North Burnett Regional Council

DRINKING WATER QUALITY MANAGEMENT PLAN

REVISION STATUS

Rev	Date	Prepared	Reviewed	Comment
Draft-1	11/05/2012	Kane Macready	Nil	
Draft-2	03/07/2012	Graham Cole	Trevor Harvey	
0	19/07/2012	Trevor Harvey	Graham Cole & Trevor Harvey	
Rev 1	31/07/2013	GHD -Fendall Hill & Gina Leach	Graham Cole & Trevor Harvey	Revision in response to issues raised in the OWSR letter of 16 November 2012
Rev 2	30/11/2017	Patty Chier (GHD) & Phil Taylor (GHD)		Revision to include additional information.
Rev 3	23/01/2018	Phil Taylor (GHD)		Updated data tables and graphs
Rev 4	21/02/2018	Phil Taylor (GHD)		Updated data tables and graphs
Rev 5	17/12/2018	Matthew Cook Brad Thode Patty Chier (GHD)	Peter Hirst Matthew Cook	This revision was undertaken by Council with assistance from GHD and the document have been reviewed by the NBRC Water Operations Team. Sections were added for Mingo and Paradise Dam Schemes.
Rev 6	28/06/2019	Matthew Cook Brad Thode Patty Chier (GHD)	Peter Hirst Matthew Cook	This revision was undertaken by Council with assistance from GHD and the document have been reviewed by the NBRC Water Operations Team. Additional information added for Mingo and plan modified based on feedback from DNRME, audit report and Wide Bay Burnett Organisation of Councils' regional assessment of DWQMP's.
Rev 7		Shaun Johnston Mark Curtis Katrina Cekanauskas	Peter Willey	A regular review and subsequent revision was undertaken by new management at NBRC. Regional issues and improvements have been removed from each system and

Rev	Date	Prepared	Reviewed	Comment
				centralised as region-wide issues with region-wide treatments. Brand-names have been removed from infrastructure descriptions where applicable. Assessment of UV systems and required upgrades and changes have been included. Plans to divest Council of one system (Paradise Dam) included. All past actions have been updated in tables and future actions consolidated accordingly. Operational and verification monitoring, CCPs, information that requires regular updating, and sensitive information have been appendicised so they can be updated separately and secured. Staff changes and new positions updated. Events, incidents, and audit addressed.

Executive Summary

The Australian Drinking Water Guidelines (ADWG) (NHMRC, NRMMC, 2011) was developed to provide guidance to water utilities and set out a framework to assist them in the development of a drinking water management system and provides the basis for the operational targets for Queensland water supply providers (WSPs). This framework incorporates elements from Hazard Analysis and Critical Control Point (HACCP) system, ISO 9001 (Quality Management) and AS/NZS 4360 (Risk Management).

This Drinking Water Quality Management Plan provides the basis for operations, supported by other referenced documents, procedures, and additional relevant information, referred to as supporting systems, to facilitate the supply of safe drinking water. It encompasses a description and understanding of the water supply systems, the water quality hazards present within the supply network and their associated risks.

Table of Contents

1. REGISTERED SERVICE DETAILS

1.1 Service Provider Details

Table 1-1 Registered Service Provider Details

Drinking Water Service Provider:		North Burnett Regional Council	**SPID**		490
Contact Details:					
Family Name:	Johnston	**First Name:**	Shaun	**Position:**	Water and Wastewater Manager
Postal Address:	PO Box 390 Gayndah Qld 4625				
Email Address:	admin@northburnett.qld.gov.au				

1.2 Scheme Details

North Burnett Regional Council (NBRC) owns and operates nine separate water supply schemes that cover several townships within the local government area. These schemes are detailed in Table 1-2.

Table 1-2 North Burnett Regional Council Water Supply Schemes

Scheme Name	Operator (Organisation)	Communities Served	Current (2016)			Projected in 10 years (2026)		
			Population Served	Connections	Demand ML/D	Population Served	Connections	Demand ML/d
Gayndah	NBRC	Gayndah	1981	1090	1.32	1980	1228	1.49
Biggenden	NBRC	Biggenden	845	438	0.28	960	493	0.32
Mundubbera	NBRC	Mundubbera	1261	573	0.99	1350	646	1.12
Mulgildie	NBRC	Mulgildie	174	64	0.07	160	72	0.08
Mount Perry	NBRC	Mount Perry	538	219	0.09	500	247	0.10
Monto	NBRC	Monto	1189	750	0.71	1250	845	0.80
Eidsvold	NBRC	Eidsvold	567	327	0.54	600	368	0.61
Mingo Crossing	NBRC	Mingo Crossing Caravan Park	2	16[2]	0.008	2	32	0.02
Paradise Dam	NBRC	Paradise Dam Caravan Park	2	7[2]	0.004	[2]	19	0.01

Notes: This figure is based on 2 permanent residents

The current population figures have been obtained from the 2016 Census data (except for Mingo Crossing and Paradise Dam as explained in the notes to the Table). The projected figures are based on reasonable projections, the average growth rate per annum between 2011 and 2016 Census data, which was calculated to be 1.2% shown not to be indicative.

Mingo Crossing and Paradise Dam projected figures have been calculated differently as they are caravan parks. They usually have 2 permanent residents. Only the Caretakers are counted in the population served.

The extent of the catchments from which various water supply schemes in NBRC draw their water is shown in Figure 1-1. This figure shows the complexity of the rivers, creeks, water courses and dams which all eventually join with the Burnett River. The North Burnett Region catchment includes the headwaters of most of the rivers and creeks which flow through this region. The Burnett River reaches the sea at Burnett Heads near Bundaberg. The diverse land uses within some of the catchments may present challenges to maintaining suitable water quality for urban water supply.

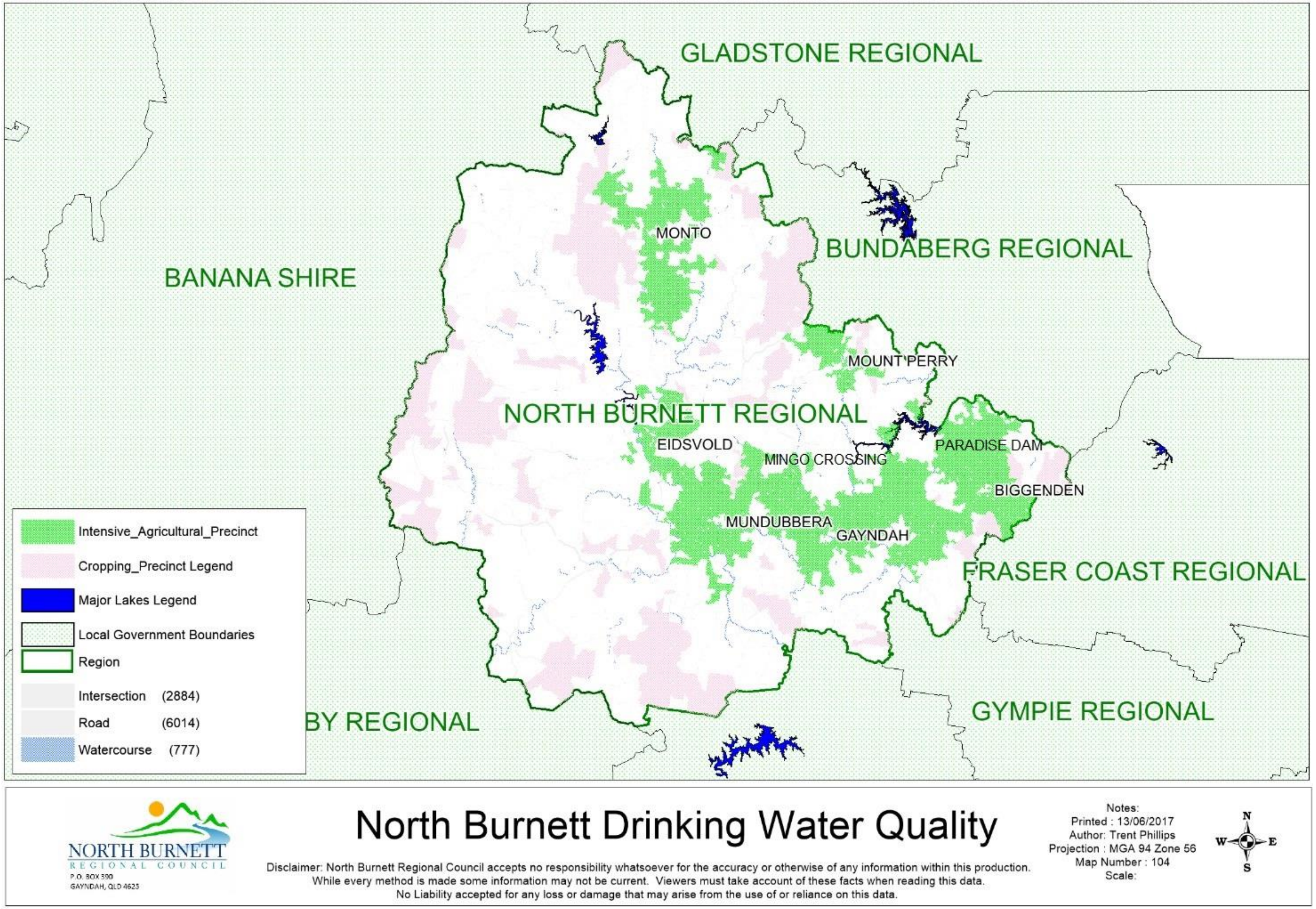


Figure 1-1 North Burnett Regional Council Water Catchments

2. KEY STAKEHOLDERS

The personnel listed in Table 2-1 were involved in the hazard identification and risk assessment process. They include the water supervisor and the senior operator responsible for each of the nine water supply schemes. This ensured that current and on-the-spot information was available to the team.

A list of external stakeholders relevant to this DWQMP is provided in Table 2-2. These stakeholders have a role in the supply of key chemicals for water treatment, or a critical interest in a safe and reliable water supply, either from a regulatory or consumption perspective.

Table 2-1 Internal Stakeholders

Contact Name & Organisation	Relevance to management of drinking water quality	How the stakeholder is engaged in the DWQMP	Operational Experience with NBRC	Experience in Risk Assessment Process
Randall Percy North Burnett Regional Council	General Manager Works	General, as Executive Manager responsible	24 Months with Council; Previous experience as contractor in water industry	N/A
Shaun Johnston North Burnett Regional Council M: 0458 771 193 E: shaun.johnston@northburnett.qld.gov.au	Water and Wastewater Manager	Operational Manager: Risk assessment and management, Water Treatment Plant (WTP)process assessment and compliance; Network risk assessment and compliance	15 months with Council; 12 years industry experience as Project Manager, Treatment and Compliance Manager and Water and Wastewater Manager	Position requires assessment and monitoring of risk in water and sewer operations across the whole jurisdiction of NBRC, including WH&S, water quality, and Regulatory compliance and performance standards in both water and sewer service delivery. Also Responsible for planning and obtaining funding for needed upgrades..
Mark Curtis North Burnett Regional Council M: 0437 502 453 E: mark.curtis@northburnett.qld.gov.au	Senior Water and Wastewater Supervisor	Risk assessment, WTP and process assessment	9 years	Assessment and monitoring of risk in daily treatment and supply of water and sewer services for the Region, including WH&S, water quality, and regulatory compliance and performance standards in both water and sewer service delivery.
Peter Willey North Burnett Regional Council M: Peter.willie@northburnett.qld.gov.au	Senior Water and Wastewater Technical Officer	Compliance: assessment of processes, reporting of shortfalls, provision of system solutions; data collection, analysis and reporting	9 months	Experienced water engineer and manager
Laurie Hebblewhite North Burnett Regional Council M: 0419 780 894 E: laurie.hebblewhite@northburnett.qld.gov.au	Senior Water and Wastewater Operator – Biggenden and Paradise Dam	Risk assessment, WTP and process assessment	23 years with Biggenden Shire Council previous to amalgamation and 13 years with NBRC since amalgamation	Position requires assessment and monitoring of risk in daily treatment and supply of water and sewer services for the towns of Biggenden and Paradise Dam, including WH&S, water quality, and Regulatory compliance and performance standards in both water and sewer service delivery. Operator has adequate skills and experience and is able to assist the manager with risk assessments and mitigation.
Jordan Giddins North Burnett Regional Council M: 0428 408 986 E: Jordan.giddins@northburnett.qld.gov.au	Senior Water and Wastewater Operator – Gayndah and Mingo Crossing	Risk assessment, WTP and process assessment	6 years with Council	Position requires assessment and monitoring of risk in daily treatment and supply of water and sewer services for the towns of Gayndah and Mingo Crossing, including WH&S, water quality, and Regulatory compliance and performance standards in both water and sewer service delivery.

Contact Name & Organisation	Relevance to management of drinking water quality	How the stakeholder is engaged in the DWQMP	Operational Experience with NBRC	Experience in Risk Assessment Process
				Operator has adequate skills and experience and is able to assist the manager with risk assessments and mitigation.
Ashley Augustine North Burnett Regional Council M: 0429 653 997 E: ashley.augustine@northburnett.qld.gov.au	Senior Water and Wastewater Operator – Mundubbera and Eidsvold	Risk assessment, WTP and process assessment	9 years with NBRC since amalgamation	Position requires assessment and monitoring of risk in daily treatment and supply of water and sewer services for the towns of Mundubbera and Eidsvold, including WH&S, water quality, and Regulatory compliance and performance standards in both water and sewer service delivery. Operator has adequate skills and experience and is able to assist the manager with risk assessments and mitigation.
Rob Staines North Burnett Regional Council M: 0429 661 725 E: rob.staines@northburnett.qld.gov.au	Senior Water and Wastewater Operator – Monto, Mt. Perry and Mulgildie	Risk assessment, WTP and process assessment	9 years with Monto Shire Council previous to amalgamation and 13 years with NBRC since amalgamation	Position requires assessment and monitoring of risk in daily treatment and supply of water and sewer services for the towns of Monto and Mulgildie, including WPH&S, water quality, and Regulatory compliance and performance standards in both water and sewer service delivery. Operator has adequate skills and experience and is able to assist the manager with risk assessments and mitigation.
Jeff Miles North Burnett Regional Council M: 0427 669 919 E: jeff.miles@northburnett.qld.gov.au	Environmental Services Manager	Review and Compliance	4 years	Position requires assessment and monitoring of risk relating to public health and environmental compliance of Council activities.

Table 2-2 External Stakeholders

Scheme	Organisation	Relevance to management of drinking water quality	Contact details
All Schemes	IXOM Operations	Chemical Supplier	1300 550 036
	Coogee QCA Pty Ltd	Chemical Supplier	(07) 3987500
	Qld Health Laboratory	Laboratory Service Provider	(07) 3274 9075
	Office of the Water Supply Regulator	Regulatory Agency	(07) 3199 4871

Scheme	Organisation	Relevance to management of drinking water quality	Contact details
	Toll Courier Service	Transport Service Provider	1300 366 684
Biggenden	Biggenden Hospital	Vulnerable Customers	(07) 4127 6400
Biggenden	Biggenden State School	Vulnerable Customers	(07) 4127 6333
Biggenden	Biggenden & District Kindergarten	Vulnerable Customers	(07) 4127 1259
Eidsvold	Eidsvold Hospital	Vulnerable Customers	(07) 4165 7100
Eidsvold	Eidsvold Kindergarten	Vulnerable Customers	(07) 4165 1200
Eidsvold	Eidsvold State School	Vulnerable Customers	(07) 4165 7333
Eidsvold	SunWater	Raw Water Supply	13 15 89 (24 hour emergency) (07) 3120 0000 (Office)
Gayndah	Gayndah Hospital	Vulnerable Customers	(07) 4161 3500
Gayndah	Gayndah State School	Vulnerable Customers	(07) 4160 3333
Gayndah	Gayndah High School	Vulnerable Customers	(07) 4161 3888
Gayndah	St Joseph's Primary	Vulnerable Customers	(07) 4161 1889
Gayndah	Burnett State College	Vulnerable Customers	(07) 4161 3888
Gayndah	Gayndah Early Learning Centre	Vulnerable Customers	(07) 4140 8555
Gayndah	Gunther Village	Vulnerable Customers	(07) 4161 3699

Scheme	Organisation	Relevance to management of drinking water quality	Contact details
Gayndah	SunWater	Raw Water Supply	13 15 89 (24 hour emergency) (07) 3120 0000 (Office)
Mingo Crossing	SunWater	Raw Water Supply	13 15 89 (24 hour emergency) (07) 3120 0000 (Office)
Mount Perry	Mount Perry Medical Centre	Vulnerable Customers	(07) 4156 2300
Mount Perry	Mount Perry State School	Vulnerable Customers	(07) 4156 3241
Monto	Monto Hospital	Vulnerable Customers	(07) 4166 9300
Monto	Monto Kindergarten	Vulnerable Customers	(07) 4166 1584
Monto	North Burnett Childcare services	Vulnerable Customers	(07) 4166 1769
Monto	Monto State School	Vulnerable Customers	(07) 4166 9111
Monto	Monto State High School	Vulnerable Customers	(07) 4166 9555
Monto	St Therese's Catholic Primary School	Vulnerable Customers	(07) 4166 1654
Monto	Ridge Haven Retirement Complex	Vulnerable Customers	(07) 4166 1654
Monto	SunWater	Raw Water Supply	13 15 89 (24 hour emergency) (07) 3120 0000 (Office)
Mulgildie	Department of Natural Resources and Mines	Artesian Raw Water Supply	13 74 68
Mulgildie	Mulgildie State School	Vulnerable Customers	(07) 4167 2154

Scheme	Organisation	Relevance to management of drinking water quality	Contact details
Mundubbera	Mundubbera Hospital	Vulnerable Customers	(07) 4167 2154
Mundubbera	Mundubbera Family Day Care	Vulnerable Customers	(07) 4165 3099
Mundubbera	Mundubbera Kindergarten	Vulnerable Customers	(07) 4165 4170
Mundubbera	Mundubbera State School	Vulnerable Customers	(07) 4165 5333
Mundubbera	Burnett State College	Vulnerable Customers	(07) 4161 3888 (Gayndah number)
Mundubbera	SunWater	Raw Water Supply	13 15 89 (24 hour emergency) (07) 3120 0000 (Office)
Paradise Dam	SunWater	Raw Water Supply	13 15 89 (24 hour emergency) (07) 3120 0000 (Office)

3. HAZARD IDENTIFICATION, RISK ASSESSMENT AND UNCERTAINTY

3.1 Methodology

The methodology adopted for the risk assessment is consistent with the risk assessment recommendations advised by DERM throughout the advisory stage of this project. This is consistent with the risk methodology within AS/NZS 4360:2004. The description includes definitions for the (qualitative) likelihood and consequence descriptors (Table 3-1).

Three workshops were undertaken with NBRC personnel to identify the risks throughout the water supply chain including source, treatment and reticulation. NBRC has indicated that an acceptable level of risk is equal to or less than Medium (6) as defined by Table 3-2.

Table 3-1 Risk Methodology

Likelihood	Descriptors
Rare	Occurs less than or equal to once every 5 years.
Unlikely	Occurs more often than once every 5 years and up to once per year.
Possible	Occurs more often than once per year and up to once a month (12/yr)
Likely	Occurs more often than once per month (12/yr) and up to once per week (52/yr)
Almost Certain	Occurs more often than once per week (52/yr)
Consequence	Descriptors
Insignificant	Isolated exceedance of aesthetic parameter with little or no disruption to normal operation.
Minor	Potential local aesthetic, isolated exceedance of chronic health parameter.
Moderate	Potential widespread aesthetic impact or repeated breach of chronic health parameter.
Major	Potential acute health impact, no declared outbreak expected
Catastrophic	Potential acute health impact, declared outbreak expected.

Table 3-2 Likelihood and consequence risk matrix

Likelihood	**Consequence**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost Certain	Medium (6)	High (10)	High (15)	Extreme (20)	Extreme (25)
Likely	Medium (5)	Medium (8)	High (12)	High (16)	Extreme (20)
Possible	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
Unlikely	Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
Rare	Low (1)	Low (2)	Low (3)	Medium (5)	Medium (6)

3.2 Uncertainties

The quality of information underpinning the risk assessment varies significantly throughout all schemes. The following table demonstrates the qualitative description to identify the reliability of the data.

Table 3-3 Levels of Uncertainty

Level of Uncertainty	Definition
Certain	There is 5 years of continuous monitoring data, which has been trended and assessed, with at least daily monitoring; or The processes involved are thoroughly understood.
Confident	There is 5 years of continuous monitoring data, which has been collated and assessed, with at least a weekly monitoring or for the duration of seasonal events; or There is a good understanding of the processes involved.
Reliable	There is at least a year of continuous monitoring data available, which has been assessed; or There is reasonable understanding of the processes involved.
Estimate	There is limited monitoring data available; or There is limited understanding of the processes involved.
Uncertain	There is limited or no monitoring data available; or The processes are not well understood.

4. BIGGENDEN WATER SUPPLY SCHEME

4.1 Details of Infrastructure for Providing the Service

Source Water

Biggenden, current population 845 (2016 census), is the eastern-most town in North Burnett Regional Council's jurisdiction. The primary sources of water for the Biggenden water supply are Bores 1 and 2 located in aquifers adjacent to Degilbo Creek and creek offtake. Bore 2 is normally used in preference to Bore 1, due to its higher capacity. When operationally possible, the bores are alternated on a fortnightly basis to attempt to provide even usage and wear of the respective pumps at both bores. The capacity of the bores under drought conditions, when Degilbo Creek is dry, has been modelled.

The river abstraction infrastructure (pump intake, submersible pump and associated infrastructure) is operational and used in cycles with the bores.

This alternative creek raw water source is sometimes unavailable for use, either because of low natural flow in the creek or following heavy rain when Degilbo Creek floods and the water quality deteriorates.

Treatment Process

Pre-dosing of the raw water with sodium hypochlorite for oxidation of manganese and iron prior to treatment. The raw water is then dosed with aluminium chlorohydrate (ACH) and LT25 Polymer prior to clarification and filtration.

Chlorine dosing of the treated water occurs during filtration.

The Biggenden WTP is automatic in operation. The WTP has staff onsite daily to conduct manual visual plant inspections. The WTP pumps and reservoir levels are linked to the NBRC SCADA management system. If problems at these WTP elements are detected through this SCADA system (i.e. failure of pump, low or overflow reservoir levels) an alarm is triggered, and an automatic SMS is sent to the water and wastewater manager and operator's phones. The operator will then be called out to address this SCADA alarm condition.

The Biggenden WTP has online analysers for chlorine, pH and turbidity. A failure in the chlorine injection system would trigger an alarm through SCADA. There is a 1,500 L chlorine storage tank at the WTP, the level of which is reviewed daily by operators. There is a documented operating manual for the WTP. The WTP schematic is displayed below in Figure 4-1.

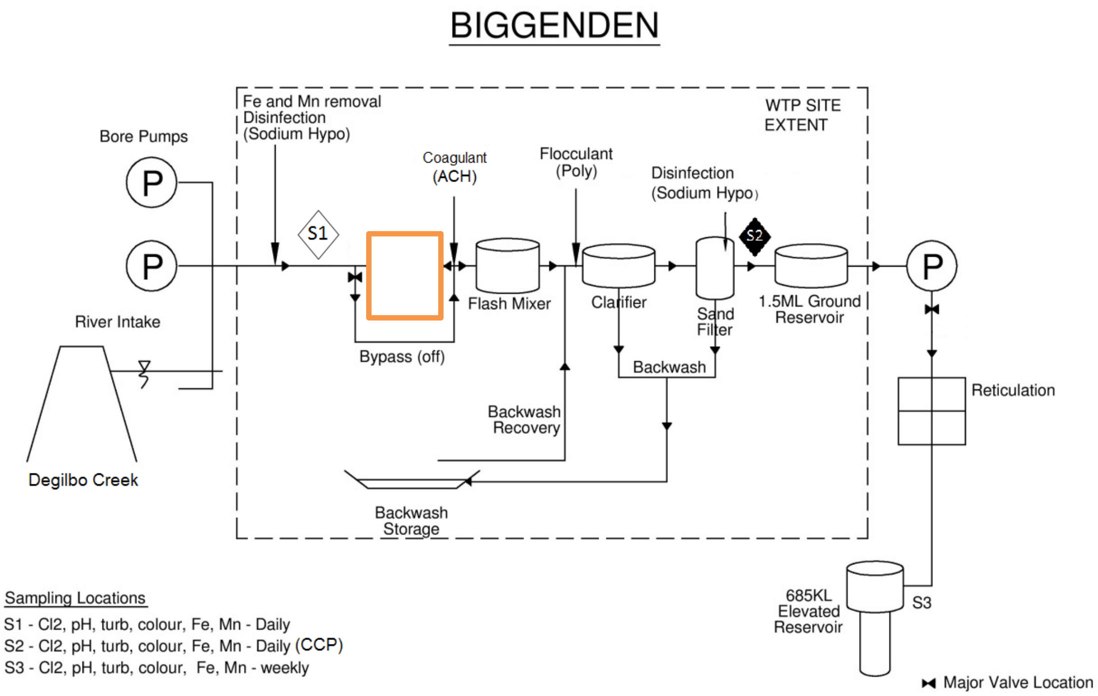


Figure 4-1 Biggenden WTP Schematic

Distribution

Following treatment and storage, potable water is pumped from the Ground Reservoir at the WTP through the reticulation to a 685 kL Elevated Reservoir. When the pumps are not in operation, the water is gravity fed from the Elevated Reservoir back into the Reticulation.

Sampling locations are sited at key points determined to provide the best indication of chlorine residual levels in the system. Raw water samples are taken monthly at the plant and sent to Queensland Health for chemical and biological analysis. Samples are also taken each month from a minimum of one (1) of the six (6) reticulation system residual chlorine sampling points (selected on a rotational basis) and sent to Qld Health for biological analysis. One reticulation sample is taken each quarter and sent to Qld Health for chemical analysis.

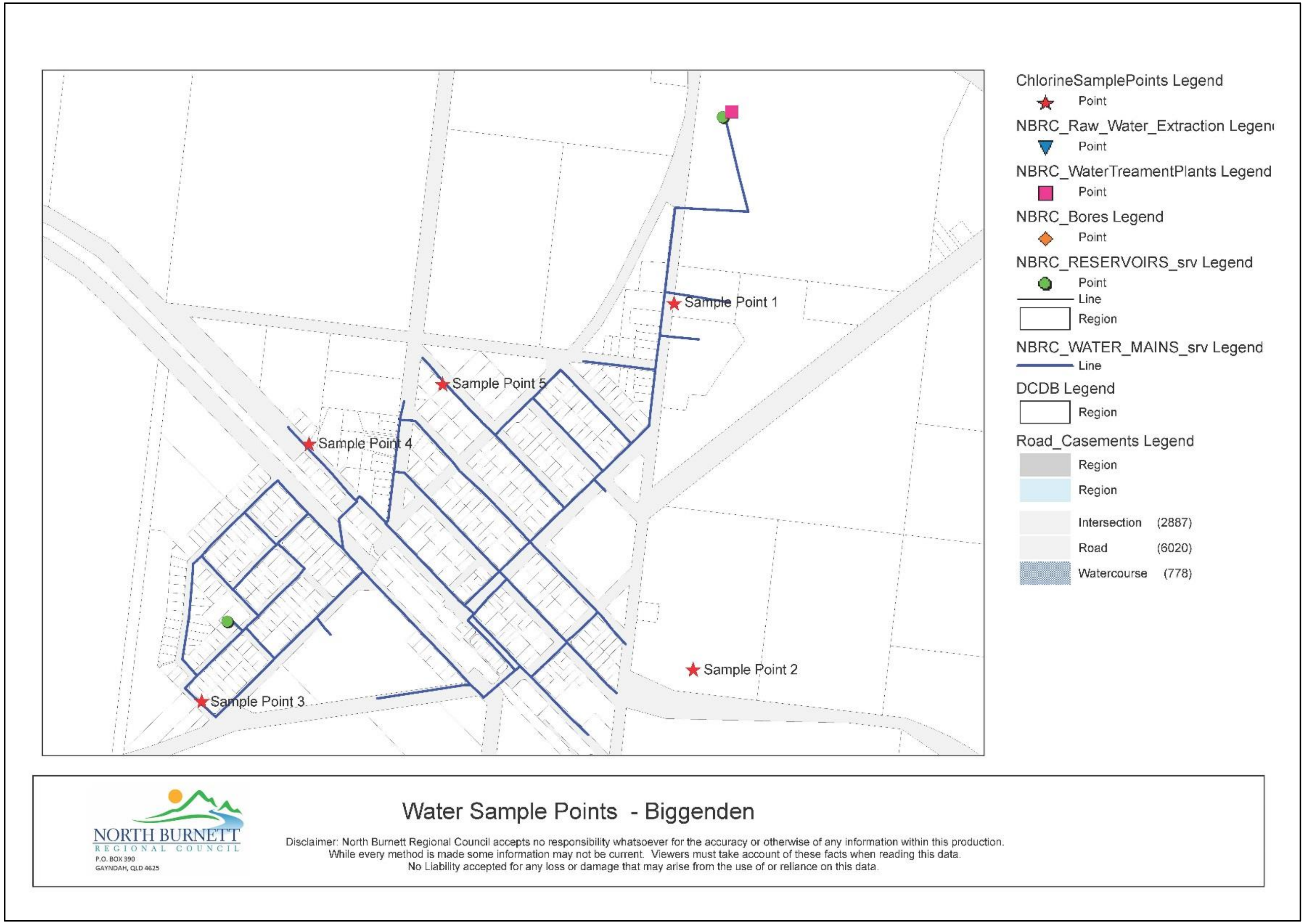


Figure 4-2 Biggenden Water Supply Map

Table 4-1 Infrastructure Details – Biggenden Water Supply Scheme

Component		Scheme 1
Sources	**Name**	**Degilbo Creek**
	Type	River
	% of supply	10%
	Reliability	Seasonal
	Water quality issues	High turbidity, arsenic, hardness, and conductivity (dissolved salts) and manganese
	Name	**Bore 1 and 2**
	Type	Bores
	% of supply	90%
	Reliability	Reliable, pumped supply from aquifer
	Water quality issues	High in hardness, conductivity (dissolved salts), manganese and some evidence of arsenic–arsenic at moderate level from samples NBRC have added arsenic to the verification monitoring schedule.
Sourcing Infrastructure	Degilbo Creek	River Intake (single intake structure) Pump Nominal Capacity = 14L/s Submersible Pumps Protection = Intake is protected from debris by a pipe strainer. Intake is protected from flood damage by pylons installed in a staggered formation upstream of the intake. Pylons are meant to divert debris away from intake. Ownership = NBRC
	Bore 1	Pump Capacity = 8L/s Submersible Bore Pumps Casing = PVC

Component		Scheme 1
		Diameter = DN250 Depth =16m Ownership = NBRC
	Bore 2	Pump Nominal Capacity = 14L/s @ 45m Submersible Bore Pumps Casing = PVC Diameter = DN250 Depth = 30 m Ownership = NBRC
Are there any sources that **do not** undergo treatment prior to supply?	No	
Biggenden WTP	Name	Biggenden WTP
	Process	Aquagenics WTP Process comprises clarification, and filtration.
	Design Capacity (20 hr operation)	1.0 ML/d
	Daily flow range	200 – 700 kL/d
	Chemicals added	ACH, polymer, sodium hypochlorite
	Standby chemical dosing facilities (Y/N)	N
	Water sourced from and %	River 10% and Bore 90%
	% of average day demand provided	100%
	% of scheme supply Distribution area supplied	100%
	Bypasses / Variations	No

Component		Scheme 1
Are there any sources that **do not** undergo disinfection prior to supply?	No	
Disinfection	Location	Dosed into sand filter and prior to reticulation
	Make and Date installed	7.5-16 FCM
	Type	Liquid sodium hypochlorite via diaphragm dosing pump
	Dose rate	Based on in-line analyser
	Target residual levels	0.5 mg/L
	Duty/standby	No
	Dosing arrangements	Dose rate also adjusted on receipt of new supply of chlorine and when changing water source.
	Alarms	No alarms
	Auto shut-off arrangements	No
Distribution and Reticulation System	Pipe material	AC
	Age range	35- 45 years
	Approx. % of total length	100%
	Areas where potential long detention periods could be expected	Water is pumped *through* the reticulation system to the tower reservoir. If town is supplied *only* from the tower chlorine may be low.
	Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	Nil
Ground Reservoir	Name	Clear Water Reservoir
	Capacity (ML)	1.5 ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

Component		Scheme 1
Elevated Reservoir	Name	Elevated Reservoir
	Capacity (ML)	685kL
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

4.2 Biggenden Water Quality: Identifying Hazards and Hazardous Events

Water quality information has been collected by NBRC for raw water, treated water and reticulated supply for the period of January 2010 to November 2018. Analysis of this data has been completed to assess the results in comparison to the Australian Drinking Water Guidelines (ADWG) values for parameters measured.

A summary of the water analysis undertaken for the Biggenden Water Supply Scheme is contained in Table 4-3, Table 4-4 and Table 4-5. Section 4.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

The reticulated water scheme has been measured for pH, residual chlorine, *E. coli* and total coliforms.

Interpretation

Over the period of sampling, daily testing was performed on raw, treated and reticulated water by water operators. Microbiological and chemical analytes were tested on a monthly basis by the Queensland Health and Forensic Services (QHFSS) to meet the requirements of the scheme.

All parameters tested showed levels below the health guideline values for treated water except for nitrate, which was exceeded in March 2012.

Within the reticulation system test results, there was one instance where total coliforms were detected. Potential water quality issues did arise within the reticulation system due to previously low levels of residual chlorine. There were also a large number of data points missing from the data provided and a number of very high outlying readings. Increased frequency of sampling and testing, recording and operational response, has since reduced this risk.

Table 4-2 Biggenden Raw Water Source

Biggenden Source – Bore							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Turbidity (NTU)	Bore 2	Jan 2010 – Nov 2018	98	174	98.7	<1	
Fluoride	Bore 2	Jan 2010 – Nov 2018	98	0.5	0.15	<0.05	Multiple limits of detection were used (<0.05, <0.1 and <0.25). In order to calculate the stats, the absolute values were used.
Nitrate	Bore 2	Jan 2010 – Nov 2018	98	58	1.9	<0.5	Multiple limits of detection were used (<0.5, <1 and <2.5). In order to calculate the stats, the absolute values were used.
Sulfate	Bore 2	Jan 2010 – Nov 2018	98	73	21.9	3.6	
Dissolved metals							
Aluminium	Bore 2	Jan 2010 – Nov 2018	98	0.18	0.052	<0.05	Multiple limits of detection were used (<0.05 and <0.1). In order to calculate the stats, the absolute values were used.
Boron	Bore 2	Jan 2010 – Nov 2018	98	0.11	0.06	0.02	
Copper	Bore 2	Jan 2010 – Nov 2018	98	0.14	0.032	<0.03	Multiple limits of detection were used (<0.03 and <0.06). In order to calculate the stats, the absolute values were used.
Iron	Bore 2	Jan 2010 – Nov 2018	98	0.31	0.016	<0.01	Multiple limits of detection were used (<0.01 and <0.02). In order to calculate the stats, the absolute values were used.
Manganese	Bore 2	Jan 2010 – Nov 2018	98	1.5	0.68	<0.01	
Zinc	Bore 2	Jan 2010 – Nov 2018	98	0.48	0.03	<0.01	Multiple limits of detection were used (<0.01 and <0.02). In order to calculate the stats, the absolute values were used.

Biggenden Source – Bore							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time Period**	**No of samples**	**Summary of Results**			**Comments**
				Maximum Value	**Average Value**	**Minimum Value**	
Total metals							
Aluminium	Bore 1 & 2	Nov 2017 – Oct 2018	5	<0.003	<0.003	<0.003	All samples were <0.003 mg/L
Arsenic	Bore 1 & 2	Nov 2017 – Oct 2018	5	0.021	0.013	0.0072	
Cadmium	Bore 1 & 2	Nov 2017 – Oct 2018	5	<0.0001	<0.0001	<0.0001	All samples were <0.0001 mg/L
Chromium	Bore 1 & 2	Nov 2017 – Oct 2018	5	<0.0001	<0.0001	<0.0001	All samples were <0.0001 mg/L
Copper	Bore 1 & 2	Nov 2017 – Oct 2018	5	0.005	0.003	<0.001	
Iron	Bore 1 & 2	Nov 2017 – Oct 2018	5	9.2	7.36	6	
Lead	Bore 1 & 2	Nov 2017 – Oct 2018	5	0.0002	0.00012	<0.0001	
Manganese	Bore 1 & 2	Nov 2017 – Oct 2018	5	1.1	0.9	0.54	
Nickel	Bore 1 & 2	Nov 2017 – Oct 2018	5	0.0013	0.0009	0.0008	
Zinc	Bore 1 & 2	Nov 2017 – Oct 2018	5	0.034	0.016	0.008	

Table 4-3 Biggenden Treated Water

Plant	Biggenden WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Turbidity (NTU)	WTP	Jan 2010 – Nov 2018	106	2	1.03	<1	5	0	Aesthetic guideline only
Fluoride	WTP	Jan 2010 – Nov 2018	106	0.6	0.17	<0.1	1.5	0	Multiple limits of detection were used (<0.1, <0.2, <0.25 and <0.5). In order to calculate the stats, the absolute values were used.
Nitrate	WTP	Jan 2010 – Nov 2018	106	59	2.2	<0.5	50	1	Aesthetic guideline only Multiple limits of detection were used ranging from <0.5 to <5). In order to calculate the stats, the absolute values were used. Exceedance in March 2012
Sulphate	WTP	Jan 2010 – Nov 2018	106	57	22.8	10.6	250	0	Aesthetic guideline only
Dissolved metals									
Aluminium	WTP	Jan 2010 – Nov 2018	106	<0.05	<0.05	<0.05	0.1	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable All samples taken were <0.05 mg/L

Plant	Biggenden WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Boron	WTP	Jan 2010 – Nov 2018	106	0.11	0.057	0.02	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L Most samples below detection limit.
Copper	WTP	Jan 2010 – Nov 2018	106	0.15	0.03	<0.03	2 (1)	0	Number in brackets denotes the aesthetic guideline value Multiple limits of detection were used (<0.03 and <0.15). In order to calculate the stats, the absolute values were used.
Iron	WTP	Jan 2010 – Nov 2018	106	0.05	0.01	<0.01	0.3	0	Aesthetic guideline only Multiple limits of detection were used (<0.01 and <0.05). In order to calculate the stats, the absolute values were used.

Plant	Biggenden WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Manganese	WTP	Jan 2010 – Nov 2018	106	0.23	0.015	<0.01	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value Most samples below detection limit, though one exceedance of the aesthetic guideline value occurred in Oct 2012 Multiple limits of detection were used (<0.01 and <0.15). In order to calculate the stats, the absolute values were used.
Zinc	WTP	Jan 2010 – Nov 2018	106	0.51	0.021	<0.01	3	0	Multiple limits of detection were used (<0.01 and <0.05). In order to calculate the stats, the absolute values were used.
Total metals									
Aluminium	WTP	Nov 2017 – Oct 2018	3	0.011	0.0063	0.004	0.2	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable
Arsenic	WTP	Nov 2017 – Oct 2018	3	0.0003	0.00026	0.0002	0.01	0	
Cadmium	WTP	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L

Plant	Biggenden WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Chromium	WTP	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.05	0	All samples were <0.0001 mg/L
Copper	WTP	Nov 2017 – Oct 2018	3	0.002	0.0013	<0.001	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	WTP	Nov 2017 – Oct 2018	3	0.021	0.015	0.009	0.3	0	Aesthetic guideline only
Lead	WTP	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.01	0	All samples were <0.0001 mg/L
Manganese	WTP	Nov 2017 – Oct 2018	3	0.0039	0.0027	0.0007	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Nickel	WTP	Nov 2017 – Oct 2018	3	0.0007	0.0005	0.0003	0.02	0	
Zinc	WTP	Nov 2017 – Oct 2018	3	0.003	0.002	0.001	3	0	Aesthetic guideline only

Table 4-4 Biggenden Reticulated Water Supply

Scheme	Biggenden Reticulated Water							
Sampling Location								
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
pH (pH units)	Jan 2010 – Nov 2018	106	8.02	7.47	6.56	6.5 - 8.5	0	Aesthetic guideline only
Disinfectant residual	Jul 2016 – Jun 2018	65	2.3	1.4	0.54	>0.2 - 0.5	0	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition
Total coliforms (mpn/100mL)	Jul 2016 – Jun 2018	66	10	0.2	0	NA	NA	
E. coli (CFU/100mL)	Jul 2016 – Jun 2018	66	0	0	0	None detected	0	
Trihalomethanes	Sept 2016 – Oct 2018	5	0.104	0.046	0.016	0.25	0	

Table 4-5 Biggenden Water quality complaints

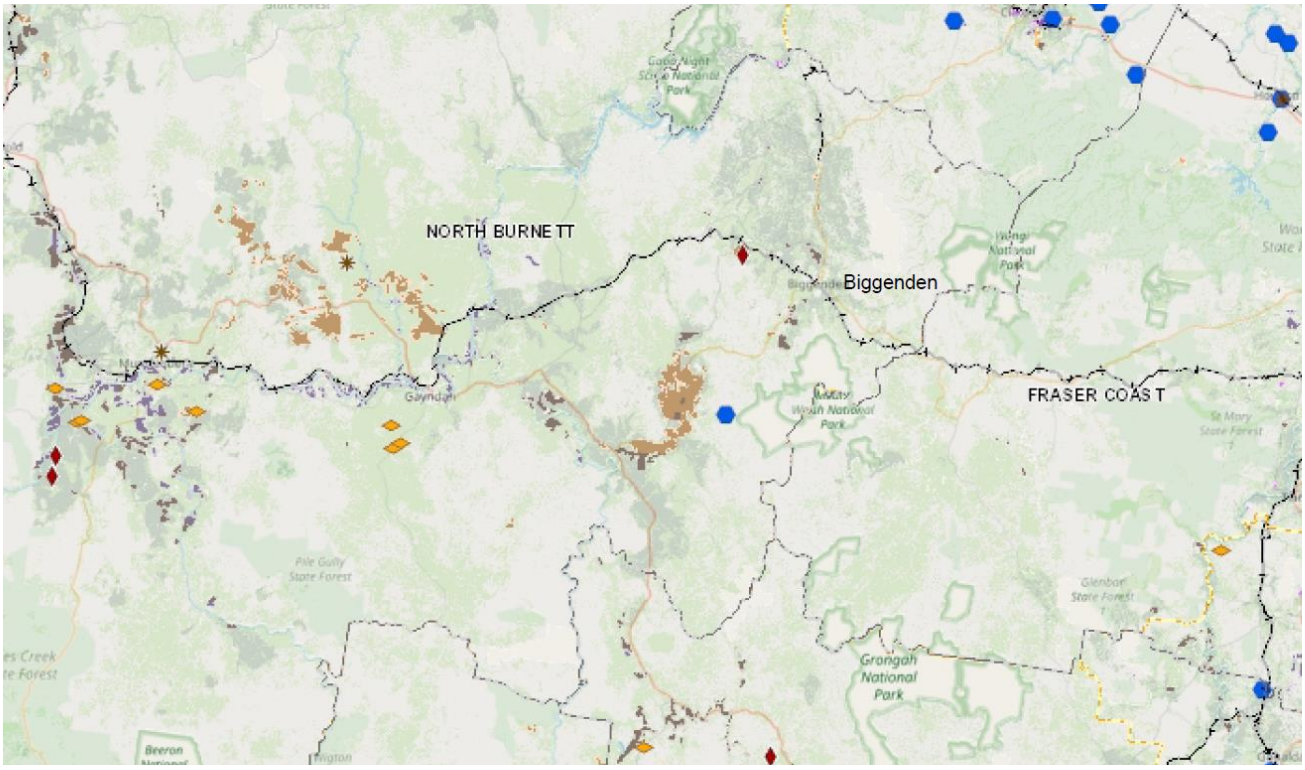
Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
1-7-2010 To 26-10-2018	0	0			

4.3 Biggenden (Degilbo Creek) Catchment Characteristics

The Degilbo Creek catchment area is a rural grazing area with few environmental threats to natural water courses e.g. pesticides, fertilizer. The catchment varies from flats along the creeks to undulating and hilly. The topography is dominated by The Bluff Mountain which lies about 10 kilometres to the South of Biggenden. Degilbo creek itself conjoins with several smaller creeks including Mungore Creek and Fairview Creek. Biggenden is the only town within the catchment. Districts such as Degilbo and Didcot also have a very small number of rural residential properties. Economic activity throughout the catchment is restricted to grazing cattle though there are a few dairy farms in the catchment precincts (see Figure 4-3). Risk to water quality in the Degilbo catchment is therefore restricted to possible contamination caused by unrestricted access to the creek by cattle or natural events such as flooding and drought.

Past snapshot sampling and testing has revealed higher than expected arsenic levels in water samples taken from Degilbo Creek. Latest treated water results demonstrate that the supply is still well within safe drinking water guidelines, and the arsenic levels are still monitored for at least annually.

Water is pumped from the Degilbo creek directly or from two alluvial bores that adjoin the river. Both bores are fully enclosed and raised, preventing storm water ingress.



Legend:

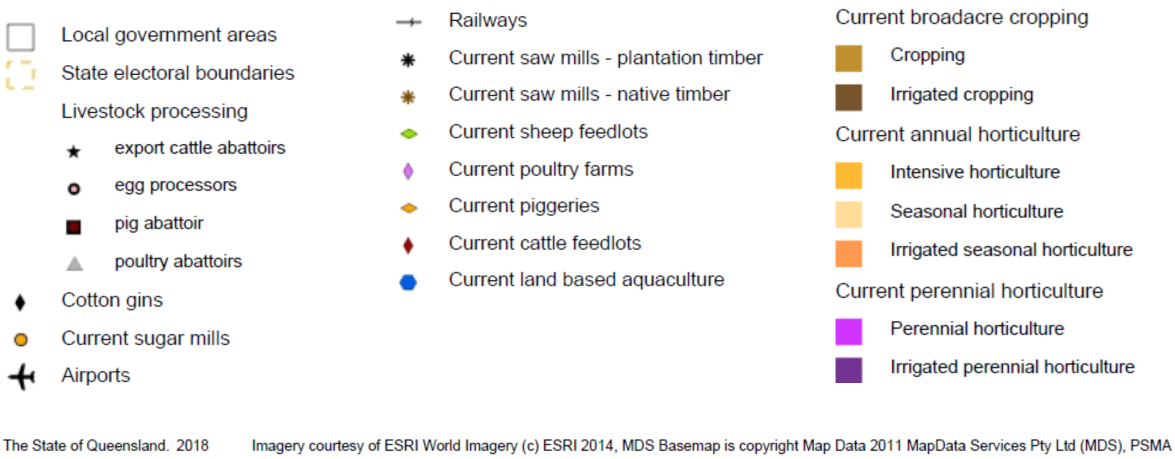


Figure 4-3 Biggenden and Degilbo Creek Catchment Area

4.4 Biggenden Hazard Identification, Risk Assessment and Uncertainty

Table 4-6 Biggenden Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Likely	High (10)	1. The bores are completely enclosed and appropriately cased so stormwater runoff and infiltration is avoided and vermin cannot enter 2. Filtration and coagulation	Catastrophic	Rare	Medium (6)	Uncertain	Degilbo creek poses the only risk as it is a natural surface watercourse.	Seek alternate source and funding to develop Seek funding for UV in new plant
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Likely	High (10)	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection at raw water and at filter stage and leaving clearwater reservoir 3. Coagulation and filtration	Catastrophic	Rare	Medium (6)	Uncertain	Historically, low levels of bacteria found in scheme	Seek alternate source and funding to develop Seek plant replacement funding for UV in new plant
3	Source water	Chemical contamination • Heavy metals: Arsenic	1. Natural arsenic and other chemicals in water	Major	Likely	High (16)	1. Treatment processes, coagulation and filtration .	Major	Unlikely	Medium (8)	Confident	Main concern is arsenic level in raw water which is removed in the treatment process. These parameters are regularly monitored in the treated water.	Seek alternate source and funding to develop Plant replacement funding.
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Minor	Likely	Medium (6)	1. Treatment processes, coagulation and filtration	Minor	Unlikely	Low (4)	Uncertain	Few farmers use either pesticides or fertiliser as the area is predominantly grazing. These parameters are regularly monitored in the treated water.	Seek alternate source and funding to develop and PAC dosing in plant replacement
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Natural chemicals in water	Moderate	Likely	Medium (6)	1. Treatment processes, coagulation, oxidisation with Cl for iron and manganese	Moderate	Rare	Low (3)	Confident	Hardness and conductivity ongoing aesthetic issues for customers	Seek funding for plant replacement Seek alternate source and funding to develop
6	Source water	Chemical contamination	1. Accidental spills	Moderate	Rare	Low (3)	1. Detection and dilution during treatment processes and storage 2. Emergency response Public notification process (do not drink alert)	Moderate	Rare	Low (1)	Confident	Small concentration. Only risk of any real consequence would be a chemical spill near the intake Inability to predict type or consistency of possible spill	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	Minor	Possible	Medium (6)	1. Treatment processes –sand filters 2. Public notification process (boil water alert)	Minor	Unlikely	Low (4)	Confident		
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. Blockage of creek intake structure	Moderate	Possible	Medium (6)	1. Estimated one week's supply in reserve at clearwater and tower reservoir. 2.Trucked water from other towns as backup supply	Moderate	Rare	Low (3)	Confident		Seek plant replacement funding
9	Source water	Lack of supply	Climatic variations	Moderate	Possible	High (12)	1. Importing water 2. Drought management Plan actions: restrictions, communication etc 3. Increasing WTP operating times	Moderate	Rare	Low (3)	Confident	Modelling done.	Option: Ensure DMP is up-to-date and appropriate. Seek alternate source and funding to develop
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	Major	Possible	High (12)	1. Treatment processes – Chlorine disinfection at raw water and at filter stage and leaving ground reservoir 2. Chlorine levels are tested once per day. 3. Injection pump and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment **Biggenden 2013-01** Operation of chlorine injection system have been linked to water flow. **Biggenden 2013-02** Online analyser has been installed and alarmed. On-line chlorine and turbidity analysers installed for WTP. **Biggenden 2018-02:** Spare dosing pump is readily available for use	Major	Rare	Medium (5)	Reliable	Multiple points of treatment but improvements can be made	Plant upgrade including UV Seek alternate source and funding to develop

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Filtration (limited efficacy) 3. Trained and qualified operators – good housekeeping	Catastrophic	Rare	Medium (6)	Uncertain	Option: Raw and treated water monitoring program has been reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations.	Seek plant replacement funding for UV in new plant Seek alternate source and funding to develop
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication breakdown (alarms) 4. Staff error 5. Plant Design	Moderate	Unlikely	Medium (6)	1. Treatment processes, flocculation, clarifier, oxidisation with Cl for iron and manganese 2. Chemical injection levels are tested once per day. 3. Dosing equipment is checked once per day. 4. Trained and qualified operators – good housekeeping	Moderate	Rare	Low (3)	Confident	Clear water pump failure causes an alarm but does not shut down injection pumps Existing measures are robust.	Upgraded systems with plant replacement-seek funding.
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Plant Design THM monitoring have commenced. All results are below ADWG limits. **Biggenden 2018-03:** THM monitoring occurs monthly	Minor	Rare	Low(3)	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill 2. Staff aware of potential issues and refill fortnightly if possible	Minor	Rare	Low (3)	Confident		Seek plant replacement funding for PAC in new plant Seek alternate source and funding to develop
14	Treatment	Physical/chemical Contamination • Turbidity • Manganese • Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of manganese or turbidity. 4. Communication Breakdown 5. Staff error	Minor	Likely	Medium (8)	1. Treatment processes, flocculation, clarifier, oxidisation with chlorine for iron and manganese 2. Operation of filters and clarifier monitored daily. 3. Trained and qualified operators – good housekeeping **Biggenden 2018-04:** Online turbidity meters installed	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	Seek plant replacement funding for process upgrades in new plant
15	Treatment	Clearwater reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	Moderate	Unlikely	Medium (6)	1. Estimated 3 day's supply in tower reservoir. 2. WTP has back- up generator to run clearwater pumps 3. Stand-by pump installed	Moderate	Rare	Low (3)	Confident	Existing measures are robust	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
16	Treatment	Perimeter Fence Security	Trespassing or property damage	Moderate	Possible	Medium (9)		Moderate	Possible	Medium (9)	Low	Repair Fencing behind backwash pods	Repair Fencing behind backwash pods
17	Treatment	• Microbial/Turbidity	Raw water from catchment	Major	Unlikely	Medium (9)	Coagulation, sedimentation, and filtration	Major	Rare	Medium (7)	Low	Jar testing to manage operational efficiency	Seek plant replacement funding for process upgrades in new plant
18	Treatment	• Operational Treatment Failures	Aged plant	Medium	Possible	High (11)	Various engineering and administrative	Medium	Unlikely	Medium (7)	Low	Plant upgrade required	Seek funding for plant replacement
19	Treatment	Short Circuit in treatment	Section of pipeline joining raw to treated reservoir	Major	Unlikely	Medium (9)	Valving lockout and staff training	Major	Rare	Medium (7)	Low	Remove section of pipe or plate flange	Remove section of pipe or plate flange

4.5 Biggenden Risk Management Measures

In this section, existing preventative measures and the proposed preventative measures are outlined.

Table 4-7 Biggenden Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	1. The bores are completely enclosed and appropriately cased so stormwater runoff and infiltration is avoided and vermin cannot enter 3. Filtration and coagulation	Likelihood	Moderately-data	Medium (6)	Yes	Seek alternate source and funding to develop Seek funding for UV in new plant	Major Projects
2	Source water	Biological contamination Bacteria Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection at raw water and at filter stage and leaving clearwater reservoir 3. Coagulation and filtration	Likelihood	Moderately-data	Medium (6)	Yes	Seek alternate source and funding to develop Seek plant replacement funding for UV in new plant	Major Projects
3	Source water	Chemical contamination Heavy metals: Arsenic	1. Natural arsenic and other chemicals in water	1. Treatment processes, coagulation and filtration .	Likelihood	Moderately-data	Medium (8)	Yes	Seek alternate source and funding to develop Plant replacement funding.	Major Projects
4	Source water	Chemical contamination Nutrients: Nitrate Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	1. Treatment processes, coagulation and filtration	Likelihood	Effective - data	Low (4)	Yes	Seek alternate source and funding to develop and PAC dosing in plant replacement	Major Projects
5	Source water	Chemical contamination General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Natural chemicals in water	1. Treatment processes, coagulation, oxidisation with Cl for iron and manganese	Likelihood	Moderately-data	Low (3)	Yes	Seek funding for plant replacement Seek alternate source and funding to develop	Major Projects
6	Source water	Chemical contamination	1. Accidental spills	1. Detection and dilution during treatment processes and storage 2. Emergency response	Likelihood/ consequence	Moderately-data	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	1. Treatment processes –sand filters 2. Public notification process (boil water alert)	Likelihood/ consequence	Moderately-data	Low (4)	Yes		
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. Blockage of creek intake structure	1. Estimated one week's supply in reserve at clearwater and tower reservoir. 2.Trucked water from other towns as backup supply	Likelihood	Unknown-has not occurred before	Medium (5)	Yes	Seek plant replacement funding	Major Projects

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
9	Source water	Lack of supply	Climatic variations	1. Importing water 2. Drought management Plan actions: restrictions, communication etc 3. Increasing WTP operating times	Likelihood	Moderately-data	Medium (6)	Yes	Option: Ensure DMP is up-to-date and appropriate. Seek alternate source and funding to develop	Major Projects
10	Treatment	Biological contamination Bacteria Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	1. Treatment processes – Chlorine disinfection at raw water and at filter stage and leaving ground reservoir 2. Chlorine levels are tested once per day. 3. Injection pump and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment **Biggenden 2013-01** Operation of chlorine injection system have been linked to water flow. **Biggenden 2013-02** Online analyser has been installed and alarmed. On-line chlorine and turbidity analysers installed for WTP. **Biggenden 2018-02:** Spare dosing pump is readily available for use	Likelihood	Effective-data	Low (3)	Yes	Plant upgrade including UV Seek alternate source and funding to develop	Major Projects
11	Treatment	Biological contamination Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	1. Security and vermin-proofing 2. Filtration (limited efficacy) 3. Trained and qualified operators – good housekeeping	Likelihood	Unknown	Low (3)	Yes	Seek plant replacement funding for UV in new plant Seek alternate source and funding to develop	Major Projects
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication breakdown (alarms) 4. Staff error 5. Plant Design	1. Treatment processes, flocculation, clarifier, oxidisation with Cl for iron and manganese 2. Chemical injection levels are tested once per day. 3. Dosing equipment is checked once per day. 4. Trained and qualified operators – good housekeeping	Likelihood	Effective-Proven processes	Low (4)	Yes	Upgraded systems with plant replacement-seek funding.	Major Projects/ Water and Wastewater
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Plant Design THM monitoring have commenced. All results are below ADWG limits. **Biggenden 2018-03:** THM monitoring occurs monthly	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill 2. Staff aware of potential issues and refill fortnightly if possible	Likelihood	Effective-data	Low (3)	Yes	Seek plant replacement funding for PAC in new plant Seek alternate source and funding to develop	Major Projects

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
14	Treatment	Physical/chemical Contamination Turbidity Manganese Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of manganese or turbidity. 4. Communication Breakdown 5. Staff error	1. Treatment processes, flocculation, clarifier, oxidisation with chlorine for iron and manganese 2. Operation of filters and clarifier monitored daily. 3. Trained and qualified operators – good housekeeping **Biggenden 2018-04:** Online turbidity meters installed	Likelihood	Effective-Proven processes	Low (3)	Yes	Seek plant replacement funding for process upgrades in new plant	Major Projects
15	Treatment	Clearwater reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	1. Estimated 3 day's supply in tower reservoir. 2. WTP has back- up generator to run clearwater pumps 3. Stand-by pump installed	Likelihood	Effective-Proven processes	Low (3)	Yes		
16	Treatment	Perimeter Fence Security	Trespassing or property damage		N/A	N/A	Medium (9)	No	Repair Fencing behind backwash pods	Water and Wastewater
17	Treatment	Microbial/Turbidity	Raw water from catchment	Coagulation, sedimentation, and filtration	Likelihood	Moderately-data	Medium (9)	No	Seek plant replacement funding for process upgrades in new plant	Major Projects
18	Treatment	Operational Treatment Failures	Aged plant	Various engineering and administrative	Likelihood	Moderately-data	Medium (7)	Yes	Seek funding for plant replacement	Major Projects
19	Treatment	Short Circuit in treatment	Section of pipeline joining raw to treated reservoir	Valving lockout and staff training	Likelihood	Effective-has not occurred before	Medium (7)	Yes	Remove section of pipe or plate flange	Water and Wastewater

4.6 Biggenden Risk Management Improvement Plan

The following table displays the Risk Improvement Program for NBRC. The items identified to reduce risk have been developed to reduce the unacceptable risks identified in Table 4-6 and are shown in blue shaded boxes. General improvement items have also been listed here.

