters. There were 2 findings of total coliforms. Water hardness is occasionally above the ADWG aesthetic guideline value, however that is due to the nature of the groundwater. There are no issues of health concern identified.

Table 5 Gunnedah Verification Monitoring Data 2016-2020

Analysis Type	Characteristic	Guideline Value	Units	Mean	Median	Standard Deviation	Min	Max	Sample Count	Exception Count	95th Percentile	5th Percentile	% meeting guideline values
Chemistry	Aluminium	0.20	mg/L	0.0072	0.0050	0.0120	0.005	0.1	67	0	0.01	0.005	100.00
	Antimony	0.00	mg/L	0.0002	0.0001	0.0002	0.00005	0.0005	67	0	0.0005	0.00005	100.00
	Arsenic	0.01	mg/L	0.0010	0.0010	0.0011	0.0005	0.009	67	0	0.001	0.0005	100.00
	Barium	2.00	mg/L	0.0206	0.0200	0.0043	0.014	0.033	67	0	0.029	0.015	100.00
	Boron	4.00	mg/L	0.0332	0.0268	0.0122	0.0158	0.05	67	0	0.05	0.021	100.00
	Cadmium	0.00	mg/L	0.0001	0.0001	0.0001	0.00005	0.00025	67	0	0.00025	0.00005	100.00
	Calcium	10000.00	mg/L	39.9507	39.3000	4.1574	33.4	56.6	67	0	47	35.8	100.00
	Chloride	250.00	mg/L	34.6119	33.0000	8.4279	21	69	67	0	49	26	100.00
	Chromium	0.05	mg/L	0.0013	0.0010	0.0009	0.0005	0.0025	67	0	0.0025	0.0005	100.00
	Copper	2.00	mg/L	0.0272	0.0270	0.0122	0.0025	0.054	67	0	0.049	0.008	100.00
	Fluoride	1.50	mg/L	0.1272	0.1300	0.0199	0.05	0.19	67	0	0.15	0.1	100.00
	Iodine	0.50	mg/L	0.0113	0.0100	0.0039	0.01	0.03	67	0	0.02	0.01	100.00
	Iron	0.30	mg/L	0.0078	0.0050	0.0108	0.005	0.09	67	0	0.02	0.005	100.00
	Lead	0.01	mg/L	0.0007	0.0005	0.0008	0.0001	0.0066	67	0	0.001	0.0001	100.00
	Magnesium	10000.00	mg/L	19.8076	19.0300	2.6874	16.47	30.8	67	0	23.61	16.98	100.00
	Manganese	0.50	mg/L	0.0010	0.0003	0.0012	0.00015	0.005	67	0	0.0025	0.00015	100.00
	Mercury	0.00	mg/L	0.0003	0.0004	0.0002	0.00005	0.0004	67	0	0.0004	0.00005	100.00
	Molybdenum	0.05	mg/L	0.0010	0.0003	0.0011	0.00005	0.0025	67	0	0.0025	0.0002	100.00
	Nickel	0.02	mg/L	0.0023	0.0008	0.0030	0.0002	0.02	67	0	0.005	0.0002	100.00
	Nitrate	50.00	mg/L	5.6343	6.0000	2.1401	0.5	11	67	0	9	2	100.00
	Nitrite	3.00	mg/L	0.0500	0.0500	0.0000	0.05	0.05	67	0	0.05	0.05	100.00
	pH	6.5 - 8.5		7.2642	7.2000	0.2254	6.8	7.9	67	0	7.8	7	100.00
	Selenium	0.01	mg/L	0.0027	0.0035	0.0012	0.001	0.0035	67	0	0.0035	0.001	100.00
	Silver	0.10	mg/L	0.0004	0.0001	0.0004	0.0001	0.001	67	0	0.001	0.0001	100.00
	Sodium	180.00	mg/L	28.0448	27.0000	4.1026	23	46	67	0	35	24	100.00
	Sulfate	250.00	mg/L	35.8955	36.0000	6.5137	6	56	67	0	45	29	100.00
	Total Dissolved Solids	10000.00	mg/L	220.7612	219.0000	31.2929	145	361	67	0	246	179	100.00
	Total Hardness	200.00	mg/L	181.3224	176.8000	21.0620	153.8	268.2	67	9	212.8	157.8	86.57
	True Colour	15.00	HU	0.6940	0.5000	0.6906	0.5	6	67	0	1	0.5	100.00
	Turbidity	5.00	NTU	0.3925	0.1000	0.5209	0.05	2.4	67	0	1.5	0.05	100.00
	Uranium	0.02	mg/L	0.0009	0.0002	0.0011	0.00005	0.0025	67	0	0.0025	0.0001	100.00
	Zinc	3.00	mg/L	0.0447	0.0200	0.0466	0.005	0.18	67	0	0.16	0.01	100.00
Microbiology	*E. coli*	0.00	mpn/100mL	0.0000	0.0000	0.0000	0	0	430	0	0	0	100.00
	Free Chlorine	0.2 - 5	mg/L	0.8590	0.9300	0.2071	0.22	1.38	433	0	1.13	0.47	100.00
	pH	6.5 - 8.5		7.1673	7.1300	0.3959	0.77	8.2	432	1	7.7	6.83	99.77
	Temperature	30.00	C	21.5446	21.7500	3.8314	13.5	30	370	0	27.6	15.6	100.00
	Total Chlorine	5.00	mg/L	1.1041	1.0000	3.5657	0.24	75	433	1	1.23	0.54	99.77
	Total Coliforms	0.00	mpn/100mL	0.0047	0.0000	0.0681	0	1	430	2	0	0	99.53
	Turbidity	5.00	NTU	0.2209	0.0900	1.3522	0	27.9	433	1	0.6	0	99.77

3.4 Mullaley Drinking Water Supply System Analysis

The Mullaley drinking water system consists of 2 bores that are chlorinated with sodium hypochlorite and pumped into town and to the Mullaley Tank. The scheme services a population of about 100 people, with 47 connections. There are approximately 1.57 km of 100mm trunk main, and 2.28 km of 100mm reticulation mains.

There is a connection to the Mullaley Campdraft prior to the reservoir, however it was determined that as the water supply was only used infrequently that water to this customer is supplied as non-potable as there is insufficient contact time to always ensure the safety of the supply at this location.

The schematic is included below.

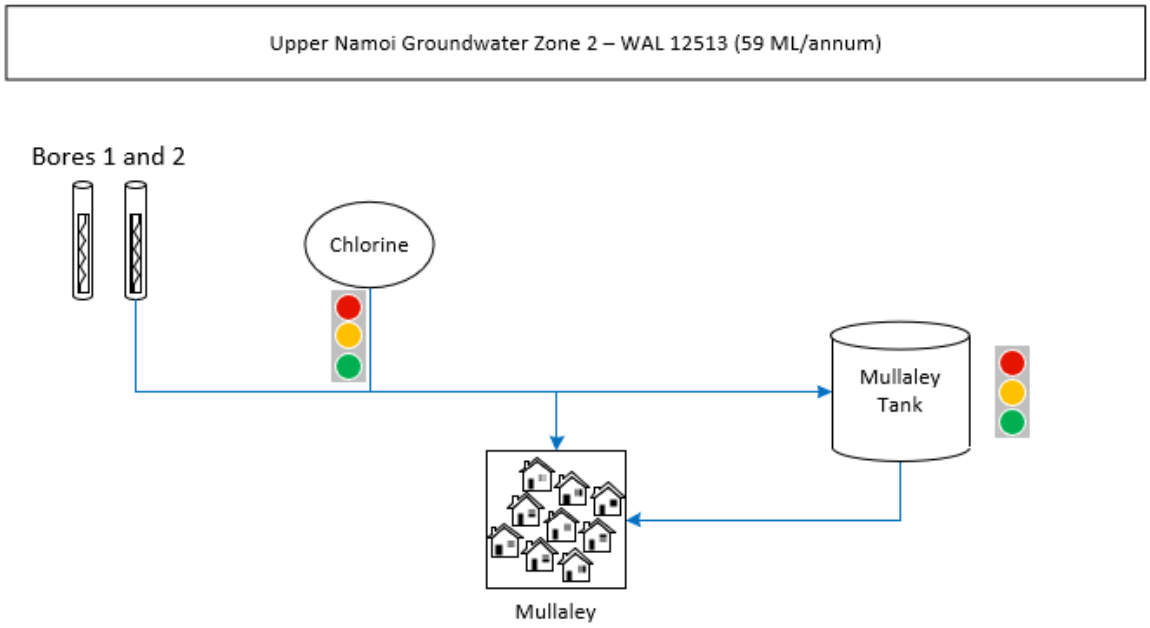

Figure 3 Mullaley Schematic

3.4.1 Mullaley water quality

As with Gunnedah, there is limited raw water quality data from the bores. However, treated water quality is monitored and the following section demonstrates typical performance.

3.4.1.1 Treated Water Quality

Treated water is monitored for chlorine, pH and turbidity. The pH is typically between 7.5 and 8, with little variation, and the chlorine residual maintained in the system varies seasonally and with temperature. At times free chlorine can be low, but hasn't breached the circular LWU 18 reticulation lower limit of 0.2 mg/L in the recent years. There are periodic episodes where turbidity is > 1 NTU (only once between Jul 22-Nov 23) but these are more likely to result from issues within the reticulation network and are not considered to represent a change in bore water quality. More operational data can be found in the relevant annual reports and collided in the risk briefing document in Appendix B.

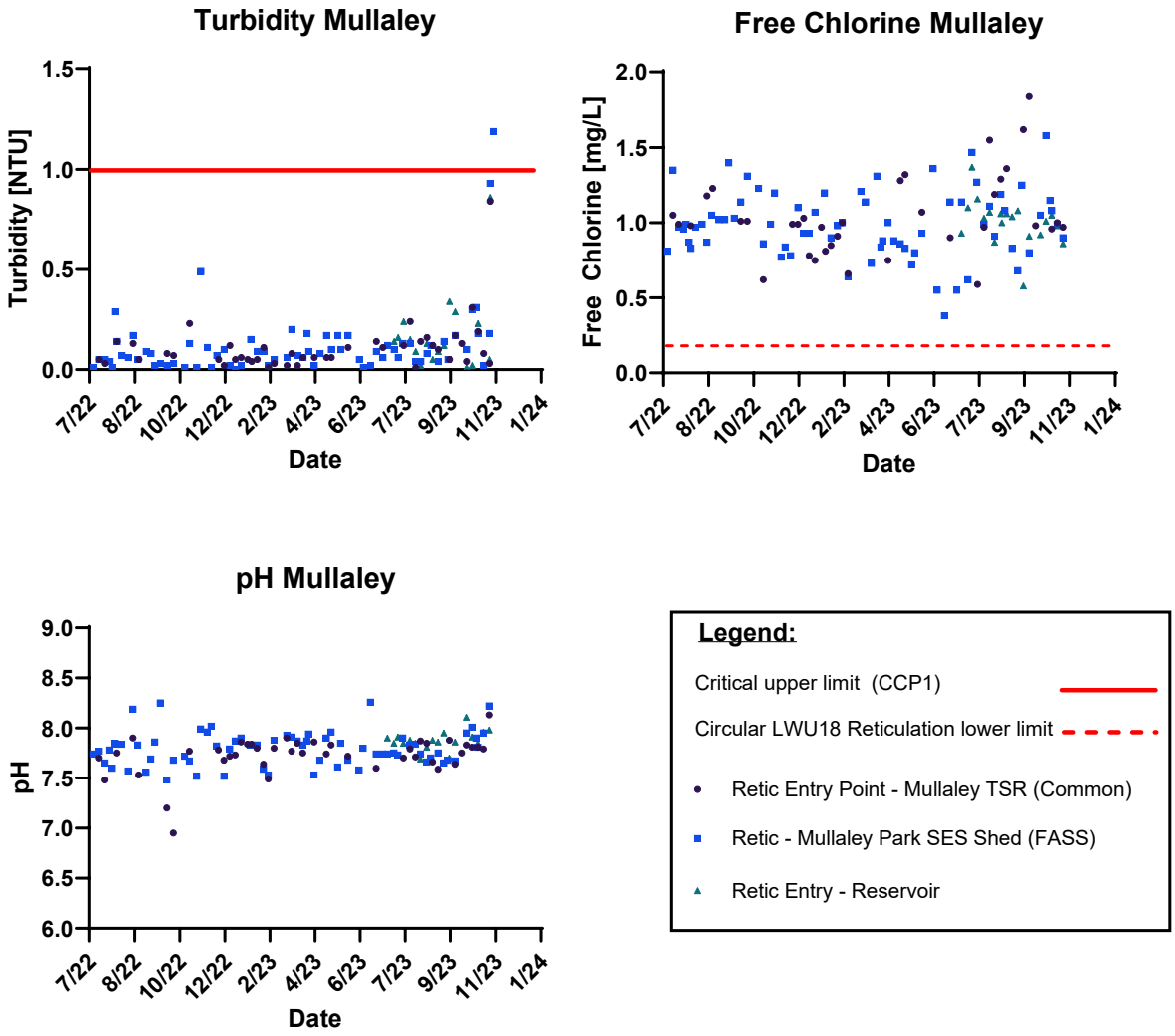

Figure 4 Mullaley treated water quality

3.4.1.1.1 Treated water quality – NSW Health water quality monitoring data.

The NSW Health water quality database was queried from 2018-2023. As can be seen in the table below, there are no ADWG (Health) exceedances of chemical parameters.

