Rockhampton Regional Council

Registered Service Provider No. SP493

Drinking Water Quality Management Plan

2022-2023

Version Control

Revision No.	Revision Description	Revision Date	Reviewer
0	Original Approved Version	June 2012	Jason Plumb, Nimish Chand
1	First Review	October 2014	Ariane Leyden, Jason Plumb, Nimish Chand
2	Second Review	August 2016	Ariane Leyden, Jason Plumb
3	Third Review	August 2018	Ariane Leyden, Jason Plumb
4	Fourth Review	August 2021	Ariane Leyden, Jason Plumb
5	Fifth Review	August 2023	John Stevens Dan Toon
6	Revision of Fifth review	November 2023	John Stevens Dan Toon Chris Dunglison

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EXECUTIVE SUMMARY

In accordance with section 94 of the *Water Supply (Safety and Reliability) Act*, the purpose of the Drinking Water Quality Management Plan (DWQMP) is to protect public health through the comprehensive management of drinking water quality. The drinking water quality management provisions in Queensland follow a risk-based management approach and it is intended that this approach is documented in a plan that demonstrates effective management of drinking water services to ensure a safe and reliable supply of drinking water is provided.

The DWQMP is intended to be a living document that reflects the requirements of the water service provider and what needs to be actioned on a day to day basis now and into the future to ensure the supply of safe drinking water. In doing so, the DWQMP will then be used by the water service provider as a means of achieving drinking water quality outcomes in the short and long term through the demonstration that good drinking water quality management measures are in place. A thorough understanding, and effective management of, the drinking water infrastructure, water treatment processes, hazards and hazardous events, and the monitoring of operational processes and the quality of drinking water supplied to customers is therefore essential. Consequently, this DWQMP documents the information required in order to achieve the delivery of safe and reliable drinking water services.

The DWQMP also requires the generation and implementation of a Risk Management Improvement Program (RMIP). The purpose of the RMIP is to describe the management measures proposed for any unacceptable residual risk. The description of these measures must include the proposed measures, actions, strategies or processes, priorities and implementation timeframes. The RMIP included in the DWQMP is based on the following elements:

- Element 1 - Infrastructure Upgrades and Improved Infrastructure Performance
- Element 2 - Optimisation of Information Management and Reporting Capabilities
- Element 3 - Enhanced Engagement with Stakeholders Associated with Drinking Water Infrastructure Management
- Element 4 - Improved Service Through Staff Awareness and Training
- Element 5 - Enhanced Water Quality Performance

These five elements represent high priority action items for which completion is required in order to mitigate risks posed to drinking water quality. The timeframe for completion and availability of funding for completion of each element is provided.

REGISTERED SERVICE DETAILS

1.1 Service Provider Name

Rockhampton Regional Council – SP493
Ph: 1300 22 55 77| Fax: 1300 22 55 79
Address: PO Box 1860, Rockhampton QLD 4700
Web: www.rockhamptonregion.qld.gov.au

1.2 Drinking Water Service Operator

Fitzroy River Water (a business unit of Rockhampton Regional Council)
Ph: 1300 22 55 77| Fax: 1300 22 55 79
Address: PO Box 1860, (Belmont Road), Rockhampton QLD 4700
Web: www.rockhamptonregion.qld.gov.au

1.3 Drinking Water Schemes Covered by this Plan

The following schemes are described or referred to in this DWQMP:

Rockhampton Water Supply Scheme (Rockhampton Regional Council)
Mount Morgan Water Supply Scheme (Rockhampton Regional Council)

For the purposes of the DWQMP, unless otherwise stated in the text, a scheme refers to the entire contiguous distribution system irrespective of the local government ownership of the various parts of the scheme.

1.4 Current Details for Location, Size and Demand of Drinking Water Schemes

Figure 1.1 provides an overview of the location of each of the drinking water schemes described in this DWQMP. Table 1.1 lists current information on the names of the communities, the population size, the number of connections and the average daily demand for each drinking water scheme. Table 1.2 provides an indication of the anticipated population, connections and demand for each of the schemes in the year 2031. The projections on the number of connections and average daily demand for 2031 are based on calculations using the Planning Assumption Model (PAM) projections developed within Rockhampton Regional Council (RRC) localities.

Figure 1 1: Map showing the location of the two drinking water schemes (Rockhampton, Mount Morgan) operated by Fitzroy River Water and the neighbouring Council areas.

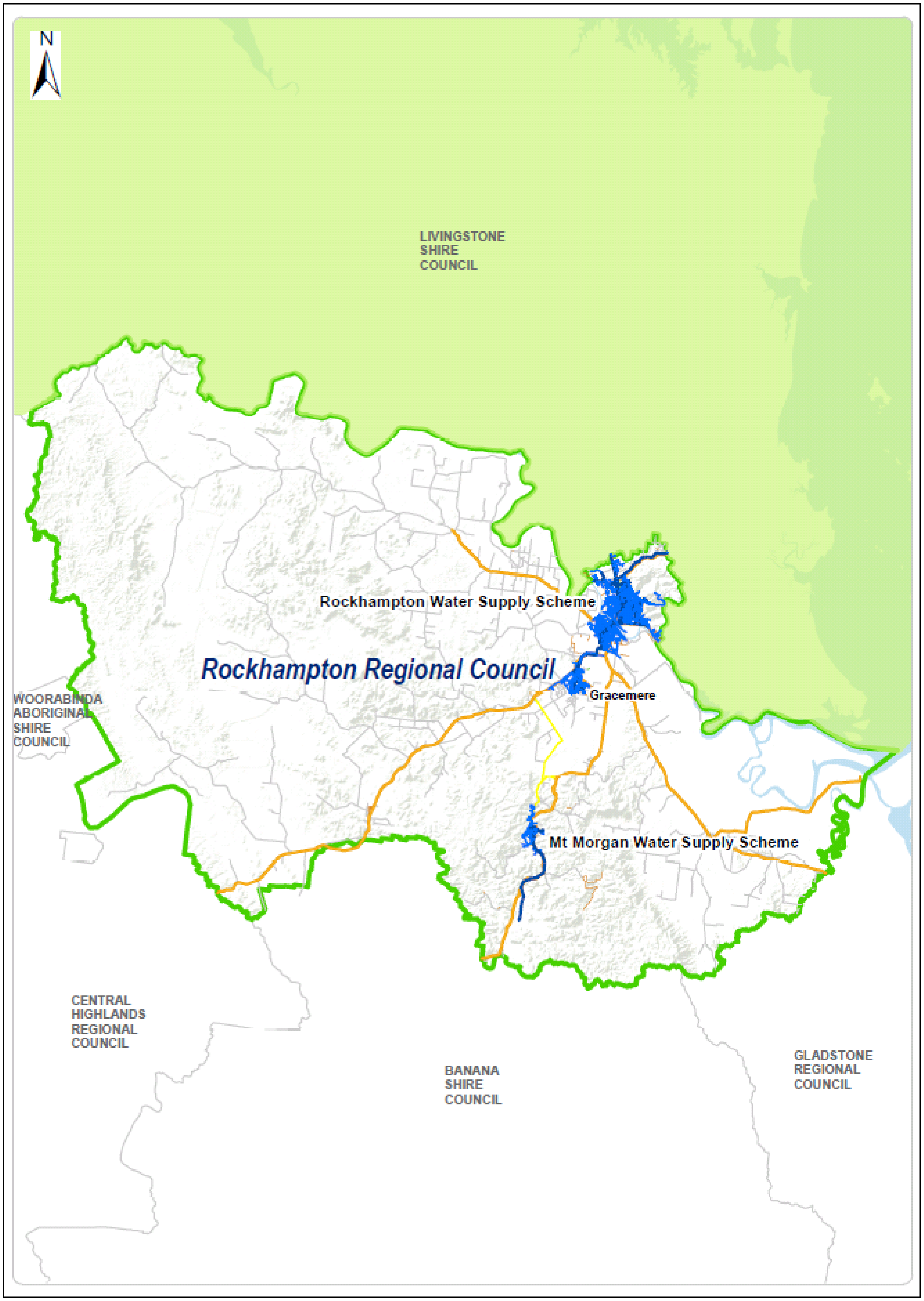


Table 1.1: Current (2022) information for the communities fully or partially served by the water infrastructure operated by Rockhampton Regional Council, population, number of connections and demand for each drinking water supply scheme

Scheme	Communities Served	Population	Connections	Average Demand (ML/d)[d]
Rockhampton *(localities part of LSC's The Caves and Nerimbera Water Supply Schemes)*	Rockhampton, Gracemere, (*The Caves, Etna Creek, Glenlee, Glendale, Rockyview, Mt Charlton, Nerimbera*)	92,372[b] (*3,713*[c])	30,848[a] (*1,485*[c])	47.20 (*5.10*)
Mount Morgan	Mount Morgan, Baree	2,945[b]	1,495[a]	0.93

[a] Source: SWIM Reporting 2019
[b] Source: Australian Bureau of Statistics (2021 Census)
[c] Source: LSC's DWQMP 2021
[d] Source: Fitzroy River Water's operational data for 2018-19. Average demand indicated for the Capricorn Water Supply Scheme is based on the water supplied via Rockhampton to Yeppoon Water Supply Pipeline.

Table 1.2: Estimated population, number of connections and demand for each drinking water scheme in 2031.

Scheme	Population	Connections	Average Demand (ML/d)
Rockhampton	101,590[a]	44,582[b]	60.2[b]
Mount Morgan	3,139[a]	1,342[b]	1.8[b]

[a] Source: Australian Bureau of Statistics
[b] Source: RRC's Local Government Infrastructure Plan adopted March 2020
[c] Source: LSC's DWQMP 2021. Approximately 20-25% of the water demand in the Capricorn Coast Water Supply Scheme is anticipated to be supplied via the Rockhampton to Yeppoon Water Supply Pipeline.

2 DETAILS OF DRINKING WATER SCHEME INFRASTRUCTURE

2.1 Overview of Scheme Infrastructure

Tables 2.1 to 2.3 and Figures 2.1 to 2.3 provide summary information for the infrastructure and scheme layout for each drinking water scheme that is either fully or partially served by water infrastructure that is owned and operated by Rockhampton Regional Council (RRC). Only water source and treatment infrastructure that is owned and operated by RRC or is involved in supplying drinking water to RRC customers is described in detail in this DWQMP. In Figure 2.1 due to the size of the scheme and the number of WPS in this scheme, only bulk transfer WPS or those that supply to whole supply zones are shown.

A water grid-style connection exists between the Rockhampton and Capricorn Coast Water Supply Schemes. Figures 1.1, 2.1 and 2.2 show the location of this connection point. Although the Capricorn Coast Water Supply Scheme is owned and operated by Livingstone Shire Council (LSC), its distribution system is shown and described briefly to indicate the manner in which it is served by the Rockhampton Water Supply Scheme. Similarly, The Caves Water Supply Scheme located north of Ramsay Creek valve to Mt Charlton and Nerimbera Water Supply Scheme located east of Lakes Creek in North Rockhampton are part of the Livingstone Shire Council are described due to their direct physical link to the Rockhampton Water Supply Scheme despite their ownership by Livingstone Shire Council.