Table 4-8 Biggenden Risk Management Improvement Program

No.	Scheme Component	Hazard	Hazard Source	Priority	Risk Improvement Actions-Short Term	Risk Improvement Actions-Long-term	Target Dates	Estimated Costs	Responsibility
1	Source water	Biological contamination Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	High	Seek funding to develop new source(s)	Seek funding to develop new source(s)	30/6/2022; 30/6/2024	$400,000	Major Projects
2	Source water	Biological contamination Bacteria Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	High	Seek funding to develop new source(s)	Seek funding to develop new source(s)	30/6/2022; 30/6/2024	$400,000	Major Projects
3	Source water	Chemical contamination Heavy metals: Arsenic	1. Natural arsenic and other chemicals in water	High	Seek funding to develop new source(s)	Seek funding to develop new source(s)	30/6/2022; 30/6/2024	$400,000	Major Projects
4	Source water	Chemical contamination Nutrients: Nitrate Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Medium	Seek funding to develop new source(s)	Seek funding to develop new source(s)	30/6/2022; 30/6/2024	$400,000	Major Projects
5	Source water	Chemical contamination General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Natural chemicals in water	Medium	Seek funding to develop new source(s)	Seek funding to develop new source(s)	30/6/2022; 30/6/2024	$400,000	Major Projects

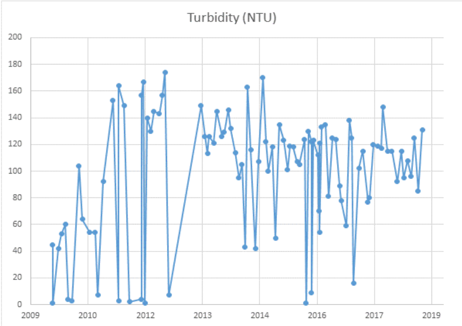
No.	Scheme Component	Hazard	Hazard Source	Priority	Risk Improvement Actions-Short Term	Risk Improvement Actions- Long-term	Target Dates	Estimated Costs	Responsibility
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. Blockage of creek intake structure	Medium	Seek funding to develop new source(s)	Seek funding to develop new source(s)	30/6/2022; 30/6/2024	$400,000	Major Projects
9	Source water	Lack of supply	Climatic variations	Medium	Seek funding to develop new source(s)	Seek funding to develop new source(s)	30/6/2022; 30/6/2024	$400,000	Major Projects
10	Treatment	Biological contamination Bacteria Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design		Seek Funding for new plant with upgraded processes	Seek funding to renew and upgrade WTP	01/10/21; 30/6/2023	$7.2M	Major Projects
11	Treatment	Biological contamination Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design		Seek Funding for new plant with upgraded processes	Seek funding to renew and upgrade WTP	01/10/21; 30/6/2023	$7.2M	Major Projects
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication breakdown (alarms) 4. Staff error 5. Plant Design		Seek Funding for new plant with upgraded processes	Seek funding to renew and upgrade WTP	01/10/21; 30/6/2023	$7.2M	Major Projects/ Water and Wastewater
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Plant Design THM monitoring have commenced. All results are below ADWG limits. **Biggenden 2018-03:** THM monitoring occurs monthly		Seek Funding for new plant with upgraded processes	Seek funding to renew and upgrade WTP	01/10/21; 30/6/2023	$7.2M	Major Projects

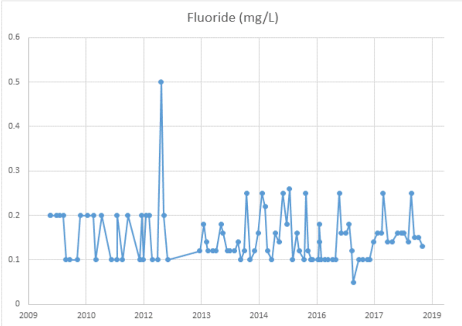
No.	Scheme Component	Hazard	Hazard Source	Priority	Risk Improvement Actions-Short Term	Risk Improvement Actions-Long-term	Target Dates	Estimated Costs	Responsibility
14	Treatment	Physical/chemical Contamination Turbidity Manganese Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of manganese or turbidity. 4. Communication Breakdown 5. Staff error		Seek Funding for new plant with upgraded processes	Seek funding to renew and upgrade WTP	01/10/21; 30/6/2023	$7.2M	Major Projects
16	Treatment	Perimeter Fence Security	Trespassing or property damage		Repair Fencing behind backwash pods		30/08/2022	$5000	Water and Wastewater
17	Treatment	Microbial/Turbidity	Raw water from catchment		Seek Funding for new plant with upgraded processes	Seek funding to renew and upgrade WTP	01/10/21; 30/6/2023	$7.2M	Major Projects
18	Treatment	Operational Treatment Failures	Aged plant		Seek Funding for new plant with upgraded processes	Seek funding to renew and upgrade WTP	01/10/21; 30/6/2023	$7.2M	Major Projects
19	Treatment	Short Circuit in treatment	Section of pipeline joining raw to treated reservoir		Remove section of pipe or plate flange		01/10/21; 30/6/2023	Operational	Water and Wastewater

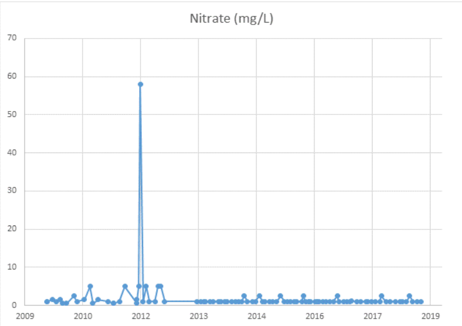
4.7 Biggenden Water Scheme Water Quality Data

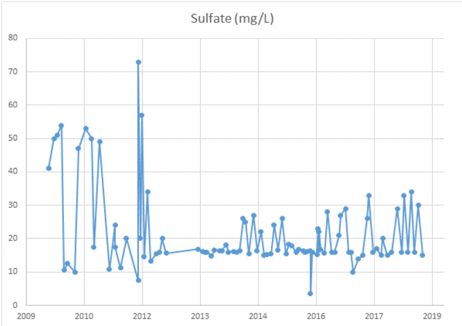
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

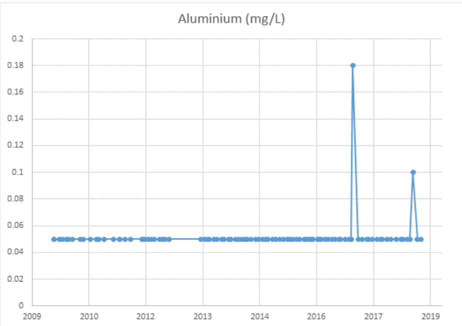
Biggenden untreated bore water 2010-2018

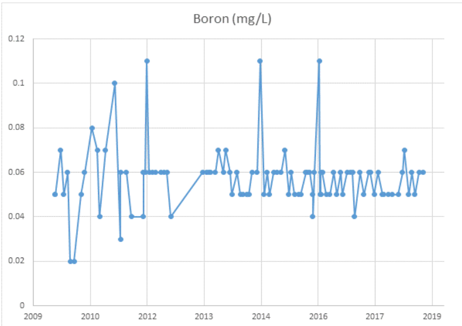


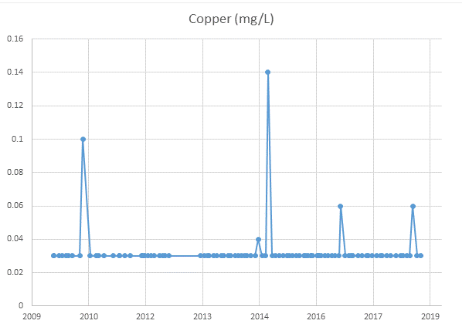


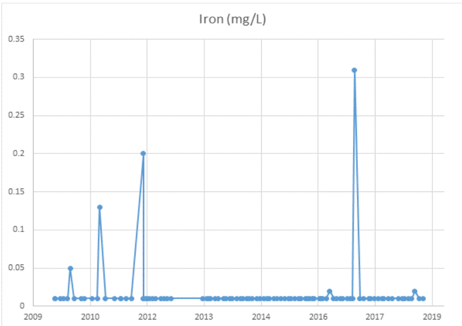


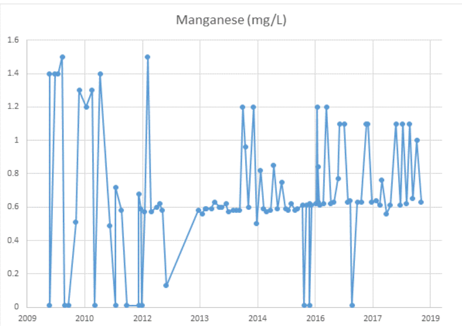


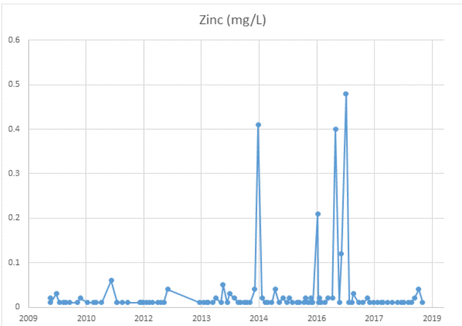




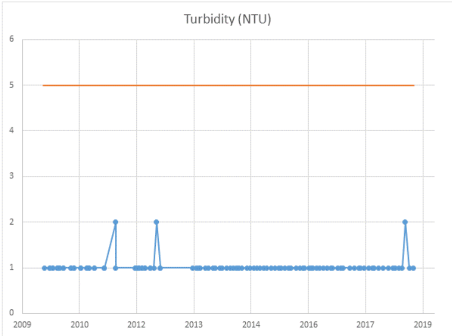


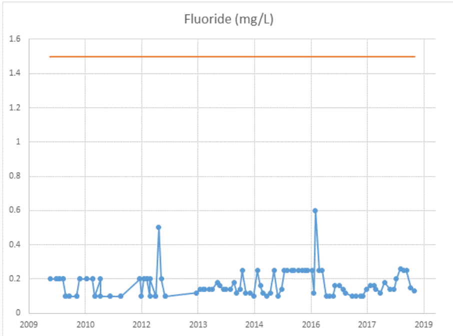


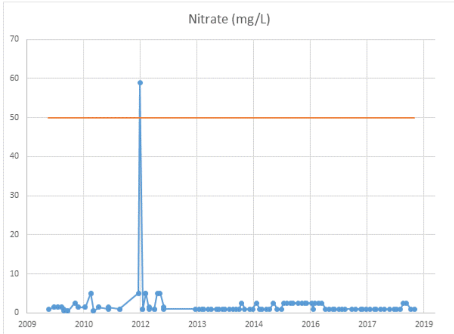


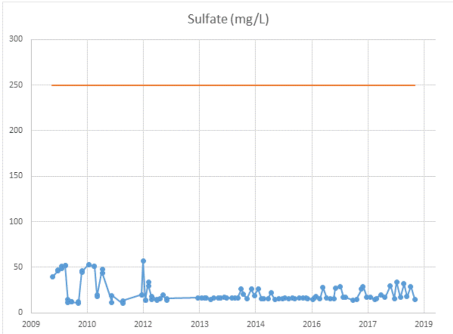


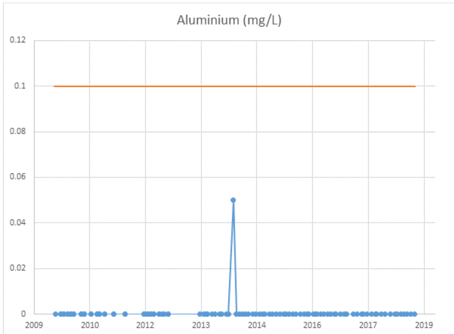
Biggenden WTP treated water 2010-2018

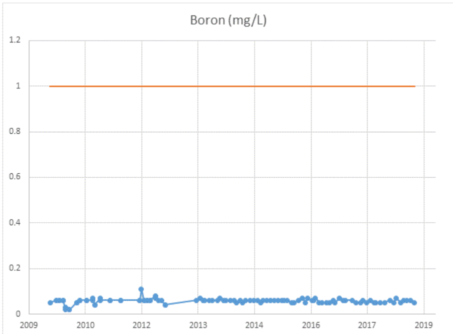


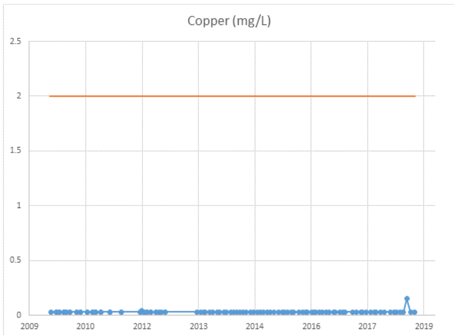


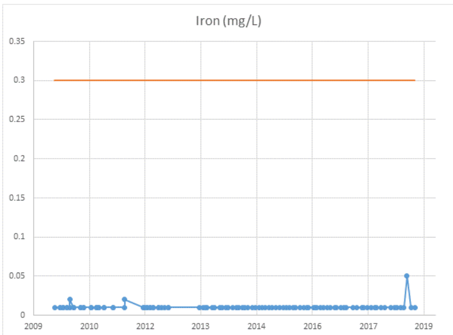


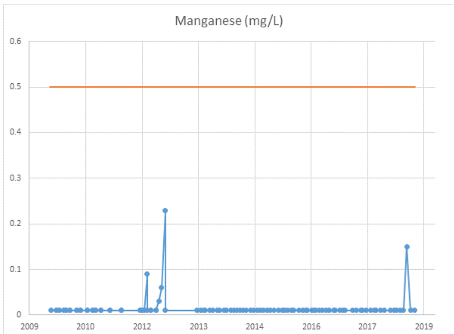


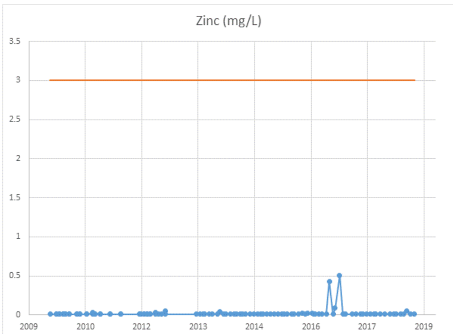












5. EIDSVOLD WATER SUPPLY SCHEME

5.1 Details of Infrastructure for Providing the Service

Source Water

The Eidsvold Water Supply Scheme is based on ground water extraction from two alluvial bores adjacent to the Burnett River four kilometres southwest of the town. SunWater are the independent supplier of bulk water in the Upper Burnett Water Supply Scheme and NBRC receive a priority water allocation. The bore intake infrastructure is owned and operated by NBRC.

The two alluvial bores were commissioned in 1990 and refurbished in 1999/2000 and 2020/2021 to increase their capacity. The rivers beds sand substrate provides an initial filtration of the water before it enters the WTP. The raw water contains significant amounts of iron and manganese.

Treatment Process

New WTP (2016)

In 2016, a new WTP, commissioned by NBRC on a design and construct basis was installed.

Raw water is pumped from the bores, it is dosed with potassium permanganate and it passes through a static mixer, it is dosed with ACH and Polymer prior to entry to the floc tank. From there, the water flows through the two Lamella Separators. Water then passes through three gravity media filters to the filtered water storage tank. It is then pumped through the Carbon Pressure Filters before entering the treated water storage tanks. It is then pumped through to Reservoir 1 receiving UV and sodium hypochlorite disinfection as it leaves the WTP.

The chlorine disinfection effectiveness of the plant was calculated to verify that the chlorine critical limits value required for primary kill is satisfied. Chlorination effectiveness is usually determined based on chlorine contact time (*C.t*). This is calculated by using the following formula:

$$C.t = C \times BF \times {}^{V}/_{F}$$

Where,

C = minimum free chlorine concentration at outlet of the secondary chlorinated water storage tank (2 mg/L)

BF = baffling factor or the tanks, here assumed to be 0.1 (ie no baffles)

V = volume, pipe volume post dosing point (0.09 m^3) plus tank volume (2 x 76.3 m^3)F = flowrate (0.51 m^3/min)

Therefore, the C.t for the critical limit is 30.0 mg/m^3.min. A 4-log removal of *E. coli* requires a C.t of 15 mg/m^3.min, and 4-log removal of viruses at pH 7.5 and 22°C requires a C.t of about 3 mg/m^3.min. Therefore, the chlorine critical limit meets the 4-log removal of *E. coli* and viruses.

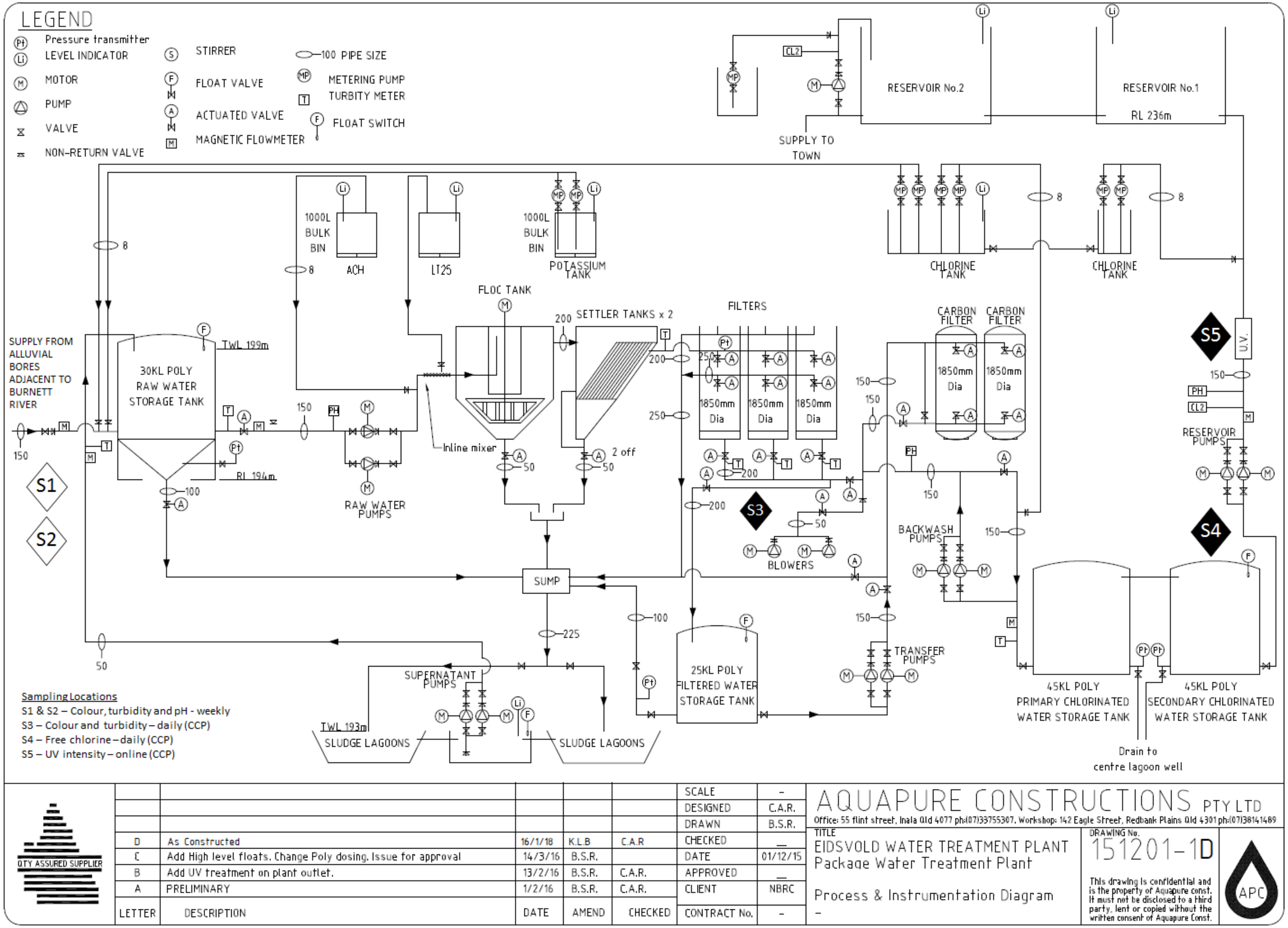

LEGEND
Pressure transmitter
LEVEL INDICATOR
MOTOR
PUMP
VALVE
NON-RETURN VALVE
STIRRER
FLOAT VALVE
ACTUATED VALVE
MAGNETIC FLOWMETER
100 PIPE SIZE
METERING PUMP
TURBITY METER
FLOAT SWITCH
SUPPLY TO TOWN
RESERVOIR No.2
RESERVOIR No.1
RL 236m
1000L BULK BIN
ACH
LT25
POTASSIUM TANK
CHLORINE TANK
CHLORINE TANK
FLOC TANK
SETTLER TANKS x 2
FILTERS
CARBON FILTER
CARBON FILTER
1850mm Dia
SUPPLY FROM ALLUVIAL BORES ADJACENT TO BURNETT RIVER
30KL POLY RAW WATER STORAGE TANK
TWL 199m
RL 194m
RAW WATER PUMPS
Inline mixer
2 off
BLOWERS
BACKWASH PUMPS
RESERVOIR PUMPS
U.V.
S1
S2
S3
S4
S5
SUMP
25KL POLY FILTERED WATER STORAGE TANK
TRANSFER PUMPS
45KL POLY PRIMARY CHLORINATED WATER STORAGE TANK
45KL POLY SECONDARY CHLORINATED WATER STORAGE TANK
Drain to centre lagoon well
SUPERNATANT PUMPS
TWL 193m
SLUDGE LAGOONS
SLUDGE LAGOONS
Sampling Locations
S1 & S2 – Colour, turbidity and pH - weekly
S3 – Colour and turbidity – daily (CCP)
S4 – Free chlorine – daily (CCP)
S5 – UV intensity – online (CCP)
QTY ASSURED SUPPLIER
D As Constructed 16/1/18 K.L.B C.A.R
C Add High level floats. Change Poly dosing. Issue for approval 14/3/16 B.S.R.
B Add UV treatment on plant outlet. 13/2/16 B.S.R. C.A.R.
A PRELIMINARY 1/2/16 B.S.R. C.A.R.
LETTER DESCRIPTION DATE AMEND CHECKED
SCALE -
DESIGNED C.A.R.
DRAWN B.S.R.
CHECKED
DATE 01/12/15
APPROVED
CLIENT NBRC
CONTRACT No. -
AQUAPURE CONSTRUCTIONS PTY LTD
Office: 55 flint street, Inala Qld 4077 ph:(07)33755307, Workshop: 142 Eagle Street, Redbank Plains Qld 4301 ph:(07)38141489
TITLE
EIDSVOLD WATER TREATMENT PLANT
Package Water Treatment Plant
Process & Instrumentation Diagram
DRAWING No.
151201-1D
This drawing is confidential and is the property of Aquapure const. It must not be disclosed to a third party, lent or copied without the written consent of Aquapure Const.
APC

Figure 5-1 Eidsvold WTP Schematic

Distribution

After filtration, water is pumped to Ground Level Reservoir 1 located on Hospital Hill which has a capacity of 450kL. In 1984 an additional reservoir, Ground Level Reservoir 2, (750kL) was constructed on Airport Road to improve water pressure and quantity in the northern section of the township. Ground Level Reservoir 2 is filled by gravity flow through the reticulation mains from Ground Level Reservoir 1. The reticulation system supplies the town and has offshoots feeding semi-rural areas. Reservoir 2 chlorine dosing point is activated by low level reading (<1mg/L) on localised chlorine analyser.

Sampling locations are sited at key points determined to provide the best indication of chlorine residual levels in the system. Samples are also taken as water leaves the reservoir. Chlorine residuals in the network are sampled and tested on-site weekly. Raw water and treated water samples are sent regularly to the Queensland Health Laboratory for chemical analysis. Raw water and treated water samples are sent regularly to the Qld Health Laboratory for biological testing.

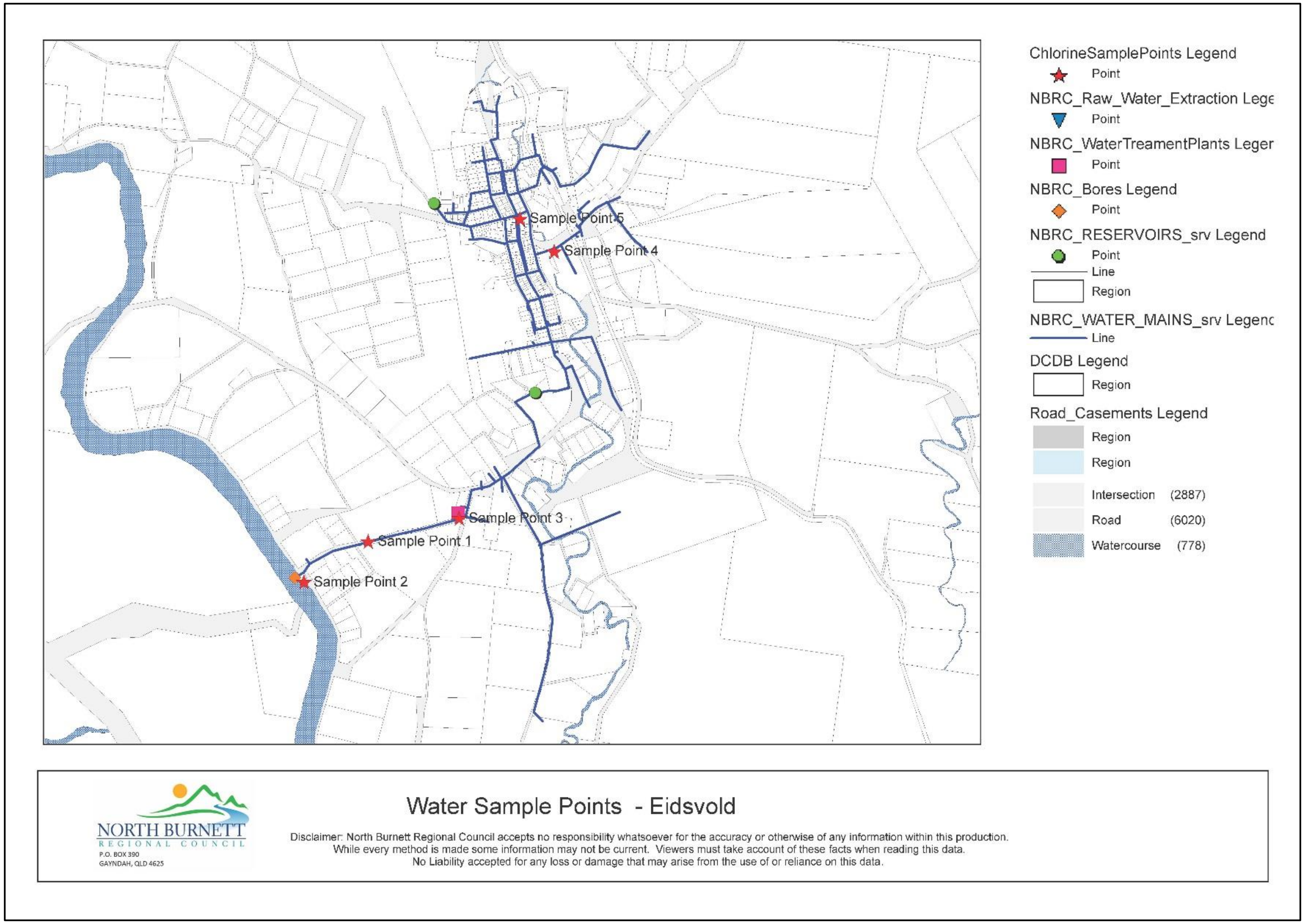


Figure 5-2 Eidsvold Water Supply Map

Table 5-1 Infrastructure Details – Eidsvold Water Supply Scheme

Component		Scheme
Sources	Name	Burnett River
	Type	2 x spears
	% of supply	100%
	Reliability	High reliability with back up pumps
	Water quality issues	High iron and manganese
Sourcing Infrastructure	Type	Pumped spear x 2 Submersible bore 5.4kL/hr Submersible bore 6.5kL/hr
	Description	Adjacent to Burnett River Age = 28 years old Casing = Steel Diameter = DN250 Depth = 10m
	Ownership	NBRC
Are there any sources that **do not** undergo treatment prior to supply?	No	
Eidsvold WTP	Name	Eidsvold WTP
	Process	Pre-dosing for oxidation Flocculation and coagulation Sedimentation Multimedia Filtration Carbon filters

Component		Scheme
		U.V
	Design Capacity (20 hr operation)	62kL/hr
	Daily flow range	8L/s – 18L/s
	Chemicals added	Sodium hypochlorite, potassium permanganate, ACH, Magnafloc LT 25 Polymer
	Standby chemical dosing facilities (Y/N)	N
	Water sourced from and %	Burnett River spears 100%
	% of average day demand provided	100%
	% of scheme supply Distribution area supplied	100%
	Bypasses / Variations	Bypasses available but are clearly labelled gate valves which are valved shut.
Disinfection	Location	At plant
	Type	Liquid sodium hypochlorite via diaphragm dosing pump
	Dose rate	Based on in-line analyser
	Target residual levels	0.5 mg/l
	Duty/standby	Nil
	Dosing arrangements	Manually set depending on hypo strength and raw water quality
	Alarms	Through SCADA
	Auto shut-off arrangements	Yes
Distribution and Reticulation System	Pipe material	Asbestos cement
	Age range	45-55 years
	Approx % of total length	90%
	Pipe material	Poly
	Age range	5-10 years

Component		Scheme
	Approx % of total length	10%
	Areas where potential long detention periods could be expected	Both ground reservoirs Rural residential end of pipelines
	Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	This will generally occur at extremities of the distribution network in rural residential areas.
Reservoirs	**Ground (No)**	1
	Name	Reservoir 1
	Capacity (ML)	0.450
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y
	Ground (No)	2
	Name	Reservoir 2
	Capacity (ML)	0.750
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

5.2 Eidsvold Water Quality: Identifying Hazards and Hazardous Events

Water quality information has been collected by NBRC for raw water, treated water and reticulated supply for the period of February 2010 to November 2018. Analysis of this data has been completed to assess the results in comparison to the ADWG guideline values for parameters measured. It is noted that no SunWater water quality data was reviewed for raw water.

A summary of the water analysis undertaken for the Eidsvold Water Supply Scheme is contained in Table 5-2, Table 5-3, Table 5-4 and Table 5-5. Section 5.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

The reticulated water scheme has been tested for pH, residual chlorine, *E. coli* and total coliforms.

Interpretation

Over the period of testing there has been a higher rate of sampling for Eidsvold compared to other schemes with approximately two tests per month for both raw water and treated water. The reticulated scheme was tested weekly for *E.coli* to QHFSS.

Within the raw water test results, manganese, iron, and turbidity sometimes exceed the guideline value for treated water; all other values are below the guideline values for treated water.

Test results on samples taken from the Eidsvold WTP show six occurrences of turbidity exceeding the guideline value of 5 NTU and eleven occurrences of manganese exceeding the guideline value of 0.1 mg/L during the period January 2010 to November 2018. Current practice has improved monitoring and sampling which has reduced the possibility of manganese dropping out after treatment.

Within the reticulation system test results, there were many occurrences when residual chlorine fell below the ADWG recommended value. One *E. coli* detection was recorded in 2018. There were potential water quality issues within the reticulation system due to low levels of residual chlorine. Increased frequency of sampling and testing, recording, and operational response, has since reduced this risk.

Table 5-2 Eidsvold Raw Water Source

Eidsvold Source – Burnett River Bores							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Turbidity (NTU)	Bore	Feb 2010 – Nov 2018	313	84	9.49	<1	Bore name should be recorded to distinguish between bores
Fluoride	Bore	Feb 2010 – Nov 2018	314	0.5	0.17	0.1	
Nitrate	Bore	Feb 2010 – Nov 2018	314	1	0.6	<0.5	Multiple limits of detection were used (<0.5 and <1). In order to calculate the stats, the absolute values were used.
Sulfate	Bore	Feb 2010 – Nov 2018	314	68	23.2	4.5	
Dissolved metals							
Aluminium	Bore	Feb 2010 – Nov 2018	314	0.05	0.05	<0.01	Multiple limits of detection were used (<0.01 and <0.05). In order to calculate the stats, the absolute values were used.
Boron	Bore	Feb 2010 – Nov 2018	314	0.1	0.05	0.03	
Copper	Bore	Feb 2010 – Nov 2018	314	0.14	0.03	<0.03	
Iron	Bore	Feb 2010 – Nov 2018	314	0.48	0.02	<0.01	
Manganese	Bore	Feb 2010 – Nov 2018	314	1.6	0.5	<0.01	
Zinc	Bore	Feb 2010 – Nov 2018	314	1.4	0.03	<0.01	Multiple limits of detection were used (<0.01 and <0.1). In order to calculate the stats, the absolute values were used.
Total metals							
Aluminium	Bore 1	Nov 2017	1	0.006	0.006	0.006	Single sample
Arsenic	Bore 1	Nov 2017	1	0.012	0.012	0.012	Single sample

Eidsvold Source – Burnett River Bores							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Cadmium	Bore 1	Nov 2017	1	<0.0001	<0.0001	<0.0001	Single sample
Chromium	Bore 1	Nov 2017	1	<0.0001	<0.0001	<0.0001	Single sample
Copper	Bore 1	Nov 2017	1	0.001	0.001	0.001	Single sample
Iron	Bore 1	Nov 2017	1	0.56	0.56	0.56	Single sample
Lead	Bore 1	Nov 2017	1	0.0004	0.0004	0.0004	Single sample
Manganese	Bore 1	Nov 2017	1	0.37	0.37	0.37	Single sample
Nickel	Bore 1	Nov 2017	1	0.0007	0.0007	0.0007	Single sample
Zinc	Bore 1	Nov 2017	1	0.002	0.002	0.002	Single sample

Table 5-3 Eidsvold Treated Water

Eidsvold WTP									
Plant	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
Parameter (mg/L unless otherwise specified)				Maximum value	Average value	Minimum value			
Turbidity (NTU)	WTP	Feb 2010 – Nov 2018	307	22	1.3	<1	5	6	Aesthetic guideline only Exceedances in June 2011, Jan 2013, July 2013 and Sept 2013

Eidsvold WTP									
Plant				Summary of results					
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Maximum value	Average value	Minimum value	Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
Fluoride	WTP	Feb 2010 – Nov 2018	308	0.30	0.17	0.09	1.5	0	
Nitrate	WTP	Feb 2010 – Nov 2018	308	2.5	0.6	<0.5	50	0	Aesthetic guideline only Multiple limits of detection were used (<0.5 to <2.5). In order to calculate the stats, the absolute values were used.
Sulfate	WTP	Feb 2010 – Nov 2018	308	66	24	4.4	250	0	Aesthetic guideline only
Dissolved metals									
Aluminium	WTP	Feb 2010 – Nov 2018	308	<0.05	<0.05	<0.05	0.1	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable
Boron	WTP	Feb 2010 – Nov 2018	308	0.1	0.05	0.03	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L
Copper	WTP	Feb 2010 – Nov 2018	308	0.07	0.03	<0.03	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	WTP	Feb 2010 – Nov 2018	308	0.16	0.014	<0.01	0.3	0	Aesthetic guideline only

Eidsvold WTP									
Plant	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
Parameter (mg/L unless otherwise specified)				Maximum value	Average value	Minimum value			
Manganese	WTP	Feb 2010 – Nov 2018	308	0.8	0.02	<0.01	0.5 (0.1)	3	Number in brackets denotes the aesthetic guideline value Most samples below detection limit Exceedances in May 2012, July 2012 and July 2013
Zinc	WTP	Feb 2010 – Nov 2018	308	2.0	0.02	<0.01	3	0	
Total metals									
Aluminium	WTP	Nov 2017	2	0.18	0.095	0.01	0.2	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable
Arsenic	WTP	Nov 2017	2	0.0075	0.0055	0.0035	0.01	0	
Cadmium	WTP	Nov 2017	2	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L
Chromium	WTP	Nov 2017	2	0.0015	0.00145	0.0014	0.05	0	
Copper	WTP	Nov 2017	2	0.011	0.006	<0.001	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	WTP	Nov 2017	2	0.12	0.064	0.008	0.3	0	Aesthetic guideline only
Lead	WTP	Nov 2017	2	0.0005	0.0003	<0.0001	0.01	0	

Eidsvold WTP									
Plant				Summary of results					
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Maximum value	Average value	Minimum value	Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
Manganese	WTP	Nov 2017	2	0.45	0.23	0.012	0.5 (0.1)	2	Number in brackets denotes the aesthetic guideline value. Exceedances in November 2017
Nickel	WTP	Nov 2017	2	0.0023	0.0017	0.0012	0.02	0	
Zinc	WTP	Nov 2017	2	0.008	0.0045	<0.001	3	0	Aesthetic guideline only

Table 5-4 Eidsvold Reticulated Water

Scheme	Eidsvold Reticulated Water							
Sampling Location								
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
pH (pH units)	Feb 2010 – Nov 2018	308	8.2	7.7	7.04	6.5 - 8.5	0	Aesthetic guideline only

Scheme	Eidsvold Reticulated Water							
Sampling Location								
Parameter (mg/L unless otherwise specified)	**Time Period**	**No of samples**	**Summary of Results**			**Australian Drinking Water Guidelines guideline value for health unless otherwise specified**	**No of samples exceeding Australian Drinking Water Guidelines guideline value**	**Comment**
			Maximum Value	**Average Value**	**Minimum Value**			
Disinfectant residual	July 2016 – Nov 2018	261	5.7	1.5	0	>0.2 - 0.5	3	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition Chlorine residual of zero in Oct and Nov 2017, and 0.16 mg/L in Nov 2016
Total coliforms (mpn/100mL)	July 2016 – Nov 2018	264	32	0.2	0	NA	NA	
E. coli (CFU/100mL)	July 2016 – Nov 2018	264	9	0.03	0	None detected	1	Failures occurred in Mar 2018
Trihalomethanes	Sept 2016	1	0.12	0.12	0.12	0.25	0	

Table 5-5 Eidsvold Water Quality Complaints

Year	**No of Water Quality Complaints**	**Water Quality Complaints per 1000 Connections**	**Main Reasons for Complaints**	**Likely Sources / Causes of Problems**	**Resolution of Problem**
1-7-2010 to 26-10-2018	9	30.3	- Taste 1 - Colour 8	- High turbidity in source water	- More frequent backwashing

5.3 Eidsvold Catchment Characteristics

The town of Eidsvold, population 567, lies approximately 75 kilometres south of Monto and 35 kilometres north of Mundubbera.

Eidsvold is supplied from two alluvial bores on the Burnett River. The catchment includes the entire Burnett River/Three Moon Creek system to the north of the town. The topography varies from flats along the Burnett River to undulating and hilly grassland interspersed with natural forest. Cattle grazing is the chief economic activity across 90% of the catchment (discounting national parks) with the remainder accounted for by a few small isolated agricultural areas further north on the main road to Monto.

The raw water bores are sealed and impervious to stormwater run-off and flooding, though water quality is affected by high turbidity when the Burnett River floods. Bores are operated alternately.

Risk to water quality in the Burnett River catchment are numerous including possible physical, biological, and chemical contamination caused by cattle, fertilisers, pesticides, and herbicides associated with fodder cropping. Other risks include natural events such as flooding and drought, or accidental spillage of chemicals on the main road to Monto which intersects the Burnett River north of Eidsvold.

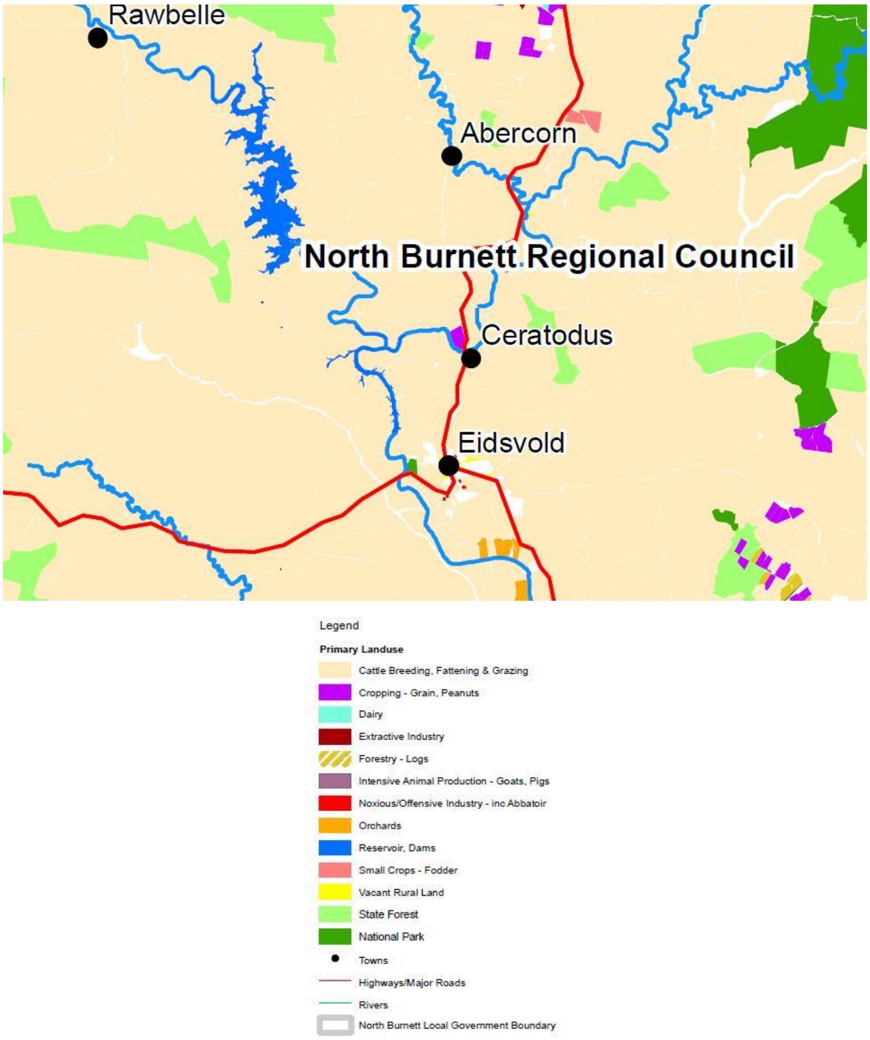


Figure 5-3 Eidsvold Catchment area

5.4 Eidsvold Hazard Identification, Risk Assessment and Uncertainty

Table 5-6 Eidsvold Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological Contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. The bores are sealed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter.	Catastrophic	Rare	Medium (6)	Confident	Existing measures are robust	
2	Source water	Biological Contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. The bores are sealed and appropriately cased so storm runoff and infiltration are avoided and vermin cannot enter. 2. Treatment processes – U.V, Chlorine disinfection at raw water stage	Catastrophic	Rare	Medium (6)	Confident	Existing measures are robust	
3	Source water	Contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Major	Unlikely	Medium (8)	1. Treatment processes, flocculation coagulation, clarifier, filtration, U. V	Major	Rare	Medium (5)	Confident	Existing measures are robust	Pre-dosing potassium permanganate in raw water
4	Source water	Contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers	Minor	Possible	Medium (6)	1. Treatment processes, flocculation, coagulation, clarifier, filtration, G.A.C	Minor	Unlikely	Low (4)	Confident	Existing Measures are robust	
5	Source water	Contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. Treatment processes, flocculation, clarifier, oxidisation with Cl or $KMnO_4$ for iron and manganese, filtration	Moderate	Rare	Low (3)	Confident	Existing Measures are robust	Pre-dosing potassium permanganate in raw water
6	Source water	Chemical Contamination	1. Accidental spills	Moderate	Rare	Low (3)	1. Detection and dilution during treatment processes and storage 2. Emergency response, G.A.C 3. Public notification process (do not drink alert)	Insignificant	Rare	Low (1)	Uncertain	Small concentration. Only risk of any real consequence would be a chemical spill near the intake Inability to predict type or consistency of possible spill?	
7	Source water	Physical Contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	Minor	Possible	Medium (6)	1. Bores 2. Treatment processes – sand filters, coagulation, flocculation, sedimentation 2. Public notification process water restrictions	Minor	Unlikely	Low (4)	Confident	Occasional flooding of Burnett River can't be avoided.	
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack of standby pumps 3. power failure	Moderate	Unlikely	Medium (6)	1. Two alternative sources of supply with individual pumps. 2. Estimated one week's supply in both reservoirs	Moderate	Rare	Low (3)	Reliable	Although there is no backup power source, the reserve capacity of supply would allow plenty of time to get a generator on-site	
9	Source water	Lack of supply	1. Climatic variations	Moderate	Unlikely	Medium (6)	1. Importing water 2. Drought Management Plan actions : restrictions, communication etc.	Moderate	Rare	Low (2)	Uncertain	Uncertainty in future climate	
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual	Major	Possible	High (12)	1. Treatment processes – Chlorine disinfection primary and secondary chlorinated water storage tanks 2. Chlorine levels are tested continuously.	Major	Rare	Medium (5)	Estimate		UV Operational review

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
			3. Loss of Chemical supplies 4. Staff error				3. Injection pump and chlorine supply are also checked and inspected Monday to Friday. 4. Public notification process (boil water alert) 5. Trained and qualified operators– good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment 8. U.V Eidsvold 2013-02: On-line chlorine analyser is installed and alarmed to SCADA Eidsvold 2013-03: Chlorine levels in reticulation system are tested at least weekly. Eidsvold 2013-04: Additional chlorine injection system installed on the Airport Rd reservoir Monitor chlorine dosage as needed						
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Filtration 3. Trained and qualified operators – good housekeeping 4. U.V	Catastrophic	Rare	Medium (6)	Reliable	Inability to detect contamination in the treatment process	UV Operational review
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error 5. Plant Design	Moderate	Possible	Medium (9)	1. Treatment processes, flocculation, clarifier, oxidisation with Cl for iron and manganese 2. Chemical injection levels monitored on SCADA 3. Dosing equipment is checked once per day. 4. Trained and qualified operators – good housekeeping **Eidsvold 2013-02:** On-line chlorine analyser is installed and alarmed to SCADA **Eidsvold 2013-05:** Control logic for chemical addition to be re-programmed to be a function of raw water flow. A new treatment plant has been constructed towards the end of 2016.	Moderate	Rare	Low (3)	Reliable		
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	Major	Rare	Medium (5)	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill. 2. **Eidsvold 2018-01:** THM monitoring occurs monthly	Major	Rare	Medium (5)	Confident		
14	Treatment	Physical/chemical contamination	1. Failure of back-wash of sand filters	Minor	Rare	Low (2)	1. Chlorine dosing 2. Post treatment monitoring	Minor	Rare	Low (2)	Confident	Existing measures are robust	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
		• Turbidity • Manganese • Particulates	2. Failure of dosing equipment or clarifier. 3. High levels of Manganese or turbidity. 4. Communication Breakdown 5. Staff error				3. Operation of filters and clarifier monitored daily. 4. Trained and qualified operators – good housekeeping						
15	All	• Sabotage or natural disaster causing contamination or supply failure	1. Damaged equipment 2. Harmful substances	Major	Rare	Medium (5)	1. Bores are adequately sealed 2. Treatment plant fenced and locked	Moderate	Rare	Low (3)	Confident	All practical steps have been taken	

5.5 Eidsvold Risk Management Measures

In this section existing preventative measures and proposed preventative measures are considered in greater detail.

Table 5-7 Eidsvold Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Options and Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter.	Likelihood	Unknown	Medium (6)	Yes		
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection at raw water stage	Likelihood	Effective-data	Medium (6)	Yes		
3	Source water	Chemical contamination • Heavy metals: Arsenic	1. Natural heavy metals and other chemicals in water	1. Treatment processes, oxidation, flocculation, clarifier and filtration	Likelihood	Effective, as supported by results	Medium (5)	Yes		
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers	1. Treatment processes, flocculation, clarifier, and filtration	Likelihood	Effective, as supported by results	Low (4)	Yes		
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	1. Treatment processes, flocculation, clarifier, filtration, oxidisation with Cl or $KMnO_4$ for iron and manganese	Likelihood	Effective, as supported by results	Low (3)	Yes	Pre-dosing potassium permanganate in raw water	Water and Wastewater
6	Source water	Chemical contamination	1. Accidental spills	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert)	Consequence	Unknown as has not occurred	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	1. Treatment processes – flocculation, clarifier, and filtration 2. Public notification process (boil water alert)	Likelihood	Effective in reducing turbidity as per water quality samples	Low (4)	Yes		
8	Source water	Lack of supply	1. Inadequate maintenance 2. Power failure	1. Two alternative sources of supply with individual pumps. 2. Estimated one weeks supply in both reservoirs	Likelihood	Effective- multiple backups and past history	Low (3)	Yes		
9	Source water	Lack of supply	1. Climatic variations	1. Importing water 2. Drought management Plan actions: restrictions, communication etc.	Likelihood	Effective – based on community compliance water restriction	Low (2)	Yes		
10	Treatment	Biological contamination	1. Failure of chlorine injection 2. Insufficient chlorine residual	1. Treatment processes – flocculation, clarifier, and filtration Chlorine disinfection at raw water stage	Likelihood	Effective	Medium (5)	Yes	UV Operational review of UV	Water and Wastewater

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Options and Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
		• Bacteria • Viruses	3. Loss of Chemical supplies 4. Staff error 5. Plant Design	2. Chlorine levels are tested once per day. 3. Injection pump and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment **Eidsvold 2013-02:** On-line chlorine analyser is installed and alarmed to SCADA **Eidsvold 2013-03:** Chlorine levels in reticulation system are tested weekly. **Eidsvold 2013-04:** Additional chlorine injection system installed on the Airport Rd reservoir Monitor chlorine dosage as needed Continue to monitor operation						
11	Treatment	Biological Contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	1. Security and vermin-proofing 2. Filtration (limited efficacy) 3. Trained and qualified operators – good housekeeping	No	Inability to detect contamination in the treatment process	Medium (6)	Yes	Operational review of UV	Water and Wastewater
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error 5. Plant Design	1. Treatment processes, flocculation, clarifier, oxidisation with Cl for iron and manganese 2. Chemical injection levels are tested once per day. 3. Dosing equipment is checked once per day. 4. Trained and qualified operators – good housekeeping	Likelihood	Effective and reliable and monitored by SCADA and alarmed	Low (3)	Yes		
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Plant Design	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill 2. Staff aware of potential issues and refill fortnightly if possible	No	No THM exceedances recorded in treated water	Medium (5)	Yes		
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of Manganese or turbidity. 4. Communication Breakdown 5. Staff error	1. Treatment processes, flocculation, clarifier, oxidisation with Cl and K for iron and manganese 2. Operation of filters and clarifier monitored daily. 3. Trained and qualified operators – good housekeeping	Likelihood/Consequence	Effective	Low (4)	Yes		
15	Treatment	Substandard chemicals	1. Inappropriate chemical storage or defective batch	1. Chemicals stored as per regulation 2. Daily monitoring of manganese, turbidity and chlorine	Likelihood and consequence	Moderately effective based on treatment results	Low (1)	Yes		

5.6 Eidsvold Risk Management Improvement Program

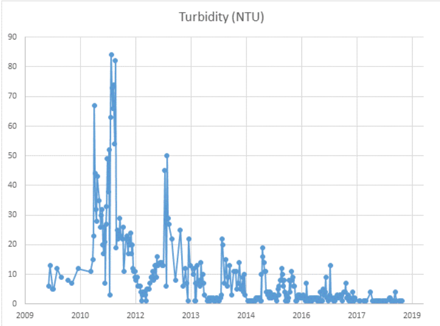
Table 5-8 Eidsvold Risk Improvement Program

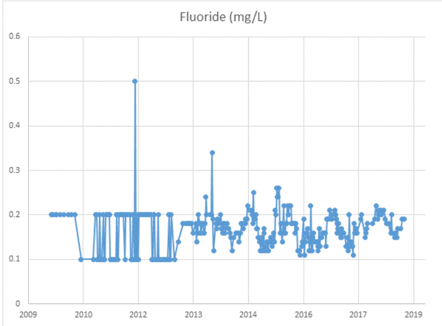
Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	Medium			Pre-dosing potassium permanganate in raw water	30/09/2022	$15000	Water and Wastewater
10	Treatment	Biological contamination Bacteria Viruses	High		Operational review of UV	Upgrade of UV	30/06/2022	$10000 $40000	Water and Wastewater
11	Treatment	Biological Contamination Protozoa	High		Operational review of UV	Upgrade of UV	30/06/2022	$10000 $40000	Water and Wastewater

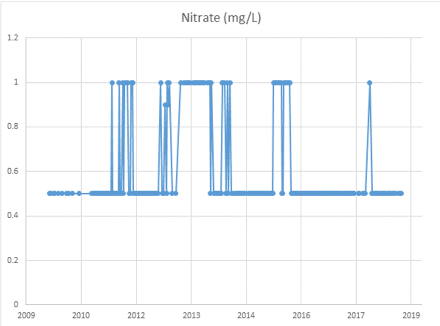
5.7 Eidsvold Water Supply Scheme Water Quality Data

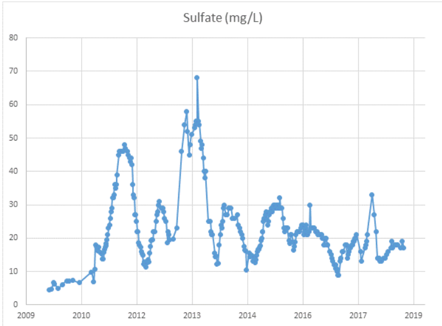
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

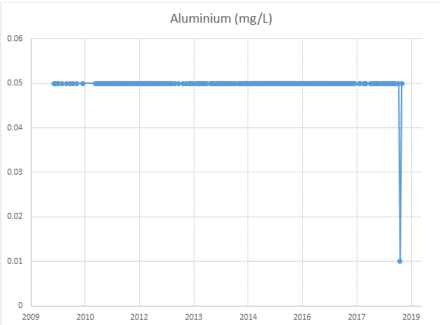
Eidsvold bore untreated water 2010-2018

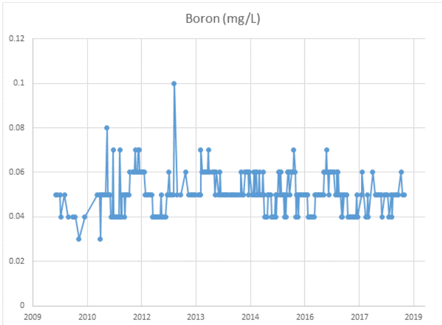


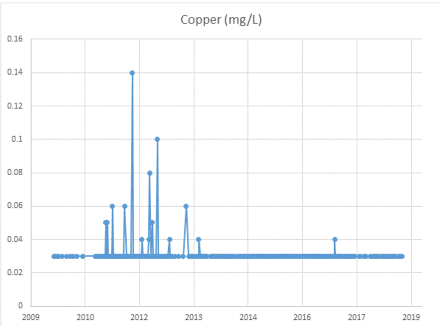


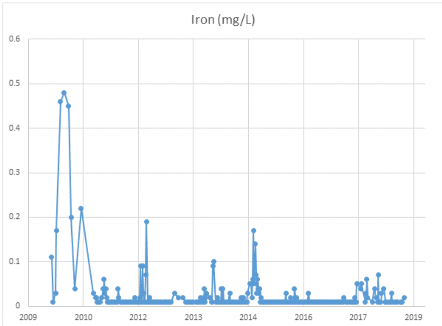


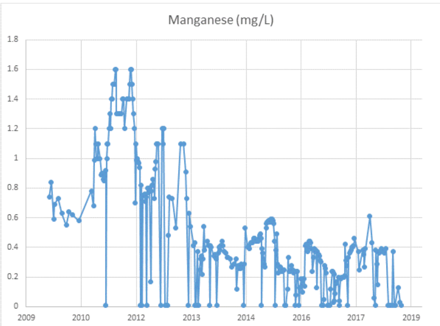


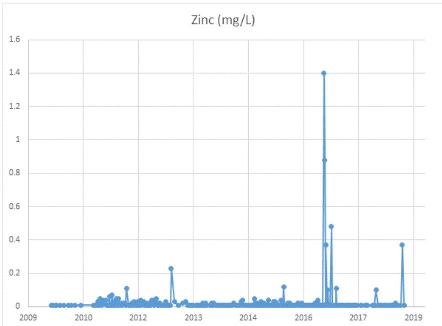




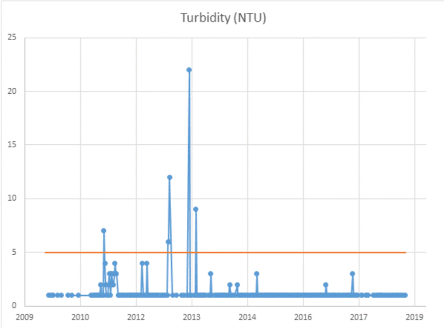


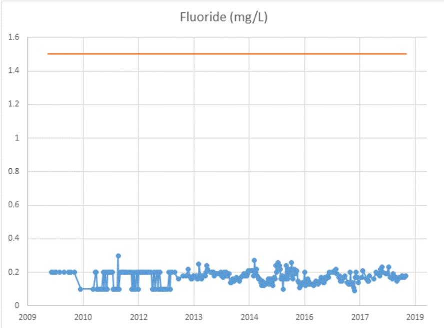


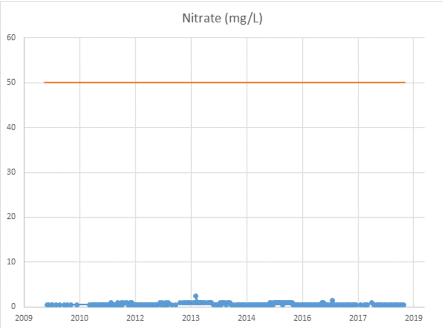


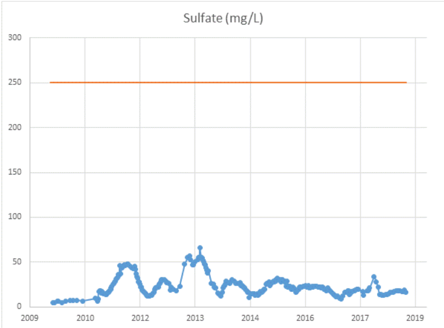


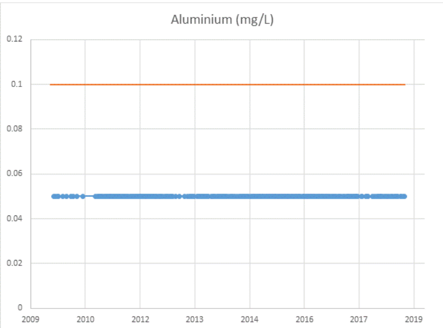
Eidsvold reservoir treated water 2010-2018

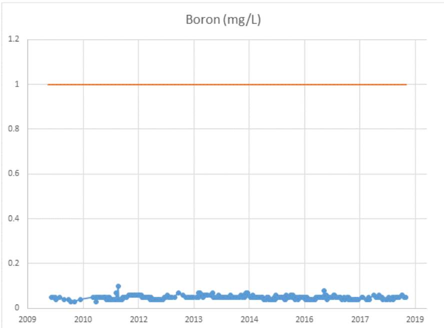


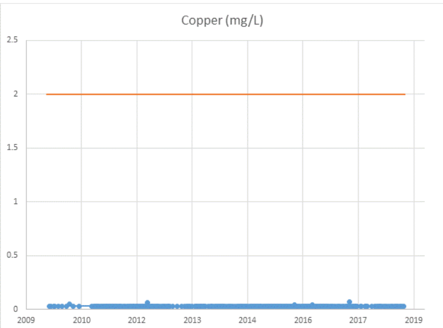


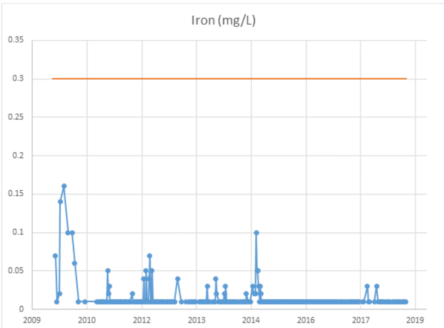


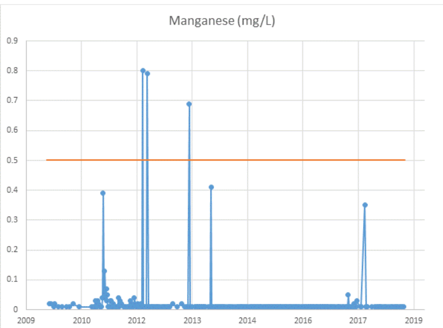


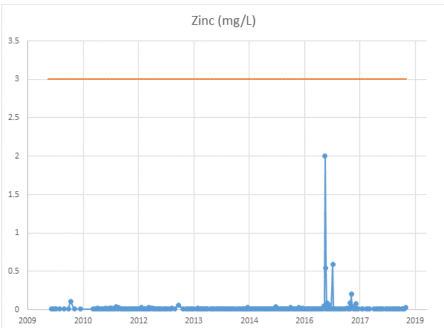












6. GAYNDAH WATER SUPPLY SCHEME

6.1 Details of Infrastructure for Providing the Service

Source Water

The Gayndah Water Supply Scheme is supplied from the Burnett River. SunWater are the independent supplier of bulk water in the Upper Burnett Water Supply Scheme and NBRC receive a priority water allocation. The intake infrastructure is owned and operated by NBRC.

