Drinking Water Quality Management Plan

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Approval and Revision Control

Approved by	Title	Signature	Date
Nigel Deacon	Manager Water and Waste		20/09/2022

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Revision

Revision No.	Title	Revised By	Date
1	Drinking Water Quality Management Plan	Sean Fallis	25/6/2015
2	Drinking Water Quality Management Plan	Sean Fallis	28/9/2018
3	Drinking Water Quality Management Plan	Sean Hinton	24/8/2020
4	Drinking Water Quality Management Plan	Sean Hinton	10/12/2020
5	Drinking Water Quality Management Plan	Nigel Deacon	30/03/2021
6	Drinking Water Quality Management Plan	Peter Stapleton	20/09/22

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EXECUTIVE SUMMARY

The Livingstone Shire Council (LSC) Drinking Water Quality Management Plan (DWQMP) has been prepared in accordance with section 94 of the *Water Supply (Safety and Reliability) Act*. The purpose of the DWQMP is to protect public health through the comprehensive management of drinking water quality.

The drinking water quality management plan follows a risk-based management approach and demonstrates how LSC effectively manages the drinking water services on the Capricorn Coast and Marlborough from catchment to tap, and from point of supply from Rockhampton Regional Council to tap for The Caves and Nerimbera water supply scheme to ensure that a safe and reliable supply of drinking water is provided to all our customers.

The DWQMP is structured in four parts to provide an overview of the drinking water service, and the key management measures that apply to all schemes. Each drinking water scheme is detailed separately to provide a site based management plan suitable for use by the operators of the schemes. It is intended that these documents are used in conjunction with the operational procedures to ensure effective management of the drinking water supply.

This plan identifies the key hazards and hazardous events which may affect the services, and after identifying the preventative measures that are in place, assesses the mitigated risk that these hazards pose to the service. Where mitigated risks are considered unacceptable, further preventative measures are identified as improvement items. These improvement items are prioritised and recommended to Council for funding as considered appropriate.

1 Purpose

The Livingstone Shire Council (LSC) Drinking Water Quality Management Plan (DWQMP) documents the water services supplied by Council. The DWQMP identifies, and demonstrates how Council manages the risks to the water supply services provided. The DWQMP is based on the best practice guidelines of the Australian Drinking Water Guidelines.

1.1 Plan structure

The DWQMP is structured to address the 12 Elements of the Australian Drinking Water Guidelines. Part 1 of the DWQMP provides:

- Commitment to drinking water quality (Element 1)
- A high level overview of the drinking water services,
- Description of the Risk Methodology used (partially meeting Element 2)
- Emergency Response Plan, (Element 6)
- Supporting Requirements (Elements 7-10)
- Review and Audit requirements (Elements 11-12)

Parts 2 to 5 of the DWQMP are scheme based; each scheme individually addresses the:

- Assessment of the drinking water supply system (Element 2)
- Preventative measures for drinking water quality (Element 3)
- Operational procedures and process control (Element 4)
- Verification of drinking water quality (Element 5)

In so doing, the regulatory requirements (detailed in Section 2) are also addressed.

1.2 Commitment to Drinking Water Quality

LSC will:

- Take all reasonable action to provide its customers with reliable and continuous services.
- Endeavour to ensure that the water supplied meets the health and aesthetic guidelines stated in the Australian Drinking Water Quality Guidelines.

2 Regulatory Requirements

Drinking Water Quality Management is regulated in part by the following Acts and Regulations.

- *Water Supply (Safety and Reliability) Act 2008*
    - Water Supply (Safety and Reliability) Regulation 2011
- *Public Health Act 2005*
    - Public Health Regulation 2018

Water management is also impacted by other Acts (such as the *Water Act 2000*, and the *Environment Protection Act 1994*), but these are outside the scope of the Drinking Water Quality Management Plan.

3 Service Details

Livingstone Shire Council

Registered Service Provider ID 556

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3.1 Overview of Drinking Water Schemes

LSC de-amalgamated from Rockhampton Regional Council on 1st January 2014. LSC defines 4 drinking water schemes:

1. Capricorn Coast Water Supply Scheme (Multiple provider arrangement).
2. The Caves Water Supply Scheme (Multiple provider arrangement).
3. Nerimbera Water Supply Scheme (Multiple provider arrangement).
4. Marlborough Water Supply Scheme (LSC only).

LSC also operates the non-potable Ogmore water supply.

The Capricorn Coast Scheme centres on Yeppoon, the Caves and Nerimbera schemes (Figure 2) are located close to Rockhampton, and the Marlborough Water Supply Scheme (Figure 1) is located at Marlborough. The current Council boundary is identified in green for the Figures 1 and 2.

A high level schematic showing all of LSC's water supply schemes, reservoirs, and key trunk mains is provided in Figure 3.

Figure 1 Marlborough location map

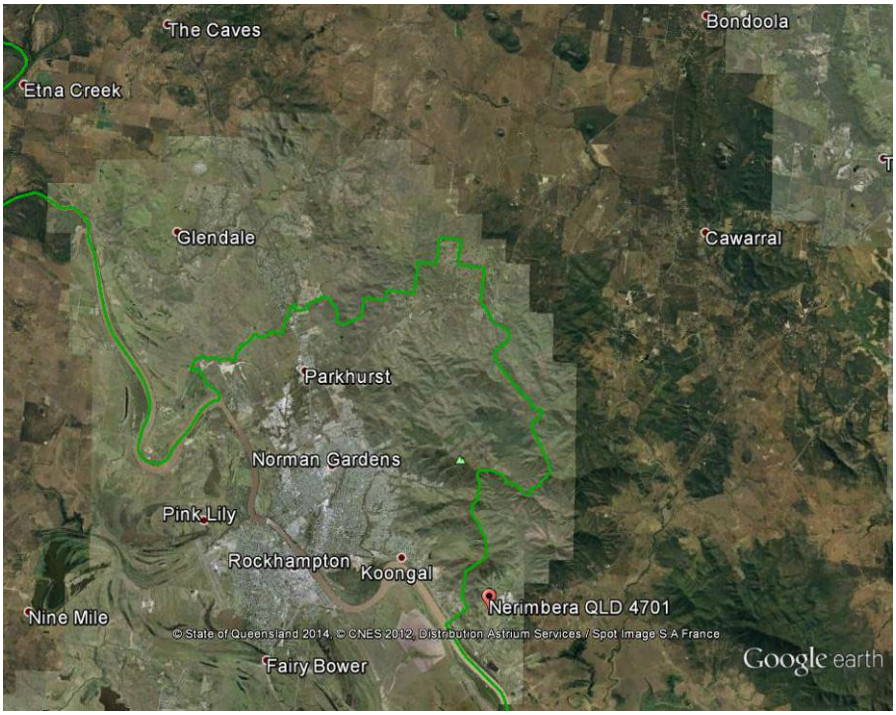


Figure 2 Nerimbera and the Caves location map

3.2 High Level Scheme Description

Operationally, these schemes are unique and each scheme has different considerations.

The Capricorn Coast Scheme serves the communities of Yeppoon, The Causeway, Kinka Beach, Zilzie, Emu Park and Keppel Sands. The Mercure Capricorn Resort is a major customer at Yeppoon. Capricorn Coast has two distinct water supplies. The first supply is Water Park Creek which is harvested into the Kelly's Offstream Storage. Water from this storage is conventionally treated and disinfected at the Woodbury Water Treatment Plant

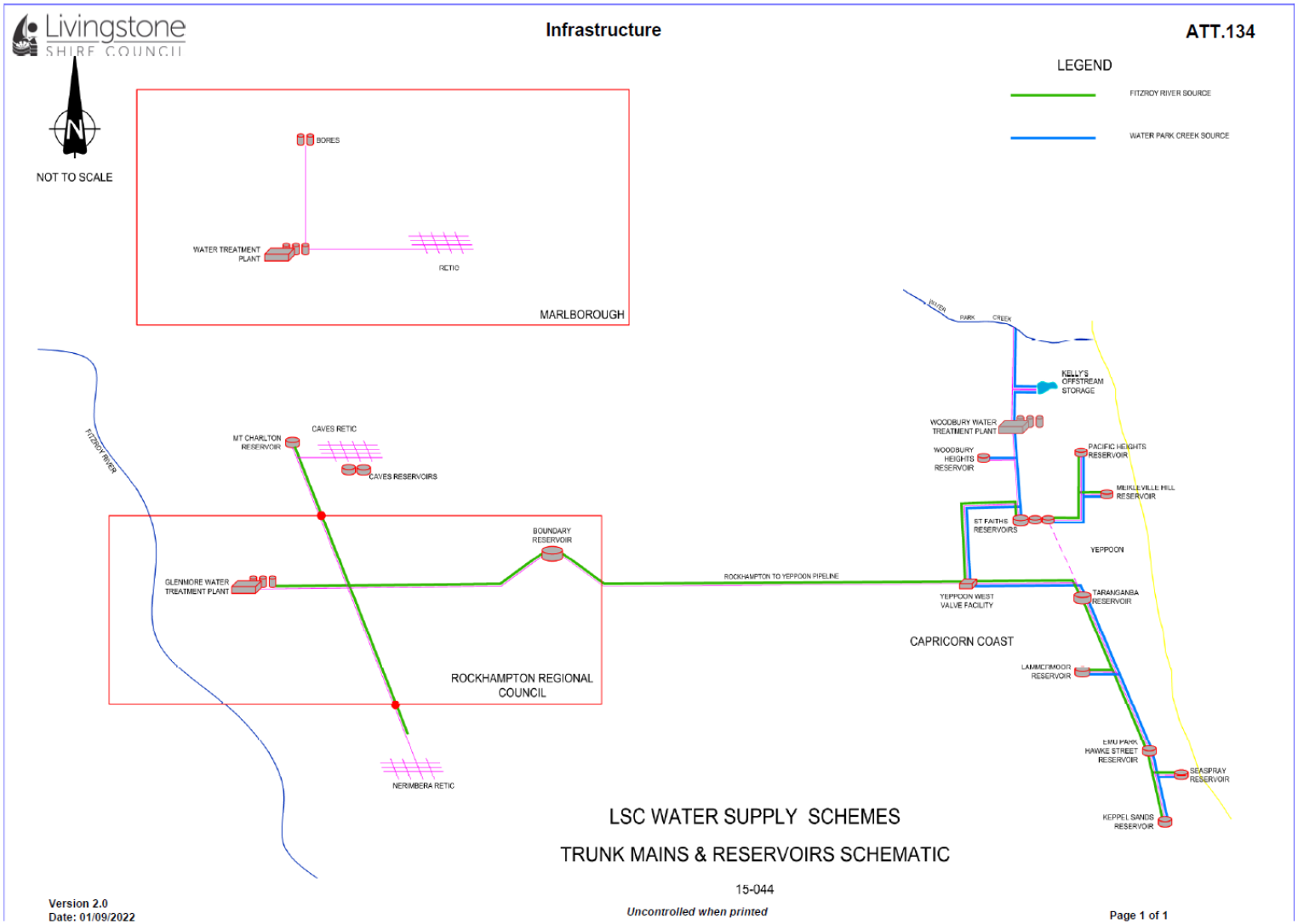
(WTP), which is operated by LSC. Water from the Woodbury WTP is supplemented by a second water supply via the Rockhampton to Yeppoon Water Supply Pipeline. This 40 km pipeline supplies water treated conventionally by FRW, a business unit of Rockhampton Regional Council, at their Glenmore WTP.

The water supplies for The Caves and Nerimbera areas are sourced from, and are zones within the Glenmore Water Treatment Plant reticulation network. LSC has no role in treating the water for these zones with the exception of re-chlorination at Mt Charlton reservoir in The Caves scheme. The local government boundary separates these areas from the Glenmore WTP reticulation network. The Caves and Nerimbera distribution areas are separate and distinct. The Caves area, located to the North of Rockhampton, includes the Mt Charlton, Ramsay Creek, Etna Creek, Glenlee, Glendale and Rockyview, and The Caves communities. The Capricorn Correctional Centre is a major customer in this zone. Water is supplied to LSC at the Ramsay St flow monitoring point. There is a small reticulation area off Argyle St where drinking water returns to FRW control. Areas of Parkhurst can also be backfed through the Ramsay Creek valve when FRW is not pumping into Mount Charlton. Both LSC and FRW agree that there is no further increase in public health risks to FRW due to this arrangement. Nerimbera is a small community located 8 km East of Rockhampton town centre, and pressure is maintained by the Lakes Creek Road Water Pump Station. LSC has no pumps or reservoirs in the Nerimbera scheme. There is an abattoir located at the far end of this reticulation zone, and this is considered to be a high-risk customer. There is no further treatment or re-chlorination in this zone.

The points of transfer between FRW and LSC are shown in Figure 3.

The Marlborough Water Supply Scheme is a bore water catchment to tap scheme that serves the community of Marlborough. Bore water is treated by bag filtration and/or reverse osmosis prior to disinfection. It is fully owned and operated by LSC.

Figure 3 - ATT.134 Livingstone Shire Council's Water Supply Schemes – High Level Schematic



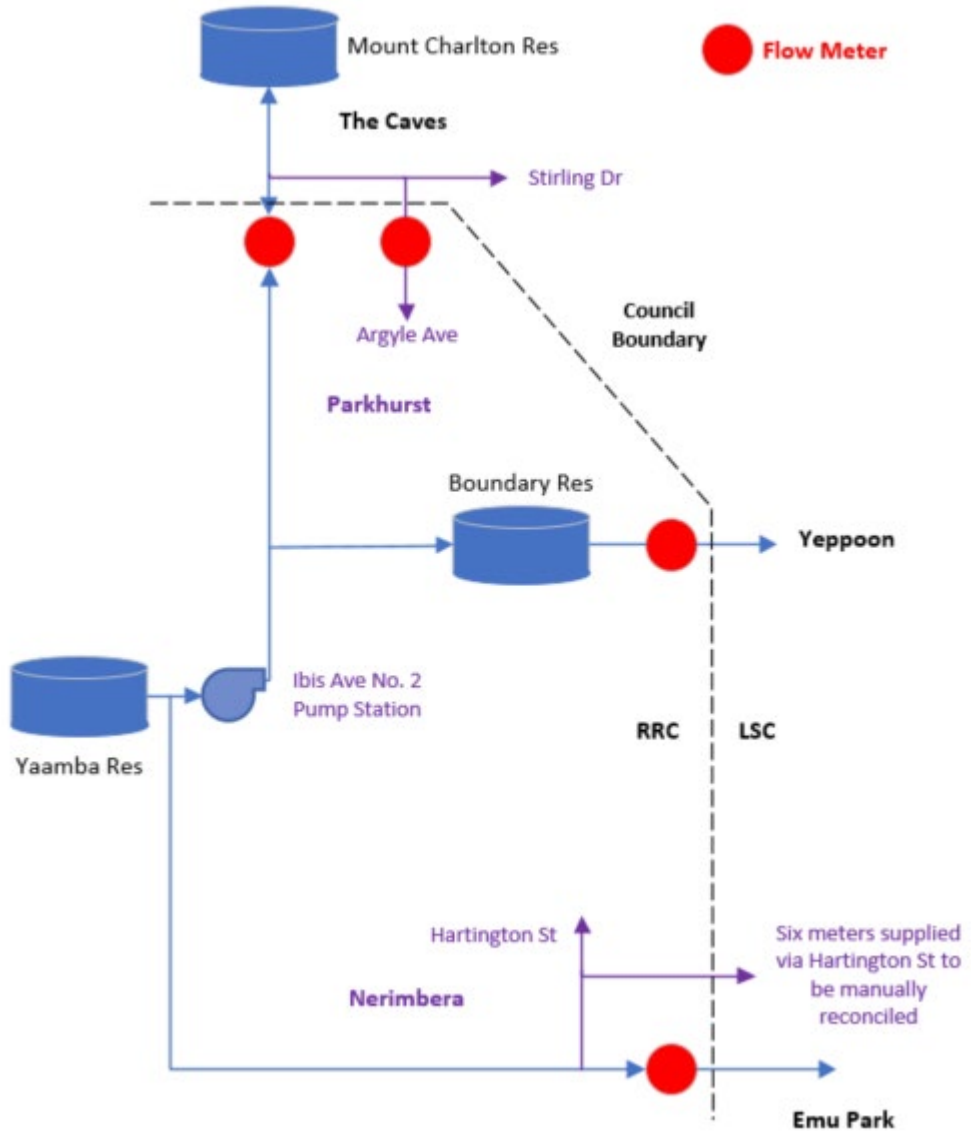


Figure 3 Points of transfer between FRW and LSC

3.3 Current Details and Future Demand

Table 1 Current and future connections, population and water demands

Scheme	Current (2023)			Future (2031)		
	Population	Connections	Demand (ML/day)	Population	Connections	Demand (ML/day)
Capricorn Coast	29123	11,649	12.2	34044	13618	14.3
The Caves	3655	1462	3.4	4273	1709	4
Nerimbera	248	99	1.3	289	116	1.5
Marlborough	140	56	0.035	164	65	0.04

Population estimates based on QLD Govt. Statistician's Office data; 2.5 persons per dwelling.

Future scenario based on QLD Govt. Statistician's Office projected 10 year growth rate of 1.6%.

Current and future demand can be met with existing infrastructure as the proportion of flow to Capricorn Coast from the pipeline is able to be significantly increased; population growth does not need to be considered as a hazard to the service at this time.

4 Stakeholders Relevant to Managing Drinking Water Quality

The following list includes the stakeholders that are involved in various aspects of drinking water quality management.

Table 2 Stakeholders involved in the management of drinking water quality

Name of Stakeholder	How Involved	Stakeholder Contribution
All Water Supply Schemes		
Department of Regional Development, Manufacturing and Water	*Water Supply (Safety and & Reliability) Act Water Act 2008*	Regulator of drinking and recycled water schemes, incident management (referred to in this document as the Regulator)
	Water Act 2000	Water quality and quantity monitoring and management
Queensland Health	*Public Health Act 2005 Water Fluoridation Act*	Primary responsibility for public health, incident management
Department of Environment and Science	*Environment Protection Act 1994*	Regulator for protection of the environment.
Capricorn Coast Water Supply Scheme		
Rockhampton Regional Council (trades as Fitzroy River Water)	Bulk water supply	Treats and supplies drinking water through the Rockhampton-Yeppoon water pipeline
Byfield Community Reference Panel	Water Park Creek raw water source	Water Park Creek waterways health management
Hospital/ Aged Care/ Child Care	Vulnerable customers	At risk customers
Surf Lakes	Reticulation supply to wave park	Major commercial customer
The Caves Water Supply Scheme		
Fitzroy River Water	Bulk water supply	Treats and supplies drinking water to The Caves scheme.
Capricorn Correctional Centre	Reticulation supply to Prison	Major customer, large population.
Nerimbera Water Supply Scheme		
Fitzroy River Water	Bulk water supply	Treats and supplies drinking water to Nerimbera scheme.
JBS Meatworks	Reticulation supply to abattoir	Major commercial customer
External Contractors/Suppliers		
Ixom	WTPs and Reservoirs	Treatment chemical supplier
Omega Chemicals	WTPs	Treatment chemical supplier
Coogee Chemicals	WTPs and Reservoirs	Treatment chemical supplier
SNF	WTPs	Treatment chemical supplier
Activated Carbon Technologies	WTPs	Treatment chemical supplier

5 Hazard Identification and Risk Assessment

5.1 Risk Methodology

LSC has adopted a risk assessment methodology that is adapted from the "Preparing a Drinking Water Quality Management Plan Supporting Information, September 2010" documentation provided by the Regulator. The methodology differs from the published version in that the consequence and uncertainty definitions have been tailored to more accurately reflect the circumstances at LSC. The methodology and definitions also vary from Council's Enterprise Risk Management Procedure to be better suited to this specific risk assessment activity.

Table 3 Risk Assessment Definitions and Descriptors

Likelihood	Descriptor
Almost Certain	Occurs more often than once per week
Likely	Occurs more often than once per month, and up to once per week
Possible	Occurs more often than once per year, and up to once per month
Unlikely	Occurs more often than once every 5 years, and up to once per year
Rare	Occurs less than once every 5 years
Consequence	**Descriptor**
Catastrophic	Potential acute health impact, significant community illness (> 4 people) expected
Major	Potential acute health impact, no community illness expected
Moderate	Repeated breach of chemical health guideline value
Minor	Isolated breach of chemical health guideline value, or widespread occurrence of parameter above aesthetic guideline
Insignificant	Potential isolated occurrence of aesthetic parameter above guideline value.
Uncertainty	**Descriptor**
Certain	The processes involved are thoroughly understood and supported by very extensive on site knowledge covering multiple drought and flood cycles, and/or high frequency (weekly or better) water quality monitoring data.
Confident	The processes involved are well understood and supported by extensive on site knowledge of more than one drought and flood cycle, and/or monthly water quality data
Reliable	There is a good understanding of the process which is supported by quarterly water quality data and/or operational experience that covers drought and flood years.
Estimate	The process is reasonably well understood, and/or data covers seasonal variations for drought and flood cycles.
Unreliable	The process is not well understood, and/or water quality data does not cover seasonal variations for drought and flood years.