Table 2.1: Summary of Infrastructure for the Rockhampton Water Supply Scheme

Rockhampton Water Supply Scheme		
Source		Fitzroy River 50,383 ML/annum. Surface Water (Unprotected)
Source Infrastructure		Fitzroy Barrage and associated pondage
Treatment Plant		Glenmore Water Treatment Plant coagulation, flocculation, sedimentation, filtration, pH correction and disinfection Treatment Capacity = 120 ML/d
Reservoirs	Number	22
	Capacity	126.7 ML
Pump Stations		28
Length of Mains and Common Services		774.9 km
No. of rechlorination sites		10

Table 2.2: Summary of Infrastructure owned by Livingstone Shire Council[a]

Capricorn Coast Water Supply Scheme		
Source		Waterpark Creek 5,000 ML/annum Fitzroy River 50,383 ML/annum via the Rockhampton to Yeppoon Water Supply Pipeline.
Source Infrastructure		Waterpark Creek Weir, Fitzroy Barrage, Kelly's Off-Stream Storage
Treatment Plant		Glenmore Water Treatment Plant
Reservoirs	Number	11
	Capacity	33.9 ML
Pump Stations		>30
Length of Mains and Common Services		450 km
No. of rechlorination sites		4
The Caves and Nerimbera Water Supply Schemes		
Source		Fitzroy River 50,383 ML/annum
Source Infrastructure		Fitzroy Barrage
Treatment Plant		Glenmore Water Treatment Plant

Reservoirs	Number	3
	Capacity	9.2 ML
Pump Stations		1
Combined Length of Mains		86 km
No. of rechlorination sites		1

Source: LSC's DWQMP 2021. There are no reservoirs or pump stations for Nerimbera Water Supply Scheme.

Figure 2.1: Schematic of the Rockhampton Water Supply Scheme (Bulk WPS or WPS to whole supply zones shown only)

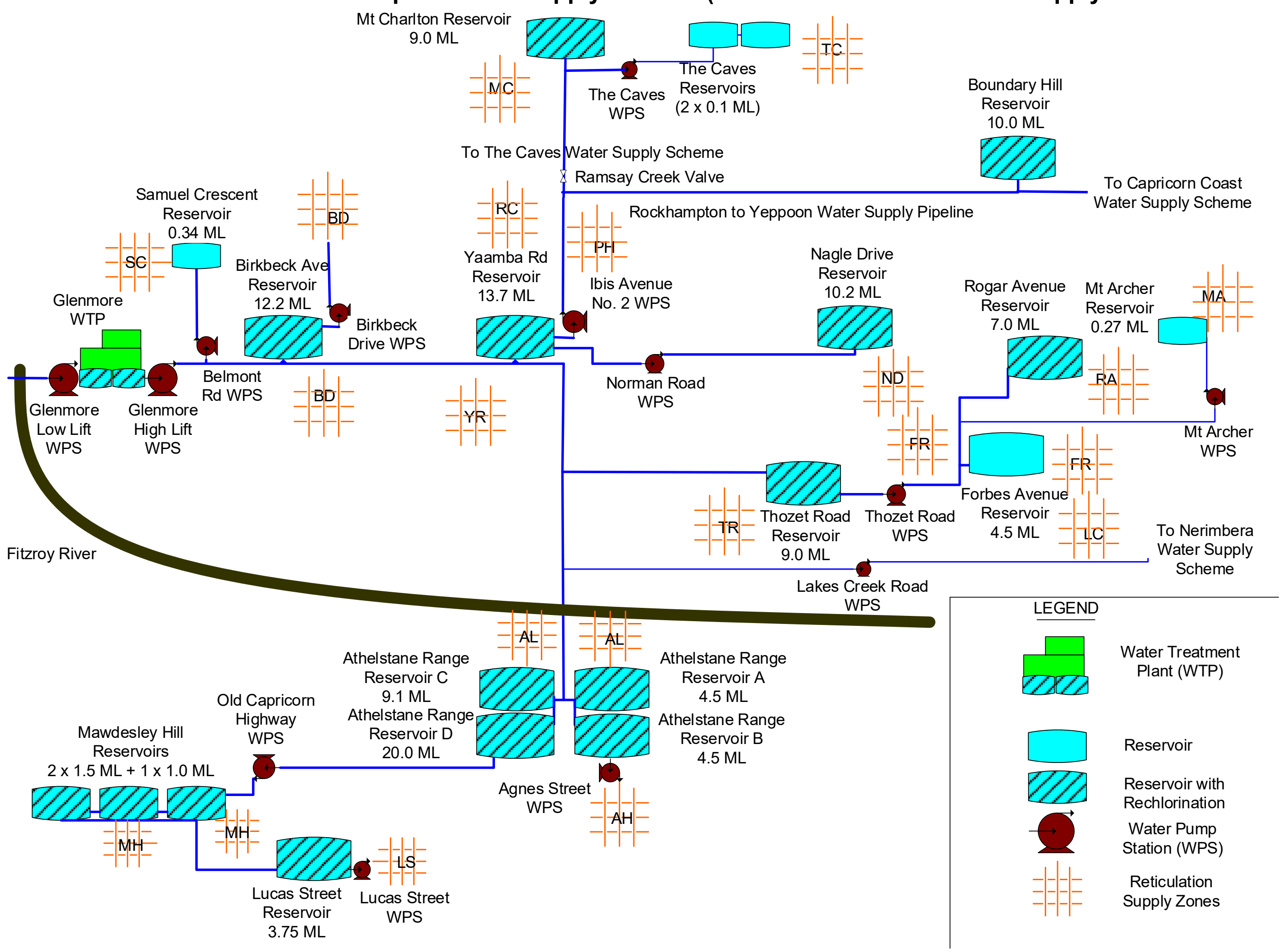


Figure 2.2: Schematic of the Capricorn Coast Water Supply Scheme (Livingstone Shire Council Owned)

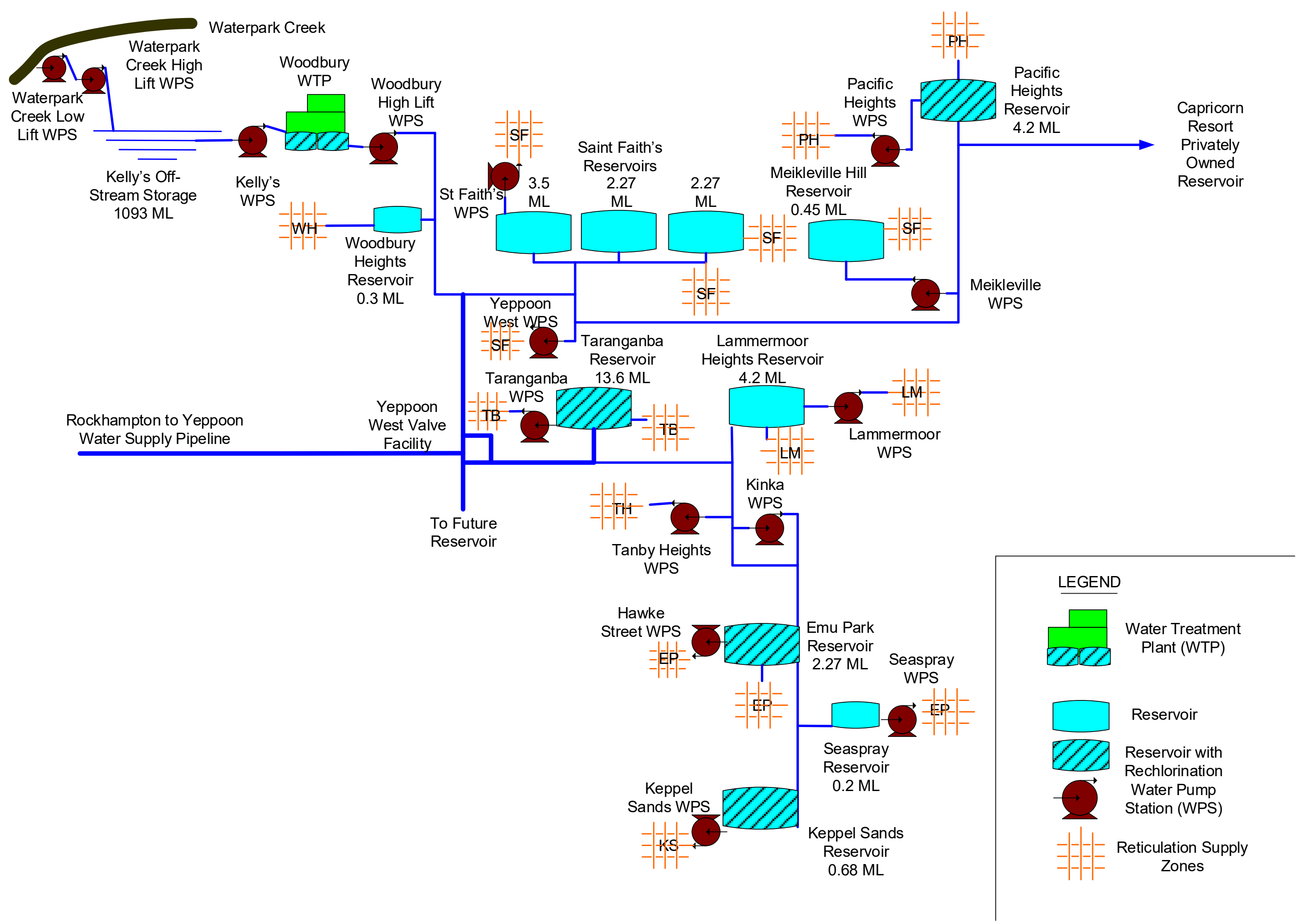
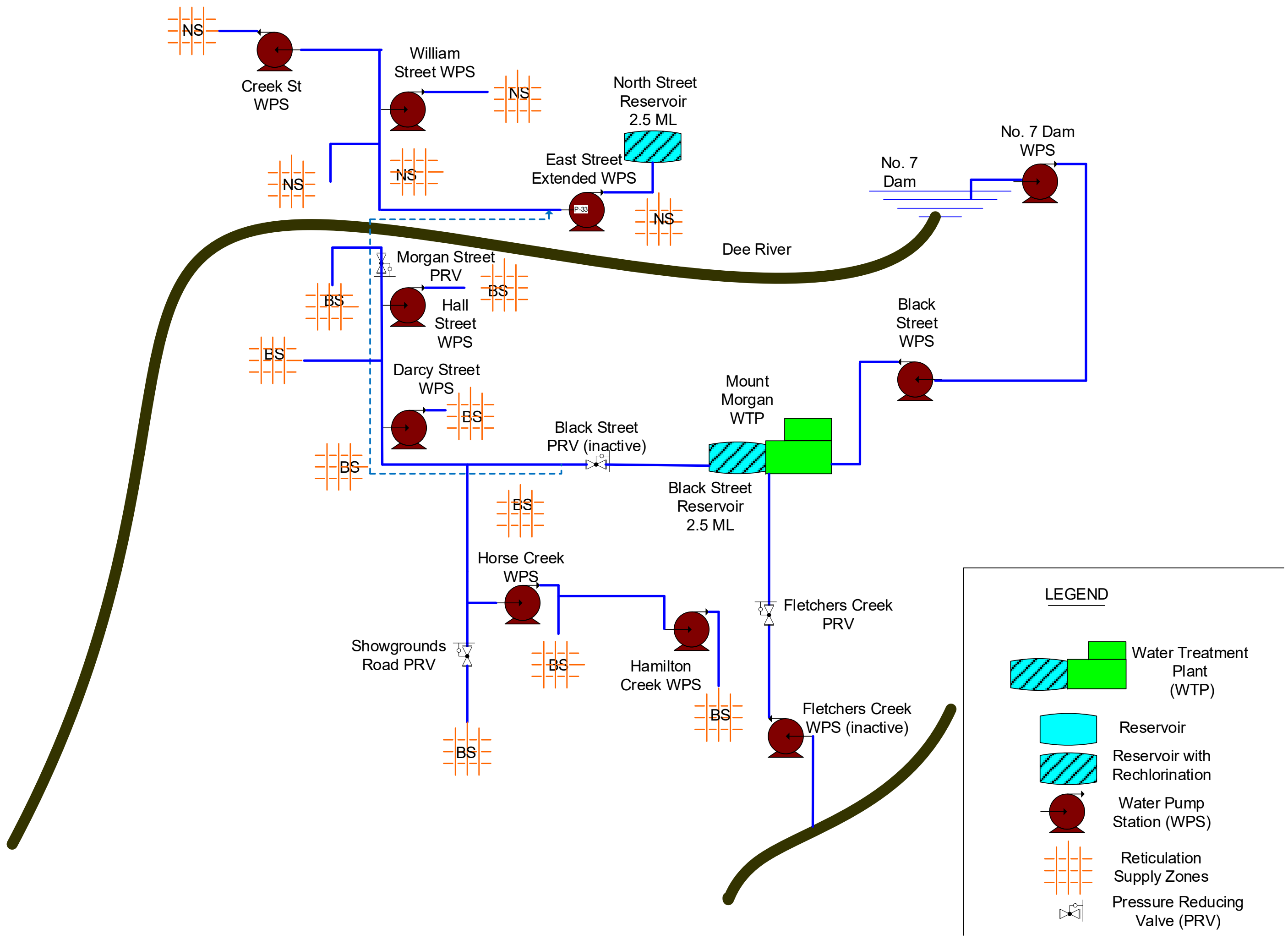