Intake Works :

Circa 2015, new raw water supply intake and pump station was constructed immediately upstream of the Claude Warton Weir, on the southern bank. This location provides improved reliability of supply through:

- Improved flood resilience of the intake infrastructure.
- Efficient use of the existing weir storage.
- Improved drought resistance during periods of low runoff within the Burnett River.
- Improved efficiency of water usage during times of low flow in the Burnett River, as the placement of the intake upstream of the weir, removes the previous requirement for large water releases to accommodate the need to provide river flow within the alluvial river channel in the vicinity of alluvial bore intakes.

SunWater own and operate the Claude Wharton Weir and own the segments of land immediately adjacent to the riverbanks. This land ownerships permits SunWater to facilitate operational access and requirements and prevents unauthorised access to the weir impoundment. The NBRC raw water intake, pump station and associated works are therefore located on SunWater property. An agreement has been entered into between SunWater and NBRC, to provide NBRC with full access rights to their infrastructure

The new raw water supply system to the existing treatment works comprises of:

- “Box in bank” intake structure with submerged inlet screens, near the upstream wall of the weir.
- Intake pumps, pipework and associated structural intake elements.
- 2.79km 250ND rising main to the existing WTP.

The construction of the intake also allows for the connection of emergency extension piping to the pump inlets, to allow for the extension of the system abstraction point to the lowest level behind the weir. This is to cater for extreme drought conditions when the depth of impoundment behind the weir is at critically low levels.

This combination intake is considered most appropriate for the site upstream of the weir due to the potentially large range of operating water levels in the weir pool.

The intake is screened to protect the pumping equipment from gross debris. Experience has shown that heavy horizontal bars are preferable to vertically mounted screens as they are less prone to blockage. There is visual evidence of sand accumulation upstream of the weir and accordingly, provision has been made for sand trapping and removal prior to the pump intakes.

The intake pump station configuration provides the following operational performance outcomes:

- Exhibits the least problems associated with long term performance.
- Offers coarse screening ability via trash racks.

- Provides protection to pumping equipment.
- Operates soundly in high sediment/sand environments.

The design flow rate, delivered to the WTP, is between 34 and 50 L/s. VSD pumps have been installed, to enable the operational flow rate to be varied to suit the varying treatment capacity of the WTP. The treatment capacity of the WTP varies, because of the widely varying raw water quality.

Treatment Process

The raw water is pumped to the treatment plant located in Simon Street, Gayndah. The treatment plant can process a continuous maximum supply of 46L/s, subject to raw water quality parameters falling within acceptable range. Gayndah's current average usage is 1032kL per day.

The inflow of water to the treatment plant initiates the treatment process. The raw water pump is automatically switched off when the top water level in the clear-water storage reservoir reaches Full Supply Level (FSL) and flow through the treatment plant ceases.

Potassium permanganate (for iron and manganese removal) and activated carbon is dosed prior to the detention tank with aeration for iron removal. pH correction is also performed using caustic soda into the detention tank. ACH and LT 25 Polymer are dosed prior to the clarifier. Following that, further oxidation occurs through liquid sodium hypochlorite injection. The water then undergoes sand filtration and pH correction. In June 2018, a Wedeko UV unit was installed downstream of the sand filters as per the Gayndah Risk Improvement Program. The water is then transferred to the clearwater ground reservoir and is disinfected using sodium hypochlorite before it reaches the three ground reservoirs and the network.

The Gayndah WTP operates automatically; however, since the flood damage in 2011, the WTP has been operated manually with daily attendance from operators. The WTP pumps and reservoir levels are linked to the SCADA (i.e. failure of chlorine dosing or reservoir levels), if an alarm is triggered an SMS is sent to the operator's phone, who will then visit the site.

Chlorine injection, pH and Turbidity are all linked to the SCADA system. There are 1,200 L and 2,500 L chlorine storage tanks at the WTP, the levels of which are reviewed daily by operators. There is a documented operating manual for the WTP.

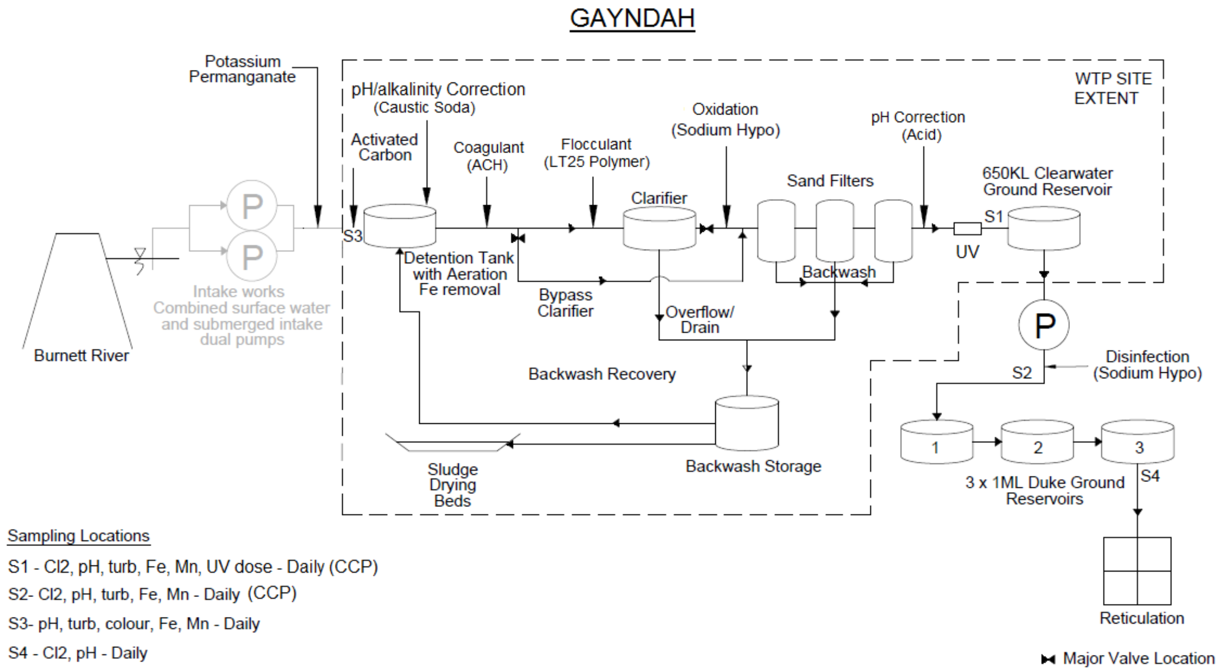


Figure 6-1 Gayndah WTP Schematic

Distribution

The chlorinated water is pumped from the clearwater ground reservoir to the town reservoirs (three x 1 ML) on Duke Mountain. One flows into the other two balance tanks in series, each has an outlet, so water does not remain in any one reservoir for long periods. All water levels are at the same level at the same time. Water is then gravity fed to the reticulation system. Recent upgrades and augmentations to the reticulation network have been made to ensure that the supply pressure to the community is between 25m and 40m. The system meets normal day demands in accordance with this pressure supply regime.

All services are metered, and demand is controlled through a two-part tariff, which includes an access charge and water usage. Stepped water restrictions are adopted during drought conditions.

Sampling locations are sited at key points determined to provide the best indication of chlorine residual levels in the system. Samples are also taken as water leaves the reservoir. Chlorine residuals in the network are sampled and tested on-site weekly. Raw water and treated water samples are sent regularly to the Queensland Health Laboratory for chemical analysis. Raw water and treated water samples are sent regularly to the Qld Health Laboratory for biological testing.

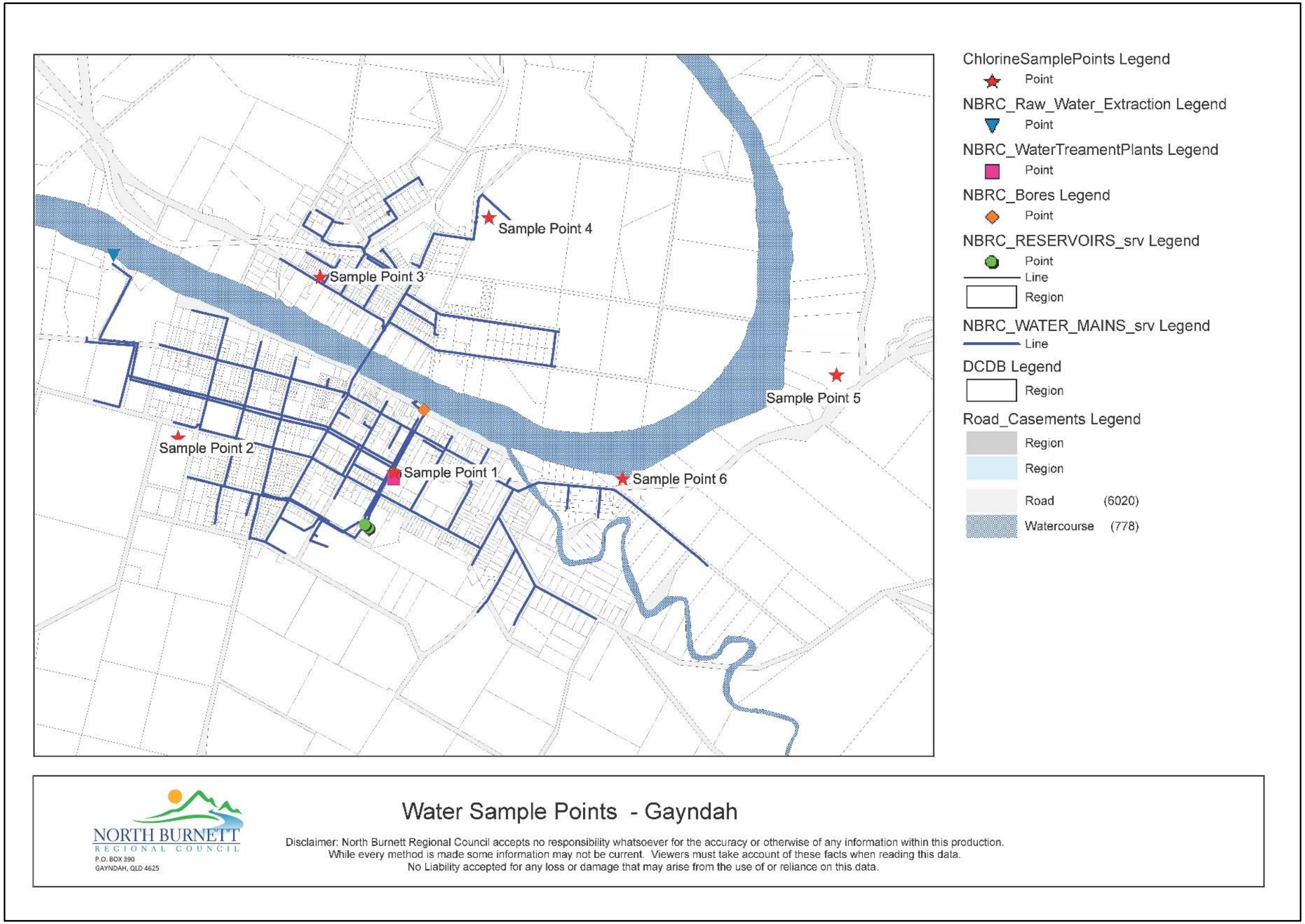


Figure 6-2 Gaydah Water Supply Map

Table 6-1 Infrastructure Details - Gaydah Water Supply Scheme

Component		Scheme
Sources	Name	Burnett River
	Type	Surface water
	% of supply	100%
	Reliability	Reliable flow though prone to flood damage
	Water quality issues	Turbidity and Colour
Sourcing Infrastructure	Type (pumped/gravity/equipped bore/etc)	Pumped surface water intake Capable of delivering 15 to 50 L/s
	Description	Burnett River
Are there any sources that **do not** undergo treatment prior to supply?	No	
Gayndah WTP	Name	Gayndah WTP
	Process	Aeration, coagulation, flocculation, clarification, filtration, pH adjustment (caustic soda and hydrochloric acid), activated carbon treatment, UV, disinfection (sodium hypochlorite), U.V
	Design Capacity (20 hr operation)	4.0 ML/d
	Daily flow range	As required by township typically 0.5 – 2.0 ML/d
	Chemicals added	Potassium permanganate, ACH, polymer, sodium hypochlorite, hydrochloric acid, caustic soda
	Standby chemical dosing facilities (Y/N)	N
	Water sourced from and %	Burnett River alluvial gravels 100%
	% of average day demand provided	100%
	% of scheme supply Distribution area supplied	100%

Component		Scheme
	Bypasses / Variations	No
Disinfection	Location	After clearwater ground reservoir
	Type	Liquid sodium hypochlorite via diaphragm dosing pump
	Dose rate	Based on in-line analyser
	Target residual levels	0.5 mg/L
	Duty/standby	Yes
	Dosing arrangements	Fixed
	Alarms	No
	Auto shut-off arrangements	No
	Location	Before the Clearwater Ground Reservoir
	Type	Wedeco Spektron 90e U.V
	Dose rate	40 mJ/cm^2 for a flow up to 25 L/s at a UVT of over 86%
	Target residual levels	NA
	Duty/standby	No
	Dosing arrangements	Fixed
	Alarms	Yes
	Auto shut-off arrangements	Yes
Distribution and Reticulation System	Pipe material	Asbestos Cement and Ductile Iron Cement Lined
	Age range	35-45 years
	Approx % of total length	90%
	Pipe material	HDPE and Blue Brute PVC
	Age range	5-8 years
	Approx % of total length	10 %

Component		Scheme
	Areas where potential long detention periods could be expected	Latham Terrace
	Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	None
Reservoirs	**Ground (No)**	1
	Name	Duke Ground Reservoirs
	Capacity (ML)	3 x 1ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

6.2 Gaydndah Water Quality: Identifying Hazards and Hazardous Events

Water quality information has been collected by NBRC for raw water, treated water and reticulated supply for the period of January 2010 to November 2018. Analysis of this data has been completed to assess the results in comparison to the ADWG guideline values for parameters measured. It is noted that no SunWater water quality data was reviewed for raw water.

A summary of the water analysis undertaken for the Gayndah Water Supply Scheme is contained in Table 6-2, Table 6-3, Table 6-4 and Table 6-5. Section 6.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

The reticulated water scheme has been measured for pH, residual chlorine, *E. coli* and total coliforms.

Interpretation

Over the period of testing there has been a medium rate of sampling for Gayndah with approximately 3 tests per month for raw water and 3.5 tests per month for treated water.

For samples taken from the Gayndah WTP, there is one occurrence of turbidity, nitrate and iron exceeding the guideline value.

Within the reticulation system there were several occurrences when residual chlorine fell below the ADWG recommended value. There were 5 instances of total coliforms being detected within the system. There were potential water quality issues within the reticulation system due to low levels of residual chlorine and total coliforms being detected. Increased frequency of sampling and testing, and operational response, has since reduced this risk.

Table 6-2 Gayndah Raw Water Source

Gayndah Source – Burnett River							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Turbidity (NTU)	Bore	Jan 10 – Nov 2018	356	777	22	<1	Bore number to be recorded to distinguish between bores
Fluoride	Bore	Jan 10 – Nov 2018	356	0.50	0.18	0.07	Multiple limits of detection were used (<0.1, <0.2 and <0.25). In order to calculate the stats, the absolute values were used.
Nitrate	Bore	Jan 10 – Nov 2018	356	5.4	1.07	<0.5	Multiple limits of detection were used (<0.5, <1, <2.5 and <5). In order to calculate the stats, the absolute values were used.
Sulfate	Bore	Jan 10 – Nov 2018	356	74.0	26.7	2	
Dissolved metals							
Aluminium	Bore	Jan 10 – Nov 2018	356	1.80	0.06	<0.05	Multiple limits of detection were used (<0.05 and <0.1). In order to calculate the stats, the absolute values were used.
Boron	Bore	Jan 10 – Nov 2018	356	0.12	0.07	0.02	
Copper	Bore	Jan 10 – Nov 2018	356	0.13	0.03	<0.03	
Iron	Bore	Jan 10 – Nov 2018	356	1.20	0.05	<0.01	Multiple limits of detection were used (<0.01 and <0.02). In order to calculate the stats, the absolute values were used.
Manganese	Bore	Jan 10 – Nov 2018	356	0.95	0.07	<0.01	Multiple limits of detection were used (<0.01 and <0.06). In order to calculate the stats, the absolute values were used.

Gaydah Source – Burnett River							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time Period**	**No of samples**	**Summary of Results**			**Comments**
				Maximum Value	**Average Value**	**Minimum Value**	
Zinc	Bore	Jan 10 – Nov 2018	356	0.83	0.02	<0.01	Multiple limits of detection were used (<0.01 and <0.02). In order to calculate the stats, the absolute values were used.
Total metals							
Aluminium	Water plant Simon St	Nov 2017 – Oct 2018	4	0.34	0.25	0.17	
Arsenic	Water plant Simon St	Nov 2017 – Oct 2018	4	0.002	0.0013	0.0018	
Cadmium	Water plant Simon St	Nov 2017 – Oct 2018	4	<0.0001	<0.0001	<0.0001	All samples taken were <0.0001 mg/L
Chromium	Water plant Simon St	Nov 2017 – Oct 2018	4	0.0007	0.0005	0.0004	
Copper	Water plant Simon St	Nov 2017 – Oct 2018	4	0.002	0.002	0.002	All raw samples taken were 0.002 mg/L
Iron	Water plant Simon St	Nov 2017 – Oct 2018	4	0.56	0.47	0.32	
Lead	Water plant Simon St	Nov 2017 – Oct 2018	4	0.0003	0.00022	0.0002	
Manganese	Water plant Simon St	Nov 2017 – Oct 2018	4	0.11	0.09	0.06	
Nickel	Water plant Simon St	Nov 2017 – Oct 2018	4	0.0018	0.0016	0.0013	

Gaydah Source – Burnett River							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Zinc	Water plant Simon St	Nov 2017 – Oct 2018	4	0.003	0.002	0.001	

Table 6-3 Gayndah Treated Water

Plant	Gayndah WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Turbidity (NTU)	WTP	Jan 10 – Nov 18	371	8.0	1.07	<1.0	5	1	Aesthetic guideline only Exceedance in Dec 2016
Fluoride	WTP	Jan 10 – Nov 18	371	1.0	0.25	0.05	1.5	0	Multiple limits of detection were used (<0.05, <0.25 and <1). In order to calculate the stats, the absolute values were used.

Plant	Gaydah WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Nitrate	WTP	Jan 10 – Nov 18	371	100	1.5	<0.50	50	2	Aesthetic guideline only Multiple limits of detection were used (<0.5 to <5). In order to calculate the stats, the absolute values were used. Exceedances occurred in Nov and Dec 2016
Sulfate	WTP	Jan 10 – Nov 18	371	75.0	27.3	2.5	250	0	Aesthetic guideline only
Dissolved metals									
Aluminium	WTP	Jan 10 – Nov 18	371	0.1	0.05	<0.05	0.1	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable Multiple limits of detection were used (<0.05 and <0.1). In order to calculate the stats, the absolute values were used.

Plant	Gaydah WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Boron	WTP	Jan 10 – Nov 18	371	0.4	0.07	0.02	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L
Copper	WTP	Jan 10 – Nov 18	371	0.14	0.03	<0.03	2 (1)	0	Number in brackets denotes the aesthetic guideline value Multiple limits of detection were used (<0.03 and <0.06). In order to calculate the stats, the absolute values were used.
Iron	WTP	Jan 10 – Nov 18	371	0.43	0.01	<0.01	0.3	1	Aesthetic guideline only Multiple limits of detection were used (<0.01 and <0.02). In order to calculate the stats, the absolute values were used. Exceedance in April 2010

Plant	Gaydah WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Manganese	WTP	Jan 10 – Nov 18	371	0.06	0.01	<0.01	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value Multiple limits of detection were used (<0.01 and <0.06). In order to calculate the stats, the absolute values were used.
Zinc	WTP	Jan 10 – Nov 18	371	0.88	0.02	<0.01	3	0	Multiple limits of detection were used (<0.01 and <0.02). In order to calculate the stats, the absolute values were used.
Total metals									
Aluminium	Water plant Simon St	Nov 2017 – Oct 2018	4	0.019	0.016	0.014	0.2	0	Aesthetic guideline only
Arsenic	Water plant Simon St	Nov 2017 – Oct 2018	4	0.004	0.0014	0.0004	0.01	0	
Cadmium	Water plant Simon St	Nov 2017 – Oct 2018	4	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L
Chromium	Water plant Simon St	Nov 2017 – Oct 2018	4	<0.0001	<0.0001	<0.0001	0.05	0	All samples were <0.0001 mg/L

Plant	Gaydndah WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Copper	Water plant Simon St	Nov 2017 – Oct 2018	4	0.013	0.008	0.006	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	Water plant Simon St	Nov 2017 – Oct 2018	4	0.032	0.013	0.006	0.3	0	Aesthetic guideline only
Lead	Water plant Simon St	Nov 2017 – Oct 2018	4	0.0005	0.0002	<0.0001	0.01	0	
Manganese	Water plant Simon St	Nov 2017 – Oct 2018	4	0.0016	0.0011	0.0006	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Nickel	Water plant Simon St	Nov 2017 – Oct 2018	4	0.0007	0.00067	0.0006	0.02	0	
Zinc	Water plant Simon St	Nov 2017 – Oct 2018	4	0.009	0.0047	0.003	3	0	Aesthetic guideline only

Table 6-4 Gaydah Reticulated Water

Scheme								
Sampling Location								
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
pH (pH units)	Jan 10 – Nov 18	371	8.1	7.6	6.7	6.5 - 8.5	0	Aesthetic guideline only
Disinfectant residual	July 2016 – Nov 2018	264	2.8	0.82	0.03	>0.2 - 0.5	31	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition Chlorine residual below 0.2 in: • Nov 2016 • Jan, Feb, May, Jun, July, Oct 2017 • Jan, Feb, Mar, Apr, Sept 2018
Total coliform (mpn/100mL)	July 2016 – Nov 2018	264	8	0.07	0	NA	NA	
E. coli (CFU/100mL)	July 2016 – Nov 2018	264	0	0	0	None Detected	0	
Trihalomethanes	Sept 2016 – Oct 2018	4	0.23	0.121	0.076	0.25	0	

Table 6-5 Gaydah Water Quality Complaints

Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
1-7-2010 to 26-10-2018	0	0			

6.3 Gayndah Catchment Characteristics

Gayndah with a population 1981, is NBRC's largest town and, along with Mundubbera, is the centre of one of the largest Citrus growing areas in Qld.

The catchment for Gayndah's potable water source includes all the Burnett River and its tributaries to the north of the town. The topography of this large area includes hilly and undulating natural forest areas, river, and creek flats.

Land use within this area is varied and includes extensive irrigated citrus orchids, cropping and cattle grazing. The citrus growing area extends primarily from the north of the town through to Mundubbera and continues along the Burnett to Eidsvold. Gaydah is thus downstream of most of the economic activity within the NBRC region. This has important implications for water quality.

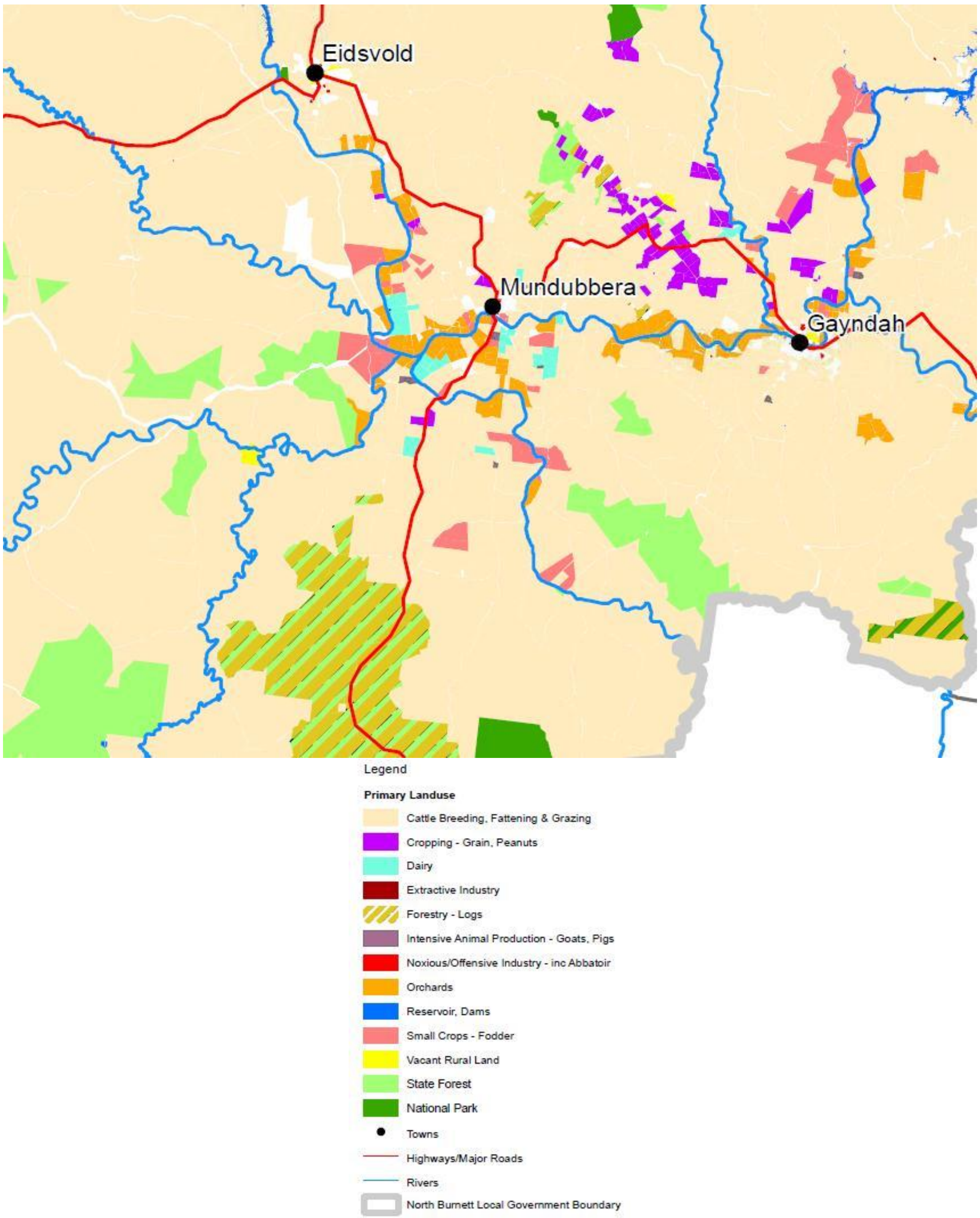


Figure 6-3 Gayndah Catchment Area

6.4 Gayndah Hazard Identification, Risk Assessment and Uncertainty

Table 6-6 Gayndah Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. Clarification, filtration, and disinfection, oxidation, and UV 2. Dilution during treatment processes and storage 3. Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations.	Catastrophic	Rare	Medium (6)	Uncertain	Large fruit bat colonies sometimes roost over the river in the vicinity of extraction points. This has resulted in some very high total coliform counts in the raw water, but treatment systems are robust	Validate filter for protozoa using surrogate microbe challenge testing
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. WTP processes including filtration and disinfection, oxidation, and UV. 2. Environmental Management Plans for vegetation control to deter flying foxes roosting. 3. Catchment group education programs Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations.	Catastrophic	Rare	Medium (6)	Uncertain. Biological contamination always in the raw water but treatment seen and shown as effective	Large fruit bat colonies roost over the river in the vicinity of extraction points. This has resulted in some very high total coliform counts in the raw water, but treatment systems are robust	Consider removal of colony of trees to remove bat roosts and discourage the bat colonies.
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Major	Unlikely	Medium (8)	1. Treatment processes, flocculation, clarifier, filtration, 2. Annual monitoring and testing of source water.	Major	Rare	Medium (5)	Confident	Existing measures are robust	
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Minor	Possible	Medium (6)	1. Treatment processes, flocculation, clarifier, filtration	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. Treatment processes, flocculation, clarifier, oxidisation, filtration	Moderate	Rare	Low (3)	Confident	Existing measures are robust	
6	Source water	Chemical contamination	1. Accidental spills	Moderate	Rare	Low (3)	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert)	Insignificant	Rare	Low (1)	Uncertain	Small concentration. Only risk of any real consequence would be a chemical spill near the intake Inability to predict type or consistency of possible spill?	
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	Minor	Possible	Medium (6)	1. Catchment group education programs 2. Treatment processes – clarifier, flocculants, sand filters 3. Public notification process (boil water alert)	Minor	Unlikely	Low (4)	Confident	Occasional flooding of Burnett River cannot be avoided.	
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. power failure	Moderate	Unlikely	Medium (6)	1. Estimated 4 day's supply in reserve at clearwater and hill-top reservoirs. 2. **Gayndah 2018-01** A dual submerged pumps (duty/stand-by/alternating)	Moderate	Rare	Low (3)	Reliable	Existing measures are robust	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
			4. Blockage of intake structure										
9	Source water	Lack of supply	Climatic variations	Moderate	Unlikely	Medium (6)	1. Importing water (trucked) 2. Drought management Plan actions: restrictions, communication etc.	Moderate	Rare	Low (2)	Uncertain		
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	Major	Possible	High (12)	1. Treatment processes – Clarification, flocculation, filtration, UV, Chlorine disinfection at filter stage and leaving clearwater reservoir. 2. Chlorine levels are tested at least 3 times per day. 3. Injection pumps and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment Gayndah 2013-03: Operation of the chlorine injection system needs to be linked to raw water meter signal. Council is reassessing whether this is still required as now have online analysers and alarm if water quality is off spec. Gayndah 2013-04: On line chlorine analyser are installed and alarmed to SCADA	Major	Rare	Medium (5)	Reliable		UV Operational review
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Coagulation, clarification, filtration and UV 3. Trained and qualified operators – good housekeeping Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations. **Gayndah 2018-02:** UV unit has been installed at the WTP	Major	Rare	Medium (5)	Uncertain	Inability to detect contamination in the treatment process	UV Operational review
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff Error 5. Plant Design	Moderate	Unlikely	Medium (6)	1. Treatment processes, flocculation, clarifier, oxidisation with Cl and KMn04 for iron and manganese 2. Chlorine levels are tested at least 3 times per day. 3. Injection pumps and chlorine supply are also checked and inspected at the same time. 4. Trained and qualified operators – good housekeeping Gayndah 2013-03: Operation of the chlorine injection system needs to be linked to raw water meter signal. Council is reassessing	Moderate	Rare	Low (3)	Uncertain	Online chlorine analyser will detect chlorine exceedance and alarm and shut the plant down.	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
							whether this is still required as now have online analysers and alarm if water quality is off spec. Gayndah 2013-04: Online chlorine analyser are installed and alarmed to SCADA						
13	Treatment	Disinfection by-products (THMs)	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	Major	Rare	Medium (5)	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill 2. Staff aware of potential issues and refill fortnightly if possible THM monitoring have commenced. All results are below ADWG limits. **Gayndah 2018-03:** THM monitoring occurs monthly	Major	Rare	Medium (5)	Confident		
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of Manganese or turbidity. 4. Communication Breakdown 5. Staff error	Minor	Likely	Medium (8)	1. Treatment processes, flocculation, clarifier, oxidisation with Cl and $KMnO_4$ for iron and manganese 2. Operation of filters and clarifier monitored daily. 3. Trained and qualified operators – good housekeeping **Gayndah 2013-04**: On line chlorine analyser are installed and alarmed to SCADA	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	
15	Treatment	Clearwater reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	Moderate	Unlikely	Medium (6)	1. Estimated 4 day's supply at the hilltop reservoirs. 2. Standby pump installed	Moderate	Rare	Low (3)	Confident	Existing measures are robust	
16	Treatment	Substandard chemicals	1. Inappropriate chemical storage or defective batch	Moderate	Rare	Low (3)	1. Chemicals stored as per regulation 2. Monitoring of manganese, turbidity and chlorine occurs every 3 hours **Gayndah 2013-04**: Online chlorine analyser are installed and alarmed to SCADA	Insignificant	Rare	Low (1)	Confident	Existing measures are robust	
17	All	• Sabotage or natural disaster causing contamination or supply failure	1. Damaged equipment 2. Harmful substances	Major	Rare	Medium (5)	1. Treatment plant fenced and locked	Moderate	Rare	Low (3)	Confident	All practical steps have been taken	
18	All	• Power failure causing contamination or supply failure	1. Power failure	Minor	Unlikely	Low (4)	1. Estimated one week's supply in reserve at clearwater and tower reservoir.	Minor	Rare	Low (3)	Confident	Existing measures and capacity are robust. Some incidents have occurred with no consequence.	
19	Raw Water	Pesticides: • Imidacloprid • Tebiurithon	Farming chemicals	Major	Rare	Medium (5)	1. Regular monitoring program	Moderate	Rare	Low (3)	Confident	All practical steps have been taken	

6.5 Gaydah Risk Management Measures

Table 6-7 Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	1. Filtration (limited efficacy) 2. Dilution during treatment processes and storage	Likelihood & Consequence	Unknown	Medium (6)	Yes	Validate filter for protozoa using surrogate microbe challenge testing	Water and Wastewater
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	1. WTP processes including filtration and disinfection. 2. Environmental Management Plans for vegetation control to deter flying foxes roosting. 3. Catchment group education programs	Likelihood & Consequence	Unknown	Medium (6)	Yes	Consider removal of colony of trees to remove bat roosts and discourage the bat colonies.	Water and Wastewater
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	1. Treatment processes, flocculation, clarifier 2. Annual monitoring and testing of source water	Likelihood	Unknown	Medium (5)	Yes		
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	1. Treatment processes, flocculation, clarifier	Likelihood	Unknown	Low (4)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	1. Treatment processes, flocculation, clarifier, oxidisation with Cl for iron and manganese	Likelihood	Unknown	Low (3)	Yes		
6	Source water	Chemical contamination	1. Accidental spills	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert)	Consequence	Unknown as has not occurred	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	1. Catchment group education programs 2. Treatment processes – clarifier, flocculants, sand filters 3. Public notification process (boil water alert)	Likelihood & Consequence	Unknown	Low (4)	Yes		
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. Power failure 4. Blockage of intake structure	1. Estimated 4 day's supply in reserve at clearwater and hill-top reservoirs.	Likelihood	Not effective- neither stand by pumps or alternate source currently available.	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
9	Source water	Lack of supply	Climatic variations	1. Importing water 2. Drought management Plan actions: restrictions, communication etc.	Likelihood	Effective- reliable supply	Low (2)	Yes		
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of chemical supplies 4. Staff error 5. Plant Design	1. Treatment processes – Chlorine disinfection at raw water and at filter stage and leaving clearwater reservoir 2. Chlorine levels are tested at least 3 times per day. 3. Injection pumps and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5 Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment	Likelihood	Effective-online and alarmed	Medium (5)	Yes	UV Operational review	Water and Wastewater

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
				Gayndah 2013-03: Now have online analysers and alarm if water quality is off spec. **Gayndah 2013-04**: On line chlorine analyser are installed and alarmed to SCADA						
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	1. Security and vermin-proofing 2. Filtration (limited efficacy) and UV 3. Trained and qualified operators – good housekeeping	Yes	Inability to detect contamination in the treatment process	Medium (5)	Yes	UV Operational review	Water and Wastewater
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error 5. Plant Design	1. Treatment processes, flocculation, clarifier, oxidisation with Cl and $KMnO_4$ for iron and manganese 2. Chlorine levels monitored by an On Line Chlorine Analyser 3. Injection pumps and chlorine supply are also checked and inspected at the same time.	Likelihood	Effective- based on there being no instance of overdose yet.	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
				4 Trained and qualified operators – good housekeeping						
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill 2. Staff aware of potential issues and refill fortnightly if possible	No	No THM exceedances recorded in treated water	Medium (5)	Yes		
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of Manganese or turbidity. 4. Communication breakdown 5. Staff error	1. Treatment processes, flocculation, clarifier, oxidisation with Cl and $KMnO_4$ for iron and manganese 2. Operation of filters and clarifier monitored daily. 3. Trained and qualified operators – good housekeeping	Likelihood	Less than effective-based on some tests not meeting parameters.	Low (4)	Yes		
15	Treatment	Clearwater reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	1. Estimated 4 day's supply at the hilltop reservoirs. 2. Standby pump installed	Likelihood	Effective- multiple backups	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
16	Treatment	Substandard chemicals	1. Inappropriate chemical storage or defective batch	1. Chemicals stored as per regulation 2. Monitoring of manganese, turbidity and chlorine occurs every 3 hours	Consequence	Moderately effective- based on treatment results	Low (1)	Yes		
17	All	Sabotage or natural disaster causing contamination or supply failure	1. Damaged equipment 2. Harmful substances	1. Treatment plant fenced and locked	Likelihood	Moderate- Experience	Low (3)	Yes		
18	All	Power failure causing contamination or supply failure	1. Power failure	1. Estimated one week's supply in reserve at clearwater and tower reservoir.	Likelihood and Consequence	Effective- history	Low (3)	Yes		
19	Raw Water	Pesticides: • Imidacloprid Tebiurithon	Farming chemicals	1. Regular monitoring program	Consequence	Effective- history	Low (3)	Yes		

6.6 Gayndah Risk Management Improvement Program

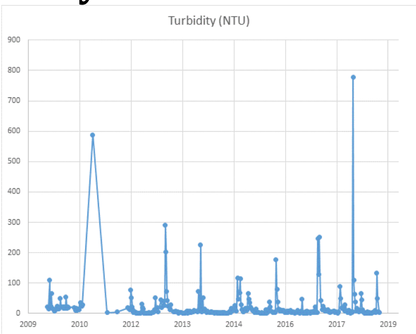
Table 6-8 Gayndah Risk Improvement Program

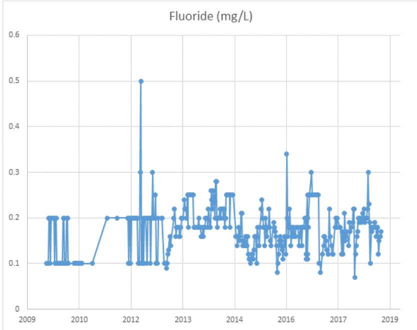
Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
1	Source water	Biological contamination Protozoa	Medium			Validate filter for protozoa using surrogate microbe challenge testing	20/12/2022	$30,000	Water and Wastewater
2	Source water	Biological contamination • Bacteria • Viruses	Medium		Consider removal of colony of trees to remove bat roosts and discourage the bat colonies.		20/12/2021	$-	Water and Wastewater
10	Treatment	Biological contamination • Bacteria • Viruses	Medium			UV Operational review	30/6/2022	$10,000	Water and Wastewater
11	Treatment	Biological contamination Protozoa	Medium			UV Operational review	30/6/2022	$10,000	Water and Wastewater

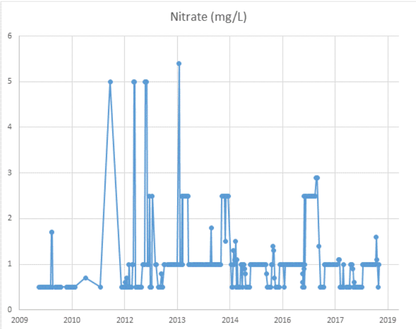
6.7 Gaydah Water Supply Scheme Water Quality Data

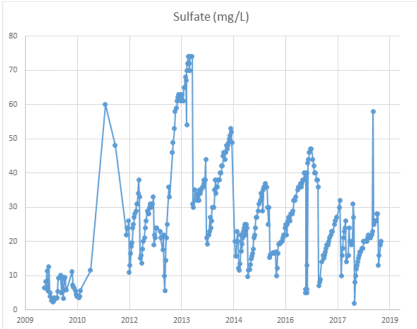
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

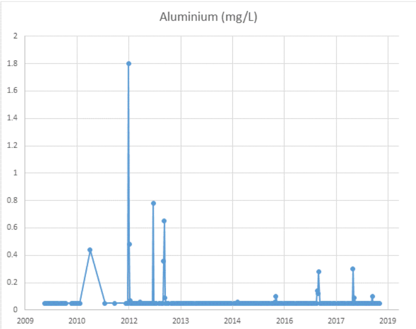
Gayndah untreated bore water 2010-2018

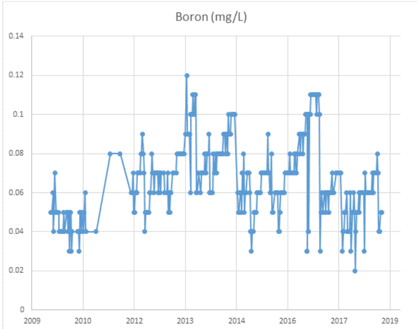


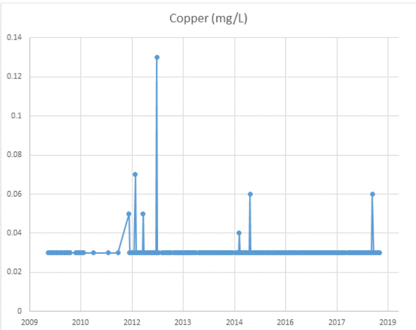


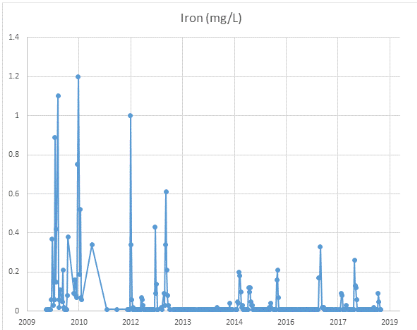


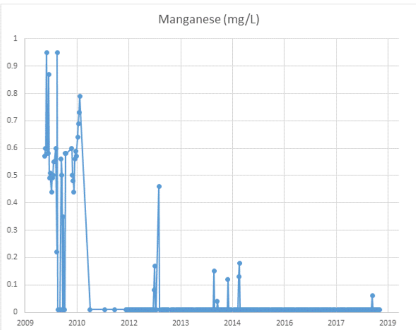


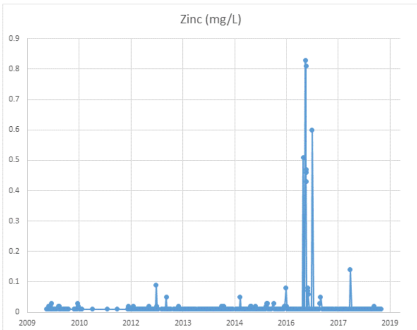




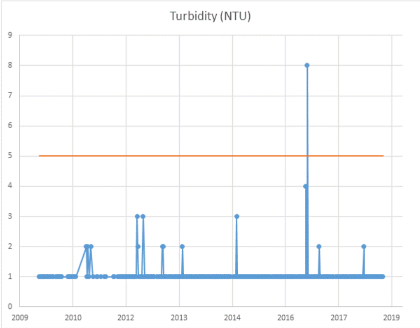


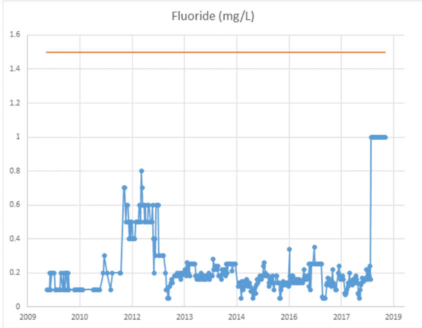


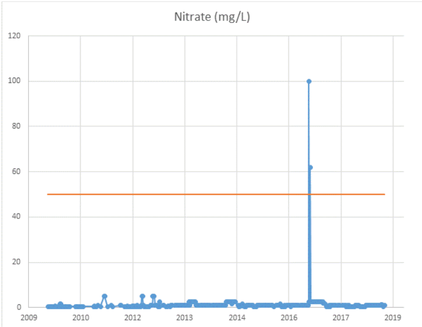


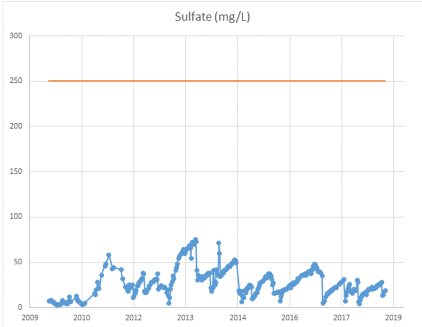


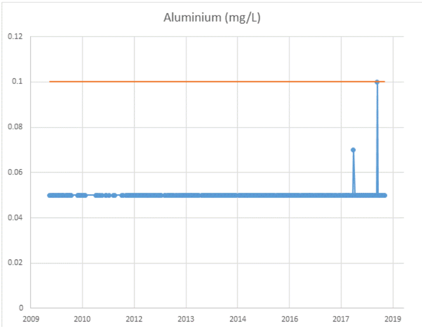
Gayndah treated water 2010-2018

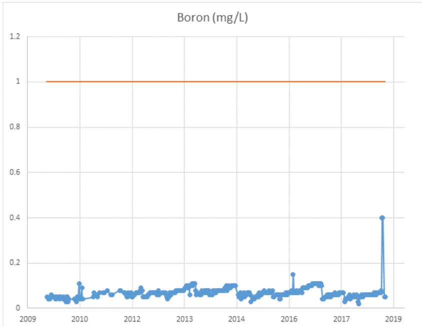


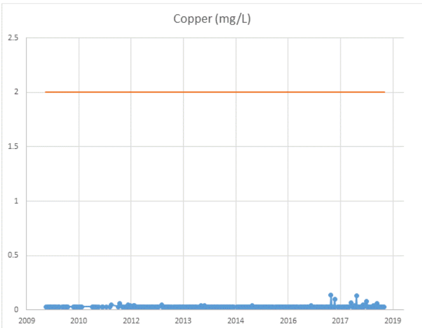


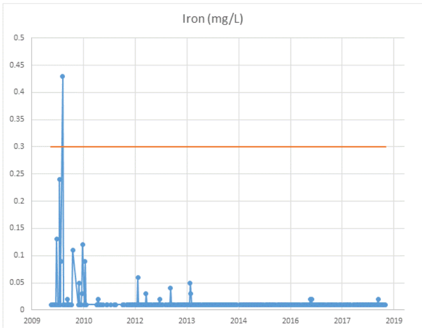


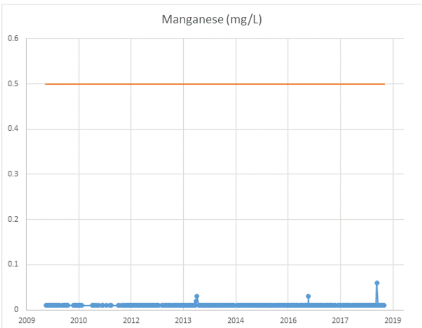


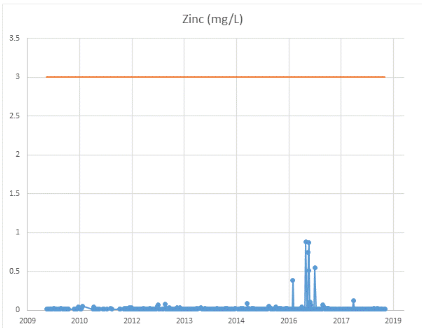












7. MINGO CROSSING CARAVAN PARK WATER SUPPLY SCHEME

7.1 Details of Infrastructure for Providing the Service

Source Water

Mingo Crossing Caravan Park Water Supply Scheme only supplies potable water to the caravan park. The park consists of a caretaker's residence with one permanent resident.

Source water at Mingo Crossing is the Burnett River, backwater to Paradise Dam next to the campgrounds. The intake infrastructure consists of a submersible pump on floating pontoon secured in place. A 50mm PE pipe supplies the WTP from this pump. This source may no longer be available for the site due to the lowing of dam levels for dam safety reasons.

During flood events, the raw water quality can be highly turbid and coloured, and the treatment plant would not have the capacity to treat this. During these times, water extraction from the Burnett River is suspended and potable water is trucked in. This water is put through the WTP and re-treated prior to supply into the reticulation.

Treatment Process

The raw water is pumped to the treatment plant located in the caravan park. The designed flow rate to the WTP is 32 kL/d. Mingo Crossing's average usage is approximately 8 kL/d.

The inflow of water from the river to the treatment plant is initiated by a low-level switch, and conversely switched off by a high-level switch, in the Raw Water Tank 1 (one of three tanks). The three raw water tanks are balanced by a common low-level connection pipe.

Operation of the raw water pumps will initiate the dosing of flocculant (poly aluminium chloride or PACl). As water enters the clarification process, it first passes a vessel which incorporates several chambers and baffles as well as air agitation. Air is supplied by the mixing/backwash blower. From the flocculant mixing vessel, water flows to the clarifier.

The clarifier is designed with structured packing to facilitate the flocculation, settling and removal of solids. The solids settle to the bottom cone of the clarifier where they are withdrawn and disposed of. The operation of a control valve on a periodic basis allows for water and solids removal and disposal under gravity to the waste stream. The valve is set for 3 minutes open every 60 minutes. Clarified water gravity flows from the clarifier to the clarified water tank, a 22.5 m^3 poly tank. The clarified water tank is fitted with a low-level switch that controls the booster pumps and is also fitted with an ultrasonic level transmitter for monitoring tank level.

The clarified water then flows through to the sand filter. Over time, the differential pressure will increase as the accumulated solids restrict flow. On a timed basis or a low UF inlet pressure, backwash will be performed. After backwash, clarified water is then used to top down wash the sand bed and dispose of the rinse water to the common waste line. The exit of the sand filter is fitted with a pressure transmitter for measuring discharge pressure which is used as a trigger for a backwash of the sand filter.

The water post sand filter is then passed through the activated carbon filter to remove solids, primarily metals, possible blue-green algal toxins, total organic carbon, and other contaminants. As with the sand filter, the activated carbon filter is backwashed. The source water for backwashing is water that has been filtered by the sand filter.

The water post carbon filtration flows through a 300-micron bag filter which is fitted with a pressure transmitter that will identify either the requirement for a bag change or a backwash of the carbon filter.

The UF process then filters the water to 40 nano-meters nominal size thereby removing most harmful blue-green algae and bacterium. The process involves passing the feed water through fine membrane tubules where water passes through into the “permeate” and retention of solids. The process is set with a crossflow where 20% of the feed flow reports as solids rich crossflow being disposed of via the common wastewater line.

The feed flow to UF is set by manipulation of a manual valve and setting of feed flow via a rotameter flow meter. Crossflow is set by similar means. Adjusting feed and crossflow valving impacts pressure profile around membranes.

After a set period, a backwash is performed whereby the feed is stopped by stopping the booster pumps and then control valving is changes. The backwash water is potable water which has been filtered by UF and chlorinated.

Permeate that exits the UF is dosed with sodium hypochlorite for disinfection. The product water is measured for turbidity, free chlorine, and conductivity. The permeate, now deemed potable water, flows to one of the four site potable water tanks.

The potable water system is recirculated from one tank to the other tanks within the storage system and is dosed with sodium hypochlorite to maintain stored potable water free chlorine. The potable water tank that is utilised for the supply to the recirculation and backwash pump is fitted with a low level switch to protect pumping and a high level switch that will stop/start process based on potable water inventory.

A schematic of the treatment plant is shown in Figure 7-1.

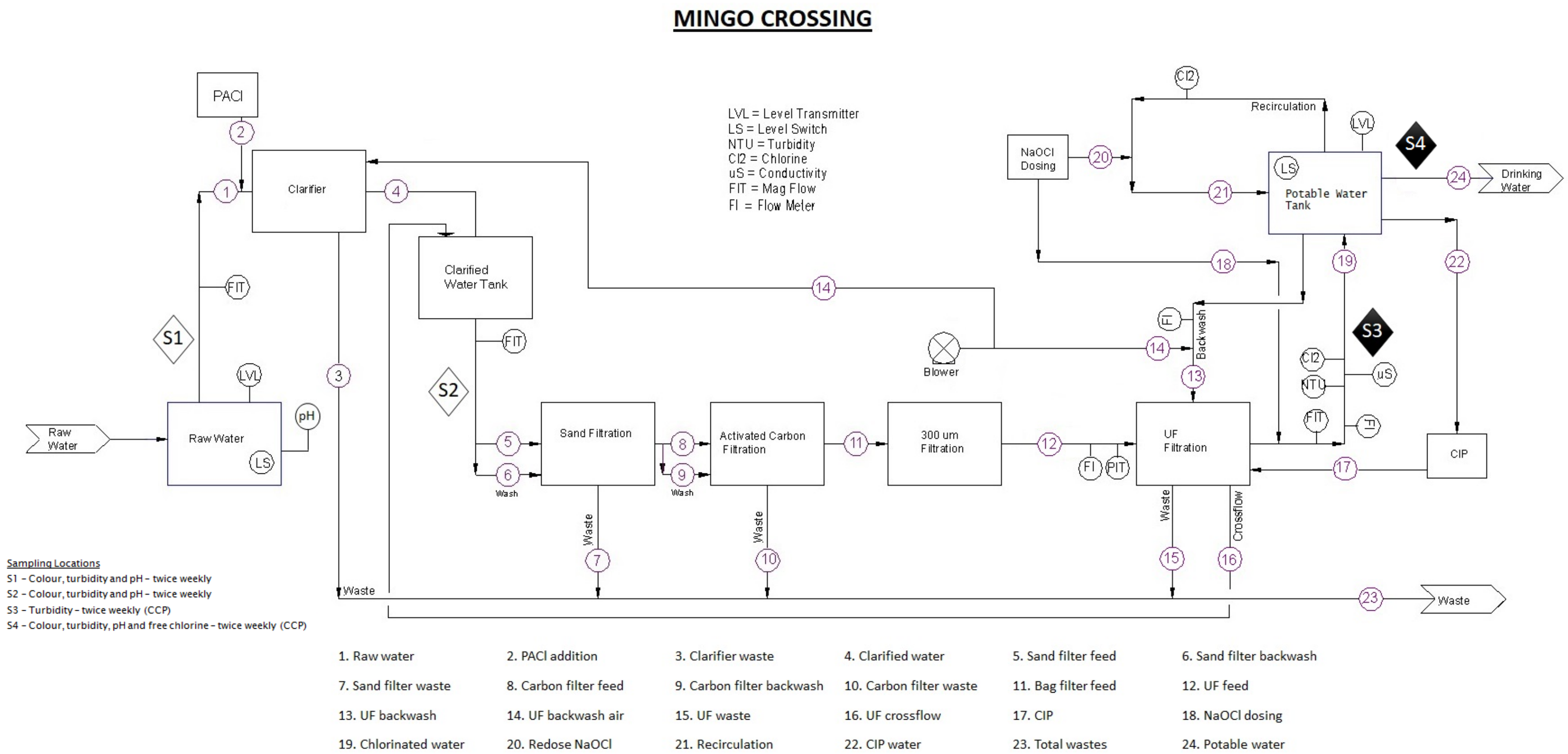


Figure 7-1 Mingo Crossing WTP Schematic

Distribution

The treated water is pumped from the potable water tanks directly to the caravan park internal plumbing.

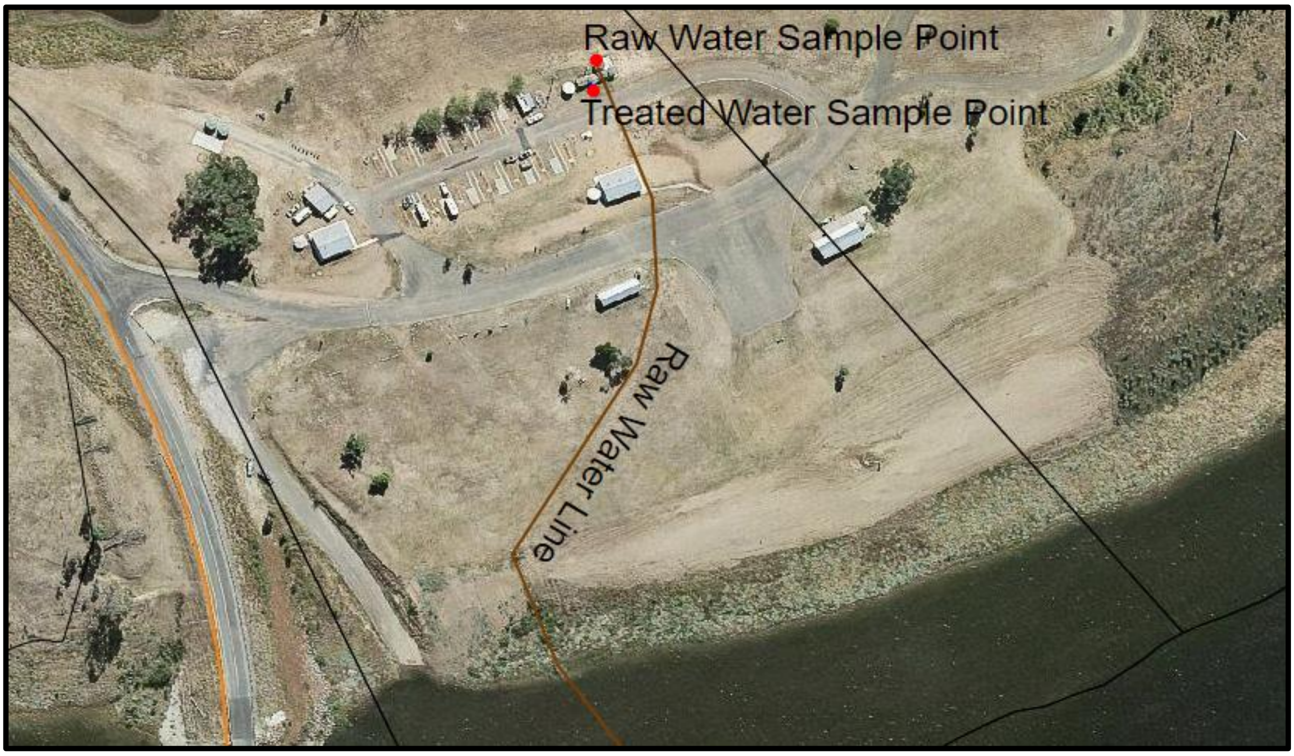


Figure 7-2 Mingo Crossing Water Supply Map

Table 7-1 Infrastructure Details – Mingo Crossing Water Supply Scheme

Component		Scheme
Sources	Name	Burnett River Paradise Dam
	Type	River/Impoundment
	% of supply (normal)	100%
	Reliability	Very poor
	Water quality issues	Turbidity, colour, and high pH
Sourcing Infrastructure	Type	Pumped
	Description	Pump Capacity = 66 L/min Centrifugal submersible bore pump mounted on pontoon Installed = 2013
	Ownership	NBRC
Are there any sources that **do not** undergo treatment prior to supply?	No	
Mingo Crossing WTP	Name	Mingo Crossing WTP
	Process	Coagulation, clarification, sand filtration, carbon filtration, bag filtration, ultrafiltration, chlorination
	Design Capacity (20 hr operation)	32 kL/d
	Daily flow range	0.23 L/s (average) to 0.4 L/s (peak)
	Chemicals added	Sodium hypochlorite PACl
	Standby chemical dosing facilities (Y/N)	N
	Water sourced from and %	Burnett River 0% - Other townships (trucked) – 100% (Emergency)
	% of average day demand provided	0%
	% of scheme supply	0%

Component		Scheme
	Distribution area supplied	Nil
	Bypasses / Variations	No
Disinfection	Location	After ultrafiltration and into the potable water tanks
	Type	Liquid sodium hypochlorite via LMI dosing pumps
	Dose rate	12 L/h (both dosing pumps)
	Target residual levels	0.7 – 1.7 mg/L (measured at the potable water tank 1)
	Duty/standby	No
	Dosing arrangements	Fixed
	Alarms	Low free chlorine Low potable water level High turbidity level
	Auto shut-off arrangements	Y – based on low free chlorine

7.2 Mingo Crossing Water Quality: Identifying Hazards and Hazardous Events

The WTP was upgraded and commissioned on the 3rd of April 2019. Water quality information has been collected by NBRC for raw water and treated water since August 2015 and data summarised here includes results up to September 2018. Analysis of this data has been completed to assess the results in comparison to the ADWG guideline values for parameters measured. It is noted that no SunWater water quality data was reviewed for raw water.