There have been no *E. coli* detections in this dataset. Turbidity has reached 1, but is not a general occurrence anymore.

Temperature is similar to Gunnedah, but due to the smaller reticulation network water hasn't reached 30°C in the last 5 years. Chlorine is sometimes below the lower alert level in the extremities of the reticulation network.

Verification data for Mullaley indicates that the hardness of the water is usually above the aesthetic guideline value, however that is due to the nature of the groundwater. There are no issues of health concern identified.

Table 6 Mullaley Verification Monitoring Data 2018-2023

Analysis Type	Characteristic	Guideline Value	Units	Mean	Median	Standard Deviation	Min	Max	Sample Count	Exception Count	95th Percentile	5th Percentile	% meeting guideline values
Chemistry	Aluminium	0.200	mg/L	0.0050	0.0050	0.0000	0.005	0.005	13	0	0.005	0.005	100.00
	Antimony	0.003	mg/L	0.0002	0.0001	0.0002	0.00005	0.0005	13	0	0.0005	0.00005	100.00
	Arsenic	0.010	mg/L	0.0009	0.0010	0.0002	0.0005	0.001	13	0	0.001	0.0005	100.00
	Barium	2.000	mg/L	0.0778	0.0770	0.0094	0.0653	0.0996	13	0	0.0996	0.0653	100.00
	Boron	4.000	mg/L	0.0347	0.0288	0.0109	0.0234	0.05	13	0	0.05	0.0234	100.00
	Cadmium	0.002	mg/L	0.0001	0.0001	0.0001	0.00005	0.00025	13	0	0.00025	0.00005	100.00
	Calcium	10000	mg/L	39.7385	39.0000	5.9177	34.2	57.8	13	0	57.8	34.2	100.00
	Chloride	250.000	mg/L	101.9231	98.0000	9.1147	92	126	13	0	126	92	100.00
	Chromium	0.050	mg/L	0.0028	0.0025	0.0015	0.001	0.006	13	0	0.006	0.001	100.00
	Copper	2.000	mg/L	0.0338	0.0320	0.0185	0.008	0.07	13	0	0.07	0.008	100.00
	Fluoride	1.500	mg/L	0.0992	0.1100	0.0233	0.05	0.13	13	0	0.13	0.05	100.00
	Iodine	0.500	mg/L	0.0362	0.0400	0.0104	0.01	0.05	13	0	0.05	0.01	100.00
	Iron	0.300	mg/L	0.0065	0.0050	0.0043	0.005	0.02	13	0	0.02	0.005	100.00
	Lead	0.010	mg/L	0.0008	0.0007	0.0003	0.0004	0.0013	13	0	0.0013	0.0004	100.00
	Magnesium	10000	mg/L	44.6031	44.6700	2.7939	37.81	49.17	13	0	49.17	37.81	100.00
	Manganese	0.500	mg/L	0.0009	0.0002	0.0011	0.00015	0.0025	13	0	0.0025	0.00015	100.00
	Mercury	0.001	mg/L	0.0003	0.0004	0.0002	0.00005	0.0004	13	0	0.0004	0.00005	100.00
	Molybdenum	0.050	mg/L	0.0013	0.0009	0.0008	0.0005	0.0025	13	0	0.0025	0.0005	100.00
	Nickel	0.020	mg/L	0.0026	0.0020	0.0020	0.0002	0.005	13	0	0.005	0.0002	100.00
	Nitrate	50.000	mg/L	4.0769	4.0000	0.2774	4	5	13	0	5	4	100.00
	Nitrite	3.000	mg/L	0.0500	0.0500	0.0000	0.05	0.05	13	0	0.05	0.05	100.00
	pH	6.5 - 8.5		8.0231	8.0000	0.1423	7.8	8.3	13	0	8.3	7.8	100.00
	Selenium	0.010	mg/L	0.0027	0.0035	0.0012	0.001	0.0035	13	0	0.0035	0.001	100.00
	Silver	0.100	mg/L	0.0004	0.0001	0.0004	0.0001	0.001	13	0	0.001	0.0001	100.00
	Sodium	180.000	mg/L	133.3077	137.0000	20.9340	79	155	13	0	155	79	100.00
	Sulfate	250.000	mg/L	8.8462	9.0000	0.8987	8	10	13	0	10	8	100.00
	Total Dissolved Solids (TDS)	10000	mg/L	533.2308	547.0000	62.7019	350	600	13	0	600	350	100.00
	Total Hardness as CaCO3	200.000	mg/L	282.9077	284.8000	21.6166	241.1	328.3	13	13	328.3	241.1	0.00
	True Colour	15.000	HU	0.8077	0.5000	0.4349	0.5	2	13	0	2	0.5	100.00
	Turbidity	5.000	NTU	0.4692	0.3000	0.5611	0.05	1.7	13	0	1.7	0.05	100.00
	Uranium	0.017	mg/L	0.0019	0.0017	0.0005	0.001	0.0025	13	0	0.0025	0.001	100.00
	Zinc	3.000	mg/L	0.0427	0.0200	0.0400	0.005	0.13	13	0	0.13	0.005	100.00
Microbiology	E. coli	0.000	mpn/100 mL	0.0000	0.0000	0.0000	0	0	70	0	0	0	100.00
	Free Chlorine	0.2 - 5	mg/L	0.8706	0.9100	0.2403	0.33	1.27	71	0	1.21	0.43	100.00
	pH	6.5 - 8.5		7.8713	7.8500	0.2304	6.9	8.5	71	0	8.3	7.6	100.00
	Temperature	30.000	C	21.9356	22.7000	4.3397	14.6	29	59	0	28.3	15.6	100.00
	Total Chlorine	5.000	mg/L	0.9600	0.9800	0.2524	0.38	1.42	71	0	1.3	0.48	100.00
	Total Coliforms	0.000	mpn/100 mL	0.0000	0.0000	0.0000	0	0	70	0	0	0	100.00
	Turbidity	5.000	NTU	0.1756	0.1400	0.1646	0	1.05	71	0	0.49	0.01	100.00

3.5 Tambar Springs Drinking Water Supply System Analysis

The Tambar Springs scheme is similar to Mullaley in that there are 2 bores that are chlorinated and pumped to the reservoirs, however as opposed to Mullaley there is a separate rising and reticulation main from the bore field.

There are 3 high level reservoirs, but currently only one reservoir is being used while new reservoirs are being built. The currently used reservoir is mixed with a recirculation pump. The new reservoirs will be 2 x 77kL and operated in series to increase water turnover.

The scheme provides drinking water for approximately 100 customers with 72 connections. There are 5.62 km of 100 mm trunk mains, and 5.86km of 40-100 mm reticulation mains.

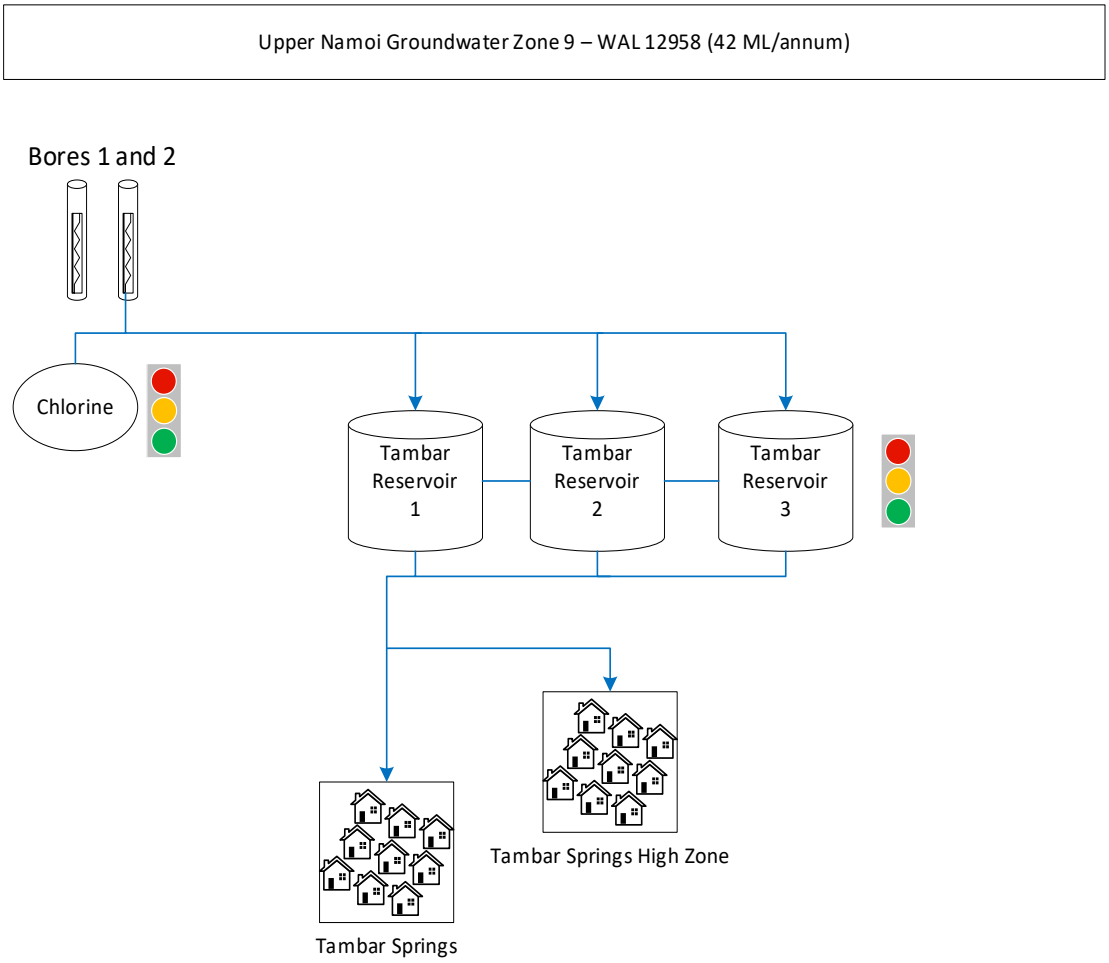

Figure 5 Tambar Springs Treatment Schematic

3.5.1 Tambar Springs Water Quality

As with Gunnedah, there is limited raw water quality data from the bores. However, treated water quality is monitored and the following section demonstrates typical performance.