Table 2.3: Summary of Infrastructure for the Mount Morgan Water Supply Scheme

Mount Morgan Water Supply Scheme		
Source		Dee River – No 7 Dam Council Allocation 584 ML/ annum
Treatment Plant		Mount Morgan Water Treatment Plant coagulation, sedimentation, filtration, pH correction and disinfection Treatment Capacity = 2.6 ML/d
Reservoirs	No.	2
	Capacity	5.0 ML
Pump Stations		10
Length of Mains and Common Services		72.9 km
No. of rechlorination sites		2

Figure 2.3: Schematic of the Mount Morgan Water Supply Scheme



2.2 Water Sources for Drinking Water Supply

2.2.1 Fitzroy River Barrage Storage

The Rockhampton, The Caves, Nerimbera and Capricorn Coast Water Supply Schemes are supplied with raw water drawn from RRC's 50,383 ML/year high priority water allocation, which is stored in an impoundment behind the Fitzroy River Barrage.

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. Fitzroy River Water (FRW) operates the Barrage in accordance with a Resource Operations Plan (ROP) which defines the requirement for storage management, environmental passing flows and water quality as well as other monitoring that is required to be performed. Releases from the Barrage impoundment are made by controlling the operation of 18 vertical lift gates that separate the freshwater from the downstream estuary using a fully automated control system.

FRW manages the storage of 11,583 ML/year of medium priority/high priority water for 299 licensed water allocation holders who draw water from the Barrage impoundment. These allocations are diverted by private infrastructure but FRW, as the delegate of the registered water service provider, oversees the process and ensures the objectives of the *Water Act 2000* are met as they affect the service provider.

The operating rules for the Barrage storage are entwined with the Eden Bann storage which stores a 24,000 ML/year high priority water allocation for the Stanwell Corporation. The Stanwell Corporation draws its water from the Barrage impoundment with water released from the Eden Bann storage into the Barrage by the Eden Bann operator as part of this supply arrangement.

The Barrage impoundment and upstream catchment are deemed a category four unprotected catchment. This is due to there being no exclusion zone to the inner catchment. In the wider catchment area there are several sewage treatment plants, and also several cattle farms for both meat and dairy production. 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, fluctuations in Fe and Mn concentration. The raw water contains a low concentration of fluoride at ~0.1 mg/L. A thorough review of the Fitzroy Basin, its characteristics, status and management framework is provided in the Fitzroy Basin Water Quality Improvement Report (2008) prepared by the Fitzroy Basin Association Incorporated.

The Glenmore Water Treatment Plant (WTP) intake structure is located approximately 5 km upstream of the Fitzroy Barrage. The intake is designed to provide four different depths from which water is pumped for treatment, from the surface to more than 5 m deep. Multiple high level intake structures provide the ability to pump raw water for treatment during high flow and flooding events. All intake structures are designed to withstand damage from debris and high flows that occur during flooding events.

The Glenmore Low Lift Water Pump Station (WPS) contains four centrifugal pumps ranging in capacity from 270 L/sec to 715 L/sec. This WPS pumps raw water from the river intake into the inlet of the Glenmore WTP which is located about 250 m away from the riverbank. Combinations of these four pumps can be operated to meet the demand requirements and to balance the flow rate of raw water into the Glenmore WTP with the flow rate of drinking water out of the clear water storage reservoirs.

2.2.2 No.7 Dam and Fletchers Creek Weir

The Mount Morgan Water Supply Scheme obtains its water from the No.7 Dam (primary water source) when dam water quality allows. In an emergency or when the water from No. 7 Dam is deemed very low and/or of unacceptable quality which is the current conditions. Since April 2021 potable water has been carted to Mount Morgan from specified filling areas in the Rockhampton Water Supply Scheme and delivered to the Mount Morgan WTP for distribution to the Mount Morgan network.

The No.7 Dam is located on the Dee River which runs through the centre of Mount Morgan. The No.7 Dam was originally constructed in 1900 by the Mount Morgan Gold Mine Company and was later raised an additional 4.5 m in 1999. The total storage capacity of the dam is 2,800 ML.

For many years long term water security in Mount Morgan has been an area of much attention. The area receives lower annual rainfall than the coastal parts of the region and the Dee River and Fletchers Creek catchments are quite small by comparison. Based on historical data, the 99.9% reliable supply from the No.7 Dam is 1.6 ML/d. Land use in the Dee River and Fletchers Creek catchments above the two storages is predominantly cattle grazing or undisturbed bushland. There are no exclusion zones designated within both catchments, this makes each catchment a category four unprotected catchment. The two storages are upstream from the extensive gold and copper mining activities associated with Mount Morgan’s history. Water quality issues associated with these two storages include problems associated cyanobacterial blooms and occasional increases in the concentrations of iron and manganese in the raw water.

The raw water intake at the No.7 Dam is located approximately 15 m away from dam wall and approximately 20 m from the shore of the dam. An anchored pontoon provides the support for the raw water intake pipe which is supplied via a single submersible pump capable of pumping 24 L/sec located at a fixed depth (600 mm) in water with a maximum depth of 12 m. An identical submersible pump is available for rapid installation as a replacement in the event of a raw water pump failure.

2.3 Water Treatment Processes

Water treatment for each of the drinking water schemes is performed using slight variations of the same conventional coagulation, flocculation, sedimentation, filtration, pH correction and disinfection process. The individual treatment processes are described below for each water treatment plant.

2.3.1 Glenmore Water Treatment Plant

The Glenmore WTP in Rockhampton is the source of treated water supplied to residents in Rockhampton, Gracemere, north of Parkhurst in North Rockhampton, east of Lakes Creek in North Rockhampton and Capricorn Coast via the Rockhampton to Yeppoon Water Supply Pipeline. Commencing operation in 1971, the Glenmore WTP has a maximum capacity to treat 120 ML/d and the maximum demand recorded on the system was 114 ML/d, which was recorded in 2002/03 prior to the introduction of water meters in Rockhampton. Since consumption-based charging commenced in 2005, maximum demand on the Glenmore WTP has been approximately 100 ML/d.

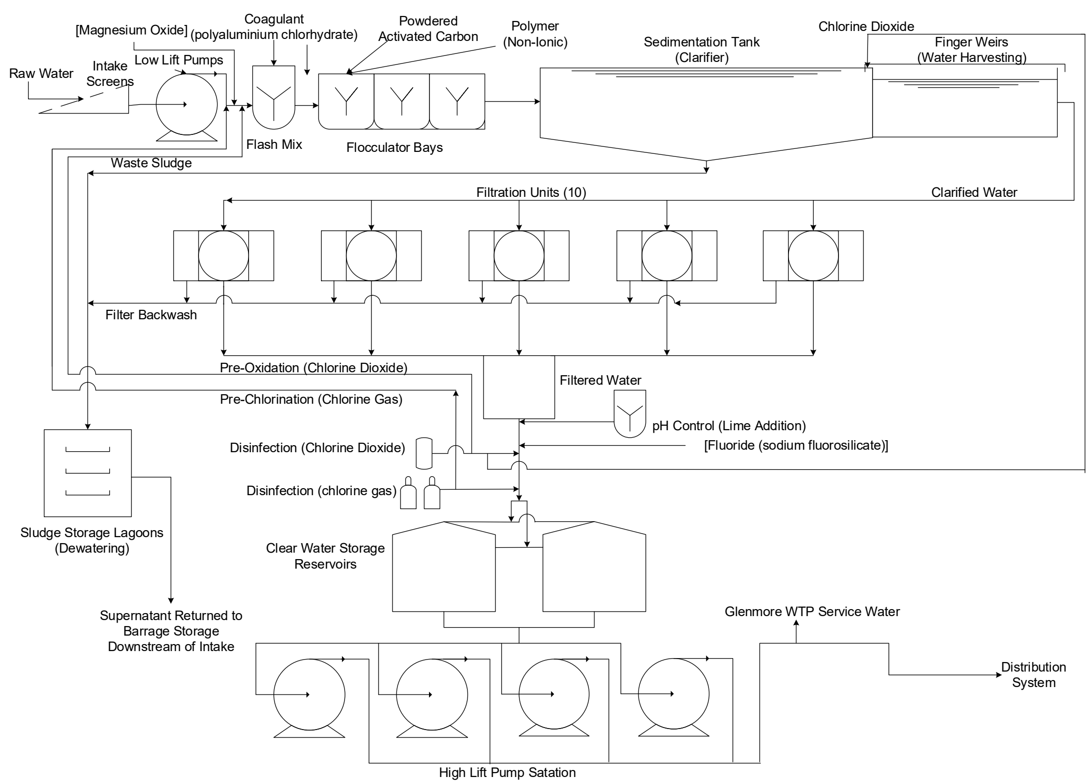
Design of the Glenmore WTP has been maximised to handle very high raw water turbidity with large rapid variations in raw water turbidity. There are no defined raw water turbidity operational limits for the operation of the WTP. The WTP has effectively treated raw water with turbidity in excess of 2000 NTU and is consistently capable of achieving more than 4-log removal of turbidity through its treatment stages. Operational performance is monitored using on-line and manual turbidity measurement to ensure the effectiveness of treatment barriers (see further descriptions below).