A summary of the water analysis undertaken for the Mingo Crossing Caravan Park Water Supply Scheme is contained in Table 7-2, Table 7-3 and Table 7-4. Section 7.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured on a regular basis:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Chlorine residual
- Total coliform
- *E. coli*
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

Note that reticulated water had not been sampled or tested as explained in Section 7.1 above.

Interpretation

Over the period of testing, the frequency of sampling for Mingo Crossing was once a month for both raw water and for treated water.

For samples taken from the Mingo Crossing WTP, there is one occurrence of turbidity exceeding the guideline value (10/7/18). However, it was clear that the results were mixed up as the raw water turbidity taken on the same sample run was <1 NTU, while the treated water turbidity was 14 NTU. There were also three instances where total coliforms were detected and six instances where chlorine residual was below 0.2 mg/L in the treated samples.

No reticulated water quality data has been collected and therefore, no comment can be made at this time.

Table 7-2 Mingo Crossing Raw Water Source

Mingo Crossing Source – Burnett River							
Parameter (mg/L unless otherwise specified)	Sampling location	Time period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Turbidity (NTU)	River	Aug 2015 – Sep 2018	33	71	13.6	1	
Fluoride	River	Aug 2015 – Sep 2018	33	0.2	0.13	0.08	
Nitrate	River	Aug 2015 – Sep 2018	33	6.5	0.86	0.5	
Sulfate	River	Aug 2015 – Sep 2018	33	17	10.1	6	
Dissolved Metals							
Aluminium	River	Aug 2015 – Sep 2018	33	0.77	0.08	0.05	
Boron	River	Aug 2015 – Sep 2018	33	0.05	0.04	0.03	
Copper	River	Aug 2015 – Sep 2018	33	0.03	0.03	0.03	97% of values below LOR (i.e. <0.03)
Iron	River	Aug 2015 – Sep 2018	33	0.47	0.05	0.01	
Manganese	River	Aug 2015 – Sep 2018	33	0.01	0.01	0.01	All values below LOR (i.e. <0.01)
Zinc	River	Aug 2015 – Sep 2018	33	0.53	0.04	0.01	
Total metals							
Aluminium	Raw water tank	Nov 2017 – Oct 2018	4	0.77	0.52	0.11	
Arsenic	Raw water tank	Nov 2017 – Oct 2018	4	0.0024	0.0021	0.0014	
Cadmium	Raw water tank	Nov 2017 – Oct 2018	4	<0.0001	<0.0001	<0.0001	All samples taken were <0.0001 mg/L
Chromium	Raw water tank	Nov 2017 – Oct 2018	4	0.0011	0.0005	0.0002	
Copper	Raw water tank	Nov 2017 – Oct 2018	4	0.008	0.005	0.004	
Iron	Raw water tank	Nov 2017 – Oct 2018	4	1.2	0.51	0.14	
Lead	Raw water tank	Nov 2017 – Oct 2018	4	0.0007	0.0005	0.0002	
Manganese	Raw water tank	Nov 2017 – Oct 2018	4	0.04	0.027	0.015	
Nickel	Raw water tank	Nov 2017 – Oct 2018	4	0.0021	0.0017	0.0012	
Zinc	Raw water tank	Nov 2017 – Oct 2018	4	0.014	0.0077	0.005	

Table 7-3 Mingo Crossing Treated Water

Plant	Mingo Crossing WTP								
Parameter (mg/L unless otherwise specified)	Sampling location	Time period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comments
				Maximum value	Average value	Minimum value			
Turbidity (NTU)	WTP	Aug 2015 – Sep 2018	33	3	1.15	1	5	0	Exceedance in July 2018 but likely to be lab reporting error – reporting the raw water result rather than the treated water, as raw water result was <1NTU Aesthetic guideline only
Fluoride	WTP	Aug 2015 – Sep 2018	33	0.18	0.09	0.05	1.5	0	
Nitrate	WTP	Aug 2015 – Sep 2018	33	8.19	7.72	7	50	0	Aesthetic guideline only
Sulfate	WTP	Aug 2015 – Sep 2018	33	13.5	8.18	1	250	0	Aesthetic guideline only
pH (pH units)	WTP	Jun 2015 – Oct 2018	31	8.05	7.63	7.1	6.5-8.5	0	Aesthetic guideline only
Disinfectant residual	WTP	Jun 2015 – Oct 2018	31	4.3	0.9	0.01	>0.2 - 0.5	6	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition Chlorine residual below 0.2 in: • June, Aug, Nov 2016 • Jan, Sept 2017 • Feb 2018
Total coliform (mpn/100mL)	WTP	Jun 2015 – Oct 2018	33	70	2.7	0	NA	NA	
E. coli (mpn/100mL)	WTP	Jun 2015 – Oct 2018	33	0	0	0	None detected	0	

Plant	Mingo Crossing WTP								
Parameter (mg/L unless otherwise specified)	Sampling location	Time period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comments
				Maximum value	Average value	Minimum value			
Dissolved metals									
Aluminium	WTP	Aug 2015 – Sep 2018	33	<0.05	<0.05	<0.05	0.1	0	All values below limit of reporting
Boron	WTP	Aug 2015 – Sep 2018	33	0.05	0.03	0.03	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L Most samples below detection limit
Copper	WTP	Aug 2015 – Sep 2018	33	<0.03	<0.03	<0.03	2 (1)	0	Number in brackets denotes the aesthetic guideline value All values below limit of reporting
Iron	WTP	Aug 2015 – Sep 2018	33	0.1	0.01	0.01	0.3	0	Aesthetic guideline only
Manganese	WTP	Aug 2015 – Sep 2018	33	0.03	0.01	0.01	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value Most samples below detection limit
Zinc	WTP	Aug 2015 – Sep 2018	33	0.52	0.04	0.01	3	0	
Total metals									
Aluminium	WTP tap	Nov 2017 – Oct 2018	4	0.066	0.042	0.024	0.2	0	Aesthetic guideline only
Arsenic	WTP tap	Nov 2017 – Oct 2018	4	0.0007	0.0005	0.0003	0.01	0	
Cadmium	WTP tap	Nov 2017 – Oct 2018	4	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L

Plant	Mingo Crossing WTP								
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time period**	**No of samples taken in time period**	**Summary of results**			**Australian Drinking Water Guidelines guideline value for health unless otherwise specified**	**No of samples exceeding Australian Drinking Water Guidelines guideline value**	**Comments**
				Maximum value	**Average value**	**Minimum value**			
Chromium	WTP tap	Nov 2017 – Oct 2018	4	<0.0001	<0.0001	<0.0001	0.05	0	All samples were <0.0001 mg/L
Copper	WTP tap	Nov 2017 – Oct 2018	4	0.003	0.0027	0.002	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	WTP tap	Nov 2017 – Oct 2018	4	0.013	0.0075	0.005	0.3	0	Aesthetic guideline only
Lead	WTP tap	Nov 2017 – Oct 2018	4	0.0004	0.0003	0.002	0.01	0	
Manganese	WTP tap	Nov 2017 – Oct 2018	4	0.0025	0.0013	0.0004	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Nickel	WTP tap	Nov 2017 – Oct 2018	4	0.0011	0.0009	0.0008	0.02	0	
Zinc	WTP tap	Nov 2017 – Oct 2018	4	0.006	0.0047	0.003	3	0	Aesthetic guideline only
Trihalomethanes	WTP tap	Jan 2018 – Oct 2018	3	0.11	0.094	0.079	0.25	0	

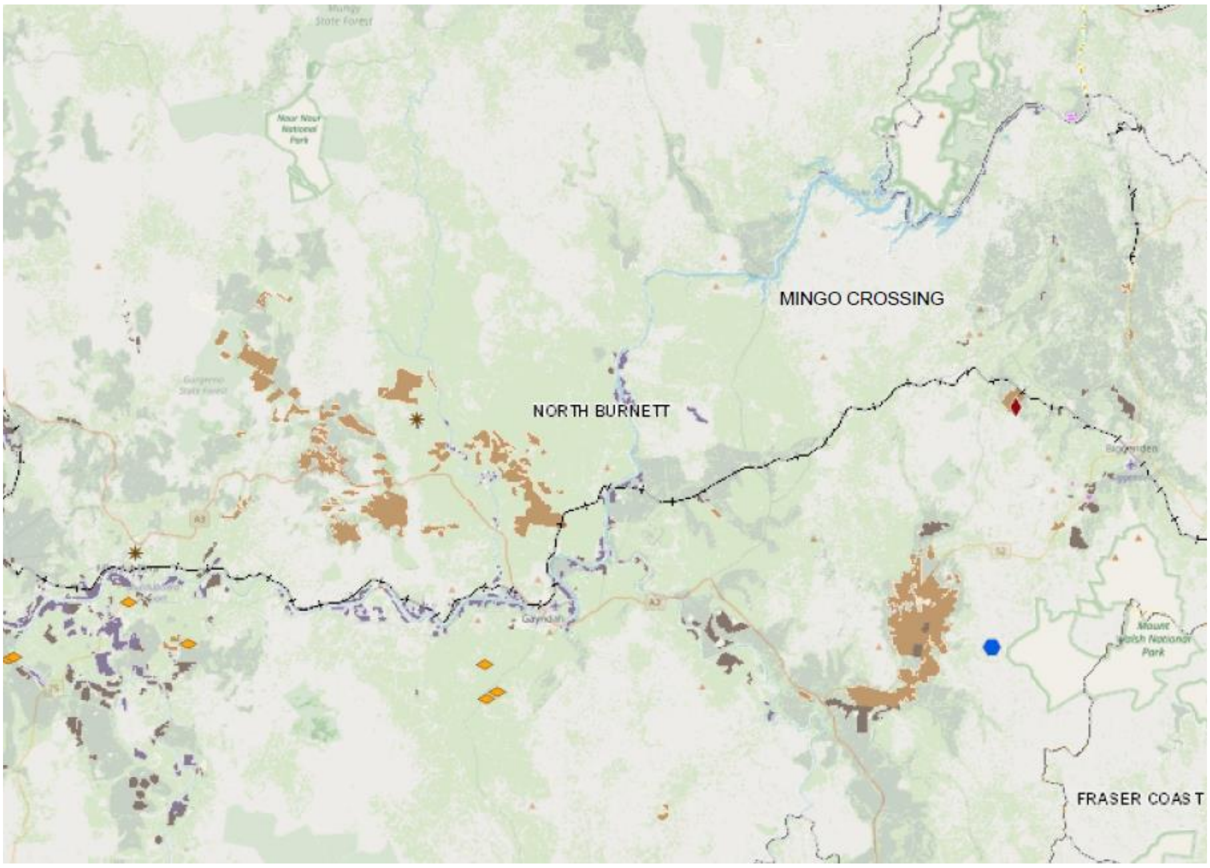
Table 7-4 Mingo Crossing Water Quality Complaints

Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
16-6-2015 to 26-10-2018	0	0			

7.3 Mingo Crossing Catchment Characteristics

The catchment for Mingo Crossing potable water source includes all the Burnett River and its tributaries to the north of the town. The topography of this large area includes hilly and undulating natural forest areas, river, and creek flats.

Land use within this area is varied and includes extensive irrigated citrus orchids, cropping and cattle grazing. The citrus growing area extends primarily from the north of Gayndah through to Mundubbera and continues along the Burnett to Eidsvold. Mingo Crossing is thus downstream of most of the economic activity within the NBRC region.



Legend:

Local government areas
State electoral boundaries
Livestock processing
- export cattle abattoirs
- egg processors
- pig abattoir
- poultry abattoirs

Cotton gins
Current sugar mills
Airports

Railways
Current saw mills - plantation timber
Current saw mills - native timber
Current sheep feedlots
Current poultry farms
Current piggeries
Current cattle feedlots
Current land based aquaculture

Current broadacre cropping
- Cropping
- Irrigated cropping

Current annual horticulture
- Intensive horticulture
- Seasonal horticulture
- Irrigated seasonal horticulture

Current perennial horticulture
- Perennial horticulture
- Irrigated perennial horticulture

Figure 7-3 Mingo Crossing Catchment Area

7.4 Mingo Crossing Hazard Identification, Risk Assessment and Uncertainty

Table 7-5 Mingo Crossing Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Possible	High (15)	1. WTP process includes flocculation, clarification, filtration, UF and disinfection 2. Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations. 3. Effluent Disposal area has been moved further from water offtake area.	Catastrophic	Rare	Medium (8)	Confident	Intake is approximately 50m from the shoreline. Recreational activities are allowed on the dam. Area next to the intake is accessible by swimmers. Likelihood categories based on *E. coli* results from 2015. Based on available data, no *E. coli* detection has been experienced since 2015 (ie 'Rare' likelihood). However, this is only 3 years' worth of data and therefore, the likelihood was increased to 'Unlikely'. To find an alternative water source, a test bore was drilled in Jun 2017 and the water was tested. However, the water returned positive results for heavy metals and therefore, the water was considered not appropriate for potable use. Water carting to site is available if water quality is not suitable.	Investigate implementing an exclusion zone around the intake or moving the intake away from recreators, in consultation with SunWater. Investigate installing riparian Spear at current offtake site
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. WTP process includes flocculation, clarification, filtration, UF and disinfection 2. Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations. 3. Effluent Disposal area has been moved further from water offtake area	Catastrophic	Rare	Medium (6)	Confident	Intake is approximately 50m from the shoreline. Recreational activities are allowed on the dam. Area next to the intake is accessible by swimmers. Likelihood categories based on *E. coli* results from 2015. Based on available data, no *E. coli* detection has been experienced since 2015 (ie 'Rare' likelihood). However, this is only 3 years' worth of data and therefore, the likelihood was increased to 'Unlikely'. To find an alternative water source, a test bore was drilled in Jun 2017 and the water was tested. However, the water returned positive results for heavy metals and therefore, the water was considered not appropriate for potable use. Water carting to site is available if water quality is not suitable.	Investigate implementing an exclusion zone around the intake or moving the intake away from recreators, in consultation with SunWater. Investigate installing riparian Spear at current offtake site
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Major	Unlikely	Medium (8)	1. WTP process includes flocculation, clarification, filtration and UF.	Major	Rare	Medium (5)	Confident	Heavy metals and pesticides testing of the raw water at Mingo Crossing commenced Dec 2017. Heavy metal levels in treated water all below ADWG limits.	
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Minor	Unlikely	Low (4)	1. WTP process includes flocculation, clarification, filtration and UF.	Minor	Rare	Low (2)	Confident	Based on monthly water quality data. No exceedances since 2015.	
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. WTP process includes flocculation, clarification, filtration and UF.	Moderate	Rare	Low (3)	Confident	Based on monthly water quality data. No exceedances since 2015.	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
6	Source water	Chemical contamination	1. Accidental spills	Moderate	Rare	Low (3)	1. WTP process includes flocculation, clarification, filtration and UF.	Insignificant	Rare	Low (1)	Uncertain	Small concentration. Only risk of any real consequence would be a chemical spill near the intake (ie fuel for boats, raw sewage leak from motor homes). Inability to predict type or consistency of possible spill.	
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	Minor	Possible	Medium (6)	1. WTP process includes flocculation, clarification, filtration, UF and chlorine disinfection. 2. Water carting to site	Minor	Unlikely	Low (4)	Confident	Occasional flooding of Burnett River cannot be avoided. Site is closed during flood events. Water carting is available if required.	
8	Source water	Lack of supply	1. River level drop beyond intake level 2. Failure of intake pump 3. Power failure 4. Blockage of intake structure	Moderate	Unlikely	Medium (6)	1. Extension pipework available for when river levels drop 2. Fire pump available to use as an alternative intake pump 3. In case of power failure, there is approx. 2 days' worth of clearwater storage for potable water. Worst case scenario, the campers are suggested to vacate. 4. Cart water	Moderate	Likely	Medium (6)	Confident	Blockage from weeds have occurred in the past. Lowering of Paradise Dam has caused ongoing raw water shortages The backup generator can run the treated water pump to supply the whole site. Though once the clearwater storage tank is empty, alternative potable water source is required.	Seek assistance from Sunwater to provide reliable source infrastructure such as a riparian spear.
9	Source water	Lack of supply	Climatic variations	Moderate	Unlikely	Medium (6)	1. Cart water	Moderate	Likely	Medium (6)	Confident	Uncertainty in future climate	Seek assistance from Sunwater to provide reliable source infrastructure such as a riparian spear.
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of chemical supplies 4. Staff error 5. Plant Design	Major	Possible	High (12)	1. Treatment processes – Chlorine disinfection post filtration and top up in Potable Water Tank 2. Chlorine levels are tested at least once a week (ideally twice a week) 3. Low free chlorine alarm 4. Injection pumps and chlorine supply are also checked and inspected at the same time. 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment	Major	Rare	Medium (5)	Reliable		
11	Treatment	Biological contamination • Protozoa	1. Vermin and bird access 2. Staff error 3. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Filtration 3. Trained and qualified operators – good housekeeping	Catastrophic	Rare	Medium (6)	Uncertain	Treated water turbidity is monitored on-line.	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
12	Treatment	Chemical contamination • PACl	1. Chemical overdose due to equipment failure 2. Loss of chemical supplies 3. Staff error 5. Plant Design	Minor	Unlikely	Low (4)	1. Injection pumps and chemical supplies are also checked and inspected at least once a week. 2 Trained and qualified operators – good housekeeping	Minor	Rare	Low (2)	Uncertain		
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Failure of ACH dosing 3. Failure of filtration system	Major	Rare	Medium (5)	1. Treatment plant is designed to remove turbidity under normal raw water quality conditions 2. In the event of highly turbid/coloured water, operation of the treatment plant would be suspended, and water carted in 3. Regular maintenance of filter media and bag filters **Mingo 2019-01:** WTP now has online monitoring of turbidity with alarm. Continue to monitor THM monthly.	Major	Rare	Medium (5)	Confident	Recent treated water THM results were all below ADWG limits.	
14	Treatment	Physical/chemical contamination • Turbidity • Particulates	1. Failure of filtration system 2. Failure of dosing equipment 3. High levels of turbidity 4. Communication Breakdown 5. Staff error	Minor	Likely	Medium (8)	1. Regular maintenance of filter media and bag filters 2. In the event of highly turbid/coloured water, operation of the treatment plant would be suspended, and water carted in 3. Trained and qualified operators – good housekeeping	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	
15	Treatment	Clearwater storage tank pump failure	1. Inadequate maintenance 2. Power failure 3. Communication Breakdown	Moderate	Unlikely	Medium (6)	1. Standby pump available 2. If there is a power failure, the backup generator can run the treated water pump to supply the whole site. 3. Cart water in if required	Moderate	Rare	Low (3)	Confident	Existing measures are robust	
16	Treatment	Plant Controls: Unregistered software (pirated) is unable to be patched or serviced	Contractor used pirated (Chinese) software for control system	Moderate	Certain	High (10)	System is operational and no side-effects are observed	Moderate	Certain	High (10)	Confident	Will be part of SCADA upgrade program	Replace as part of SCADA Upgrade Program
17	Treatment	Chemical contamination from treatment components (tanks)	Butanone (Methyl ethyl Ketone) and Tetrahydrofuran (THF)	Moderate	Certain	High (10)	Tanks flushed before first use	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	

7.5 Mingo Crossing Risk Management Measures

Table 7-6 Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	WTP process includes flocculation, clarification, filtration, UF and disinfection	Likelihood	Effective	High (10)	No	Investigate implementing an exclusion zone around the intake or moving the intake away from recreators, in consultation with SunWater. Investigate installing riparian Spear at current offtake site	Water and Sewerage
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations.	Likelihood	Effective	Medium (6)	No	Investigate implementing an exclusion zone around the intake or moving the intake away from recreators, in consultation with SunWater. Investigate installing riparian Spear at current offtake site	Water and Sewerage
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Effluent Disposal area has been moved further from water offtake area.	Likelihood	Effective based on recent data	Medium (5)	No		
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	WTP process includes flocculation, clarification, filtration, UF and disinfection	Likelihood	Limited reduction based on data	Low (2)	Yes		
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations.	Likelihood	Uncertain as levels in raw water are already low	Low (3)	Yes		
6	Source water	Chemical contamination	1. Accidental spills	Effluent Disposal area has been moved further from water offtake area	Consequence	Uncertain	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	1. WTP process includes flocculation, clarification, filtration and UF.	Likelihood	Effective	Low (4)	Yes		
8	Source water	Lack of supply	1. River level drop below intake level 2. Failure of intake pump 3. Power failure 4. Blockage of intake structure	1. Truck water	Likelihood	Effective	Medium (6)	Yes	Seek assistance from Sunwater to provide reliable source infrastructure such as a riparian spear.	Water and Sewerage
9	Source water	Lack of supply	Climatic variations	1. Truck Water	Likelihood	Effective	Medium (6)	Yes	Seek assistance from Sunwater to provide reliable source infrastructure such as a riparian spear.	Water and Sewerage
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of chemical supplies 4. Staff error 5. Plant Design	1. WTP process includes flocculation, clarification, filtration and UF.	Likelihood	Effective	Medium (5)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
11	Treatment	Biological contamination • Protozoa	1. Vermin and bird access 2. Staff error 3. Plant Design	1. WTP process includes flocculation, clarification, filtration, UF and chlorine disinfection. Implemented a regular tank inspection regime.	No change	Uncertain	Medium (6)	No		
12	Treatment	Chemical contamination • PACl	1. Chemical overdose due to equipment failure 2. Loss of chemical supplies 3. Staff error 5. Plant Design	2. Water carting to site	Likelihood	Effective	Low (2)	Yes		
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Failure of ACH dosing 3. Failure of filtration system	1. Extension pipework available for when river levels drop	No change	Effective. No THM exceedances recorded in treated water.	Medium (5)	Yes		
14	Treatment	Physical/chemical contamination • Turbidity • Particulates	1. Failure of filtration system 2. Failure of dosing equipment 3. High levels of turbidity 4. Communication Breakdown 5. Staff error	2. Fire pump available to use as an alternative intake pump	Likelihood	Effective	Low (4)	Yes		
15	Treatment	Clearwater storage tank pump failure	1. Inadequate maintenance 2. Power failure 3. Communication Breakdown	3. In case of power failure, there is approx. 2 days' worth of clearwater storage for potable water. Worst case scenario, the campers are suggested to vacate.	Likelihood	Effective	Low (3)	Yes		
16	Treatment	Plant Controls: Unregistered software (pirated) is unable to be patched or serviced	Contractor used pirated (Chinese) software for control system	4. Observation	No change	Uncertain	High (10)	No	Replace as part of SCADA Upgrade Program	Water and Wastewater
17	Treatment	Chemical contamination from treatment components (tanks)	Butanone (Methyl ethyl Ketone) and Tetrahydrofuran (THF)	Tanks flushed before first use	Likelihood	Effective	Low (4)	Yes		

7.6 Mingo Crossing Risk Management Improvement Program

Table 7-7 Mingo Crossing Risk Improvement Program

Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
1	Source	Biological contamination • Protozoa	Medium		Investigate implementing an exclusion zone around the intake or moving the intake away from recreational water users, in consultation with SunWater.	Investigate installing riparian Spear at current offtake site	20/06/2022	$1500 for signage. Sunwater to supply	Water and Wastewater
2	Source water	Biological contamination • Bacteria • Viruses	Medium			Investigate installing riparian Spear at current offtake site	20/06/2022	$1500 for signage. Sunwater to supply	Water and Wastewater
8	Source	• Lack of supply	High	Truck water		Seek assistance from Sunwater to provide reliable source infrastructure such as a riparian spear.	20/06/2022	Sunwater to supply	Water and Wastewater
9	Source	Lack of supply	High	Truck water		Seek assistance from Sunwater to provide reliable source infrastructure such as a riparian spear.	20/06/2022	Sunwater to supply	Water and Wastewater
16	Treatment	Plant Controls: Unregistered software (pirated) is unable to be patched or serviced	Medium	Monitor		Replace as part of SCADA Upgrade Program	30/06/2024	$50,000	Water and Wastewater

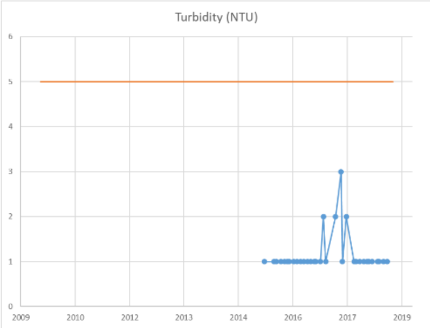
7.7 Mingo Crossing Water Supply Scheme Water Quality Data

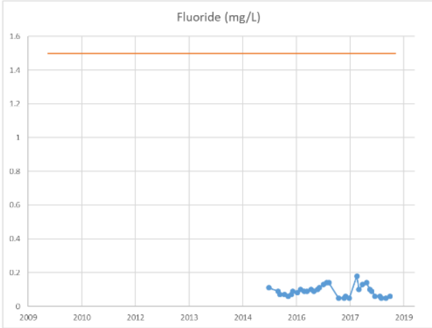
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

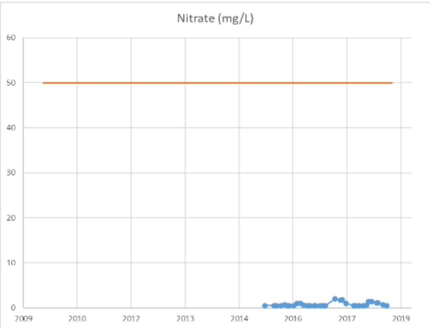
Mingo Crossing – Raw Water 2016 – 2018

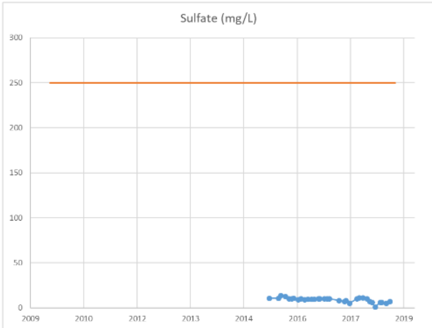
S

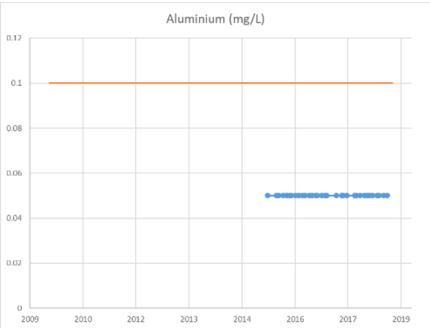
Mingo Crossing – Treated Water 2016 – 2018

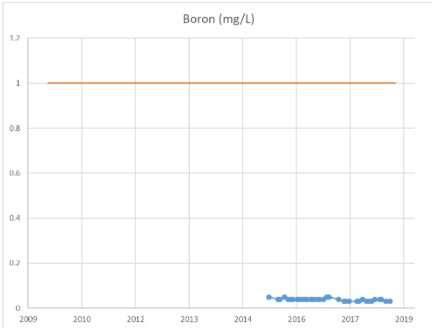


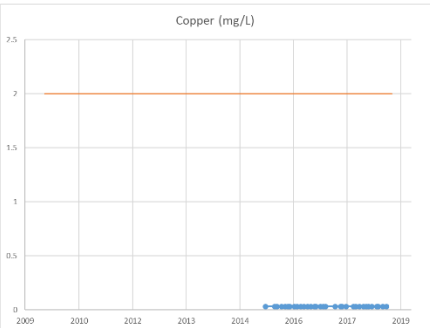


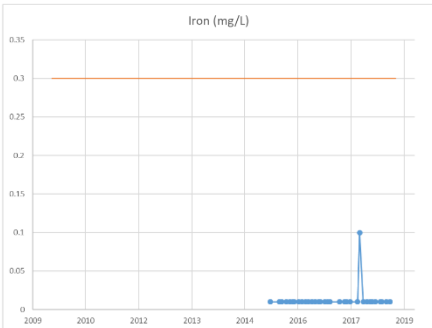


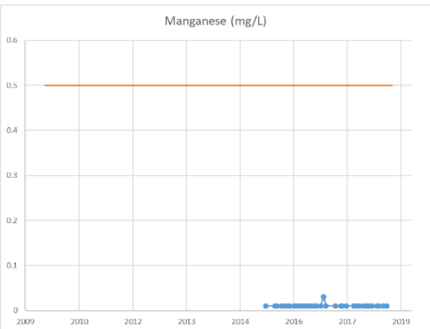


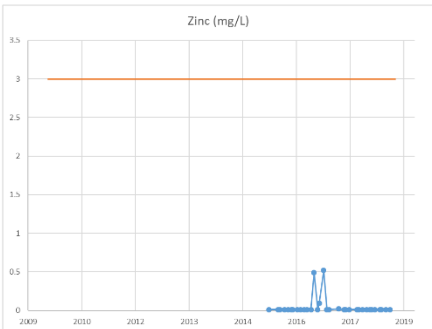












8. MONTO WATER SUPPLY SCHEME

8.1 Details of Infrastructure for Providing the Service

Source Water

The source of supply has been the groundwater in the alluvium of Three Moon Creek in its confluence with Monal Creek north-west of the town. Although there are six available bore sites within the bore field, four have bores, only two are equipped with pumps and functioning and both these are equipped with SunWater flowmeters. Water is pumped from the two operational bores through a 250mm AC rising main to a 1.14ML and a 1.7ML raw water ground level reservoirs located on the western edge of town.

Treatment Process

The water quality has been traditionally of high standard and therefore only undergoes chlorination through liquid sodium hypochlorite injection (see Figure 8-1). The liquid sodium hypochlorite injection occurs after the raw water ground reservoirs and prior to the distribution system.

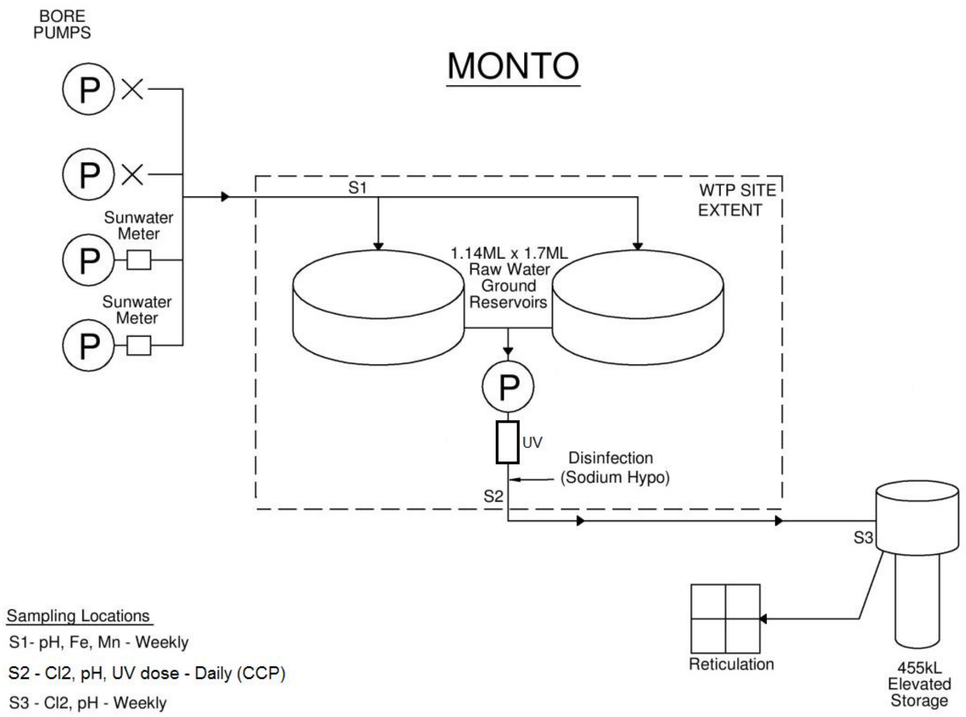


Figure 8-1 Monto WTP Schematic

The Monto WTP is automatic in operation with daily inspections carried out by operators. The WTP pumps and reservoir levels are linked to the SCADA system. If problems at these WTP elements are detected through SCADA (i.e. failure of chlorine dosing or reservoir levels) an alarm is triggered and an SMS is sent to the operator's phone and laptops, who will then visit the site as a special call out to address this alarm incident. There is no provision for bypassing the raw water reservoir and the dosing point. Provision for bypass of raw water storage is being undertaken to allow maintenance work without restricting operations.

Chlorine injection at the WTP is also linked to the SCADA system. In-line chlorine and turbidity analyser will assist in failure detection. There is a 1,500 L chlorine storage tank at the WTP, the level of which is reviewed daily by operators. There is no documented WTP operation manual.

In June 2018, a UV unit was installed downstream of the raw water ground reservoirs as per the Monto's Risk Improvement Program.

Distribution System

The township of Monto had its first reticulated water supply system installed in 1949-1950. Most of the mains have been replaced since the Council amalgamation in 2008. All the 250 mm mains have been replaced, with only minor reticulation remaining to be progressively replaced.

Treated water is pumped to a 455kL elevated reservoir located on the eastern sector of the town. A recent upgrade has been completed which feeds treated water directly to the high tower. Following treatment and storage, water is gravity fed to the reticulation system.

Sampling locations are sited at key points determined to provide the best indication of chlorine residual levels in the system. Samples are also taken as water leaves the reservoir. Chlorine residuals in the network are sampled and tested on-site weekly. Raw water and treated water samples are sent to the Queensland Health Laboratory for chemical analysis. Raw water and treated water samples are sent regularly to the Qld Health Laboratory for biological testing.

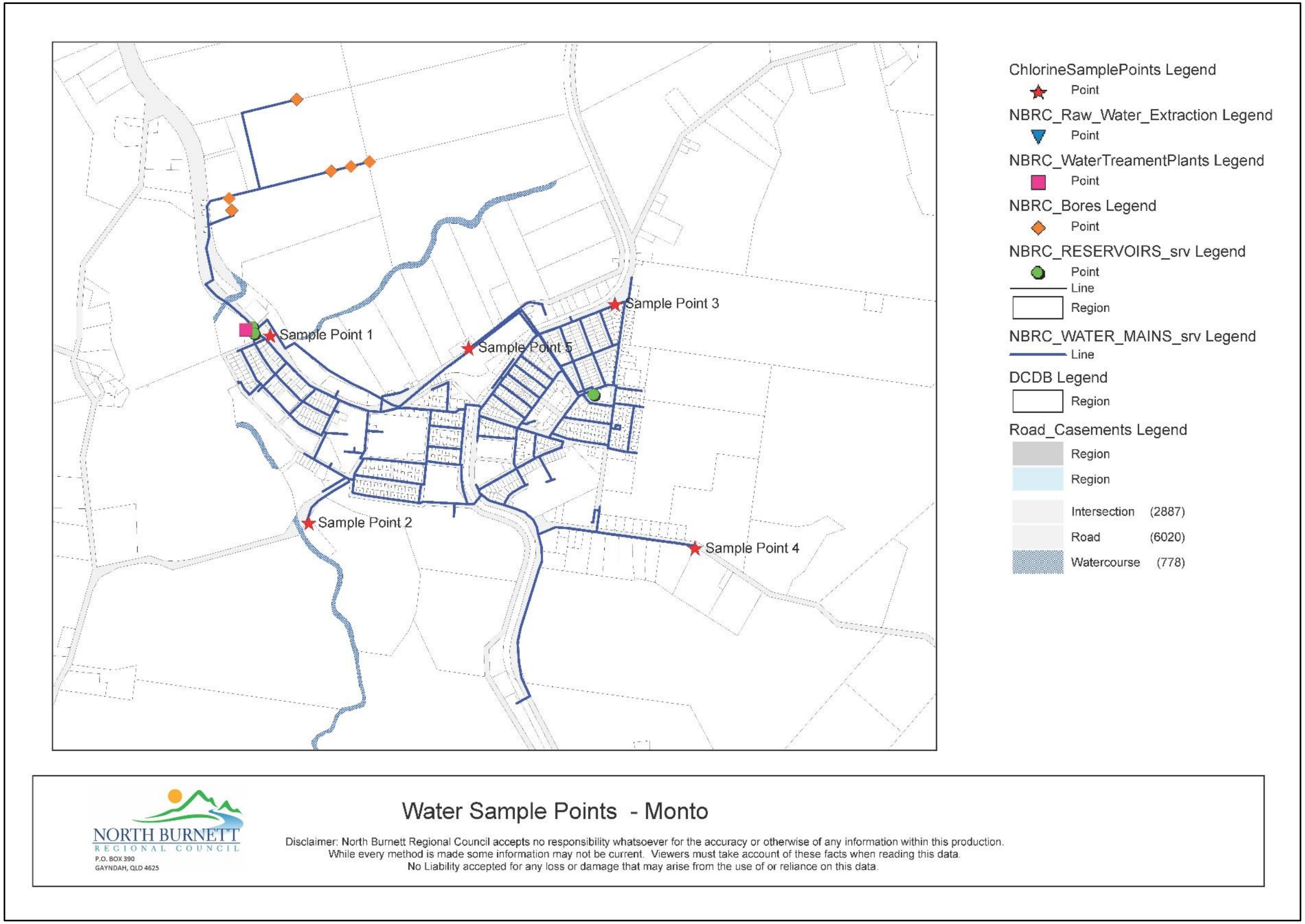


Figure 8-2 Monto Water Supply Map

Table 8-1 Infrastructure Details – Monto Water Supply Scheme

Component		Scheme 1
Sources	Name	Three Moon Creek Bores
	Type	Bore field x 4 bores with only two equipped
	% of supply	100%
	Reliability	High
	Water quality issues	Minimal. Iron and manganese is present at low levels generally below 0.03. Total coliform presence is rare in raw water.
Sourcing Infrastructure	Type	Pumped bore
	Description	Alluvial gravels of Three Moon Creek, 18 metres deep
	Bore 3	Pump Capacity = 8 L/s Bore Pumps Static Water Level = 20-21m Draw down Level = 21.5-22m
	Bore 4	Pump Capacity = 16L/s @ 45m Bore Pumps Static Water Level = 20-21m Draw down Level = 22.5-23m
	Ownership	NBRC
Are there any sources that **do not** undergo treatment prior to supply?	No	
Monto WTP	Name	Monto WTP
	Process	Disinfection
	Design Capacity (20 hr operation)	1.92 ML/d

Component		Scheme 1
	Daily flow range	0.5 – 1.5 ML/d
	Chemicals added	Sodium Hypochlorite
	Standby chemical dosing facilities (Y/N)	N
	Water sourced from and %	Bores 100%
	% of average day demand provided	100%
	% of scheme supply Distribution area supplied	100%
	Bypasses / Variations	No
Disinfection	Location	Reservoir supply pump station
	Type	Liquid sodium hypochlorite
	Dose rate	Driven by in-line analyser
	Target residual levels	0.5 mg/l
	Duty/standby	nil
	Dosing arrangements	fixed
	Alarms	nil
	Auto shut-off arrangements	No
	Location	Post transfer pump
	Type	Wedeco Spektron 50e U.V
	Dose rate	49 mJ/cm^2 for a flow up to 15 L/s at a UVT of over 86%
	Target residual levels	NA
	Duty/standby	No
	Dosing arrangements	NA
	Alarms	Yes

Component		Scheme 1
	Auto shut-off arrangements	Yes
Distribution and Reticulation System	Pipe material	AC
	Age range	65 years plus
	Approx % of total length	35%
	Pipe material	PVC
	Age range	0-12 years
	Approx % of total length	65%
	Areas where potential long detention periods could be expected	Nil
	Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	Nil
Reservoirs	**Ground**	1
	Name	Raw Water Ground Reservoir
	Capacity (ML)	1.14ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y
	Ground	2
	Name	Raw Water Ground Reservoir
	Capacity (ML)	1.7ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y
	Elevated	2

Component		Scheme 1
	Name	Elevated Reservoir
	Capacity (ML)	0.455ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

8.2 Monto Water Quality: Identifying Hazards and Hazardous Events

Water quality information has been collected by NBRC for raw water, treated water and reticulated supply for the period of January 2010 to November 2018. Analysis of this data has been completed to assess the results in comparison to the ADWG guideline values for parameters measured.

A summary of the water analysis undertaken for the Monto Water Supply Scheme is contained in Table 8-2, Table 8-3, Table 8-4 and Table 8-5. Section 8.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

The reticulated water scheme has been measured for pH, residual chlorine, *E. coli* and total coliforms.

Interpretation

In recent history, over the period of testing reviewed, the average sampling frequency for Monto is approximately twice a month for raw water, treated water and for the reticulated system.

Within the raw water sampling data, only a limited number of samples exceeded the guideline value for turbidity, iron, manganese, and sulphate. All other values are below the guideline values for treated water.

For sampling data taken from the Monto WTP there are six occurrences of turbidity exceeding the guideline value, all other parameters are below the guideline values.

Within the reticulation system, there were two occurrences when manganese exceeded the aesthetic guideline levels. There was one instance of total coliform being detected within the distribution system. There were potential water quality issues within the reticulation system due to low levels of residual chlorine and total coliforms being detected. Increased frequency of sampling and testing, and operational response, has since reduced this risk.

Table 8-2 Monto Raw Water Source

Monto Source – Three Moon Creek Bores							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time Period**	**No of samples**	**Summary of Results**			**Comments**
				Maximum Value	**Average Value**	**Minimum Value**	
Turbidity (NTU)	Bore	Jan 2010 – Nov 2018	167	348	5.17	<1.0	Bore number to be recorded
Fluoride	Bore	Jan 2010 – Nov 2018	167	0.5	0.16	<0.05	
Nitrate	Bore	Jan 2010 – Nov 2018	167	10	3.2	<0.5	Multiple limits of detection were used (<0.5 and <5). To calculate the stats, the absolute values were used.
Sulfate	Bore	Jan 2010 – Nov 2018	167	700	27.7	7	
Dissolved metals							
Aluminium	Bore	Jan 2010 – Nov 2018	167	0.10	0.05	<0.05	Multiple limits of detection were used (<0.05 and <0.1). In order to calculate the stats, the absolute values were used.
Boron	Bore	Jan 2010 – Nov 2018	167	0.09	0.04	0.02	
Copper	Bore	Jan 2010 – Nov 2018	167	0.06	0.03	<0.03	Multiple limits of detection were used (<0.03 and <0.06). In order to calculate the stats, the absolute values were used.
Iron	Bore	Jan 2010 – Nov 2018	167	0.4	0.01	<0.01	
Manganese	Bore	Jan 2010 – Nov 2018	167	1.8	0.06	<0.01	
Zinc	Bore	Jan 2010 – Nov 2018	167	0.3	0.03	<0.01	
Total metals							
Aluminium	Res	Nov 2017 – Oct 2018	2	<0.03	<0.03	<0.03	All samples taken were <0.03 mg/L
Arsenic	Res	Nov 2017 – Oct 2018	2	0.0005	0.0005	0.0005	All samples taken were 0.0005 mg/L

Monto Source – Three Moon Creek Bores							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time Period**	**No of samples**	**Summary of Results**			**Comments**
				Maximum Value	**Average Value**	**Minimum Value**	
Cadmium	Res	Nov 2017 – Oct 2018	2	<0.0001	<0.0001	<0.0001	All samples were <0.0001 mg/L
Chromium	Res	Nov 2017 – Oct 2018	2	<0.0001	<0.0001	<0.0001	All samples were <0.0001 mg/L
Copper	Res	Nov 2017 – Oct 2018	2	0.003	0.002	<0.001	
Iron	Res	Nov 2017 – Oct 2018	2	0.013	0.011	0.012	
Lead	Res	Nov 2017 – Oct 2018	2	0.001	0.0005	<0.0001	
Manganese	Res	Nov 2017 – Oct 2018	2	0.046	0.034	0.023	
Nickel	Res	Nov 2017 – Oct 2018	2	0.0005	0.0004	0.0003	
Zinc	Res	Nov 2017 – Oct 2018	2	0.004	0.0025	0.001	

Table 8-3 Monto Treated Water

Plant	Monto WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Turbidity (NTU)	WTP	Jan 2010 – Nov 2018	106	20	1.99	<1	5	6	Aesthetic guideline only Exceedances in Apr and May 2010, Apr 2016, and Mar and May 2017
Fluoride	WTP	Jan 2010 – Nov 2018	106	0.80	0.22	01	1.5	0	
Nitrate	WTP	Jan 2010 – Nov 2018	106	6.4	2.3	0.5	50	0	Aesthetic guideline only
Sulfate	WTP	Jan 2010 – Nov 2018	106	50.0	20.9	11.3	250	0	Aesthetic guideline only
Dissolved metals									
Aluminium	WTP	Jan 2010 – Nov 2018	106	<0.05	<0.05	<0.05	0.1	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable All values below detection limit
Boron	WTP	Jan 2010 – Nov 2018	106	0.08	0.05	0.03	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L

Plant	Monto WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Copper	WTP	Jan 2010 – Nov 2018	106	0.14	0.03	<0.03	1	0	Multiple limits of detection were used (<0.05 and <0.1). To calculate the stats, the absolute values were used.
Iron	WTP	Jan 2010 – Nov 2018	106	0.01	0.01	<0.01	0.3	0	Aesthetic guideline only
Manganese	WTP	Jan 2010 – Nov 2018	106	0.08	0.01	<0.01	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Zinc	WTP	Jan 2010 – Nov 2018	106	0.32	0.02	<0.01	3	0	

Table 8-4 Monto Reticulated Water

Scheme / Sampling Location	Monto Reticulated Water							
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
pH (pH units)	Jan 2010 – Nov 2018	167	7.9	7.4	6.8	6.5 - 8.5	0	Aesthetic guideline only

Scheme / Sampling Location	Monto Reticulated Water							
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
Disinfectant residual	July 2016 – Nov 2018	347	2.6	1.4	0.35	>0.2 - 0.5	0	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition
Total coliforms (mpn/100mL)	July 2016 – Nov 2018	350	1	0.003	0	NA	NA	
E. coli	July 2016 – Nov 2018	350	0	0	0	None Detected	0	
Total metals								
Aluminium	Nov 2017 – Oct 2018	3	0.03	0.017	0.011	0.2	0	Aesthetic guideline only Max value is actually <0.03 mg/L.
Arsenic	Nov 2017 – Oct 2018	3	0.0008	0.0006	0.0005	0.01	0	
Cadmium	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L
Chromium	Nov 2017 – Oct 2018	3	0.001	0.0004	<0.0001	0.05	0	
Copper	Nov 2017 – Oct 2018	3	0.019	0.016	0.014	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	Nov 2017 – Oct 2018	3	0.049	0.03	0.007	0.3	0	Aesthetic guideline only
Lead	Nov 2017 – Oct 2018	3	0.0024	0.0014	0.0008	0.01	0	

Scheme / Sampling Location	Monto Reticulated Water							
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
Manganese	Nov 2017 – Oct 2018	3	0.2	0.11	0.012	0.5 (0.1)	2	Number in brackets denotes the aesthetic guideline value Exceedance of aesthetic limit in April and October 2018
Nickel	Nov 2017 – Oct 2018	3	0.0021	0.001	0.0005	0.02	0	
Zinc	Nov 2017 – Oct 2018	3	0.007	0.006	0.005	3	0	Aesthetic guideline only
Trihalomethanes	Sept 2016 – Oct 2018	3	0.063	0.041	0.026	0.25	0	

Table 8-5 Monto Water Quality Complaints

Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
1-7-2010 to 26-10-2018	0	0			

8.3 Monto Catchment Characteristics

Monto Township is supplied with water from bores in Three Moon Creek. Cania dam, upstream of Monto, is located on the Three Moon Creek and is the major water storage in the area. The catchment for Cania Dam is fed by Three Moon and Munholme Creeks which originate in the surrounding Dawes Ranges. Periodic water releases from Cania Dam recharge the alluvium of the Three Moon Creek.

The predominant land-use in this area is National Park and low-density cattle grazing on mostly unimproved pasture. Land use downstream of Cania Dam includes grazing, fodder cropping and piggeries. Irrigation for the cropping and piggeries is typically drawn from alluvial bores as is the Monto town water supply. The land-use activities upstream of the township water source pose only a minor concern for the quality of the raw water supply to Monto, as the filtering process of the alluvial sands provides an effective filtering and quality improvement mechanism. The town bores have a sanitary seal to the bore heads, which eliminates the possibility of contaminated surface water ingress.

It is to be noted that the Piggeries are not in proximity to the bore field, so are currently not considered an extra risk. However, any future expansions towards the bore field will need to be noted and may need to be assessed for its impact on raw water quality.

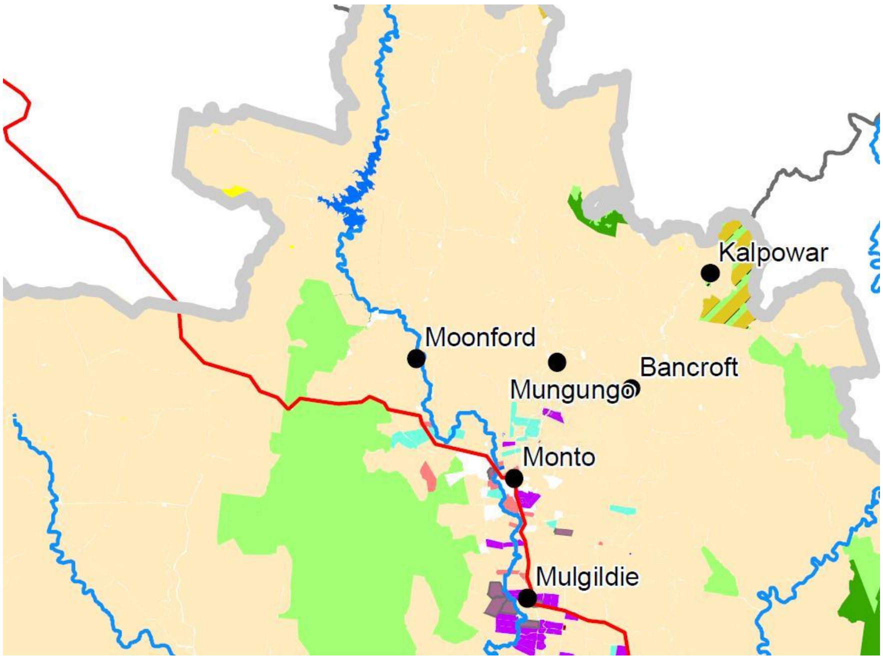


Figure 8-3 Monto Catchment Area

8.4 Monto Hazard Identification, Risk Assessment and Uncertainty

Table 8-6 Monto Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. The bores are sealed and appropriately cased so storm runoff and infiltration are avoided and vermin cannot enter. UV	Catastrophic	Rare	Medium (6)	Estimate	Inability to detect contamination	Sanitary survey to identify the potential risks and the source of the protozoa
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection, UV	Catastrophic	Rare	Medium (6)	Confident	Existing measures are robust	Sanitary survey to identify the potential risks and the source
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Major	Unlikely	Medium (8)	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection	Major	Rare	Medium (5)	Confident	Main concern is arsenic level in raw water which is still below safe levels.	
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Minor	Possible	Medium (6)	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection	Minor	Unlikely	Low (4)	Confident	Few farmers use either pesticides or fertiliser as the area is predominantly grazing.	
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection	Moderate	Rare	Low (3)	Confident	Few farmers use either pesticides or fertiliser as the area is predominantly grazing.	
6	Source water	Chemical contamination	Accidental spills	Moderate	Rare	Low (3)	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert)	Insignificant	Rare	Low (1)	Uncertain	Small concentration. Only risk of any real consequence would be a chemical spill near the intake Inability to predict type or consistency of possible spill?	
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	Minor	Unlikely	Low (4)	1. Public notification process (boil water alert) 2. Detention time in reservoir for settling out particulates	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. Power failure	Moderate	Unlikely	Medium (6)	1. Two alternative sources of supply with individual pumps. 2. Estimated 4-5 day's supply in raw water reservoirs.	Moderate	Rare	Low (3)	Confident	Existing measures are robust	
9	Source water	Lack of supply	Climatic variations	Moderate	Unlikely	Medium (6)	1. Importing water	Moderate	Rare	Low (2)	Uncertain	Uncertainty in future climate	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
							2. Drought management Plan actions: restrictions, communication etc.						
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	Major	Possible	High (12)	1. Treatment processes – Chlorine disinfection post UV 2. Chlorine levels are tested once per day at WTP. 3. Chlorine residual tested at least weekly in reticulation system 4. Injection pump and chlorine supply are also checked and inspected at the same time. 5. Public notification process (boil water alert) 6. Trained and qualified operators – good housekeeping 7. Security and vermin-proofing 8. Regular cleaning and maintenance of process equipment	Major	Rare	Medium (5)	Confident	Multiple barriers	UV Operational review
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Trained and qualified operators – good housekeeping Option: Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations. **Monto 2018-01** UV unit has been installed at the WTP	Major	Rare	Medium (5)	Confident	Inability to detect contamination in the treatment process	UV Operational review
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error 5. Plant Design	Moderate	Unlikely	Medium (6)	1. Chemical injection levels are tested once per day. 2. Dosing equipment is checked once per day. 3. Trained and qualified operators – good housekeeping **Monto 2018-02** On-line analysers are installed and alarmed to SCADA for this plant **Monto 2018-03** The operation of the chlorine injection system is linked to the high lift pumps	Moderate	Rare	Low (3)	Confident	Existing measures are robust.	
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Plant Design	Major	Rare	Medium (5)	1. Degradation of sodium hypochlorite unlikely due to relatively small storage capacity which requires monthly refilling 2. Staff aware of potential issues and refill fortnightly if possible **Monto 2018-04:** THM monitoring occurs monthly	Major	Rare	Medium (5)	Confident	THM monitoring have commenced. All results are below ADWG limits.	
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of Raw Water storage Reservoir integrity	Minor	Unlikely	Low (4)	1. Dilution during treatment processes and storage 2. Reservoir management	Minor	Unlikely	Low (4)	Confident	Raw water reservoir roofs are asbestos. Existing measures are robust	
15	Treatment	Clearwater pump failure	1. Inadequate maintenance 2. Lack of standby pumps 3. Power failure	Moderate	Unlikely	Medium (6)	1. Estimated 1 day's supply in tower reservoir. 2. There are two standby pumps installed	Moderate	Rare	Low (3)	Confident	Existing measures are robust	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
16	All	Power failure causing contamination or supply failure	1. Power failure	Minor	Unlikely	Low (4)	1. Estimated one week's supply in reserve at clearwater and tower reservoir.	Minor	Rare	Low (3)	Confident	Existing measures and capacity are robust. Some incidents have occurred with no consequence.	Seek funding for disaster funding of generators

8.5 Monto Risk Management Measures

Table 8-7 Monto Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	1. The bores are sealed and appropriately cased so storm runoff and infiltration are avoided, and vermin cannot enter. UV	Likelihood	Moderately effective based on treatment plant results	Medium (6)	No	Sanitary survey to identify the potential risks and the source of the protozoa	Water and Wastewater
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection	Likelihood	Moderately effective based on treatment plant results	Medium (6)	Yes	Sanitary survey to identify the potential risks and the source	Water and Wastewater
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection UV	Likelihood	Unknown	Medium (5)	No		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
4	Source water	Chemical contamination • Nutrients: Nitrate Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection	Likelihood	Unknown	Low (4)	Yes		
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	1. The bores are completely enclosed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection	Likelihood	Unknown	Low (3)	Yes		
6	Source water	Chemical contamination	Accidental spills	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert)	Consequence	Unknown as has not occurred	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	1. Public notification process (boil water alert) 2. Detention time in reservoir for settling out particulates	Likelihood	Effective in reducing turbidity as per water quality samples	Low (4)	Yes		
8	Source water	Lack of supply	1. Inadequate maintenance	1. Two alternative sources of supply with individual pumps. 2. Estimated 4-5 day's supply in raw water reservoirs.	Likelihood	Effective- multiple backups and past history	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
			2. Lack or failure of standby pumps 3. Power failure							
9	Source water	Lack of supply	Climatic variations	1. Importing water 2. Drought management Plan actions: restrictions, communication etc.	Likelihood	Effective- reliable supply	Low (2)	Yes		
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	1. Treatment processes – Chlorine disinfection post UV 2. Chlorine levels are tested once per day at WTP. 3. Chlorine residual tested at least weekly in reticulation system 4. Injection pump and chlorine supply are also checked and inspected at the same time. 5. Public notification process (boil water alert) 6. Trained and qualified operators – good housekeeping 7. Security and vermin-proofing 8. Regular cleaning and maintenance of process equipment	Likelihood	Moderately effective based on treated water test results	Medium	Yes	UV Operational review	Water and Wastewater
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access	1. Security and vermin-proofing 2. Trained and qualified operators – good housekeeping	Likelihood	Inability to detect contamination in the	(5)	Yes	UV Operational review	Water and Wastewater

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
			3. Staff error 4. Plant Design	Option: Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations. **Monto 2018-01** UV unit has been installed at the WTP		treatment process				
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error 5. Plant Design	1. Chemical injection levels are tested once per day. 2. Dosing equipment is checked once per day. 3. Trained and qualified operators – good housekeeping **Monto 2018-02** On-line analysers are installed and alarmed to SCADA for this plant **Monto 2018-03** The operation of the chlorine injection system is linked to the high lift pumps	Consequence	Effective based on treated water test results	Medium	Yes		
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Plant Design	1. Degradation of sodium hypochlorite unlikely due to relatively small storage capacity which requires monthly refilling 2. Staff aware of potential issues and refill fortnightly if possible **Monto 2018-04:** THM monitoring occurs monthly	No	No THM exceedances recorded in treated water	(5)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of Raw Water storage Reservoir integrity	1. Dilution during treatment processes and storage 2. Reservoir management	Likelihood	Effective based on current water quality tests	Low (3)	Yes		
15	Treatment	Clearwater pump failure	1. Inadequate maintenance 2. Lack of standby pumps 3. Power failure	1. Estimated 1 day's supply in tower reservoir. 2. There are two standby pumps installed	Likelihood and consequence	Effective-multiple backups	Medium (5)	Yes		
16	All	Power failure causing contamination or supply failure	1. Inappropriate chemical storage or defective batch	1. Estimated one week's supply in reserve at clearwater and tower reservoir.	Consequence	Moderately effective-based on treatment results	Low (4)	Yes	Seek disaster funding of generators	Major Projects Water and Wastewater

8.6 Monto Risk Management Improvement Program

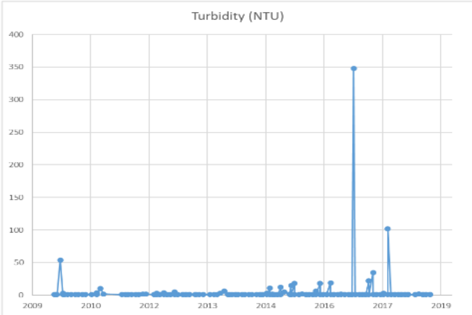
Table 8-8 Monto Risk Improvement Program

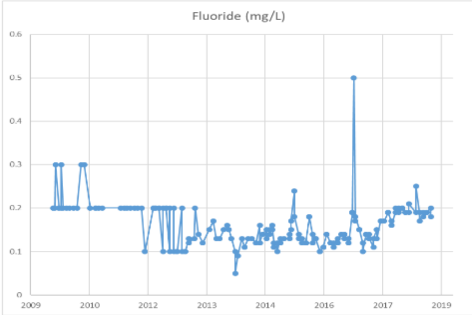
Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
1	Source	Biological contamination • Protozoa	Medium			Investigate the impact of the Piggeries staged expansion on source water quality.	Ongoing	$20k	Water and Wastewater Environment and Planning
3	Source	Biological contamination • Bacteria • Viruses	Medium			Investigate the impact of the Piggeries staged expansion on source water quality.	Ongoing	$20k	Water and Wastewater Environment and Planning
10	Treatment	Biological contamination • Bacteria Viruses	Medium		UV Operational review		30/06/2022	$20k	Water and Wastewater
11	Treatment	Biological contamination Protozoa	Medium		UV Operational review		30/06/2022	$20k	Water and Wastewater
16	All	Power failure causing contamination or supply failure	Low			Seek disaster funding of generators	30/06/2025	$50k	Major Projects Water and Wastewater

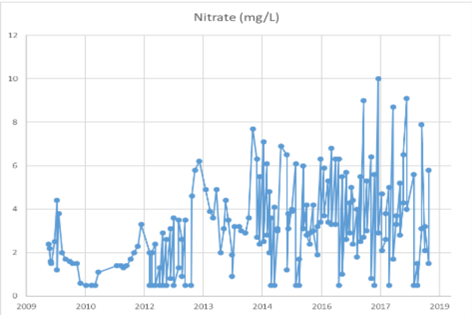
8.7 Monto Water Scheme Water Quality Data

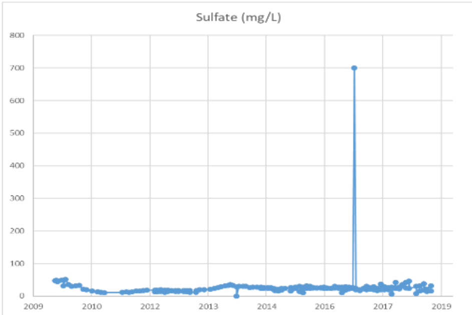
The results are spread across the twelve month period of the year indicated. Note the orange lines indicate the ADWG limits.