3.5.1.1 Treated Water Quality

Treated water is monitored for chlorine, pH and turbidity. The pH is typically around 7.5, with little variation up to 8. A chlorine residual is maintained throughout the system, but varies seasonally with temperature. At times free chlorine is low, but hasn't breached the circular LWU 18 reticulation lower limit of 0.2 mg/L. There are periodic episodes where turbidity is > 1 NTU but these are more likely to result from issues within the reticulation network and are not considered to represent a change in bore water quality. More operational data can be found in the relevant annual reports and collided in the risk briefing document in Appendix B.

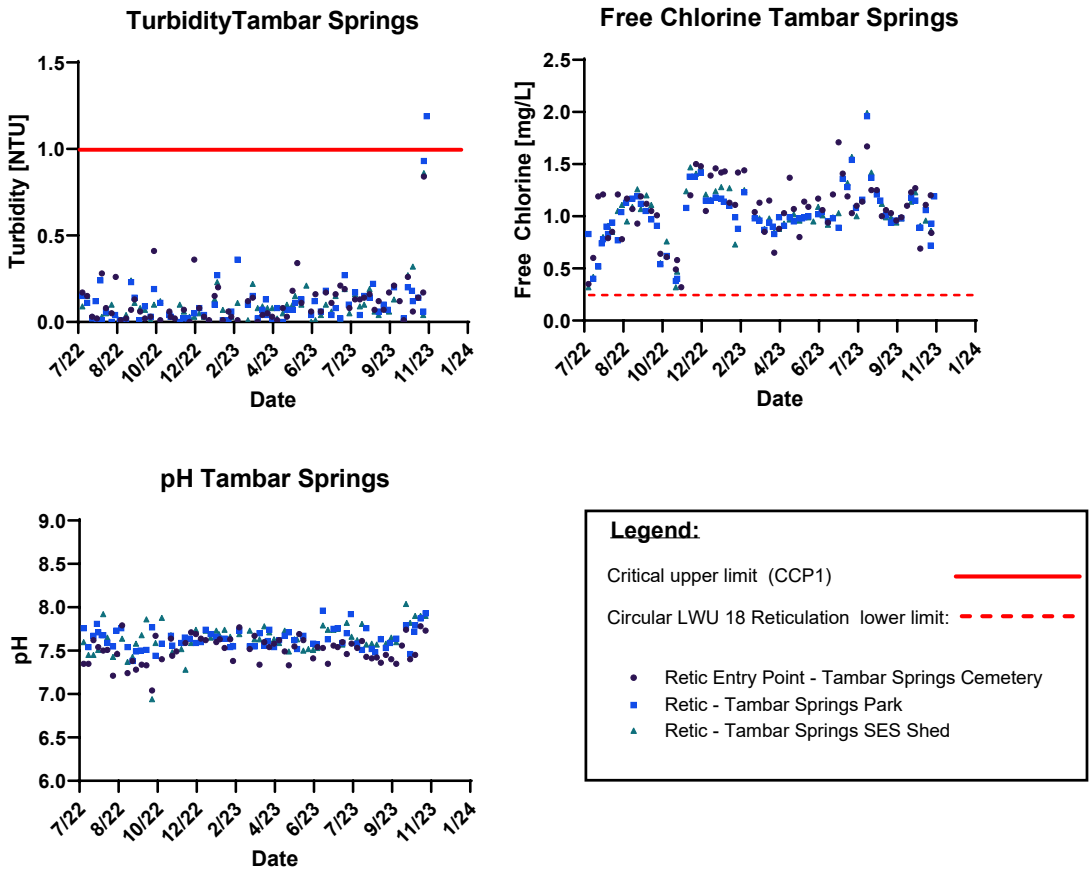

Figure 6 Tambar Springs Water Quality

3.5.1.1.1 Treated water quality – NSW Health water quality monitoring data.

Verification monitoring data is generally good, with only 1 *E. coli* detection in the 5-year time period selected (2018-2023). There were 4 detections of coliforms. Free chlorine was within the limits for the last 5 years. All other parameters other than hardness are within health and aesthetic guideline values.

The NSW Health chemistry data for Tambar Springs indicates that the hardness of the water is usually above the aesthetic guideline value, however that is due to the nature of the groundwater. There are no issues of health concern identified within the chemistry data.

Table 7 Tambar Springs Verification Monitoring Data 2016-2020

Analysis Type	Characteristic	Guideline Value	Units	Mean	Median	Standard Deviation	Min	Max	Sample Count	Exception Count	95th Percentile	5th Percentile	% meeting guideline values
Chemistry	Aluminium	0.200	mg/L	0.0054	0.0050	0.0014	0.005	0.01	13	0	0.01	0.005	100.00
	Antimony	0.003	mg/L	0.0002	0.0001	0.0002	0.00005	0.0005	13	0	0.0005	0.00005	100.00
	Arsenic	0.010	mg/L	0.0008	0.0010	0.0003	0.0005	0.001	13	0	0.001	0.0005	100.00
	Barium	2.000	mg/L	0.1024	0.1020	0.0124	0.0735	0.123	13	0	0.123	0.0735	100.00
	Boron	4.000	mg/L	0.0298	0.0223	0.0147	0.014	0.05	13	0	0.05	0.014	100.00
	Cadmium	0.002	mg/L	0.0001	0.0001	0.0001	0.00005	0.00025	13	0	0.00025	0.00005	100.00
	Calcium	10000	mg/L	52.4846	54.4000	4.4702	41.6	58.7	13	0	58.7	41.6	100.00
	Chloride	250.000	mg/L	62.3077	62.0000	2.5293	59	66	13	0	66	59	100.00
	Chromium	0.050	mg/L	0.0014	0.0010	0.0010	0.0005	0.003	13	0	0.003	0.0005	100.00
	Copper	2.000	mg/L	0.0463	0.0380	0.0281	0.0025	0.094	13	0	0.094	0.0025	100.00
	Fluoride	1.500	mg/L	0.1169	0.1200	0.0118	0.1	0.14	13	0	0.14	0.1	100.00
	Iodine	0.500	mg/L	0.0400	0.0400	0.0071	0.02	0.05	13	0	0.05	0.02	100.00
	Iron	0.300	mg/L	0.0096	0.0050	0.0063	0.005	0.02	13	0	0.02	0.005	100.00
	Lead	0.010	mg/L	0.0008	0.0009	0.0002	0.0005	0.0011	13	0	0.0011	0.0005	100.00
	Magnesium	10000	mg/L	39.0262	39.0200	3.0575	35.01	46.02	13	0	46.02	35.01	100.00
	Manganese	0.500	mg/L	0.0012	0.0004	0.0015	0.00015	0.005	13	0	0.005	0.00015	100.00
	Mercury	0.001	mg/L	0.0003	0.0004	0.0002	0.00005	0.0004	13	0	0.0004	0.00005	100.00
	Molybdenum	0.050	mg/L	0.0011	0.0005	0.0010	0.0004	0.0025	13	0	0.0025	0.0004	100.00
	Nickel	0.020	mg/L	0.0019	0.0006	0.0022	0.0002	0.005	13	0	0.005	0.0002	100.00
	Nitrate	50.000	mg/L	0.5000	0.5000	0.0000	0.5	0.5	13	0	0.5	0.5	100.00
	Nitrite	3.000	mg/L	0.0500	0.0500	0.0000	0.05	0.05	13	0	0.05	0.05	100.00
	pH	6.5 - 8.5		7.8615	7.8000	0.1609	7.6	8.2	13	0	8.2	7.6	100.00
	Selenium	0.010	mg/L	0.0027	0.0035	0.0012	0.001	0.0035	13	0	0.0035	0.001	100.00
	Silver	0.100	mg/L	0.0004	0.0001	0.0004	0.0001	0.001	13	0	0.001	0.0001	100.00
	Sodium	180.000	mg/L	77.6923	75.0000	19.3666	58	139	13	0	139	58	100.00
	Sulfate	250.000	mg/L	7.5385	7.0000	0.6602	7	9	13	0	9	7	100.00
	Total Dissolved Solids	10000	mg/L	407.5385	423.0000	46.1801	268	450	13	0	450	268	100.00
	Total Hardness (CaCO3)	200.000	mg/L	291.7615	294.9000	15.8273	264.5	311.7	13	13	311.7	264.5	0.00
	True Colour	15.000	HU	0.6538	0.5000	0.2402	0.5	1	13	0	1	0.5	100.00
	Turbidity	5.000	NTU	0.5885	0.3000	0.7009	0.05	2.4	13	0	2.4	0.05	100.00
	Uranium	0.017	mg/L	0.0016	0.0012	0.0007	0.001	0.0025	13	0	0.0025	0.001	100.00
	Zinc	3.000	mg/L	0.0715	0.0400	0.0641	0.01	0.22	13	0	0.22	0.01	100.00
Microbiology	E. coli	0.000	mpn/100 mL	1.2361	0.0000	10.4888	0	89	72	1	0	0	98.61
	Free Chlorine	0.2 - 5	mg/L	0.8970	0.8800	0.2599	0.33	1.61	73	0	1.38	0.54	100.00
	pH	6.5 - 8.5		7.6862	7.7000	0.1921	7	8	73	0	8	7.4	100.00
	Temperature	30.000	C	19.4383	20.0000	4.6164	11.8	28	60	0	26.4	12.9	100.00
	Total Chlorine	5.000	mg/L	0.9784	0.9500	0.2453	0.41	1.75	73	0	1.42	0.63	100.00
	Total Coliforms	0.000	mpn/100 mL	5.7500	0.0000	33.2607	0	202	72	4	1	0	94.44
	Turbidity	5.000	NTU	0.1551	0.1100	0.1986	0	1.04	73	0	0.44	0.01	100.00

4 RISK MANAGEMENT AND CONTROLS

4.1 Risk Assessment

The Australian Drinking Water Guidelines is a risk-based framework to assess the risks to the drinking water supply, identify and implement robust mitigations, and where risks are not acceptable, identify improvements that are required for the schemes. For the 2020 DWMS, a risk workshop was conducted in Gunnedah to assess the risks to each of the drinking water schemes. The risk assessment was reviewed in another workshop held in November 2023. The assessment team and methodology are described below.

4.1.1 Risk Assessment Team

Table 8 identifies the people present at the risk assessment in November 2023.

Table 8 Risk Team members -2023

Attendee	Organisation	Position
Michael Ludlow	Gunnedah Shire Council	Manager Water Services
Brendon Lemon	Gunnedah Shire Council	Coordinator Water Services
Keshan Dharmasena	Gunnedah Shire Council	Water Services Engineer
Trent Betts	DPE	Water and Sewerage Inspector
Adam Turville	DPE	Senior Project Officer, Water Utilities North
Fidelis Jaravani	HNE PHU, NSW Health	Environmental Health Officer
Joshua Frank	Bligh Tanner	Facilitator

4.2 Risk Methodology

For the 2023 risk assessments Council used the following risk methodology, which is an adaption of the ADWG risk framework, but uses a matrix published by the Queensland Department of Energy and Water Supply as it is more intuitive to operators and tends to provide more consistent results between updates of the risk assessment.

The consequence descriptors use terminology such as “acute” which includes all pathogens, and “chronic”, which generally are the chemical health parameters where negative health outcomes would only be expected after a lifetime of exposure.

Similarly, the likelihood timeframes are altered, with more explicit quantifying statements to put the number of expected occurrences into perspective.

Lastly, the actual risks are altered in the matrix to ensure that a catastrophic consequence can be reduced to a medium “acceptable” risk if the likelihood can be reduced to rare. The choice of this matrix reduces the variability between reviews and eliminates the need to consider risks ‘as low as possible” or the need to alter consequences of a hazard to achieve an acceptable risk.

The methodology is described below.

- Review the schematics and water quality data
- Identify the hazards
- Determine the unmitigated risks
- Identify the preventive measures
- Determine the mitigated risks
- Identify the procedures used to ensure the preventive measures are effective
- Where mitigated risks are unacceptable, identify risk management improvements

4.2.1 Hazard identification

The hazards identified in the previous risk assessment, and any additional relevant hazards, were identified.