Figure 2.4 shows a schematic representation of the treatment processes used at the Glenmore WTP. Water flows through coarse mesh screens into the river inlet structure and gravitates to the low-lift pump station where it is pumped to the inlet of the WTP. Upon entry to the inlet of the WTP, the option exists for pre-oxidation using chlorine dioxide to oxidise manganese, iron and other oxidisable compounds, or to assist with the destruction and removal of cyanobacteria. The recently installed chlorine dioxide system will be used as the pre-treatment step due to its ability to oxidise organics and inorganics in the water while minimising the production of disinfection by-products. There is also an option to manually add magnesium oxide at the inlet of the WTP to increase alkalinity and adjust pH. The WTP inlet is designed to promote rapidly mixing conditions, and at this point the influent raw water is dosed with a coagulant (ACH Aluminium Chlorohydrate) using a duty/standby two pump set system. Coagulant-dosed raw water gravitates to two identical parallel train flocculation/sedimentation basins, each with a design capacity of 70 ML/d.

At the entry to the first bay of the flocculation tank powdered activated carbon (Acticarb PS1000 or equivalent) is dosed into the water using a duty/standby activated carbon dosing system, when required, to remove soluble organics. The flocculation tank is comprised of three bays that contain horizontal paddle mixers to provide gentle mixing to promote flocculation. Direction of flow through each bay is opposite to the previous bay. Upon entry to the second bay of each flocculation tank, the water is dosed with a polyacrylamide (Praestol DW20) as a water clarification aid.

Water containing well-formed floc particles leaves the flocculation tank and enters the sedimentation tank through a series of slots in the wall of the final flocculation bay. At this point the absence of mixing promotes the settling of the floc particles as the water passes through the sedimentation tank. The majority of the sedimentation process occurs within the first half of the sedimentation tank. A mechanical sludge scraper in each sedimentation tank is used to remove settled sludge through drains in the bottom of the sedimentation tank. Water treatment sludge is collected in on-site sludge holding lagoons. Gravity separation is used to separate the sludge from the supernatant which is then returned to the Fitzroy River Barrage impoundment. Strict discharge conditions require that the supernatant is of high quality and therefore poses no risk to the quality of raw water in the Fitzroy River Barrage storage. At the end of the first half of each sedimentation tank, water is able to be dosed with low levels of chlorine dioxide to oxidise residual organics and inorganics in the clarified water. The second half of each sedimentation tank contains a tube settler array to maximise sedimentation of fine floc particles. At this point, clarified top water (target turbidity of 1.0 to 1.5 NTU measured by a pre-filtration mid-tank on-line turbidity meter) is collected via finger weirs into collection channels which then transfer the clarified water to the sand filters.

Figure 2.4: Schematic Representation of the Treatment Process at the Glenmore WTP.



Filter Information

CWT Media Design-Backwash 30m/h (453L/s) @ 25C with Triton Underdrains (1mm slots)								
Parameter	Media Size	Size Unit	Media Depth, mm	Media L:d Ratio	Media and Filter EL, mm	Media Expansion	Expanded Media EL,mm	Launder Clearance, mm
Base of Launder					1200			20
Coal	1	ES	500	500	1075	20%	600	
Sand	0.6	ES	275	458	575	2%	281	
Garnet, top	0.6 - 2	NOM	0		300	0%	0	
Garnet mid	1.2 - 2.4	NOM	75		300	0%	75	
Garnett bottom	2.4 - 4.8	NOM	75		225	0%	75	
Tritan Underdrains			150		150		150	
Totals			1075	958			1181	

Filters are automatically backwashed based on time, loss of head or turbidity triggers which are monitored in real-time by the Honeywell Programmable Logic Controller (PLC) and Experion PKS R511.3 Supervisory Control and Data Acquisition (SCADA) system. Backwashing is achieved using a duty/standby two pump set and a blower to wash and air scour each filter. 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, with 0.3 NTU used as a setpoint to trigger a backwash (as per the USEPA Long Term 2 Enhanced Surface Water Treatment Rule). Filter backwash or other waste waters are diverted to the sludge holding lagoons mentioned above and are treated and disposed of accordingly.

Filtered water passes through dual collection pipes which gravity transfer the water to the clear water reservoirs (2 x 2.2 ML reservoirs). Before reaching the clear water reservoirs, the dual collection pipes intersect at a pit designed to provide mixing, a water storage for the filter backwash pumps and also be used as a common dosing point for chlorine. An option also exists to dose chlorine dioxide into the pit as a disinfectant to minimise the production of disinfection by-products. Prior to entry into this pit filtered water is dosed with hydrated lime by one of two duty/standby lime feeding systems to correct pH (pH 7.8 target).

Disinfection is achieved by adding chlorine gas into the pit via one of two duty/standby Siemens gas feed chlorinators. The chlorine gas storage room is designed to allow four cylinders containing 920 kg each to be connected for use at any time. A free chlorine residual setpoint of 1.0 mg/L is used for the final water, and this is achieved using flow-paced dosing at rates of between 4 and 8 kg/h of chlorine gas required to achieve the free chlorine residual setpoint. An option also exists to dose chlorine dioxide into the pit as a disinfectant to minimise the production of disinfection by-products. Water from the clear water reservoirs is then pumped to the distribution system using the High Lift Pump Station on site. Alarm setpoints for low, low low, high and high high alarms for the free chlorine residual are in place to detect excursions outside of a target range (0.5 to 1.5 mg/L of free chlorine) and the

Glenmore WTP PLC is programmed to automatically shutdown the WTP and High Lift Pump Station if the free chlorine residual exceeds 1.8 mg/L for more than 15 minutes or if free chlorine residual exceeds 1.5 mg/L for 60 minutes. If the free chlorine residual triggers a low level alarm, urgent action is taken to address the cause of the excursion via the attendance to site of suitably qualified reactive maintenance staff. If required the WTP will be shutdown to prevent the distribution of non-disinfected water to customers.

As indicated above, the Glenmore WTP has a maximum treatment capacity of 120 ML/d. This maximum capacity is based on the recorded peak operating rate used in the early 2000s when demand before the implementation of water meters in Rockhampton was significantly higher than it is currently. Each sedimentation tank is capable of achieving effective clarification of raw water at a rate of 70 ML/d. The 10 rapid sand filters are capable of achieving effective filtration of clarified water at a flow rate of 120 ML/d. The chlorine gas disinfection system is capable of achieving. effective disinfection up to at least 120 ML/d.

Despite these stated maximum capacity rates, a safe working maximum treatment capacity of 115 ML/d has been adopted as the normal maximum flow rate through the Glenmore WTP. Therefore, current maximum loadings are well beneath the known effective capacity of the sedimentation tanks, filters and disinfection process steps and no bypasses for any of these steps exists in the WTP process design. This rate has been determined based on its suitability over a range of differing raw water quality conditions. If required to meet high demand or maximise the cost effectiveness of operating during the off-peak electricity period, the Glenmore WTP is operated at the 115 ML/d flow rate, however, much of the time when demand is low, the flow rate through the Glenmore WTP ranges between 60 and 85 ML/d.

The Glenmore WTP is attended by at least one operator all day every day in order to closely monitor and operate (if required) the Glenmore WTP as well as to perform a range of water quality and process performance tests and checks.

2.3.2 Mount Morgan Water Treatment Plant

Mount Morgan Water Treatment Plant has been non operational for the last two years. This is due primarily to the historical low levels in the No. 7 Dam, the poor quality of the water remaining in the No. 7 Dam, and the need for the treatment plant to be refurbished to be able to provide consistent treatment of water of the quality currently in the No. 7 Dam. The supply of water to the Mount Morgan Water Supply Scheme has been of treated water from the Glenmore WTP Supply Scheme. This water has been transported in bulk water carriers to the clear water reservoir (Black St Reservoir) at Mount Morgan WTP. The transportation of water to the Mount Morgan WTP is planned till the completion of the water pipeline which is currently due for conclusion in July 2025.

For water transported to the scheme by bulk carriers, the following describes the process. Immediately downstream of the de-commissioned fluoride dosing point is a butterfly valve that is used as a filling point for tankered potable water. Filtered water is then gravity fed to the on-site clear water reservoir (2.5 ML total storage volume). The water is passed through the UV disinfection system, which is provided with an online remote UV transmissivity monitoring to ensure system performance. The water is chlorinated using chlorine gas as it enters the clear water reservoir (Black St Reservoir) which also provides half of the service reservoir storage for the Mount Morgan Water Supply Scheme. The Siemens chlorinator is designed to dose chlorine gas at the rate required to achieve a free chlorine residual of 1.0 mg/L in the clear water reservoir. The dosing is flow paced and also includes dosing control based on the on-line measurement of free chlorine residual.

Alarm setpoints for low, low low, high and high high alarms for the free chlorine residual are in place to detect excursions outside of a target range. A number of process interlocks have been implemented to stop the WTP in the event of high free chlorine residual (>1.8 mg/L for 15 min), low free chlorine residual (<0.5 mg/L for 15 min), high clear well turbidity (>1 NTU for 15 min), high filtered water turbidity (>1 NTU for 15 min). Two other interlocks in the event of faults with the chlorine dispersion pump or chlorine dosing valve, and another interlock in the event of an alum pump fault also stop the WTP operation.

The plant operation is currently controlled by an Allen Bradley Compact Logix PLC that provides automated operation of plant starting and stopping, filter backwashing and de-sludging processes. On-line monitoring of a number of water quality parameters are monitored at the Mount Morgan WTP with pH, turbidity and electrical conductivity monitored in raw water, filtered water and final water.

The Mount Morgan WTP is attended by an operator for at least four hours each day in order to closely monitor and operate (if required) the Mount Morgan WTP as well as to perform a range of water quality and process performance tests and checks.

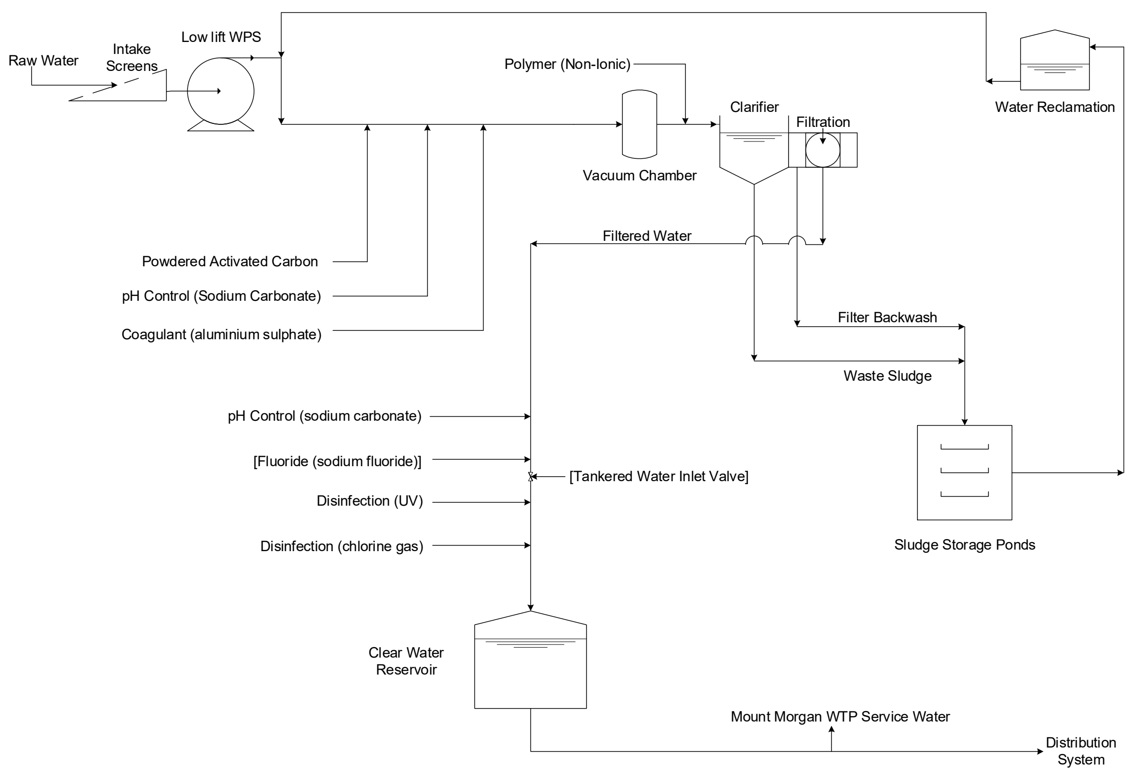
The Mount Morgan WTP has just finished refurbishment and physical commissioning, and is awaiting the completion of practical commissioning which is likely to be completed in January 2024. Once practical commissioning is successfully completed, the plant will be used to provide treated water for the MMWSS using the water in No. 7 Dam as the source, for the period of pipeline construction when bulk carrier movements will be limited due to pipelaying work on the Razorback Road. During this period the treatment process is as described below.