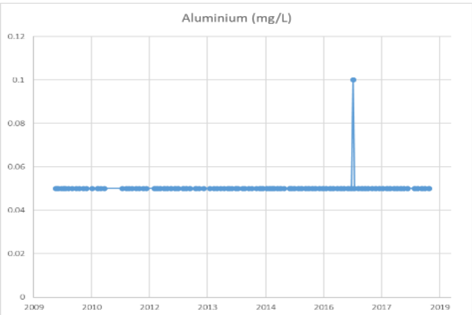
Monto untreated bore water 2010-2018

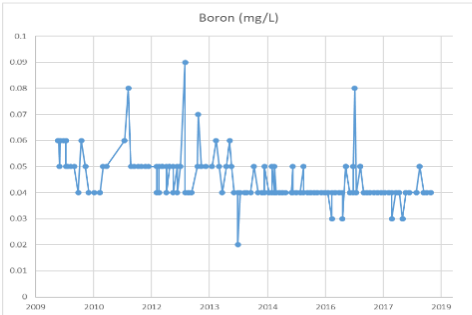


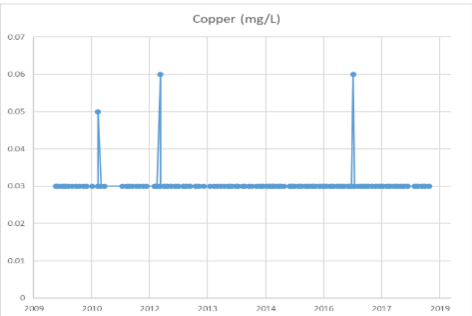


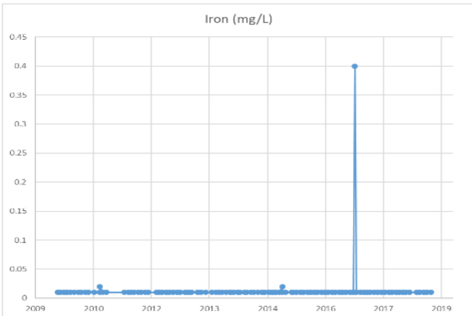


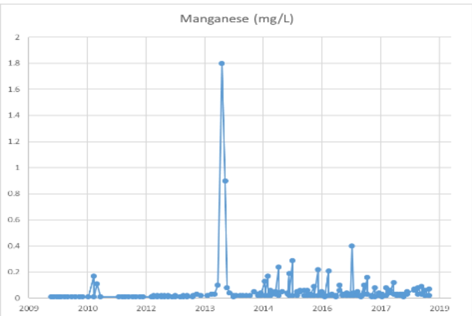


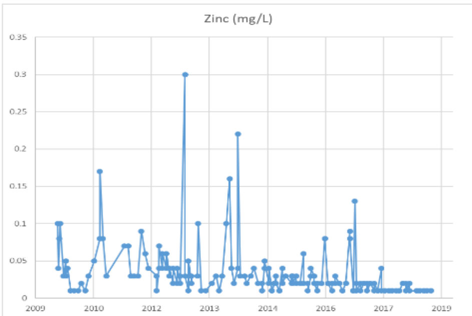




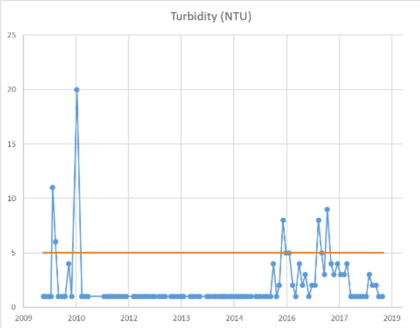


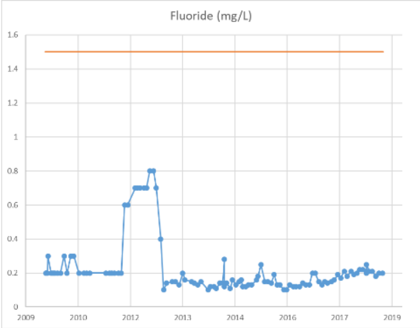


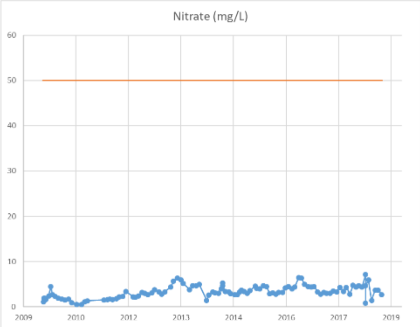


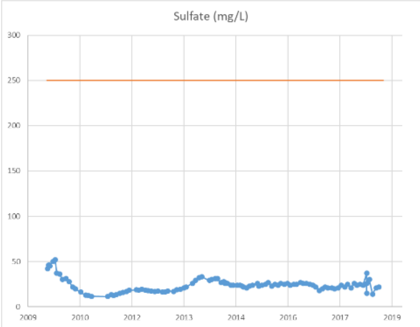


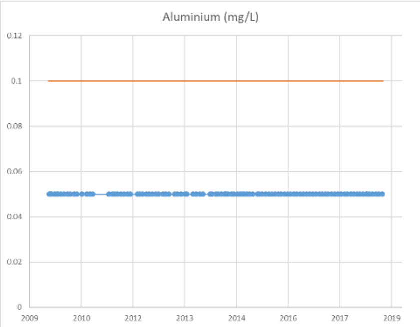
Monto treated water 2010-2018

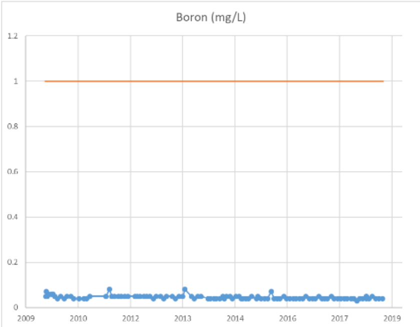


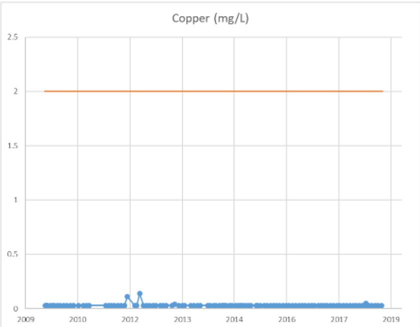


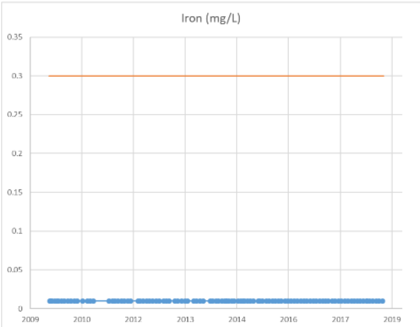


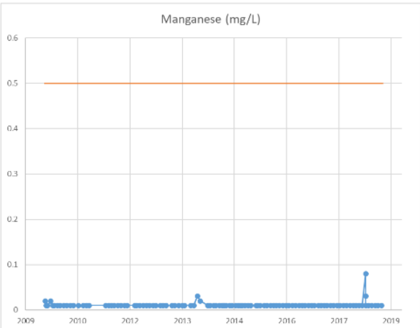


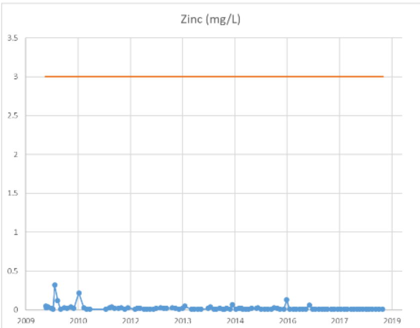












9. MOUNT PERRY WATER SUPPLY SCHEME

9.1 Details of Infrastructure for Providing the Service

Source Water

Mount Perry is supplied from two ground water sources. Wolca Bore is located 7.5km north east of Mount Perry and can supply 3.0L/s. Drummers Creek Bore is located 7km north east of Mount Perry and can supply 3.0L/s.

Bore water is pumped 5.75 km through a 100mm PVC line to the 590 kL ground level storage reservoir located on the road to Normanby Range lookout on the northern outskirts of the town.

Treatment Process

Aeration and disinfection are carried out before the ground level storage reservoir.

The Mount Perry WTP is automatic in operation with twice weekly inspections carried out by operators.

Disinfection is achieved through liquid sodium hypochlorite injection at automated dosing points. The WTP pumps and reservoir levels are linked to the SCADA system. If problems at these WTP elements are detected through SCADA (i.e. failure of chlorine dosing or reservoir levels) an alarm is triggered and an SMS is sent to the operator's phone, who will then visit the site.

Chlorine injection at the WTP is also linked to the SCADA system. In-line chlorine and turbidity analyser assist in failure detection. There is a 200 L chlorine storage tank at the WTP, the level of which is reviewed weekly by operators. There is no documented WTP operation manual.

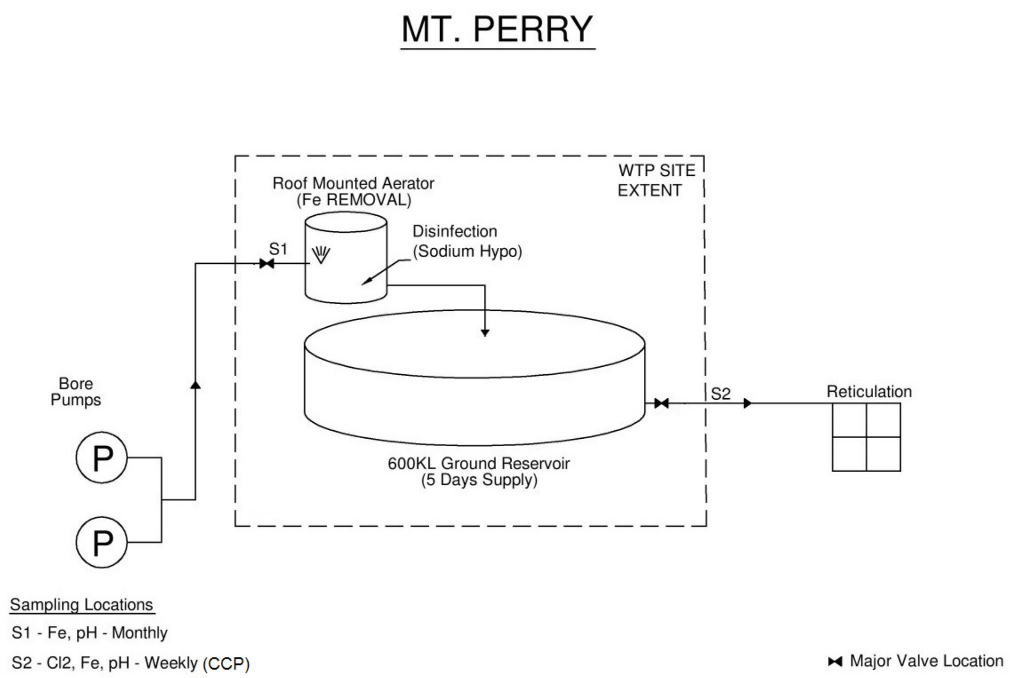


Figure 9-1 Mount Perry WTP Schematic

Distribution

Following treatment and storage, water is gravity fed from the ground reservoir to the town's reticulation system.

Sampling locations are sited at key points determined to provide the best indication of chlorine residual levels in the system. Samples are also taken as water leaves the reservoir. Chlorine residuals in the network are sampled and tested on-site regularly. Raw and treated water samples are sent once a month to the Queensland Health Laboratory for chemical analysis. Raw and treated water samples are sent to the Qld Health Laboratory for biological testing.

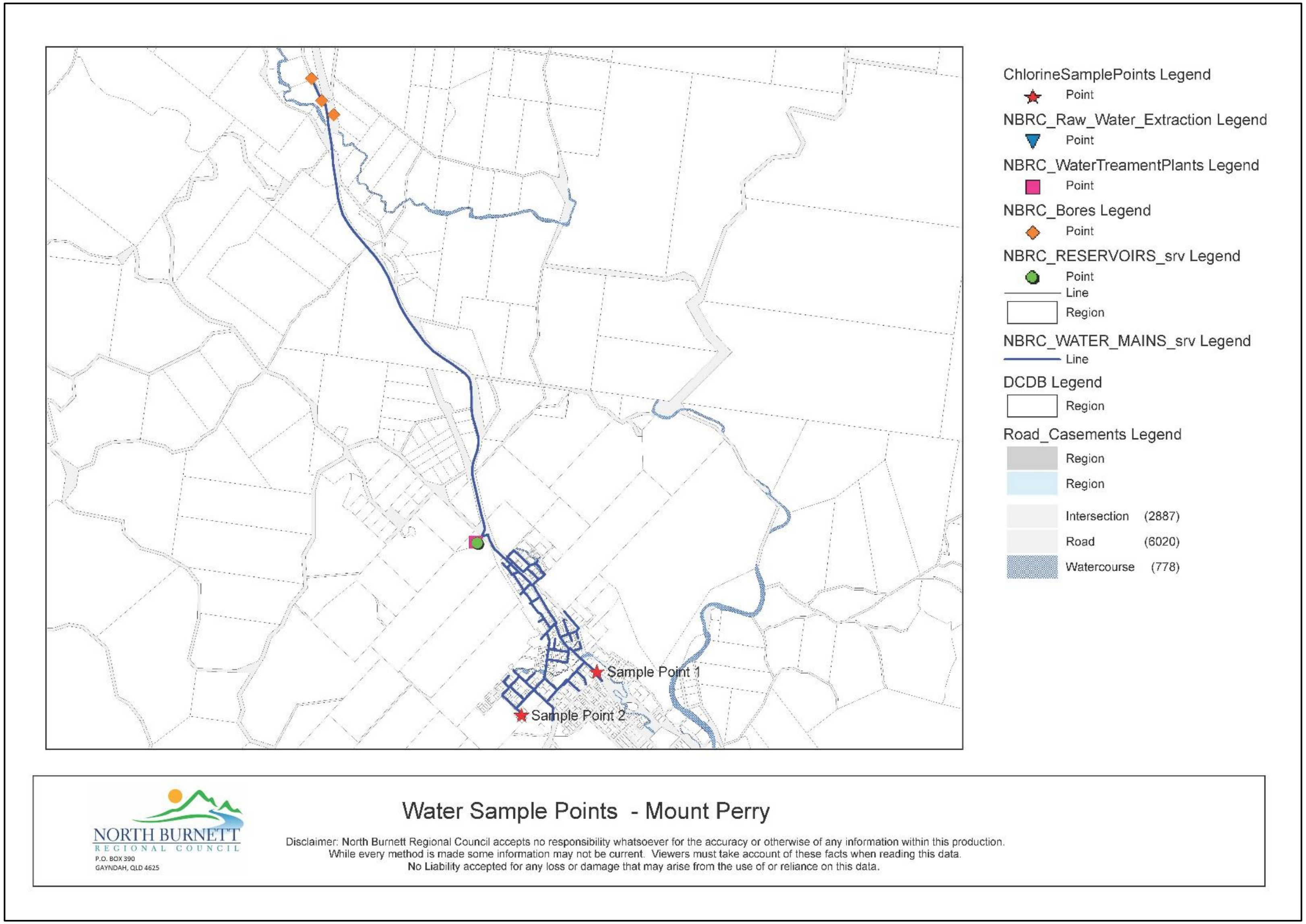


Figure 9-2 Mount Perry Water Supply Map

Table 9-1 Infrastructure Details – Mount Perry Water Supply Scheme

Component		Scheme
Sources	Name	Bore Field
	Type	Sub-Artesian Bore x 2
	% of supply	100%
	Reliability	High
	Water quality issues	High iron content
	Name	Drummers Creek Bore – 3L/s Wolca Bore – 3 L/s
	Type	Bore
	% of supply	100%
	Reliability	100%
Sourcing Infrastructure	Type	Pumped bore
	Drummers Creek Bore	Pump Capacity = 4.0L/s @ Bore Pumps Installed = 2000 Casing = Steel Diameter = DN250 Depth = 25m
	Wolca Creek Bore	Pump Capacity = 4.0L/s @ 75m Bore Pumps Installed = 2000 Casing = Steel Diameter = DN250 Depth = 25m

Component		Scheme
	Ownership	NBRC
Are there any sources that **do not** undergo treatment prior to supply?	No	
Mount Perry WTP	Name	Mount Perry WTP
	Process	Aeration, Chlorination
	Design Capacity (20 hr operation)	216 kL/d
	Daily flow range	60-80 kL/d
	Chemicals added	Sodium Hypochlorite
	Standby chemical dosing facilities (Y/N)	N
	Water sourced from and %	Bores 100%
	% of average day demand provided	100%
	% of scheme supply Distribution area supplied	100%
	Bypasses / Variations	Yes
Disinfection	Location	Reservoir
	Type	Liquid sodium hypochlorite via Dosing Pump
	Dose rate	Controlled by in-line analyser
	Target residual levels	0.5 mg/L
	Duty/standby	No
	Dosing arrangements	Fixed
	Alarms	Nil
	Auto shut-off arrangements	Nil

Component		Scheme
Distribution and Reticulation System	Pipe material	PVC
	Age range	15-20 years
	Approx. % of total length	100%
	Areas where potential long detention periods could be expected	Nil
	Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	Nil
Reservoir	**Ground**	1
	Name	Ground Reservoir
	Capacity (ML)	590kL
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

9.2 Mount Perry Water Quality: Identifying Hazard and Hazardous Events

Water quality information has been collected by NBRC for raw water, treated water and reticulated supply for the period of February 2010 to November 2018. Analysis of this data has been completed to assess the results in comparison to the Australian Drinking Water Guidelines guideline values for parameters measured.

A summary of the water analysis undertaken for the Mount Perry Water Supply Scheme is contained in Table 9-2, Table 9-3, Table 9-4 and Table 9-5. Section 9.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

The reticulated water scheme has been measured for pH, residual chlorine, *E. coli* and total coliforms.

Interpretation

In recent history, over the period of testing, sampling as occurred approximately once per month to meet the requirements for Qld. Health tests at Mount Perry.

Sampling and testing in the reticulated system was conducted approximately twice a month for disinfectant residual and total coliform, but more frequently for *E. coli* and pH.

The raw water sampling indicated that turbidity and manganese were above drinking water guideline values, but all other parameters were below the guideline values.

For sampling data taken from the Mount Perry WTP, there are no instances where values exceeded the guideline value.

Within the reticulation system, four residual chlorine samples were below the ADWG recommended values. There were potential water quality issues within the reticulation system due to low levels of residual chlorine and total coliforms being detected. Increased frequency of sampling and testing, and operational response, has since reduced this risk.

Table 9-2 Mount Perry Raw Water Source

Mount Perry Source – Bores							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time Period**	**No of samples**	**Summary of Results**			**Comments**
				Maximum Value	**Average Value**	**Minimum Value**	
Turbidity (NTU)	Reservoir (in)	Feb 2010 – Nov 2018	96	46	2.2	<1.0	
Fluoride	Reservoir (in)	Feb 2010 – Nov 2018	96	0.4	0.28	0.15	
Nitrate	Reservoir (in)	Feb 2010 – Nov 2018	96	1.80	0.57	<0.05	Multiple limits of detection were used (<0.05 and <0.5). In order to calculate the stats, the absolute values were used.
Sulfate	Reservoir (in)	Feb 2010 – Nov 2018	96	14.2	9.9	5.6	
Dissolved metals							
Aluminium	Reservoir (in)	Feb 2010 – Nov 2018	96	<0.05	<0.05	<0.05	All values below level of detection
Boron	Reservoir (in)	Feb 2010 – Nov 2018	96	0.06	0.03	<0.02	
Copper	Reservoir (in)	Feb 2010 – Nov 2018	96	0.14	0.03	<0.03	
Iron	Reservoir (in)	Feb 2010 – Nov 2018	96	0.04	0.01	<0.01	
Manganese	Reservoir (in)	Feb 2010 – Nov 2018	96	0.14	0.02	<0.01	
Zinc	Reservoir (in)	Feb 2010 – Nov 2018	96	0.51	0.03	<0.01	
Total metals							
Aluminium	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.07	0.05	0.03	
Arsenic	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.0025	0.002	0.0015	
Cadmium	Drummers Creek Bore	Nov 2017 – Oct 2018	2	<0.0001	<0.0001	<0.0001	All samples were <0.0001 mg/L

Mount Perry Source – Bores							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time Period**	**No of samples**	**Summary of Results**			**Comments**
				Maximum Value	**Average Value**	**Minimum Value**	
Chromium	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.0025	0.0013	<0.0001	
Copper	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.001	0.001	<0.001	
Iron	Drummers Creek Bore	Nov 2017 – Oct 2018	2	1	0.521	0.042	
Lead	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.0007	0.0005	0.0003	
Manganese	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.29	0.17	0.047	
Nickel	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.0046	0.0026	0.0007	
Zinc	Drummers Creek Bore	Nov 2017 – Oct 2018	2	0.004	0.003	0.002	

Table 9-3 Mount Perry Treated Water

Plant	Mount Perry WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Turbidity (NTU)	WTP	Feb 2010 – Nov 2018	96	2.0	1.03	<1.0	5	0	Aesthetic guideline only
Fluoride	WTP	Feb 2010 – Nov 2018	96	0.40	0.27	0.18	1.5	0	
Nitrate	WTP	Feb 2010 – Nov 2018	96	2.00	0.59	0.50	50	0	Aesthetic guideline only
Sulfate	WTP	Feb 2010 – Nov 2018	96	14.30	9.85	6.10	250	0	Aesthetic guideline only
Dissolved metals									
Aluminium	WTP	Feb 2010 – Nov 2018	96	0.06	0.05	0.05	0.1	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable
Boron	WTP	Feb 2010 – Nov 2018	96	0.2	0.03	<0.02	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L Multiple limits of detection were used (<0.0 and <0.2). In order to calculate the stats, the absolute values were used.
Copper	WTP	Feb 2010 – Nov 2018	96	0.22	0.05	<0.03	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	WTP	Feb 2010 – Nov 2018	96	0.02	0.01	<0.01	0.3	0	Aesthetic guideline only

Plant	Mount Perry WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Manganese	WTP	Feb 2010 – Nov 2018	96	0.02	0.01	<0.01	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Zinc	WTP	Feb 2010 – Nov 2018	96	0.54	0.04	<0.01	3	0	

Table 9-4 Mount Perry Reticulated Water

Scheme / Sampling Location	Mount Perry Reticulated Water							
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified)	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
pH (pH units)	Feb 2010 – Nov 2018	96	8.1	7.6	7.3	6.5 - 8.5	0	Aesthetic guideline only
Disinfectant residual	July 2016 – Nov 2018	75	1.86	1.01	0	>0.2 - 0.5	4	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition Chlorine residual <0.2 occurred in Nov 2017 and Jan 2018

Scheme / Sampling Location	Mount Perry Reticulated Water							
Parameter (mg/L unless otherwise specified)	**Time Period**	**No of samples**	**Summary of Results**			**Australian Drinking Water Guidelines guideline value for health unless otherwise specified)**	**No of samples exceeding Australian Drinking Water Guidelines guideline value**	**Comment**
			Maximum Value	**Average Value**	**Minimum Value**			
Total coliform (mpn/100mL)	July 2016 – Nov 2018	75	0	0	0	NA	NA	
E. coli (CFU/100mL)	July 2016 – Nov 2018	75	0	0	0	None Detected	0	
Total metals								
Aluminium	Nov 2017 – Oct 2018	3	0.03	0.021	<0.003	0.2	0	Aesthetic guideline only
Arsenic	Nov 2017 – Oct 2018	3	0.0015	0.0014	0.0014	0.01	0	
Cadmium	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L
Chromium	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.05	0	All samples were <0.0001 mg/L
Copper	Nov 2017 – Oct 2018	3	0.016	0.012	0.007	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	Nov 2017 – Oct 2018	3	0.13	0.056	0.017	0.3	0	Aesthetic guideline only
Lead	Nov 2017 – Oct 2018	3	0.0022	0.0009	0.0003	0.01	0	
Manganese	Nov 2017 – Oct 2018	3	0.14	0.05	0.0047	0.5 (0.1)	1	Number in brackets denotes the aesthetic guideline value Exceedance in November 2017

Scheme	Mount Perry Reticulated Water							
Sampling Location								
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified)	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
Nickel	Nov 2017 – Oct 2018	3	0.0023	0.0012	0.0006	0.02	0	
Zinc	Nov 2017 – Oct 2018	3	0.01	0.008	0.005	3	0	Aesthetic guideline only
Trihalomethanes	Sept 2016 – Oct 2018	3	0.015	0.011	0.009	0.25	0	

Table 9-5 Mount Perry Water Quality Complaints

Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
1-7-2010 to 26-10-2018	0	0	-	-	-

9.3 Mount Perry Catchment Characteristics

The general terrain around the township of Mount Perry is hilly to mountainous. Most of the district is unimproved grazing land. Gold mining occurs on the south eastern outskirts of Town. Influence of this activity on the town water source is non-detectable. The bores are fully enclosed, housed and inside a locked perimeter fence. There are no known potential influences that would affect the water quality.

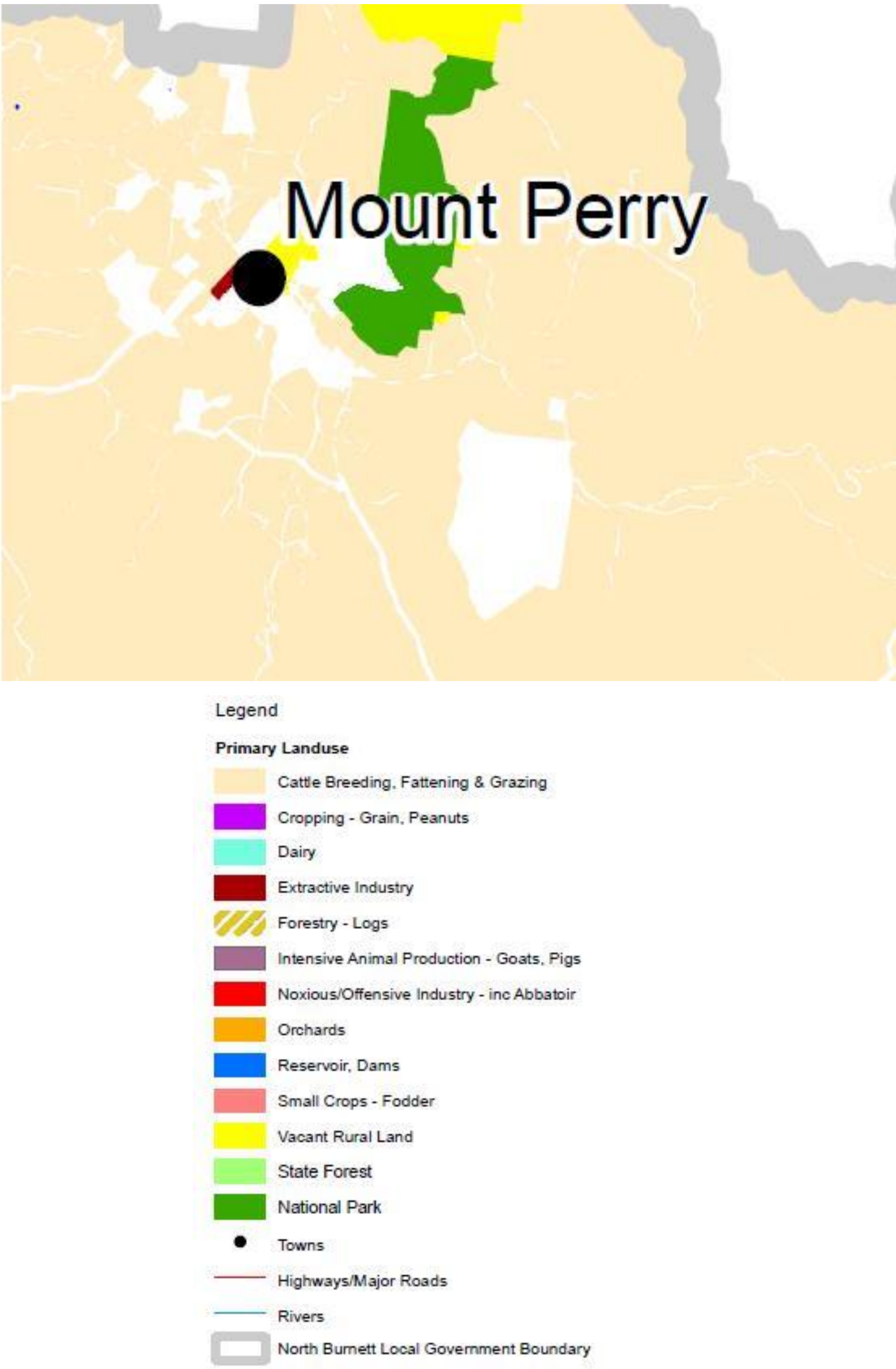


Figure 9-3 Mount Perry Catchment Area

9.4 Mount Perry Hazard Identification, Risk Assessment and Uncertainty

Table 9-6 Mount Perry Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. The bores are sealed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Raw and treated water monitoring program was reviewed	Catastrophic	Rare	Medium (6)	Confident	Inability to detect contamination	Apply for funding for UV Disinfection
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. The bores are sealed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection Raw and treated water monitoring program was reviewed	Catastrophic	Rare	Medium (6)	Confident	Existing measures are robust	Apply for funding for UV Disinfection
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Major	Unlikely	Medium (8)	1. Dilution during treatment processes and storage 2. Treatment processes - aerator for iron removal Annual monitoring and testing of source water.	Major	Rare	Medium (5)	Confident	Main concern is arsenic level in raw water which is still below unsafe levels.	
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Minor	Possible	Medium (6)	1. Dilution during treatment processes and storage 2. Treatment processes - aerator for iron removal Regular testing program	Minor	Unlikely	Low (4)	Confident	Few farmers use either pesticides or fertiliser as the area is predominantly grazing.	
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. Dilution during treatment processes and storage 2. Treatment processes - aerator for iron removal Regular testing program	Moderate	Rare	Low (3)	Confident	Few farmers use either pesticides or fertiliser as the area is predominantly grazing.	
6	Source water	Chemical contamination	1. Accidental spills	Moderate	Rare	Low (3)	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert) Regular testing program	Insignificant	Rare	Low (1)	Uncertain	Small concentration. Only risk of any real consequence would be a chemical spill near the intake Inability to predict type or consistency of possible spill?	
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	Minor	Unlikely	Low (4)	1. Detention time in storage for settling out particulates 2. Public notification process (boil water alert)	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. Power failure	Moderate	Unlikely	Medium (6)	1. Two alternative sources of supply with individual pumps. 2. Estimated 4-5 days supply in reservoir 3. Spare pump kept at local depot	Moderate	Rare	Low (3)	Confident	Existing measures are robust	
9	Source water	Lack of supply	Climatic variations	Moderate	Unlikely	Medium (6)	1. Importing water 2. Drought Management Plan actions: restrictions, communication etc.	Moderate	Rare	Low (2)	Uncertain	Uncertainty in future climate	
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	Major	Possible	High (12)	1. Treatment processes – Chlorine disinfection 2. Injection pump and chlorine supply are also checked and inspected twice weekly. 3. Public notification process (boil water alert) 4. Trained and qualified operators – good housekeeping 5. Security and vermin-proofing 6. Regular cleaning and maintenance of process equipment SCADA monitoring and alarming **Mount Perry 2018-01:** Operation of the chlorine injection system is linked to raw water meter signal in 2015. **Mount Perry 2013-02:** On-line chlorine analyser is installed and alarmed to SCADA **Mount Perry 2013-03:** Chlorine levels in retic system are tested at least weekly.	Major	Rare	Medium (5)	Reliable	SCADA has been upgraded to provide better monitoring and alarming	Seek funding to install UV
11	Treatment	Biological Contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Trained and qualified operators – good housekeeping Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk	Catastrophic	Rare	Medium (6)	Uncertain	Inability to detect contamination in the treatment process	Seek funding to install UV
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error 5. Plant Design	Moderate	Unlikely	Medium (6)	1. Chemical injection levels are inspected twice per week. 2. Dosing equipment is checked twice per week. 3. Trained and qualified operators – good housekeeping 4. On line analyser installed and alarmed to SCADA **Mount Perry 2018-01:** Operation of the chlorine injection system is linked to raw water meter signal in 2015.	Moderate	Rare	Low (3)	Confident	Existing measures are robust.	
14	Treatment	Physical/chemical contamination • Turbidity • Manganese Particulates	Failure of aeration sprayers	Minor	Rare	Low (2)	1. Dilution during treatment processes and storage 2. Aerator checked weekly	Minor	Rare	Low (2)	Confident	Existing measures are robust	

9.5 Mount Perry Risk Management Measures

Table 9-7 Mount Perry Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	1. The bores are sealed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. Raw and treated water monitoring program was reviewed	Likelihood	Effective based on water test results	Medium (6)	Yes	Apply for funding for UV Disinfection	Major Projects Water and Wastewater
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	1. The bores are sealed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Treatment processes – Chlorine disinfection Raw and treated water monitoring program was reviewed	Likelihood	Effective based on water test results	Medium (6)	Yes	Apply for funding for UV Disinfection	Major Projects Water and Wastewater
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	1. Dilution during treatment processes and storage 2. Treatment processes - aerator for iron removal Annual monitoring and testing of source water.	Likelihood	Unknown	Medium (5)	No		
4	Source water	Chemical contamination	1. Pesticides and Fertilisers	1. Dilution during treatment processes and storage	Likelihood	Unknown	Low (4)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
		• Nutrients: Nitrate • Anions: Sulphate, Fluoride	2. Natural occurrences of anions	2. Treatment processes - aerator for iron removal Regular testing program						
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	1. Dilution during treatment processes and storage 2. Treatment processes - aerator for iron removal Regular testing program	Likelihood	Unknown	Low (3)	Yes		
6	Source water	Chemical contamination	1. Accidental spills	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert) Regular testing program	Consequence	Unknown as has not occurred	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	1. Detention time in storage for settling out particulates 2. Public notification process (boil water alert)	Likelihood	Effective in reducing turbidity as per water quality samples	Low (4)	Yes		
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps	1. Two alternative sources of supply with individual pumps.	Likelihood	Effective- multiple backups and past history	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
			3. Power failure	2. Estimated 4-5 days supply in reservoir 3. Spare pump kept at local depot						
9	Source water	Lack of supply	Climatic variations	1. Importing water 2. Drought Management Plan actions: restrictions, communication etc.	Likelihood	Effective- reliable supply	Low (2)	Yes		
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	1. Treatment processes – Chlorine disinfection 2. Injection pump and chlorine supply are also checked and inspected twice weekly. 3. Public notification process (boil water alert) 4. Trained and qualified operators – good housekeeping 5. Security and vermin-proofing 6. Regular cleaning and maintenance of process equipment SCADA monitoring and alarming **Mount Perry 2018-01:** Operation of the chlorine injection system is linked to raw water meter signal in 2015.	Likelihood	Not effective. Monitoring is inadequate	Medium (5)	No	Seek funding to install UV	Major Projects Water and Wastewater

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
				Mount Perry 2013-02: On-line chlorine analyser is installed and alarmed to SCADA **Mount Perry 2013-03:** Chlorine levels in retic system are tested at least weekly.						
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	1. Security and vermin-proofing 2. Trained and qualified operators – good housekeeping Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk	No	Inability to detect contamination in the treatment process	Medium (6)	No	Seek funding to install UV	Major Projects Water and Wastewater
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error 5. Plant Design	1. Chemical injection levels are inspected twice per week. 2. Dosing equipment is checked twice per week. 3. Trained and qualified operators – good housekeeping	Likelihood	Effective based on water test results	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
				On line analyser installed and alarmed to SCADA **Mount Perry 2018-01:** Operation of the chlorine injection system is linked to raw water meter signal in 2015.						
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	1. Dilution during treatment processes and storage 2. Aerator checked weekly	No	No THM exceedances recorded in treated water	Medium (5)	Yes		
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	Failure of aeration sprayers	1. The bores are sealed and appropriately cased so storm runoff and infiltration is avoided and vermin cannot enter. 2. Raw and treated water monitoring program was reviewed	Likelihood	Effective	Low (2)	Yes		

9.6 Mount Perry Risk Management Improvement Program

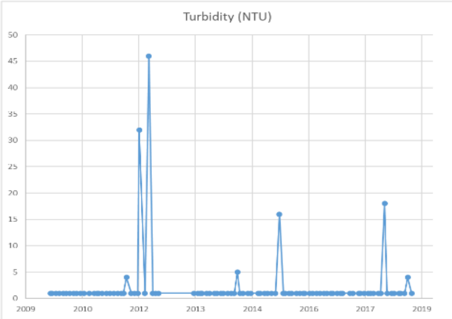
Table 9-8 Mount Perry Risk Improvement Program

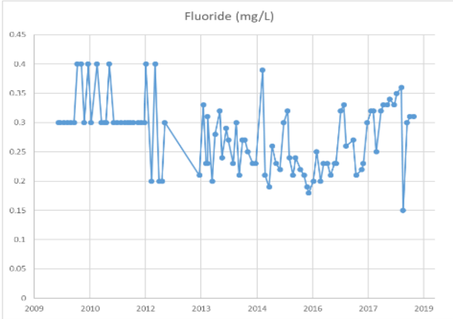
Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
1	Source water	Biological contamination • Protozoa	Medium			Apply for funding for UV Disinfection	30/06/2024	$100k	Major Projects Water and Wastewater
2	Source water	Biological contamination • Bacteria Viruses	Medium			Apply for funding for UV Disinfection	30/06/2024	$100k	Major Projects Water and Wastewater
10	Treatment	Biological contamination • Bacteria Viruses	Medium			Apply for funding for UV Disinfection	30/06/2024	$100k	Major Projects Water and Wastewater
11	Treatment	Biological contamination • Protozoa	Medium			Apply for funding for UV Disinfection	30/06/2024	$100k	Major Projects Water and Wastewater

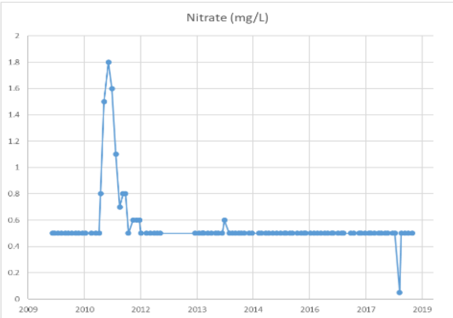
9.7 Mount Perry Water Scheme Water Quality Data

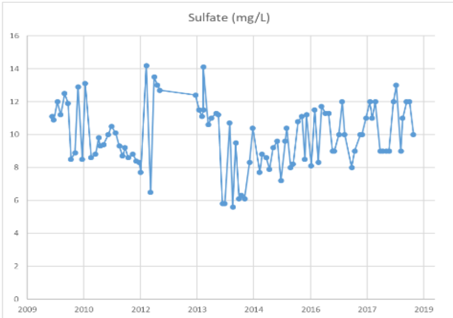
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

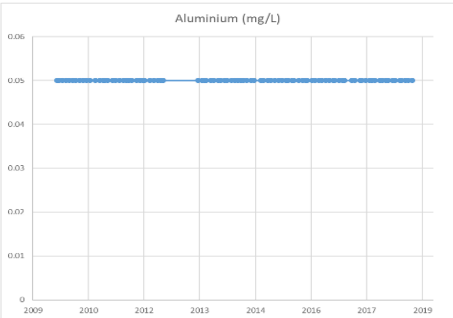
Mount Perry untreated bore water 2010-2018

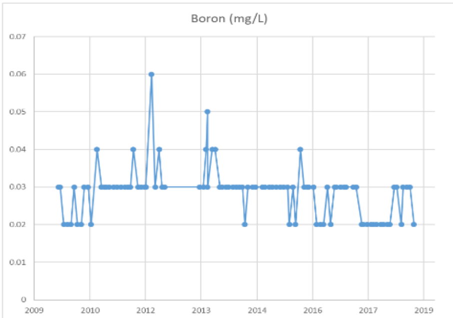


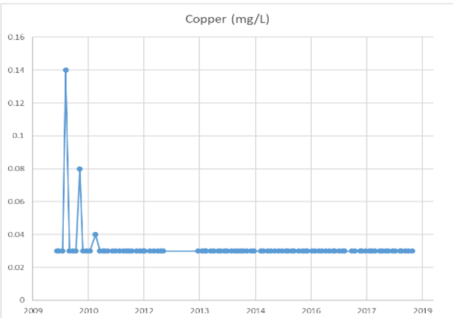


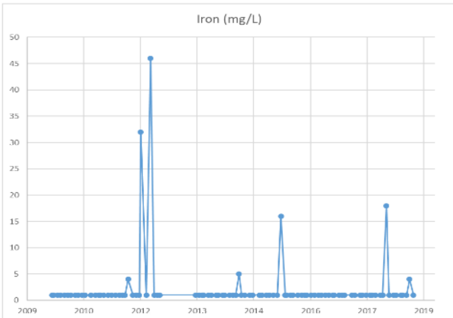


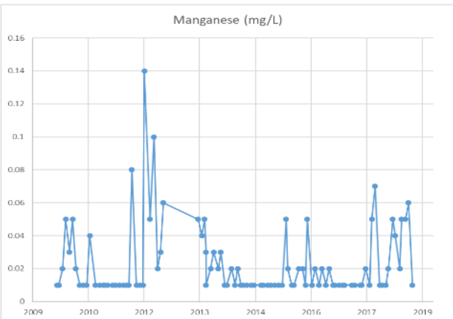


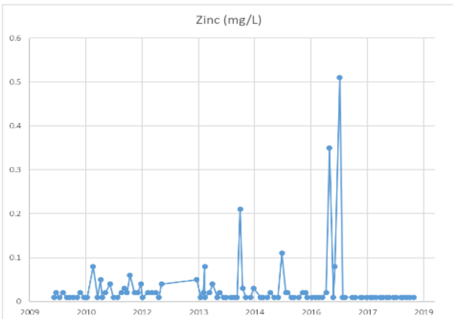




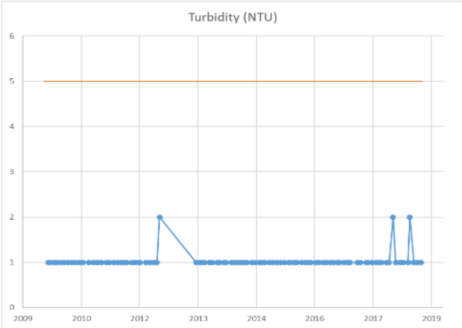


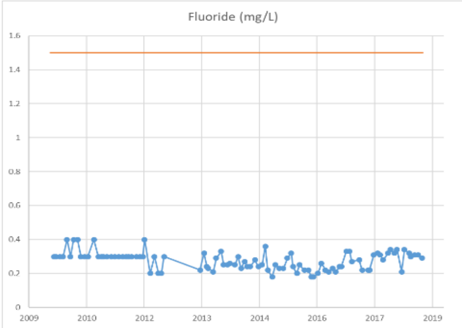


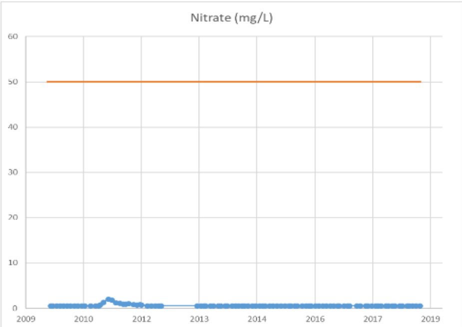


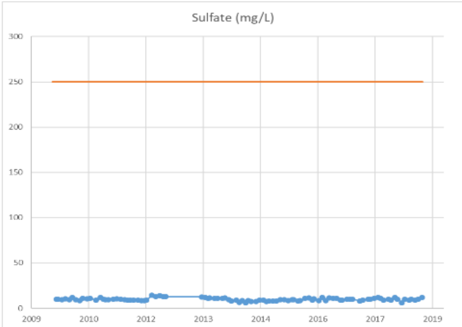


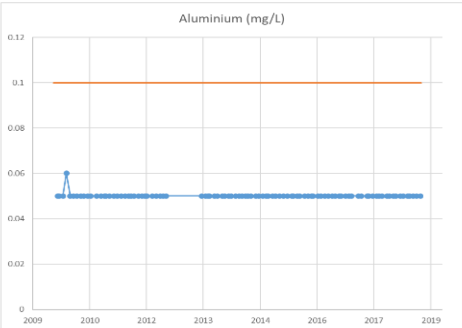
Mount Perry treated water 2010-2018

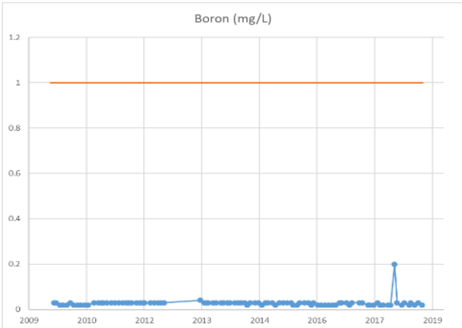


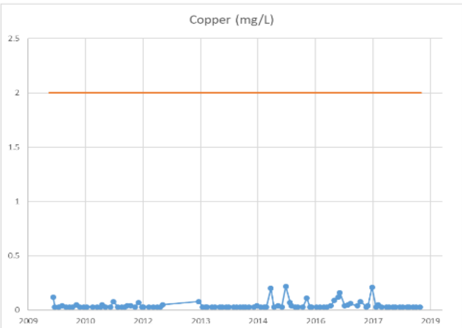


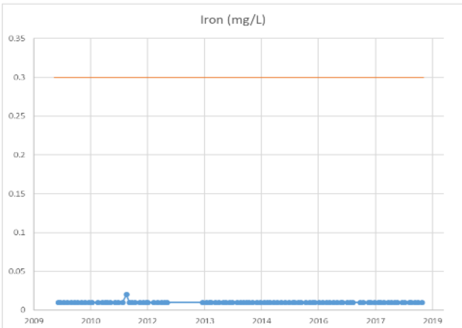


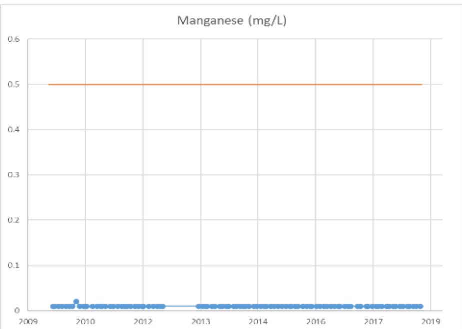


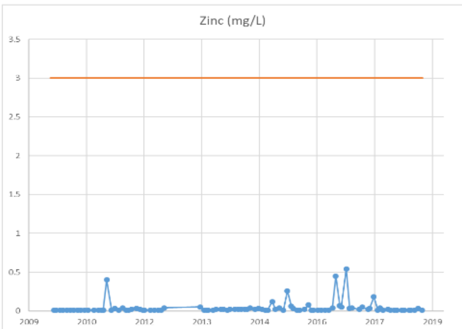












10. MULGILDIE WATER SUPPLY SCHEME

10.1 Details of Infrastructure for Providing the Service

Source Water

Raw water for the scheme is drawn from a single artesian bore located on the western edge of town, adjacent to Hughes Street. The water is now pumped from the bore, as the natural artesian flow rate has dropped to a point where it would not sustain the town water demand. The pump is set 20m from the Bore head and pumps at 2.5L/s. The supply is drawn from the Great Artesian Basin.

Treatment Process

In 1990, a treatment plant was constructed next to the bore site to improve the quality of the raw water which had failed to comply with NHMRC guidelines with respect to excessive hardness and salinity (total dissolved solids) and high concentration of iron. The treatment facility consists of chemical feeding, aeration, sedimentation, rapid filtration, UV, clearwater storage (Balance Tanks) and chlorination. The treatment plant was upgraded in 2005 to provide additional clearwater storage and a variable speed clearwater pump. Overflow and backwash water can discharge to a holding dam some distance from the treatment plant and dissipate back into the ground by soakage under an EPA licence. In 2016, the original aeration/cooling tower was removed, and aeration sprays set up in the sedimentation tank. Also, the existing filter was removed, and a new Glacier Filtration unit installed and U.V installed

The Mulgildie WTP is automatic in operation with daily inspections carried out by operators.

Disinfection is achieved through sodium hypochlorite injection at automated dosing points. The WTP pumps and reservoir levels are linked to the SCADA system. If problems at these WTP elements are detected through SCADA (i.e. failure of chlorine dosing or reservoir levels) an alarm is triggered and an SMS is sent to the operator’s phone, who will then visit the site. Chlorine injection at the WTP is also linked to the SCADA system, and pH and chlorine analysers are installed and alarmed. There is a 200 L chlorine storage tank at the WTP, the level of which is monitored daily by operators. There is no documented WTP operation manual.

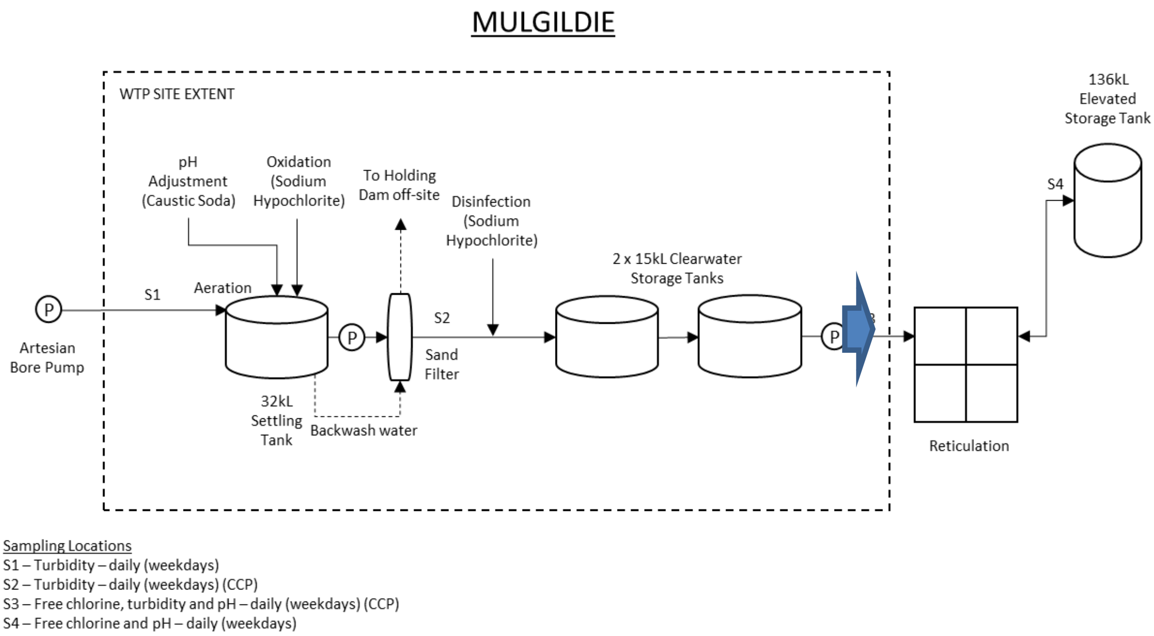


Figure 10-1 Mulgildie WTP Schematic

Distribution

Water from the clearwater tank is pumped by a high lift pump into a grid of 100mm AC pipes forming the distribution network and to a 136kL elevated storage reservoir located on the eastern edge of town. When the pumps are not in operation the water is gravity fed from the elevated reservoir back into the reticulation system.

Sampling locations are sited at key points determined to provide the best indication of chlorine residual levels in the system. Chlorine residuals in the reticulation system are sampled and tested weekly. Samples are also taken as water leaves the reservoir. In addition, raw water and one treated water samples are taken regularly and sent to the Qld Health Laboratory for chemical analysis. One raw water and two treated water samples are taken regularly and sent to Qld Health Laboratory for biological testing.

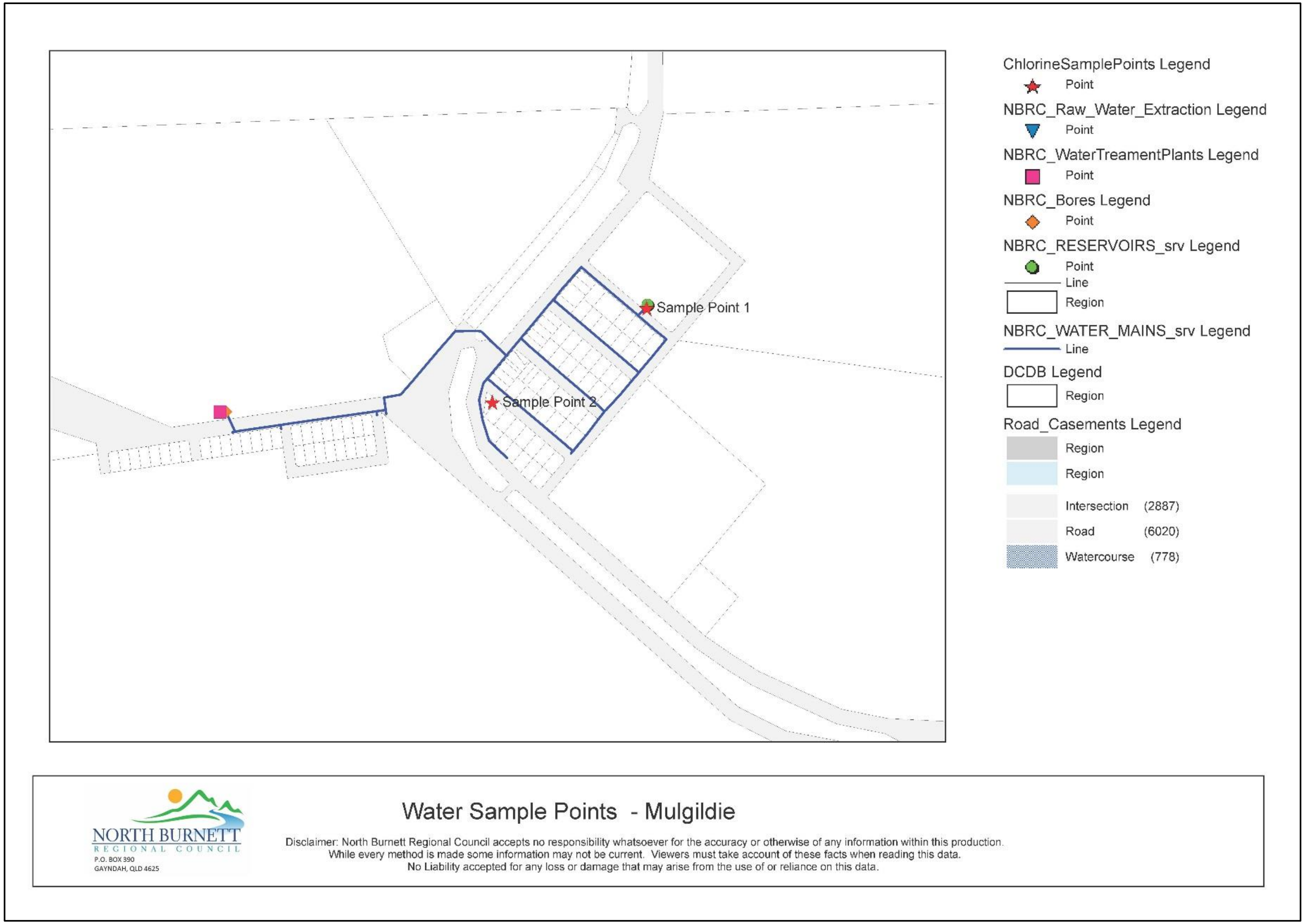


Figure 10-2 Mulgildie Water Supply Map

Table 10-1 Infrastructure Details Mulgildie Water Supply Scheme –

Component		Scheme
Sources	Name	Bore
	Type	Artesian Bore x 1 2L/s
	% of supply	100%
	Reliability	High
	Water quality issues	Iron, hardness, salinity, pH and temperature
Sourcing Infrastructure	Type	Artesian Bore
	Description	Artesian Bore Installed = 1999 Casing = Steel Diameter = DN125 Depth = 634m
	Ownership	NBRC
Are there any sources that **do not** undergo treatment prior to supply?	No	
Mulgildie WTP	Name	Mulgildie WTP
	Process	Aeration, pH adjustment (soda ash), sedimentation, filtration, UV, and disinfection (chlorination)
	Design Capacity (20 hr operation)	2.5 L/s
	Daily flow range	60-70 kL/d
	Chemicals added	Caustic, sodium hypochlorite
	Standby chemical dosing facilities (Y/N)	N

Component		Scheme
	Water sourced from and %	Bore 100%
	% of average day demand provided	100%
	% of scheme supply Distribution area supplied	100%
	Bypasses / Variations	No
Disinfection	Location	Post Filter
	Type	Liquid sodium hypochlorite and U.V
	Dose rate	Controlled by in-line analyser
	Target residual levels	0.5 mg/l
	Duty/standby	Nil
	Dosing arrangements	Fixed
	Alarms	Nil
	Auto shut-off arrangements	Nil
Distribution and Reticulation System	Pipe material	AC
	Age range	40 – 50 years
	Approx % of total length	100%
	Areas where potential long detention periods could be expected	Nil
	Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	Nil
Reservoirs	**Name**	Elevated Reservoir
	Capacity	136kL
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y

Component		Scheme
	Runoff directed off roof (Y/N)	Y

10.2 Mulgildie Water Quality: Identifying Hazards and Hazardous Events

Water quality information has been collected by NBRC for raw water, treated water and reticulated supply for the period of April 2010 to November 2018. Analysis of this data has been completed to assess the results in comparison to the ADWG guideline values for parameters measured.
A summary of the water analysis undertaken for the Mulgildie Water Supply Scheme is contained in Table 10-2, Table 10-3, Table 10-4 and

Table 10-5. Section 10.5 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

The reticulated water scheme has been measured for pH, residual chlorine, *E. coli* and total coliforms.