The type of hazards that were assessed include biological, chemical, physical, and radiological, followed by identifying the sources for each of the hazards within the specific catchments.

4.2.2 Unmitigated risk assessment

Unmitigated risk is determined by considering the consequence and likelihood of a hazard in the absence of any other controls.

Consequence is the impact that the hazard would have if it were to occur.

Likelihood is an assessment of the frequency at which the hazardous event is likely to occur, resulting in the potential consequence.

The consequence and likelihood descriptors are included overleaf.

Once the consequence and likelihood are determined, the risk is read from the risk matrix.

For example, for most hazards, the unmitigated risk represents the risk of drinking raw water with no treatment. For chemicals that are added in the water treatment process (e.g., chlorine) the unmitigated risk assumes that chlorine has been added, but without any monitoring or control of the dose rate.

Comments that place the unmitigated risks in context are included in the table.

4.2.3 Mitigated risk assessment

The mitigated risk assessment is undertaken by considering the hazardous events that could lead to the hazard being present. The unmitigated risk is brought forward from the unmitigated risk assessment, and the barriers that prevent or minimise the risk of that hazard are identified.

Barriers include the current treatment barriers (disinfection etc.), but also include any actions that may minimise the hazard in the catchment (e.g., ensuring reservoir integrity). The effectiveness of these measures is then considered in the context of any recent incidents, and with water quality data where available.

This allows an assessment of the mitigated risk by again assessing the consequence (which normally will not change – i.e., bacteria make you sick if they are present), and the new likelihood. An uncertainty rating is included in the mitigated risk assessment.

Table 9 Risk Matrix including consequence and likelihood descriptors.

Public Health Risk Matrix / Likelihood		Insignificant	Minor	Moderate	Major	Catastrophic
	Consequence	Isolated aesthetic exceedance – little operational disruption	Local aesthetic exceedance, potential isolated breach of chemical health parameter	Widespread aesthetic exceedances, or repeated breaches of chronic health guidelines	Potential acute health impact, no outbreak expected	Potential acute health impact, declared outbreak likely
Almost Certain	Occurs daily to weekly	Medium	High	High	Extreme	Extreme
Likely	1-4 occurrences per month	Medium	Medium	High	High	Extreme
Possible	1-11 occurrences per year	Low	Medium	Medium	High	High
Unlikely	1 occurrence every 1-5 years	Low	Low	Medium	Medium	High
Rare	<1 occurrence every 5 years	Low	Low	Low	Medium	Medium

Table 10 Uncertainty descriptors

Uncertainty Level	Description
Certain	The processes involved are thoroughly understood and supported by very extensive on-site knowledge covering multiple drought and flood cycles, and/or high frequency (weekly or better) water quality monitoring data.
Confident	The processes involved are well understood and supported by extensive on-site knowledge of more than one drought and flood cycle, and/or monthly water quality data
Reliable	There is a good understanding of the process which is supported by quarterly water quality data and operational experience that covers drought and flood years.
Estimate	The process is reasonably well understood, and data covers seasonal and drought and flood cycles.
Unreliable	The process is not well understood, and water quality data does not cover seasonal variations for drought and flood years.

4.3 Key barriers

The NSW DPE (Water) issued Circular LWU 18 'Assuring the safety of drinking water supplies', (4 June 2014) with corresponding protocols that are to be implemented by all local water utilities providing a drinking water supply. The Circular is available in Appendix A. Council must meet the minimum requirements to achieve the three key barriers outlined below (NSW DPE (Water), 2014):

- Effective disinfection to kill or remove pathogens in the raw water
- Ensure distribution system integrity to prevent contamination
- Maintenance of free chlorine residual in the reticulation system

Council is required to ensure the SOPs meet the minimum requirement for each key barrier as outlined by NSW DPE (Water).

4.3.1 Bore Integrity

The ADWG note that protection of water sources is of paramount importance in reducing risks.

While aquifers are generally at lower risk of microbial contamination, aquifer recharge (if rapid) can introduce contamination. Similarly, aquifers in the vicinity of septic systems can also become contaminated. Finally, there is also a real risk of contamination through cracked bore casings, or through the bore head-works.

Bore integrity is therefore a very high priority to ensure the ongoing safety of the water supplies. As a risk mitigation measure, no open screens are installed in bore casing within 15 meters of the ground surface level.

4.3.2 Effective Disinfection

To achieve effective disinfection, NSW DPE (Water) recommends that Council operates the drinking water supply systems to achieve the targets as summarised in Table 11.

Table 11 Monitoring for Effective Disinfection

Parameter	Target	Unit	Notes
Chlorine residual	≥ 0.5	mg/L	Target is prior to first consumer. It is recommended that Council monitors chlorine demand after changes in raw water quality and adjust chlorine dosing as required. It is recommended that free chlorine tests be performed at representative sample points in each drinking water supply system at least once per week.
Ct.	> 15	mg/L/min	C.t. is a measure of free chlorine residual concentration (C) and contact time (t). The C.t. values can be achieved by adjusting chlorine dose or contact time.
pH	< 8.5	pH units	Disinfection effectiveness is compromised at pH above 8.5, with the desirable pH range for disinfection between 7.8 - 8.2
Temperature	> 10	°C	Monitoring is recommended when < 10 °C, as disinfection decreases after this point. Any water body that seasonally exceeds 30°C or continually exceeds 25°C can support the growth of *Naegleria fowleri.*
Turbidity	< 0.2	NTU	NSW DPE (Water) recommends turbidity target to be as low as practicable, but preferably below 0.2 NTU after filtration and below 1 NTU at the time of disinfection

4.3.3 Distribution System Integrity

Once water is effectively disinfected, the only avenue for pathogens to enter the drinking water supply system is through a breach in the distribution system. It is therefore extremely important for Council to protect the integrity of their drinking water distribution system. Council is required to undertake the actions listed below to maintain the integrity of the distribution system (NSW DPIE (Water), 2014).

4.3.4 Free Chlorine in Distribution System

Maintaining chlorine residual is important to protect drinking water from minor contamination due to breaches in system integrity (NSW DPE (Water), 2014). Free chlorine residuals of ≥ 0.2 mg/L should be maintained at all points within the reticulation; a sudden large drop in chlorine residual should be an indicator to water operators that contamination may have occurred.

As can be seen in the chlorine data presented for each scheme, this is achievable for all three schemes in the Gunnedah Shire Council area.

4.4 Unmitigated Risks

The unmitigated risks as determined in the risk workshop are included in the following table.

Table 12 Unmitigated Risk Assessment

Hazard	Sources of Hazard	Unmitigated Risk			Comment
		Consequence	Likelihood	Risk	
Bacteria/ Virus	Ingress through bore head, old bores not fully decommissioned, contamination of aquifer	Catastrophic	Unlikely	**High**	
Bacteria/ Virus (Reticulation)	Faecal contamination into reservoirs or ingress after mains break / unsanitary main repair	Catastrophic	Likely	Extreme	Reservoirs have potential points under ridges of roofing material. Tambar Springs reservoirs roof does not overhang, and buildup of material around edges (reservoir to be replaced). Some minor holes. Gunnedah – Links Road Res has new roof.
Protozoa (*Crypto/ Giardia*) (Bore Water)	Ingress through bore head	Catastrophic	Unlikely	**High**	Bores generally elevated above typical flood levels – minor points of ingress on a number of bores (e.g. down power hole)
Protozoa (*Crypto/ Giardia*) (Retic)	reservoir contamination, mains contamination	Catastrophic	Possible	**High**	This could occur through sewer and water main breaks in same vicinity. Sewer only under pressure in rising main, which is relatively new (1 year)
Protozoa (*Naegleria*) (Reticulation)	reservoir contamination, mains contamination, elevated temperatures	Major	Unlikely	**Medium**	Temperature below 25 in winter, and only rarely reaches 30 in summer.
Chlorate	Breakdown product				Not enough information to rank risk. Council wide swap to chlorine gas.
Chlorine	Chemical overdose	Moderate	Likely	**High**	
Copper	Corrosion of pipework	Moderate	Possible	**Medium**	
Disinfection by-products	Reaction of organics and chlorine	Moderate	Rare	**Low**	Low chlorine demand observed
Heavy metals	natural geology, chemical impurities, corrosion of assets	Moderate	Unlikely	**Medium**	Curlewis bores decommissioned - supply from Gunnedah
Lead	lead containing brass fittings, lead joins in pipes	Moderate	Possible	**Medium**	New hydrants anecdotally are lower quality
Hydrocarbons	spills in catchment	Moderate	Rare	**Low**	
Hydrocarbons (retic)	mains contamination	Moderate	Unlikely	**Medium**	Mullaley and Tambar Springs have PVC pipes
Manganese (Source)	natural geology	Moderate	Unlikely	**Medium**	
Nitrate	Agriculture in region	Moderate	Rare	**Low**	Maximum of 11 mg/L in Gunnedah NSW Health monitoring data from past 5 years. Possibly bores 1 and 2 - but all bores close to agricultural activities.
Pesticides	Ingress into aquifer	Moderate	Unlikely	**Medium**	Uncertain - not been tested - investigate option to undertake pesticide project with NSW Health
Radioactivity	Natural geology	Moderate	Rare	**Low**	
Sodium	Gunnedah has maximum of 60mg/L	Moderate	Unlikely	**Medium**	
Aluminium	natural sources	Moderate	Possible	**Medium**	
Iron	natural geology, sediment	Minor	Possible	**Medium**	
Taste and odour		Minor	Unlikely	**Low**	

Hazard	Sources of Hazard	Unmitigated Risk			Comment
		Consequence	Likelihood	Risk	
Hardness	Mullaley and Tambar Springs average > 250 mg/L, Gunnedah well below 250.	Minor	Likely	**Medium**	Consider monitoring hardness in all individual bores. Identify if some bores offer lower hardness than others.
pH	pH of Gunnedah bores generally 7 or below - but not below 6.5. Hypo dosing can increase pH as can AC mains, but not often above 8.5 except at far ends at some times	Moderate	Possible	**Medium**	May need to consider pH adjustment in new dosing system
Turbidity	Bore starts can have increased turbidity up to 5 NTU	Moderate	Possible	**Medium**	Monitor water quality further as bores 1 and 2 are decommissioned. Review with more available data.
Turbidity (Retic)	resuspension of sediment in reservoirs/mains, main break	Minor	Possible	**Medium**	
Loss of Supply	Bore pump failure/ power supply	Catastrophic	Unlikely	**High**	Gunnedah multiple bores, on different lines.
Telemetry Failure	Telemetry failures - heat, lightning etc	Major	Unlikely	**Medium**	
Malicious action	Sabotage/Terrorism	Catastrophic	Rare	**Medium**	
Operator Error	Mistake/ lack of training / overworked / understaffed	Catastrophic	Almost Certain	Extreme	
Chemical Supply	Unable to get supply from providers	Catastrophic	Unlikely	**High**	
Fluoride	Overdose	Moderate	Possible	**Medium**	Limited capability of system
Fluoride underdose	Underdose	Minor	Possible	**Medium**	This is a regulatory risk and also represents the risk of not achieving the expected dental health benefits
Site Access	Unable to access as some infrastructure is not on council land	Major	Possible	**High**	

Following the assessment of the unmitigated risks, a mitigated risk assessment was undertaken for each of the schemes. The mitigated risk assessment is included on the following pages.