Table 4 Risk matrix

	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

Medium and low risks are considered acceptable from a public health perspective. The rationale is that pathogen risks are acute and must retain major or catastrophic consequences, and as a result, Medium reflects the achievable risk in well-managed systems.

5.2 Risk Assessment Team

The hazard identification and risk assessments were reviewed and updated at a risk workshop held in August 2022 by a team consisting of:

Table 5 Risk assessment team

Attendee	Title	Years of experience in Livingstone/ Water Industry	Public Health Risk Training / Experience
Jon Edge	Coordinator Water & Sewerage Operations	14 / 23	Involved in previous 2014 & 2020 risk assessments
Michael Dalton	Technical Specialist	8 / 22	Formal training and involved in previous 2014 & 2020 risk assessments
John Massingham	Principal Process Systems Technician	8 / 22	Involved in previous 2014 & 2020 risk assessments
Peter Stapleton	Coordinator Water and Wastewater Process Operations	1 / 18	Risk assessment training and significant experience
Nige Deacon	Manager Water and Waste Operations	2 / 30	Risk assessment training and significant experience

5.3 Hazard identification and Unmitigated Risk Assessment

Biological, chemical, physical and whole of system hazards have been identified, and the sources of hazards have been considered for all water supply schemes. Consideration is then given as to whether the hazard is equally relevant to all schemes. Separate line items are included where the sources of hazards have a different relevance to a particular scheme.

Note: for the Caves, Nerimbera and Pipeline, the unmitigated risk is the risk for the source water for LSC – in these cases, this is the treated water from Glenmore WTP.

For each hazard, the unmitigated public health consequence, and the likelihood of the hazard causing that consequence in the absence of any preventative measures implemented by LSC were evaluated. Using the risk matrix above, the unmitigated risk to the scheme was calculated.

Where a hazard is considered as potentially relevant to the scheme (i.e. the unmitigated risk was medium or above), the preventative measures in place to manage the hazard have been identified, and the mitigated risk calculated by the methodology identified below. Mitigated risk assessments are included on a scheme by scheme basis in the following sections. Unmitigated risks that are considered low are not progressed through to the mitigated risk assessment. Where mitigated risks are unacceptable, risk management improvement items to manage the risk have been identified and prioritised.

Table 6 Hazard Identification – all schemes

Hazard	Sources of Hazard	Unmitigated (Maximum) Risk			Uncertainty	Comments	Treatment Barrier/s
		Consequence	Likelihood	Risk			
Aluminium	Overdose/underdose	Minor	Unlikely	Low 4	Reliable		Operational procedures
Bacteria/Virus (Network)	Backflow, network contamination	Catastrophic	Unlikely	High 10	Reliable		New connections have backflow prevention
Bacteria/Virus (Glenmore)	Failure to disinfect, reservoir/ mains contamination	Catastrophic	Rare	Medium 6	Confident		Managed by FRW (conventional treatment, SCADA) - more WQ monitoring now
Bacteria/Virus (Marlborough)	Farming, weather event, mains contamination	Catastrophic	Possible	High 15	Estimate		Disinfection
Bacteria/Virus (Woodbury)	Sewage discharge, farming, recreational activities, weather event, reservoir/ mains contamination	Catastrophic	Likely	Extreme 20	Reliable	Risk is based on the broader catchment, 1.2GL off-stream storage always used - likely to result in die-off. This is taken into account with residual risk	Off-stream storage, Disinfection
Chemical	Backflow	Moderate	Unlikely	Medium 6	Reliable		New connections have backflow prevention
Chlorate	Chemical breakdown	Moderate	Possible	Medium 9	Estimate	0.8mg/L has been identified as a required reporting limit by Queensland Health.	Chemical management
Chlorine	Overdose	Moderate	Possible	Medium 9	Reliable		Operational procedures
Colour	Naturally occurring	Minor	Almost Certain	High 10	Certain	Tannins in Water Park Creek are constant	Coagulation, Powdered Activated Carbon
Cyanobacteria (Glenmore)	Breakthrough WTP	Minor	Unlikely	Low 4	Confident		Managed by FRW (conventional treatment, SCADA)
Cyanobacteria (Woodbury)	Minimal runoff and elevated nutrients result in algal blooms	Minor	Likely	Medium 8	Confident	Kelly's storage has had algal blooms	Filtration
Cyanobacterial toxins (Woodbury)	Algal blooms	Major	Possible	High 12	Reliable		Powdered Activated Carbon, chlorine oxidation
Cyanobacterial toxins (Glenmore)	Algal blooms	Major	Rare	Medium 5	Reliable	Multiple years of treated water data	Powdered Activated Carbon, chlorine oxidation
Disinfection byproducts	Elevated organics and long detention times	Moderate	Unlikely	Medium 6	Confident		Operational procedures, flushing. RRC have installed a chlorine dioxide system
Failure of supply	Malfunction, power outage, flood, fire	Major	Unlikely	Medium 8	Estimate		Availability of spare parts, generators at key infrastructure.
Fluoride	Overdose	Moderate	Rare	Low 3	Certain	Removed from supply	No longer used
Hardness/ TDS (Marlborough)	Natural geology	Minor	Almost Certain	High 10	Certain	TDS is aesthetic, not a public health risk	Reverse Osmosis

Hazard	Sources of Hazard	Unmitigated (Maximum) Risk			Uncertainty	Comments	Treatment Barrier/s
		Consequence	Likelihood	Risk			
Hardness/ TDS (Woodbury)	Natural geology, mine releases	Minor	Rare	Low 2	Certain	TDS is aesthetic, not a public health risk	Source control
Hardness/ TDS (Glenmore)	Natural geology, mine releases	Minor	Unlikely	Low 4	Certain	TDS is aesthetic, not a public health risk	Source control
Heavy metals	Mining activities, natural geology, cattle dips	Moderate	Unlikely	Medium 6	Reliable		Source control, Coagulation
Heavy metals (Marlborough)	Natural geology	Moderate	Rare	Low 3	Reliable	Elevated TDS, but heavy metals concentrations acceptable	Source control, Coagulation
Hydrocarbons	Road runoff, spill, road accidents, infiltration through pipes	Moderate	Rare	Low 3	Confident		Selective extraction
Iron	Natural geology, sediment	Minor	Unlikely	Low 4	Reliable	Depth sampling indicated stratification, offtake above that level.	Source control, oxidation, flushing
Manganese (Woodbury)	Natural geology, storage overturning	Moderate	Rare	Low 3	Confident	Not seen in over 20 years at Kelly's.	Source control, oxidation, flushing
Manganese (Glenmore)	Natural geology, storage overturning	Moderate	Rare	Low 3	Confident	0.41mg/L measured in treated water at the time of TC Marcia - big issues in the system at the time (5 years ago)	Conventional treatment, potentially changes made by Rockhampton (chlorine dioxide)
Operator error	Untrained/fatigued/accident	Catastrophic	Possible	High 15	Reliable	In last 5 years have had one critical incident arising from operator error combined with hardware failure	Trained staff, staff development
Opportunistic Pathogen *(Naeglaria fowlerii)*	Temperature, mains contamination, inadequate disinfection residual	Major	Rare	Medium 5	Estimate	Above ground pipe from Rockhampton into Mt Charlton Res and stop/start flow – re-chlorination afterward	Disinfection
Other chemical contamination	Treatment chemical contamination	Moderate	Rare	Low 3	Reliable		Chemicals certified for use in drinking water
Oxygen	Stagnant water, long transport times	Minor	Rare	Low 2	Confident		Nil
Pesticides (Glenmore)	Agriculture, horticulture	Minor	Rare	Low 2	Reliable	No values above health guideline	PAC
Pesticides (Woodbury)	Agriculture, horticulture	Minor	Unlikely	Low 4	Reliable	Minimal agriculture in this catchment	PAC
pH (high or low)	Dosing failure, raw water quality	Minor	Possible	Medium 6	Confident		Operational procedures
Protozoa (Glenmore)	Filter breakthrough > 1 NTU, reservoir cont	Catastrophic	Rare	Medium 6	Certain		Managed by FRW (conventional treatment, SCADA)

Hazard	Sources of Hazard	Unmitigated (Maximum) Risk			Uncertainty	Comments	Treatment Barrier/s
		Consequence	Likelihood	Risk			
Protozoa (network)	Network contamination	Catastrophic	Rare	Medium 6	Certain		Upstream Treatment, maintenance of chlorine residuals.
Protozoa (Marlborough)	Farming, weather event, mains contamination	Catastrophic	Unlikely	High 10	Confident		Infiltration into aquifer (natural attenuation), 5 µm filters and RO treatment
Protozoa (Woodbury)	Farming, recreational activities, Septic systems, weather event, reservoir/ mains contamination, animals in catchment	Catastrophic	Likely	Extreme 20	Reliable	Testing has not detected protozoa, but limited samples, and probable sources	Catchment management, Coagulation/Flocculation, Filtration
Radioactive elements	Natural geology	Moderate	Rare	Low 3	Confident		Historical data indicates this is not a significant hazard
Taste and odour	Algae blooms	Minor	Almost Certain	High 10	Certain		PAC
Temperature	Seasonal	Insignificant	Unlikely	Low 2	Confident		Nil
Terrorism /sabotage	Various, including cybersecurity	Catastrophic	Unlikely	High 10	Reliable	Has been an increase (nuisance/vandalism) recently in Rockhampton, but not targeting water quality	Physical and cyber security measures
Turbidity	Storms, flooding	Minor	Likely	Medium 8	Confident		Coagulation, filtration
Turbidity (network)	Reservoir sediment, sloughing in pipes	Minor	Likely	Medium 8	Reliable		Coagulation, filtration

Relevant hazards and unmitigated risks of medium and above that are identified in this table are carried forward to the scheme based mitigated risk assessments.

6 Operational and Verification Monitoring

6.1 Operational monitoring

LSC undertakes operational monitoring to confirm that the preventative measures are implemented and effective for each of the schemes. Operational monitoring includes daily testing at the Woodbury WTP, as well as all Supervisory Control and Data Acquisition (SCADA) monitored processes, and site inspections of bores, dams and reservoirs. The operational monitoring details are stated individually in the scheme specific sections.

Typically, a large proportion of the operational monitoring is managed using SCADA, although some water quality testing at the WTP is also considered to be operational. SCADA limits are set up with a target level and target range. Alarms occur when the parameter is outside the target range, and operators will take necessary actions to bring the process within the target range. Alarms are set to allow an operator to correct any issue rapidly, and before the issue escalates. Within the context of the management plan, the typical target ranges are indicated; however, as these operational limits necessarily change (e.g. coagulant dose rates) these values should not be considered fixed, so as to allow operational flexibility.

The critical SCADA limits for ensuring risks are managed are the outer acceptable limits (e.g. the high-high and low-low SCADA alarms). These limits do not change due to operational changes.

Many of the high-high and low-low critical alarms result in the WTP shutdown process to prevent poor quality water reaching the consumers. Where plant shut-down occurs, an operator identifies and corrects the cause of the issue before restarting the WTP.

The focus of online monitoring and automatic shutdowns is on chlorine and turbidity, in recognition of guiding principle 1 of the Australian Drinking Water Guidelines 2011 (NHMRC) “the greatest risks to consumers of drinking water are pathogenic microorganisms”. By focusing on filtration and disinfection effectiveness, LSC is managing the risk of pathogenic microorganisms.

6.1.1 Operational Procedures

LSC continues to develop further work instructions and operational procedures. These are outlined in the ongoing Risk Management Improvement Program (RMIP).

A list of existing operational documentation including work instructions, plans, procedures, guides and attachments has been provided in Appendix B.

6.2 Verification monitoring:

Verification monitoring is undertaken to demonstrate that the water quality produced was acceptable. This monitoring is “after the fact” testing and while corrective actions can be taken based on the results, drinking water has been delivered to customers prior to this sampling being undertaken.

LSC have installed specific locked water sampling points that facilitate sample tap flaming and collection of representative samples.

Sampling locations are listed in Table 7 below. Sample locations were selected to be representative of the water quality in each zone, and include higher risk locations (either on the basis of historical issues, population at risk, or longer water ages).

Most verification monitoring samples are sent to external laboratories for analysis. The Technical Specialist reviews the results immediately upon receipt, and the incident and emergency response plan is activated if any parameters are above the water quality criteria.

Table 7 ATT.146 Potable Water Sampling Points

Scheme	Reservoir Zone	Site Code	Location	Monitoring Frequency
Capricorn Coast	St Faith's	SF1	Anzac Pde (Council Office)	Sites rotated – one per week
		SF2	Pacific Heights Rd(St Benedict's Sch)	
		SF3	Arthur St (St Ursula College)	
		SF4	Adelaide Park Rd (St Faiths Reservoir)	
		SF5	Rockhampton Rd	
	Taranganba	TB1	Matthew Flinders Dr (Cooee Bay Pool)	
		TB2	Poinciana Ave (Poinciana Park)	
	Lammermoor	LM1	Scenic Hwy (Lammermoor Beach)	
		LM2	Vin E Jone Memorial Dr (Roslyn Bay)	
		LM3	Scenic Hwy (Causeway)	
		LM4	Scenic Hwy (Kinka)	
	Emu Park	EP1	Pattison St (Police Stn)	Sites rotated – one per week
		EP2	Haven Rd (Tanby Point)	
		EP3	Svendsen Rd (Zilzie)	
	Keppel Sands	KS1	Schofield Pde North (Musa Dr)	
		KS2	Schofield Pde South	
	Yeppoon Pipeline	YP0	Yeppoon West Valve Facility	Sites rotated – one per fortnight
		YP1	Sawmill	
		YP2	Dairy Inn Rd	
		YP3	Boundary Reservoir (Iron Pot Road)	
Marlborough	Marlborough	ML1	Magog Road (Marlborough School)	Sites rotated – one per month
		ML2	Railway Street (Marlborough Park)	
The Caves	Mount Charlton	MC1	Rossmoya Rd (The Caves Pub)	Sites rotated – one per month
		MC2	Glendale Rd	
		MC3	Bruce Hwy (Etna Creek Prison)	
		MC4	Emerson Dr (Glenlee)	
		MC5	Mount Charlton Reservoir	Weekly
Nerimbera	Nerimbera	NR1	Lakes Ck Rd (Boundary)	Sites rotated – one per month
		NR2	Nerimbera School	
		NR3	Lot 1, St Christophers Chapel Road	

6.2.1 *Escherichia coli* monitoring schedule

E. coli is monitored at a frequency that meets the Public Health Regulation requirement for the population served. Each scheme has been considered separately, and meets the Public Health Regulation in its own right.

As previously noted, dedicated sample points have been installed at locations throughout each water supply scheme. Sample locations are rotated according to an operational schedule that is updated annually. Sample locations were selected as they are representative of the water supplied to Council's customers, but also samples areas that may be subject to specific water quality concerns (for example, the Correctional Centre, which can experience low residual chlorine concentrations).

When *E. coli* samples are collected, a field test of the free chlorine is undertaken, and a second water sample collected for analysis of pH, colour, turbidity and conductivity at the LSC laboratory.

Samples are sent away for analysis at an external NATA accredited laboratory. The sampling schedule is as per the Monitoring Frequency column in Table 7. The specific rotation schedule is updated annually to identify the specific sampling weeks for the next calendar year. An appropriate number of samples will be collected to meet the minimum PHR requirements, and samples rotated through the sampling sites. Additional samples will be taken if the Technical Specialist is concerned about the water quality at any particular location. This may be in response to customer complaints, or identification of low chlorine residuals.

6.2.2 Other Monitoring Parameters

Other water quality parameters are tested either monthly, 3 monthly or annually. Samples are sent away for analysis at an external NATA accredited laboratory. The chosen parameters reflect the hazards and risks for the water supply schemes. Parameters include:

Standard Water Analysis – Monthly - Woodbury and Marlborough - raw and potable water.

This includes the following parameters:

Alkalinity, chloride, colour, EC, nitrate, sulphate, fluoride, aluminium, copper, iron, lead, manganese, zinc, calcium, magnesium, potassium, sodium, pH, TDS, total hardness, and turbidity.

These parameters provide a background water quality profile predominantly to verify that water quality meets aesthetic guidelines, and on this basis, a monthly frequency is believed to be sufficient.

Blue Green Algae – Risk based, typically monthly in summer, Woodbury raw water. Algae monitoring can assist in making operational decisions, however in practice, powdered activated carbon is dosed year-round to manage taste and odour concerns, and the conventional treatment process (coagulation, sedimentation, filtration and chlorination) is sufficient to remove or inactivate both algal cells and toxins.

Total Organic Carbon – 3 monthly - Woodbury and Marlborough - raw and potable water. TOC data provides background data on the potential for disinfection by-product formation, but also raw water quality more generally.

Pesticides – Annually - Woodbury and Marlborough - raw water. With no detections in any scheme to date, annual monitoring for pesticides is believed to be appropriate.

Cryptosporidium and *Giardia* – Annually - Woodbury WTP - raw and potable water. Monitoring for these pathogens is undertaken annually to gradually build a dataset, noting the high cost and relatively poor enumeration performance of the test method (particularly for *Cryptosporidium*).

Trihalomethanes & chlorate – 3 monthly - Woodbury and Marlborough - reticulated water supply. Sample locations SF2, KS2, MC1, NR3 & ML1 (e.g. locations considered to be the highest risk). Quarterly is considered to be appropriate for the verification of THM and chlorate levels in drinking water, and no exceedances of the water quality criteria have been identified in the data summarised in this DWQMP.

Heavy metals – Annually - Woodbury and Marlborough - raw and potable water. Annual monitoring is deemed to be appropriate for heavy metals given the very low likelihood of their occurrence in drinking water.

This includes the following parameters:

Arsenic, cadmium, chromium, nickel, selenium, mercury

Raw and potable water samples are taken at the water treatment plants. This level of monitoring, and the selection of parameters is considered to be sufficient for these schemes given the limited number of water quality incidents detected by LSC, the mostly protected nature of the Water Park Creek catchment, and the limited likely risks to the quality of the Marlborough aquifer. If additional hazards to the schemes are identified, other parameters may be added to the monitoring schedule.

LSC undertook radiological testing of the water supplies in 2014, but as all results are below detection limit, further testing is considered unnecessary.

Under the bulk water agreement, FRW provides monthly physical and chemical water quality monitoring data for the Glenmore WTP raw and treated.

7 DWQMP Emergency Response Plan

LSC DWQMP operates on a 3 level Emergency Response Plan. The levels are outlined below:

Table 8 Emergency Response Levels

Response Level	Description of Level	Typically Identified by	Communication and Response Management
Level 3 Disaster	• Declared Disaster	• Manager Water and Waste Operations • CEO	• CEO • External Agencies
Level 2 Incident or Emergency	• Potential public health risk, • exceedance of water quality criteria, • major loss of supply (e.g. widespread loss for > 6 hours) • cybersecurity threat	• WTP Operators • Coordinator Water and Sewerage Process Operations • Critical and operational Control Point Procedure • Technical Specialist	• Manager Water and Waste Operations • potential CEO • Regulatory reporting. • LSC Customer Service and Media team
Level 1 Operational Action	• Operational exceedances, • minor loss of supply, • other issue not considered to be a potential health risk	• WTP Operators or • Critical and operational Control Point Procedure • Technical Specialist	• Coordinator Water and Sewerage Process Operations • Technical Specialist

7.1 Detail of Incidents and Response Levels:

7.1.1 Level 1 Operational Action

At Level 1, operational actions are required to manage the issue and prevent escalation.

Issues at this level are normally identified through operational monitoring and through the operational Alert limit identified in the MSP.064 “Critical and Operational Control Point Procedure”. In many cases, SCADA alerts will provide the first indication of a problem.

Corrective actions will be taken to ensure processes are brought back to target levels, a note made in the WTP diary (WTP exceedances) and the Coordinator Water and Sewerage Process Operations informed. Where the issue is identified by the Technical Specialist, the issue and corrective actions are recorded in their diary (e.g. flushing of dirty water from reticulation).

Note: Exceedances of upper and lower alarms that result in the WTP shutdown process are considered to be within the scope of normal operation of the management plan, and do not automatically escalate beyond Level 1 unless the situation warrants. For example, a high-high chlorine alarm that shuts down the treatment plant **before** the chlorine level exceeds the water quality criteria is dealt with as a Level 1 action. If the water quality criteria are exceeded, or a widespread outage is for an extended period, the issue is a Level 2 incident.

7.1.2 Level 2 Incident or Emergency

At Level 2, there is a potential for an adverse public health impact.

These issues are typically identified through either operational or verification monitoring and through the Critical limit identified in the MSP.064 Critical and Operational Control Point Procedure of the processes and water quality, or where there has been a significant widespread treatment or reticulation network failure resulting in the loss (or likely loss) of water supply for a period >6 hours. Alternatively, ICT Services or the Process Systems Technician may identify a cyber security breach or threat. When identified, these issues are escalated to the Coordinator Water and Sewerage Process Operations, or alternatively the Technical Specialist and/or Manager of Water and Waste Operations if the Coordinator Water and Sewerage Process Operations is not available.