Interpretation

Based on the data available, over the period of testing, there has been a low rate of sampling for Mulgildie with less than one test per month for raw water and treated water, and even less for the reticulated system.

Within the raw water sampling, turbidity and iron were above the guideline values for treated water, and all other values were below.

For sampling data taken from the Mulgildie WTP, there were two instances where turbidity values exceeded the guideline value. Iron also exceeded the ADWG guideline level in November 2017.

Within the reticulation system, there were two occurrences when residual chlorine fell below the ADWG recommended value. No total coliform or *E. coli* were detected in the reticulated water. There may be potential water quality issues within the reticulation system due to low levels of residual chlorine and total coliforms being detected. Increased frequency of sampling and testing, and operational response, has since reduced this risk.

Table 10-2 Mulgildie Raw Water

Mulgildie Source – Bore							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Turbidity (NTU)	Bore	Apr 2010 – Nov 2018	100	49	6.3	<1	
Fluoride	Bore	Apr 2010 – Nov 2018	100	0.1	0.07	<0.05	Multiple limits of detection were used (<0.05 and <0.1). To calculate the stats, the absolute values were used.
Nitrate	Bore	Apr 2010 – Nov 2018	100	0.90	0.51	<0.50	
Sulfate	Bore	Apr 2010 – Nov 2018	100	16	12.9	10.6	
Dissolved metals							
Aluminium	Bore	Apr 2010 – Nov 2018	100	0.07	0.05	<0.05	
Boron	Bore	Apr 2010 – Nov 2018	100	0.28	0.20	0.17	
Copper	Bore	Apr 2010 – Nov 2018	100	0.05	0.03	<0.03	
Iron	Bore	Apr 2010 – Nov 2018	100	7.1	0.5	<0.01	
Manganese	Bore	Apr 2010 – Nov 2018	100	0.07	0.03	<0.01	
Zinc	Bore	Apr 2010 – Nov 2018	100	0.45	0.12	<0.01	
Total metals							
Aluminium	Bore	Nov 2017 – Oct 2018	2	0.047	0.038	0.029	
Arsenic	Bore	Nov 2017 – Oct 2018	2	<0.0001	<0.0001	<0.0001	All samples taken were <0.0001 mg/L
Cadmium	Bore	Nov 2017 – Oct 2018	2	<0.0001	<0.0001	<0.0001	All samples taken were <0.0001 mg/L
Chromium	Bore	Nov 2017 – Oct 2018	2	0.0002	0.00015	<0.0001	
Copper	Bore	Nov 2017 – Oct 2018	2	0.009	0.008	0.007	

Mulgildie Source – Bore							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Iron	Bore	Nov 2017 – Oct 2018	2	3.8	2.55	1.3	
Lead	Bore	Nov 2017 – Oct 2018	2	0.0019	0.0013	0.0007	
Manganese	Bore	Nov 2017 – Oct 2018	2	0.036	0.019	0.0037	
Nickel	Bore	Nov 2017 – Oct 2018	2	0.012	0.011	0.009	
Zinc	Bore	Nov 2017 – Oct 2018	2	0.041	0.034	0.028	

Table 10-3 Mulgildie Treated Water

Plant	Mulgildie WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Turbidity (NTU)	Reservoir	Apr 2010 – Nov 2018	93	6.0	1.5	<1.0	5	2	Aesthetic guideline only Exceedances in Oct and Nov 2015

Plant	Mulgildie WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Fluoride	Reservoir	Apr 2010 – Nov 2018	93	0.20	0.07	<0.05	1.5	0	Multiple limits of detection were used (<0.05 and <0.1). To calculate the stats, the absolute values were used.
Nitrate	Reservoir	Apr 2010 – Nov 2018	93	4.20	0.60	<0.50	50	0	Aesthetic guideline only Multiple limits of detection were used (<0.5 and <1). To calculate the stats, the absolute values were used.
Sulfate	Reservoir	Apr 2010 – Nov 2018	93	24.0	13.6	12.0	250	0	Aesthetic guideline only
Dissolved metals									
Aluminium	Reservoir	Apr 2010 – Nov 2018	93	<0.05	<0.05	<0.05	0.1	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable All values below detection limit

Plant	Mulgildie WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Boron	Reservoir	Apr 2010 – Nov 2018	93	0.32	0.20	<0.05	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L
Copper	Reservoir	Apr 2010 – Nov 2018	93	0.04	0.03	<0.03	2(1)	0	Number in brackets denotes the aesthetic guideline value
Iron	Reservoir	Apr 2010 – Nov 2018	93	0.08	0.01	0.01	0.3	0	Aesthetic guideline only All values below detection limit
Manganese	Reservoir	Apr 2010 – Nov 2018	93	0.04	0.01	<0.01	0.5(0.1)	0	Number in brackets denotes the aesthetic guideline value
Zinc	Reservoir	Apr 2010 – Nov 2018	93	1.0	0.05	0.01	3	0	
Total metals									
Aluminium	Mulgildie Park	Nov 2017 – Oct 2018	3	0.013	0.007	<0.003	0.2	0	Aesthetic guideline only
Arsenic	Mulgildie Park	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.01	0	All samples were <0.0001 mg/L

Plant	Mulgildie WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Cadmium	Mulgildie Park	Nov 2017 – Oct 2018	3	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L
Chromium	Mulgildie Park	Nov 2017 – Oct 2018	3	0.0012	0.001	0.0007	0.05	0	
Copper	Mulgildie Park	Nov 2017 – Oct 2018	3	0.029	0.02	0.006	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	Mulgildie Park	Nov 2017 – Oct 2018	3	0.58	0.26	0.052	0.3	1	Aesthetic guideline only Exceedance in November 2017
Lead	Mulgildie Park	Nov 2017 – Oct 2018	3	0.0016	0.0009	0.0003	0.01	0	
Manganese	Mulgildie Park	Nov 2017 – Oct 2018	3	0.046	0.017	0.0016	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Nickel	Mulgildie Park	Nov 2017 – Oct 2018	3	0.007	0.006	0.004	0.02	0	
Zinc	Mulgildie Park	Nov 2017 – Oct 2018	3	0.023	0.019	0.015	3	0	Aesthetic guideline only

Table 10-4 Mulgildie Reticulated Water

Scheme / Sampling Location	Mulgildie Reticulated Water							
Parameter (mg/L unless otherwise specified)	**Time Period**	**No of samples**	**Summary of Results**			**Australian Drinking Water Guidelines guideline value for health unless otherwise specified**	**No of samples exceeding Australian Drinking Water Guidelines guideline value**	**Comment**
			Maximum Value	**Average Value**	**Minimum Value**			
pH (pH units)	Apr 2010 – Nov 2018	93	7.9	7.4	6.8	6.5 - 8.5	0	Aesthetic guideline only
Disinfectant residual	July 2016 – Nov 2018	26	1.9	0.97	0	>0.2 - 0.5	2	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition Chlorine residual <0.2 mg/L occurred in July 2016 and Dec 2017
Total coliform (mpn/100mL)	July 2016 – Nov 2018	27	0	0	0	NA	NA	
E. coli (CFU/100mL)	July 2016 – Nov 2018	27	0	0	0	None Detected	0	
Trihalomethanes	Sept 2016 – Oct 2018	3	0.016	0.013	0.012	0.25	0	

Table 10-5 Mulgildie Water Quality Complaints

Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
1-7-2010 to 26-10-2018	1	13.69	- Taste and odour	- Unknown	- Unknown

10.1 Mulgildie Catchment Characteristics

The area around Mulgildie has no influence on the water quality as the source water is from the Mulgildie Management Area which is part of the Great Artesian Basin.

There is no fracking occurring in the area.

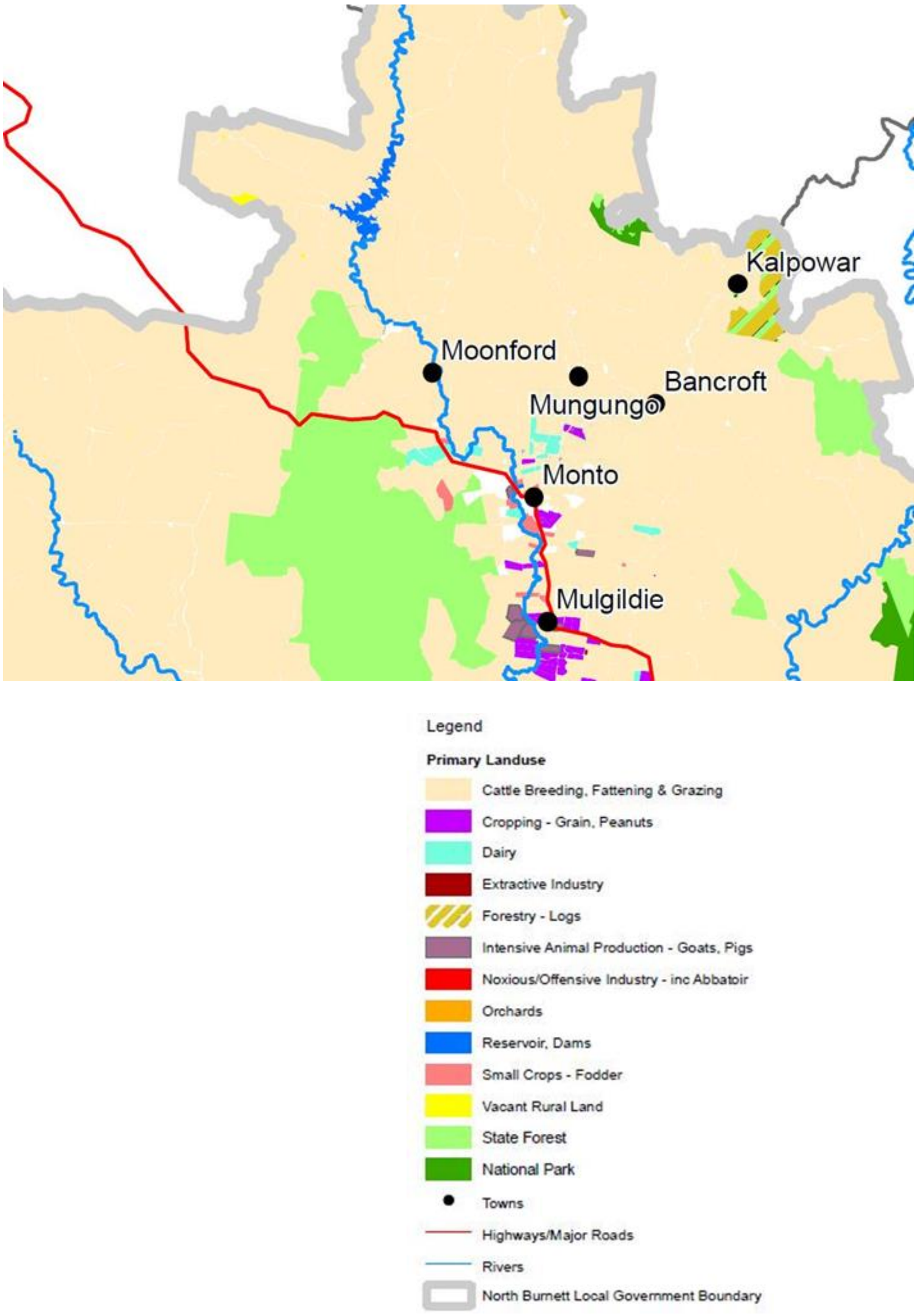


Figure 10-3 Mulgildie Area

10.2 Mulgildie Hazard Identification, Risk Assessment and Uncertainty

Table 9.6: Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration	Catastrophic	Rare	Low (4)	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. Treatment Process: oxidation, coagulation, filtration, UV, chlorination	Catastrophic	Never	Low (0)	Certain	Artesian	
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration	Catastrophic	Rare	Low (4)	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. 4. Treatment Process: oxidation, coagulation, filtration, UV, chlorination	Catastrophic	Never	Low (0)	Certain	Artesian	
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Major	Unlikely	Medium (8)	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. 4. Treatment processes, pH adjustment oxidation aeration and filtration Annual monitoring and testing of source water.	Moderate	Rare	Low(5)	Certain	Artesian	
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Minor	Possible	Medium (6)	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep.	Major	Rare	Low (1)	Certain	Artesian.	
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 640 metres deep. 4. Treatment processes, pH adjustment oxidation aeration and filtration Annual monitoring and testing of source water.	Moderate	Rare	Low (3)	Certain	Artesian	
8	Source water	Lack of supply	1. Casing failure	Moderate	Rare	Low (3)	1. Periodic Casing Inspection (5-7 years)	Minor	Rare	Low (2)	Certain	Artesian	
9	Source water	Lack of supply	Depletion of Great Artesian Basin aquifer	Moderate	Rare	Medium (5)	1. Installation of pump Importing water 2. Drought management Plan actions: restrictions, communication etc. 3. Daily standing levels and pumping water levels for the bore are monitored and data trended. Monthly reports provided to Council and DNR.	Moderate	Rare	Low (3)	Reliable	Artesian	
10	Treatment	Biological contamination • Bacteria	1. Sand filters are open topped 2. Staff error	Major	Rare	High (10)	1. Treatment processes – Chlorine disinfection 2. Chlorine levels are tested daily	Minor	Rare	Low (4)	Confident		

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
		• Viruses					3. Injection pumps and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment						
11	Treatment	Biological contamination Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error	Moderate	Rare	Medium (6)	1. Detection and dilution during treatment processes and storage 2. Treatment processes, Coagulation, filtration and UV 3. Chemical injection levels are tested three times per week. 4. Dosing equipment is checked three times per week 5 Security and vermin-proofing 6. Trained and qualified operators – good housekeeping **Mulgildie 2013-02:** Online analyser installed and alarmed to SCADA.	Major	Rare	Low (4)	Reliable	Multiple barriers	
12	Treatment	• Chemical contamination	1. Chemical overdose due to equipment failure 2. Sand filters are open topped 3. Loss of Chemical supplies 4. Communication Breakdown (alarms) 5. Staff error 6. Plant Design	Moderate	Possible	Medium (9)	1. Detection and dilution during treatment processes and storage 2. Treatment processes, pH adjustment and aeration 3. Chemical injection levels are tested three times per week. On-line chlorine analyser is installed and alarmed to SCADA 4. Dosing equipment is checked three times per week 5. Trained and qualified operators	Moderate	Rare	Medium (6)	Confident		
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	Major	Rare	Medium (5)	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill 2. Staff aware of potential issues and refill fortnightly if possible Mulgildie 2018-01: THM monitoring occurs monthly	Minor	Unlikely	Low (4)	Confident	THM monitoring have commenced. All results are below ADWG limits.	
14	Treatment	Physical/chemical contamination • Turbidity • Manganese Particulates	1. Failure of back-wash of sand filters 2. Sand filters are open topped	Minor	Unlikely	Low (4)	1. Treatment processes, pH adjustment and aeration, coagulation and filtration 2. Operation of filters monitored three times per week.	Moderate	Rare	Low(3)	Confident		
15	Treatment	• Clearwater reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	Moderate	Unlikely	Medium (6)	1. Estimated one week's supply in tower reservoir. 2. Pumping equipment checked three times per week	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
							3. Standby pump installed						

10.3 Mulgildie Risk Management Measures

Table 9.7: Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. Treatment Process: oxidation, coagulation, filtration, UV, chlorination	Likelihood	Effective. No known instances of contamination recorded	Low (1)	Yes		
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. 4. Treatment Process: oxidation, coagulation, filtration, UV, chlorination	Likelihood	Effective. No known instances of contamination recorded	Low(1)	Yes		
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. 4. Treatment processes, pH adjustment oxidation aeration and filtration Annual monitoring and testing of source water.	Likelihood	Effective. No known instances of contamination recorded	Low (5)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep.	Likelihood	Effective. No known instances of contamination recorded	Low (1)	Yes		
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 640 metres deep. 4. Treatment processes, pH adjustment oxidation aeration and filtration Annual monitoring and testing of source water.	Likelihood	Effective. No known instances of contamination recorded	Low (3)	Yes		
6	Source water	Chemical contamination	1. Accidental spills	1. Periodic Casing Inspection (5-7 years)	Likelihood and Consequence	Effective – No known instances of contamination recorded	Low (2)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires 4. Major Storms	1. Installation of pump Importing water 2. Drought management Plan actions: restrictions, communication etc. 3. Daily standing levels and pumping water levels for the bore are monitored and data trended. Monthly reports provided to Council and DNR.	Likelihood and Consequence	Effective – No known instances of contamination recorded	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
8	Source water	Lack of supply	1. Casing failure	1. Treatment processes – Chlorine disinfection 2. Chlorine levels are tested daily 3. Injection pumps and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment	Likelihood	Effective – no casing failure recorded to date	Low (4)	Yes		
9	Source water	Lack of supply	1. No flow	1. Detection and dilution during treatment processes and storage 2. Treatment processes, Coagulation, filtration and UV 3. Chemical injection levels are tested three times per week. 4. Dosing equipment is checked three times per week 5 Security and vermin-proofing 6. Trained and qualified operators – good housekeeping **Mulgildie 2013-02:** Online analyser installed and alarmed to SCADA.	Likelihood	Effective- reliable artesian supply	Low (4)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Sand filters are open topped 4. Loss of Chemical supplies 5. Staff error 6. Plant Design	1. Detection and dilution during treatment processes and storage 2. Treatment processes, pH adjustment and aeration 3. Chemical injection levels are tested three times per week. On-line chlorine analyser is installed and alarmed to SCADA 4. Dosing equipment is checked three times per week 5. Trained and qualified operators	Likelihood	Ineffective - three tests per week is not enough to maintain confidence that residual chlorine levels are within guidelines	Medium (6)	Yes		
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	1. Degeneration of sodium hypochlorite unlikely due to the relatively small storage capacity which requires monthly refill 2. Staff aware of potential issues and refill fortnightly if possible Mulgildie 2018-01: THM monitoring occurs monthly	No	Inability to detect contamination in the treatment process	Low (4)	Yes		
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure 2. Sand filters are open topped	1. Treatment processes, pH adjustment and aeration, coagulation and filtration 2. Operation of filters monitored three times per week.	Likelihood	Effective proven treatment processes	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
			3. Loss of Chemical supplies 4. Communication breakdown (alarms) 5. Staff error 6. Plant Design							
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	1. Estimated one week's supply in tower reservoir. 2. Pumping equipment checked three times per week 3. Standby pump installed	No	No THM exceedances recorded in treated water	Low (4)	Yes		
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of back-wash of sand filters 2. Sand filters are open topped	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. Treatment Process: oxidation, coagulation, filtration, UV, chlorination	Likelihood and Consequence	Effective.	Low (1)	Yes		
15	Treatment	Clearwater reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	1. Bore head sealed. 2. Bore & treatment compound fully fenced and locked. 3. Bore is artesian and 600 metres deep. 4. Treatment Process: oxidation, coagulation, filtration, UV, chlorination	Likelihood	Effective, reservoir capacity allows time to provide a generator.	Low(1)	Yes		

10.4 Mulgildie Risk Management Improvement Program

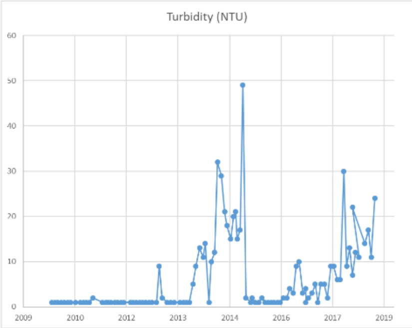
Table 10-6 Mulgildie Risk Improvement Program

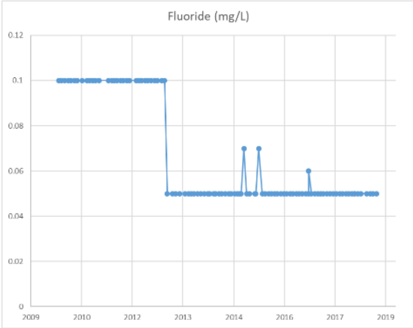
Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
		N/A							

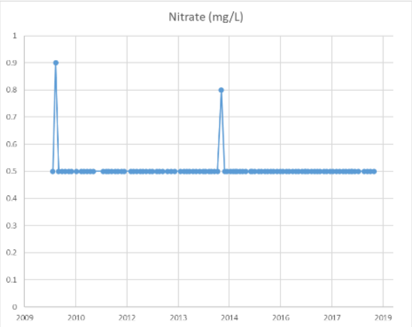
10.5 Mulgildie Water Scheme Water Quality Data

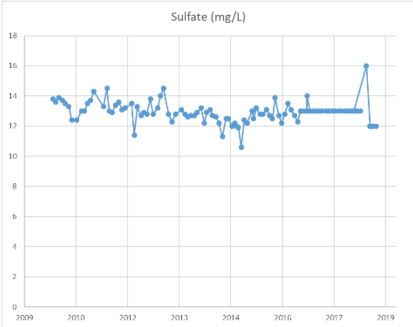
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

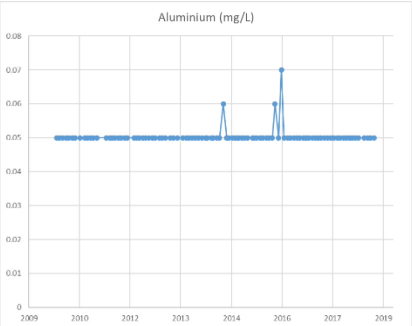
Mulgildie untreated bore water 2010-2018

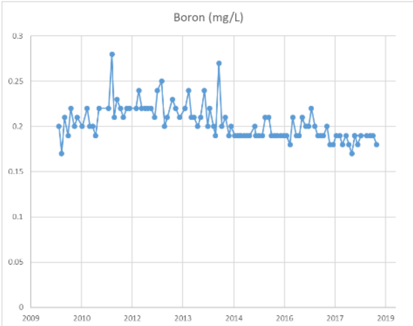


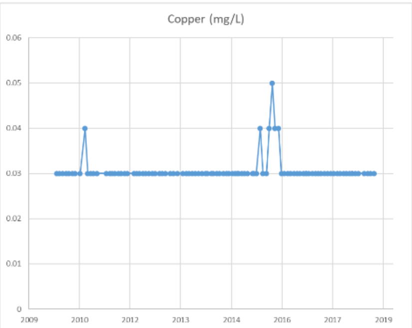


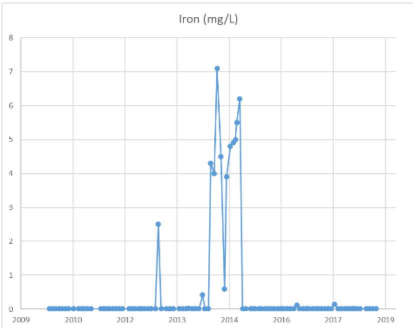


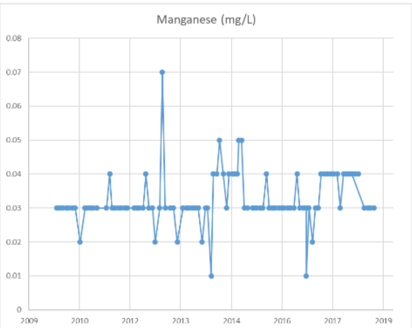


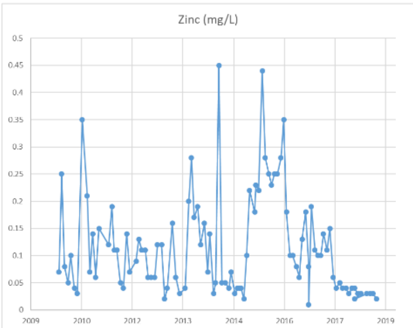




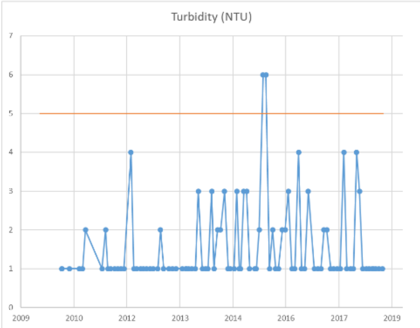


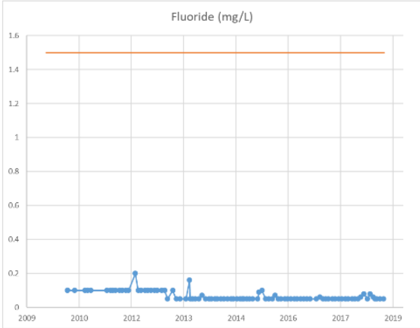


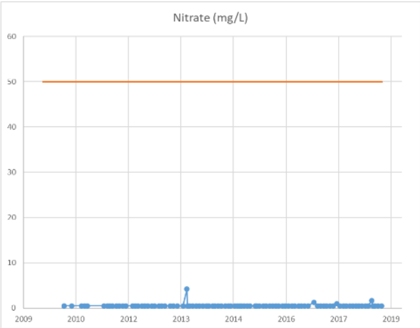


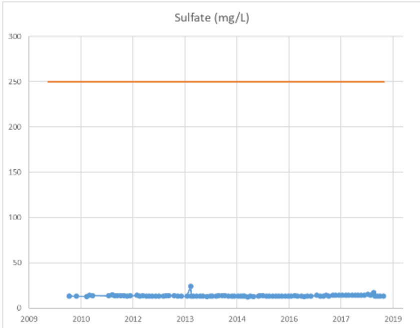


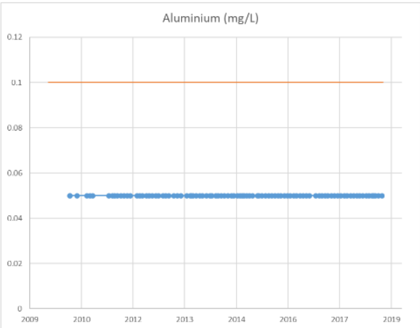
Mulgildie treated water 2010-2018

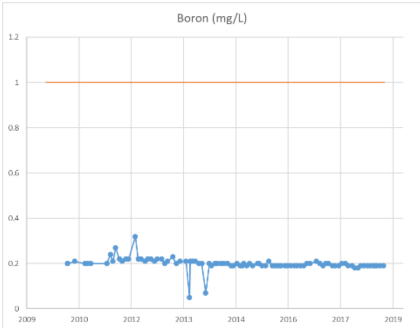


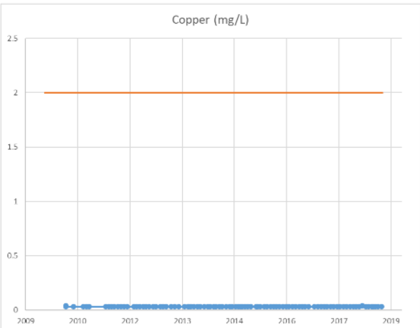


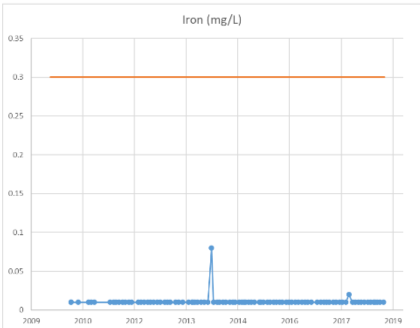


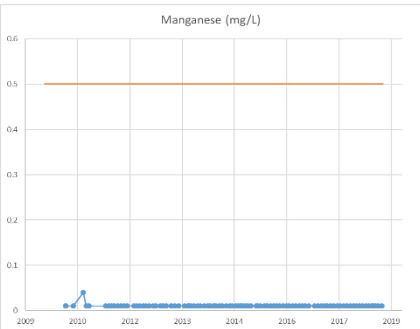


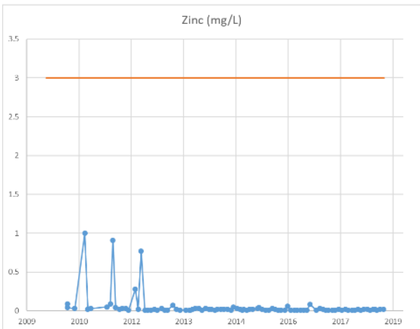












11. MUNDUBBERA WATER SUPPLY SCHEME

11.1 Details of Infrastructure for Providing the Service

Source Water

Raw water for Mundubbera is sourced from the Burnett River at a location south of the town. SunWater are the independent supplier of bulk water in the Upper Burnett Water Supply Scheme and NBRC receive priority water allocation.

Bathymetric survey and geotechnical assessments were undertaken to inform the proposed design outcomes and replacement intake location.

A jetty structure is located close to a local depression in the riverbed, downstream of the existing jetty structure and approximately 450m upstream of the Jones Weir. Jetty is 25m long, approximately 4 m wide and supported on six bored piles, which have been provided with a rock socket footing into the fresh arenite rock formation. The replacement jetty structure has been designed to withstand 1 in 500 ARI flood event conditions, flood loading applied by a 3m high debris mat and impact loading from a two-tonne log. This will provide this replacement jetty with more resilience than the previous structures.

The original 26.5 L/s maximum flow rate pumps have been reused. Pump intakes have been set at RL 104.73 and are protected with intake screens and shroud covers.

Riser pipework has been constructed from Grade 316L stainless steel. Jetty pipework is DICL, with rubber expansion joints to allow for expansion movements. Pipework connection between the jetty pipework and existing rising main is constructed from OD 250 PE 100 SDR 11 piping.

Treatment Process

The 2.8ML ground level reservoir and 36L/s WTP are located adjacent to Mundubbera's only other treated water storages, a 680kL ground level reservoir and 455kL elevated storage reservoir.

Augmentation of Mundubbera's WTP occurred in early 1999 with the replacement of the 19L/s WTP with a 36L/s (greensand) automated plant with a design population of 2,160 and construction of the 2.8ML ground level reservoir. The WTP is an Aquagenics Plant which includes clarification, filtration, pH adjustment and activated carbon treatment. Disinfection is achieved through liquid chlorine injection.

The Mundubbera WTP is automatic in operation. The WTP has staff onsite daily who conduct manual plant inspections. The WTP pumps and reservoir levels are linked to the SCADA system. If problems at these WTP elements are detected through SCADA (i.e. failure of chlorine dosing or reservoir levels) an alarm is triggered and an SMS is sent to the operator's phone, who will then visit the site. Chlorine injection at the WTP is also linked to the SCADA system, however the recorded data needs to be reviewed by operators to detect an injection failure; it is not linked to an alarm system. There is a 2000 L chlorine storage tank at the WTP, the level of which is reviewed daily by operators. There is a documented WTP operation manual.

MUNDUBBERA

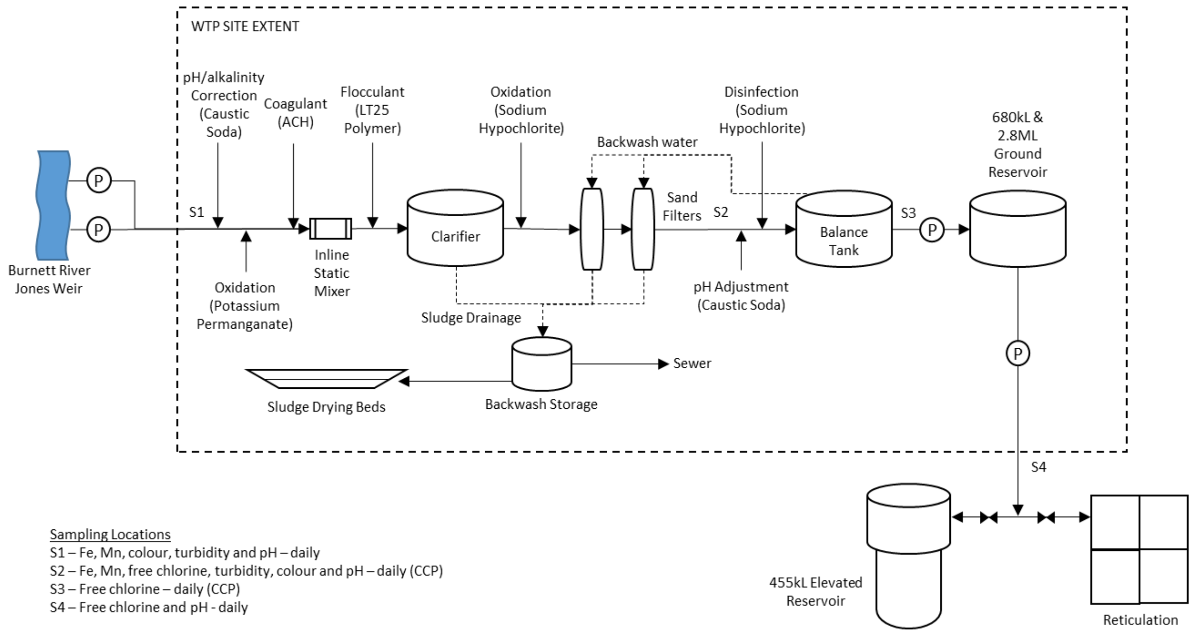


Figure 11-1 Mundubbera Water Infrastructure Scheme Schematic

Distribution

Following treatment, water is pumped from the Ground Level Reservoir at the WTP through the reticulation system to the Elevated Reservoir. When the pumps are not in operation the water is gravity fed from the Elevated Reservoir back into the reticulation system.

Sampling locations are sited at key points determined to provide the best indication of chlorine residual levels in the system. Samples are also taken as water leaves the reservoir. Chlorine residuals in the network are sampled and tested on-site weekly. Raw and treated water samples are sent regularly to the Queensland Health Laboratory for chemical analysis. Raw and treated water samples are sent regularly to the Qld Health Laboratory for biological testing.

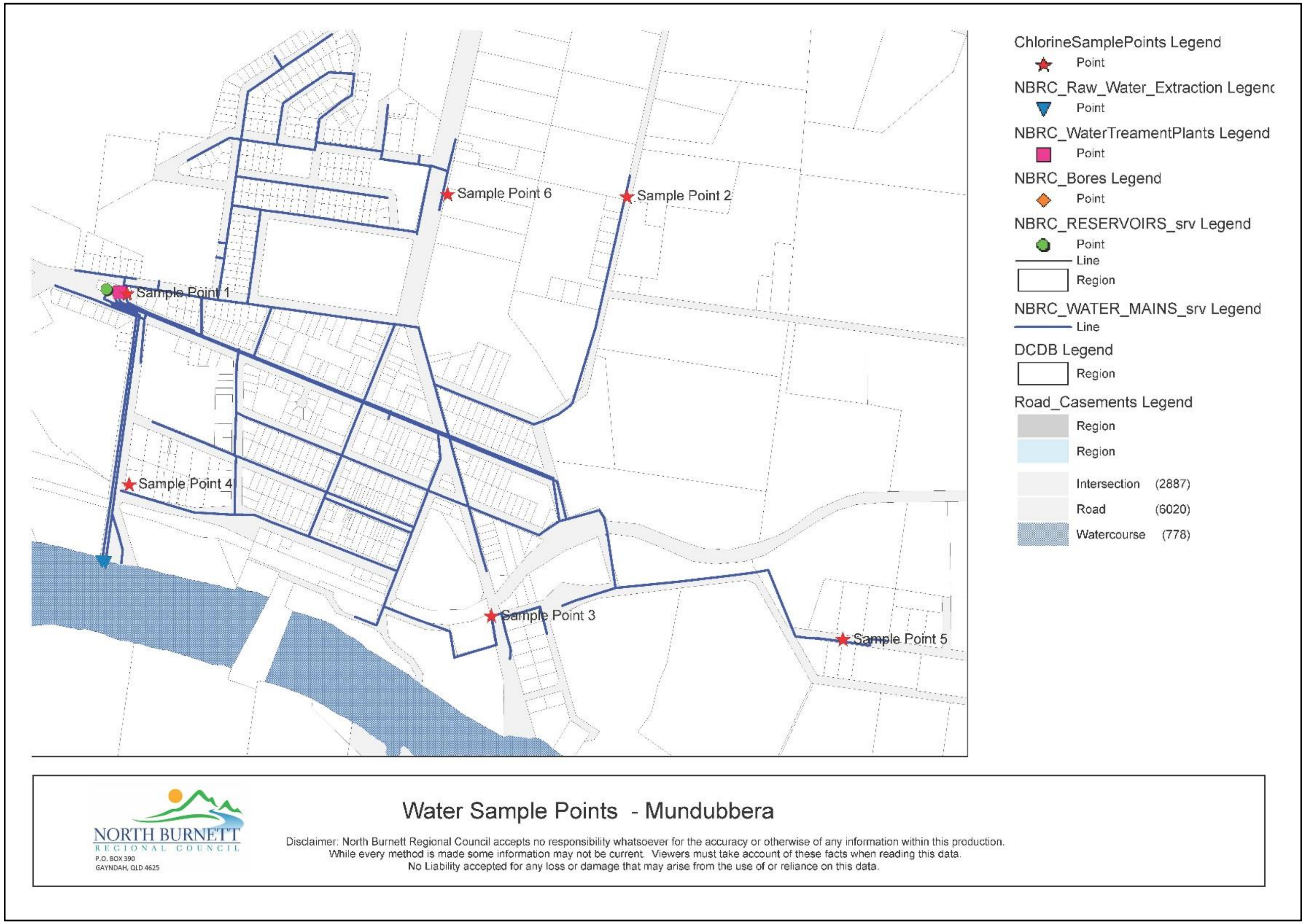


Figure 11-2 Mundubbera Water Supply Network

Table 11-1 Infrastructure Details – Mundubbera Water Supply Scheme

Component		Scheme
Sources	Name	Burnett River
	Type	Submerged river intakes, upstream of Jones Weir
	% of supply	100%
	Reliability	Reliable flow though intake structure. Prone to flood damage under extreme flood events
	Water quality issues	hardness, iron, manganese
Sourcing Infrastructure	Type	Pumped
	Description	2 x submersible centrifugal pumps
Are there any sources that **do not** undergo treatment prior to supply?	No	
Mundubbera WTP	Name	Mundubbera WTP
	Process	Aquagenics Plant which includes clarification, filtration, pH adjustment activated carbon treatment
	Design Capacity (20 hr operation)	36L/s
	Daily flow range	0.5 – 1.2 ML/d
	Chemicals added	Poly, ACH, caustic, sodium hypochlorite
	Standby chemical dosing facilities (Y/N)	Y
	Water sourced from and %	River 100%
	% of average day demand provided	100%
	% of scheme supply Distribution area supplied	100%
	Bypasses / Variations	No
Disinfection	Location	Between clarifier and sand filter

Component		Scheme
	Type	Liquid sodium hypochlorite via dosing pump
	Dose rate	Controlled by in-line analyser
	Target residual levels	0.5 mg/l
	Duty/standby	Y
	Dosing arrangements	fixed
	Alarms	Nil
	Auto shut-off arrangements	Nil
Distribution and Reticulation System	Pipe material	AC
	Age range	60 – 65 years
	Approx % of total length	80%
	Pipe material	PVC
	Age range	5 – 15 years
	Approx % of total length	20%
	Areas where potential long detention periods could be expected	No
	Areas where low water pressure (e.g. < 12 m) could be expected during peak or other demand periods)	No
Reservoirs	Name	Ground Level Reservoir 1
	Capacity (ML)	2.8ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y
	Name	Ground Reservoir

Component		Scheme
	Capacity (ML)	0.680ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y
	Name	Elevated Reservoir
	Capacity (ML)	0.455ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

11.2 Mundubbera Water Quality: Identifying Hazards and Hazardous Events

Water quality information has been collected by NBRC for raw water, treated water and reticulated supply for the period of January 2010 to November 2018. Analysis of this data has been completed to assess the results in comparison to the ADWG guideline values for parameters measured. It is noted that no SunWater water quality data was reviewed for raw water

A summary of the water analysis undertaken for the Mundubbera Water Supply Scheme is contained in Table 11-2, Table 11-3, Table 11-4 and Table 11-5. Section 11.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

The reticulated water scheme has been measured for pH, residual chlorine, *E. coli* and total coliforms.

Interpretation

Over the period of testing there has been a high rate of sampling for Mundubbera with approximately 3 tests per month for raw water and treated water, and 11.5 tests per month for the reticulated system.

Within the raw water sampling turbidity, iron, manganese, and aluminium are higher than the drinking water guideline values but tend to decrease from 2013 onwards.

For sampling data taken from the Mundubbera WTP, turbidity, iron, and aluminium also exceeded the drinking water guideline levels.

Within the reticulation system, pH fell below 9.5 in October 2010. There were 23 occurrences when residual chlorine fell below the ADWG recommended value, though no total coliforms or *E. coli* were detected. There were potential water quality issues within the reticulation system due to low levels of residual chlorine and total coliforms being detected. Increased frequency of sampling and testing, and operational response, has since reduced this risk.

Table 11-2 Mundubbera Raw Water Source

Mundubbera Source - Burnett River							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Turbidity (NTU)	River	January 2010 – Nov 2018	345	456	34.8	<1.0	
Fluoride	River	January 2010 – Nov 2018	345	0.60	0.17	0.05	Multiple limits of detection were used (<0.1, <0.2 and <0.25). To calculate the stats, the absolute values were used.
Nitrate	River	January 2010 – Nov 2018	345	5.00	0.93	0.50	Multiple limits of detection were used (<0.5 to <5). To calculate the stats, the absolute values were used.
Sulfate	River	January 2010 – Nov 2018	345	80.0	26.1	1.6	
Dissolved metals							
Aluminium	River	January 2010 – Nov 2018	345	2.2	0.1	<0.05	
Boron	River	January 2010 – Nov 2018	345	0.14	0.06	0.02	
Copper	River	January 2010 – Nov 2018	345	0.43	0.04	<0.03	
Iron	River	January 2010 – Nov 2018	345	1.30	0.08	<0.01	
Manganese	River	January 2010 – Nov 2018	345	7.0	0.08	<0.01	
Zinc	River	January 2010 – Nov 2018	345	0.56	0.02	<0.01	
Total metals							
Aluminium	115 Leichhardt Street	April 2018 – October 2018	2	0.7	0.59	0.48	

Mundubbera Source - Burnett River							
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples	Summary of Results			Comments
				Maximum Value	Average Value	Minimum Value	
Arsenic	115 Leichhardt Street	April 2018 – October 2018	2	0.0018	0.0015	0.0012	
Cadmium	115 Leichhardt Street	April 2018 – October 2018	2	<0.0001	<0.0001	<0.0001	All samples taken were <0.0001 mg/L
Chromium	115 Leichhardt Street	April 2018 – October 2018	2	0.001	0.0009	0.0008	
Copper	115 Leichhardt Street	April 2018 – October 2018	2	0.02	0.013	0.006	
Iron	115 Leichhardt Street	April 2018 – October 2018	2	1.2	1.06	0.93	
Lead	115 Leichhardt Street	April 2018 – October 2018	2	0.013	0.0068	0.0007	
Manganese	115 Leichhardt Street	April 2018 – October 2018	2	0.45	0.26	0.074	
Nickel	115 Leichhardt Street	April 2018 – October 2018	2	0.004	0.003	0.002	
Zinc	115 Leichhardt Street	April 2018 – October 2018	2	0.002	0.013	0.006	

Table 11-3 Mundubbera Treated Water

Plant	Mundubbera WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Turbidity (NTU)	Reservoir	January 2010 – Nov 2018	374	162	2.3	<1.0	5	7	Aesthetic guideline only Exceedances occurred in: • Jan, Mar, Oct 2010 • Jan, Sept 2011 • Feb, Nov 2012
Fluoride	Reservoir	January 2010 – Nov 2018	374	0.6	0.2	0.08	1.5	0	Multiple limits of detection were used (<0.1, <0.2 and <0.25). To calculate the stats, the absolute values were used.
Nitrate	Reservoir	January 2010 – Nov 2018	373	5.0	0.98	0.15	50	0	Aesthetic guideline only Multiple limits of detection were used (<0.5 to <5). To calculate the stats, the absolute values were used.
Sulfate	Reservoir	January 2010 – Nov 2018	374	216	26	1.1	250	0	Aesthetic guideline only
Dissolved metals									

Plant	Mundubbera WTP								
Parameter (mg/L unless otherwise specified)	**Sampling location(s)**	**Time Period**	**No of samples taken in time period**	**Summary of results**			**Australian Drinking Water Guidelines guideline value for health unless otherwise specified**	**No of samples exceeding Australian Drinking Water Guidelines guideline value**	**Comment**
				Maximum Value	**Average Value**	**Minimum Value**			
Aluminium	Reservoir	January 2010 – Nov 2018	374	2.0	0.06	<0.05	0.1	2	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable Exceedances occurred in Oct 2010 and Nov 2012
Boron	Reservoir	January 2010 – Nov 2018	374	0.19	0.06	0.02	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L
Copper	Reservoir	January 2010 – Nov 2018	374	0.72	0.08	<0.03	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	Reservoir	January 2010 – Nov 2018	374	1.00	0.02	<0.01	0.3	2	Aesthetic guideline only Exceedances occurred in Oct 2010 and Nov 2012
Manganese	Reservoir	January 2010 – Nov 2018	374	0.04	0.01	<0.01	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Zinc	Reservoir	January 2010 – Nov 2018	374	0.65	0.02	<0.01	3	0	
Total metals									

Plant	Mundubbera WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Aluminium	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.081	0.038	0.013	0.2	0	Aesthetic guideline only
Arsenic	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.0007	0.0004	0.0003	0.01	0	
Cadmium	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L
Chromium	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.0002	0.0001	<0.0001	0.05	0	
Copper	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.068	0.05	0.035	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.1	0.046	0.019	0.3	0	Aesthetic guideline only
Lead	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.0018	0.0007	0.00004	0.01	0	
Manganese	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.013	0.0057	0.0013	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value

Plant	Mundubbera WTP								
Parameter (mg/L unless otherwise specified)	Sampling location(s)	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Nickel	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.0006	0.0005	0.0004	0.02	0	
Zinc	115 Leichhardt/Jack Parr Street	April 2018 – October 2018	3	0.014	0.009	0.006	3	0	Aesthetic guideline only

Table 11-4 Mundubbera Reticulated Water

Scheme	Mundubbera Reticulated Water							
Sampling Location								
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
pH (pH units)	January 2010 – Nov 2018	374	8.3	7.4	6.2	6.5 - 8.5	1	Aesthetic guideline only pH <6.5 occurred in Oct 2010

Scheme / Sampling Location	Mundubbera Reticulated Water						
Parameter (mg/L unless otherwise specified)	Time Period	No of samples	Summary of Results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
			Maximum Value	Average Value	Minimum Value			
Disinfectant residual	July 2016 – Nov 2018	302	3.2	1.5	0	>0.2 - 0.5	23	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition Chlorine residual <0.2 mg/L occurred in Jul, Aug, Oct and Nov 2017
Total coliform (mpn/100mL)	July 2016 – Nov 2018	311	2	0.006	0	NA	NA	Improved sampling and response have reduced risk
E. coli (CFU/100ml)	July 2016 – Nov 2018	311	0	0	0	None Detected	0	
Trihalomethanes	Sept 2016 –Jun 2018	17	0.37	0.22	0.012	0.25	5	Exceedance in April 2018 and May 2018

Table 11-5 Mundubbera Water Quality Complaints

Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
1-7-2010 to 26-10-2018	0	0			

11.3 Mundubbera Catchment Characteristics

The water source for the Mundubbera Township is taken from Jones Weir built over the Burnett River and located on the southern edge of town.

Influences on the water quality are numerous as approximately nine kilometres upstream from the weir is the confluence of the Boyne and Auburn rivers with the Burnett. Catchments of the three rivers are from mostly hilly to undulating topography with agricultural industry consisting of large areas of grazing on both improved and unimproved pasture, fodder cropping, cereal cropping, pecan, mango, forestry, National Parks, citrus and stone fruit orchards and the largest table grape growing industry in the state.

Dependant on rainfall in any area of the 23,000 km² catchment, the natural water quality can change rapidly making water treatment a continuously challenging process.

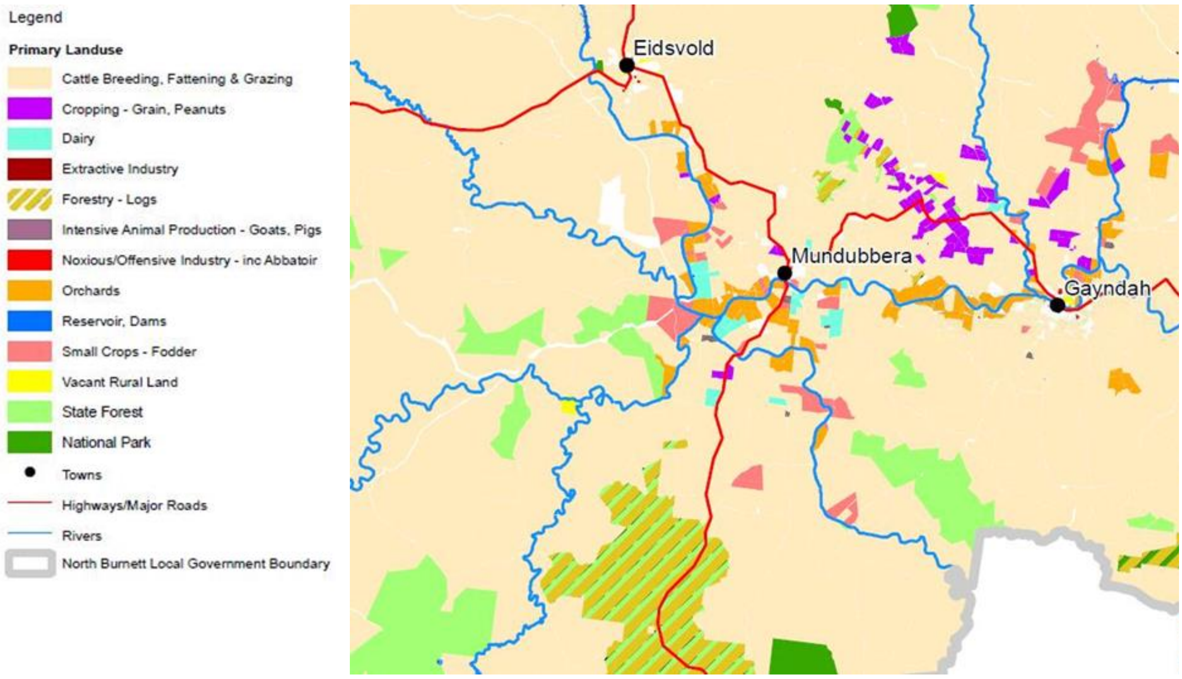


Figure 11-3 Mundubbera Catchment Area

11.4 Mundubbera Hazard Identification, Risk Assessment and Uncertainty

Table 11-6 Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. Coagulation, clarification, and dual filtration followed by disinfection	Catastrophic	Rare	Medium (6)	Uncertain	Treatment systems are robust	
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. Coagulation, clarification, and dual filtration followed by disinfection 2. Catchment group education programs	Catastrophic	Rare	Medium (6)	Treatment seen and shown as effective	Treatment systems are robust	
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metal and other chemicals in water	Major	Unlikely	Medium (8)	1. Treatment processes, flocculation, clarifier, oxidisation, and filtration	Major	Rare	Medium (5)	Confident	Existing measures are robust. Annual monitoring and testing of source water is undertaken	
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Minor	Possible	Medium (6)	1. Treatment processes, flocculation, clarifier, oxidisation, and filtration	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. Treatment processes, flocculation, clarifier, oxidisation, and filtration	Moderate	Rare	Low (3)	Confident	Existing measures are robust	
6	Source water	Chemical contamination	1. Accidental spills	Moderate	Rare	Low (3)	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert)	Insignificant	Rare	Low (1)	Uncertain	Small concentration. Only risk of any real consequence would be a chemical spill near the intake Inability to predict type or consistency of possible spill?	
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	Moderate	Possible	Medium (9)	1. Catchment group education programs 2. Treatment processes – clarifier, flocculants, sand filters 3. Public notification process (boil water alert)	Moderate	Rare	Low (3)	Confident	Occasional flooding of Burnett, Boyne and Auburn Rivers can't be avoided.	
8	Source water	Lack of supply	1. Inadequate maintenance 2. Power Failure 3. Damage to river intake structure pipework and pumps caused by flood waters 4. Blockage of intake structure	Moderate	Unlikely	Medium (6)	1. Estimated one week's supply of treated water in reservoirs. 2. Standby pump installed 3. Option: Audit of all pumps has been carried out and one spare pump for each make and model will be purchased.	Insignificant	Unlikely	Low (2)	Confident	Existing measures are robust	
9	Source water	Lack of supply	1. Climatic variations	Moderate	Unlikely	Medium (6)	1. Importing water	Minor	Rare	Low (2)	Uncertain	Inability to predict when it will rain next	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
							2. Drought management Plan actions: restrictions, communication etc.						
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	Major	Possible	High (12)	1. Treatment processes and Chlorine disinfection post filters and leaving Ground reservoir 2. Chlorine levels are tested once per day. 3. Injection pump and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing 7. Regular cleaning and maintenance of process equipment **Mundubbera 2018-01:** Changes to flow are manually conducted seasonally and chemical dosing is adjusted accordingly	Major	Rare	Medium (5)	Uncertain	Online chlorine analyser installed and alarmed to SCADA and linked to plant shut down.	
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff error 4. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Treatment processes, flocculation, clarifier, oxidisation 3. Chemical injection levels are tested once per day. 4. Dosing equipment is checked once per day. 5. Trained and qualified operators – good housekeeping	Catastrophic	Rare	Medium (6)	Uncertain	Inability to detect contamination in the treatment process Raw and treated water monitoring program was reviewed to ensure its efficacy in providing sufficient data to provide confidence in the risk categorisations	Seek funding to install UV unit to meet HBTs.
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure. 2. Loss of Chemical supplies 3. Communication Breakdown (alarms) 4. Staff error	Moderate	Unlikely	Medium (6)	1. Treatment processes, flocculation, clarifier, oxidisation and filtration 2. Chemical injection levels are tested once per day. 3. Dosing equipment is checked once per day. 4. Trained and qualified operators 5. On-line analyser installed and alarmed to SCADA.	Moderate	Rare	Low (3)	Uncertain	Chlorine injection is triggered by raw water pump start. There is a possibility that pump failure could result in continued chlorine injection. Once pumping re-starts this pool will be carried forward through the reticulation system causing possible overdose.	
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	Major	Rare	Medium (5)	1. Degeneration of sodium hypochlorite unlikely due to relatively small storage capacity which requires monthly refilling. 2. Staff aware of potential issues and refill fortnightly if possible 3. **Mundubbera 2018-02:** THM monitoring occurs monthly	Major	Rare	Medium (5)	Confident	THM monitoring have commenced. All results are below ADWG limits.	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of Manganese or turbidity. 4. Communication Breakdown 5. Staff error	Minor	Likely	Medium (8)	1. Treatment processes, flocculation, clarifier, oxidisation, filtration 2. Operation of filters and clarifier monitored daily. 3. Trained and qualified operators – good housekeeping	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	
15	Treatment	Ground reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	Moderate	Unlikely	Medium (6)	1. Estimated one day of treated water supply in high tower reservoir. 2. Standby pump installed. 3. Mobile back-up generator located at Works Depot.	Moderate	Rare	Low (3)	Confident	Existing measures are robust	

11.5 Mundubbera Risk Management Measures

Table 11-7 Mundubbera Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	1. Coagulation, clarification, and dual filtration followed by disinfection	Likelihood	Unknown	Medium (6)	Yes		
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	1. Coagulation, clarification, and dual filtration followed by disinfection 2. Catchment group education programs	Likelihood	Unknown	Medium (6)	Yes		
3	Source water	Chemical contamination • Heavy metals: Arsenic	1. Natural arsenic and other chemicals in water	1. Treatment processes, flocculation, clarifier, oxidisation, and filtration	Likelihood	Unknown	Medium (5)	Yes		
4	Source water	Chemical contamination • Nutrients: Nitrate	1. Pesticides and Fertilisers	1. Treatment processes, flocculation, clarifier, oxidisation, and filtration	Likelihood	Unknown	Low (4)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
		• Anions: Sulphate, Fluoride	2. Natural occurrences of anions							
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	1. Treatment processes, flocculation, clarifier, oxidisation, and filtration	Likelihood	Unknown	Low (3)	Yes		
6	Source water	Chemical contamination	1. Accidental spills	1. Detection and dilution during treatment processes and storage 2. Emergency response 3. Public notification process (do not drink alert)	Consequence	Unknown	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	1. Catchment group education programs 2. Treatment processes – clarifier, flocculants, sand filters 3. Public notification process (boil water alert)	Likelihood	Unknown	Low (3)	Yes		
8	Source water	Lack of supply	1. Inadequate maintenance 2. Power failure	1. Estimated one week's supply of treated water in reservoirs.	Likelihood	Effective backups and history	Low (2)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
			3. Damage to river intake structure pipework and pumps caused by flood waters 4. Blockage of intake structure	2. Standby pump installed 3. Option: Audit of all pumps has been carried out and one spare pump for each make and model will be purchased.						
9	Source water	Lack of supply	1. Climatic variations	1. Importing water 2. Drought management Plan actions: restrictions, communication etc.	Likelihood & Consequence	Effective- reliable supply	Low (2)	Yes		
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	1. Treatment processes and Chlorine disinfection post filters and leaving Ground reservoir 2. Chlorine levels are tested once per day. 3. Injection pump and chlorine supply are also checked and inspected at the same time. 4. Public notification process (boil water alert) 5. Trained and qualified operators – good housekeeping 6. Security and vermin-proofing	Likelihood	Effective –online analysers provide updated chlorine levels.	Medium (5)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
				7. Regular cleaning and maintenance of process equipment **Mundubbera 2018-01:** Changes to flow are manually conducted seasonally and chemical dosing is adjusted accordingly						
11	Treatment	Biological contamination • Protozoa	1. Cross contamination 2. Vermin and bird access 3. Staff Error 4. Plant Design	1. Security and vermin-proofing 2. Treatment processes, flocculation, clarifier, oxidisation 3. Chemical injection levels are tested once per day. 4. Dosing equipment is checked once per day. 5. Trained and qualified operators – good housekeeping	No	Inability to detect contamination in the treatment process	Medium (6)	Yes	Seek funding to install UV unit .	Water and Wastewater
12	Treatment	Chemical contamination	1. Chemical overdose due to equipment failure. 2. Loss of Chemical supplies	1. Treatment processes, flocculation, clarifier, oxidisation and filtration 2. Chemical injection levels are tested once per day. 3. Dosing equipment is checked once per day.	Likelihood	Effective- based on there being no instance of overdose yet.	Low (3)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
			3. Communication Breakdown (alarms) 4. Staff error	4. Trained and qualified operators 5. On-line analyser installed and alarmed to SCADA.						
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2.. Plant Design	1. Degeneration of sodium hypochlorite unlikely due to relatively small storage capacity which requires monthly refilling. 2. Staff aware of potential issues and refill fortnightly if possible 3. Mundubbera 2018-02: THM monitoring occurs monthly	No	No THM exceedances recorded in treated water	Medium (5)	Yes		
14	Treatment	Physical/chemical contamination • Turbidity • Manganese • Particulates	1. Failure of back-wash of sand filters 2. Failure of dosing equipment or clarifier. 3. High levels of Manganese or turbidity.	1. Treatment processes, flocculation, clarifier, oxidisation, filtration 2. Operation of filters and clarifier monitored daily. 3. Trained and qualified operators – good housekeeping	Likelihood	Effective – based on water quality testing	Low (4)	Yes		