Table 13 Mitigated Risk Assessment

Process Step	Primary Hazard	Source of Hazard/ Hazardous event	Maximum Risk	Primary preventive measure	Other preventive measures	Comments	Residual Risk				Improvement Items		
							Consequence	Likelihood	Risk	Uncertainty	This year	1-2 years	~5 years
Bores	Protozoa (Crypto/ Giardia) (Bore Water)	Ingress into bore	High	Bore construction	Sealed bores, raised above normal expected floods. Fenced, concrete aprons. Bores on inspection and maintenance rotation (~4years)	-	Catastrophic	Rare	Medium	Reliable	-	Welding sockets on boreheads so there are gland nuts on and can be fully sealed.	-
Bores	Bacteria/ Virus	Ingress into bores or aquifer	High	Bore construction	Chlorine added. Bores raised above normal expected floods. Fenced, concrete aprons. Bores on inspection and maintenance rotation (~4years)	-	Catastrophic	Rare	Medium	Confident	-	Welding sockets on boreheads so there are gland nuts on and can be fully sealed.	-
Bores	Turbidity	Turbid on start if not operated for a period of time	Medium	Bores are scoured prior to bringing into service, Water centrally collected in reservoirs before retic	SOP	Flushing initiated if elevated or unusual turbidity for site.	Moderate	Unlikely	Medium	Reliable			
Bores	Pesticides	Contamination of aquifer	Medium	No active measures			Moderate	Unlikely	Medium	Unreliable	Talk to PHU about a project for pesticide screening on all bores.		
Chlorination	Bacteria/ Virus	Underdose chlorine	High	Disinfection CCP	Duty standby pumps, SCADA Alarms, weekday checks of the entry points in Gunnedah - weekly at villages.	Retest if an issue check at entry points.	Catastrophic	Unlikely	High	Reliable	Install temperature probe at WTP reservoir, Update CCPs to include higher minimum chlorine to ensure effective disinfection. SOPS and CCPs to be available on sites.	-	
Chlorination	Bacteria/ Virus	Underdose chlorine - Mullaley Campdraft	High	Disinfection CCP	Duty standby pumps, SCADA Alarms, weekly checks		Catastrophic	Unlikely	High	Reliable	Change the supply at the one customer at Campdraft that the supply is non-potable.		
Chlorination	Bacteria/ Virus	Turbidity	High	Disinfection CCP	Routine flushing program	There are rare turbidity spikes, but generally in reticulation, not from the bore. Bores are scoured prior to bringing online.	Catastrophic	Rare	Medium	Confident	-		
Chlorination	Chlorine	Overdose chlorine	High	Disinfection CCP	SCADA alarms, weekday checks in Gunnedah, weekly in Villages	Was on high level in Mullaley - dosing pump didn't stop.	Moderate	Unlikely	Medium	Confident		Change Mullaley and Tambar Springs to Cl2 (Gas) with Chlorine analyser onsite.	
Fluoridation	Fluoride	Overdose fluoride	Medium	Safety in design, fluoride code of practice, interlocks, daily inspections. Online SCADA monitoring.	Operators will require training in fluoride systems prior to operating the plant.		Moderate	Unlikely	Medium	Reliable			
Fluoridation	Fluoride underdose	Underdose fluoride	Medium	Safety in design, fluoride code of practice, interlocks, daily inspections. Online SCADA monitoring.	Operators will require training in fluoride systems prior to operating the plant.	Underdose means loss of dental health benefits	Minor	Unlikely	Low	Reliable			
Reticulation	Heavy metals	Leaching out of pipes/ fittings	Medium	Regular flushing - weekly normally.		Plumbing standards, AS 4020	Minor	Unlikely	Low	Confident			
Reticulation	Bacteria/ Virus (Reticulation)	Vermin contamination of reservoirs	Extreme	Res integrity SOP, residual chlorine	Reservoir inspection, service, cleaning program every 2 years		Catastrophic	Unlikely	High	Reliable	Build new reservoirs in Tambar Springs	-	Links road to be assessed for access and hatch.
Reticulation	Protozoa (Crypto/ Giardia) (Retic)	Contamination following mains breaks	High	Trained operators, robust mains repair procedure	New mains commissioning procedure. Superchlorination of new mains.	Flush for minimum 30 minutes after repair. Staff induction - in water quality team.	Catastrophic	Rare	Medium	Reliable			
Reticulation	Protozoa (Naegleria) (Reticulation)	Opportunistic contamination, and survival in reticulation	Medium	Chlorine residual, Chlorine CCP		Generally > 0.5 mg/L across schemes	Major	Rare	Medium	Reliable			
Reticulation	Bacteria/ Virus (Reticulation)	contamination following mains breaks	Extreme	Chlorine residual. Trained operators, robust mains repair procedure	New mains commissioning procedure. Superchlorination of new mains.	Flush for minimum 30 minutes after repair. Staff induction - in water quality team.	Catastrophic	Rare	Medium	Reliable			

Process Step	Primary Hazard	Source of Hazard/ Hazardous event	Maximum Risk	Primary preventive measure	Other preventive measures	Comments	Residual Risk				Improvement Items		
							Consequence	Likelihood	Risk	Uncertainty	This year	1-2 years	~5 years
Reticulation	Bacteria/ Virus (Reticulation)	Backflow	Extreme	Taggle meters recently installed across all residential services.		Council not currently checking backflow prevention devices annually	Catastrophic	Unlikely	High	Estimate	Identify high risk sites to be prioritised. Develop register and testing strategy - including communication to customers of the requirements and costs.	New staff to get accreditation of backflow prevention	
Reticulation	Bacteria/ Virus (Reticulation)	Illegal accessing of hydrants	Extreme	New hydrants built across towns - swipe card access		These are easily accessible, and are likely to discourage illegal access.	Catastrophic	Rare	Medium				
Reticulation	Protozoa (Crypto/ Giardia) (Retic)	Backflow	High	Taggle meters recently installed across all residential services.		Council not currently checking backflow prevention devices annually	Catastrophic	Possible	High	Estimate	Identify high risk sites to be prioritised. Develop register and testing strategy - including communication to customers of the requirements and costs.	New staff to get accreditation of backflow prevention	
Reticulation	Malicious action	Terrorism/ Vandalism	Medium	weekday checks of Gunnedah, weekly at village schemes. Low level alarms.	CCTV at Curlewis, some intruder alarms on hatches (Apex). SCADA system integrated into Water Ops server, daily backups, Backup systems. Separate sites. Firewalls.	Locking system changed 2 years ago. Passwords changed 3 monthly.	Catastrophic	Rare	Medium	Reliable			
Site access	Site Access	No easement for infrastructure	High	Some assets may be located in places where there is not a formal easement			Major	Possible	High	Reliable	Identify all assets not on council or crown land/ potential for lack of access.	Develop strategy to formalise access to Council water infrastructure.	
Whole of System	Operator Error	e.g. from an accidental oversight, an untrained or overworked operator	Extreme	Trained operators, backup operators	Cert 3 minimum qualification required (either have or to complete). Change of critical limits requires administrator level	Water quality is understaffed. Will need to undertake fluoride training	Catastrophic	Unlikely	High	Reliable	Need to employ several new operators	Succession planning.	
Whole of System	Chemical Supply	unable to supply	High	Procurement strategy	AS4020, contracts with suppliers.		Catastrophic	Unlikely	High	Reliable		Change Mullaley and Tambar Springs to Cl2 (Gas)	

4.5 Critical Control Points

Critical Control Points (CCPs) are activities, procedures or processes where the operator can apply control, and are essential processes in reducing risks to an acceptable level.

In order to define acceptable from unacceptable performance at each point, target levels, alert levels and critical limits have been identified for Council's drinking water supply systems.

Critical Control Points were identified in consultation with Gunnedah Shire Council, NSW Health and NSW DPE and documented on the following pages.

Three different limits have been set for each CCP within Council's drinking water supply systems:

1. **Target Level**: Representing day to day operational limits and procedures. This is where the process should normally operate.
2. **Adjustment Level**: Deviation from the Adjustment Limit indicates a trend towards loss of control and corrective actions should be immediately taken to resolve the problem and restore control to the Drinking Water Supply System.
3. **Critical Limit**: Deviation from the Critical Limit indicates loss of control and the potential of unacceptable health risks. If the critical limit is exceeded, incident and emergency plans should be immediately activated.

The CCPs are presented as a traffic light format as operators and managers alike understand the format and engage with them.

In 2018, NSW Health published updated guidance for setting critical limits for CCPs (refer to https://www.health.nsw.gov.au/environment/water/Pages/critical-control-points.aspx) – (current as of December 2023). This information was used when reviewed CCP critical limits.

The CCPs are included on the following pages.

Gunnedah Shire Council (all schemes)
CCP1: Turbidity Critical Control Point Procedure

What is measured	How is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Turbidity	Grab samples at the Entry Points of Villages Grab sample at entry of Gunnedah WTP	Weekdays	Bore pumping	Bacteria and viruses	Operator log sheets

Critical Limit

> 1 NTU

- Repeat tests to confirm results
- For any breach, inform Manager Water Services – 0428477173
  - Provide detail of the issue and likely timeframe to resolve
- Manager Water Services to contact Public Health Unit
  - Contact PHU on 02 6764 8000/0249246477
  - After Hours call John Hunter Hospital 02 4921 3000 and ask for the on-call environmental health officer.
- Follow the advice of the PHU
- If required contact DPE Inspector on 0417 458 247
- Consider need to measure iron if particular bores need to be investigated

Target

< 1 NTU

Weekly

- Follow SOP WQ 11 Calibrate Turbidity Meter to ensure equipment is measuring correctly
- Check turbidity from bores if pumping
- Collect grab samples for turbidity and free chlorine from Reservoirs
- Gunnedah Bores to be flushed prior to bringing on line – Follow SOP 17 Pumping Regime

If turbidity is increasing, but still below 1 NTU

- Investigate if turbidity is increasing (e.g. identify if a particular bore is causing issues)
- Flush contributing bore to ensure turbidity decreases, otherwise contact Manager Water Services to consider taking bore offline.

Gunnedah
CCP2: Disinfection Critical Control Point Procedure

What is measured	How is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Free Chlorine	Online (free) and weekday grab	Continuously and daily	Post treated water reservoir	Bacteria and viruses	SCADA, Operator records

Critical Limit
< 0.9 mg/L or
> 5 mg/L

- If >5 mg/L immediately turn down chlorine dosing to 1 mg/L
- For any breach, inform Manager Water Services 0428477173
  - Provide detail of the issue and likely timeframe to resolve
- Manager Water Services to contact Public Health Unit
  - Contact PHU on 02 6764 8000/0249246477
  - After Hours call John Hunter Hospital 02 4921 3000 and ask for the on-call environmental health officer.
- Follow the advice of the PHU
- If required contact DPE Inspector on 0417 458 247

Adjustment Limit
< 1.0 mg/L or
> 1.2 mg/L

- Notify Coordinator Water Services
- Take a grab sample to confirm hand-held reading is the same as online reading.
  - Recalibrate if required
- Check chlorine dosing system
  - Sufficient chlorine gas remaining in cylinder
  - Dosing pumps
  - Dosing lines
  - Analyser
- Adjust chlorine dose rate (up or down) as necessary to bring dose back to target level
- Troubleshoot system and implement corrective actions as appropriate
- Increase monitoring until chlorine dose is within adjustment limits

Target
1.0 – 1.2 mg/L
Free Chlorine

Daily site visits

- Perform routine daily lab tests – react as required
- Visual plant check
  - Sufficient chlorine gas remaining in cylinder
  - Dosing pumps
  - Dosing lines
  - Analyser
- Re-order chlorine gas as required
- (Curlewis Reservoirs are also on gas dosing – check weight of cylinder and gas dosing system)

Weekly

- Sample pH, turbidity and free chlorine in reticulation
- Check calibration of online meter (cross check with hand-held and adjust calibration if required).

Validation: See validation section 8.3.2 in DWMS – flow rate was the maximum flow of the transfer pumps supplying the reticulation network from the WTP reservoirs. A chlorine residual of 0.9 mg/L ensures that there is suitable disinfection (> 30 mg.min/L) even with *N. Fowleri* risk. Dosing above 0.9. mg/L ensures effective primary disinfection.