Appropriate corrective actions have been identified in the MSP.064 Critical and Operational Control Point Procedure, and will be implemented as soon as practicable to minimise the effect of the incident. Examples for typical actions that we will normally take for the detection of a parameter above the water quality criteria (including *E. coli*, and chlorate >0.8mg/L) follow. For cyber threats, ICT Services will take a key role in the incident management process.

Level 2 incidents and emergencies are reportable to the Regulator. The Technical Specialist or Coordinator Water and Process Operations will inform the Regulator immediately after the provider becomes aware of an incident. Advice may be directly sought from Queensland Health if required. A report will be sent to the Regulator with findings after the event.

Resampling: Where a water quality criterion has been exceeded, LSC always assumes that the failure is real and will respond as such. Due to the assumption that the failure is real, the resample is collected after any immediate corrective actions have been completed (e.g. after re-establishing disinfection or after flushing).

By resampling after the corrective actions have commenced, the resample results help quantify the effectiveness of the corrective actions that have been taken to date.

Council will contact high risk customers, as identified in Appendix A by appropriate means (letter drop, phone call, personal visit) if required.

7.1.3 Level 3 Declared Disaster

This level is reached when the Chief Executive Officer (CEO) of Council activates the Disaster Management Plan or a Disaster is declared by the State Government.

When a Disaster Management Group is stood up, drinking water quality management actions will be taken as necessary to respond to the requirements of the Disaster Coordinator.

While every effort will be made to continue to implement the DWQMP, Disaster Management actions may take precedence. Where this occurs, LSC will inform the Regulator immediately after the provider becomes aware of an incident. A report will be sent to the Regulator with findings after the event.

Scenarios where this may occur include major events such as imminent cyclones, bushfires and floods. At such times, communications can be difficult, and actions may be required to immediately reduce threats to human life. Actions that contradict the DWQMP would not normally be taken, except under advice from appropriate and relevant authorities.

7.2 Multiple entity arrangements

The Capricorn Coast, Caves and Nerimbera Schemes are multiple entity schemes. In all schemes, water quality is monitored close to the point of handover, as per the verification monitoring programs of both providers (refer to section 6.2 for details of LSC's verification monitoring). In the case of the Boundary Reservoir (Rockhampton to Yeppoon Pipeline), online monitoring of chlorine residual is available to both providers.

Where the water quality at the point of handover does not meet acceptable standards (which are defined in the Bulk Water Supply Agreement to include both health and aesthetic parameters), the Coordinator Water and Sewerage Process Operations, Technical Specialist, or the Manager Water and Waste Operations will contact the Water Quality Officer or the Manager at FRW to inform them of the issue, and request corrective actions. The communication protocol is formalised in the Operating Protocols, which are an appendix to the Bulk Water Supply Agreement between LSC and FRW.

If the quality of water supplied does not meet the water quality criteria for the service, the Regulator will then be informed of the exceedance, and will be advised as to what actions are being taken to investigate and/or correct the issue.

Where a water quality issue is identified within the reticulation network, but not at the point of supply, this is not a multiple entity situation, and LSC will manage the incident accordingly. In some instances Council may choose to inform Rockhampton Regional Council (RRC).

The Bulk Water Supply Agreement between FRW (RRC) and LSC indicates that both parties will respond to ensure that water quality issues can be managed. The Bulk Water Supply Agreement is financially reviewed annually and renewed 5 yearly.

7.3 Example incident response

7.3.1 Exceedance of Water Quality Criteria

Verification monitoring data is sent to the Technical Specialist and the Coordinator Water and Sewer Process Operations and reviewed as soon as possible. Where water quality does not meet the water quality criteria, the following steps are normally undertaken:

1) **Define the extent of the problem:**

   Determine the potentially affected locations – e.g.
   - whole scheme,
   - whole zone, or
   - the end of a reticulation line

2) **Define the water quality at the time of sampling:**

   Confirm the following at the sampling location, and upstream of the sampling location (e.g. an upstream reservoir, a point of handover, or WTP):
   - disinfection residual,
   - turbidity and
   - pH at time of sampling

3) **Identify if any parameter is outside the normal range for this location.**

4) **Confirm correct operation of LSC water treatment processes in relevant scheme (for example):**
    - Reverse Osmosis (Marlborough)
    - Coagulation/Filtration
    - pH adjustment
    - Disinfection
    - Redosing facilities
5) **Consider need/ ability to isolate source**
   (e.g. could a potentially contaminated reservoir by bypassed, should the Woodbury water treatment plant be shut down, or should the Rockhampton-Yeppoon pipeline be shut down?)
6) **Consider ability to flush reticulation network**
7) **Operator or Technical Specialist to go on site to confirm turbidity, disinfection and pH levels**
8) **Flush if appropriate:**
    - If any water quality parameter is outside the normal range for that area, flush until residual disinfection is re-established.
    - For *E. coli* detection at any sample location, flush to achieve disinfection residual of ~ 0.5 mg/L
9) **Resample**

These incidents are reported to the Regulator immediately after the provider becomes aware of an incident. A report will be sent to the Regulator with findings after the event. As many of the above steps are undertaken as possible prior to reporting so that relevant information can be provided. Upon resolution of the incident, the causes for the failure are identified, and the relevant aspects of the DWQMP are reviewed to determine whether the DWQMP is appropriate to prevent the issue from reoccurring.

8 Employee Awareness and Training

8.1 Training

8.1.1 Formal training:

Water treatment plant operators are generally trained to NWP30219 Certificate III in Water Industry Operations or higher. Exceptions can occur where trainees or new staff are employed. In these cases, formal training for those staff members is sourced to achieve these training levels within a reasonable timeframe.

8.1.2 Informal training:

Start-up discussions/meetings occur most mornings where the Coordinator Water and Sewerage Process Operations outlines the key tasks. Toolbox meetings occur monthly, and any water quality issues are discussed in these meetings. Where new processes are implemented, these are discussed during these meetings or during reviews of the Quality Assurance Documents.

8.1.3 Employee awareness of DWQMP

The DWQMP is an important document. LSC undertakes yearly 'Take 5' toolbox talks with all Water & Waste staff which covers the key aspects of the DWQMP that relate to staff responsibilities. Attendance is logged for staff training records. The Coordinator Water and Sewerage Process Operations and Treatment Plant Operators can access the DWQMP electronically. It is also discussed on engagement of a new starter through a quality assurance awareness session that goes through important documents that pertain to the staff members' area. This awareness session is also logged for staff training records.

9 Community Engagement

9.1 Consultation and Communication

LSC publishes the DWQMP report (annual report) on the council website to ensure customers are informed of water quality and its management. Council conducts open days to educate the community about water treatment and quality, and carries out school / university tours of our water and sewer treatment plants.

Council engages catchment management groups, such as the Byfield Community Reference Panel who undertake catchment works in the Water Park Creek area.

Council informs customers of any major works that will disrupt their services and will publish water quality advisories on the council website as necessary.

10 Research and Development

10.1 Investigative studies

Where LSC is concerned about unknown risks, appropriate monitoring programs are initiated and undertaken.

Monitoring for emerging hazards is not included in the verification monitoring program, but may be undertaken as deemed necessary. If the water quality criteria are ever found to have been exceeded, the incident and emergency response will be implemented. LSC has recently tested for per- and poly-fluoroalkyl substances (PFAS) with nil detections recorded in both raw & treated water.

10.2 Validation

LSC has begun validation of the key water treatment barriers, and is continuing to gather information to justify the assumptions used. A summary of the current state of validation is provided below:

1) The filters at Woodbury are backwashed on head loss, not a turbidity trigger. Turbidity based backwash triggers will be investigated at completion of the filter upgrade project.
2) Woodbury WTP Disinfection - at a low chlorine of 0.5mg/L (auto-shutdown level), as well as lowest clear water tank level of 84.66% (of 1.5ML total volume), and maximum outflow rate of 196L/sec, a chlorine concentration time (CT) of 16.2mg.min/L is achieved at the clear water tank outlet; assuming a baffle factor of 0.1 (poor baffling). The baffle factor has not been validated, and there has been some suggestion that 0.1 may be more appropriate. However given that the water from the clear water tank flows through another 0.22ML tank, it is considered that this is an appropriate estimate in the absence of tracer study data. Furthermore, no in-

pipe CT has been calculated (though it is noted that the first customer is located approximately 300m downstream of the WTP).

3) Marlborough WTP Disinfection - at a low chlorine of 0.3mg/L, low clear water tank level of 90% (of 135kL total volume), and maximum outflow rate of 4L/sec, a CT of 45.6mg.min/L is achieved at the clear water tanks outlet; assuming a baffle factor of 0.1 (poor baffling). There is no ability to automatically shut down the Marlborough WTP without putting the town out of water, so responses to low critical limit alarms must occur quickly. Furthermore, any mains break or mains flushing activity has the potential to increase the flow rates to significantly higher than 4L/sec, meaning that CT could become compromised under these conditions.

10.3 Design of equipment

Any new equipment or process will undergo appropriate design and testing prior to implementation.

11 Documentation and Reporting

A number of different software systems are used to capture, manipulate and archive information relating to drinking water. These systems are accessible to all relevant staff through Council's online IT services. A listing of the software systems that are currently in use is provided below. Operations & Maintenance Manuals are stored in hardcopy. The group responsible for maintaining and updating each software system is also indicated.

Information is made available or distributed to all staff via Toolbox Meetings held each month or through specially organised meetings or training workshops as required.

Table 9 Software systems used for management of information

System	Function	Group Responsible
Objective ECM	Archiving of all business critical documents including internal and external correspondence	LSC Administration
Conquest / WAM	Management of all asset inventory, maintenance management information and all O&M Manuals	LSC Assets Management
Pathway	Management of all customer engagements including complaints and information requests	LSC Administration
Arc Portal (GIS)	Management of Council-wide Arc Portal and asset location information	LSC Assets Management
Experion SCADA	Recording and controlling of all on-line monitored operational data for drinking water infrastructure	LSC Water and Waste Team
Microsoft Excel	Management of all water quality monitoring information. Information stored on W: drive and ECM is accessible by all relevant staff.	LSC Water and Waste Team
SWIMWATER	Recording of all on-line monitored operational data for drinking water infrastructure	LSC Water and Waste Team

All records are kept in accordance with the *Public Records Act 2002* requirements.

11.1 Operational monitoring data

Online plant operational details are recorded in SCADA.

Operational details such as the total WTP production, and the daily chemical usage and remaining stock are recorded in the Treatment Plant Compliance and Performance spreadsheet.

Daily testing results for pH, turbidity, conductivity, alkalinity and temperature are recorded for the raw water, with the same parameters and free chlorine also measured in the treated water and at St Faiths reservoir. The alum dose rate and raw water inflow rate are also recorded.

Additional plant operational details are documented in the WTP diary, including details of when filters are manually backwashed, or plant maintenance undertaken. Information from the test log and operators log is then transferred to the “Compliance and Reporting” Excel file saved on W:drive, and is accessible by all relevant staff.

The Technical Specialist (or Coordinator Water and Sewerage Process Operations) also records operational details such as sampling date, locations, free chlorine residual, turbidity, colour and electrical conductivity which is then all entered into Water Quality excel file on W: drive.

Calibration checks of instrumentation used in the water treatment process are stored within the Conquest Maintenance System.

11.2 Verification monitoring data

All laboratory results from verification monitoring are collated and saved in Councils record management system. These results can be accessed by the WTP Operators if necessary.

11.3 Cyber security

LSC ensures the integrity of its information and control systems within a process that has been formalised into the MSP.064 SCADA Cyber Security Procedure. ICT Services are responsible for the broader Council network architecture protections (e.g. firewalls, configurations between different systems, provision of network access) while the Principal Process Systems Technician is responsible for maintaining backup copies of the various programmable logic controllers, ensuring hardware is functioning correctly, and liaising with ICT Services as required.

12 Evaluation and Audit

12.1 Long term evaluation of results

LSC assesses verification monitoring data on receipt of the results. Results are translated, by the Technical Specialist into the water quality spreadsheet, based on sample location. This spreadsheet automatically calculates the average for the site.

The Technical Specialist compares the current result to the long term average result and investigates if there are significant unexplained deviations outside the normal range. Where parameters exceed the water quality criteria, the Incident and Emergency Response plan is followed.

12.2 Audits

Audits of the drinking water quality management plan are required under section 108 of the Act. Internal Audits are performed by the Infrastructure Quality Assurance Team. LSC also

undertakes regulatory audits in accordance with the requirements of the Regulator. 4 yearly external audits and 2 yearly internal reviews.

13 Review and Continual Improvement

Council formally reviews the effectiveness of the management plan in accordance with the regulatory requirements. Primarily the review is to determine the relevance of the DWQMP.

Council also reviews all drinking water incidents following resolution, and in conjunction with regulatory reporting requirements, to determine the effectiveness of the management plan. If the management plan requires amendments, Council determines whether the amendment is urgent, and requires immediate attention, or whether the amendment should be made following the subsequent regular review. The need for any minor amendments will be discussed with the Regulator.

13.1 Risk Management Improvement Plan

Council uses the risk assessment process to identify the items that are essential to ensure risks to the service are lowered to acceptable levels. These items are included in the risk management improvement program (RMIP). The RMIP is considered by Council to be a highly changeable part of the management plan as items will be added and removed from the RMIP as necessary (for example, new items are added when identified, and any old items can be removed when completed, or when alternate solutions have been implemented that achieve the intended outcome).

The RMIP follows directly from the risk assessment, and items are recorded in the risk assessment for each scheme. A collated version of all RMIP items is provided below.

Table 10 Risk management improvement program

Item	Relevant Scheme(s)	Unmitigated Risk level	Mitigated Risk level	Actions			Responsibility
				Immediate actions (31/03/2021)	Short Term (30/06/2021)	Long Term (30/06/2023)	
Recontamination from supernatant	Capricorn Coast	Extreme	High	Install turbidity analyser on return line & develop protocol around high turbidity shutdown	Turbidity meter installed and automatic plant shutdown at greater than 10NTU.		Coordinator Water & Sewerage Process Operations
Coagulation failure (e.g. change of raw water quality)	Capricorn Coast	Medium	Low			Consider Installing ORP analyser at Woodbury WTP inlet	Technical Specialist
Source water contamination / filtration	Capricorn Coast	Extreme	High	Review turbidity-based backwash triggers (e.g. >0.3 for 14mins if possible)	Consider installing a turbidity meter at the clarifier to provide advance warning of carryover	Business case for CAPEX - structural works and filter media replacements	Coordinator Water & Sewerage Process Operations
						Consider undertaking Cost-Benefit Analysis for installation of UV at Woodbury WTP	Coordinator Water & Sewerage Process Operations
Failure filtration/ soda ash	Capricorn Coast	Medium	Medium		Install duty/standby soda ash pumps at Woodbury WTP. Complete.		Coordinator Water & Sewerage Process Operations
Disinfection / underdosing	Capricorn Coast	Extreme	Medium		Investigate auto-removal of control system inhibit (e.g. when calibrating)	Look at including as part of filtration upgrade.	Coordinator Water & Sewerage Process Operations
Deliberate contamination (incl cyber security attacks with a physical element)	Whole of System	High	High		Develop scope of works for site security upgrades	Undertake site security upgrades. site security checked.	Manager Water and Waste
Change to SCADA limits resulting in compromised system operation	Whole of System	Extreme	High		Review SCADA access protocols to determine if any short-term improvements are available	Consider engaging an expert to undertake a cyber security review. Cyber security	Manager Water and Waste

Item	Relevant Scheme(s)	Unmitigated Risk level	Mitigated Risk level	Actions			Responsibility
				Immediate actions (31/03/2021)	Short Term (30/06/2021)	Long Term (30/06/2023)	
Unauthorised remote access to systems leading to water quality impacts	Whole of System	High	Medium			exercise ran in September 2022.	
Insufficient Operators available	Whole of System	Extreme	High		Prepare a business case for additional Operator(s). Business case complete. 2 x operators employed.		Coordinator Water & Sewerage Process Operations
Source contamination	Marlborough	High	Medium	Inspect bore heads and seal any identified gaps	Bore heads inspected and gaps sealed.		Coordinator Water & Sewerage Process Operations
Failure of chlorine dosing	Marlborough	High	Medium		Begin monitoring *E. coli* in raw water. Complete.		Technical Specialist
Recontamination of reservoirs/network (Mount Charlton)	The Caves	High	High	Implement weekly verification monitoring at Mount Charlton Reservoir (*E. coli* and chlorine). Complete.	Address vermin proofing and reservoir integrity breaches upon inspections where a high risk is identified. Inspections initiated.	Replace roof structure and sheeting on Mount Charlton Reservoir (To be completed end of October 2022)	Manager Water and Waste

PART 2 CAPRICORN COAST DRINKING WATER SCHEME

1 Overview of Scheme

The Capricorn Coast Scheme serves the communities of Yeppoon, The Causeway, Kinka Beach, Zilzie, Emu Park and Keppel Sands. Surf Lakes wave park is a major customer.

The Capricorn Coast Scheme is a multiple entity scheme that has 2 distinct water supplies. The first supply is Water Park Creek which is harvested into the Kelly's Offstream Storage. Water from this storage is conventionally treated and disinfected by the Woodbury Water Treatment Plant (WTP), which is operated by LSC.

Water from the Woodbury WTP is supplemented by a second water supply via the Rockhampton to Yeppoon Water Supply Pipeline. The ~40 km pipeline supplies conventionally treated water from Rockhampton Regional Council at their Glenmore (WTP).

1.1 Catchment Description

1.1.1 Water Park Creek

Water Park Creek drains the Byfield and adjacent areas within the Shoalwater Bay Military Training Area located along the coastal margin to the north of Yeppoon. The limited industrial, agricultural and other human activities that occur in the catchment mean that this catchment can almost be considered a protected catchment. This area to the north of Yeppoon receives higher rainfall than other parts of the region with average annual rainfall above 1500 mm. Most of this rainfall is received during the summer months. The heavy summer rainfalls and consistent rainfall throughout the year means that Water Park Creek usually maintains a flow all year round.

The catchment area is dominated by largely uncleared lowland and mountain areas to the north of the catchment, a line of sand dune areas along the coast to the east and pine forest plantations to the south. The heavily forested catchment and limited rural or urban development in the area helps to ensure a high quality of water in Water Park Creek. In the more mountainous areas, stands of tall eucalypt and other forest hardwoods dominate the ridge lines with softwood and rainforest vegetation types abundant around gorges and other watercourses. At lower elevations the uncleared areas consist of a mix of either hardwood forests on clay or loam soils and teatree and heath areas on the sandy soils nearer to the coast.

Apart from the pine plantation activities, the catchment area is largely undeveloped with low level agriculture and grazing activities occurring at lower elevations. The staging of military training activities in the upper parts of the catchment does not appear to have any negative impact on Water Park Creek and its water quality. The potential for significant further development in the catchment area is unlikely due to the high conservation values of the area and the ongoing future use of the military training area.

The Water Park Creek storage is provided by a small concrete weir which is located immediately upstream of the Water Park Creek Road crossing of Water Park Creek at Byfield. The total volume of the weir storage is not well defined and not relevant to water security as pumping from Water Park Creek is only allowed when the creek is flowing, and other requirements are met.

Raw water from Water Park Creek is pumped to Kelly's Off-Stream Storage. This dam has a capacity of ~1200 ML, or approximately 3 months storage. Kelly's Off-Stream Storage has its own very small catchment which is dominated by moderately thick eucalypt forest on rocky hillsides. This storage is fully fenced and is not accessible by livestock. Kelly's Off-

Stream Storage is normally operated to maintain 93% storage capacity so that this volume of water could be relied upon during periods (usually late spring to early summer) when flow in Water Park Creek can decrease, and pumping is not allowed. Whilst there is a direct pipeline from Water Park Creek, to the WTP it is not used under normal operation. Supply of raw water from Kelly's Off-Stream Storage to Woodbury WTP is the constant operational arrangement.

Yield: The yield from Water Park Creek is based on more than 100 years of records. The historical no failure yield over this period is 2,020 ML/year. If an event that occurred in 1902 is excluded from the calculation of yield then Water Park Creek has a safe yield of 4,020 ML/annum (Water Supply Sources Study, Cardno, 2005). Both of the above-mentioned yields include the operation of the existing Kelly's Off-Stream Storage.

Water Quality: The Water Park Creek raw water is typical of a densely vegetated coastal catchment area with a high rainfall. The raw water is highly coloured, low alkalinity, low turbidity surface water. Apart from the high colour content, no significant water quality issues arise from the Water Park Creek site. The Kelly's Off-Stream Storage has occasional cyanobacterial blooms.

1.1.2 Fitzroy River Catchment

The Glenmore WTP draws raw water from the Barrage on the Fitzroy River. The Barrage sits at the bottom of the Fitzroy River Catchment which is the second largest in Australia covering in excess of 140,000 km^2. Due to the size of the catchment and the predominantly sub-tropical climate, the system is subject to highly variable but historically reliable flows with an average discharge between 5,000,000 and 6,000,000 ML/year. FRW operates the Barrage in accordance with a Resource Operations Plan (ROP).