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
			4. Communication Breakdown 5. Staff error							
15	Treatment	Clearwater reservoir pump failure	1. Inadequate maintenance/lack of standby pumps 2. Communication Breakdown	1. Estimated one day of treated water supply in high tower reservoir. 2. Standby pump installed. 3. Mobile back-up generator located at Works Depot.	Likelihood	Effective- multiple backups	Low (3)	Yes		
16	Treatment	Substandard chemicals	1. Inappropriate chemical storage or defective batch	1. Coagulation, clarification, and dual filtration followed by disinfection	Consequence	Moderately effective- based on treatment results	Low (1)	Yes		

11.6 Mundubbera Risk Management Improvement Program

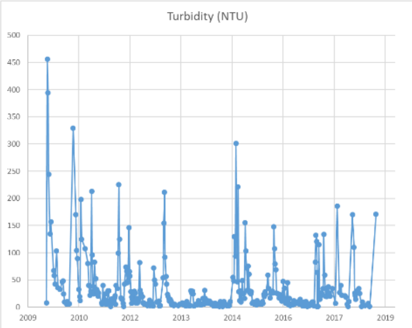
Table 11-8 Mundubbera Risk Improvement Program

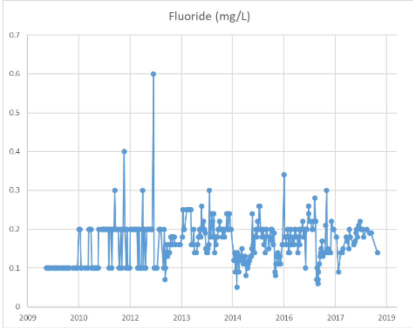
Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
11	Treatment	Biological contamination • Protozoa	Medium			Seek funding for installation of a UV unit	30/12/2025	$100k EACH $15k OP	Water and Wastewater

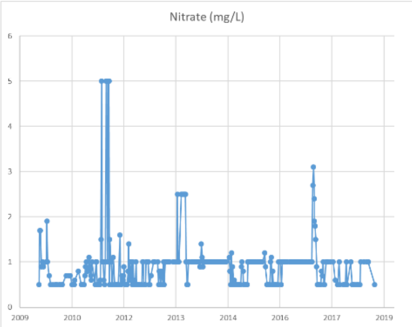
11.7 Mundubbera Water Scheme Water Quality Data

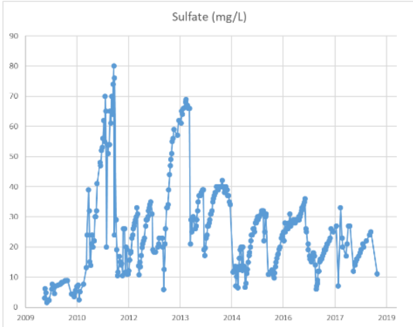
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

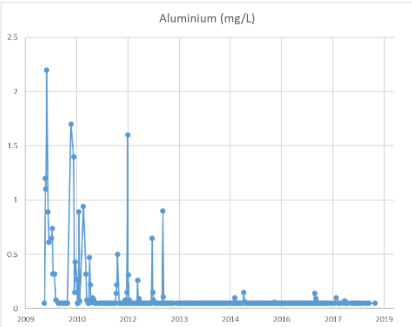
Mundubbera untreated bore water 2010-2018

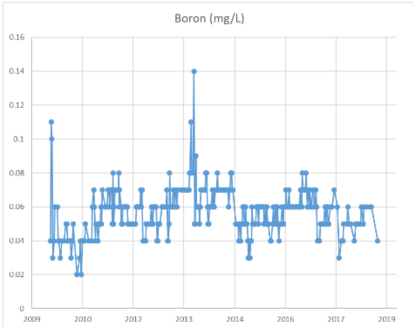


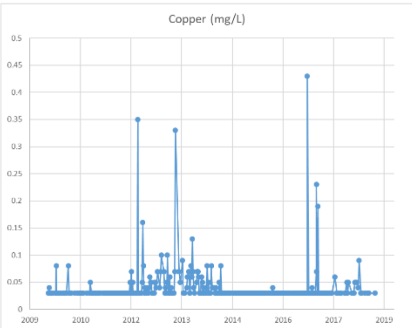


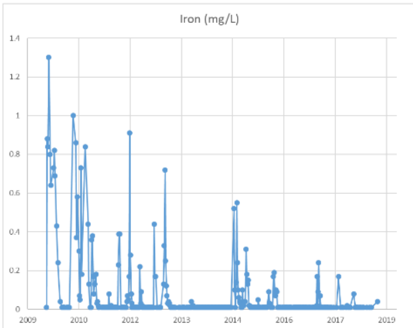


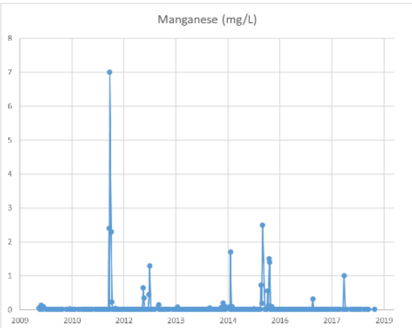


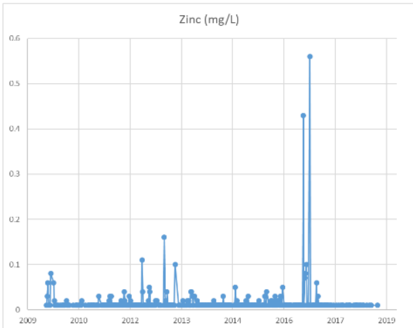




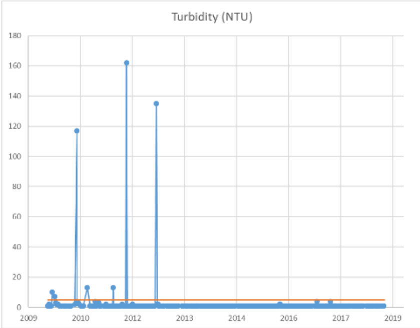


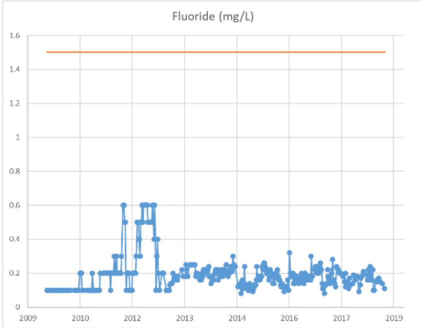


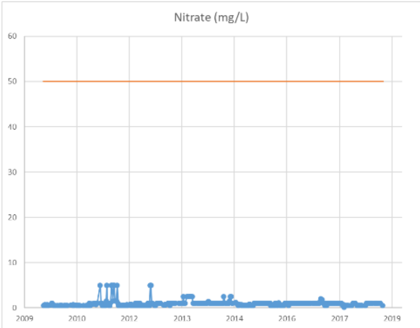


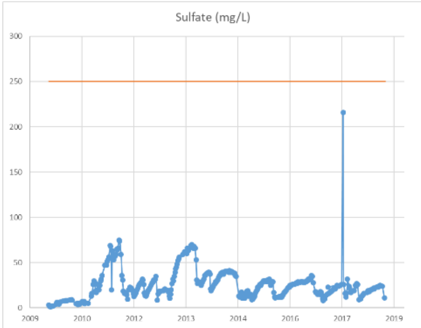


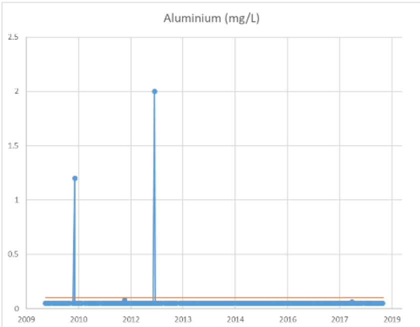
Mundubbera treated water 2010-2018

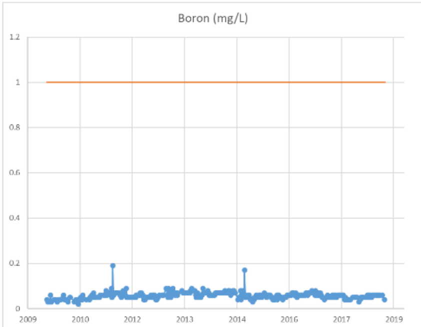


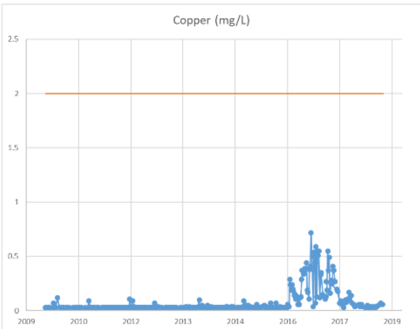


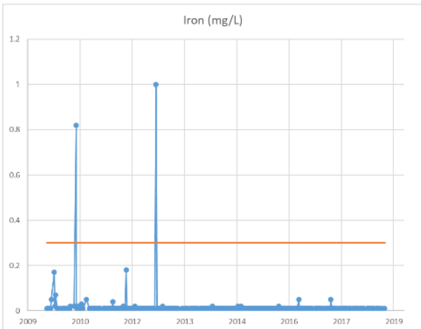


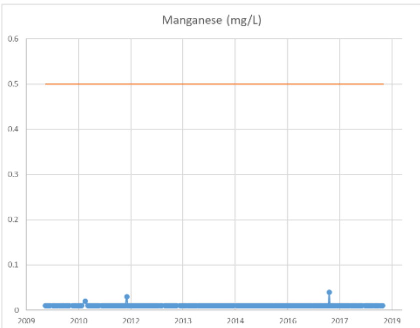


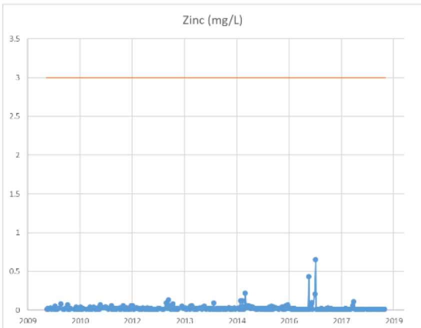












12. PARADISE DAM CARAVAN PARK WATER SUPPLY SCHEME

12.1 Details of Infrastructure for Providing the Service

Source Water

Paradise Dam Water Supply Scheme provides potable water to the Caravan Park and campgrounds,.

Source water at Paradise Dam is the Burnett River adjacent to the campgrounds at the base of the Paradise Dam wall. The intake infrastructure consists of a submersible pump on floating pontoon secured in place. A 50mm PE pipe supplies the WTP from this pump.

During flood events, the raw water quality can be highly turbid and coloured, and the treatment plant does not have the capacity to treat this. During these times, water extraction from the Burnett River is suspended and potable water is carted in by a certified water carrier. This water is put through the WTP and re-treated prior to supply into the reticulation if a certified carrier is not available.

Treatment Process

The raw water is pumped to the treatment plant The designed flow rate to the WTP is 72 kL/d. The treatment plant can process a continuous maximum supply of 1L/s, subject to raw water quality parameters falling within acceptable range. Paradise Dam's average usage is approximately 4kL/d.

This plant consists of a raw water tank, a settled water tank, a sand filter, a carbon filter, two bag filters (25 micron and 5 micron) and a clearwater storage tank. ACH is dosed prior to the raw water tank and sodium hypochlorite is dosed prior to the clearwater storage tank. Pumping of water through the treatment plant is triggered by the floats in each of the tanks reaching a set low water level. Once each tank reaches the set high water level, the float triggers a switch that stops the pumps. A schematic of the plant is shown in Figure 12-1.

Due to the low water usage at this site, raw water tank has sufficient residence time for the flocs to settle out.

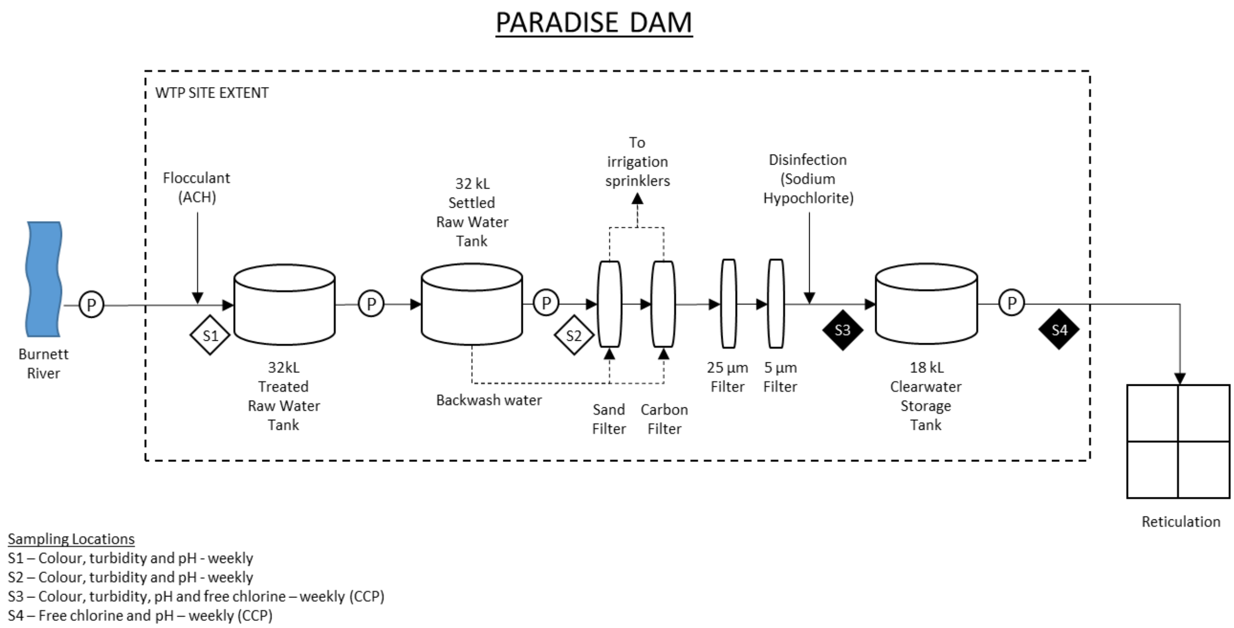


Figure 12-1 Paradise Dam WTP Schematic

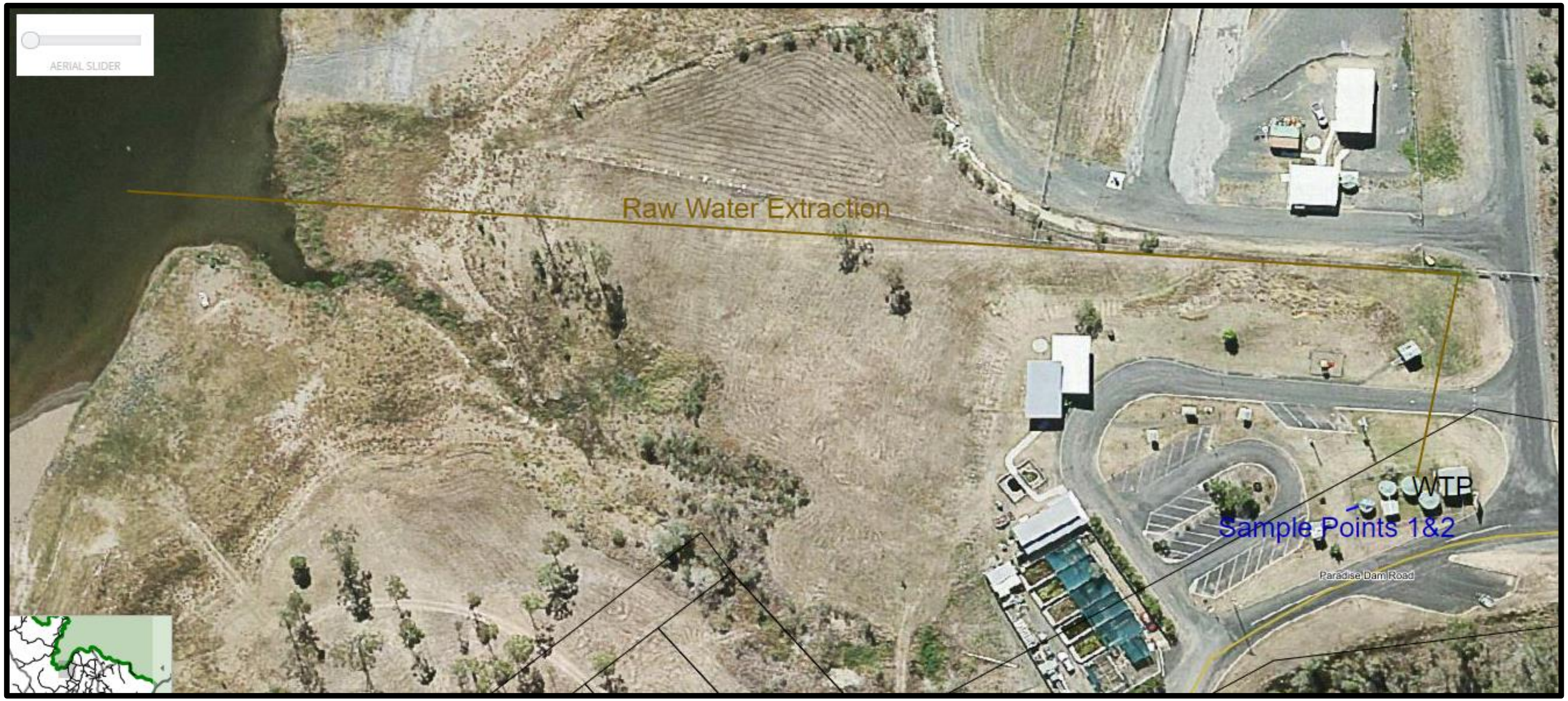


Figure 12-2 Paradise Dam Water Supply Map

Table 12-1 Infrastructure Details – Paradise Dam Water Supply Scheme

Component		Scheme
Sources	Name	Burnett River
	Type	River
	% of supply	100%
	Reliability	High
	Water quality issues	Turbidity, colour and high pH
Sourcing Infrastructure	Type	Pumped
	Description	Pump Capacity = 1 L/s at 40m head Davey Pump 1.1kW submersible bore pump Installed = Nov 2013
	Ownership	NBRC
Are there any sources that **do not** undergo treatment prior to supply?	No	
Paradise Dam WTP	Name	Paradise Dam WTP
	Process	Coagulation, clarification, sand filtration, carbon filtration, bag filtration, chlorination
	Design Capacity (20 hr operation)	72 kL/d
	Daily flow range	4 kL/d
	Chemicals added	Sodium hypochlorite ACH
	Standby chemical dosing facilities (Y/N)	N
	Water sourced from and %	River 100%
	% of average day demand provided	100%

Component		Scheme
	% of scheme supply Distribution area supplied	100%
	Bypasses / Variations	No
Disinfection	Location	Reservoir
	Type	Liquid sodium hypochlorite via Grunfos dosing pump
	Dose rate	0.9 – 1.5 L/h
	Target residual levels	0.5 mg/L
	Duty/standby	No
	Dosing arrangements	Fixed
	Alarms	Nil
	Auto shut-off arrangements	Nil
Reservoir	Name	Ground Reservoir
	Capacity (ML)	0.018 ML
	Roofed (Y/N)	Y
	Vermin-proof (Y/N)	Y
	Runoff directed off roof (Y/N)	Y

12.2 Paradise Dam Quality: Identifying Hazards and Hazardous Events

Water quality information has been collected by NBRC for raw water and treated water since January 2016 and data summarised here includes results up to October 2018. Analysis of this data has been completed to assess the results in comparison to the ADWG guideline values for parameters measured. It is noted that no SunWater water quality data was reviewed for raw water.

A summary of the water analysis undertaken for the Paradise Dam Caravan Park Water Supply Scheme is contained in Table 12-2, Table 12-3 and

Table 12-4. Section 12.7 includes graphs of sampling data.

For raw water and treated water the following parameters have been measured monthly:

- Conductivity
- pH
- Total & temporary hardness
- Alkalinity (including residual)
- Silica
- Total dissolved ions
- Total dissolved solids
- True colour
- Turbidity
- Saturation index
- Chlorine residual
- Total coliform
- *E. coli*
- Mole ratio
- Sodium absorption ratio
- Figure of merit ratio
- Cations (sodium, potassium, calcium, magnesium, and hydrogen)
- Anions (bicarbonate, carbonate, hydroxide, chloride, fluoride, nitrate, sulphate)
- Dissolved metals (iron, manganese, zinc, boron, copper, aluminium)
- Total metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc)
- THM

Interpretation

Over the period of testing, the approximate frequency of sampling for Paradise Dam is once a month for both raw water and for treated water.

For samples taken from the Paradise Dam WTP, there has been no occurrences of any parameters exceeding the guideline value.

Table 12-2 Paradise Dam Raw Water Source

Paradise Dam – raw water							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time period**	**No of samples**	**Summary of results**			**Comments**
				Maximum value	**Average value**	**Minimum value**	
Turbidity (NTU)	River	Feb 2015 – Sep 2018	28	69	15.17	1	
Fluoride	River	Feb 2015 – Sep 2018	28	56	2.11	0.08	
Nitrate	River	Feb 2015 – Sep 2018	28	1.8	0.76	0.5	
Sulfate	River	Feb 2015 – Sep 2018	28	11	8.66	6	
pH (pH units)	River	Feb 2016 – Oct 2018	22	8.0	7.6	7.1	
Total coliform (mpn/100mL)	River	Feb 2016 – Oct 2018	24	>2400	1453	110	
E. coli (mpn/100mL)	River	Feb 2016 – Oct 2018	24	5	1.3	0	
Dissolved metals							
Aluminium	River	Feb 2015 – Sep 2018	28	0.27	0.08	0.05	
Boron	River	Feb 2015 – Sep 2018	28	0.05	0.03	0.03	
Copper	River	Feb 2015 – Sep 2018	28	<0.03	<0.03	<0.03	All values below limit of reporting
Iron	River	Feb 2015 – Sep 2018	28	0.26	0.06	0.01	
Manganese	River	Feb 2015 – Sep 2018	28	0.1	0.01	0.01	
Zinc	River	Feb 2015 – Sep 2018	28	0.51	0.03	0.01	
Total metals							

Paradise Dam – raw water							
Parameter (mg/L unless otherwise specified)	**Sampling location**	**Time period**	**No of samples**	**Summary of results**			**Comments**
				Maximum value	**Average value**	**Minimum value**	
Aluminium	Raw water tank tap	Nov 2017 – Oct 2018	5	1.7	0.42	0.004	
Arsenic	Raw water tank tap	Nov 2017 – Oct 2018	5	0.0022	0.0014	0.0002	
Cadmium	Raw water tank tap	Nov 2017 – Oct 2018	5	<0.0001	<0.0001	<0.0001	All samples taken were <0.0001 mg/L
Chromium	Raw water tank tap	Nov 2017 – Oct 2018	5	0.0016	0.0005	<0.0001	
Copper	Raw water tank tap	Nov 2017 – Oct 2018	5	0.011	0.0062	<0.001	
Iron	Raw water tank tap	Nov 2017 – Oct 2018	5	1.9	0.52	<0.005	
Lead	Raw water tank tap	Nov 2017 – Oct 2018	5	0.0011	0.0004	<0.0001	
Manganese	Raw water tank tap	Nov 2017 – Oct 2018	5	0.052	0.029	0.0008	
Nickel	Raw water tank tap	Nov 2017 – Oct 2018	5	0.003	0.0015	0.0005	
Zinc	Raw water tank tap	Nov 2017 – Oct 2018	5	0.013	0.0076	0.001	

Table 12-3 Paradise Dam Treated Water

Plant	Paradise Dam – Treated Water								
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Turbidity (NTU)	WTP	Feb 2015 – Sep 2018	28	<1	<1	<1	5	0	Aesthetic guideline only All values below limit of reporting (<1)
Fluoride	WTP	Feb 2015 – Sep 2018	28	0.16	0.08	0.05	1.5	0	
Nitrate	WTP	Feb 2015 – Sep 2018	28	2	0.68	0.05	50	0	Aesthetic guideline only
Sulfate	WTP	Feb 2015 – Sep 2018	28	10.4	8.14	6	250	0	Aesthetic guideline only
pH (pH units)	WTP	Feb 2016 – Oct 2018	23	8.05	7.58	7.15	6.5-8.5	0	Aesthetic guideline only
Disinfection residual	WTP	Feb 2016 – Oct 2018	17	3.2	1.0	0.05	0.2 - 0.5	0	Guideline value is from the World Health Organization's Guidelines for Drinking-water Quality 4th edition
Total coliform (mpn/100mL)	WTP	Feb 2016 – Oct 2018	25	0	0	0	NA	NA	
E. coli (mpn/100mL)	WTP	Feb 2016 – Oct 2018	25	0	0	0	None detected	0	
Dissolved metals									
Aluminium	WTP	Feb 2015 – Sep 2018	28	<0.05	<0.05	<0.05	0.1	0	Although 0.2mg/L is the aesthetic guideline value, <0.1 mg/L is desirable All values below limit of reporting

Plant	Paradise Dam – Treated Water								
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Boron	WTP	Feb 2015 – Sep 2018	28	0.05	0.03	0.03	1	0	Although 4mg/L is the health guideline value, concentrations in uncontaminated sources is usually <1 mg/L Most samples below detection limit
Copper	WTP	Feb 2015 – Sep 2018	28	0.05	0.03	0.03	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	WTP	Feb 2015 – Sep 2018	28	0.01	0.01	0.01	0.3	0	Aesthetic guideline only 96% of values below limit of reporting
Manganese	WTP	Feb 2015 – Sep 2018	28	<0.01	<0.01	<0.01	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value All values below limit of reporting
Zinc	WTP	Feb 2015 – Sep 2018	28	0.53	0.03	0.03	3	0	
Total metals									
Aluminium	WTP tap	Nov 2017 – October 2018	5	0.043	0.03	0.011	0.2	0	Aesthetic guideline only
Arsenic	WTP tap	Nov 2017 – October 2018	5	0.0006	0.0005	0.0004	0.01	0	
Cadmium	WTP tap	Nov 2017 – October 2018	5	<0.0001	<0.0001	<0.0001	0.002	0	All samples were <0.0001 mg/L

Plant	Paradise Dam – Treated Water								
Parameter (mg/L unless otherwise specified)	Sampling location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value for health unless otherwise specified	No of samples exceeding Australian Drinking Water Guidelines guideline value	Comment
				Maximum Value	Average Value	Minimum Value			
Chromium	WTP tap	Nov 2017 – October 2018	5	<0.0001	<0.0001	<0.0001	0.05	0	All samples were <0.0001 mg/L
Copper	WTP tap	Nov 2017 – October 2018	5	0.003	0.0024	0.002	2 (1)	0	Number in brackets denotes the aesthetic guideline value
Iron	WTP tap	Nov 2017 – October 2018	5	0.016	0.0094	<0.005	0.3	0	Aesthetic guideline only
Lead	WTP tap	Nov 2017 – October 2018	5	0.0003	0.0002	<0.0001	0.01	0	
Manganese	WTP tap	Nov 2017 – October 2018	5	0.0012	0.0007	<0.0001	0.5 (0.1)	0	Number in brackets denotes the aesthetic guideline value
Nickel	WTP tap	Nov 2017 – October 2018	5	0.008	0.002	0.0007	0.02	0	
Zinc	WTP tap	Nov 2017 – October 2018	5	0.018	0.01	0.005	3	0	Aesthetic guideline only
Trihalomethanes	WTP tap	Jan 2018 – Oct 2018	4	0.21	0.13	0.071	0.25	0	

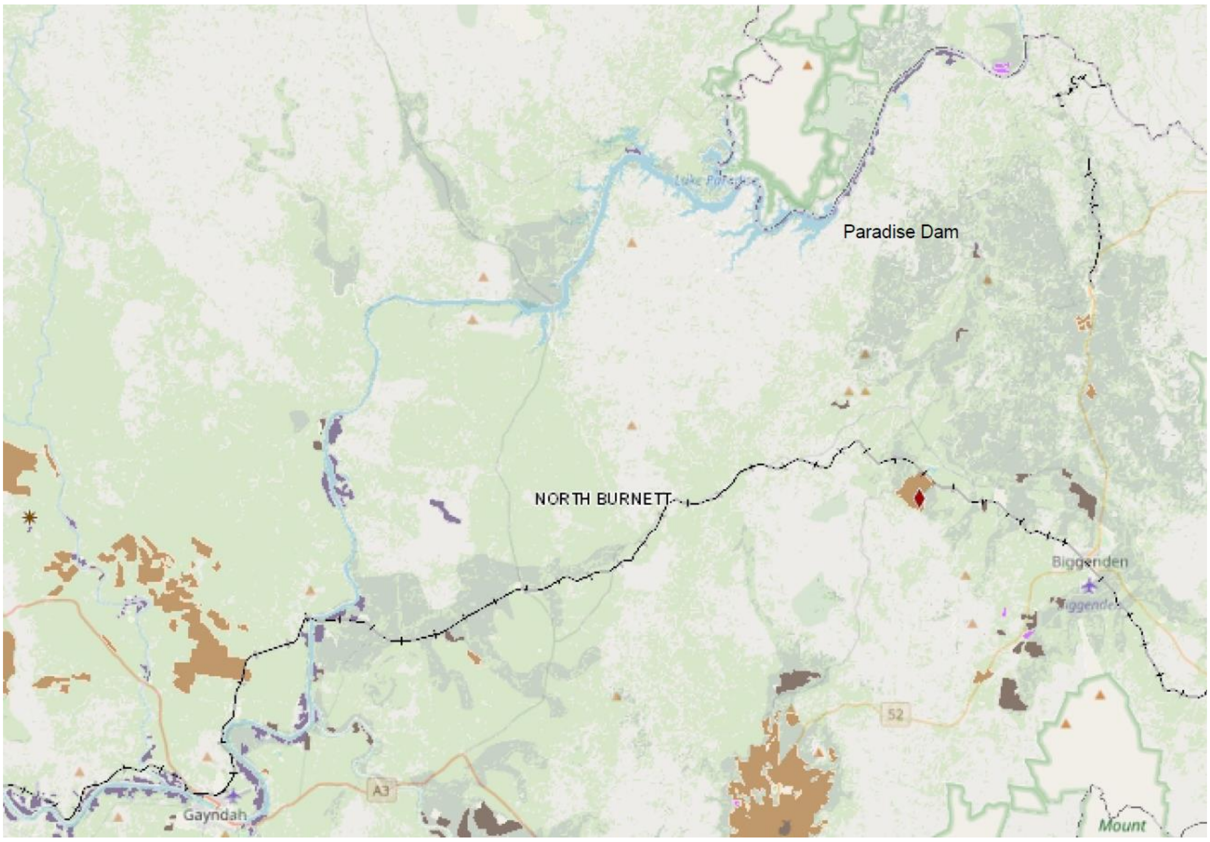
Table 12-4 Paradise Dam Water Quality Complaints

Year	No of Water Quality Complaints	Water Quality Complaints per 1000 Connections	Main Reasons for Complaints	Likely Sources / Causes of Problems	Resolution of Problem
20-1-2016 to 26-10-2018	0	0			

12.3 Paradise Dam Catchment Characteristics

The catchment for Paradise Dam's potable water source includes all the Burnett River and its tributaries to the north of the town. The topography of this large area includes hilly and undulating natural forest areas, river, and creek flats.

Land use within this area is varied and includes extensive irrigated citrus orchids, forestry, National Parks, cropping and cattle grazing. The citrus growing area extends primarily from the north of the town through to Mundubbera and continues along the Burnett to Eidsvold. Paradise Dam is thus downstream of most of the economic activity within the NBRC region.



Legend:

- Local government areas
- State electoral boundaries
- Livestock processing
  - export cattle abattoirs
  - egg processors
  - pig abattoir
  - poultry abattoirs
- Cotton gins
- Current sugar mills
- Airports
- Railways
- Current saw mills - plantation timber
- Current saw mills - native timber
- Current sheep feedlots
- Current poultry farms
- Current piggeries
- Current cattle feedlots
- Current land based aquaculture
- Current broadacre cropping
  - Cropping
  - Irrigated cropping
- Current annual horticulture
  - Intensive horticulture
  - Seasonal horticulture
  - Irrigated seasonal horticulture
- Current perennial horticulture
  - Perennial horticulture
  - Irrigated perennial horticulture

Figure 12-3 Paradise Catchment Area

12.4 Paradise Dam Hazard Identification, Risk Assessment and Uncertainty

Table 12-5 Paradise Dam Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	Catastrophic	Possible	High (15)	1. WTP process includes flocculation, clarification and filtration	Catastrophic	Unlikely	High (10)	Confident	Likelihood categories based on *E. coli* results from 2016. Based on available data, no *E. coli* detection has been experienced since 2015 (i.e. 'Rare' likelihood). However, this is only 2 years' worth of data and therefore, the likelihood was increased to 'Unlikely'. Water carting to site is available if water quality is not suitable.	Seek funding to install UV and SCADA/Close site
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	Catastrophic	Unlikely	High (10)	1. WTP process includes flocculation, some clarification, filtration, and chlorine disinfection.	Catastrophic	Rare	Medium (6)	Confident	Likelihood categories based on E. coli results from 2016. Based on available data, no E. coli detection has been experienced since 2015 (i.e. 'Rare' likelihood). However, this is only 2 years' worth of data and therefore, the likelihood was increased to 'Unlikely'. Water carting to site is available if water quality is not suitable.	Seek funding to install UV and SCADA/Close site
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	Moderate	Unlikely	Medium (6)	1. WTP process includes flocculation, some clarification, filtration.	Moderate	Rare	Low (3	Confident	Heavy metals and pesticides testing of the raw water at Paradise Dam commenced Nov 2017.	
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	Moderate	Unlikely	Medium (6)	1. WTP process includes flocculation, some clarification, filtration and chlorine disinfection.	Moderate	Rare	Low (3)	Confident	Based on monthly water quality data. No exceedances since 2016.	
5	Source water	Chemical contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	Moderate	Unlikely	Medium (6)	1. WTP process includes flocculation, some clarification, filtration and chlorine disinfection. 2. 3-monthly clean of all tanks or more frequently based on water quality results	Moderate	Rare	Low (3)	Confident	Based on monthly water quality data.	
6	Source water	Chemical contamination	1. Accidental spills	Moderate	Rare	Low (3)	1. WTP process includes flocculation, some clarification, filtration.	Insignificant	Rare	Low (1)	Uncertain	Small concentration. Only risk of any real consequence would be a chemical spill near the intake (ie fuel for boats, raw sewage leak from motor homes). Inability to predict type or consistency of possible spill.	
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	Minor	Possible	Medium (6)	1. WTP process includes flocculation, some clarification, filtration, and chlorine disinfection. 2. Water carting to site	Minor	Unlikely	Low (4)	Confident	Occasional flooding of Burnett River cannot be avoided. Site is closed during flood events. Water carting is available if required.	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
8	Source water	Lack of supply	1. Inadequate maintenance 2. Lack or failure of standby pumps 3. Power failure 4. Blockage of intake structure	Moderate	Unlikely	Medium (6)	1. In case of power failure, there is approx. 2 days' worth of clearwater storage for potable water. Worst case scenario, the campers are suggested to vacate. 2. Cart water	Moderate	Rare	Low (3)	Estimate		
9	Source water	Lack of supply	Climatic variations	Moderate	Unlikely	Medium (6)	1. Cart water	Moderate	Rare	Low (3)	Uncertain	Uncertainty in future climate	
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of Chemical supplies 4. Staff error 5. Plant Design	Major	Possible	High (12)	1. Treatment processes – Chlorine disinfection post filtration 2. Chlorine levels are tested at least once a week (ideally twice a week) 3. Injection pumps and chlorine supply are also checked and inspected at the same time. 4. Trained and qualified operators – good housekeeping 5. Security and vermin-proofing 6. Regular cleaning and maintenance of process equipment	Major	Unlikely	Medium (8)	Reliable		Seek funding to install UV and SCADA/Close site
11	Treatment	Biological contamination • Protozoa	1. Vermin and bird access 2. Staff error 3. Plant Design	Catastrophic	Rare	Medium (6)	1. Security and vermin-proofing 2. Filtration (limited efficacy) 3. Trained and qualified operators – good housekeeping	Catastrophic	Rare	Medium (6)	Uncertain	Inability to detect contamination in the treatment process. Informal visual inspections of the tanks occur periodically.	Seek funding to install UV and SCADA/Close site
12	Treatment	Chemical contamination • ACH	1. Chemical overdose due to equipment failure 2. Loss of chemical supplies 3. Staff error 5. Plant Design	Minor	Unlikely	Low (4)	1. Injection pumps and ACH supply are also checked and inspected at least once a week. 2. Trained and qualified operators – good housekeeping	Minor	Rare	Low (2)	Uncertain		Seek funding to install UV and SCADA/Close site
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Failure of ACH dosing 3. Failure of filtration system	Major	Rare	Medium (5)	1. Treatment plant is designed to remove turbidity under normal raw water quality conditions 2. In the event of highly turbid/coloured water, treatment plant would be suspended and water carted in 3. Regular maintenance of filter media and bag filters 4. **Paradise Dam 2018-01:** THM monitoring occurs monthly	Major	Rare	Medium (5)	Confident	THM monitoring have commenced. All results are below ADWG limits.	

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
14	Treatment	Physical/chemical contamination • Turbidity • Particulates	1. Failure of filtration system 2. Failure of dosing equipment 3. High levels of turbidity 4. Communication Breakdown 5. Staff error	Minor	Likely	Medium (8)	1. Regular maintenance of filter media and bag filters 2. In the event of highly turbid/coloured water, treatment plant would be suspended and water carted in 3. Trained and qualified operators – good housekeeping	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	
15	Treatment	Clearwater storage tank pump failure	1. Inadequate maintenance 2. Power failure 3. Communication Breakdown	Moderate	Unlikely	Medium (6)	1. Standby pump available 2. If there is a power failure, the backup generator can run the treated water pump to supply the whole site. 3. Cart water in if required	Moderate	Rare	Low (3)	Confident	Existing measures are robust	

12.5 Paradise Dam Risk Management Measures

Table 12-6 Existing and Proposed Preventative Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Source water	Biological contamination • Protozoa	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic systems/sewage 5. Recreation	1. WTP process includes flocculation, clarification and filtration	Likelihood	Effective	High (10)	No	Seek funding to install UV and SCADA/Close site	Facilities, Water and Wastewater
2	Source water	Biological contamination • Bacteria • Viruses	1. Livestock 2. Wildlife 3. Issues with Bore Infiltration 4. Septic Systems/sewage 5. Recreation	1. WTP process includes flocculation, some clarification, filtration, and chlorine disinfection.	Likelihood	Effective	Medium (6)	Yes	Seek funding to install UV and SCADA/Close site	Facilities, Water and Wastewater
3	Source water	Chemical contamination • Heavy metals	1. Natural heavy metals and other chemicals in water	1. WTP process includes flocculation, some clarification, filtration.	Likelihood	Effective based on recent data	Low (3	Yes		
4	Source water	Chemical contamination • Nutrients: Nitrate • Anions: Sulphate, Fluoride	1. Pesticides and Fertilisers 2. Natural occurrences of anions	1. WTP process includes flocculation, some clarification, filtration and chlorine disinfection.	Likelihood	Limited reduction based on data	Low (3)	Yes		
5	Source water	Chemical Contamination • General metals: Aluminium, Iron, Manganese, Boron, Copper	1. Pesticides and Fertilisers 2. Natural chemicals in water	1. WTP process includes flocculation, some clarification, filtration and chlorine disinfection. 2. 3-monthly clean of all tanks or more frequently based on water quality results	Likelihood	Uncertain as levels in raw water are already low	Low (3)	Yes		
6	Source water	Chemical contamination	1. Accidental spills	1. WTP process includes flocculation, some clarification, filtration.	Consequence	Uncertain	Low (1)	Yes		
7	Source water	Physical contamination • Ash • Mud	1. Soil erosion 2. Flood waters (high turbidity and colour) 3. Bush fires	1. WTP process includes flocculation, some clarification, filtration, and chlorine disinfection. 2. Water carting to site	Likelihood	Effective	Low (4)	Yes		
8	Source water	Lack of supply	1. River level drop beyond intake level 2. Failure of intake pump 3. Power failure 4. Blockage of intake structure	1. In case of power failure, there is approx. 2 days' worth of clearwater storage for potable water. Worst case scenario, the campers are suggested to vacate. 2. Cart water	Likelihood	Effective	Low (3)	Yes		
9	Source water	Lack of supply	Climatic variations	1. Cart water	Likelihood	Effective	Low (3)	Yes		
10	Treatment	Biological contamination • Bacteria • Viruses	1. Failure of chlorine injection 2. Insufficient chlorine residual 3. Loss of chemical supplies 4. Staff error 5. Plant Design	1. Treatment processes – Chlorine disinfection post filtration 2. Chlorine levels are tested at least once a week (ideally twice a week) 3. Injection pumps and chlorine supply are also checked and inspected at the same time. 4. Trained and qualified operators – good housekeeping 5. Security and vermin-proofing 6. Regular cleaning and maintenance of process equipment	Likelihood	Effective	Medium (8)	Yes	Seek funding to install UV and SCADA/Close site	Facilities, Water and Wastewater

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
11	Treatment	Biological contamination • Protozoa	1. Vermin and bird access 2. Staff error 3. Plant Design	1. Security and vermin-proofing 2. Filtration (limited efficacy) 3. Trained and qualified operators – good housekeeping	No change	Uncertain	Medium (8)	Yes	Seek funding to install UV and SCADA/Close site	Facilities, Water and Wastewater
12	Treatment	Chemical contamination • ACH	1. Chemical overdose due to equipment failure 2. Loss of chemical supplies 3. Staff error 5. Plant Design	1. Injection pumps and ACH supply are also checked and inspected at least once a week. 2. Trained and qualified operators – good housekeeping	Likelihood	Effective	Low (2)	Yes	Seek funding to install SCADA/Close site	Facilities, Water and Wastewater
13	Treatment	Disinfection by-products	1. High raw water turbidity (dependent on nature of turbidity) 2. Failure of ACH dosing 3. Failure of filtration system	1. Treatment plant is designed to remove turbidity under normal raw water quality conditions 2. In the event of highly turbid/coloured water, treatment plant would be suspended and water carted in 3. Regular maintenance of filter media and bag filters 4. **Paradise Dam 2018-01:** THM monitoring occurs monthly	No	Effective. No THM exceedances recorded in treated water.	Medium (6)	Yes		
14	Treatment	Physical/chemical contamination • Turbidity • Particulates	1. Failure of filtration system 2. Failure of dosing equipment 3. High levels of turbidity 4. Communication Breakdown 5. Staff error	1. Regular maintenance of filter media and bag filters 2. In the event of highly turbid/coloured water, treatment plant would be suspended, and water carted in 3. Trained and qualified operators – good housekeeping	Likelihood	Effective	Low (4)	Yes		
15	Treatment	Clearwater storage tank pump failure	1. Inadequate maintenance 2. Power failure 3. Communication Breakdown	1. Standby pump available 2. If there is a power failure, the backup generator can run the treated water pump to supply the whole site. 3. Cart water in if required	Likelihood	Effective	Low (2)	Yes		

12.6 Paradise Dam Risk Management Improvement Program

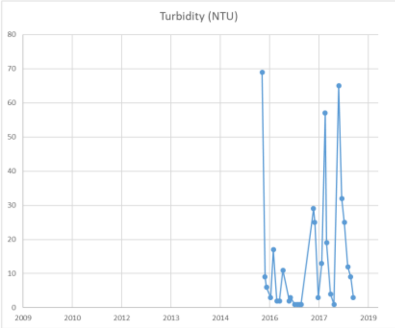
Table 12-7 Paradise Dam Risk Improvement Plan

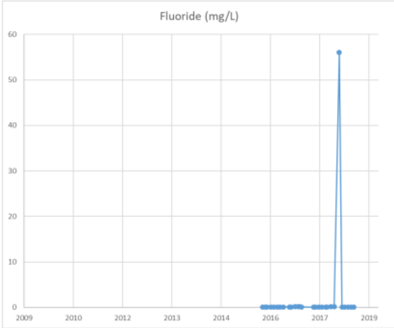
Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
1 & 2	Source	Biological contamination • Protozoa	Medium	Seek funding to install UV and SCADA	Close site		November 2021		Facilities, Water and Wastewater
10 & 11	Treatment	Biological contamination • Bacteria • Viruses • Protozoa	Medium	Seek funding to install UV and SCADA	Close site		November 2021		Facilities, Water and Wastewater
12	Treatment	Chemical contamination • ACH	Medium	Seek funding to install SCADA	Close site		November 2021		Facilities, Water and Wastewater

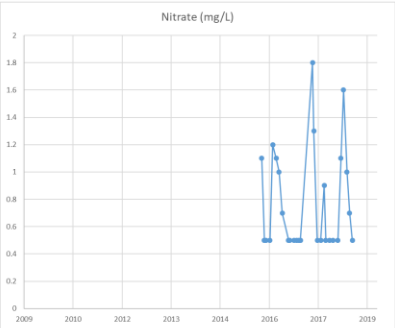
12.7 Paradise Dam Water Scheme Water Quality Data

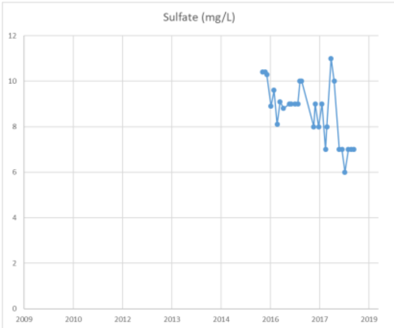
The results are spread across the twelve-month period of the year indicated. Note the orange lines indicate the ADWG limits.

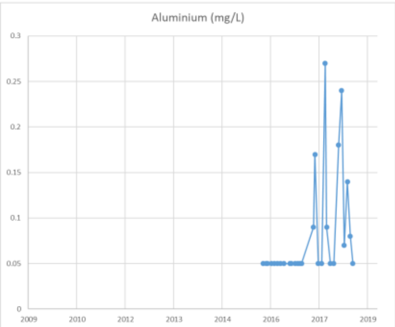
Paradise Dam – Raw Water 2016 - 2018

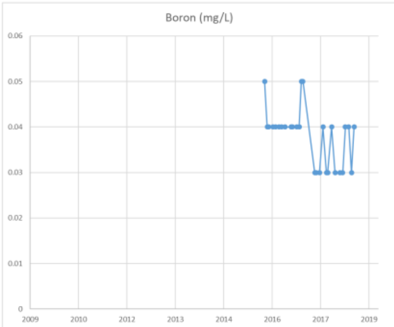


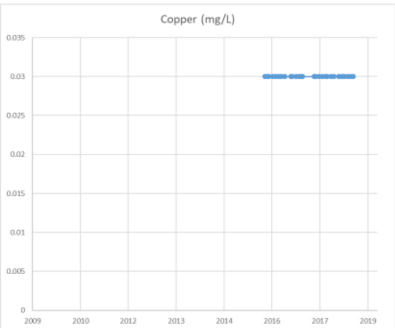


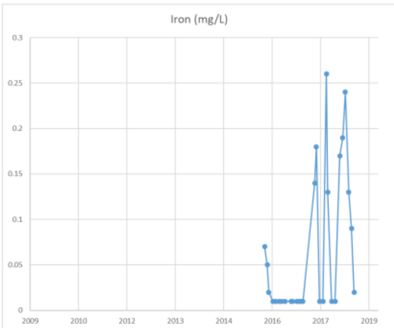


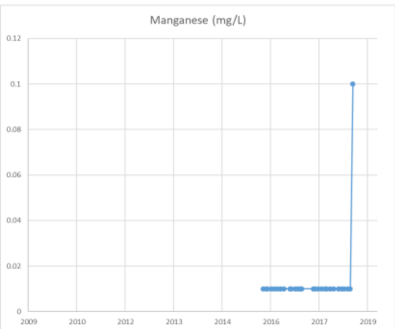


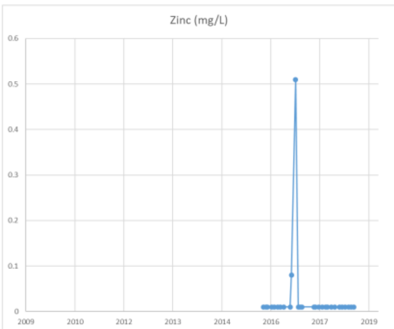




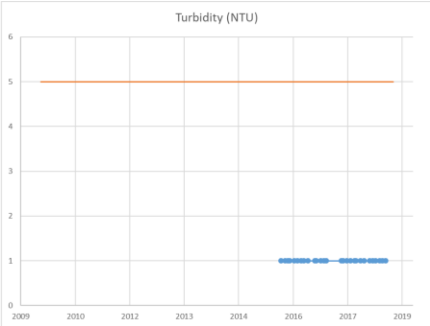


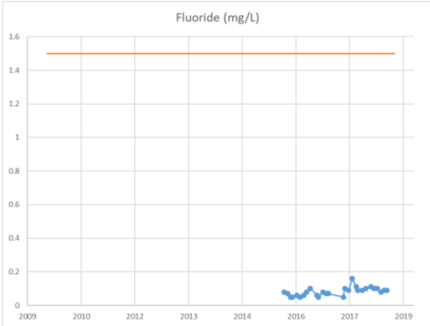


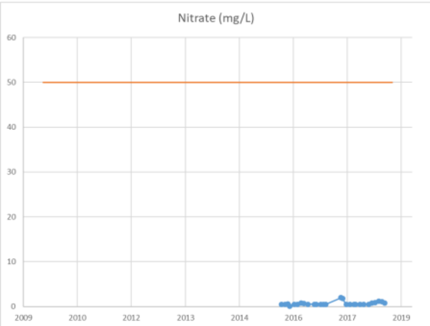


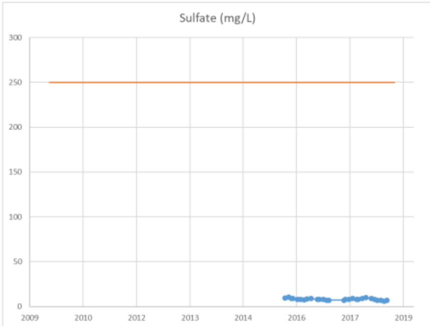


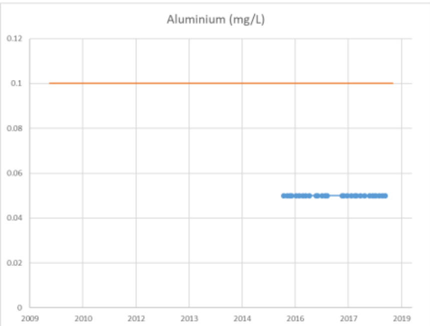
Paradise Dam – Treated Water 2016 - 2018

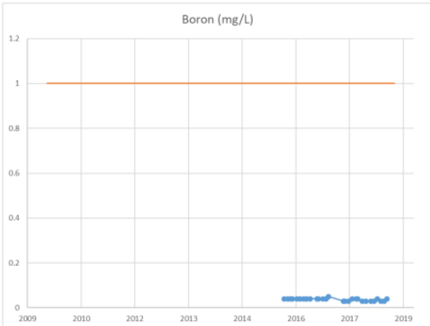


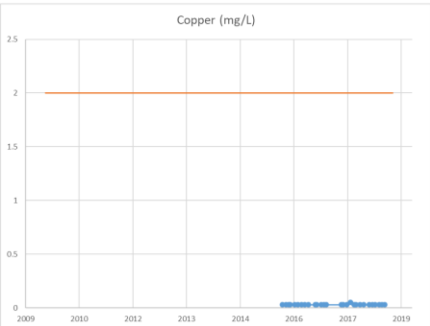


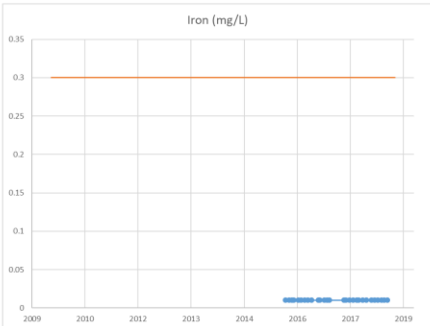


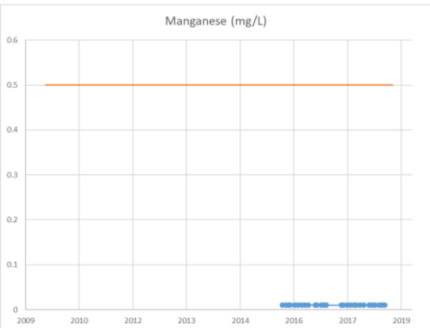


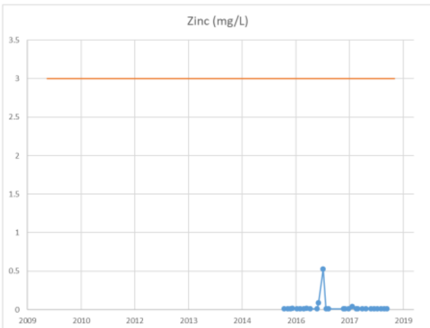












13. REGION-WIDE OPERATIONS

Some operational procedures, quality issues and improvement opportunities are region-wide in nature and have been grouped here to limit repetition.

13.1 Regional Hazard Identification, Risk Assessment and Uncertainty

Table 13-1 Regional Hazard Identification, Risk Assessment and Uncertainty

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
1	Treatment	Substandard chemicals (eg. Chlorates)	1. Inappropriate chemical storage or defective batch	Catastrophic	Unlikely	Medium (8)	1. Chemicals stored as per regulation	Major	Rare	Medium (5)	Confident	Uncooperative chemical supplier with few alternatives	Require chemical quality document with each batch received from supplier Test each batch from supplier inhouse
2	Reticulation	Biological contamination Protozoa	1. Holes in reservoir roof allows access to vermin 2. Lack of backflow prevention 3. No disinfecting when repairing pipe breaks and leaks 4. Staff error 5. Works on/near reticulation	Catastrophic	Unlikely	Medium (8)	1. Backflow prevention devices fitted on all commercial carriers and/or commercial fill-points. 2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Household meters have non-return valves built into them. 4. Processes for working on network 5. Only approved / qualified operators allowed to work on the network – hygiene procedures etc. 6. Regular inspection and maintenance of tower reservoir Option: 6 monthly scheduled reservoir roof inspections has begun.	Moderate	Rare	Low (3)	Confident	Existing measures are robust Residual consequence drops as less quantity of contaminant due to measures in place	Option: Develop procedure for disinfecting mains after repairs. WIOA procedures and Operators disinfection training required. Require Aquacard completion by all workers on and around Council water infrastructure
3	Reticulation	Biological contamination • Bacteria • Viruses	1. Holes in reservoir roof allows access to vermin 2. Lack of backflow prevention 3. No disinfecting when repairing pipe breaks and leaks 4. Staff error 5. Works on/near reticulation	Catastrophic	Unlikely	Medium (8)	1. Backflow prevention devices fitted on all commercial carriers and/or commercial fill-points. 2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Household meters have non-return valves built into them. 4. Processes for working on network 5. Only approved / qualified operators allowed to work on the network – hygiene procedures etc. 6. Regular inspection and maintenance of tower reservoir	Moderate	Rare	Low (3)	Confident	Existing measures are robust Residual consequence drops as less quantity of contaminant due to measures in place	Option: Develop procedure for disinfecting mains after repairs. WIOA procedures and Operators disinfection training required. Require Aquacard completion by all workers on and around Council water infrastructure
4	Reticulation	Biological contamination – opportunistic pathogen (*Naegleria fowleri*)	Growth in pipework under stagnant water conditions and warm temperatures	Major	Possible	High (12)	1. Disinfection residual in reticulation 2. Minimal dead ends 3. Flushing of problem areas regularly	Major	Rare	Medium (5)	Reliable	The conditions conducive to growth of opportunistic pathogens are well understood	
5	Reticulation	Chemical contamination	1. Lack of backflow prevention 2. Staff error 3. Works on/near reticulation	Moderate	Unlikely	Medium (6)	1. Backflow prevention devices fitted on all commercial carriers and/or commercial fill-points. 2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Household meters have non-return valves built into them. 4. Processes for working on network	Moderate	Rare	Low (3)	Confident	Back flow prevention is effective throughout	Require Aquacard completion by all workers on and around Council water infrastructure

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
							5. Only approved / qualified operators allowed to work on the network						
6	Reticulation	Physical contamination	1. Dead ends (stale or dirty water) 2. Lack of backflow prevention 3. Staff error 4. Works on/near reticulation	Minor	Possible	Medium (6)	1. Flushing program for dead end mains. 2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Backflow prevention devices fitted to commercial industrial premises where required. 4. Household meters have non-return valves built into them. 5. Processes for working on network e.g. disinfection of service and mains repairs 6. Only approved / qualified operators allowed to work on the network – hygiene procedures etc.	Minor	Unlikely	Low (4)	Confident	Existing measures are robust	Require Aquacard completion by all workers on and around Council water infrastructure
7	All	• Power failure causing contamination or supply failure	1. Power failure	Moderate	Likely	Medium (9)	1. Good storage levels of treated water always maintained 2. Backup generators available at some sites	Moderate	Rare	Low (3)	Confident		Seek natural disaster funding for onsite automatic generator installation
8	All	• SCADA Communication breakdown causing contamination or supply failure	1. Communication breakdown	Moderate	Possible	Medium (9)	1. Good storage levels of treated water always maintained 2. Regular sampling of chemical levels at the treatment plant by staff on site	Moderate	Rare	Low (3)	Confident		Progressively implement recommendations of audit as SCADA strategy implemented. Engineer dosing equipment to ensure overdosing impossible.
9	All	• Staff error causing contamination or supply failure	1. Staff error 2. Dosing error 3. Inadequate data control and reporting	Moderate	Possible	Medium (9)	1. Qualified and trained staff 2. Unable to bypass clearwater and tower reservoir providing lag time 3. Public notification process 4. Triggers and alarms 5. WQ data processes, including online analysers and trending information on SCADA 6. Untreated water cannot bypass to reticulation	Moderate	Unlikely	Medium (6)	Uncertain	1. Even though operators are experienced, there is a lack of documented policy and procedure. 2. Verification monitoring and reporting is performed through the QHFSS 3. Drinking water incident and emergency management is based on information in section 15.	**Regional 2013-01:** Develop and implement Operation and Maintenance procedures.
10	All	• Uncertainty of source risks	Lack of consolidated data and analysis of last 5 years' monitoring	Moderate	Likely	Medium (9)	Data up to last revision attached and assessed.	Minor	Unlikely	Low (4)	Confident	Original data and assessment still valid, but risks have been more accurately re-assessed	Implementation of SWIMLocal and population with available data followed by re-assessment
11	All	• Uncertainty of causes of events	Lack of consolidated data for comparison	Moderate	Likely	Medium (9)	Data up to last revision attached and assessed.	Minor	Unlikely	Low (4)	Confident	Original data and assessment still valid, but risks have been more	Implementation of SWIMLocal and population with available data followed by specific assessment of variations to the normal at events and mitigations

No.	Scheme Component	Hazard	Hazard Source	Maximum Risk			Existing Preventive Measures / Barriers.	Residual risk			Level of Uncertainty	Comments	Possible and Proposed Further Risk Reduction Actions (Risk Management Improvement Plan Actions)
				Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level			
												accurately re-assessed	
12	All	• Untrained staff, limited control parameters and instructions	Lack of supporting documentation: Procedures, manuals, forms, and sub-plans etc.	Moderate	Possible	Medium (6)		Moderate	Possible	Medium (6)	Confident	Identified in audit	Updating the procedures to reflect operational experience, output quality changes and different chemical use as well as developing O&M manuals for the remaining water supply schemes.
		•											

13.2 Regional Risk Management Measures

In this section, existing preventative measures and the proposed preventative measures are outlined.