The Mount Morgan Water Treatment Plant consists of an AQUAPAC package plant (Aquagenics Pty Ltd) that incorporates coagulation, flocculation, sedimentation and gravity filtration in a single tank system. This plant commenced operation in 1994 and has a design flow capacity of 30 L/sec (~2.6 ML/d). A refurbishment of the plant was completed in October 2023.

Figure 2.5 shows a schematic representation of the treatment process used at the Mount Morgan WTP. The incoming raw water is dosed with powdered activated carbon to assist with the removal of soluble organics and colour. Sodium carbonate prepared in a batch mixing tank is then added to the raw water to adjust the pH. The coagulant aluminium sulphate is dosed using a duty/standby dual pump system into the inlet pipework. Coagulant dosed water then enters the vacuum chamber which is designed to provide rapid mixing conditions through intermittent high flows into the dosing manifold of the clarifier. The coagulant-dosed water raw water is then dosed with a polymer (non-ionic) as a water clarification aid.

Clarification is achieved when the ‘pulsed’ intermittent high flows expand the sludge blanket then longer quiescent periods allow the sludge blanket to settle. As the coagulant dosed water passes through the dense sludge blanket, flocs and other particles collide to promote the flocculation and sedimentation process. Clarification also includes the use tube settlers to promote the sedimentation of fine floc particles and reduce carry-over of fine flocs to the filters. The tube settlers are located above the sludge blanket in the clarification tank. The sludge blanket depth is maintained by a sludge hopper which is designed to act as a sludge concentrator to collect excess sludge. Sludge is removed through a manual or automated desludging process to on-site storage ponds where the sludge is gravity settled and the supernatant is either evaporated to avoid any possible impact on Mount Morgan WTP water quality or if required is transferred to a storage tank before being returned to the plant inlet.

Figure 2.5: Schematic Representation of the Treatment Process at the Mount Morgan WTP.(WTP offline since April 2021 due to poor quality and low level of No 7 Dam and need for refurbishment)



2.4 Availability of Equipment and Critical Spares

For all WTP and water distribution infrastructure an extensive inventory of equipment and critical spares is kept locally for most of the components of existing water treatment and distribution infrastructure. Table 2.4 provides an indication of the spares kept and provides a description of the type or function of the components.

Standard designs and equipment specifications have been adopted where possible to improve the consistency of processes, and to reduce the number of spares that need to be kept to satisfy maintenance demands. Critical equipment such as on-line and bench-top water quality monitoring instrumentation, chemical dosing pumps, flow meters, ultrasonic level indicators, PLCs and radio telemetry systems are among the items for which standard design and equipment specifications have been adopted. Future infrastructure upgrades are planned in accordance with these adopted specifications.

A significant amount of redundancy has been designed into the WTPs. Items or equipment such as air compressors, chemical storage tanks, chemical batch tanks, mixers and dosing pumps, flow meters and flow switches have been installed in either duty/standby or in an arrangement which provides a level of backup redundancy to help ensure continuity of operation.

Table 2.4: Critical Spares Kept for Water Treatment and Distribution Infrastructure

Equipment Category	Type of Equipment/Parts in Each Category
Mechanical	Compressor and pneumatic system spares Pumps and pumpheads for process sampling or chemical dosing Backup generator set spares Mixers for chemical batching tanks Valves and valve actuator spares
Electrical	Switching gear and spares for high lift and low lift pump stations Programmable Logic Controller spares Electrical components, contactors, flow switches, circuit breakers Radio telemetry equipment and spares Variable speed drives and spares
Process Control	SCADA servers and spares Flow meters, flow meter head units, flow sensors On-line instrument probes, ultrasonic level indicators

2.5 Water Distribution and Reticulation Infrastructure

A summary of the operation and flow regime through the water distribution system is provided below for each of the five water supply schemes that are supplied fully or partially with water by Fitzroy River Water. Except for Nerimbera Water Supply Scheme, all drinking water schemes are comprised of a range of different assets that are used to store, re-chlorinate and distribute water to customers. In all schemes a combination of gravity and pumped distribution mains are used to ensure flow and pressure requirements are met. A detailed description of the below ground pipe infrastructure, the above ground reservoirs and re-chlorination facilities, and water pump stations that are required to transport water and pressurise supply zones is also provided. Specific details of these assets in each scheme are provided in Tables 2.5 to 2.8. Appendix D provides an overview of the reservoir supply zones in the Rockhampton and Mount Morgan Water Supply Schemes.

2.5.1 Overview of Operation – Rockhampton Water Supply Scheme

The Glenmore high-lift water pump station (WPS) pumps water from the WTP through a network of trunk distribution mains to fill the Birkbeck Avenue, Yaamba Road, Thozet Road and Athelstane Range Reservoirs (see Figure 2.1). Birkbeck Avenue, Yaamba Road and Thozet Road Reservoirs gravity feed water to the surrounding reticulation networks in North Rockhampton while Athelstane Range Reservoirs gravity feed water to the surrounding networks in South Rockhampton and West Rockhampton. The Belmont Road WPS lifts water to the Samuel Crescent Reservoir which then gravity feeds a small reticulation network near the Glenmore WTP.

The Norman Road WPS is used to fill the Nagle Drive Reservoir which gravity feeds the Norman Gardens reticulation zone in North Rockhampton. The Thozet Road WPS lifts water from the Thozet Road Reservoir to fill the Forbes Avenue and Rogar Avenue Reservoirs which then gravity feeds water to the surrounding reticulation that serves the Frenchville area of North Rockhampton. A series of four small WPS are used to lift water to the Mt Archer Reservoir (approximately 600 m elevation) which then gravity feeds a small reticulation system on the top of Mt Archer. To the south-east of the Thozet Road Reservoir is Lakes Creek Road WPS which supplies water to a privately owned and operated reservoir and the surrounding reticulation network. East of Lakes Creek in North Rockhampton is LSC's Nerimbera Water Supply Scheme which is supplied with water via gravity or Lakes Creek Road WPS. Nerimbera Water Supply Scheme which supplies water to Nerimbera and another privately owned and operated reservoir does not have a reservoir or disinfection facility.

The Athelstane Range Reservoir Complex gravity feeds water to the South Rockhampton and West Rockhampton reticulation networks as well as supply water along a gravity trunk main to the town of Gracemere where the Old Capricorn Highway WPS lifts the water to fill the Mawdesley Hill Reservoirs. Water is then gravity fed from the Mawdesley Hill Reservoirs to the surrounding reticulation system and to the Lucas Street Reservoir which supplies the reticulation system on the south-western side of Gracemere.

The Yaamba Road Reservoir supplies water via gravity or Ibis Ave WPS to the Parkhurst, Park Avenue and Kawana areas. Ibis Ave No. 2 WPS supplies water to Mt Charlton and the Caves Reservoirs to meet demand of the localities in The Caves Water Supply Scheme located north of Ramsay Creek valve including Glenlee, Glendale, Rockyview and Etna Creek areas All these localities to the north of Parkhurst in North Rockhampton are part of Livingstone Shire Council which owns and operates the water distribution infrastructure in these areas. The Caves and Mt Charlton Reservoirs can also gravity feed in some areas in Parkhurst when Ibis Ave No. 2 WPS is not pumping into Mt Charlton Reservoir.

The Ibis Ave No. 2 WPS also pumps water to the Boundary Hill Reservoir via the Rockhampton to Yeppoon Water Supply Pipeline. Boundary Reservoir which is located halfway between Rockhampton and Yeppoon then gravity fed water through the Yeppoon West Valve Facility to either the St Faith's or Taranganba Reservoirs in the Capricorn Coast Water Supply Scheme. The Boundary Hill Reservoir is owned by Rockhampton Regional Council and operated by Fitzroy River Water and the pipeline infrastructure on the Yeppoon side of the Boundary Hill Reservoir is owned and operated by Livingstone Shire Council. All arrangements relating to the supply of this water are as per the Operating Protocol which forms part of the commercial water supply agreement between Rockhampton Regional Council and Livingstone Shire Council. A copy of this Operating Protocol is provided in Appendix E.

Details of the material type, age and length of water distribution pipes is provided in Table 2.5 below. The water distribution pipe infrastructure includes a range of different material types and ages. Details of the service reservoirs used to supply the distribution and reticulation systems are provided in Table 2.6.

Drinking water is rechlorinated at a number of locations throughout the distribution system. A list of rechlorination facilities and details of their design is provided in Table 2.7. All rechlorination facilities are monitored using the SCADA system through a radio telemetry network.

Details of the location, purpose and design of WPS are provided in Table 2.8.

2.5.2 Overview of Operation – Mount Morgan Water Supply Scheme

Drinking water tankered to the MMWTP is gravity fed into the Black Street Reservoir which also serves as the clear water reservoir for the WTP. From here the water is gravity fed to the reticulation system in the Mount Morgan and Baree areas. Water is pumped by the East Street Extended WPS to fill the North Street Reservoir. These two 2.5 ML reservoirs are typically used to supply the northern and southern parts of the reticulation respectively. A number of pressure reducing valves and booster WPS are used to maintain appropriate water pressure in low and high elevation areas within the Mount Morgan Water Supply Scheme. The use of pressure reducing valves is needed to cater for the range of changes in elevation throughout the distribution network and also to avoid over-pressuring of some relatively old underground assets to prevent pipe breaks.

Details of the material type, age and length of water distribution pipes is provided in Table 2.5 below. The water distribution pipe infrastructure includes a range of different material types and ages. Details of the service reservoirs used to supply the distribution and reticulation systems are provided in Table 2.6.

Drinking water is re-chlorinated at the North Street Reservoir. Details of the design of this re-chlorination facility are provided in Table 2.7. This re-chlorination facility is monitored using the SCADA system through a radio telemetry network.

Details of location, purpose and design of WPS are provided in Table 2.8.

2.5.3 Overview of Operation – Capricorn Coast Water Supply Scheme

Drinking water is supplied to the Capricorn Coast Water Supply Scheme from the Glenmore WTP via the Boundary Hill Reservoir as described in the overview for the Rockhampton Water Supply Scheme above, from the Woodbury WTP or through the combination of supply from each of these two WTPs.