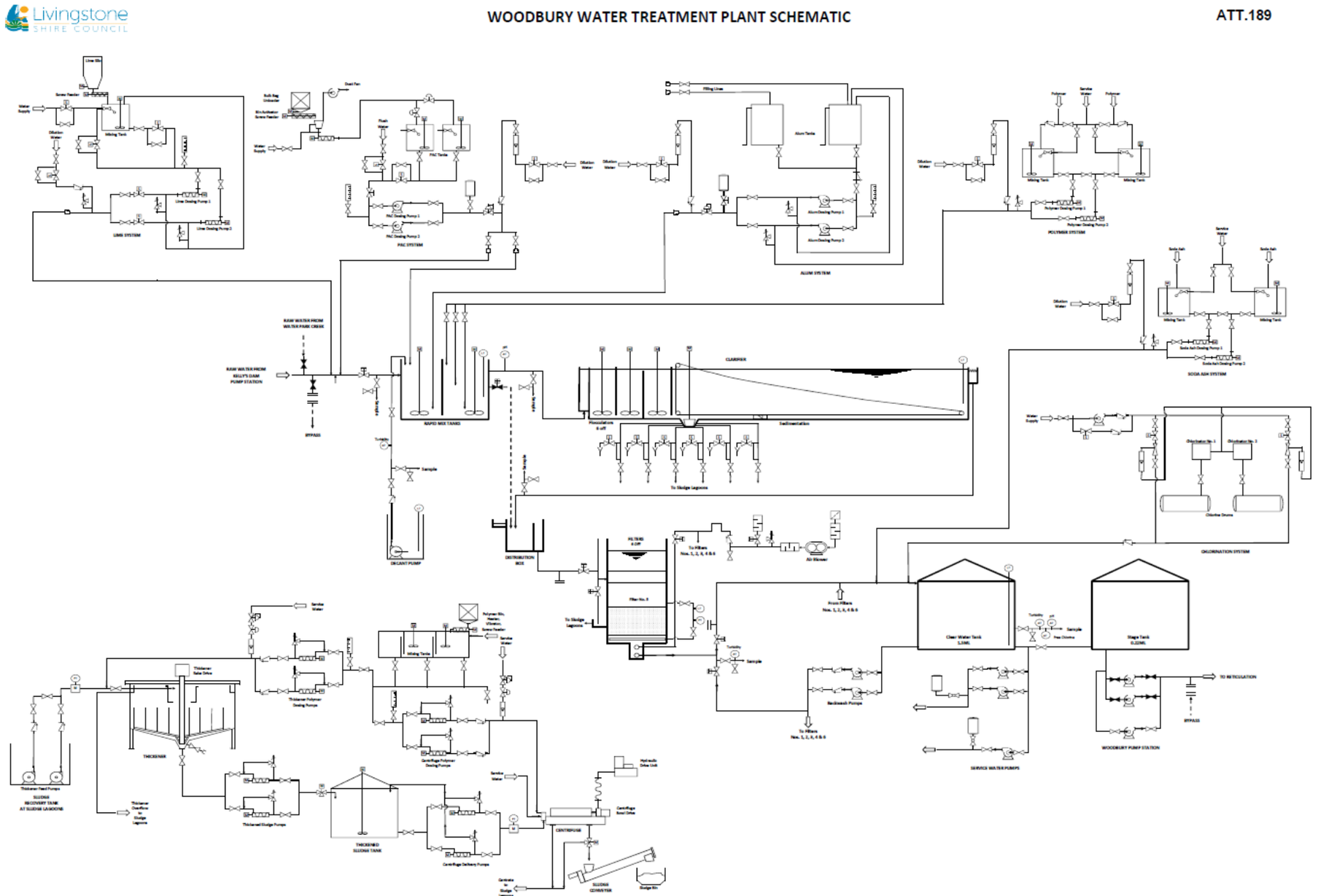
The Barrage impoundment and upstream catchment are unprotected surface waters that are highly impacted by a multitude of different land use practices and industrial activities that occur in the various sub-catchments within the Fitzroy Basin. As such the raw water in the Barrage storage is a higher risk source than Water Park Creek. Typical water quality issues that arise include cyanobacterial blooms, mine water discharges that alter water quality aesthetics and high flow or flooding events that lead to highly variable raw water quality e.g. rapid changes in turbidity (up to 2000 NTU), and fluctuations in iron and manganese concentration. However, FRW is responsible for managing these risks.

2 Scheme Infrastructure and Operation

2.1 Woodbury Water Treatment Plant

The Woodbury WTP is a conventional water treatment plant, located at Woodbury, ~ 17 km north of Yeppoon on the Capricorn Coast. Commencing operation in 1988, the Woodbury WTP has a design capacity of 21.6 ML/d, with a peak flow of 250 L/s, however there is some doubt as to whether this is achievable. As the Capricorn Coast supply is supplemented by the Rockhampton-Yeppoon pipeline, the WTP typically produces 10-12 ML/day, or ~3/4 of the required supply, with a typical peak flow of ~190L/s. Optimum plant flow rate is 15-16ML/day which equates to around 185L/sec. At times of higher demand, water supply from the pipeline is increased, and the proportion of water produced is dependent on demand. It is possible for either supply to produce 100% of normal daily demand for the scheme, but this is not typical.

Figure 4 ATT.189 Woodbury Water Treatment Plant Schematic



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2.1.1 Process description:

Intakes and sourcing infrastructure:

Raw water is pumped form the intake at Water Park Creek, which is located approximately 150m upstream of the weir and consists of a fixed single intake pipe structure approximately one metre beneath the normal water level. The opening of the intake pipe is designed with a cylindrical intake strainer that contains bars with a spacing of ~ 80mm to prevent the large debris from entering the intake pipe. The duty/standby low lift pumps of ~ 150 L/sec capacity pump water a distance of approximately 400m to the Water Park Creek High Lift Pump Station (3 pumps of ~150 L/sec capacity each) which then pumps the water about 20km to the Kelly's Off-Stream Storage located in Woodbury which serves as a buffer storage for the Woodbury WTP.

The offtake structure at Kelly's Off-Stream Storage consists of nine different 2m inlets located at different depths with a 150mm bar screen set at the offtake depth to prevent the entry of large objects or debris. As the water quality in the storage is very stable, with turbidity rarely exceeding 5 NTU, the off-take depth is rarely varied. The Kelly's WPS contains two duty/standby variable speed drive pumps each with a capacity of 500 L/sec, with typical pumping rates of 190-205L/sec. These pumps are used to supply raw water from the Kelly's Off-Stream Storage about 800m to the Woodbury WTP inlet.

Powdered Activated Carbon (PAC) dosing:

Raw water is dosed with 0.2 to 0.3mg/L PAC using a duty/standby dosing system. The system is capable of ~2 mg/L dosing rate, but this is not required. PAC dosing is required to remove colour and other soluble organic compounds.

pH adjustment:

Hydrated lime is added (duty/standby arrangement) to increase the pH and alkalinity for the coagulation process. The target pH is set by jar testing (approximately monthly) and is typically in the range of 6.4-7. SCADA action alarms are set between the target and shutdown levels, with automatic plant shutdown if pH drops below 6.2, or exceeds 7.7. Soda ash can be substituted for the hydrated lime if required.

Coagulation/Sedimentation:

Water is dosed with liquid aluminium sulphate using a duty/standby dosing pump system as it enters the rapid mixing tank to commence coagulation. The use of the Kelly's Off-Stream Storage promotes a highly stable raw water quality which enables coagulant dose to remain relatively constant over time. Dose rates of 34-55 mg/L are typical, but doses up to 100 mg/L are possible.

Water is then pumped into a flocculation tank where reciprocating mixers provide gentle mixing which promotes the formation of floc particles. Polyelectrolyte is dosed into the water to assist floc formation.

The chemically dosed water then passes into a sedimentation tank where floc particles are gravity settled to clarify the water. An array of tube settlers is used to promote the clarification process. The clear top surface of the water is then collected via finger weirs into a clear water channel which transfers the water to the filters. The tube settlers operate effectively at 200 L/s, but at higher flow rates, clarified water turbidities increase. The turbidity target for the water entering the filtration process is 1 NTU, and this is measured daily by the WTP operators and recorded in the WTP log.

Sludge management:

Sludge is removed automatically from the clarifier by a sludge scraper. The sludge is centrifuged with the thickened sludge removed offsite, and the supernatant returned to the

head of plant at a rate of 4.5 L/s. Supernatant return commences 10 min after the plant starts up.

Filtration:

Filtration is achieved using six rapid gravity sand filters of 1500 mm total bed depth. Each filter contains three 100 mm layers of silica sand gravel (effective size = 3.0-6.0 mm, 6.0-12.0 mm and 12.0-19.0 mm) beneath a 100 mm layer of silica sand (effective size = 1.5-3.0 mm) which is beneath a 400 mm deep layer of top sand (effective size = 0.9-1.0 mm). The layer of top sand is covered by a 600 mm deep layer of filter anthracite (effective size = 1.7-1.9 mm). Filters are automatically backwashed on head loss, with the current head loss trigger at 1.7m. Filters that reach the trigger are automatically taken offline and queued for backwash. One filter per day is also manually backwashed in addition to the automatic backwash cycle. Following backwash, the filters are filtered to waste for two minutes prior to being brought back online. Filter performance under these operating conditions generally produces water at less than 0.3 NTU, and typically closer to 0.1 NTU. Turbidity is monitored online at each individual filter by SCADA, with an alarm at 0.3NTU and a filter shutdown sequence initiated at >0.5NTU for 300 seconds. LSC is currently investigating the feasibility of implementing turbidity-based backwash triggers at a lower threshold (refer to RMIP).

pH adjustment:

Following filtration the water is dosed with sodium carbonate using duty/standby dosing pump system to adjust the pH to a target of ~7.4. SCADA alarms indicate the action limits around the target pH, with plant shutdown triggered when pH is below 6.7 or exceeds 8.2 in the 1.5 ML clearwater reservoir.

Fluoridation:

Fluoride dosing equipment is present, but is no longer used, and is not considered further.

Disinfection:

Disinfection is achieved using a single flow-paced automatic gas chlorination system. A target disinfection concentration is typically 1.75 mg/L with operational action limits set to indicate low and high dose rates. The WTP shuts down if the dose rate drops below 0.5 mg/L or exceeds 3.0 mg/L for >15 minutes.

The final water is then pumped to the distribution system by the Woodbury high-lift pump station located on the Woodbury WTP site. The Woodbury high-lift WPS supplies water along 15-20 km of trunk main to the St Faith's Reservoir complex. Part way along this trunk main water is diverted to fill the small Woodbury Heights Reservoir. It is standard procedure to pump water from the Woodbury high-lift WPS via the Yeppoon West Valve Facility located on the Rockhampton to Yeppoon Water Supply Pipeline to fill the Taranganba Reservoir.

The Woodbury WTP is typically attended by two operators for up to seven hours each day in order to monitor and operate (if required) the Woodbury WTP as well as to perform a range of water quality and process performance tests and checks. All operators are trained to Certificate III level (new operators may not have this qualification, but are trained to this level as soon as possible).

Operational details are recorded on WTP operating log sheets, and then transferred to the "Compliance and Reporting" spreadsheet that is saved on W: drive and accessible to all relevant staff. Details recorded include daily water quality test results, rainfall, treated water flow, chemical usage, and remaining amount.

Bypasses:

It is possible to bypass the clarification step and operate in "direct filtration" mode, however this would only be considered in emergency situations. There is no longer a full treatment plant bypass, this has been physically air gapped.

Dosing Chemicals:

Powdered activated carbon, hydrated lime, aluminium sulphate, polyacrylamide, chlorine gas, and soda ash.

2.2 Rockhampton- Yeppoon Pipeline

2.2.1 Glenmore Water Treatment Plant

The Glenmore WTP in Rockhampton is owned and operated by Rockhampton Regional Council, and this information is included here for completeness of understanding of potential risks that LSC may have to manage.

The Glenmore WTP has a maximum capacity to treat 120 ML/d.

The design of the Glenmore WTP has been maximised to handle very high raw water turbidity and the WTP can treat raw water with turbidity in excess of 2000 NTU.

Raw water is pumped to the inlet of the WTP where the option exists for pre-chlorination or chlorine dioxide dosing. Influent raw water is dosed with a coagulant and pumped into two identical parallel train flocculation/sedimentation basins.

Powdered Activated Carbon is added to remove colour, and polyacrylamide is added as a water clarification aid.

Water then passes through the sedimentation tank (chlorine dioxide can be dosed here also) and clarified water (target turbidity of 1.0 to 1.5 NTU) is collected via finger weirs into collection channels which then transfer the clarified water to the filters.

Filtration is achieved using 10 rapid gravity sand and garnet filters. Each filter contains a filter-to-waste function which enables poor quality filtered water to be wasted until the target water quality is achieved. Filters typically produce water with turbidity of <0.1 NTU.

Filtered water is dosed with hydrated lime by one of two duty/standby lime feeding systems to correct pH (pH 7.8 target) and is then disinfected with chlorine gas with a free chlorine residual setpoint of 1.1 mg/L with a target range of 0.5 to 1.5 mg/L of free chlorine (alternatively, chlorine dioxide is able to be used for disinfection).

The Glenmore high-lift water pump station (WPS) pumps water from the WTP through a network of trunk distribution mains to fill the Yaamba Road Reservoir which is the normal reservoir that supplies water to LSC. The Ibis Avenue WPS pumps water from the Yaamba Road Reservoir along the Rockhampton to Yeppoon Water Supply Pipeline to the Boundary Reservoir located halfway between Rockhampton and Yeppoon. The point of supply is on the outlet of the Boundary Reservoir. From here, the water is gravity fed (~140 m head) through 23.87 km of 600 mm DICL pipe to the Yeppoon West Valve Facility, and from here a further 3.3 km 750mm and 1.6 km of 600 mm DICL dedicated mains to Taranganba Reservoir. There are also 6 km of 600 mm DICL mains from the Yeppoon West Valve Facility that enter the existing trunk mains from the water treatment plant to the St Faith's Reservoir. There is a single control valve at the Yeppoon West Valve facility that is operated by the WTP operators remotely, but is set manually. There are currently 4 customers between the Boundary Reservoir and the Yeppoon West Valve Facility (identified in Appendix 1) who are informed of any water quality issues, if required.

The Bulk Water Supply Agreement requires that a minimum of 3 ML/d of water is sourced through the pipeline. At times when the demand of the Woodbury WTP averages less than 15 ML/day, 3-5 ML/day treated water is sourced through the pipeline (e.g. 3 ML on weekdays, and typically closer to 5 ML on the weekends). When the WTP demand exceeds 16 ML/day, 6-8 ML/day is sourced from the pipeline. However, LSC is not required to take non-compliant water and will shut down this supply if necessary. Under these circumstances the impacted customers are contacted (refer Appendix A).

The water age in the pipeline is typically 5-7 days by the time it reaches the Yeppoon West Valve facility.

2.3 Reticulation network

The Capricorn Coast reticulation network consists of 450 km of pipes, with the following age and material breakdown (Figure 5). The majority of reticulation mains are 100mm-150mm, and the largest trunk mains reach up to 750mm diameter.

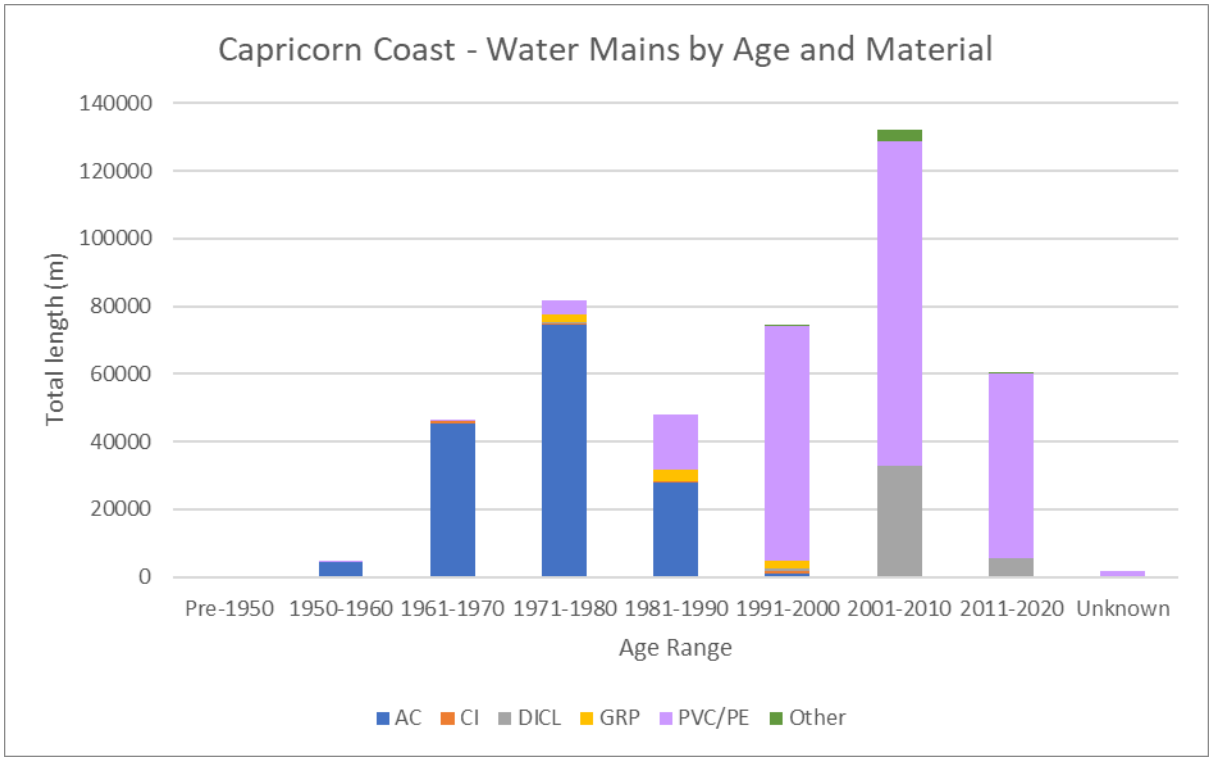

Figure 5 Capricorn Coast Water Mains by Age and Material

There are 11 reservoirs in the reticulation network, with a combined capacity of ~34 ML, or 2 days supply.

Table 11 Capricorn Coast reservoir details

Reservoir Name	Year Built	Capacity (ML)	Type/Design	Roof
Woodbury Heights	1995	0.3	Concrete circular	Fully enclosed concrete
St Faith's 1	1950	2.27	Concrete rectangular	Fully enclosed metal sheet
St Faith's 2	1958	2.27	Concrete rectangular	Fully enclosed metal sheet
St Faith's 3	2011	3.5	Concrete circular	Fully enclosed concrete
Meikleville Hill	1978	0.45	Concrete circular	Fully enclosed metal sheet
Pacific Hts	2002	4.2	Concrete circular	Fully enclosed concrete
Taranganba	1976	13.6	Concrete circular	Fully enclosed metal sheet
Lammermoor Hts	2002	4.2	Concrete circular	Fully enclosed concrete
Emu Park	1983	2.27	Concrete circular	Fully enclosed metal sheet
Seaspray	2005	0.2	Concrete circular	Fully enclosed concrete
Keppel Sands	1983	0.68	Concrete circular	Fully enclosed metal sheet

The Woodbury WPS supplies water along 15-20 km of trunk main to the St Faith's Reservoir complex. Part way along this trunk main water is diverted to fill the small Woodbury Heights Reservoir. From the St Faith's Reservoir complex water is gravity fed to the reticulation network in Central Yeppoon, to the Meikleville WPS which pumps water to fill the Meikleville Hill, and also gravity feeds to Pacific Heights Reservoir which supplies the reticulation network to the north of Yeppoon. To the north of the Pacific Heights Reservoir a trunk main supplies water to a privately owned and operated reservoir for the Mercure Resort. Water is also pumped from the St Faith's Reservoir complex to supply the reticulation area in West Yeppoon.

The Taranganba Reservoir supplies a local reticulation network and also gravity feeds water to fill the Lammermoor Heights Reservoir and the Emu Park Reservoir which supply local reticulation networks. The reticulation network in the community of Keppel Sands and the Keppel Sands Reservoir are supplied with water that is gravity fed from the Emu Park Reservoir.

Drinking water is rechlorinated with sodium hypochlorite at Taranganba, Emu Park, Keppel Sands and Pacific Heights Reservoirs. Dosing is interlocked to inflow, with a target residual of 0.8 mg/L, there are operational action limits set on each reservoir, and high- and low-level call outs above 1.8 mg/L and below 0.3 mg/L. There are duty/standby arrangements at Taranganba, but single dosing pumps at the other facilities. All rechlorination facilities are monitored using the SCADA system through a radio telemetry network.

St Faiths' and Lammermoor reservoirs have chlorine residual SCADA monitoring, but the SCADA limits are different, with high alarms at 1.9mg/L and low-level alarms at 0.5 mg/L. These limits may trigger actions at the WTP as there is no dosing at these sites.

There are more than 30 pumps in the reticulation network that are used to transfer water and/or maintain pressure within the network. These pumps are monitored by SCADA.

Pressure is maintained throughout the network with the assistance of booster pump stations as required.