Gunnedah
CCP3: Fluoride Critical Control Point Procedure

What is measured	How is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Fluoride	Online and daily grab	Continuously and daily	Fluoride dosing	Fluoride (if overdosed)	SCADA, Operator records

Critical Limit
>1.5 mg/L

- Stop fluoride dosing
- Notify Manager Water Services - 0428477173
- Manager Water Services to notify local PHU - 02 6764 8000/ 02 4924 6477
- After Hours call John Hunter Hospital 02 4921 3000 and ask for the on-call environmental health officer
- Initiate Fluoride Emergency Response Plan
- Full fluoride plant investigation
- Continue actions as per Adjustment Limit
- Sample and test reservoir and reticulation fluoride
- Complete and submit Form 5 to NSW Health
- Follow the advice of the PHU
- If required contact DPE Inspector on 0417 458 247

Adjustment Limit
<0.95 mg/L or >1.05 mg/L

- Notify Coordinator Water Services
- Inspect fluoride dosing system
- Inspect online fluoride meter and verify result with manual test
- Drop test dosing pump(s)/ feeder
- Test raw water fluoride content
- Adjust fluoride dose
- Record details of exceedance and any actions taken in WTP lab testing log
- If <0.9mg/L for 72 hours, failure to dose for >24 hours, or fluoride plant offline for repair/maintenance – complete and submit Form 5 to NSW Health

Target
0.95 – 1.05 mg/L

- WTP water sampling and testing
- Plant walkaround and visual inspection
- Complete and submit Form 2 to NSW Health
- Complete and submit Form 4 to NSW Health
- Instrument calibration
- Dosing rate checks
- Equipment checks

Tambar Springs
CCP4: Disinfection Critical Control Point Procedure

What is measured	How is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Free and Total Chlorine	Online (free) and weekday grab	Continuously and daily	Post chlorine dosing	Bacteria and viruses	SCADA, Operator records

Critical Limit
< 0.5 mg/L or
> 5 mg/L

- If >5 mg/L immediately turn down chlorine dosing to 1 mg/L
- For any breach, inform Manager Water Services – 0428477173
  - Provide detail of the issue and likely timeframe to resolve
- Manager Water Services to contact Public Health Unit
  - Contact PHU on 02 6764 8000/0249246477
  - After Hours call John Hunter Hospital 02 4921 3000 and ask for the on-call environmental health officer.
- Follow the advice of the PHU
- If required contact DPE Inspector on 0417 458 247

Adjustment Limit
< 0.7 mg/L or
> 1.2 mg/L

- Notify Coordinator Water Services
- Take a grab sample to confirm hand-held reading is the same as online reading.
  - Recalibrate if required
- Check chlorine dosing system
  - Sufficient chemical stock remaining
  - Dosing pumps
  - Dosing lines
  - Analyser
- Adjust chlorine dose rate (up or down) as necessary to bring dose back to target level
- Troubleshoot system and implement corrective actions as appropriate
- Increase monitoring until chlorine dose is within adjustment limits

Target
0.7 – 1.2 mg/L
Free Chlorine

Daily site visits

- Perform routine daily lab tests – react as required
- Visual plant check
  - Sufficient chemical stock remaining
  - Dosing pumps
  - Dosing lines
  - Analyser
- Re-order sodium hypochlorite as required

Weekly

- Sample pH, turbidity and free chlorine in reticulation
- Check calibration of online meter (cross check with hand-held and adjust calibration if required).

Validation: See validation section 8.3.2 in DWMS – flow rate was the maximum flow of the system at the location, and pipe lengths and materials were captured from GIS. 0.5 mg/L ensures that there is suitable disinfection (> 15 mg.min/L) in all schemes except Mullaley where 0.6 mg/L is required to reach this level. Dosing above 0.5. mg/L ensures effective primary disinfection.

Mullaley

CCP5: Disinfection Critical Control Point Procedure

What is measured	How is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Free and Total Chlorine	Online (free) and weekday grab	Continuously and daily	Post chlorine dosing	Bacteria and viruses	SCADA, Operator records

Critical Limit
< 0.6 mg/L or
> 5 mg/L

- If >5 mg/L immediately turn down chlorine dosing to 1 mg/L
- For any breach, inform Manager Water Services – 0428477173
  - Provide detail of the issue and likely timeframe to resolve
- Manager Water Services to contact Public Health Unit
  - Contact PHU on 02 6764 8000/0249246477
  - After Hours call John Hunter Hospital 02 4921 3000 and ask for the on-call environmental health officer.
- Follow the advice of the PHU
- If required contact DPE Inspector on 0417 458 247

Adjustment Limit
< 0.7 mg/L or
> 1.2 mg/L

- Notify Coordinator Water Services
- Take a grab sample to confirm hand-held reading is the same as online reading.
  - Recalibrate if required
- Check chlorine dosing system
  - Sufficient chemical stock remaining
  - Dosing pumps
  - Dosing lines
  - Analyser
- Adjust chlorine dose rate (up or down) as necessary to bring dose back to target level
- Troubleshoot system and implement corrective actions as appropriate
- Increase monitoring until chlorine dose is within adjustment limits

Target
0.7 – 1.2 mg/L
Free Chlorine

Daily site visits

- Perform routine daily lab tests – react as required
- Visual plant check
  - Sufficient chemical stock remaining
  - Dosing pumps
  - Dosing lines
  - Analyser
- Re-order sodium hypochlorite as required

Weekly

- Sample pH, turbidity and free chlorine in reticulation
- Check calibration of online meter (cross check with hand-held and adjust calibration if required).

Validation: See validation section 8.3.2 in DWMS – flow rate was the maximum flow of the system at the location, and pipe lengths and materials were captured from GIS. 0.5 mg/L ensures that there is suitable disinfection (> 15 mg.min/L) in all schemes except Mullaley where 0.6 mg/L is required to reach this level. Dosing above 0.5. mg/L ensures effective primary disinfection.

Gunnedah Shire Council (all schemes)
CCP6: Reservoir Integrity Critical Control Point Procedure

What is measured	How is it measured	When is it measured	What is the control point	What are the hazards	Record Keeping
Reservoir Integrity	Inspections of ladders, hatches, and roof integrity	Routine visual when on site Quarterly detailed external inspection 5 yearly internal inspections	Reservoir Integrity	Pathogens	Operator Diary External inspection reports

Critical Limit

Evidence of contamination, unauthorised access or vermin identified

- For any breach, inform Manager Water Services – 0428477173
  - Provide detail of the issue and likely timeframe to resolve
- Manager Water Services to contact Public Health Unit
  - Contact PHU on 02 6764 8000 /0249246477
  - After Hours call John Hunter Hospital 02 4921 3000 and ask for the on-call environmental health officer.
- Follow the advice of the PHU
- If required contact DPE Inspector on 0417 458 247

Adjustment Limit

Possible points of ingress identified

- Notify Coordinator Water Services
- Seal the reservoir as soon as possible (replace vermin proofing, seal small holes, replace missing bolts etc.)
- Conduct thorough inspection of the reservoir looking for evidence of contamination (includes a visual inspection of the water within the reservoir)
- Contact Manager Water Systems to report breaches that cannot be immediately fixed
- Rectification works to be programmed with priority based on severity of issue

Target

Secure and vermin proof

- Ensure hatches are sealed and locked
- Check vermin proofing is intact
- Check for water leaks/ signs of deterioration
- Look for evidence of animals/ birds nesting
- Inspect ladders and fencing for security
- Routine reservoir and grounds maintenance
- Ensure no overhanging vegetation

5 MONITORING OF DRINKING WATER SYSTEMS

The sections below outline the operational and verification monitoring for the Gunnedah Shire Council drinking water supply systems. Operational monitoring includes the planned sequence of measurements and observations to assess and confirm the performance of preventive measures. Verification monitoring assesses the overall performance of the system and the quality of the drinking water being supplied to the consumer. Council undertakes both operational and verification monitoring in the drinking water supply systems.

5.1 Operational Monitoring

Operational monitoring of water quality includes both online SCADA data and grab sampling.

Table 14 Gunnedah Operational Monitoring

Monitoring Point	Parameter	Frequency
• WTP Combined raw water point	Turbidity	Weekdays
• WTP Reservoir outlet	Free Chlorine – Analyser + Grab	Weekdays
Entry Points	Free Chlorine	Weekdays
• Cohens Bridge	Total Chlorine	Weekdays
• Donnelly Fields	pH	Weekdays
• Peppergrove Lane	Turbidity	Weekdays
• Carrol St	Temperature	Weekdays
Analysers	Free Chlorine - Analyser	Weekly
• Links Road	Total Chlorine- Analyser	Weekly
• South St • Curlewis Analyser • Curlewis Reservoir Analyser 1 • Curlewis Reservoir Analyser 2	Free Chlorine - Grab	Minimum Weekly
Low Zone	Free Chlorine	Minimum Monthly
• 24 Rosemary St	Total Chlorine	Minimum Monthly
• 309 Conadilly St	pH	Minimum Monthly
• 45 Abbott St	Turbidity	Minimum Monthly
• 59 Marquis St	Temperature	Minimum Monthly
Med Zone	Free Chlorine	Minimum Monthly
• 231 Bloomfield St	Total Chlorine	Minimum Monthly
• 125 Stock Rd	pH	Minimum Monthly
• 19 George St	Turbidity	Minimum Monthly
• 42 Lincoln St • 2 Apex Rd	Temperature	Minimum Monthly
High Zone	Free Chlorine	Minimum Monthly
• 68 Links Rd	Total Chlorine	Minimum Monthly
• 59 Bridge St	pH	Minimum Monthly
• 41 Baxter St	Turbidity	Minimum Monthly
• 21 Short St	Temperature	Minimum Monthly
Semi-Rural	Free Chlorine	Minimum Monthly
• 170 Bushes Ln	Total Chlorine	Minimum Monthly
• Waste Management – Quia Rd	pH	Minimum Monthly
• 203 Kamilaroi Rd	Turbidity	Minimum Monthly
• 46 Booloocooroo Rd	Temperature	Minimum Monthly

Monitoring Point	Parameter	Frequency
Curlewis • 35 Cameron St • Curlewis Church • Hamilton (Park) • Sport Rec Ground • Pike Street	Free Chlorine	Minimum Monthly
	Total Chlorine	Minimum Monthly
	pH	Minimum Monthly
	Turbidity	Minimum Monthly
	Temperature	Minimum Monthly

Table 15 Mullaley Operational Monitoring

Monitoring Point	Parameter	Frequency
Mullaley • Mullaley Common • Mullaley Park • Retic Entry Reservoir	Free Chlorine	Weekly
	Total Chlorine	Weekly
	pH	Weekly
	Turbidity	Weekly
	Temperature	Weekly

Table 16 Tambar Springs Operational Monitoring

Monitoring Point	Parameter	Frequency
Tambar Springs • Tambar Springs Cemetery • Tambar Springs Park • Tambar Springs SES Shed • Tambar Springs Green box	Free Chlorine	Weekly
	Total Chlorine	Weekly
	pH	Weekly
	Turbidity	Weekly
	Temperature	Weekly
Tambar Springs Analyser	Free Chlorine - Analyser	Weekly
	Free Chlorine	Weekly
	Total Chlorine	Weekly

5.2 Verification of Drinking Water Management

The verification of drinking water quality supplied to the consumer assesses the overall performance of the system. Verification provides an important link back to the operation of the water supply system and additional assurance that the preventive measures and treatment barriers have worked and are supplying safe quality water.

Gunnedah Shire Council monitors water quality as part of the NSW Health Drinking Water Monitoring Program which provides ongoing independent verification of the treatment process. Frequency of sampling is based on population. The Program assesses 36 parameters for microbial, physical and chemical properties of the water as detailed in Table 17. The results can be accessed at www.drinkingwaterdb.nsw.gov.au.

Table 18 lists the sampling sites for verification monitoring. Samples are collected by Council and submitted in accordance with the "Guide for Submitting Water Samples to FASS for Analysis" (Sydney West Area Health Service, 2010).