Currently, approximately 20-25% (usually a minimum of 3 ML per day) of the Capricorn Coast Water Supply Scheme demand is supplied with water from the Glenmore WTP via the Rockhampton to Yeppoon Water Supply Pipeline with the remaining supply coming from the Woodbury WTP. The existing infrastructure allows for a number of supply permutations with varied contributions from each source and associated WTP. Figure 2.6 provides a schematic overview of the main options including the current split scheme operating arrangement for supply to the Capricorn Coast Water Supply Scheme. As indicated above, the supply of water by Rockhampton Regional Council to Livingstone Shire Council is carried out in accordance with agreed terms and conditions as specified in the current commercial water supply agreement. A copy of the Operating Protocol included in this agreement is provided in Appendix E. Once the water is supplied to Livingstone Shire Council from the Boundary Hill Reservoir, it is supplied to the various parts of the Capricorn Coast Water Supply Scheme according to the operating regime that is implemented and controlled by Livingstone Shire Council.

The existing infrastructure enables the Capricorn Coast Water Supply Scheme to be supplied either solely by the Glenmore WTP, solely by the Woodbury WTP or via a split scheme arrangement where the Glenmore WTP and Woodbury WTP supply water to the northern and southern part of the scheme respectively. The management of the distribution of water supplied by each of the Woodbury and Glenmore WTPs is the responsibility of Livingstone Shire Council. As required though, the Livingstone Shire Council will take as much water from the Boundary Hill Reservoir as they require, to meet demand during periods where either demand exceeds the supply capacity of the Woodbury WTP or when the operation of the Woodbury WTP is suspended for the completion of maintenance.

Specific details of pipe materials, reservoirs and water pump stations are not provided in Tables 2.5 to 2.8 as these details are not part of the responsibility of Fitzroy River Water with these assets owned by Livingstone Shire Council.

Figure 2.6: Overview of Supply Scenarios for Supplying Water to the Capricorn Coast Water Supply Scheme.

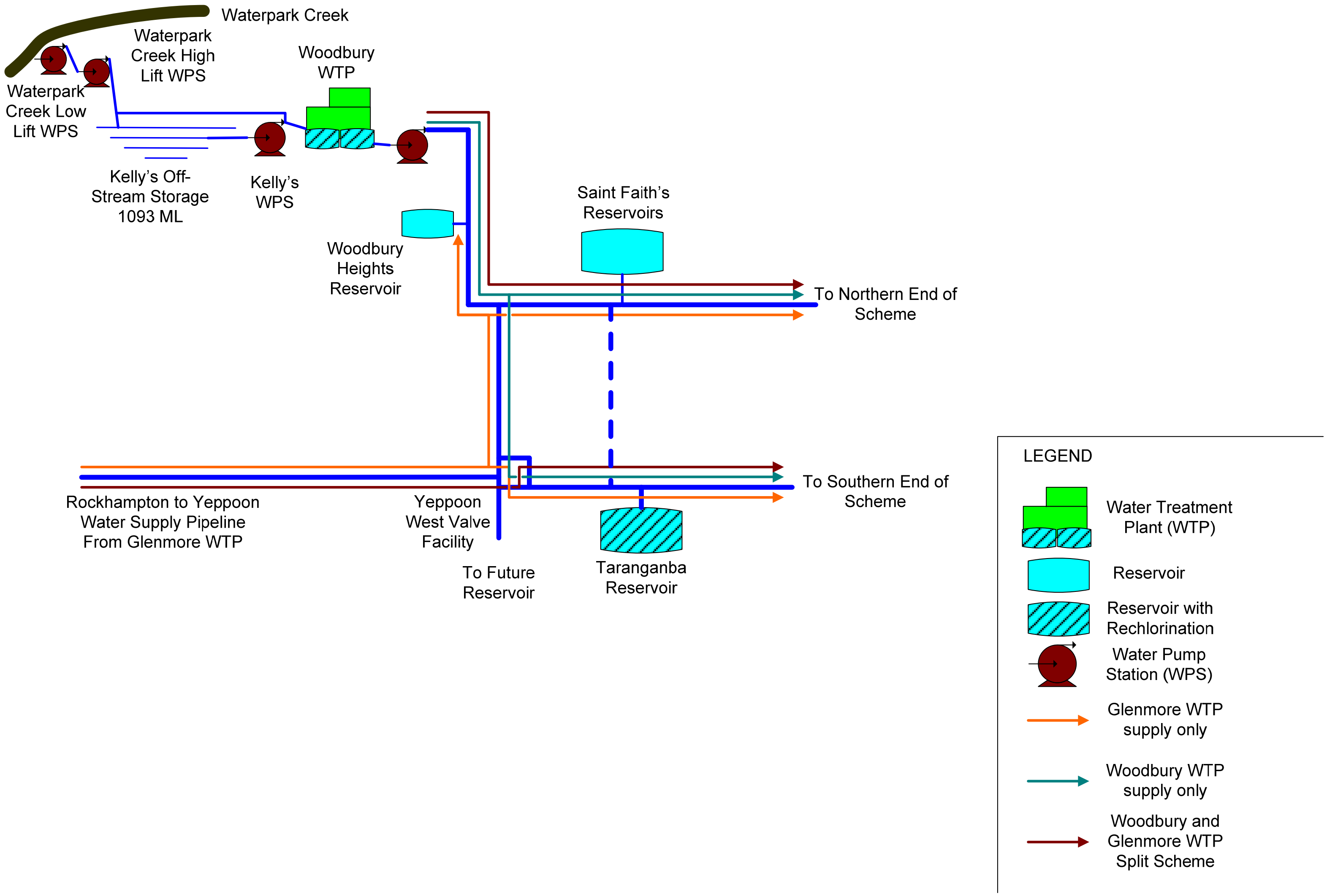


Table 2.5: Details of Pipeline Infrastructure in each Drinking Water Supply Scheme

Material	Length (km)	Year Constructed
Rockhampton Water Supply Scheme		
AC	155.2	1920-1986
CI	17	Prior 1930
CICL	48.7	1930-1970
PE	56.6	1970-2023
mPVC	286.2	2002-2023
uPVC	179.1	1970-2002
MSCL	28.9	1920-2022
DICL	19.8	1980-2023
oPVC	11.4	2008-2023
GI	2.1	1920-1980
Mount Morgan Water Supply Scheme		
AC	7.2	1948
CICL	8.09	1948-1952
uPVC	9.2	1992-2002
mPVC	32	2008-2023
MSCL	8.2	1952
PE	7.73	1970-2009
GI	0.225	1975
DICL	0.07	2019

AC = asbestos cement, CI = cast iron, PE = polyethylene, mPVC = modified polyvinyl chloride, uPVC = unplasticised polyvinyl chloride, MSCL = mild steel cement lined, DICL = ductile iron cement lined, oPVC = oriented polyvinyl chloride, CICL = cast iron cement lined, GI = galvanised,

Table 2.6: Details of Drinking Water Reservoirs in each Water Supply Scheme

Reservoir Name	Year Built	Capacity (ML)	Type/Design	Roof
Rockhampton Water Supply Scheme[a]				
Clear Water 1&2	1971	2 x 2.2	2 x Concrete circular reservoir	Fully enclosed concrete
Birkbeck Ave.	1999	12.2	Concrete circular reservoir	Fully enclosed metal sheet
Samuel Crescent	1993	0.34	Steel panel circular reservoir	Fully enclosed metal sheet
Yaamba Rd	1974	13.7	Concrete circular reservoir	Fully enclosed metal sheet
Nagle Drive	1986	10.2	Concrete circular reservoir	Fully enclosed metal sheet
Thozet Rd	1963	9.0	Steel plate circular reservoir	Fully enclosed metal sheet
Forbes Ave	1976	4.5	Concrete circular reservoir	Fully enclosed metal sheet
Rogar Ave	2004	7.0	Concrete circular reservoir	Fully enclosed concrete
Mt Archer	1974	0.27	Concrete circular reservoir	Fully enclosed concrete
Athelstane A	1958	4.5	Concrete circular reservoir	Fully enclosed metal sheet
Athelstane C	1932	9.1	Concrete rectangular reservoir	Fully enclosed fibro sheet
Athelstane D	1996	20.0	Concrete circular reservoir	Fully enclosed metal sheet
Mawdesley Hill 1	1986	1.5	Concrete circular reservoir	Fully enclosed metal sheet
Mawdesley Hill 2	1993	1.5	Concrete circular reservoir	Fully enclosed metal sheet
Mawdesley Hill 3	1972	1.0	Concrete circular reservoir	Fully enclosed metal sheet
Lucas St	2004	3.75	Concrete circular reservoir	Fully enclosed metal sheet
Boundary Hill	2010	10	Concrete circular reservoir	Fully enclosed concrete
Mount Morgan Water Supply Scheme				
Black St	1955	2.5	Concrete circular reservoir	Fully enclosed metal sheet
North St	1993	2.5	Concrete circular reservoir	Fully enclosed metal sheet

[a] Note that the Mt Charlton and The Caves reservoirs are owned and operated by Livingstone Shire Council.

Table 2.7: Reservoir Re-chlorination Facilities and Details of the Disinfection System at each Site

Reservoir Name	Disinfectant Type	Year Installed	Dosing Mode/Design	Target Residual (mg/L)*	Monitoring/Alarms	Pump Setup
Rockhampton Water Supply Scheme						
Birkbeck Ave	Sodium hypochlorite	1999	Inlet flow paced, Cl analyser, Overdose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High,	Single Dosing Pump, Recirculation Pump
Yaamba Rd	Chlorine gas	1993	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Gas Weight Low, Lo Low, High, Hi High,	Not applicable
Nagle Drive	Sodium hypochlorite	2011	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Single Dosing Pump, Recirculation Pump
Thozet Rd	Sodium hypochlorite	1993	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Single Dosing Pump, Recirculation Pump
Rogar Ave	Sodium hypochlorite	2017	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Single Dosing Pump, Recirculation Pump
Athelstane	Sodium hypochlorite	1992	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Single Dosing Pump, Recirculation Pump
Mawdesley Hill	Sodium hypochlorite	2007	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Single Dosing Pump, Recirculation Pump
Lucas St	Sodium hypochlorite	2004	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Single Dosing Pump, Recirculation Pump
Boundary Hill	Sodium hypochlorite	2010	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Duty/Standby Dosing Pump, Recirculation Pump
Mount Morgan Water Supply Scheme						
North St	Sodium hypochlorite	2014	Inlet flow paced, Cl analyser, High dose auto shut-off, Telemetry to SCADA	1.0	Residual & Hypo tank level Low, Lo Low, High, Hi High	Single Dosing Pump, Recirculation Pump

* Target residual may be varied depending on factors like seasonal demand, customer feedback or in response to a drinking water quality non-compliance.

^ Mt Charlton reservoir is owned and operated by Livingstone Shire Council. Target residual is current Set Point.