Water age increases towards Keppel Sands, but rechlorination as described above manages the risks associated with longer water age.

3 Water Quality Information

Typical water quality for the Capricorn Coast scheme follows, based on a review of operational and verification monitoring data from 2014-2020. This information was reviewed by the Risk Assessment team prior to the risk review workshop in May 2020.

Table 12 Operational monitoring data summary – Woodbury WTP (2014 to 2022)

Sample Location	Parameter	Units	Count	Min	Average	Max
Raw Water	pH	-	2975	5.17	6.23	8.5
	Turbidity	NTU	2974	0.68	2.46	283
	Colour	HU	2961	0.47	67	294
	Conductivity	µS/cm	2972	108	138	220
	Alkalinity	mg/L as $CaCO_3$	2968	3.5	7.30	90
	Temperature	°C	2975	16	24.2	32.1
	OC/OP Pesticides	µg/L	8	ND	ND	ND
	Total Cyanophytes*	cells/mL	47	150	6060	30600
	Potentially Toxic Cyanophytes*	cells/mL	47	15	46	80
Dosed Water	pH	-	2973	5.4	6.8	8.2
Settled Water	Turbidity	NTU	2945	0.04	0.47	48
	Colour	HU	2934	0	6.74	44
Final Water	pH	-	2991	5.0	7.32	8.1
	Turbidity	NTU	2986	0	0.19	1.5
	Colour	HU	2979	0	1.60	10
	Conductivity	µS/cm	2986	176	216	351
	Alkalinity	mg/L as $CaCO_3$	2987	6.5	17.8	216
	Temperature	°C	2911	14.6	24.0	31
	Free chlorine	mg/L	2987	0.08	2.07	3.4
	OC/OP Pesticides	µg/L	6	ND	ND	ND
St Faiths Reservoir	pH	-	2991	6.4	7.30	9.1
	Turbidity	NTU	2985	0.02	0.19	1.1
	Colour	HU	2980	0	1.36	14
	Conductivity	µS/cm	2988	180	222	1075
	Alkalinity	mg/L as $CaCO_3$	2988	0.89	18.5	229
	Free Chlorine	mg/L	4016	0	0.56	2
	Temperature	°C	2989	14.5	23.10	32.9

**results from 2017-2022 only*

Table 13 Verification monitoring data – Woodbury WTP raw and treated water, standard water analyses and heavy metals (2014-2022)

Parameter	Units	Raw					Treated			
		Count	Min	Average	Max	Stdev	Count	Min	Average	Max
Nitrate	mg/L	75	0.01	0.042	0.53	0.074	75	0.003	0.036	0.28
Sulfate	mg/L	100	1.0	3.2	26	3.9	101	2	25.36	34
Fluoride (naturally occurring)	mg/L	101	0.10	0.225	0.4	0.048	99	0.05	0.18	0.3
Aluminium (acid-soluble)	mg/L	98	0.009	0.100	4.56	0.534	100	0.001	0.05	0.16
Copper	mg/L	101	0.001	0.135	1.76	0.224	99	0.001	0.007	0.286
Iron	mg/L	101	0.01	1.0	5.17	1.072	101	0.07	0.221	0.75
Lead	mg/L	101	0.001	0.003	0.009	0.001	101	0.006	0.006	0.006
Manganese	mg/L	101	0.002	0.017	0.08	0.018	101	0.001	0.007	0.037
Zinc	mg/L	101	0.005	0.011	0.132	0.016	101	0.005	0.019	0.088
pH	-	102	6.14	6.74	8.83	0.378	102	5.37	7.13	7.64
Turbidity	NTU	102	0.3	2.522	6.7	1.238	102	0.1	0.66	6
Alkalinity (Total as CaCO3)	mg/L	102	1.2	7.266	24	3.602	102	2.0	16.75	48
Calcium	mg/L	102	1.0	1.765	11	1.702	102	1	10.7	15
Chloride	mg/L	100	21	32	42	4.043	100	22	35	46
Colour (True)	HU	102	2	46	215	34	102	1	3.49	60
Conductivity	µS/cm	101	35	150	1216	126	102	139	214	261
Magnesium	mg/L	102	2	2.254	3	0.432	102	2	2.264	3
Nitrite	mg/L	75	0.01	0.01	0.01	0.001	74	0.01	0.025	0.04
Potassium	mg/L	102	1.0	1.0	1.0	0.058	102	1	1	1
Sodium	mg/L	102	16	20.49	28	2.423	102	19	25.8	48
Total Dissolved Solids (TDS)	mg/L	102	49	94.41	431	43.776	102	61	135	181
Hardness (Total as CaCO3)	mg/L	102	8	13.5	36	4.770	102	11	36	47
Total Organic Carbon (TOC)	mg/L	32	1	4.2	13	2.596	31	1	2.1	2
Arsenic	mg/L	18	0.001	0.001	0.003	0.001	19	0.001	0.001	0.003
Cadmium	mg/L	18	0.00005	0.000	0.00005	0.000	19	0.0003	0.0003	0.0003
Chromium	mg/L	18	0.0005	0.001	0.0005	0.000	19	0.002	0.002	0.002
Nickel	mg/L	18	0.0005	0.001	0.005	0.001	18	0.0007	0.007	0.0007
Selenium	mg/L	18	0.005	0.005	0.005	0.012	17	0.005	0.005	0.005
Mercury	mg/L	13	0.00005	0.000	0.00005	0.000	14	0.00005	0.000	0.00005
Cryptosporidium	Oocysts/10L	6	ND	ND	ND	N/A	6	ND	ND	ND
Giardia		6	ND	ND	ND	N/A	6	ND	ND	ND

Table 14 Verification monitoring data – Glenmore WTP raw and treated water, standard water analyses and heavy metals (2014-2022)

Parameter	Units	Raw					Treated			
		Count	Min	Average	Max	Stdev	Count	Min	Average	Max
Nitrate	mg/L	100	0.006	0.133	0.96	0.154	100	0.005	0.197	1.3
Sulfate	mg/L	100	2.0	8.21	30	4.794	100	2	8.281	39
Trihalomethanes (THMs) (Total)	µg/L	N/A	N/A	N/A	N/A	N/A	23	20	39.791	83
Fluoride (naturally occurring)	mg/L	100	0.05	0.103	0.27	0.042	100	0.0.05	0.096	0.32
Aluminium (acid-soluble)	mg/L	99	0.01	0.365	2.4	0.409	99	0.005	0.015	0.12
Copper	mg/L	96	0.0056	0.005	0.021	0.003	96	0.001	0.005	0.044
Iron	mg/L	96	0.0077	2.89	15.4	2.347	96	0.0051	0.016	0.08
Lead	mg/L	96	0.0001	0.002	0.022	0.004	96	0.00006	0.0007	0.0059
Manganese	mg/L	96	0.0014	0.093	0.95	0.138	96	0.00012	0.007	0.41
Zinc	mg/L	96	0.00075	0.015	0.092	0.014	96	0.00058	0.005	0.042
pH	-	92	6.26	7.674	8.8	0.477	90	6.25	7.592	8.36
Turbidity	NTU	100	2.9	145.316	1330	201.411	100	0.01	0.301	2
Alkalinity (Total as CaCO3)	mg/L	100	23	62.52	137	24.567	100	24	59.91	108
Calcium	mg/L	100	1.6	12.119	23	5.175	100	4.6	13.935	24
Chloride	mg/L	100	10	41.03	114	21.693	100	15	48.36	160
Colour (True)	HU	100	2	43.95	200	36.112	100	2	2.933	10
Conductivity	µS/cm	100	75	248.55	540	101.323	100	100	268.51	559
Magnesium	mg/L	100	1	8.40	24	4.663	100	3	8.009	22
Nitrite	mg/L	98	0.005	0.061	1	0.118	98	0.005	0.1445	1.1
Potassium	mg/L	99	0.23	3.620	8.0	1.166	100	1	3.492	6.0
Sodium	mg/L	100	1.1	21.774	50	9.644	100	5	22.175	49
Total Dissolved Solids (TDS)	mg/L	100	24	221.51	380	69.619	100	70	164.35	355
Hardness (Total as CaCO3)	mg/L	99	8	62.58	156	32.218	98	28	67.591	150
Total Organic Carbon (TOC)	mg/L	33	2.2	7.887	16	3.776	34	1.8	3.712	10
Arsenic	mg/L	10	0.0012	0.001	0.0025	0.011	8	0.00063	0.0006	0.00075
Cadmium	mg/L	13	0.00005	0.00005	0.00005	0.000	11	0.00005	0.000	0.00005
Chromium	mg/L	10	0.0019	0.006	0.016	0.005	10	0.00025	0.000	0.00025
Nickel	mg/L	12	0.00016	0.009	0.022	0.007	11	0.00023	0.00058	0.001
Selenium	mg/L	12	0.0005	0.0005	0.00072	0.000	11	0.00025	0.000	0.00025
Mercury	mg/L	12	0.00072	0.00072	0.00072	0.000	11	0.00005	0.000	0.00005
Cryptosporidium	Oocysts/10 L	1	ND	ND	ND	N/A	1	ND	ND	ND
Giardia		1	ND	ND	ND	N/A	1	ND	ND	ND

Table 15 Verification monitoring data summary – Capricorn Coast (2014 to 2022)

Parameter	Units	Count	Min	Average	Max
Free chlorine	mg/L	980	<0.05	0.57	2
Electrical conductivity	µS/cm	1017	154	260	886
pH	-	1027	6.5	7.9	9.5
True colour	HU	907	<1	<1	10
Turbidity	NTU	1020	<0.05	0.24	4.67
E. coli	mpn/100mL	1152	<1	<1	<1
THMs (Woodbury WTP)	mg/L	32	19	43.93	68
THMs (Capricorn Retic)	mg/L	66	68	151	251
Chlorate (Capricorn Retic)	mg/L	12	0.118	0.335	1.14

4 Hazards

The hazards and unmitigated risks (Medium, High or Extreme) that are relevant to the Capricorn Coast service have been brought forward to the Risk Assessment.

5 Risk Assessment

The preventative measures that are present for the unmitigated risks have been identified. The mitigated risk is determined based on the likelihood and consequence of the hazard occurring in the presence of the preventative measure.

Where a preventative measure is required to lower the risk to an acceptable level, the procedure used to ensure the measure is in place, and effective is identified. Where no formal procedure exists, a risk management improvement plan item is identified.

6 Operational Monitoring

The following parameters are monitored at the Woodbury WTP by SCADA with operational actions required outside the target range. The actions to return the process to the target levels are undertaken by the onsite operator. This section supplements the operational description provided above.

Daily Laboratory Testing:

Raw water: pH, Turbidity, Colour, Conductivity, Alkalinity, Temperature

Dosed water: pH

Clarifier: Alum dose rate set point, Turbidity, Colour

Final Water: pH, Turbidity, Colour, Conductivity, Alkalinity, Temperature, Chlorine

St Faiths Reservoir complex: pH, Turbidity, Colour, Conductivity, Alkalinity, Chlorine), Temperature. Note a flammable single sample tap has now been installed to obviate the need for grab samples from individual reservoirs and is considered more representative of water supplied.

Daily Testing is written on the Operators Test Log Sheet and entered into W: drive.

Online Continuous Monitoring:

WTP Hydraulics: Raw water, filtered water, treated water, Rockhampton-Yeppoon pipeline flow rates, individual filter head loss.

Dose Rates: PAC, hydrated lime, aluminium sulphate, polyelectrolyte, chlorine gas, soda ash

Online Chemical parameters: pH – pH correction, Clearwater, Turbidity – Clearwater, Disinfection Residual – Clearwater, St Faiths, Taranganba, Emu Park, Keppel Sands (Boundary Reservoir – for information, not controlled by Livingstone SC).

Table 16 Mitigated risk assessment – Capricorn Coast

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Other Preventative Measures	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
						Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
PAC dosing	Failure of PAC dosing	Taste and odour	High 10	SCADA control and alarms Duty/standby pumps	Spare pumps	Minor	Unlikely	Low 4	Confident					
PAC dosing	Toxic algal bloom in Kellys, breakthrough WTP	Cyanobacteria (Woodbury)	Medium 8	PAC, Chlorination	Oxidation during disinfection step	Moderate	Rare	Low 3	Confident	SCADA alarms and actions				
Clarifier return	Recontamination from supernatant	Protozoa (Woodbury)	Extreme 20	Filtration interlocked to inflow		Catastrophic	Unlikely	High 10	Estimate		Turbidity analyser installed on return line & automatic plant shutdown on high turbidity programmed.			Rate of return 4.5L/sec = 2-3% of plant flow
pH adjustment	Change in raw water quality, failure to dose/overdose of lime	pH (high or low)	Medium 6	auto plant shutdown <6.2 or >7.7		Minor	Unlikely	Low 4	Confident		-	-		
Coagulation	Coagulation failure (e.g. change of raw water quality, non-optimal dose)	Heavy metals	Medium 6	Alarms on loss of dosing & mixer failure Re-order at 12kL (of 30kL) tank, supply arrives within a few days Operator inspections (daily)	Filtration (oxidation with chlorination)	Minor	Unlikely	Low 4	Confident			Investigate Installing ORP analyser at Woodbury WTP inlet		Loss of dosing pump - plant alarm; plant shut down if rapid mixer goes down
Coagulation	Failure of alum pump	Colour	High 10	Duty/standby pumps Operator inspections (daily)	PAC	Minor	Unlikely	Low 4	Confident					duty standby, daily operator testing for colour, monthly jar test (or change), SCADA
Coagulation	Bypass of coagulation	Colour	High 10	Only considered during emergencies Can only operate on-site via SCADA (can't operate from off-site)	Filtration	Minor	Rare	Low 2	Confident					
Filtration	Source contamination	Protozoa (Woodbury)	Extreme 20	Filtration with individual filter turbidity monitoring. Filter alarm at 0.3NTU, filter stops production at 0.5NTU for 5 mins	Coagulation; ability to source additional water from Rockhampton	Catastrophic	Unlikely	High 10	Estimate		Review turbidity-based backwash triggers (e.g. >0.3 NTU for 14mins if possible)	Consider installing a turbidity meter at the clarifier to provide advance warning of carryover	Structural works and filter media replacements started October 2022 Consider undertaking Cost-Benefit Analysis for installation of UV at Woodbury WTP	Multiple periods in 2019 where turbidity spiked above >0.5NTU

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Other Preventative Measures	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
						Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
Filtration	Breakthrough	Protozoa (Woodbury)	Extreme 20	Filtration with individual filter turbidity monitoring. Filter alarm at 0.3NTU, filter stops production at 0.5NTU for 5 mins	2min filter to waste following backwash	Catastrophic	Rare	Low 2	Confident					Backwash pumps replaced several years ago
Filtration	Failure filtration/ soda ash	Turbidity	Medium 8	SCADA Control, turbidity monitoring, backwash		Minor	Possible	Medium 6	Confident	SCADA alarms and actions		Duty/standby soda ash pumps at Woodbury WTP are installed & spares have been purchased.		
Disinfection	Underdosing	Bacteria/Virus (Woodbury)	Extreme 20	SCADA controlled disinfection with alarm at 0.9mg/L auto-shutdown at <0.5mg/L for 5mins		Catastrophic	Rare	Medium 6	Confident	SCADA alarms and actions (CCP procedure)		Investigate auto-removal of control system inhibit (e.g. when calibrating)	To be investigated during filtration upgrade SCADA programming.	CT at CWT outlet calculated to be 16.2mg.min/L at 0.5mg/L; assuming baffle factor of 0.1. One customer close to the treatment plant
Disinfection	Overdose	Chlorine	Medium 9	SCADA controlled disinfection with auto-shutdown at >3mg/L for 5mins		Moderate	Rare	Low 3	Reliable	SCADA alarms and actions (CCP procedure)				Has not happened at Woodbury - confirm CCP procedure developed.
Pipeline	Importation of water outside of agreed quality limits	Chlorine / turbidity / pH	Medium 9	Bulk water supply agreement		Moderate	Rare	Low 3	Confident	Supply agreement				Unmitigated risk assumes RRC DWQMP is functioning
Pipeline	Recontamination of reservoirs/network	Protozoa (network)	Medium 6	Reservoir design		Catastrophic	Rare	Medium 6	Reliable					Maintaining chlorine residual in network reduces risk.
Pipeline	Recontamination/ secondary disinfection failure	Bacteria/Virus (Glenmore)	Medium 6	Maintain residual, re-chlorination		Catastrophic	Rare	Medium 6	Confident	SCADA alarms and actions				Weekly testing from FRW at handover, LSC weekly
Pipeline	Opportunistic contamination	Opportunistic Pathogen *(Naeglaria fowlerii)*	Medium 5	Disinfection residual	Mains break procedure	Major	Rare	Medium 5	Estimate	SCADA alarms and actions		-		Maintaining chlorine residual in network reduces risk.
Pipeline	Breakthrough from WTP	Manganese (Glenmore)	Low 3	Nil		Moderate	Rare	Low 3	Reliable			-		LSC samples water supplied weekly. Access to FRW online residual monitoring.
Pipeline	Overdose	Chlorine	Medium 9	SCADA Alarms and associated actions		Moderate	Unlikely	Medium 6	Certain	SCADA alarms and actions				LSC samples water supplied weekly. Access to FRW online residual monitoring.

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Other Preventative Measures	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
						Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
Pipeline	Reaction of organic matter with chlorine in pipeline	Disinfection byproducts	Medium 6	Control disinfection levels, not supply from pipeline	Communication between providers	Moderate	Unlikely	Medium 6	Reliable	SCADA alarms and actions				Control measures include not supplying from this source, increased blending etc.
Pipeline	Mains break	Failure of supply	Medium 8	Mains break procedure	Asset replacement/ management	Minor	Unlikely	Low 4	Confident			-		
Pipeline	Any error	Operator error	High 15	Chlorination post Mt Charlton. Reliant on FRW processes to identify issues.		Catastrophic	Rare	Medium 6	Reliable	staff training documented				LSC samples water supplied weekly. Access to FRW online residual monitoring.
Pipeline	Deliberate actions	Terrorism /sabotage	High 10	Inspections, site security, site door alarms, ERP		Catastrophic	Rare	Medium 6	Estimate					
Reticulation	Contamination	Protozoa (network)	Medium 6	Mains break procedure, network pressure		Catastrophic	Rare	Medium 6	Reliable					
Reticulation	Recontamination reservoirs/ retic	Bacteria/Virus (Network)	High 10	Residual disinfection, redosing at reservoirs, mains break procedure, network pressure	Quarterly inspections of reservoirs	Catastrophic	Rare	Medium 6	Reliable	SCADA alarms and actions		-		New re-chlorination station at Pacific Heights Reservoir
Reticulation	Contamination	Opportunistic Pathogen *(Naeglaria fowlerii)*	Medium 5	Disinfection		Major	Rare	Medium 5	Reliable	SCADA alarms and actions				Maintaining chlorine residual in network reduces risk.
Reticulation	Resuspension/biofilm / main break	Turbidity	Medium 8	SCADA, main break		Minor	Likely	Medium 8	Confident	mains break procedure,		Have conducted disinfection & mains brake procedure.	-	Maintaining chlorine residual in network reduces risk.
Reticulation	Reaction of organic matter with chlorine in reticulation	Disinfection byproducts	Medium 6	Removal of organics through treatment and disinfection management	Scheduled mains flushing program	Minor	Unlikely	Low 4	Reliable					THMs - 2014-2020 data average 140ug/L, maximum 250ug/L
Reticulation	Redosing multiple times	Chlorate	Medium 9			Moderate	Possible	Medium 9	Reliable			-		~~minor as there is no current health value.~~ Have only had 2 excursions above proposed limit at Keppel Sands Reservoir.
Reticulation	Supply zone failure	Failure of supply	Medium 8	Generator backup, and duty/standby, Alternate supply		Major	Rare	Medium 5	Confident					
Reticulation	Backflow	Bacteria/Virus (Network)	High 10	All metered connections have backflow prevention. Disinfection, pressurised scheme		Catastrophic	Rare	Medium 6	Reliable					Not aware of any unmetered connections

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Other Preventative Measures	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
						Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
Reticulation	Backflow	Chemical	Medium 6	All metered connections have backflow prevention Disinfection, pressurised scheme		Moderate	Rare	Low 3	Reliable					Not aware of any unmetered connections
Re-chlorination	Overdose	Chlorine	Medium 9	SCADA		Moderate	Unlikely	Medium 6	Reliable	SCADA alarms and actions				Emu Park Reservoir - optimised dosing at reservoir to correct issue
Whole of System	Woodbury plant failure	Failure of supply	Medium 8	Alternate supply		Major	Unlikely	Medium 8						
Whole of System	Mistakes	Operator error	High 15	Operators trained to Cert 3, monthly toolbox, prestart meeting	Work instructions for various tasks, buddy up new Operators with experienced Operators	Catastrophic	Rare	Medium 6		SCADA alarms and actions				
Whole of System	Deliberate contamination (incl cyber security attacks with a physical element)	Terrorism /sabotage	High 10	Security fencing/ locked gates, SCADA monitoring, separate SCADA levels	Some water pump stations have door alarms	Catastrophic	Unlikely	High 10	Confident	SCADA Cyber Security Procedure (March 2020)		Develop scope of works for site security upgrades	Undertake site security upgrades	This risk aligns with the assessment made in LSC procedure for Cyber Security management
Whole of System	Change to SCADA limits resulting in compromised system operation	Bacteria/Virus (Woodbury)	Extreme 20	Operator training		Catastrophic	Unlikely	High 10	Estimate			Review SCADA access protocols to determine if any short-term improvements are available	Consider engaging an expert to undertake a cyber security review	Need to retain standalone SCADA system at WTP to allow plant control when comms are down. No identified solution for password management consistency between normal user accounts and on-site WTP SCADA system (i.e. users passwords will become out of sync over a short period of time)
Whole of System	Unauthorised remote access to systems leading to water quality impacts	Terrorism /sabotage	High 10	Password policies Firewalls Antivirus software	SCADA user access register defines levels of access System backups	Catastrophic	Rare	Medium 6	Confident	SCADA Cyber Security Procedure (March 2020)			Consider engaging an expert to undertake a cyber security review	Cybersecurity exercise undertaken September 2022.
Whole of System	Insufficient Operators available	Bacteria/Virus (Woodbury)	Extreme 20	Disaster Management; likely call on neighbouring Councils for assistance	Contract Operators potentially available; 2 additional staff being trained to Cert III level	Catastrophic	Possible	High 15	Estimate			Prepare a business case for additional Operator(s) - Complete		Have 6 Operators now and QLDWater may be able to coordinate assistance and provide recommendations for support COVID-19 could be a significant impact
Whole of System	Breakdown of sodium hypochlorite	Chlorate	Medium 9	Chemical turnover		Moderate	Rare	Low 3	Reliable					Previous results were low; testing recommencing 2021.