Verification samples for *E. coli* are collected weekly in Gunnedah and monthly in the villages. Chemical parameters are sampled monthly in Gunnedah (rotating sites), and 6 monthly in the villages.

Table 17 NSW Health Drinking Water Monitoring Program Analytes

Parameters		
Microbial		
E. coli	Total coliforms	
Disinfection		
Free chlorine	Total chlorine	
Physical		
pH	Total Dissolved Solids	Turbidity
True Colour	Total Hardness	
Chemical (metals)		
Aluminium	Copper	Molybdenum
Antimony	Cyanide	Nickel
Arsenic	Fluoride	Nitrate
Barium	Iodine	Nitrite
Boron	Iron	Selenium
Cadmium	Lead	Silver
Calcium	Magnesium	Sodium
Chloride	Manganese	Sulphate
Chromium	Mercury	Zinc

Table 18 NSW Health Drinking Water Monitoring Program Sites

NSW Health Drinking Water Monitoring Program Sites			
Gunnedah			
3	142 Bloomfield St	8	40 Donaldson St Curlewis
4	7 Stanley St	9	75 Poole St Curlewis
5	125 Stock Rd	10	35 Cameron St Curlewis
6	77 Lincoln St	11	Goran St Curlewis
7	35 Stewart St		
Mullaley			
1	Nombi St		
Tambar Springs			
2	Tamba St		

5.3 Short Term Evaluation and Corrective Action

Council evaluates water quality data on receipt of monitoring results. Water quality results from the NSW Health Drinking Water Monitoring Program are reported to the Coordinator, Water Services Engineer and Manager Water Services.

Any exceedances are recorded and acted upon immediately with the appropriate regulatory authorities notified. All test results are recorded in the NSW Health Drinking Water Database which is completely independent of Gunnedah Shire Council. The NSW Health Drinking Water Monitoring Program provides the following response protocols, accessible to Council:

- Managing pathogen risks in drinking water: Response protocol for water utilities and public health units
- NSW Health Response Protocol: for the management of physical and chemical quality

E. coli exceedances require immediate re-testing as stipulated in the response protocol. Council should immediately discuss any *E. coli* exceedances with NSW Health, which may result in a boil water alert. This protocol also includes actions in response to failure of treatment, disinfection or poor or rapidly changing source water quality.

5.4 Consumer Satisfaction

Council has a Complaints Policy and advice as to how to make a complaint.

Complaints can be lodged in person, by telephone, or in writing. Complaints are rated as Tier 1-3, with escalating responses and responsibilities for each Tier. Customers are encouraged to make a complaint if there is an issue with water quality.

The complaint will be forwarded to the relevant section to investigate and take action. If the complaint is not actioned within the specified timeframe, or is not resolved to the complainants' satisfaction, the complaint is automatically escalated to senior management.

6 OPERATIONAL PROCEDURES AND PROCESS CONTROL

6.1 Operational Procedures

As part of the development of the DWMS, key operating procedures and corrective actions were established for each Critical Control Point (CCP) within the Gunnedah Shire Council drinking water supply systems. These included operational procedures required to achieve the target levels and corrective actions in the event that alert or critical limits are reached.

Council also has a suite of forms, SOPs and SWMS that are used to ensure all processes and procedures are completed consistently and safely. The list is provided in the table below.

Table 19 List of procedures, forms, templates and SWMS

Standard Operating Procedures	Forms and Templates
SOP WQ 01 SOP Management	CHECKLIST - Chemical Delivery
SOP WQ 02 Free Chlorine Entry Points	CHECKLIST - Disinfection Site Routine Inspection
SOP WQ 03 Reservoir Inspections	FORM WQ 01 - Monitoring of Water Entry Points.
SOP WQ 04 Drinking Water Monitoring	FORM WQ 01a - Entry Points and Analyser Monitoring.
SOP WQ 05 Water Monitoring NSW Health	FORM WQ 01b - Retic Weekly Chlorine Monitoring.
SOP WQ 06 Quality Incidents	FORM WQ 01c - Village Chlorine.
SOP WQ 07 Chlorine Testing	FORM WQ 02 - Water Reservoir Inspections.
SOP WQ 08 Measure pH	FORM WQ 03 - Water Reservoir Inspections Weekly
SOP WQ 09 Measure Turbidity	FORM WQ 03a - Water Reservoir Inspections Monthly
SOP WQ 10 Calibrate pH meter	FORM WQ 03b - Water Reservoir Inspection Form Annual
SOP WQ 11 Calibrate Turbidity Meter	FORM WQ 04 - Drinking Water Monitoring Weekly
SOP WQ 12 Drinking Water Complaint Handling	FORM WQ 05 - Water Sampling
SOP WQ 13 Chlorine Analyser Calibration	FORM WQ 06 - Quality Incident Report
SOP WQ 14 Sodium Hypo	FORM WQ 24 - Mains Flushing Sheet
SOP WQ 15 Backflow Prevention	FORM WQ 10 - pH Calibration
SOP WQ 16 Manual Chlorine Dosing	
SOP WQ 17 Pumping Regime	**Safe Work Method Statements**
SOP WQ 18 Pesticide Monitoring	SWMS - Confined Space Entry
SOP WQ 19 Microbiological Monitoring	SWMS - House Drainage Repair
SOP WQ 20 Preventative Maintenance	SWMS - Installation of Backflow Prevention Device
SOP WQ 21 Chlorine System Operation	Safe Work Method Statement - Installation of Manholes
SOP WQ 22 Communication Protocols	SWMS - Installation of Stop Valves, Hydrants and Fittings
SOP WQ 23 Disinfecting Tools	SWMS - Main Sewer Pump Station -
SOP WQ 24 Flushing Water Mains	SWMS - Main Sewer Pump Station Repairs -
SOP WQ 27 Installing New Water Mains	SWMS - Sewer Choke Clearing
SOP WQ 28 Low Pressure Investigation	SWMS - Cutting and removal of ACM (asbestos cement)
SOP WQ 29 Mains Hygiene	
SOP WQ 30 Exceedance Free Chlorine	
SOP WQ 31 Issuing a Boil Water Notice	
SOP WQ 33 Chlorine Pump Draw Down Test	
SOP WQ 34 Chlorine Injector Point Maintenance	
SOP WQ 35 FASS Data Management	
Flowchart Mains Cleaning	

6.2 Equipment Capability and Maintenance

Council's objective is to ensure all equipment purchased performs adequately and provides sufficient flexibility and process control. Water Officers have appropriate hand-held instrumentation for chlorine, pH and turbidity monitoring on site which are used to cross check analysers and ensure effective operation of the schemes.

In addition, Council has an asset management policy, and an asset management plan, both also accessible on the council website.

6.3 Materials and Chemicals

Council's objective is to ensure all equipment purchased performs adequately and provides sufficient flexibility and process control. All work is carried out in accordance with AS/NZS 3500, AUS-SPEC0071 Water Supply – Reticulation and Pump Stations (Design) (NATSPEC), Water Services Australia 03-2011 Water Supply Code of Australia Version 3.1 and Australian Standards in the purchasing of materials.

The use, including transport and storage, of chemicals listed as "Dangerous Goods" under the Work Health and Safety Regulation 2012 (NSW) (WH&S Regulation), including chlorine and fluoride, is dictated by the provisions of the WH&S Regulation and Work Cover. Storages and trucks are licensed according to the WH&S Regulation.

Council purchases water treatment chemicals through reputable suppliers i.e., Omega Chemicals, IXOM Australia.

7 MANAGEMENT OF INCIDENTS AND EMERGENCIES

This plan clearly describes the actions and accountabilities of key operational, managerial, and executive staff, and is intended to show the communication pathways and key actions at each level.

Each incident or emergency will require a considered individual response.

Council has a range of SOPs to follow for a range of incidents. A list of SOPs can be found in Section 6.1 Table 19.

7.1 Emergency Response Levels

Gunnedah Shire Council uses 3 different emergency response levels. The lower 2 levels align to the critical control points at each water scheme (adjustment actions and critical actions) whilst the highest level triggers a wider emergency response through activation of Emergency Management Plans (EMPLAN) or Local Disaster Management Plans (DISPLAN).

Table 20 Emergency Response Levels

Level 3	Activation of EMPLAN or DISPLAN
Level 2	Critical Control Point or ADWG health guideline value exceedance
Level 1	Operator adjustments to processes

7.1.1 Linkages to Critical Control Point Procedures

The colours of the Critical Control Points align to the above levels – a parameter outside of the Adjustment limit is a Level 1 operator intervention. Where a process goes outside of the CCP critical limit, this is a Level 2 incident that requires immediate reporting to the Public Health Unit. This is the same process that would occur for the detection of *E. coli.*

If there is a declared disaster or emergency and the EMPLAN or DISPLAN is activated, actions will be taken in accordance with those plans (noting the importance of maintaining the actions within this DWMS as these actions are intended to protect public health).

Table 21 Key Management Responses for each level

Level	Description	Management response(s)	Position(s) responsible
Level 3 Disaster or Emergency	▪ Emergency Management Plan activated, or natural disaster declared. ▪ Examples include flood, drought, bushfire, and terrorism ▪ Outbreak of waterborne disease	▪ External assistance requested to manage emergency or disaster ▪ Effective communication with community	▪ General Manager ▪ Director Infrastructure Services ▪ Manager Water Services
Level 2 Incidents	▪ Exceedance of ADWG health guideline value ▪ Exceedance of CCP critical limit ▪ Unable to provide treated water ▪ Loss of water supply for >6 hours	▪ Ensure all control measures are functioning effectively ▪ Ensure effective communication between Gunnedah Shire Council, PHU and DPE as appropriate.	▪ Director Infrastructure Services ▪ Manager Water Services ▪ Water Services Engineer ▪ Coordinator ▪ Team Leader – Quality
Level 1 Operator Adjustments	▪ Exceed Action Limit for CCPs ▪ Effectively managed by the water treatment operators undertaking actions in CCP document.	▪ Implement CCP actions to return to operational target ▪ Check and act upon operations and maintenance records and procedures ▪ Take appropriate actions to rectify situation	▪ Water Quality ▪ Team Leader – Water Quality ▪ Coordinator ▪ Water Operators

7.2 Level 1 - Operator Adjustment

At Level 1 operational actions are required to manage the issue and prevent escalation. Issues at this level are normally identified by the operators through operational monitoring or visual inspections.

Corrective actions will be taken to ensure processes are brought back to target levels, a note made in WTP daily monitoring sheets and database (WTP exceedances) and the Coordinator informed as required or escalated immediately if the problem cannot be rectified.

Routine reporting ensures that repeated breaches of adjustment limits are not systemic and overlooked.

7.3 Level 2 - Incident

At this level, there is a potential for an adverse public health impact.

All critical limit exceedances and detections of parameters above ADWG health guideline levels are Level 2 incidents.

These issues are identified through either operational or verification monitoring of the processes and water quality, or where there has been a significant supply issue resulting in the loss (or likely loss) of water supply for a period >6 hours.

When identified, these issues are immediately communicated to the Water Coordinator, Water Services Engineer, or Manager Water Services as required.

Level 2 incidents are reported immediately to the local PHU.

Appropriate corrective actions will be identified and implemented as soon as practicable to minimise the effect of the incident.

7.3.1 NSW Health Response Protocols

Level 2 Incidents are managed in accordance with the NSW Health Protocols. These protocols are updated periodically on the NSW Health Website.

As such, the website is the primary reference

https://www.health.nsw.gov.au/environment/water/Pages/drinking-water-quality-and-incidents.aspx

This web page has links to the appropriate information depending on the particular scenario and should always be consulted in an incident.

7.4 Level 3 – Emergency or Declared Natural Disaster

This level emergency or disaster requires coordination across departments and may require external resourcing and support from agencies, such as Department of Emergency Services, Department of Health, DPE and emergency responders.

Level 3 emergencies are generally dealt with at the General Manager level of Gunnedah Shire Council after being informed by the Director Infrastructure Services or Manager Water Services.