Table 2.8: Details of Water Pump Stations within Drinking Water Supply Schemes

Pump Station Name	Purpose	Pump Capacity L/sec	Pump Station Design#
Rockhampton Water Supply Scheme			
Glenmore Low Lift	Supply raw water to the Glenmore WTP	715, 270, 270, 560	4 Centrifugal pumps, SCADA monitored
Glenmore High Lift	Supply potable water to RWSS	540, 540, 540, 540	4 Centrifugal pumps, SCADA monitored
Agnes St	Boost pressure to high zone	270, 110, 190	3 centrifugal pumps, SCADA monitored
Birkbeck Drive	Supply water to Edenbrook Estate	30, 30, 30, 30	4 centrifugal pumps, SCADA monitored
Everingham Ave	Boost pressure to high zone	11, 11, 11, 11	4 centrifugal pumps, SCADA monitored
Frenchville Rd	Boost pressure to high zone	1, 1, 1	3 centrifugal pumps, SCADA monitored
Mt Archer 1,2,3,4	Lift water to Mt Archer (~600m elevation)	All 3.4	2 centrifugal pumps, SCADA monitored
Norman Rd	Fill Nagle Drive Reservoir	57, 57	2 centrifugal pumps, SCADA monitored
Ridgedale Ave	Boost pressure to high zone	4	1 centrifugal pump, not monitored
Samuel Crs.	Boost pressure to high zone	11,11,11	3 centrifugal pumps, SCADA monitored
Africander Ave	Boost pressure to high zone	4	1 centrifugal pump, not monitored
Ibis Ave No. 2	Supply water to Boundary Hill and Mt Charlton Reservoirs	260, 260	2 centrifugal pumps, SCADA monitored
Belmont Rd	Fill Samuel Crs Reservoir	11, 11, 11	3 centrifugal pumps, SCADA monitored
Braddy St	Boost pressure to high zone	29, 53	2 centrifugal pumps, SCADA monitored
The Caves^	Fill The Caves Reservoir	5, 5	2 centrifugal pumps, SCADA monitored
Forbes Ave	Boost pressure to high zone	20, 20	2 centrifugal pumps, SCADA monitored
Ibis Ave No. 1	Boost pressure to high zone	6.5, 6.5, 6.5, 6.5	4 centrifugal pumps, SCADA monitored
Lakes Ck Rd	Fill third party Reservoir, Supply to reticulation	30, 30	2 centrifugal pumps, SCADA monitored
Rockonia Rd	Boost pressure to high zone	25, 25	2 centrifugal pumps, SCADA monitored

Pump Station Name	Purpose	Pump Capacity L/sec	Pump Station Design#
Selwyn Crs	Boost pressure to high zone	1, 1	2 centrifugal pumps, not monitored
Sleipner St	Boost pressure to high zone	1.7	1 centrifugal pump, not monitored
Thozet Rd	Fill Forbes and Rogar Reservoirs	120, 120	2 centrifugal pumps, SCADA monitored
Wehmeier Ave	Boost pressure to high zone	20	1 centrifugal pump, SCADA monitored
Whiteley St	Boost pressure to high zone	0.5	1 centrifugal pump, not monitored
Lucas St	Boost reticulation pressure	75, 75, 75, 75	4 centrifugal pumps, SCADA monitored
Old Capricorn Hwy	Fill Mawdesley Hill Reservoir	115, 115	2 centrifugal pumps, SCADA monitored
Mount Morgan Water Supply Scheme			
No. 7 Dam	Supply raw water to Black St WPS	24, 24	2 submersible pumps, SCADA monitored
Black St	Supply raw water to MMWTP	24, 24	2 centrifugal pumps, SCADA monitored
Creek St	Boost pressure to high zone	5	1 centrifugal pump, not monitored
Darcy St	Boost pressure to high zone	5	1 centrifugal pump, not monitored
East St Extended	Fill North St Reservoir	8	1 centrifugal pump, SCADA monitored
Hall St	Boost pressure to high zone	5	1 centrifugal pump, not monitored
Horse Ck	Boost pressure to high zone	6	1 centrifugal pump, not monitored
Hamilton Ck	Boost pressure to high zone	3	1 centrifugal pump, not monitored
William St	Boost pressure to high zone	5	1 centrifugal pump, not monitored

All pump stations with multiple pumps operate as Duty/Standby pumps except the Low Lift and High Lift WPS in the Rockhampton Water Supply Scheme
^ The Caves WPS is owned and operated by Livingstone Shire Council.

2.5.4 Known Areas of Low Pressure within Distribution Systems

Due to recent improvements in pressure management in Mount Morgan there are no significant portions of this distribution system which possess less than the minimum service pressure standard of 220 kPa.

2.5.5 Known Areas of Long Detention Time within Distribution Systems

There are two locations within the drinking water schemes where Fitzroy River Water is involved partially or fully in the management of water quality, where the size and length of water supply pipelines leads to long detention times that result in a drinking water age in excess of 5 days.

The most significant of these is the Rockhampton to Yeppoon Water Supply Pipeline which is comprised of approximately 40 km of 600 mm or 750 mm diameter water trunk infrastructure. The Boundary Hill Reservoir (10 ML) is located at close to the mid-point of this length of pipeline. The combined storage capacity of the pipeline and the reservoir is approximately 24 ML. The daily volume of supply from the Glenmore WTP along the pipeline to the Capricorn Coast Water Supply Scheme is usually between 3 and 5 ML. Based on this rate of supply the water may take in excess of 5 days before it travels from the WTP to the first customer's tap.

Secondly, the rising main between Ramsay Creek valve and the Mt Charlton Reservoir to the north is another area where due to the length (~18 km) and diameter of the pipe (~600 mm), distributed water can have a relatively long detention time depending on demand. The overall operation of this part of the Rockhampton Water Supply Scheme north of Ramsay Creek valve is the responsibility of Livingstone Shire Council.

2.6 Stakeholders Involved in Managing Drinking Water Infrastructure

Apart from FRW employees, other groups, companies and organisations are involved in the management of the infrastructure and water quality associated with drinking water services provided by RRC. Table 2.9 contains a list of these stakeholders, the infrastructure they are involved in managing and their contribution as a stakeholder.

Table 2.9:Stakeholders Involved in the Management of Drinking Water Quality and Infrastructure

Name of Stakeholder	Infrastructure Involved	Stakeholder Contribution
All Water Supply Schemes		
Department of Regional Development, Manufacturing and Water	Water sources and catchments; All of scheme infrastructure	Water quality and quantity monitoring and management; Regulator of drinking and recycled water schemes, incident management
Department of Environment and Science	Water sources and receiving environments and associated catchments	Regulator for protection of the environment.
Queensland Health	All of scheme infrastructure	Primary responsibility for public health, incident management
Various commercial and industrial customers	All of scheme infrastructure	Recipients of water quality reports
Rockhampton Water Supply Scheme		
Fitzroy Basin Association Incorporated	Fitzroy Basin upstream catchment	Catchment management and water quality monitoring
Fitzroy Partnership for River Health	Water sources and catchments	Water quality monitoring and reporting.
Teys Australia Pty Ltd	Reticulation supply to abattoir	Major commercial customer
SunWater	Eden Bann Weir and other upstream storages	Management of catchment and storage releases
Capricorn Coast, The Caves and Nerimbera Water Supply Schemes		
Livingstone Shire Council	All of scheme infrastructure	All aspects of water service provision
Fitzroy River Water	All of scheme infrastructure	Bulk supply of drinking water from the Glenmore WTP
Mount Morgan Water Supply Scheme		
Smalls Egg Farm	Reticulation to Egg Farm	Major commercial customer
External Contractors/Suppliers		
Ixom	WTPs and Reservoir Disinfection	Chlorine gas and sodium chlorite supplier
Omega Chemicals, Orica	WTPs	Coagulant chemical supplier
Redox	WTPs	Treatment chemical supplier
Coogee QCA Pty Ltd	WTPs and Reservoir Disinfection	Sodium hypochlorite supplier
Nalco, Chemiplas, QMAG	WTPs	Treatment chemical supplier
Activated Carbon Technologies, Filchem	WTPs	Activated carbon supplier
Grenof Pty Ltd	WTPs	Calcium hydroxide supplier
Internal Contractors/Suppliers		
Logistics	All infrastructure	Assisting with procurement and logistics for all water operations
Business Services Team	All infrastructure	Assist with business management
Records Management	All infrastructure	Assist with data archiving
Customer Service Team	All infrastructure	Assist with customer interactions
Corporate Compliance	All infrastructure	Assist with Corporate reporting.

3 CATCHMENT AND WATER QUALITY INFORMATION

3.1 Catchment Characteristics

The five drinking water supply schemes described above that are either fully or partially supplied by Fitzroy River Water are supplied by a total of five surface water catchment systems. These catchments differ considerably with respect to size, flow volume, topography, geology, vegetation, climate and land use. The surface water sources that are owned and operated by Fitzroy River Water are described below.

3.1.1 Fitzroy River Basin

The Fitzroy River Basin is an extensive and diverse catchment. It covers an area of approximately 142,000 km^2 and consists of six major sub-catchments: Isaac/Connors, Nogoa, Comet, Mackenzie, Dawson and Fitzroy. A detailed description of the Fitzroy River Basin is provided in the Fitzroy Basin Water Quality Improvement Report published by the Fitzroy Basin Association in 2008. The topography, geology, vegetation, climate and land use within the Fitzroy River Basin vary considerably.

Based on area, the predominant vegetation type is brigalow scrub (28%) which is characterised by a range of different softwood species which thrive on a variety of clay or loam soil types. Next most abundant (24%) is mountain and range topography which consists of medium to tall hardwood forests on the rocky more elevated terrain. Eucalypt woodlands (22%) are the next most abundant vegetation type and exist on a mix of sandy or loamy tableland or clay areas dominated by ironbark or related eucalypt species. Alluvial deposits covered by ‘true gum’ species such as blue gums and red gums as well as some poplar box and brigalow scrub cover 16% of the catchment. The remaining 10% is covered by bluegrass downs with open woodlands (7%), sandy areas dominated by cypress, shrubby and heath species (2%), and the coastal sandy margins that include eucalypt, tea tree, sand dune and marine vegetation types (1%).

Average annual rainfall across the catchment ranges between 600 mm in the west, 800 mm in the east and 1000 mm in the north. Despite these rainfall averages, seasons are highly variable with long dry periods usually punctuated by short periods of high rainfall (usually in the summer months) which results in high flows and flooding events. In some parts of the basin drought occurs on average every three years. As a result, 29 dams and weirs have been constructed throughout the basin to improve water availability for agriculture, industrial and urban uses. Isolated bushfires are common during dry periods and occur especially during late winter and early spring before the onset of summer rainfall.

Land use across the basin includes livestock grazing (81%), cropping (6%), conservation (6%), forestry (5%), urban (1%), mining (0.5%) and irrigation (0.5%). Grazing activities are widespread throughout the catchment including within a few kilometres of the Glenmore WTP along the banks of the Fitzroy River. Mining activities include the activities throughout the Bowen Basin to the west and north of the basin as well as in the lower parts of the Dawson River valley. Currently at least 46 coal mine operations exist within the basin. Mining activities are expected to increase over time with the establishment of new coal mines or coal seam gas operations within the basin. The increased mining activities will inevitably lead to increased impacts on water quality in the basin. The extreme example of this impact was the release of mine-associated water from the Ensham Mine during 2008 under an emergency release arrangement. This emergency release led to sodium concentrations in excess of 100 mg/L in the Fitzroy Barrage Storage. It is estimated that coal mine water discharges contributed to between 18 and 25% of salinity loadings into the Fitzroy Basin at different times during 2011. Increased levels of total dissolved solids (TDS) have the potential to negatively impact water aesthetics.