PART 3 THE CAVES DRINKING WATER SCHEME

1 Overview of Scheme

The entire water supply for The Caves is sourced from, and is a zone within the Glenmore Water Treatment Plant reticulation network. The local government boundary cuts this area from the Glenmore WTP reticulation network. LSC has no role in treating the water for the scheme with the exception of re-chlorination at Mt Charlton reservoir.

The Caves area, located to the North of Rockhampton, includes the Mt Charlton, Ramsay Creek, Etna Creek, Glenlee, Glendale, Rockyview, and The Caves communities. The point of supply to LSC is at the outlet of Ramsay St Pump Station. The Mt Charlton Reservoir, located past The Caves, is currently the only rechlorination location. The Capricorn Correctional Centre is a major customer in this zone (second largest water user in all networks). Disinfection residuals are not currently well maintained in the area between the Ramsay St Pump station and the Mt Charlton reservoir. This includes the Capricorn Correctional Centre, and the communities of Etna Creek, Glenlee and Glendale.

1.1 Catchment description

The Caves water supply scheme is a multiple entity scheme where the water treatment is undertaken by RRC. The source water for this scheme is the treated water from the Glenmore WTP. Nonetheless, there is benefit in briefly describing the catchment from which Rockhampton sources their water as it impacts on LSC customers.

The Glenmore WTP draws raw water from the Barrage on the Fitzroy River. The Barrage sits at the bottom of the Fitzroy River Catchment which is the second largest in Australia covering in excess of 140,000 km^2. Due to the size of the catchment and the predominantly sub-tropical climate, the system is subject to highly variable but historically reliable flows with an average discharge between 5,000,000 and 6,000,000 ML/year. FRW operates the Barrage in accordance with a Resource Operations Plan (ROP).

The Barrage impoundment and upstream catchment are unprotected surface waters that are highly impacted by a multitude of different land use practices and industrial activities that occur in the various sub-catchments within the Fitzroy Basin. As such the raw water in the Barrage storage is subject to the potential impacts that occur within the catchment. Typical water quality issues that arise include cyanobacterial blooms, mine water discharges that alter water quality aesthetics and high flow or flooding events that lead to highly variable raw water quality e.g. rapid changes in turbidity (up to 2000 NTU), and fluctuations in iron and manganese concentration.

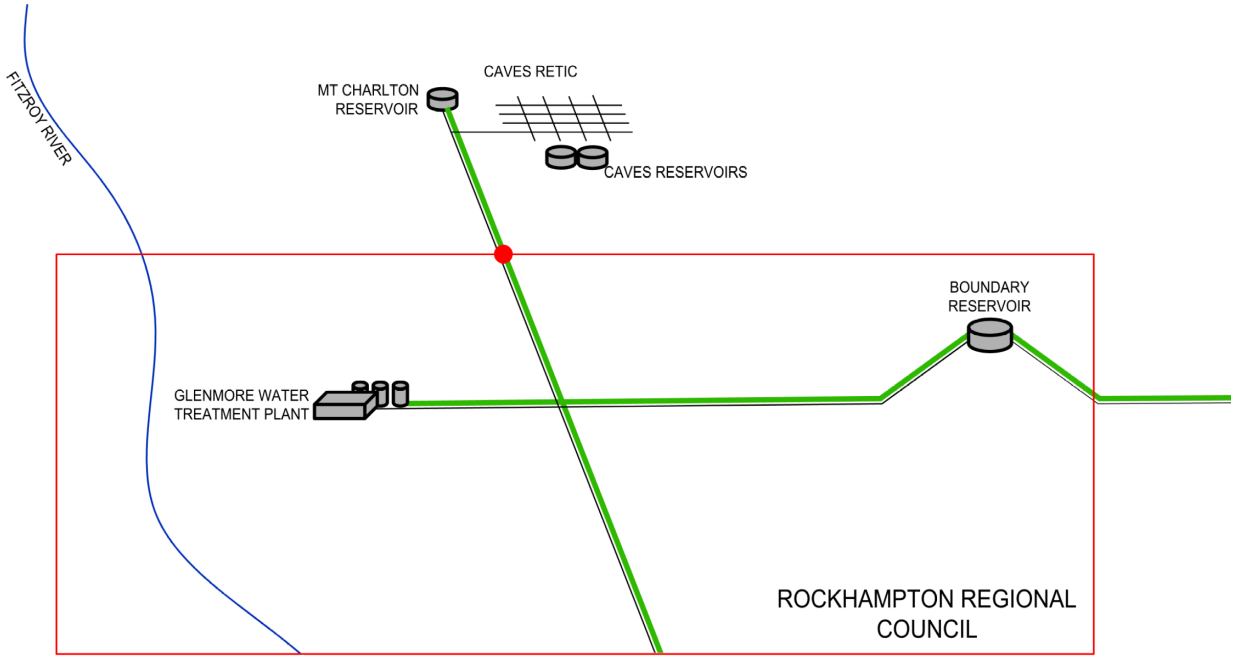

Figure 6 The Caves schematic

2 Scheme Infrastructure and Operation

2.1.1 Glenmore Water Treatment Plant

The Glenmore WTP in Rockhampton is owned and operated by Rockhampton Regional Council, and this information is included here for completeness of understanding of potential risks that LSC` may have to manage.

The Glenmore WTP has a maximum capacity to treat 120 ML/d.

The design of the Glenmore WTP has been maximised to handle very high raw water turbidity and the WTP can treat raw water with turbidity in excess of 2000 NTU.

Raw water is pumped to the inlet of the WTP where the option exists for pre-chlorination or chlorine dioxide dosing (oxidation of iron and manganese, or for treating algal toxins). Influent raw water is dosed with a coagulant and pumped into two identical parallel train flocculation/sedimentation basins.

Powdered Activated Carbon is added to remove colour, and polyacrylamide is added as a water clarification aid.

Water then passes through the sedimentation tank (chlorine dioxide can be dosed here also), and clarified water (target turbidity of 1.0 to 1.5 NTU) is collected via finger weirs into collection channels which then transfer the clarified water to the filters.

Filtration is achieved using 10 rapid gravity sand and garnet filters. Each filter contains a filter-to-waste function which enables poor quality filtered water to be wasted until the target water quality is achieved. Filters typically produce water with turbidity of <0.1 NTU.

Filtered water is dosed with hydrated lime by one of two duty/standby lime feeding systems to correct pH (pH 7.8 target) and is then disinfected with chlorine gas with a free chlorine residual setpoint of 1.1 mg/L with a target range of 0.5 to 1.5 mg/L of free chlorine (alternatively, chlorine dioxide is able to be used for disinfection).

The Glenmore high-lift water pump station (WPS) pumps water from the WTP through a network of trunk distribution mains to fill the Yaamba Road Reservoir which is the normal reservoir that supplies water to LSC.

2.1.2 Reticulation:

The FRW owned Yaamba Road Reservoir supplies water via the Ibis Ave WPS to the transfer point with LSC (Ramsay Creek flowmeter) from where water feeds the Glenlee, Glendale, Rockyview and Etna Creek areas as well as filling the Mt Charlton Reservoir and The Caves Reservoir. There is also a water meter at Argyle Avenue, where responsibility is again assumed by FRW.

The Mt Charlton Reservoir is a fully enclosed and vermin proof 9 ML concrete reservoir constructed in 1925. LSC operates a rechlorination facility at this location, with dosing of sodium hypochlorite, interlocked to inflow with a target residual of 0.8 mg/L. SCADA monitors the disinfection concentration, and action alarms indicate when the target range is exceeded, and callouts if the concentration is above 1.8 or below 0.3 mg/L.

The Mt Charlton Reservoir re-chlorination manages the risks due to the long service line from Rockhampton, and following re-chlorination, The Caves receives good residuals from Mt Charlton, but can receive low residuals when the supply bypasses the reservoir at times of high demand. However in these circumstances, the residuals are improved due to the lesser water age. There is a dead end at Barmoya Rd, the Caves. This site is regularly turned over as there is a standpipe access from the hydrant at the end of the line, and the dead end is located ~300m from the Caves Pub sampling location.

In contrast, the correctional centre and areas between the point of supply and the Mt Charlton reservoir often have difficulties maintaining disinfection residual. LSC does not have any disinfection facilities between the point of supply and Mt Charlton, so relies on FRW to manage the risk.

The Caves area is tested regularly for *E. coli*, with no detections of *E. coli* in weekly testing undertaken since de-amalgamation in 2014.

The reticulation network within The Caves contains 76km of pipes of the following materials and ages (Figure 7). Pipes are generally 100mm and 150mm reticulation mains, and 600mm trunk mains.

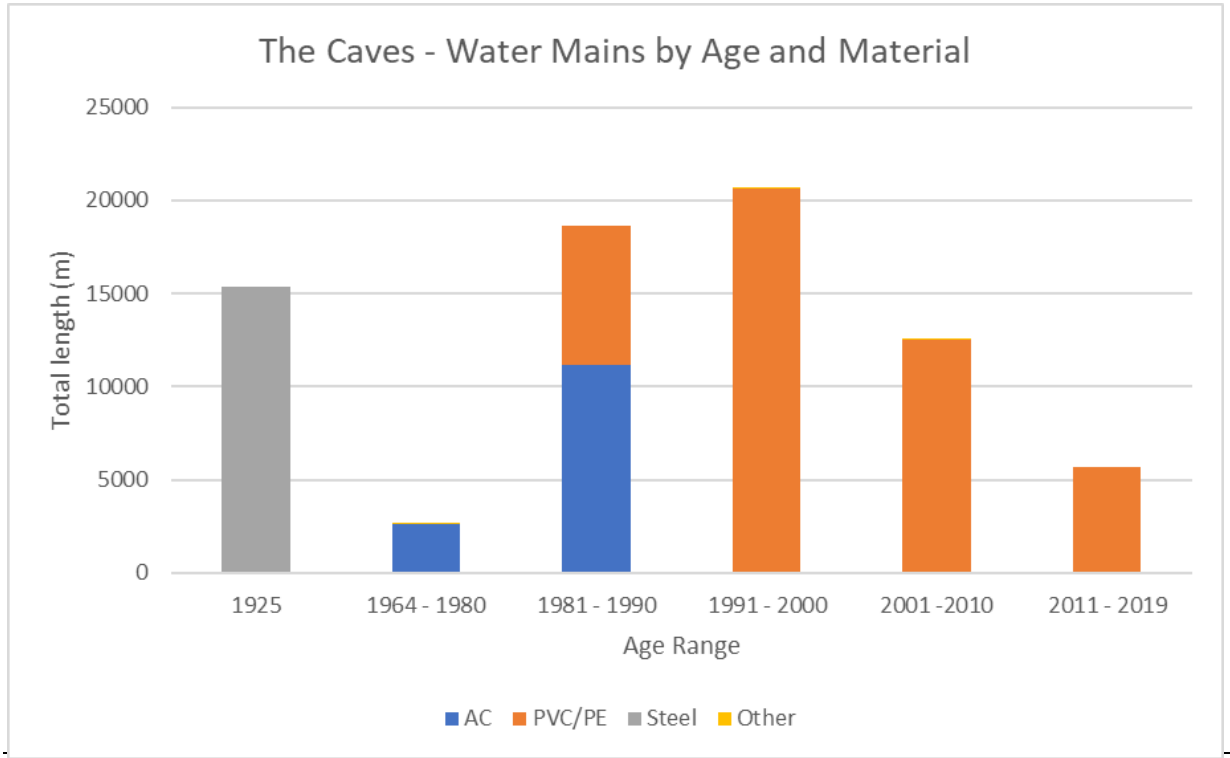

Table 17 The Caves reservoir details

Reservoir Name	Year Built	Capacity (ML)	Type/Design	Roof
Mt Charlton	1925	9.0	Concrete rectangular	Fully enclosed metal sheet
The Caves 1 & 2	1985	2 x 0.1	2 x Concrete circular	Fully enclosed concrete

3 Water Quality Information

Verification monitoring results for the Caves has been summarised in Table 18.

Table 18 Verification monitoring data summary – The Caves reticulation (2014 to 2022)

Parameter	Units	Count	Min	Average	Max
Free chlorine	mg/L	163	0	0.545	1.63
Electrical conductivity	µS/cm	207	114	285	550
pH	-	206	6.9	7.7	8.53
True colour	HU	206	0	0.25	8
Turbidity	NTU	204	0.06	0.16	1.48
E. coli	mpn/100mL	234	ND	ND	ND
THMs	mg/L	32	58	125	185
Chlorate	mg/L	66	0.027	0.12	0.25

4 Hazards

The hazards and unmitigated risks (Medium, High or Extreme) that are relevant to the scheme have been brought forward to the Risk Assessment.

5 Risk Assessment

The preventative measures that are present for the unmitigated risks have been identified. The mitigated risk is determined based on the likelihood and consequence of the hazard occurring in the presence of the preventative measure.

Where the mitigated risk is unacceptable, risk improvement items have been identified. Additional risk improvement items have been identified if they are deemed necessary.

6 Operational Monitoring

The Caves scheme has SCADA monitoring of reservoir levels at both Mt Charlton and The Caves, and disinfection residual concentration in The Mt Charlton Reservoir (target typically 0.8 mg/L), with alarms outside the target range, and operator call-out if residual is <0.3 or >1.8 mg/L.

Table 19 Mitigated Risk Assessment – The Caves

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
					Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
Bulk water supply	Importation of water outside of agreed quality limits	Chlorine / turbidity / pH	Medium 9	Bulk water supply agreement	Moderate	Rare	Low 3	Confident	Supply agreement				
Reticulation	Recontamination of reservoirs/network (Mount Charlton)	Bacteria/Virus (Network)	High 10	Reservoir design, network pressure (note - issues with Mount Charlton)	Catastrophic	Unlikely	High 10	Reliable		Implement weekly verification monitoring at Mount Charlton Reservoir (*E. coli* and chlorine)	Address vermin proofing and reservoir integrity breaches upon inspections where a high risk is identified	Replace roof structure and sheeting on Mount Charlton Reservoir (To be completed end of October 2022))	Risk scoring based on Mount Charlton Reservoir. Leaks in reservoir have being repaired and roof To be completed end of October 2022).
Reticulation	Recontamination/ disinfection failure	Bacteria/Virus (Network)	High 10	Maintain residual, rechlorination, network pressure.	Major	Unlikely	Medium 8	Confident	SCADA alarms and actions				Weekly testing from FRW at handover, LSC weekly in The Caves. Need to watch decay of residuals in points in The Caves zone.
Reticulation	Opportunistic contamination	Opportunistic Pathogen (*Naeglaria fowlerii*)	Medium 5	Disinfection residual	Major	Rare	Medium 5	Estimate					
Reticulation	Breakthrough from WTP	Manganese (Glenmore)	Low 3	Nil	Moderate	Rare	Low 3	Reliable					
Reticulation	Reservoir sediment, sloughing in pipes	Turbidity (network)	Medium 8	Mains flushing program	Minor	Possible	Medium 6	Reliable	Mains flushing program				Mains flushing at dead ends at 3/6 month intervals; can amend based on customer complaints and add to program if required
Reticulation	Reaction of organic matter with chlorine in reticulation	Disinfection by-products	Medium 6	Control disinfection levels; mains flushing program	Moderate	Unlikely	Medium 6	Reliable					
Reticulation	Mains break	Failure of supply	Medium 8	Asset replacement/ management	Minor	Unlikely	Low 4	Confident					
Rechlorination	Rechlorination overdose (The Caves)	Chlorine	Medium 9	SCADA Alarms	Moderate	Unlikely	Medium 6	Certain					
Rechlorination	Breakdown of sodium hypochlorite	Chlorate	Medium 9	Chemical turnover	Moderate	Rare	Low 3	Reliable					Testing undertaken after previous risk assessment. Results were low; this is not believed to be a concern
Whole of System	Any error	Operator error	High 15	Chlorination post Mt Charlton. Reliant on FRW processes to identify issues.	Catastrophic	Rare	Medium 6	Reliable	Staff training documented				Bulk water agreement requires two way communication of any issues. Emergency Response Procedures - responsive rather than preventative.
Whole of System	Deliberate actions	Terrorism /sabotage	High 10	Inspections, site security, site door alarms, ERP	Catastrophic	Rare	Medium 6	Estimate					
Whole of System	Insufficient Operators available	Operator error	High 15	Disaster Management; can call on neighbouring Councils for assistance; Contract Operators potentially available; 2 additional staff being trained to Cert III level	Catastrophic	Possible	High 15	Estimate			Prepare a business case for additional Operator(s)		

PART 3 NERIMBERA DRINKING WATER SCHEME

1 Overview of Scheme

The entire water supply for Nerimbera is sourced from, and is a zone within the Glenmore Water Treatment Plant reticulation network. The local government boundary cuts this area from the Glenmore WTP reticulation network. LSC has no role in treating the water for this scheme.

Nerimbera is a small community located ~8 km east of the Rockhampton town Centre, and pressure is maintained by the Lakes Creek Road Water Pump Station. LSC has no pumps or reservoirs in the Nerimbera zone. There is an abattoir located at the far end of this reticulation zone which is the largest potable water user by volume in all networks, and this is considered to be a high risk customer. There is no further treatment or rechlorination in this zone.

1.1 Catchment description

The Nerimbera water supply scheme is a multiple entity scheme where the water treatment is undertaken by Rockhampton Regional Council. The source water for this scheme is the treated water from the Glenmore WTP. Nonetheless, there is benefit in briefly describing the catchment from which Rockhampton sources their water as it impacts on LSC customers.

The Glenmore WTP draws raw water from the Barrage on the Fitzroy River. The Barrage sits at the bottom of the Fitzroy River Catchment which is the second largest in Australia covering in excess of 140,000 km^2. Due to the size of the catchment and the predominantly sub-tropical climate, the system is subject to highly variable but historically reliable flows with an average discharge between 5,000,000 and 6,000,000 ML/year. FRW operates the Barrage in accordance with a Resource Operations Plan (ROP).

The Barrage impoundment and upstream catchment are unprotected surface waters that are highly impacted by a multitude of different land use practices and industrial activities that occur in the various sub-catchments within the Fitzroy Basin. As such the raw water in the Barrage storage is subject to the potential impacts that occur within the catchment. Typical water quality issues that arise include cyanobacterial blooms, mine water discharges that alter water quality aesthetics and high flow or flooding events that lead to highly variable raw water quality e.g. rapid changes in turbidity (up to 2000 NTU), and fluctuations in iron and manganese concentration.