In these cases, the Council Business Continuity Plan, EMPLAN, or DISPLAN will be activated.

7.5 Emergency Contact List

Council has developed an emergency contact list of relevant contacts that may need to be contacted in the event of an issue with water quality.

Table 22 Emergency Contact List

Water Quality Emergency Contact List		
Name	Contact Name	Contact Details
General Manager	Eric Groth	02 6740 2115 ericgroth@infogunnedah.com.au
Director Infrastructure Services	Jeremy Bartlett	02 6740 2145 jeremybartlett@infogunnedah.com.au
Manager Water Services	Michael Ludlow	02 6740 2167 michaelludlow@infogunnedah.com.au
Water Services Engineer	Keshan Dharmasena	02 6740 2139 keshandharmasena@infogunnedah.com.au
Water Coordinator	Brendon Lemon	0427 936 717 brendonlemon@infogunnedah.com.au
NSW Public Health Unit Environmental Health Officer Hunter New England Local Health District	Fidelis Jaravani Environmental Health Officer	02 6764 8020 Fidelis.Jaravani@health.nsw.gov.au 0249246477 HNELHD-PHEnvironmentalHealth@health.nsw.gov.au
NSW EPA		131 555
Gunnedah Health Service Hospital	Health Service Manager Stephen Joyce	(02) 6741 8000
Gunnedah Medical Centres		Barber Street Medical Centre 110 Barber St (02) 6742 4466 Northwest Family Medical 59 Barber Street (02) 6742 6606 Gunnedah General Practice 27 Marquis St (02) 5743 2758
NSW Health Water Unit		02 9391 9939
SES		132 500 Gunnedah SES Commander 0429 420 872

8 SUPPORTING REQUIREMENTS

8.1 Employee Awareness and Training

WTP operators currently undertake NSW DPE (Water) "Water Treatment Operator Courses" and will transfer to the "National Certification for Operators of Drinking Water Treatment Facilities" as appropriate.

Specialist training and certification, including chemical dosing is regularly refreshed, as required. Training requirements are identified each year through the annual performance review of each employee by their direct supervisor. Training requirements for each employee are then factored into Council's budget and included in Councils staff training plan for the following financial year. All completed and ongoing training is recorded in a training register.

8.2 Community Involvement and Awareness

Council addresses the communication and consultation needs of residents through implementation of actions identified in the Community Engagement Policy. Customers are also informed of any service interruptions through the Council webpage and social media.

8.3 Research and Development

8.3.1 Investigative Studies and Research Monitoring

Investigative studies may be considered alongside the local public health unit.

8.3.2 Validation of Processes and Equipment

Validation requires the evaluation of system processes and equipment to prove the performance under all conditions expected to be encountered during operations. Validation should be undertaken on new processes and equipment when upgrades occur and on a regular basis to ensure continual performance.

Validation should be undertaken when there is a:

- Change in raw water quality (e.g. a new bore)
- Modification to the water treatment processes (centralisation of Gunnedah treatment)
- Change to the delivery, storage and distribution systems of treated and untreated water
- Change in water quality standards
- New research or understanding of water quality issues
- Receipt of information that indicates a health risk associated with the quality of the drinking water

Validation of new or upgraded processes and equipment is undertaken by qualified, experienced engineers and operators through:

- System design according to industry guidelines and standards
- Individual process and equipment specification against CCP target limits
- Procurement of equipment/chemicals from approved suppliers
- Market pre-validation by suppliers, particularly associated with water treatment chemicals

Ongoing validation processes to ensure safe and acceptable drinking water is supplied to the customer are:

- Review of scientific literature on treatment processes and industry best practice

- Evaluation of the effectiveness of CCPs in eliminating or controlling risks
- Assessment of research and development work to ensure CCP limits remain appropriate

8.3.2.1 Primary Disinfection Contact Time

The chlorine contact time for each scheme was calculated and used to determine the low critical chlorine limit. The validation assumptions are as follows:

Table 23 Gunnedah chlorine contact time

Scheme/ component	Max flow rate (L/s)	Reservoir volume (kL)	Baffle Factor	Min. Reservoir volume	Required Minimum Free chlorine (mg/L)	C.t.
Gunnedah	232	2000	0.3	78%	**0.9**	**30.3**

The NSW Health water quality database for the Gunnedah water supply has recorded temperature results with a maximum temperature of 30.1°C and the average of 24°C. NSW Health identifies any water supply that seasonally exceeds 30°C or continually exceeds 25°C may be at risk of *Naegleria fowlerii.* At risk schemes require a 2-log reduction of *N. fowlerii* which is achieved through 30 mg.min/L chlorine contact time.

Using 2x 1 ML reservoirs with a low critical chlorine concentration of 0.9 mg/L will achieve 30.3 mg.min/L C.t. This assumes that the minimum volume is > 78% in each reservoir, the flow rate is at or below the maximum of the transfer pumps of 232 L/s (evenly split to ensure 116 L/s per reservoir) and the baffle factor is of the reservoir is 0.3. Where 1 Reservoir only is used, the flow rate through the single reservoir could be 232 L/s, but the ADWG recommended 15 mg.min/L will be achieved. This will not adequately protect against *Naegleria fowlerii*, but if this was for short term maintenance activities, the risk may be further managed otherwise. E.g., planned reservoir maintenance should be undertaken during winter months with cooler temperatures.

Maintaining a minimum reservoir volume of 78% may be a challenge and can be restrictive to the operability of the reservoirs. To prevent the volume from dropping below the minimum level a sequence of bore pump startups is used to provide water to the WTP and into the reservoirs. The stepwise increase in raw water supply provides more water into the plant than the transfer pumps are capable of pumping out of the reservoir. This has been formalised in the J.A.C. bore operation model.

Table 24 Villages chlorine contact time

Scheme/ component	Max flow rate (L/s)	pipe length (m)	Diameter (mm)	Volume (L)	Required Minimum Free chlorine (mg/L)	C.t.
Tambar Springs	4.5	3972	100	31196	**0.5**	**57.8**
Mullaley to Roadhouse	6.7	1360	100	10681	**0.6**	**15.9**

The village schemes achieve their C.t. through the reservoir and pipe volumes.

In the future both schemes will be changed to be using chlorine gas and the dosing points will be relocated to the reservoirs. The contact time will then be based on the reservoirs instead of the pipe volumes.

8.4 Documentation and Reporting

8.4.1 Management of Documentation and Records

Gunnedah Council uses ECM as the record management system. Other records are included on the Council server, including Incident Reports, Water Quality Checklists, and Inspection Checklists.

Water quality results are recorded in Excel documents that also track and trend data for each of the schemes.

8.4.2 Reporting

Weekday water quality monitoring results are recorded by Water Quality officers, and then entered into Excel. These results are then used as the basis for reports which are available to the Manager Water Services and to the Director Infrastructure Services.

Council undertakes reporting as required by NSW Health and NSW DPE (Water). In line with Council's responsibilities the following reports are produced:

- Council Annual Report: available electronically on Council's website

  https://www.gunnedah.nsw.gov.au/index.php/component/search/?searchword=annual%20report&searchphrase=all&Itemid=0

- NSW Health compliance reporting for drinking water quality monitoring: drinking water quality within the Shire is monitored and the results are recorded in the NSW Health Drinking Water Database. Water quality reports can be produced from the database, which is located at the following web page: http://www.drinkingwaterdb.nsw.gov.au

- Water Supply and Sewerage NSW Performance Reporting: Council's water supply service performance is detailed in the NSW Water Supply and Sewerage Performance Monitoring Report annually. This report is available for public access from the NSW DPE (Water)

- DWMS Annual Report – this includes details of operational and verification monitoring, reservoir inspections, actions taken to implement improvement items and customer complaints. This is provided to the Public Health Unit.

9 REVIEW AND AUDIT

9.1 Evaluation and Audit

The DWMS will be maintained by the Manager Water Services.

- CCPs and their exceedances
- Improvement Plan
- Record keeping
- NSW Performance Monitoring

An external audit of the DWMS will be carried out as required by NSW Health.

NSW Department of Planning Industry and Environment (Water) Inspector carries out external assessment of the WTP on quarterly basis. NSW DPE (Water) and the NSW Health Public Health Unit may check key elements of the DWMS such as whether CCPs are implemented correctly and whether the improvement plan is being implemented. The NSW Health Regulation allows NSW Health to review a DWMS at any time.

9.2 Review by Senior Management

As part of the requirements of Council's reporting procedures, as detailed above, the Manager Water Services will review the effectiveness of the management system and report to the relevant Directors.

This review will be undertaken annually and will focus on reviewing of effectiveness and implementation of the DWMS.

10 DRINKING WATER QUALITY MANAGEMENT IMPROVEMENT PLAN

Improvement actions for Gunnedah Shire Council water supplies are listed below. Priorities have been determined based on the risks as identified through the workshop process. These are taken directly from the mitigated risk assessment tables.

The Council's Manager Water Services is responsible for the Improvement. The Improvement Plan is used by the Council to monitor the implementation of the drinking water management system.

Table 25 DWMS Improvement plan

Ref	Primary Hazard	Source of Hazard/ Hazardous event	Residual Risk	Improvement Items		
				This year	1-2 years	~5 years
1	Protozoa (Crypto/ Giardia) (Bore Water)	Ingress into bore	Medium		Welding sockets on boreheads so there are gland nuts on and can be fully sealed.	
2	Bacteria/ Virus	Ingress into bores or aquifer	Medium		Welding sockets on boreheads so there are gland nuts on and can be fully sealed.	
4	Pesticides	Contamination of aquifer	Medium	Talk to PHU about a project for pesticide screening on all bores.		
5	Bacteria/ Virus	Underdose chlorine	High	Install temperature probe at WTP reservoir, Update CCPs to include higher minimum chlorine to ensure effective disinfection. SOPS and CCPs to be available on sites.	-	
6	Bacteria/ Virus	Underdose chlorine - Mullaley Campdraft	High	Change the supply at the one customer at Campdraft that the supply is non-potable.		
8	Chlorine	Overdose chlorine	Medium		Change Mullaley and Tambar Springs to Cl2 (Gas) with Chlorine analyser onsite.	
12	Bacteria/ Virus (Reticulation)	Vermin contamination of reservoirs	High	Build new reservoirs in Tambar Springs		Links road to be assessed for access and hatch.
16	Bacteria/ Virus (Reticulation)	Backflow	High	Identify high risk sites to be prioritised. Develop register and testing strategy - including communication to customers of the requirements and costs.	New staff to get accreditation of backflow prevention	
18	Protozoa (Crypto/ Giardia) (Retic)	Backflow	High	Identify high risk sites to be prioritised. Develop register and testing strategy - including communication to customers of the requirements and costs.	New staff to get accreditation of backflow prevention	
20	Site Access	No easement for infrastructure	High	Identify all assets not on council or crown land/ potential for lack of access.	Develop strategy to formalise access to Council water infrastructure.	
21	Operator Error	e.g. from an accidental oversight, an untrained or overworked operator	High	Need to employ several new operators	Succession planning.	
22	Chemical Supply	Unable to supply	High		Change Mullaley and Tambar Springs to Cl2 (Gas)	

11 REFERENCES

1. ANZECC, Conservation Council and ARMCA&NZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1*, The Guidelines. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Sydney
2. CUPDR (2006) *NSW Code of Practice Plumbing and Drainage 3rd Edition*, Committee on Uniformity of Plumbing and Drainage, Sydney
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4. NHMRC, NRMMC (2011) *Australian Drinking Water Guidelines Paper 6* National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra
5. Sydney West Area Health Service (2010) *Guide for Submitting Water Samples to the Division of Analytical Laboratories for Analysis*. Sydney West Area Health Service, Lidcombe

APPENDIX A
LWU CIRCULAR 18

Gunnedah Shire Council

APPENDIX B
RISK BRIEFING DOCUMENT

Gunnedah Shire Council