Table 13.2 Regional Risk Management Measures

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
1	Treatment	• Substandard chemicals	1. Inappropriate chemical storage or defective batch (eg. Chlorates)	1. Chemicals stored as per regulation	Likelihood and Consequence	Moderately effective- based on treatment results	Medium (5)	No	Require chemical quality document with each batch received from supplier Test each batch from supplier inhouse	Water and Wastewater
2	Reticulation	• Biological contamination	1. Holes in reservoir roof allows access to vermin	1. Backflow prevention devices fitted on all commercial carriers and/or commercial fill-points. 2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Household meters have non-return valves built into them. 4. Processes for working on network 5. Only approved / qualified operators allowed to work on the network – hygiene procedures etc. 6. Regular inspection and maintenance of tower reservoir Option: 6 monthly scheduled reservoir roof inspections has begun.	Likelihood and Consequence	Effective	Low (3)	Yes	Option: Develop procedure for disinfecting mains after repairs. WIOA procedures and Operators disinfection training required. Require Aquacard completion by all workers on and around Council water infrastructure	Water and Wastewater
3	Reticulation	• Protozoa	2. Lack of backflow prevention	1. Backflow prevention devices fitted on all commercial carriers and/or commercial fill-points. 2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Household meters have non-return valves built into them. 4. Processes for working on network 5. Only approved / qualified operators allowed to work on the network – hygiene procedures etc. 6. Regular inspection and maintenance of tower reservoir	Consequence	Effective based on ability to maintain a chlorine residual	Low (3)	Yes	Option: Develop procedure for disinfecting mains after repairs. WIOA procedures and Operator disinfection training required. Require Aquacard completion by all workers on and around Council water infrastructure	Water and Wastewater
4	Reticulation	• Biological contamination	3. No disinfecting when repairing pipe breaks and leaks	1. Disinfection residual in reticulation 2. Minimal dead ends 3. Flushing of problem areas regularly	Likelihood	Effective – The conditions to growth of opportunistic pathogens are well understood	Medium (5)	No	Require Aquacard completion by all workers on and around Council water infrastructure	Water and Wastewater
5	Reticulation	• Bacteria	4. Staff error	1. Backflow prevention devices fitted on all commercial carriers and/or commercial fill-points.	Likelihood	Effective- based on actual tests carried out.	Low (3)	Yes	Require Aquacard completion by all workers on and around Council water infrastructure	Water and Wastewater

No.	Scheme Component	Hazard	Hazard Source	What are the existing preventative measures?	Do existing preventative measures impact on likelihood &/or consequence?	How effective is/are the existing preventative measure/s & on what basis has this been determined?	Residual risk after preventative measures	Is the level of residual risk acceptable	Proposed measures to reach an acceptable level or residual risk	Responsible Work Unit/ Organisation (& arrangements with external organisation if applicable)
				2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Household meters have non-return valves built into them. 4. Processes for working on network 5. Only approved / qualified operators allowed to work on the network						
6	Reticulation	Viruses	5. Works on/near reticulation	1. Flushing program for dead end mains. 2. Backflow prevention devices fitted to commercial industrial premises where required. 3. Backflow prevention devices fitted to commercial industrial premises where required. 4. Household meters have non-return valves built into them. 5. Processes for working on network e.g. disinfection of service and mains repairs 6. Only approved / qualified operators allowed to work on the network – hygiene procedures etc.	Likelihood	Effective- no incidents have occurred, and all practical measures have been implemented	Low (4)	Yes	Require Aquacard completion by all workers on and around Council water infrastructure	Water and Wastewater
7	All	• Biological contamination – opportunistic pathogen (Naegleria fowleri)	1. Holes in reservoir roof allows access to vermin	1. Operators have their own passwords to log in to systems 2. Active and up to date antivirus in place 3. Operating system and firmware patched and updated 4. Application software patched and updated	Consequence	Effective- no incidents have occurred, and all practical measures have been implemented	Low (1)	Yes	Progressively implement recommendations of audit as SCADA strategy implemented. Engineer dosing equipment to ensure overdosing impossible.	Water and Wastewater
8	All	Chemical contamination	2. Lack of backflow prevention	1. Good storage levels of treated water always maintained 2. Backup generators available at some sites	Consequence	Effective, achievable measures	Low (3)	Yes	Seek natural disaster funding for onsite automatic generator installation	Water and Wastewater and Major Projects
9	All	Physical contamination	3. No disinfecting when repairing pipe breaks and leaks	1. Good storage levels of treated water always maintained 2. Regular sampling of chemical levels at the treatment plant by staff on site	Consequences	Effective, achievable measures	Low (3)	Yes	Progressively implement recommendations of audit as SCADA strategy implemented. Engineer dosing equipment to ensure overdosing impossible.	Water and Wastewater
10	All	Uncertainty of source risks	Lack of consolidated data and analysis of last 5 years' monitoring	Data up to last revision attached and assessed.	Likelihood	Effective- no incidents have occurred as a result,	Low (3)	Yes	Implementation of SWIMLocal and population with available data	Water and Wastewater
11	All	Uncertainty of causes of events	Lack of consolidated data and analysis	Data up to last revision attached and assessed	Likelihood	Effective- no incidents have occurred as a result,	Low (3)	No	Implementation of SWIMLocal and population with available data followed by analysis of variations around events	Water and Wastewater
12	All	Untrained staff, limited control parameters and instructions	Lack of supporting documentation: Procedures, manuals, forms, and sub-plans etc.	Limited	Likelihood and Consequences	Requires improvement	Medium (6)	No	Updating the procedures to reflect operational experience, output quality changes and different chemical use as well as developing O&M manuals for the remaining water supply schemes.	Water and Wastewater and WHS

13.3 Regional Risk Management Improvement Plan

The 263following table displays the Risk Improvement Program for NBRC. The items identified to reduce risk have been developed to reduce the unacceptable risks identified in Table 4-6 and are shown in blue shaded boxes. General improvement items have also been listed here.

Table 13-3 Regional Risk Management Improvement Program

Risk No.	Scheme Component / Sub-component	Hazard/ Hazardous event	Priority	Risk Improvement Actions			Target dates	Estimated cost	Responsibility
				interim	short-term	long-term			
1	Treatment	Substandard chemicals (eg. Chlorates)	High		Test each batch from supplier inhouse	Require chemical quality document with each batch received from supplier Test each batch inhouse	30/12/2022 30/12/2023	$5000	Water and Wastewater
2	Reticulation	Biological contamination	Medium		Option: Develop procedure for disinfecting mains after repairs. WIOA procedures and Operators disinfection training required. Require Aquacard completion by all workers on and around Council water infrastructure		30/12/2022	$10000	Water and Wastewater and WHS
3	Reticulation	Protozoa	Low		Option: Develop procedure for disinfecting mains after repairs. WIOA procedures and Operators disinfection training required. Require Aquacard completion by all workers on and around Council water infrastructure		30/12/2022	$10000	Water and Wastewater and WHS
4	Reticulation	Biological contamination	High		Require Aquacard completion by all workers on and around Council water infrastructure	Prepare Work Instructions for disinfection of reticulation repairs	30/06/2022	$2000	Water and Wastewater and WHS
5	Reticulation	Bacteria	Medium		Require Aquacard completion by all workers on and around Council water infrastructure	Prepare Work Instructions for disinfection of reticulation repairs	30/06/2022	-	Water and Wastewater and WHS
6	Reticulation	Viruses	Medium		Require Aquacard completion by all workers on and around Council water infrastructure	Prepare Work Instructions for disinfection of reticulation repairs	30/06/2022	-	Water and Wastewater and WHS
7	All	Biological contamination – opportunistic pathogen (Naegleria fowleri)	Low	Progressively implement recommendations of audit as SCADA strategy implemented. Engineer dosing equipment to ensure overdosing impossible.			Ongoing	$500,000	Water and Wastewater
8	All	Chemical contamination	Low	Seek natural disaster funding for onsite automatic generator installation			Ongoing	$200,000	Water and Wastewater and Major Projects
9	All	Physical contamination	Low	Progressively implement recommendations of audit as SCADA strategy implemented. Engineer dosing equipment to ensure overdosing impossible.			Ongoing	$500,000	Water and Wastewater
10	All	Uncertainty of source risks	Low	Implementation of SWIMLocal and population with available data			Ongoing	Included in operating budget	Water and Wastewater
11	All	Uncertainty of causes of events	Low	Implementation of SWIMLocal and population with available data followed by analysis of variations around events			Ongoing	Included in Operating Budget	Water and Wastewater
12	All	Lack of supporting documentation: Procedures, manuals, forms, and sub-plans etc.	Medium	Updating the procedures to reflect operational experience, output quality changes and different chemical use as well as developing O&M manuals for the remaining water supply schemes.			Ongoing (Complete suite version 1 by 12/2023)	$80,000	Water and Wastewater and WHS

14. OPERATION AND MAINTENANCE PROCEDURES

The NBRC have some documented Operation and Maintenance (O&M) procedures. The need to develop and document these procedures has been identified in the risk assessments.

14.1 Water Treatment Plants

There are O&M manuals which are available for the Biggenden, Gayndah, Eidsvold, Mingo Crossing and Mundubbera WTPs. None of the plant manuals are in electronic version except for Mingo Crossing. Updating the manuals to reflect operational experience, output quality changes and different chemical use is identified as an item for improvement, as well as developing O&M manuals for the remaining water supply schemes.

14.2 Reticulation Systems

NBRC does not have any documented operation and maintenance procedures relating to the reticulation systems for the seven water supply schemes. Formally documenting operation and maintenance procedures for all nine water supply schemes has been identified as an item for improvement. A list of the operation and maintenance procedures to be formally documented is presented in Table 14-1.

NBRC has WBBROC development code as its adopted standard.

Table 14-1 Operation and Maintenance Procedures Documentation.

Scheme Component / Sub-component	Preventive measure managed (where applicable)	Documented procedure	Version date	Position responsible	Process for implementing the procedure (Activity and Frequency)	Comments (including where procedures are inadequate or need updating)
Treatment and Reticulation	Disinfection	Calibration of chlorine units	N/A	Operator	Included in induction package – signed when read by operator and supervisor. Included in monthly job list for operators.	Procedure needs to be created.
Treatment Plant	Plant Operation	Plant Operating Procedures	N/A	Operator	Included in induction package – signed when read by operator and supervisor.	Procedure needs to be created.
Treatment Plant	Periodic maintenance and inspections	Specific plant maintenance and inspection procedure	N/A	Operator	Included in induction package – signed when read by operator and supervisor.	Procedure needs to be created.
Reticulation	Disinfection	Procedure for repairing mains breaks	N/A	Operator	Included in induction package – signed when read by operator and supervisor.	Procedure needs to be created.
Sampling and testing procedures (Various)		Procedure for sampling and testing as appropriate is supplied (QLD	N/A	Operator	Included in induction package – signed when read by operator and supervisor.	

Scheme Component / Sub-component	Preventive measure managed (where applicable)	Documented procedure	Version date	Position responsible	Process for implementing the procedure (Activity and Frequency)	Comments (including where procedures are inadequate or need updating)
		Health document)			Included in daily job list for operators.	

15. MANAGEMENT OF INCIDENTS AND EMERGENCIES

15.1 General Management

NBRC have a Local Disaster Management Plan (LDMP) in place to deal with large scale regional disasters.

The management of incidents and emergencies for drinking water systems are covered in this section.

Currently, systems checks are performed by appropriately qualified staff and recorded in the SWIMLocal system. If issues are enounced, they are escalated to the NBRC Water and Wastewater Senior Supervisor, Water and Wastewater Senior Technical Officer and Water and Wastewater Manager. A summary of the current incident response levels and a description of how incidents are currently responded to is provided in Figure 15-1.

Figure 15-1 Incident Response Levels and Escalation

Table 15-1 provides an example of how incident and emergency levels may be described, and how they might be interpreted while Table 15-2 provides examples of how specific incidents and emergencies are managed and who is responsible.

Incident reporting will meet reporting requirements under the Drinking Water Service Providers Monitoring and Reporting Notice.

Table 15-1 Incident/Emergency Levels

Incident / Emergency level	Description of Level
Level 5 (event or incident)	• Widespread outbreak of waterborne disease • Declared disaster • Gross exceedances of ADWG health guideline values for a chemical parameter (e.g. more than five times the ADWG health guideline limit [after confirmation testing]).
Level 4 (event or incident)	• High level of *E. coli* (e.g. > 5 CFU/ 100 mL) detected in reticulation • Failure of infrastructure (severe or emergency level supply restrictions required to ensure continuity of supply and possible loss of supply)
Level 3 (event or incident)	• Detection of 1-5 CFU/100 mL *E. coli* in reticulation • Failure of infrastructure (ability to supply water compromised – immediate water restrictions may be required, or localised loss of supply) • Minor exceedances of ADWG health guideline value for chemical parameter (determined value is < 5 times guideline value). • Detection of parameter with no ADWG value or QLD Health interim guideline value
Level 2	• Failure of infrastructure or source supply (water quality or supply unlikely to be compromised - alternate process available to provide drinking water) • Exceedances of ADWG aesthetic guideline (customer complaints possible)
Level 1	• Exceedances of operational limit managed through operational and maintenance procedures and reported to technical and supervisory staff

Table 15-2 Management of Incidents and Emergencies

Level	Incident or emergency	Summary of actions to be taken (with documented procedure listed)	Position/s responsible for Action/s
1	Exceedances of operational limit managed through operational and maintenance procedures	Confirm results by retesting. Undertake necessary corrective actions. Resample and re-test Report to Senior Supervisor and Senior Technical Officer	Operator
2	Failure of infrastructure or source supply (water quality or supply unlikely to be compromised) / alternate process available to provide drinking water / exceedances of ADWG aesthetic guideline (customer complaints possible)	Notify Senior Water and Wastewater Supervisor and Senior Technical Officer Determine affected infrastructure and arrange immediate backup/repair/rectification Switch raw water source if appropriate If treatment component disabled refer to the plant operating manual. Arrangements can immediately be made to import potable water if necessary, to maintain water supply Notify Water and Wastewater Manager Notify Regulator if need to vary operations from DWQMP	Operator Senior Water and Wastewater Supervisor and Senior Operator Senior Water and Wastewater Supervisor Manager Water and Wastewater

Level	Incident or emergency	Summary of actions to be taken (with documented procedure listed)	Position/s responsible for Action/s
3	Detection of 1-5 CFU/100 mL *E. coli* in reticulation / Failure of infrastructure (ability to supply water compromised – short term water restrictions may be required) / Minor exceedances of ADWG health guideline value for chemical parameter (determined value is close to guideline value); Detection of parameter with no ADWG value or QLD Health interim guideline value.	Notify Senior Water and Wastewater Supervisor and Senior Technical Officer	Operator
		Notify Water and Wastewater Manager Determine potentially affected area, isolate if possible, flush and rechlorinate	Senior Water and Wastewater Supervisor
		Notify General Manager Works and Report detection to OWSR by phone Notify Communications Team to standby for public notification as required Written incident report – Part 1 incident form - within 24 hours. Signed by WWW Manager or GM Works Consider Contaminated/Boil Water alert in conjunction with Queensland Health. Escalate emergency further if situation worsens.	Water and Wastewater Manager
		Resample for *E. coli* and disinfectant residual in potentially affected infrastructure Undertake comprehensive contamination investigation	Senior Technical Officer
		Undertake necessary corrective actions – resampling, flushing and re-chlorination	Operator
		Upon resolution, provide written report to regulator (Part 2 incident form)	Water and Wastewater Manager
		Arrangements can immediately be made to import potable water if necessary, to maintain water supply.	Senior Water and Wastewater Supervisor and Senior Technical Officer
4	High level of E. coli (e.g. > 5 CFU/ 100 mL) detected in reticulation Failure of infrastructure (severe or emergency level supply restrictions required to ensure continuity of supply and possible loss of supply)	Notify Senior Water and Wastewater Supervisor and Senior Technical Officer	Operator
		Notify Water and Wastewater Manager Determine potentially affected area, isolate if possible, flush and rechlorinate	Senior Water and Wastewater Supervisor
		Notify General Manager Works and Report detection to OWSR by phone	Water and Wastewater Manager
		Arrangements can immediately be made to import potable water if necessary, to maintain water supply	Senior Water and Wastewater Supervisor
		Notify Communications Team to standby for public notification as required Written incident report – Part 1 incident form - within 24 hours. Signed by WWW Manager or GM Works	Senior Technical Officer

Level	Incident or emergency	Summary of actions to be taken (with documented procedure listed)	Position/s responsible for Action/s
		Contaminated/Boil Water alert.	Water and Wastewater Manager
		Escalate emergency further if situation worsens (OWSR).	
		Resample for E. coli and disinfectant residual in potentially affected infrastructure	Operator
		Undertake comprehensive contamination investigation Undertake necessary corrective actions – resampling, flushing and re-chlorination	Senior Water and Wastewater Supervisor and Senior Technical Officer
		Upon resolution, provide written report to regulator (Part 2 incident form)	Water and Wastewater Manager
5	Widespread outbreak of waterborne disease / Declared disaster / Supply unable to be maintained / Gross exceedances of ADWG health guideline values for a chemical parameter (e.g. more than five times the ADWG health guideline limit).	Notify NBRC Management	Operator / Senior Water and Wastewater Supervisor
		Notify LDMG Issue contaminated/boil water alert, flush and re-chlorinate Notify Qld Health Report detection to OWSR by phone Notify Qld Police Service	Water and Wastewater Manager
		LDMG Stands Up	CEO
		Written incident report – Part 1 incident form - within 24 hours Undertake comprehensive contamination investigation. Undertake necessary corrective actions as directed by LDMG Upon resolution, provide written report to regulator (Part 2 incident form)	Water and Wastewater Manager

The contact details of key people (internal and external) to be contacted in the event of an emergency is listed in **Error! Reference source not found.**. ***(Appendix C)***

15.2 Emergency Response Training

All employees that may potentially be involved in an incident response will be trained in their responsibilities. Employees likely to be involved in any of the key roles identified in this plan will receive detailed training on their responsibilities. This training is part of the staff training procedure and attendance is to be recorded.

16. SERVICE WIDE SUPPORT – INFORMATION MANAGEMENT

Water quality testing results are currently manually entered into SWIMLocal by operators or administrative staff. The operational activities and decisions made by operators, Senior Water and Wastewater Supervisor and the Water and Wastewater Manager relating to WTP operation are recorded in work diaries, which are retained onsite for future reference. Operational issues are recorded in SWIMLocal database. The Magic Document Management System is used throughout Council to maintain records pertaining to correspondence, purchasing, Council resolutions and general Council business. It also serves as the document control system for all active documents within the Water and Wastewater area, providing a framework for document numbering, revision etc. Council has various policies which control the use and operation of the system.

The following Appendices A and B detail the current operational and verification monitoring performed by NBRC.

17. APPENDIX A: OPERATIONAL MONITORING PROGRAMS

17.1 Operational Monitoring and Critical Control Points

The following sections detail the Operational Monitoring conducted by NBRC. Operational monitoring is used to confirm that the current treatment measures in place to control hazards are functioning properly and effectively. Data from operational monitoring can be used as triggers for immediate short-term corrective actions to improve drinking water quality and reduce the risk of adverse impacts to the water supply.

These tables include the monitoring locations, parameters measured; target and critical levels and actions to be taken if levels are exceeded. The frequency of sampling at each location and any other sample points is also tabulated including the sampling/analysis method (e.g., on-line, grab etc.).

The critical control point(s) (CCP) are also highlighted. A CCP is an action or process that reduces the risk associated with a particular hazard and that is critical to ensuring water quality objectives can be achieved (i.e. loss of control at a critical control point would imply that the water quality may be compromised to an unacceptable level).

As part of the plan, several preventative measures (Critical Control Points (CCPs)) have been identified with the intention to ensure the residual risk of supplying poor quality water to consumers is acceptably low. Critical response procedures, in the event of a CCP exceedance, are also a key component of this Plan. The CCP tables are presented below.

Additional CCP table

	Biggenden	Eidsvold	Gayndah	Mingo	Monto	Mt Perry	Mulgildie	Mundubbera	Paradise Dam
Critical control point	Chlorine injection								
Parameter	Free chlorine								
Hazard	Over/under dosing								
Monitoring	Daily post sand filter	Daily post-secondary chlorinated tank	Daily post Clearwater ground reservoir	Daily post potable water tank	Daily post UV	Daily post ground reservoir	Daily post clearwater storage tanks	Daily at inlet to ground reservoir	Daily post clearwater storage tank
Target range (mg/L)	0.5 - 3.0	0.8 - 3.5	0.5 - 5.0	0.7 - 1.7	1.2 to 3.5	1 to 3.5	0.5 to 4	0.5 to 5	1.5 to 3.8
Critical Limit (mg/L)	Lower - 0.2	Lower - 0.5	Lower - 0.2	Lower - 0.5	Lower - 0.5	Lower - 0.5	Lower - 0.2	Lower - 0.2	Lower - 0.8
	Upper - 5.0	Upper - 5.0	Upper - 5.5	Upper - 5	Upper - 5	Upper - 5	Upper - 5	Upper - 5.5	Upper - 5

Critical control point	Sand filter	Sand filter	Sand filter	Ultra-filtration			Sand filter	Sand filter	Filtration
Parameter	Turbidity								
Hazard	Ineffective filtration for disinfection and protozoa removal	Ineffective filtration for disinfection# and protozoa removal	Ineffective filtration for disinfection# and protozoa removal	Ineffective filtration disinfection and protozoa removal			Ineffective filtration for disinfection and protozoa removal	Ineffective filtration for disinfection and protozoa removal	Ineffective filtration for disinfection and protozoa removal
Monitoring	Daily post filter								
Target range (NTU)	<0.15	<1	<1	<0.15			<0.15	<0.15	<0.15
Critical Limit (NTU)	>0.2	>5	>5	>0.2			>0.2	>0.2	>0.2

Turbidity for these schemes are not the critical control points but have been included here as parameters that need to monitor to ensure UV disinfection effectiveness.

Critical control point	Disinfection								
Parameter		UV intensity	UV dose		UV dose				
Hazard	Reduced effectiveness of UV								
Monitoring		UV intensity monitor	SCADA		SCADA				
Target range		>80%	>500 (J/cm^2)		>500 (J/cm^2)				
Critical Limit		<60%	<400 (J/cm^2)		<400 (J/cm^2)				

Biggenden Operational Monitoring and CCP

The key elements of the Biggenden operational monitoring program are outlined in Table 17-1 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 4-1 and Figure 4-2. The locations for Chlorine Residual testing are generally located at dead end mains where longer residence times may be experienced.

Table 17-1 Biggenden Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Raw Water	Colour	Discoloured Water from Iron and Manganese	Recorded daily	10 mL sample	Photometer	>100 Hazen <220 Hazen	1. Increase oxidisation agent (Sodium Hypo) < 100 Hazen 2. Decrease oxidisation agent > 200 Hazen	-	-
Chorine Injection	Free Chlorine	Excessive or under dosage of chlorine	Recorded daily at the raw water sample tap at the inlet to the WTP	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.0 mg/L	1. Re-test and adjust dosage as required	Lower – 0.2 mg/L Upper – 4.0 mg/L	1. Shut down plant 2. Check chlorine dosing pumps 3. Rectify issue 4. Start plant 5. Re-test for free chlorine
Flocculation	Colour	Failure of flocculation	Recorded daily post sand filter	10 mL sample	Photometer	<5 Hazen	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary	>15 Hazen	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Sand Filter	Turbidity	Blocked filters	Recorded daily post sand filter	10 mL sample	Turbidity meter	<0.15 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary	>0.2 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary 3. Divert filtered water to the lagoons if necessary 4. Drain Ground Reservoir if necessary 5. Replace filter layers if necessary
Sand Filter	Turbidity	Ineffective filtration for disinfection and protozoa removal	Recorded daily	10 mL sample	Turbidity meter	<0.15 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary	>0.2 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary
Chorine Injection	Free Chlorine	Excessive or under dosage of chlorine	Recorded daily post sand filter	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.0 mg/L	1. Re-test and adjust dosage as required	For a maximum duration of 1 hour: Lower – 0.2 mg/L Upper – 5.0 mg/L	1. Check dosing pumps and injection points and rectify 2. Test chlorine in Ground Reservoir 3. Flush and drain Ground Reservoir if required 4. Overdose: Turn off injection and run water to Ground Reservoir until chlorine level is within normal parameters 5. Underdose: Add chlorine until level is within normal parameters

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
pH Correction	pH	Failure of flocculation. Acidic/alkaline water	Recorded daily	10 mL sample	Portable pH meter or photometer	>6.7 <8.3	1. Dose with soda ash to raise pH or dose with hydrochloric acid to reduce pH 2. Retest	>6.5 <8.5	1. Dose with soda ash to raise pH or dose with hydrochloric acid to reduce pH 2. Retest
Reticulation • Test Point 1 (Bush Shed Alice St) • Test Point 2 (Rollinson's Park) • Test Point 3 (Kent St) • Test Point 4 (Edward St) • Test Point 5 (John St) • Test Point 6 (North Alice Street)	Chlorine residual	Biological Contamination (Microbial Growth)	Recorded weekly	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	1. Check chlorine dosing at WTP	Lower – 0.2 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing at WTP 2. If > than 5 mg/L flush reticulation mains and Elevated Water Tower 3. Overdose: Turn off injection and run water to Ground Reservoir until chlorine level is within normal parameters 4. Underdose: Add chlorine until level is within normal parameters

Eidsvold Operational Monitoring and CCP

The key elements of the Eidsvold operational monitoring program are outlined in **Error! Reference source not found.** and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 5-1 and Figure 5-2.

Table 17-2 Eidsvold Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Flocculation	Colour	Failure of flocculation	Recorded daily post sand filters	10 mL sample	Photometer	<5 Hazen	1. Check coagulation and flocculation process 2. Backwash filters and re-test	>15 Hazen	1. Check coagulation and flocculation process 2. Backwash filters and re-test. 3. Drain filtered water tank to the lagoons if necessary 4. Replace filter layers if necessary
Sand Filter	Turbidity	Blocked Filters	Recorded daily post sand filters	10 mL sample	Turbidity meter	<1 NTU	1. Check coagulation and flocculation process 3. Backwash filters and re-test if necessary	>5 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary 3. Drain filtered water tank to the lagoons if necessary 4. Replace filter layers if necessary
Sand Filter	Turbidity	Ineffective filtration for disinfection and protozoa removal	Recorded daily post sand filter	10 mL sample	Turbidity meter	<1 NTU	1. Backwash filters 2. Check Floc Tank 3. Re-test turbidity	>5 NTU	1. Retest 2. Check coagulation and flocculation process 3. Backwash filters and re-test if necessary 4. Investigate issues and rectify

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Chorine Injection	Free Chlorine	Excessive or under dosage of chlorine	Recorded daily post-secondary chlorinated tank	10 mL sample	Photometer	Lower – 0.8 mg/L Upper – 3.5 mg/L	1. Re-test and adjust dosage as required	Lower - 0.5 mg/L Upper - 5 mg/L	1. Test chlorine in chlorinated water storage tanks 2. Overdose: Turn off injection and run water to storage tanks until chlorine level is within normal parameters 3. Underdose: Add chlorine until level is within normal parameters
UV Disinfection	UV Intensity	Reduced effectiveness of UV	Continuous		UV intensity monitor	>80%	1. Operator attend the plant to investigate	<60%	1. Plant automatically shut down 2. Operator attend the plant to investigate
Reticulation • Test Point 3 (WTP tap) • Test Point4 (Showgrounds) • Test Point 5 (Council Office)	Chlorine Residual	Biological Contamination (Microbial Growth)	Recorded weekly	10 mL sample	Photometer	>=0.5 – <=1.0 mg/L	1. Check chlorine dosing at WTP	0.5 – 5mg/L	1. Check chlorine dosing at WTP 2. If > than 5 mg/L flush reticulation mains

Gayndah Operational Monitoring and CCP

The key elements of the Gayndah operational monitoring program are outlined in Table 17-3 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 6-1. The locations for chlorine residual testing are generally located at dead end mains were longer residence times may be experienced.

Table 17-3 Gayndah Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Flocculation	Colour	Failure of flocculation	Recorded daily post sand filter	10 mL sample	Photometer	<5 Hazen	1. Check coagulation and flocculation process 1. Backwash filters and re-test if necessary	>15 Hazen	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary
Chorine Injection	Free Chorine	Excessive or under dosage of chlorine	Recorded daily at pre filtration	10 mL sample	Photometer	Lower – 0.1 mg/L Upper – 1.8 mg/L	2. Re-test and adjust dosage as required		
Sand Filter	Turbidity	Blocked Filters	Recorded daily post sand filter	10 mL sample	Turbidity meter	<0.15 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary	>0.2 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary 3. Divert filtered water to the lagoons if necessary 4. Drain the Clearwater Ground Reservoir if necessary 5. Replace filter layers if necessary

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Sand Filtration	Turbidity	Ineffective filtration for disinfection and protozoa removal	Recorded daily post sand filter	10 mL sample	Turbidity meter	<1 NTU	1. Backwash filters 2. Check clarifier 3. Re-test turbidity	>5 NTU	1. Retest 2. Check coagulation and flocculation process 3. Backwash filters and re-test if necessary 4. Investigate issues and rectify
pH Correction	pH	Failure of flocculation acidic/alkaline water	Record daily	10mL sample	pH electrode meter	>6.7 <8.3	1. Dose with caustic soda to raise pH or dose with hydrochloric acid to reduce pH 2. Retest	>6.5 <8.5	1. Dose with caustic soda to raise pH or dose with hydrochloric acid to reduce pH 2. Retest
Disinfection	UV Dose	Reduced effectiveness of UV	Continuous		SCADA	>500 J/cm^2	1. Operator attend the plant to investigate	<400 J/cm^2	1. Plant automatically shut down 2. Operator attend the plant to investigate

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Chorine Injection	Free Chorine	Excessive or under dosage of Chlorine	Recorded daily post 650kL clearwater ground reservoir at the WTP	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 5.0 mg/L	1. Re-test and adjust dosage as required	Lower - 0.2 mg/L Upper – 5.5 mg/L	1. Check dosing pumps and injection points and rectify 2. Test chlorine in Duke Ground Reservoirs 3. Flush and drain Duke Ground Reservoirs if required 4. Overdose: Turn off injection and run water to Duke Ground reservoir until chlorine level is within normal parameters 5. Underdose: Add chlorine until level is within normal parameters
Reticulation • Test Point 2 (Showgrounds) • Test Point 3 (Dowsett Park) • Test Point 4 (Gayndah Airport) • Test Point 5 (Pioneer Place) • Test Point 6 (Zonhoven Park)	Chlorine residual	Biological Contamination (Microbial Growth)	Recorded Weekly	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	1. Check chlorine dosing at WTP	Lower – 0.2 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing at WTP 2. If > than 5 mg/L flush reticulation mains and Duke Ground Reservoirs 3. Overdose: Turn off injection and run water to Duke Ground reservoir until chlorine level is within normal parameters 4. Underdose: Add chlorine until level is within normal parameters

Mingo Crossing Operational Monitoring and CCP

The key elements of Mingo Crossing operational monitoring program are outlined in Table 17-4 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 7-2.

Table 17-4 Mingo Crossing Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Post filtration	Turbidity	Ineffective filtration for disinfection and protozoa removal	Recorded daily post UF		Nephelo-meter	<0.15 NTU	1. Check raw water quality 2. Check coagulation and flocculation process 3. Backwash filters 4. Re-test turbidity	>0.2 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test. 3. Divert filtered water to irrigation if necessary 4. Replace filter layers if necessary
Chorine injection	Free chlorine	Excessive or under dosage of chlorine	Recorded twice weekly from the potable water tank	10 mL sample	Photometer	Lower – 0.7 mg/L Upper – 1.7 mg/L	Re-test and adjust dosage as required	Lower – 0.5 mg/L Upper – 5 mg/L	1. Test chlorine in potable water tank 2. Overdose: Turn off dosing pump, drain and refill potable water tank until target chlorine level is within normal parameters. 3. Underdose: Add chlorine until level is within normal parameters
Chlorine residual • Treated Water Sample Point (See water supply map Figure 7-2)	Free chlorine	Biological Contamination (Microbial Growth)	Recorded Weekly	10 mL sample	Photometer	Lower – 0.7 mg/L Upper – 1.7 mg/L	Check chlorine dosing and adjust	Lower – 0.5 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing and adjust 2. Overdose: Turn off dosing pump, drain and refill potable water tank until target chlorine level is within normal parameters.

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
									3. Underdose: Add chlorine until level is within normal parameters

Monto Operational Monitoring and CCP

The key elements of the Monto operational monitoring program are outlined in Table 17-5 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 8-1 and Figure 8-2. The locations for Chlorine Residual testing are generally located at dead end mains were longer residence times may be experienced.

Table 17-5 Monto Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Disinfection	UV Dose	Reduced effectiveness of UV	Continuous		SCADA	>500 J/cm²	1. Operators attend the plant to investigate	<400 J/cm²	1. Plant automatically shut down 2. Operators attend the plant to investigate
Chorine Injection	Free chlorine	Excessive or under dosage of chlorine	Recorded daily post UV	10 mL sample	Photometer	Lower – 1.2 mg/L Upper – 3.5 mg/L	1. Re-test and adjust dosage as required	Lower – 0.5 mg/L Upper – 5.0 mg/L	1. Check dosing pumps and injection points and rectify 2. Test chlorine in Elevated Storage 3. Flush and drain Elevated Storage if required 4. Overdose: Turn off injection and run water to Elevated Storage until chlorine level is within normal parameters 5. Underdose: Add chlorine until level is within normal parameters

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Reticulation • Test Point 1 (Don McInnes) • Test Point 2 (Monto Bowls Club) • Test Point 3 (Forsyth Triangle) • Test Point 4 (Luthje Rd) • Test Point 5 (Mill Rd)	Chlorine residual	Biological Contamination (Microbial Growth)	Recorded weekly	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	1. Check chlorine dosing at WTP	Lower – 0.2 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing at WTP 2. If > than 5 mg/L flush reticulation mains and Elevated Storage 3. Overdose: Turn off injection and run water to Elevated Storage until chlorine level is within normal parameters 4. Underdose: Add chlorine until level is within normal parameters

Mount Perry Operational Monitoring and CCP

The key elements of the Mount Perry operational monitoring program are outlined in Table 17-6 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 9-1 and Figure 9-2.

Table 17-6 Mount Perry Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Chorine Injection	Free chlorine	Excessive or under dosage of Chlorine	Recorded weekly post Ground Reservoir	10 mL sample	Photometer	Lower – 1.0 mg/L Upper – 3.5 mg/L	1. Re-test and adjust dosage as required	Lower – 0.5 mg/L Upper – 5.0 mg/L	Test chlorine in reservoir. Overdose: Turn off chlorine dosing and run water to the Ground Reservoir until chlorine levels are within normal parameters Underdose: Add chlorine until level is within normal parameters
Reticulation • Test Point 1 (Community Complex) • Test Point 2 (Hunter St)	Residual Chlorine	Biological Contamination (Microbial Growth)	Recorded weekly	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	1. Check chlorine dosing at WTP and adjust	Lower – 0.2 mg/L Upper – 5 mg/L	1. Check chlorine dosing at WTP and adjust 2. Flush reticulation mains and Ground Reservoir 3. Overdose: Turn off chlorine dosing and run water to the Ground Reservoir until chlorine levels are within normal parameters 4. Underdose: Add chlorine until level is within normal parameters

Mulgildie Operational Monitoring and CCP

The key elements of the Mulgildie operational monitoring program are outlined in Table 17-7 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 10-1 and Figure 10-2.

Table 17-7 Mulgildie Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Sand Filter	Turbidity	Ineffective filtration for manganese and iron removal	Recorded weekdays post sand filter	10 mL sample	Turbidity meter	<0.15 NTU	1. Backwash filters 2. Check settling tank 3. Test chlorine level 4. Re-test turbidity 5. Increase chlorine dose if necessary	>2 NTU	1. Backwash filters and re-test. 2. Replace filter layers if necessary.
Chorine Injection	Free Chlorine	Excessive or under dosage of Chlorine	Recorded weekdays post clearwater storage tanks	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 4.0 mg/L	1. Re-test and adjust dosage as required	Lower - 0.2 mg/L Upper – 5.0 mg/L	1. Test chlorine in clearwater reservoir. 2. Overdose: Turn off injection and clearwater pump. Run water to clearwater reservoirs until chlorine level is within normal parameters 3. Underdose: Add chlorine until level is within normal parameters
Chorine Injection	Free Chlorine	Excessive or under dosage of Chlorine	Recorded weekdays post elevated storage tank	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	1. Check chlorine dosing at WTP	Lower – 0.2 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing at WTP 2. If > than 5 mg/L flush reticulation mains

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
pH Correction	pH	Failure of flocculation. Acidic/alkaline water	Recorded weekly post clearwater reservoirs	10 mL sample	Photometer	>6.7 <8.3	1. Dose with caustic soda to raise pH or dose with hydrochloric acid to reduce pH. 2. Retest	>6.5 <8.5	1. Dose with caustic soda to raise pH or dose with hydrochloric acid to reduce pH. 2. Retest
Reticulation • Test Point 2 (Wattle St)	Chlorine Residual	Biological Contamination (Microbial Growth)	Recorded weekly	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	Check chlorine dosing at WTP	Lower – 0.2 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing at WTP 2. If > than 5 mg/L flush reticulation mains and Elevated Water Tower 3. Overdose: Turn off injection and run water to Clearwater Storage Tanks until chlorine level is within normal parameters 4. Underdose: Add chlorine until level is within normal parameters

Mundubbera Operational Monitoring and CCP

The key elements of the Mulgildie operational monitoring program are outlined in Table 17-8 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 11-1 and Figure 11-2.

Table 17-8 Mundubbera Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Raw water	Iron	Discoloured Water	Recorded Daily	10 mL sample	Photometer	0.3 (Aesthetic)	1. Increase oxidisation agent (potassium permanganate) 2. Increase detention time		
Raw water	Manganese	Discoloured Water	Recorded Daily	10 mL sample	Photometer	<0.1	1. Increase oxidisation agent (Sodium Hypo) 2. Backwash filters 3. Increase detention time	>0.5	1. Increase oxidisation agent (Sodium Hypo) 2. Backwash filters 3. Increase detention time
Flocculation	Colour	Failure of flocculation	Recorded daily post sand filter	10 mL sample	Photometer	<5 Hazen	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary	>15 Hazen	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary
Chorine Injection	Free Chlorine	Excessive or under dosage of chlorine	Recorded daily prior to filtration	10 mL sample	Photometer	Lower – 0.1 mg/L Upper –1.5 mg/L	1. Re-test and adjust dosage as required		
Sand Filter	Turbidity	Blocked Filters	Recorded daily post sand filter	10 mL sample	Turbidity meter	<0.2 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary	>5 NTU	1. Check coagulation and flocculation process 2. Backwash filters and re-test if necessary
Sand Filter	Turbidity	Ineffective filtration for disinfection and protozoa removal	Recorded daily post sand filter	10 mL sample	Photometer	<0.15 NTU	1. Backwash filters 2. Check clarifier 3. Test chlorine level 4. Re-test turbidity	>0.2 NTU	1. Backwash filters 2. Check flocculation/ coagulation 3. Retest turbidity

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
pH Correction	pH	Failure of flocculation. Acidic/alkaline water	Recorded daily	10 mL sample	Photometer	> 6.5 < 8.5	1. Dose with caustic soda to raise pH or dose with hydrochloric acid to reduce pH. 2. Retest	> 6.5 <8.5	1. Dose with caustic soda to raise pH or dose with hydrochloric acid to reduce pH. 2. Retest
Chlorine injection	Free Chlorine	Excessive or under dosage of chlorine	Recorded daily at the inlet to the 2.8 ML Ground Reservoir	10 mL sample	Photometer	Lower – 0.5 mg/L Upper –5.0 mg/L	1. Re-test and adjust dosage as required	Lower – 0.2 mg/L Upper – 5.5 mg/L	1. Test chlorine in balancing tank. 2. Overdose: Turn off injection and run water to Ground Reservoir until chlorine level is within normal parameters 3. Underdose: Add chlorine until level is within normal parameters
Reticulation • Test Point 2 (Frank McCauley St) • Test Point 3 (Cnr Hardy & Mitchell St) • Test Point 4 (River Pump Shed Orton St) • Test Point 5 (No 5 SPS Jack Parr St) • Test Point 6 (No 4 SPS Billabong Motel)	Chlorine Residual	Biological Contamination (Microbial Growth)	Recorded Weekly	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	2. Check chlorine dosing at WTP	Lower – 0.2 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing at WTP 2. If > than 5 mg/L flush reticulation mains and Elevated Reservoir 3. Overdose: Turn off injection and run water to Ground Reservoir until chlorine level is within normal parameters 4. Underdose: Add chlorine until level is within normal parameters

Paradise Dam Operational Monitoring and CCP

The key elements of the Paradise Dam operational monitoring program are outlined in Table 17-9 and the critical control point is highlighted in orange. Sampling locations for the parameters listed in this table are shown in Figure 12-2.

Table 17-9 Paradise Dam Operational Monitoring

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
Post filtration	Turbidity	Ineffective filtration for disinfection and protozoa removal	Recorded daily	10 mL sample	Turbidity meter	<0.15 NTU	1. Check raw water quality 2. Backwash filters 3. Re-test turbidity	>0.2 NTU	1. Backwash filters and re-test. 2. Replace filter layers if necessary.
Chorine injection	Free chlorine	Excessive or under dosage of chlorine	Recorded weekly at post injection point	10 mL sample	Photometer	Lower – 2.0 mg/L Upper – 3.8 mg/L	Re-test and adjust dosage as required	Lower – 1.0 mg/L Upper – 5.0 mg/L	1. Test chlorine in Clearwater Storage Tank 2. Overdose: Turn off dosing pump, drain and refill Clearwater Storage Tanks until target chlorine level is within normal parameters. 3. Underdose: Add chlorine until level is within normal parameters
Chorine injection	Free chlorine	Excessive or under dosage of chlorine	Recorded daily post clearwater storage tank	10 mL sample	Photometer	Lower – 1.5 mg/L Upper – 3.8 mg/L	Re-test and adjust dosage as required	Lower – 0.8 mg/L Upper – 5.0 mg/L	1. Check chlorine dosing at WTP and adjust 2. Flush reticulation mains and clearwater storage tank
Chlorine residual • Sample Point 1 (treated) (See water supply map Figure 12-2)	Free chlorine	Biological Contamination (Microbial Growth)	Recorded Weekly	10 mL sample	Photometer	Lower – 0.5 mg/L Upper – 3.5 mg/L	Check chlorine dosing at WTP and adjust	Lower – 0.2 mg/L Upper – 5 mg/L	1. Check chlorine dosing and adjust 2. Flush learwater storage tank 3. Overdose: Turn off dosing pump, drain and

Operational Control Points	Operational Parameter	Associated Hazard	Monitoring Requirements			Target Limits	Action if Target Level Exceeded	Critical Limit	Action if Critical Level Exceeded
									refill Clearwater Storage Tank until target chlorine level is within normal parameters. 4. Underdose: Add chlorine until level is within normal parameters

18. APPENDIX B: VERIFICATION MONITORING PROGRAMS

Verification Monitoring

The following tables details the Verification Monitoring conducted by NBRC. NBRC engages QHFSS to perform both weekly and monthly testing of water across the nine water schemes. The following tables include the parameters to be monitored, monitoring locations, frequency to ensure compliance with drinking water quality criteria; and how excursions are managed.

Biggenden Verification Monitoring

As the Biggenden system supplies a population less than 1000, biological verification monitoring is performed monthly. Key elements of Biggenden's verification monitoring table are listed in Table 18-1.

Table 18-1 Biggenden Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected	NA	Biological contamination	Monthly. One sample is obtained.	Monthly. Two samples are obtained from the residual chlorine test locations within the reticulation.	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2 1. DNRME and Qld Health notified.
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Monthly. One sample is obtained.	Monthly. The same two samples are obtained as above	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Internal investigation triggered.

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Physio Chemical • Turbidity • pH • Temp	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	With all micro and Chlorine Samples	With all micro and Chlorine Samples	Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
General Metals • Manganese Copper Iron Aluminium	• 0.5 2 - 0.2	• 0.1 1 2 -	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Heavy Metals • Arsenic	• 0.01	• NA	Exceedance of health-based limits.	12 monthlies. One sample obtained.		QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented – investigate alternate water sources
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.		Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Total THMs	200mg/L	NA	Exceedance of health-based limits.		Monthly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 1. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit		Monthly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Monthly**	Monthly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Eidsvold Verification Monitoring

The Eidsvold system services a population less than 1000, biological verification monitoring is performed monthly. Key elements of Eidsvold's verification monitoring table are listed in Table 18-2.

Table 18-2 Eidsvold Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected	NA	Biological contamination	Monthly. One sample is obtained.	Monthly. Two samples are obtained from the residual chlorine test locations shown in Table 15.2	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2. 3. DNRME and Qld Health notified.
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Monthly. One sample is obtained.	Monthly. The same samples as above are obtained from the residual chlorine test locations shown in Table 15.2	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 4. Internal investigation triggered.

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Physio Chemical • Turbidity • pH • Temp	–	• 5 NTU • 6.5 to 8.5		With all micro and Chlorine Samples	With all micro and Chlorine Samples	Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
General Metals • Manganese Copper Iron Aluminium	• 0.5 2 - 0.2	• 0.1 1 2 -	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Total THMs	200mg/L	NA	Exceedance of health-based limits.		Quarterly	QHFSS	3. Water Quality Data received from analysing authority. 4. Incident report completed identifying the cause of exceedance. 5. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit		Quarterly	QHFSS	4. Water Quality Data received from analysing authority. 5. Incident report completed identifying the cause of exceedance. 6. Corrective action implemented and documented
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Annually**	Annually	QHFSS	4. Water Quality Data received from analysing authority. 5. Incident report completed identifying the cause of exceedance. 6. Corrective action implemented and documented

Gayndah Verification Monitoring

As the Gayndah system serves more than 1000 population biological verification monitoring is performed weekly. Key elements of Gayndah's verification monitoring table are listed in Table 18-3.

Table 18-3 Gaydndah Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected		Biological contamination	Weekly One sample is obtained.	Weekly. Two samples are obtained from the residual chlorine test locations shown in Table 15.3	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2. 3. DNRME and Qld Health notified.
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Weekly. One sample is obtained.	Weekly. The same samples as above obtained from the sample points within the reticulation.	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Internal investigation triggered.
Physio Chemical • Turbidity • pH • Temp	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	– With all micro and Chlorine Samples	With all micro and Chlorine Samples	Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
General Metals • Manganese Copper	• 0.5 2	• 0.1 1	Exceedance of health-based limits.	-	Monthly.	QHFSS	1. Water Quality Data received from analysing authority.

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Iron Aluminium	- 0.2	2 -			One sample is obtained from one of the sample points within the reticulation.		2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Total THMs	200mg/L	NA	Exceedance of health-based limits.		Monthly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit		Monthly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Annually**	Annually	QHFSS	1. Water Quality Data received from analysing authority.

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
							2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Mingo Crossing Verification Monitoring

As the Mingo Crossing system supplies a population less than 1000, biological verification monitoring is performed monthly. Key elements of Mingo Crossing's verification monitoring table are listed in Table 18-4.

Table 18-4 Mingo Crossing Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected	NA	Biological contamination	Monthly. One sample is obtained.	-	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2. 3. DNRME and Qld Health notified.
• Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Monthly. One sample is obtained.	-	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Internal investigation triggered.
Physio Chemical • Turbidity • pH • Temp •	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	With all Micro and chlorine samples		Inhouse	1. Water Quality Data received from analysing authority. **2.** Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
General Metals • Manganese Copper Iron • Aluminium	• 0.5 2 - • 0.2	• 0.1 1 2 • -	Exceedance of health-based limits.	**Annual**		QHFSS	1. Water Quality Data received from analysing authority. **2.** Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.	**Annual**		QHFSS	1. Water Quality Data received from analysing authority. **2.** Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Total THMs	200mg/L	NA	Exceedance of health-based limits.	Twice Annually		QHFSS	3. Water Quality Data received from analysing authority. 4. Incident report completed identifying the cause of exceedance. 4. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit	Twice Annually		QHFSS	3. Water Quality Data received from analysing authority. 4. Incident report completed identifying the cause of exceedance. 4. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Annually**		QHFSS	3. Water Quality Data received from analysing authority. 4. Incident report completed identifying the cause of exceedance. 4. Corrective action implemented and documented

Monto Verification Monitoring

The Monto system services a population greater than 1000 so biological verification monitoring is performed weekly. Key elements of Monto's verification monitoring table are listed in Table 18-5.

Table 18-5 Monto Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected		Biological contamination	Weekly. One sample is obtained.	Weekly. Two samples are obtained from the residual chlorine test locations shown in Table 15.4	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2. 3. DNRME and Qld Health notified.
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Weekly. One sample is obtained.	Weekly. The same samples as above are obtained from the sample points within the reticulation.	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Technical Services Manager notified. 2. Internal investigation triggered.
Physio Chemical • Turbidity • pH • Temp	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	With all micro and Chlorine Samples	With all micro and Chlorine Samples	Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
General Metals • Manganese Copper Iron • Aluminium	• 0.5 2 - • 0.2	• 0.1 1 2 • -	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Total THMs	200mg/L	NA	Exceedance of health-based limits.		Quarterly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit		Quarterly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Annually**	Annually	QHFSS	1. Water Quality Data received from analysing authority.

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
							2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Mount Perry Verification Monitoring

The Mount Perry system services a population less than 1000 and biological verification monitoring is performed monthly. Key elements of Mount Perry's verification monitoring table are listed in Table 18-6.

Table 18-6 Mount Perry Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected		Biological contamination	Monthly. One sample is obtained.	Monthly. One sample is obtained from the residual chlorine test locations shown in Table 15.5	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2. 3. DNRME and Qld Health notified.
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Monthly. One sample is obtained.	Monthly. The same samples as above obtained from the sample points within the reticulation.	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Internal investigation triggered.
Physio Chemical • Turbidity • pH • Temp	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	With all micro and Chlorine Samples	With all micro and Chlorine Samples	Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
General Metals • Manganese Copper Iron Aluminium	• 0.5 2 - 0.2	• 0.1 1 2 -	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.		Monthly. The same sample as above is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Total THMs	200mg/L	NA	Exceedance of health-based limits.		Quarterly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit		Quarterly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Annually**	Annually	QHFSS	1. Water Quality Data received from analysing authority.

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
							2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Mulgildie Verification Monitoring

The Mulgildie system services a population less than 1,000 and biological verification monitoring is performed monthly. Key elements of Mulgildie's verification monitoring table are listed in Table 18-7.

Table 18-7 Mulgildie Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected		Biological contamination	Monthly. One sample is obtained.	Monthly. One sample is obtained from the residual chlorine test locations shown in Table 15.6	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2. 3. DNRME and Qld Health notified.
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Monthly. One sample is obtained.	Monthly. The same samples as above obtained from the sample points within the reticulation.	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Internal investigation triggered.
Physio Chemical • Turbidity • pH • Temp	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	With all micro and Chlorine Samples	With all micro and Chlorine Samples	Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
General Metals • Manganese Copper Iron Aluminium	• 0.5 2 - 0.2	• 0.1 1 2 -	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.		Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Total THMs	200mg/L	NA	Exceedance of health-based limits.		Tweice Annually	QHFSS	3. Water Quality Data received from analysing authority. 4. Incident report completed identifying the cause of exceedance. 4. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit		Twice Annually	QHFSS	3. Water Quality Data received from analysing authority. 4. Incident report completed identifying the cause of exceedance. 4. Corrective action implemented and documented

Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Annually**	Annually	QHFSS	3. Water Quality Data received from analysing authority. 4. Incident report completed identifying the cause of exceedance. 4. Corrective action implemented and documented

Mundubbera Verification Monitoring

The Mundubbera system services a population greater than 1000 and biological verification monitoring is performed weekly. Key elements of Mundubbera's verification monitoring table are listed in Table 18-8.

Table 18-8 Mundubbera Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected		Biological contamination	Weekly. One sample is obtained.	Weekly. Two samples are obtained from the residual chlorine test locations shown in Table 15.7	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2. 3. DNRME and Qld Health notified.
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Weekly. One sample is obtained.	Weekly. The same samples as above obtained from the sample points within the reticulation.	QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Internal investigation triggered.
Physio Chemical • Turbidity • pH • Temp	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	With all micro and Chlorine Samples	With all micro and Chlorine Samples	Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
General Metals • Manganese Copper Iron Aluminium	• 0.5 2 - 0.2	• 0.1 1 2 -	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.	-	Monthly. One sample is obtained from one of the sample points within the reticulation.	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Total THMs	200mg/L	NA	Exceedance of health-based limits.		Monthly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit		Monthly	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	**Annually**	Annually	QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Paradise Dam Verification Monitoring

As the Paradise Dam system supplies a population less than 1000, biological verification monitoring is performed monthly. Key elements of Paradise Dam's verification monitoring table are listed in Table 18-9.

Table 18-9 Paradise Dam Verification Monitoring

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Bacterial • *E. coli*	Nil detected	NA	Biological contamination	Monthly. One sample is obtained.		QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Refer to Table 15-2 3. DNRME and Qld Health notified.

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Total coliforms	NA NBRC critical limit set at 20 cfu/100mL	NA	Biological contamination	Monthly. One sample is obtained.		QHFSS	1. NBRC Senior Water and Wastewater Supervisor and Water and Wastewater Manager notified. 2. Internal investigation triggered.
Physio Chemical • Turbidity • pH • Temp	• NA • NA	• 5 NTU • 6.5 to 8.5	Reduced aesthetic quality.	With all micro and Chlorine Samples		Inhouse	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
General Metals • Manganese Copper Iron • Aluminium	• 0.5 2 - • 0.2	• 0.1 1 2 • -	Exceedance of health-based limits.	Monthly. One sample is obtained from one of the sample points within the reticulation.		QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Anions • Nitrate	• 50	• NA	Exceedance of health-based limits.	Annually		QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Contaminant Class	ADWG Value (mg/L unless specified)		Associated Hazard	Frequency		Analysing Authority	Response to Exceedances
	Health	Aesthetic		At WTP Outlet	In distribution system		
Total THMs	200mg/L	NA	Exceedance of health-based limits.	Twice Annually		QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Chlorates	0.8mg/L	QH	Detection of chemical which may cause harm with no ADWG Limit	Twice annually		QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented
Arsenic	0.01 mg/L	Heavy Metals	Health Limit	Annually		QHFSS	1. Water Quality Data received from analysing authority. 2. Incident report completed identifying the cause of exceedance. 3. Corrective action implemented and documented

Summary

Table 16-19 Verification Monitoring Summary

Parameter	Control Limit	Suite	Type	Biggenden	Eidsvold	Gayndah	Mingo Crossing CP	Monto	Mount Perry	Mulgildie	Mundubbera	Paradise Dam CP
Chlorates (Treated)	0.8mg/L	Disinfection By-products	Verification/ Source Risk	Monthly	Quarterly	Monthly	Twice Annually	Quarterly	Quarterly	Twice Annually	Monthly	Twice Annually

Parameter	Control Limit	Suite	Type	Biggenden	Eidsvold	Gayndah	Mingo Crossing CP	Monto	Mount Perry	Mulgildie	Mundubbera	Paradise Dam CP
Total THMs (Treated)	0.25mg/L	Disinfection By-products	Verification	Monthly	Quarterly	Monthly	Twice Annually *	Quarterly	Quarterly	Twice Annually *	Monthly	Twice Annually *
Aluminium (Treated)	0.2mg/L	Metals	Verification	Monthly	Annually	Annually	Annually	Annually	Annually	Annually	Annually	Annually
E. Coli	0 CFU	Microbial	Microbial	3x monthly	3x monthly	3x monthly	1x Monthly	3x monthly	2x Monthly	2x Monthly	3x monthly	1x Monthly
Total Coliforms	20 CFU/100mL	Microbial	Microbial	3x monthly	3x monthly	3x monthly	1x Monthly	3x monthly	2x Monthly	2x Monthly	3x monthly	1x Monthly
Turbidity	5 NTU	Physical	Effective Disinfection	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]
pH	6.5-8.5	Physical	Effective Disinfection	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]
Temperature	22C	Physical	Effective Disinfection	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]	All [@]
Manganese	0.5mg/L	Metals	Metals	Monthly	Monthly	Monthly	Annually	Monthly	Monthly	Monthly	Monthly	Annually
Copper	2 mg/L	Metals	Metals	Monthly	Monthly	Monthly	Annually	Monthly	Monthly	Monthly	Monthly	Annually
Arsenic (treated)	0.01 mg/L	Heavy Metals	Health	Monthly	Annually	Annually	Annually	Annually	Annually	Annually	Annually	Annually
Iron	2mg/L	Metals	Aesthetic	Monthly	Monthly	Monthly	Annually	Monthly	Monthly	Monthly	Monthly	Annually
Nitrate	50mg/L	Anions	SWA	Monthly	Monthly	Monthly	Annually	Monthly	Monthly	Annually	Monthly	Annually
[#] *Summer*												
** Late Spring & Late Summer*												
[@] with all micro and disinfection samples												

Other Monitoring

Other Monitoring												
Parameter	**Control Limit**	**Suite**	**Type**	**Biggenden**	**Eidsvold**	**Gayndah**	**Mingo Crossing CP**	**Monto**	**Mount Perry**	**Mulgildie**	**Mundubbera**	**Paradise Dam CP**
Tebuthiuron (Raw)	0.2mg/L	Pesticides	Source Risk	Annually[#]	Annually[#]	Quarterly	Annually[#]	Annually[#]	Annually[#]	Annually[#]	Quarterly	Annually[#]
TCCP (Raw)	0.1mg/L	Pesticides	Source Risk	Annually[#]	Annually[#]	Quarterly	Annually[#]	Annually[#]	Annually[#]	Annually[#]	Quarterly	Annually[#]
Imidacloprid (Raw)	0.2mg/L	Pesticides	Source Risk	Annually[#]	Annually[#]	Quarterly	Annually[#]	Annually[#]	Annually[#]	Annually[#]	Quarterly	Annually[#]
[#] *Summer*												
** Late Spring & Late Summer*												