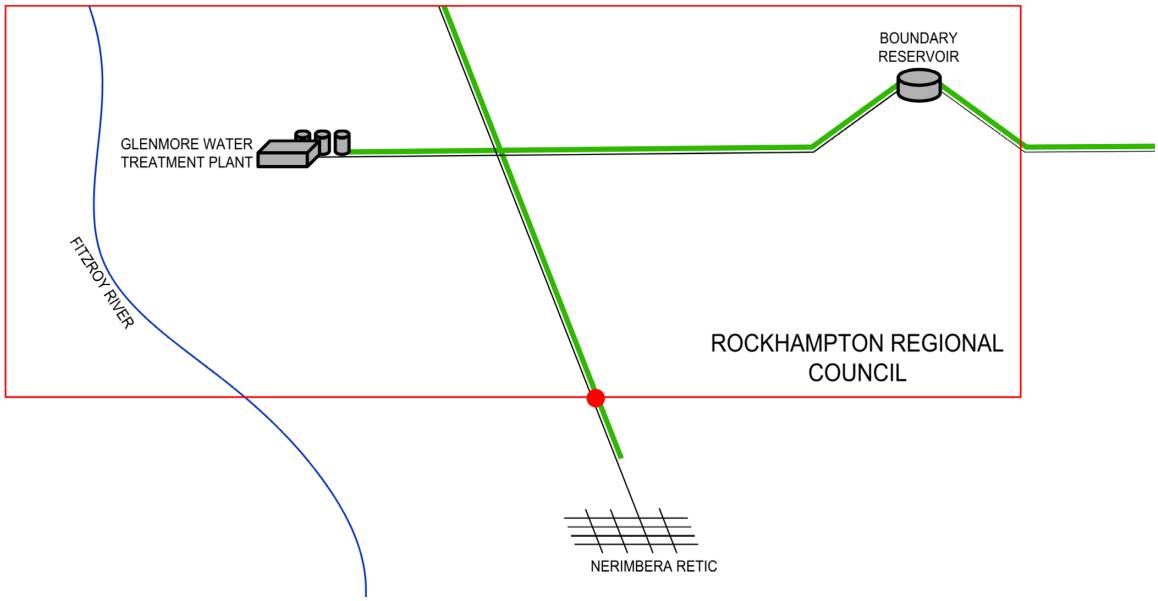

Figure 8 Nerimbera schematic

2 Scheme Infrastructure and Operation

2.1.1 Glenmore Water Treatment Plant

The Glenmore WTP in Rockhampton is owned and operated by Rockhampton Regional Council, and this information is included here for completeness of understanding of potential risks that LSC may have to manage.

The Glenmore WTP has a maximum capacity to treat 120 ML/d.

The design of the Glenmore WTP has been maximised to handle very high raw water turbidity and the WTP can treat raw water with turbidity in excess of 2000 NTU.

Raw water is pumped to the inlet of the WTP where the option exists for pre-chlorination or chlorine dioxide dosing (oxidation of iron and manganese, or for treating algal toxins). Influent raw water is dosed with a coagulant and pumped into two identical parallel train flocculation/sedimentation basins.

Powdered Activated Carbon is added to remove colour, and polyacrylamide is added as a water clarification aid.

Water then passes through the sedimentation tank (chlorine dioxide can be dosed here also), and clarified water (target turbidity of 1.0 to 1.5 NTU) is collected via finger weirs into collection channels which then transfer the clarified water to the filters.

Filtration is achieved using 10 rapid gravity sand and garnet filters. Each filter contains a filter-to-waste function which enables poor quality filtered water to be wasted until the target water quality is achieved. Filters typically produce water with turbidity of <0.1 NTU.

Filtered water is dosed with hydrated lime by one of two duty/standby lime feeding systems to correct pH (pH 7.8 target) and is then disinfected with chlorine gas with a free chlorine residual setpoint of 1.1 mg/L with a target range of 0.5 to 1.5 mg/L of free chlorine (alternatively, chlorine dioxide is able to be used for disinfection).

The Glenmore high-lift water pump station (WPS) pumps water from the WTP through a network of trunk distribution mains to fill the Yaamba Road Reservoir which is the normal reservoir that supplies water to LSC.

2.1.2 Reticulation:

The Yaamba Road Reservoir also gravity feeds to the Lakes St Pump station which maintains pressure in the Lakes Creek reticulation zone, and also to the Nerimbera scheme. The point of supply to Nerimbera is located on the outlet of the bulk water meter. There are also six houses off Hartington Ave that are directly fed using RRC infrastructure.

There are no reservoirs or disinfection facilities in Nerimbera.

The Nerimbera zone is small and there are several dead ends in the scheme. The abattoir is located on one of these lines, and is a significant water user (average usage is 14.7L/sec supplied via a 250mm main). This high water use results in a low water age within the area. There is a sampling location that has been established at this location.

There are no areas of low pressure.

A second water sampling point was installed in Nerimbera in 2015, and routine sampling of the sample points have not detected *E. coli.*

The reticulation network within Nerimbera contains 10km of pipes of the following materials and ages (Figure 9).

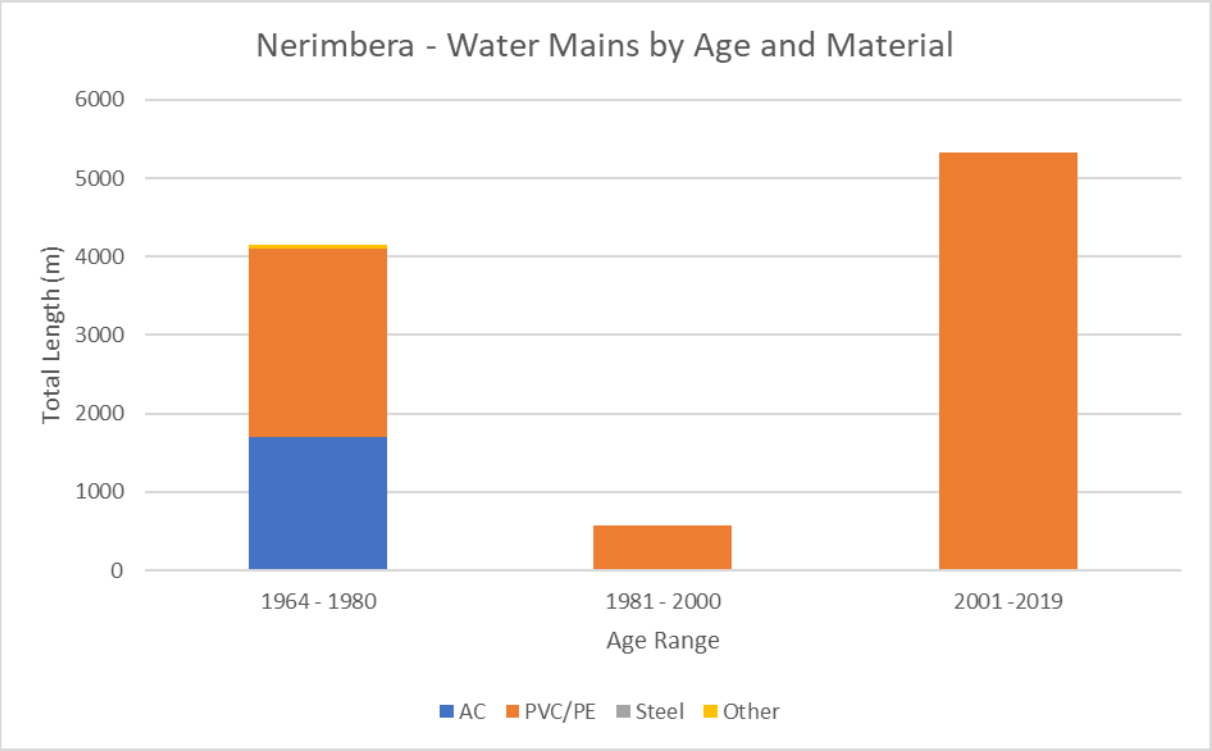

Table 20 Verification monitoring data summary – Nerimbera reticulation (2014 to 2022)

Parameter	Units	Count	Min	Average	Max
Free chlorine	mg/L	175	<0.1	0.34	1.09
Electrical conductivity	µS/cm	170	137	279	653
pH	-	173	7.1	7.5	8.7
True colour	HU	174	<1	<1	9
Turbidity	NTU	170	0.07	0.23	2.59
E. coli	mpn/100mL	167	ND	ND	ND
THMs	mg/L	27	46	80	150
Chlorate	mg/L	6	0.006	0.105	0.184

4 Hazards

The hazards and unmitigated risks (Medium, High or Extreme) that are relevant to the scheme have been brought forward to the Risk Assessment.

5 Risk Assessment

The preventative measures that are present for the unmitigated risks have been identified. The mitigated risk is determined based on the likelihood and consequence of the hazard occurring in the presence of the preventative measure.

Where the mitigated risk is unacceptable, risk improvement items have been identified. Additional risk improvement items have been identified if they are deemed necessary.

6 Operational Monitoring

There is no operational monitoring of the Nerimbera area of the scheme as there is no control over any process.

Table 21 Mitigated Risk Assessment – Nerimbera

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
					Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
Bulk water supply	Importation of water outside of agreed quality limits	Chlorine / turbidity / pH	Medium 9	Bulk water supply agreement	Moderate	Rare	Low 3	Confident	Supply agreement				
Reticulation	Recontamination/ disinfection failure	Bacteria/Virus (Network)	High 10	Maintain residual, network pressure	Major	Unlikely	Medium 8	Confident					Weekly testing from FRW at handover, LSC monthly in Nerimbera. Loss of disinfectant residual not a concern in Nerimbera due to high water user (abattoir)
Reticulation	Opportunistic contamination	Opportunistic Pathogen (*Naeglaria fowlerii*)	Medium 5	Disinfection residual	Major	Rare	Medium 5	Estimate					Factsheet in ADWG states that maintaining chloring residuals at 0.5mg/L or higher will control Naegleria fowleri,
Reticulation	Breakthrough from WTP	Manganese (Glenmore)	Low 3	Nil	Moderate	Rare	Low 3	Reliable					
Reticulation	Reservoir sediment, sloughing in pipes	Turbidity (network)	Medium 8	Mains flushing program	Minor	Possible	Medium 6	Reliable	Mains flushing program				Mains flushing at dead ends at 3/6 month intervals; can amend based on customer complaints and add to program if required
Reticulation	Reaction of organic matter with chlorine in reticulation	Disinfection by-products	Medium 6	Monitor disinfection levels; mains flushing program	Moderate	Unlikely	Medium 6	Reliable					
Reticulation	Mains break	Failure of supply	Medium 8	Asset replacement/ management	Minor	Unlikely	Low 4	Confident					
Whole of System	Any error	Operator error	High 15	Reliant on FRW processes to identify issues and communicate	Catastrophic	Rare	Medium 6	Reliable	Staff training documented				Bulk water agreement requires two way communication of any issues. Emergency Response Procedures - responsive rather than preventative.
Whole of System	Deliberate actions	Terrorism /sabotage	High 10	ERP	Catastrophic	Rare	Medium 6	Estimate					
Whole of System	Insufficient Operators available	Operator error	High 15	Disaster Management; can call on neighbouring Councils for assistance; Contract Operators potentially available; 2 additional staff being trained to Cert III level	Catastrophic	Possible	High 15	Estimate			Two additional Operator(s) have been employed.		

PART 4 MARLBOROUGH DRINKING WATER SCHEME

1 Overview of Scheme

The Marlborough water supply scheme is catchment to tap bore water scheme that serves 100 customers in the community of Marlborough. The scheme is designed to provide up to 100 kL/day. Bore water is treated sequentially by bag filtration and cartridge filtration and/or reverse osmosis prior to disinfection. It is fully owned and operated by LSC.

1.1 Marlborough Bores

Aquifer Description:
The Marlborough Drinking Water Scheme is supplied with water from two shallow bores (RN 91861 and RN 91966 on Department of Natural Resources, Mines and Energy groundwater database) located 2-3 km to the north of the Marlborough township on Glenprairie Road. The bores draw water from two shallow aquifers, the Marlborough Creek Alluvium aquifer (12-15 m depth) and a deeper decomposed granite aquifer (18-20 m depth). Land use in the area is predominantly cattle grazing with some fodder production occurring using groundwater irrigation.

The bores were drilled in late 1995 and early 1996, are approximately 20-25 m deep with about 7 m depth to water level and each bore is capable of producing water at about 5 L/sec. Pump tests conducted in early 1996 following an extended period of drought suggest that a yield of 3.9 L/sec be adopted as the target sustainable pumping rate during drought conditions. At this level of supply, the daily and annual demand targets of 40 kL and approximately 15 ML respectively are highly sustainable into the future. Two bore pumps capable of operating in duty/standby mode and with a capacity of 3.5 L/sec are used to pump raw water from the bore site to the Marlborough WTP. Bores are operated one at a time, and alternate after each pumping cycle. The selected bore begins pumping when the raw water tank drops to 70%, and shuts down at 91%.

Bore construction details:
Each bore is cased with 160 mm diameter polyvinyl chloride (PVC) pipe with two separate screens located at 13-15 m and 18-20 m depth. The bore heads are located approximately three metres apart and are encased in concrete with the bore heads raised approximately 500 mm above the surface of the ground. The bore heads are sealed to prevent the entry of any contaminating material. The bore site is contained within a fenced enclosure that is locked at all times.

2 Scheme Infrastructure and Operation

The Marlborough WTP consists of 2 parallel 50kL/day reverse osmosis (RO) treatment trains, which operate together. The treatment trains are identical in their treatment philosophy, but the reverse osmosis skids differ slightly.

Bore water is pumped from the two duty/standby bore site to a 45kL raw water storage before entering the Marlborough WTP. The bore pumps are operated automatically based on drawdown from the raw water storage tank at the WTP.

The raw water supply splits and can feed either treatment train. For each train, a single raw water feed pump pumps raw water through a 5 µm bag filter and a 5 µm cartridge filter in series. The water is then split into a “blend” stream and the RO stream.

Reverse Osmosis Plant 1 and Plant 2

Prior to entering the RO process, filtered water is dosed using a single pump with anti-scalant (Hypersperse MSI410). The trains of plant 1 and plant 2 is a 4 stage RO process with 8 membrane elements arranged in a 3:2:2:1 configuration (i.e. 3 elements as the first stage, 2 each for the second and third stages, and the concentrate from both 3rd stage elements directed through the 4th stage). Similarly, there is a proportion of RO concentrate recycling to enhance recovery, and the permeate streams are combined at an approximate ratio of 3:1 with filtered bore water to produce the final potable water.

Potable water is chlorinated prior to being directed into the top of two 45kL clear water tanks that are balanced with a third 45 kL clear water tank.

The final water is disinfected using a single pump dosing sodium hypochlorite interlocked to inflow, with a control loop to produce a free chlorine residual of 0.8 mg/L in the final drinking water. SCADA operational alarms for the free chlorine residual are in place to detect excursions outside of a target range. Alarms are sent to the Operators outside the target range, with them attending the site if chlorine drops below 0.3 or exceeds 1.8 mg/L.

Treated water is reticulated via a three pump WPS that operates in duty/standby mode to supply water at a constant pressure (~320 kPa) to the reticulation system. The Marlborough distribution system does not consist of any other reservoir storages and due to its small size and good penetration of free chlorine, no rechlorination is required.

Reject RO concentrate water produced during the reverse osmosis treatment process is stored in a 25kL reservoir that can be accessed by water carriers for non-potable water applications such as road construction. A standpipe dedicated for this purpose is clearly signed to indicate that the water is non-potable.

2 further 45kL reservoirs are also used to store RO concentrate for firefighting purposes. The remaining reject water is used to irrigate the park area surrounding the Marlborough WTP.

The Marlborough WTP is controlled automatically and remotely by SCADA with on-line pressure and flow monitoring of permeate, reject, recirculation and blended product (both plants). In addition there is monitoring of conductivity in the combined outlet from either or both plants and chlorine and pH monitoring in the chlorine dosing line that monitors product water. In addition, Plant 1 has additional separate monitoring of pH, turbidity and electrical conductivity product water prior to mixing with the product water from Plant 2. The Marlborough WTP is connected via radio telemetry to the LSC SCADA system to allow remote monitoring (not control). The Woodbury operators monitor the clear water supply level and disinfection.

There are no options for any of the treatment steps (filtration, reverse osmosis, disinfection) to be bypassed, although the flow of the split treatment streams is manually adjustable to slightly alter the blend ratio of the two treatment streams to achieve a target final water quality.

As the Marlborough area often experiences extended power outages, a diesel generator has been installed that is capable of powering the entire Marlborough WTP to allow continued treatment and supply of drinking water until mains power is restored. The bore pumps are not connected to the generator, but this is not normally an issue as the WTP has 2 days supply of treated water, and an additional storage of 1 day’s supply of raw water.

The RO membranes are replaced every 2 years as it is more cost effective to replace the membranes than to routinely clean them. Bag and cartridge filters are replaced by the Maintenance team every 2-3 months.

Treatment Chemicals:

Antiscalant, sodium hypochlorite.

Reticulation Network

Treated water is reticulated via a three pump water pump station within the WTP that operates in duty/standby mode to supply water at a constant pressure (~320 kPa) to the reticulation system. Due to its small size and good penetration of free chlorine, no re-chlorination is required.

The Marlborough pipe network consists of 4.8km of mains, with the age and material shown in Figure 10.

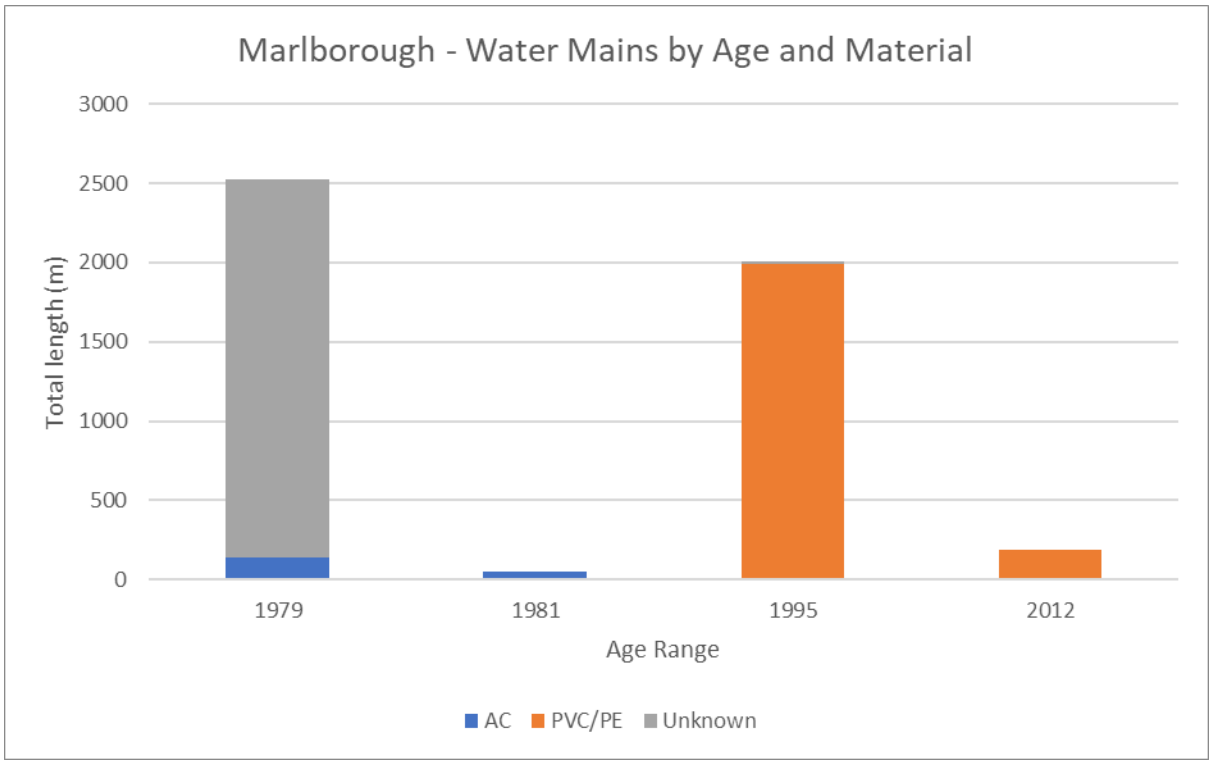

Figure 10 Marlborough – Water Mains by Age and Material

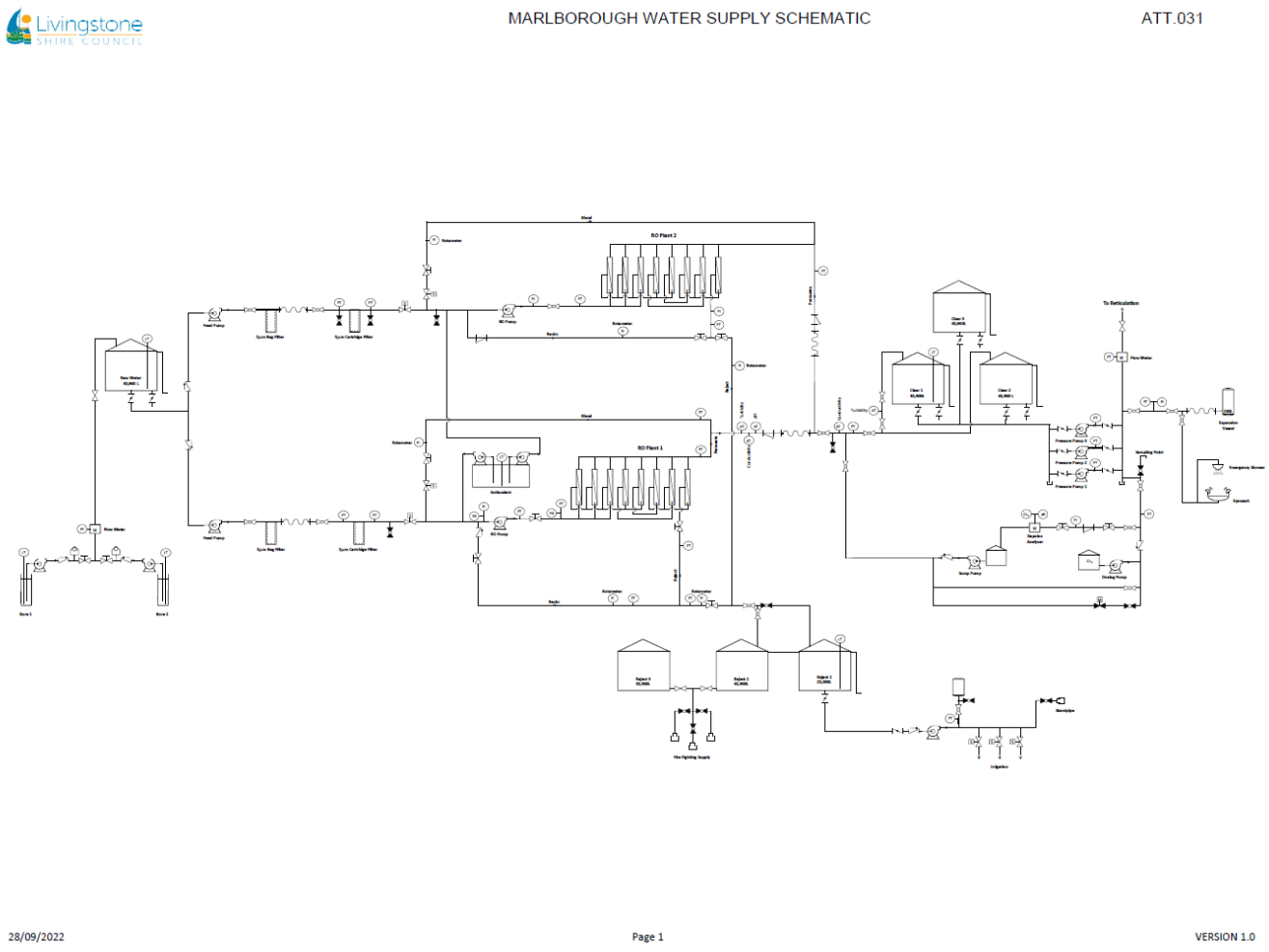

Figure 11 Marlborough WTP Schematic

Figure 11 above is a catchment to Tap Marlborough Water Supply Schematic showing water supply bores to reticulation. There are no reservoirs or pump stations within the reticulation network. Online monitoring locations are identified.

3 Water Quality Information

Typical water quality for the Marlborough scheme follows, based on a review of operational and verification monitoring data from 2014-2021. This information was reviewed by the Risk Assessment team prior to the risk review workshop in May 2020.

Table 22 Verification monitoring data summary – Marlborough reticulation (2014 to 2022)

Parameter	Units	Count	Min	Average	Max
Free chlorine	mg/L	116	0.08	0.66	1.3
Electrical conductivity	µS/cm	142	335	606	1190
pH	-	140	6.4	7.5	8.0
True colour	HU	140	0	0.31	8
Turbidity	NTU	139	0.05	0.53	40

E. coli	mpn/100mL	223	ND	ND	ND
THMs	mg/L	33	5	7.3	18
Chlorate	mg/L	6	0.09	0.22	0.32

There are no major variations in water quality that indicate that the bore field has rapid hydraulic connection to the surface. For the purposes of the risk assessment, this limits the risk that the bores can be easily contaminated due to catchment activities. The bore water produces water with a low turbidity, a TDS of ~700mg/L (considered fair quality), and hardness of ~450 mg/L.

Radionuclides:

Tested in 2014. Gross alpha and gross beta were less than the detection limit.

Cryptosporidium and *Giardia*

Have not been detected in either the raw or treated water.

Operational data: Marlborough WTP is operated to achieve an electrical conductivity of ~620 µS/cm. Records indicate that this target range is routinely achieved.

Disinfection residuals are targeted at 0.8 mg/L in the clear water tank.

Table 23 Verification monitoring – Marlborough WTP raw and treated water, standard water analyses and heavy metals (2014-22)

Parameter	Units	Raw					Treated			
		Count	Min	Average	Max	Stdev	Count	Min	Average	Max
Nitrate	mg/L	75	0.06	0.626	0.90	0.103	75	0.02	0.372	0.76
Sulfate	mg/L	98	7	22.520	34	2.242	99	5.0	8.739	24
Trihalomethanes (THMs) (Total)	mg/L	N/A	N/A	N/A	N/A	N/A	33	5	7.38	18
Fluoride (naturally occurring)	mg/L	98	0.10	0.146	0.5	0.067	98	0.10	0.14	0.2
Aluminium (acid-soluble)	mg/L	97	0.005	0.022	0.1	0.012	95	0.02	0.09	0.16
Copper	mg/L	97	0.001	0.007	0.038	0.005	94	0.002	0.008	0.07
Iron	mg/L	97	0.05	0.05	0.05	-	96	0.025	0.025	0.025
Lead	mg/L	97	0.001	0.004	0.007	0.001	95	0.002	0.002	0.002
Manganese	mg/L	97	0.001	0.0015	0.002	0.001	96	0.001	0.003	0.008
Zinc	mg/L	97	0.006	0.0023	0.148	0.020	95	0.005	0.011	0.037
pH	-	98	7.53	8.10	8.9	0.265	99	7.52	8.094	8.75
Turbidity	NTU	98	0.1	0.63	3.3	0.622	98	0.05	0.577	5.3
Alkalinity (Total as CaCO3)	mg/L	98	372	437.775	492	20.505	98	132	198.153	260
Calcium	mg/L	98	8	23.775	33	1.528	97	6	10.391	23
Chloride	mg/L	97	63	188.113	224	8.638	98	53	84.948	190
Colour (True)	HU	98	1	3.023	20.3	1.745	97	1	2.793	8
Conductivity	µS/cm	98	483	1301.1532	1450	50.004	98	416	628.765	849
Magnesium	mg/L	98	88	104.163	127	6.628	97	29	45.175.8	63
Nitrite	mg/L	82	0.02	0.02	0.02	0.009	75	0.005	0.006	0.05
Potassium	mg/L	97	1.0	1.013	2	0.228	97	0.5	0.500	0.5
Sodium	mg/L	98	92	106.520	123	5.559	97	38	53.710	70
Total Dissolved Solids (TDS)	mg/L	98	314	782.295	942	80.034	98	258	390.561	832
Hardness (Total as $CaCO_3$)	mg/L	98	412	488.673	605	29.245	97	134	211.4942	297
Total Organic Carbon (TOC)	mg/L	32	1	4.857	14	3.373	32	1.0	2.266	3
Arsenic	mg/L	25	0.002	0.002	0.002	0.000	23	0.001	0.001	0.001
Cadmium	mg/L	25	0.00005	0.000	0.00005	0.000	23	0.00005	0.000	0.00005
Chromium	mg/L	25	0.0004	0.004	0.006	0.000	23	.0.001	0.001	0.003
Nickel	mg/L	25	0.001	0.004	0.036	0.009	24	0.001	0.001	0.002
Selenium	mg/L	24	0.005	0.005	0.005	0.000	23	0.005	0.005	0.005
Mercury	mg/L	20	0.00005	0.000	0.00005	0.000	22	0.00005	0.000	0.00005
Cryptosporidium	Oocysts/10L	3	ND	ND	ND	N/A	4	ND	ND	ND
Giardia		6	ND	ND	ND	N/A	6	ND	ND	ND
OC/OP Pesticides	µg/L	6	ND	ND	ND	N/A	6	ND	ND	ND

4 Hazards

The hazards and unmitigated risks (Medium, High or Extreme) that are relevant to the Marlborough service have been brought forward to the Marlborough Risk Assessment.

5 Risk Assessment

The preventative measures that are present for the unmitigated risks have been identified. The mitigated risk is determined based on the likelihood and consequence of the hazard occurring in the presence of the preventative measure.
Where a preventative measure is required to lower the risk to an acceptable level, the procedure used to ensure the measure is in place, or a risk management improvement plan item is identified. Additional items are added to the risk management improvement plan if deemed necessary.

Table 24 Mitigated Risk Assessment – Marlborough

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Other Preventative Measures	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
						Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
Treatment	Source contamination	Protozoa (Marlborough)	High 10	Bore integrity		Catastrophic	Rare	Medium 6	Confident	O/M SCADA monitoring for integrity	Inspect bore heads and seal any identified gaps – Completed			Switchboard at bores (installed 2017) has improved reliability. Completed bore-head inspection and sealed any gaps.
Treatment	Source contamination	Bacteria/Virus (Marlborough)	High 15	Bore integrity, Disinfection		Catastrophic	Rare	Medium 6		O/M SCADA monitoring for integrity	Inspect bore heads and seal any identified gaps			E.Coli sampling conducted weekly to verify integrity of bores.
Treatment	RO breakthrough	Hardness/ TDS (Marlborough)	High 10	RO SCADA monitor conductivity – no alarm, antiscalant		Minor	Unlikely	Low 4	Confident					
Chlorination	Failure of chlorine dosing	Bacteria/Virus (Marlborough)	High 15	Disinfection SCADA controlled and monitored		Catastrophic	Rare	Medium 6	Certain	SCADA closely monitored, operators onsite within 90 min.		Begin monitoring *E. coli* in raw water		In calendar year 2019, there was one event where 16.7kL of water with Ct <15 went out (according to SCADA). Has not occurred since.
Chlorination	Chlorine overdose	Chlorine	Medium 9	SCADA monitoring and operator action		Moderate	Unlikely	Medium 6	Confident					
Chlorination	Breakdown of sodium hypochlorite	Chlorate	Medium 9	Chemical turnover		Moderate	Rare	Low 3	Reliable					Testing undertaken after previous risk assessment. Results were low; this is not believed to be a concern
Reticulation	Reaction of organic matter with chlorine in reticulation	Disinfection byproducts	Medium 6	SCADA controlled dosing		Minor	Rare	Low 2	Confident					THM results since 2014 very low
Reticulation	Contamination from main break	Protozoa (network)	Medium 6	Mains break procedure, network pressure.		Catastrophic	Rare	Medium 6	Confident					
Reticulation	Mains break	Opportunistic Pathogen *(Naeglaria fowlerii)*	Medium 5	Disinfection maintained, mains break procedure		Major	Rare	Medium 5	Reliable	Mains break procedure		Disinfection and mains break training undertaken in 2022.		Factsheet in ADWG states that maintaining chloring residuals at 0.5mg/L or higher will control Naegleria fowleri,
Reticulation	Breakdown of chemical	Chlorate	Medium 9	20L drums, ~ 2 months old at most		Moderate	Possible	Medium 9	Estimate					One off testing indicated results were low
Reticulation	Break of pipe out of CWT	Failure of supply	Medium 8	SCADA provides awareness of problem; ability to manually isolate individual tanks	Interlock of treated water pumps to prevent pumping to retic	Major	Unlikely	Medium 8	Reliable					
Reticulation	Pump pressure loss in reticulation	Failure of supply	Medium 8	SCADA control, interlocks	Three pressure pumps in system	Major	Unlikely	Medium 8	Confident					

Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventative measure	Other Preventative Measures	Mitigated			Uncertainty	Documented Procedure	Risk Management Improvements			Comments
						Consequence	Likelihood	Risk			Immediate	Short term	Long Term	
Reticulation	Backflow	Bacteria/Virus (Network)	High 10	All metered connections have backflow prevention. Disinfection, pressurised scheme		Catastrophic	Rare	Medium 6	Reliable					Not aware of any unmetered connections
Reticulation	Backflow	Chemical	Medium 6	All metered connections have backflow prevention. Disinfection, pressurised scheme		Moderate	Rare	Low 3	Reliable					Not aware of any unmetered connections
Whole of System	Manual mistake	Operator error	High 15	SCADA process monitoring		Major	Rare	Medium 5	Reliable					
Whole of System	Sabotage/ Terrorism	Terrorism /sabotage	High 10	SCADA monitoring of many parameters		Catastrophic	Rare	Medium 6	Reliable					
Whole of System	Change to SCADA limits resulting in compromised system operation	Bacteria/Virus (Marlborough)	High 15	Operator training		Catastrophic	Rare	Medium 6	Estimate	SCADA Cyber Security Procedure (March 2020)			Consider engaging an expert to undertake a cyber security review	Cybersecurity exercise conducted in September 2022.
Whole of System	Unauthorised remote access to systems leading to water quality impacts	Terrorism /sabotage	High 10	Password policies Firewalls Antivirus software	SCADA user access register defines levels of access System backups	Catastrophic	Rare	Medium 6	Confident	SCADA Cyber Security Procedure (March 2020)			Consider engaging an expert to undertake a cyber security review	Cybersecurity exercise conducted in September 2022.
Whole of System	Insufficient Operators available	Bacteria/Virus (Marlborough)	High 15	Disaster Management; likely call on neighbouring Councils for assistance	Contract Operators potentially available; 2 additional staff being trained to Cert III level	Catastrophic	Unlikely	High 10	Estimate					Now have 6 FTE positions with 2 additional trained staff within council and 1 trainee.

6 Operational Monitoring

The Marlborough WTP is operated automatically, and remotely. Plant start-up and shutdown are based on clearwater reservoir levels.

The PLC for the treatment plant has continuous on-line monitoring of permeate, reject, recirculation and blended product flow. This ensures that the process is operating as designed. In addition, feed water pump and RO pump pressures are monitored to ensure operation within the normal range.

There is online monitoring of chlorine residual, with alarms outside the target range and operation staff respond if free chlorine is outside the range of 0.3 – 1.8 mg/L. An operator can be onsite within 90 minutes if necessary.

Additionally, there is online monitoring of conductivity, pH and turbidity of the product water (the mix of RO permeate and blend water) for Plant 1. Plant 2 is not monitored in the same way as there is online conductivity monitoring for the final product water (blend plus RO permeate) that measures either Plant 2 if only this plant is operating, or the combination of Plant 1 and Plant 2 if both skids are operating. If alarms are activated a text and voice message is sent to the maintenance team who are responsible for correcting any issues with this plant.

APPENDIX A – High Risk Customers

High Risk Customers	
Scheme	**Customer contact details**
Pipeline	**1. Scott Kilpatrick,** 968 Yeppoon Rd Ironpot Scott & Meleese Kilpatrick PO Box 5254 Red Hill Rockhampton Q 4701 Meleese – 0411 722 211 Scott – 0413 373 131 Home: 4936 1100 Work: 4926 4822
	2. Surf Lakes 1662 Yeppoon Road Mulara QLD 4703 **Lessee:** Surf Lakes Holdings 5c/16 Queensland Ave Broadbeach QLD 4218 Email: info@surf-lakes.com.au
	3. Tropical Pines Pty Ltd PO Box 1054 Yeppoon Q 4703 Mobile #: 0408 315 503
	4. The Pines Residential Subdivision Jordy Drive, Yeppoon C/- Livingstone Shire Council **Owner:** PPY Developments Pty Ltd Peter Morely Mobile #: 0431 292 453 Work #: 5538 6889 Email: peter@hcorp.com.au PO Box 208 Surfers Paradise Q 4217
Nerimbera	**5. JBS Meatworks** Lot 1 St Christopher Chapel Rd Nerimbera JBS Australia Pty Ltd PO Box 630 Rockhampton Q 4700 Phone: 4930 7800 or 4930 7820
The Caves	**6. Capricorn Correctional Centre** Bruce Highway North Rockhampton Ph: 49126200

APPENDIX B – List of Operational Documents

Work Instructions	
QA ID	Title
03-WI.001	Drinking Water Monitoring (E.coli)
03-WI.002	Drinking Water Incident Reporting
03-WI.007	Emergency Process for Chlorine Gas Leak
03-WI.019	Woodbury Water Treatment Plant: Cleaning the Lime Vat
03-WI.020	Woodbury Water Treatment Plant: Batching Powdered Activated Carbon (PAC)
03-WI.021	Woodbury Water Treatment Plant: Batching Soda Ash
03-WI.024	Collecting Water Samples for Bacteriological Testing
03-WI.027	Woodbury Water Treatment Plant Jar Test
03-WI.028	WWTP Manual, Forced & Automatic Operations of Backwashing Filters
03-WI.029	Woodbury Water Treatment Plant: Draining and Cleaning the Clarifier
03-WI.030	Kellys Dam WPS – Set Outgoing Flow Rate to WTP
03-WI.031	Yeppoon West Valve Facility: Take Water from Boundary Pipeline
03-WI.032	Woodbury Water Treatment Plant: Transport & Disposal of Sludge
03-WI.033	Change Chlorine Bottle: Woodbury Water Treatment & Yeppoon Sewerage Treatment Plants
03-WI.034	Woodbury Water Treatment Plant: Alum Dose/Drop Test
03-WI.035	Woodbury Water Treatment Plant: Lab Test
03-WI.039	Water Mains – Flushing Procedure
03-WI.044	WWTP – Batching Polyelectrolyte for Plant Use
03-WI.047	Depolox Free Chlorine and pH Calibration
03-WI.049	Conductivity One Point Bump Test
03-WI.052	Re-chlorinating Reservoirs with sodium hypochlorite
03-WI.053	Re-chlorinating Reservoirs with chlorine tablets
03-WI.064	Woodbury WTP – Calibration of Dosed Water pH Probe

Plans	
QA ID	Title
WMP.003	Kelly's Offstream Storage: Emergency Action Plan
WMP.003 (Appendix)	Appendix – Kelly's Offstream storage Drawing Plans
EMP.002	Environmental Management Plan – Woodbury Water Treatment Plant
WMP.004	Customer Service Standards Water & Sewerage Services
WMP.005	Water & Waste Operations Emergency Management Plan
BCM.09	Business Continuity Plan Drinking Water and Sewerage
ASSET02	Asset Management Plan: Water

Procedures	
QA ID	Title
MSP-034	Waterpark Creek Operating Rules
MSP-035	Water Main Pressure and Flow Testing
MSP-047	Chemical Procurement and Receipt
MSP-052	New Mains or Main Breaks Disinfection Procedure
MSP-056	Scada Cyber Security
MSP-064	Critical and Operational Control Point Procedure

Attachments	
QA ID	Title
ATT.146	Potable Water Sampling Points
ATT.130	Woodbury WTP Operators Tasks Matrix
ATT.105	Waste Water Quality Monitoring Programs
ATT.106	Water Quality Monitoring Programs
ATT.107	Microbiology Sampling Schedule
ATT.077	Yeppoon Water Treatment Plant
ATT.108	Microbiology Sampling Sheet Template
ATT.109	Water Sampling Labels Template
ATT.134	LSC Water Supply Schemes
ATT.171	Testing Schedule - WWTP

Guides	
QA ID	Title
GDE.011	Woodbury Water Treatment Plant: Filtration Process
GDE.012	Reservoir Re-chlorination Process
GDE.013	Woodbury WTP Disinfection Process
GDE.015	Kelly's Offstream Storage Operations and Maintenance Manual
GDE.016	Kelly's Offstream Storage Fixed Dispersion Cone Valve Manual

APPENDIX C – Bulk Water Supply Agreement (extracts)

Below are sections extracted from the Bulk Water Supply Agreement between FRW and LSC, pertaining to water quality, monitoring and reporting.

10 Water Quality and Disinfection Management
10.1 Purpose and Scope
Both FRW and LSC will conduct their own drinking water quality monitoring and reporting program in accordance with approved Drinking Water Quality Management Plans and the Australian Drinking Water Guidelines (ADWG). The purpose of this section is to document the process for advising operators of water quality issues/concerns that have the potential to impact the quality of drinking water supplied by either party to enable timely reaction to potential risks to water quality.

10.2 Responsibilities and Accountabilities
10.2.1 Monthly Water Quality Reporting
FRW will provide to LSC on a monthly basis the results of standard physical and chemical tests on raw water and drinking water sampled at the GWTP. These results will be provided to the relevant Technical Specialist in LSC within 5 working days of receipt of the results as per the DWQMP.

10.2.2 Notification of Water Quality Non-Compliances
Each party is to notify the other of any water quality non-compliance against either health or aesthetic guidelines listed in the Australian Drinking Water Guidelines that has the potential to impact the quality of drinking water in either the RRC or LSC drinking water supply schemes. This notification should be provided within 5 hours of the detection of a non-compliance and will be provided to the relevant operations officers responsible for managing drinking water quality in each Council. The party receiving water may choose to reduce or halt supply without compromising minimum daily take provisions stated elsewhere in this agreement.

10.2.3 Notification of Cessation or Rectification of Water Quality Non-Compliance
Each party is to notify the other of the cessation of a period of water quality non-compliance and any action taken to rectify the non-compliance. This notification is to be provided to the relevant operations officers responsible for managing drinking water quality in each Council as soon as reasonably possible of the cessation of the non-compliance.

10.2.4 Disinfection Management
All disinfection including the operation of reservoir re-chlorination facilities will be performed in accordance with the approved Drinking Water Quality Management Plans currently in use by FRW and LSC.

13 Risk and Incident Management
13.1 Responsibilities and Accountabilities
FRW and LSC are responsible for developing their own risk and incident management plans and procedures. In each Council drinking water incidents will be responded to in accordance with the process defined in the approved Drinking Water Quality Management Plan (DWQMP) used by each Council.