Rockhampton is the largest urban development in the basin. The towns of Emerald and Blackwater to the west of Rockhampton and the townships along the Dawson River and Isaac River are amongst the more developed areas of the basin. Urban development is expected to grow in response to increased mining activities in the region and the future construction of additional water storage on the Connors, Dawson and Fitzroy Rivers. Currently there is minimal impact from urban development, industrial activities or recreational activities on the located adjacent to Rockhampton on the water quality in the Fitzroy River Barrage storage. Urban development includes low level residential development, industrial activities include sand dredging and livestock grazing, and recreational activities are mainly limited to rowing and water skiing. These development activities have the potential to cause slight increases in turbidity (e.g. dredging) or microbial pathogen loads (e.g. from livestock) although there is no evidence to date that these activities are significantly impacting water quality in the Barrage storage.

3.1.2 Dee River, No 7 Dam and Fletchers Creek

The township of Mount Morgan and surrounding areas receive approximately 800 mm rainfall per year on average. The Dee River passes through the township of Mount Morgan. Although more famous for its highly coloured waters due to impacts caused by acid and metal pollution from the Mount Morgan mine site, the No. 7 Dam constructed on the Dee River just upstream of the town by the Mount Morgan Gold Mining Company is by contrast a relatively clean and undisturbed catchment. It is still however, an unprotected surface water with cattle grazing activities conducted upstream of the No. 7 Dam site in what is largely open eucalypt woodland on rocky soils through hilly terrain. The upper catchment of the Dee River contains minimal other urban, rural or industrial development or land use activities. It is possible that agricultural or grazing activities could impact the water quality in No. 7 Dam through the release of nutrients or microbial pathogens to the catchment. There is currently no evidence that these activities are having a negative impact on the quality of raw water in No. 7 Dam.

Fletchers Creek is located approximately 15 km to the south of Mount Morgan and is comprised of a small catchment that winds its way through a series of low hills that consist of open dry eucalypt woodlands and grasslands. The area is used predominantly for cattle grazing purposes with minimal other urban, rural or industrial development in the catchment area. The southern edge of the copper and gold-bearing sulphide ore body that extends through to just north of Mount Morgan is located within a few kilometres of the Fletchers Creek weir. The sulphide ore body has no direct impact on the Fletchers Creek system, however, the slightly acidic soils create highly corrosive conditions for acid-sensitive metallic pipe materials.

The Mount Morgan area has not experienced significant levels of growth and development in recent years. The potential exists for the Mount Morgan mine to again become active. Although this has the potential to lead to increased development and population growth in the township, this type of development does not appear likely to impact the upper Dee River or Fletchers Creek catchment areas.

3.2 Raw Water and Drinking Water Quality

Prior to the amalgamation of Councils to form RRC in 2008, the analysis of raw water and drinking water quality was performed to varying degrees using a range of different approaches. In early 2009 a standardised approach to water quality monitoring was commenced across the existing drinking water schemes to ensure monitoring of raw water and drinking water quality was conducted appropriately. Since then, the operational and verification monitoring programs have been refined towards ensuring safe and reliable water supplies. These monitoring programs are defined in more detail in a later section. The raw water sources and the treatment processes used to produce drinking water vary significantly among the schemes included in this DWQMP. Only the raw water sources, and their associated water quality, that are owned and operated by Fitzroy River Water are described in detail below.

3.2.1 Rockhampton Water Supply Scheme

As described above, the Fitzroy Basin is a very large and complex catchment system. The Fitzroy River raw water quality data presented in Table 3.1 reflects the size and complexity of the catchment. Of particular note is the massive range over which raw turbidity measurements have been recorded. High raw water turbidity occurs due to flow events in the river. The Dawson River catchment has historically been the greatest source of high turbidity raw water with values in excess of 2000 NTU recorded during flood events that occurred late last century.

The raw water also contains low background concentrations of fluoride. The specific source of the fluoride is unknown. Relatively high concentrations of iron and manganese have also been observed in the raw water. During a flood event in early 2010 raw water total iron concentrations of up to 14 mg/L were recorded. Similarly, a flood event in February 2013 and the water quality event following Tropical Cyclone Marcia in February 2015 recorded total manganese concentrations above 0.5 mg/L.

Low levels of the cyanobacterial toxin cylindrospermopsin were detected during a bloom of *Cylindrospermopsis raciborskii* which occurred in 2009 and 2015. This toxin-producing species of cyanobacteria is usually detected during prolonged periods of low raw water turbidity in late winter and spring. Low levels of the potentially toxic *Anabaena circinalis* are also detected usually from early spring. During the period of July 2018 to July 2023 there was very minimal detection of cyanobacteria in the catchment system and there was no detection of cyanobacteria in the potable water produced by GWTP.

Testing for more than 20 different pesticides (see Appendix B) revealed the presence of many pesticides at less than the limits of detection in the raw water. None of the pesticides were detected at concentrations above ADWG values.

Drinking water produced by the GWTP is of a very high quality and consistently meets ADWG. The value for final water turbidity (95^{th} Percentile = 0.445 NTU) is slightly higher than expected compared to the individual filter outlet turbidity measurements which rarely exceed 0.3 NTU. The slightly higher turbidity readings are due to the addition of lime post-filtration. Disinfection by-product formation (e.g. trihalomethanes (THM)) in the Rockhampton Water Supply Scheme occurs with a THM concentration of between50µg/L and 200µg/L (at the extremities of the scheme).

Source Water (RAW) Glenmore Water Treatment Plant ROCKHAMPTON QLD														
(a = L/2 used for < results)	Data obtained from sampling July 2022 - June 2023								Data obtained from sampling July 2018-June 2023					
				Summary of results							Summary of results			
Parameter	**Unit**	**Time Period**	**No. of Samples**	**Average Value**	**Min value**	**Max value**	**95th percentile**	**Time Period**	**No. of Samples**	**Average Value**	**Min value**	**Max value**	**95th percentile**	
pH	Unit	1 year	12	7.44	6.70	7.86	7.76	5 years	60	7.58	6.70	8.1	8.0	
Colour (True)	HU	1 year	12	59.58	30.00	140.00	126.25	5 years	59	40.14	10	140	126.3	
Turbidity	NTU	1 year	12	184.08	51.30	530.00	499.2	5 years	60	178.14	5.40	1330	499.2	
Electrical Conductivity	µS/cm	1 year	12	213.08	133.00	303.00	290.35	5 years	60	221.20	118	310	290.4	
Total Dissolved Solids	mg/L	1 year	12	245.17	161.00	396.00	362.45	5 years	60	234.22	100	396	362.5	
Chloride	mg/L	1 year	12	23.00	16.00	36.00	32.7	5 years	60	30.77	10	81	32.7	
Fluoride a	mg/L	1 year	12	0.55	0.005	0.10	0.1	5 years	60	0.091	0.005	0.200	0.1	
Nitrate (as N)	mg/L	1 year	12	0.21	0.10	0.59	0.43	5 years	60	0.187	0.002	0.590	0.4	
Nitrite (as N) a	mg/L	1 year	12	0.005	0.005	0.005	0.005	5 years	60	0.01	0.00	0.088	0.0	
Sulphate	mg/L	1 year	12	5.00	3.00	8.00	6.9	5 years	60	5.62	2	12	9.1	
Aluminium (Acid Soluble)	mg/L	1 year	12	0.64	0.117	1.98	1.50	5 years	60	0.44	0.01	1.98	1.1	
Iron (Total)	mg/L	1 year	9	8.22	3.38	17.70	15.54	5 years	57	4.90	0.00	17.7	12.6	
Manganese (Total)	mg/L	1 year	9	0.10	0.047	0.215	0.19	5 years	57	0.10	0.00	0.723	0.3	
Copper (Total)	mg/L	1 year	9	0.009	0.01	0.017	0.02	5 years	57	0.01	0.00	0.021	0.0162	
Lead (Total) a	mg/L	1 year	9	0.002	0.001	0.004	0.004	5 years	57	0.00	0.00	0.0082	0.0056	
Zinc (Total)	mg/L	1 year	9	0.017	0.006	0.03	0.03	5 years	57	0.01	0.00	0.091	0.0356	
Calcium (Total)	mg/L	1 year	12	12.00	7.00	18.00	16.9	5 years	60	12.02	6.70	18	16.0	
Sodium (Total)	mg/L	1 year	12	20.50	14.00	28.00	27.45	5 years	60	20.13	11	28	26.1	
Potassium (Total)	mg/L	1 year	12	5.08	4.00	8.00	7.45	5 years	60	4.29	2	8	7.0	
Magnesium (Total)	mg/L	1 year	12	7.75	5.00	11.00	9.9	5 years	60	7.39	4.10	13	9.1	
Hardness (Total)	mg/L	1 year	12	51.50	31.00	72.00	70.9	5 years	59	52.81	25	75	70.2	
Alkalinity (Total) as CaCO3	mg/L	1 year	12	57.33	31.00	80.00	77.8	5 years	60	56.67	30	93	77.2	
Total Organic Carbon	mg/L	1 year	1	5.00	5.00	5.00	5	5 years	15	7.25	5.10	11	10.0	
Arsenic	mg/L	1 year	6	0.0022	0.0020	0.0030	0.00275	5 years	11	0.0019	0.0005	0.0030	0.0028	
Barium	mg/L	1 year	6	0.066	0.04	0.12	0.11	5 years	11	0.077	0.041	0.193	0.1575	
Beryllium a	mg/L	1 year	6	0.001	0.001	0.001	0.0005	5 years	11	0.00	0.00	0.001	0.0008	
Cadmium a	mg/L	1 year	6	0.00005	0.00005	0.00005	0.00005	5 years	11	0.00005	0.00005	0.00005	0.0001	
Chromium	mg/L	1 year	0	NR	NR	NR	NR	5 years	2	0.007	0.004	0.011	0.0106	
Mercury a	mg/L	1 year	5	0.00005	0.00005	0.00005	0.00005	5 years	10	0.0001	0.0001	0.00072	0.0004	
Nickel	mg/L	1 year	6	0.0165	0.0050	0.0520	0.0448	5 years	11	0.01361	0.00050	0.052	0.0375	
Selenium a	µg/L	1 year	6	0.005	0.005	0.005	0.005	5 years	11	0.00	0.00	0.005	0.0050	
Perfluorooctanoic Acid	µg/L	1 year	2	0.45	0.01	0.89	0.85	5 years	5	0.19	0.01	0.89	0.7170	
Perfluorooctane Sulphate	µg/L	1 year	0	NR	NR	NR	NR	5 years	3	0.01	0.01	0.025	0.0235	
Pesticides	µg/L	1 year	1	0.10	0.10	0.10	0.1	5 years	4	0.10	0.10	0.1	0.1000	
BOD	mg/L	1 year	11	2.50	1.00	4.00	4	5 years	16	2.81	1	5	4.2500	
Cryptosporidium	oocyst/10L	1 year	1	0.00	0.00	0.00	0.00	5 years	6	0.00	0.00	0	0.0000	
Giardia	oocyst/10L	1 year	1	0.00	0.00	0.00	0.00	5 years	6	0.00	0.00	0	0.0000	
Cyanide	mg/L	1 year	0	NR	NR	NR	NR	5 years	2	0.00	0.00	0.002	0.0020	

Potable Water (TREATED) Glenmore Water Treatment Plant ROCKHAMPTON QLD																
(a = L/2 used for < results)	Data obtained from sampling July 2022 - June 2023									Data obtained from sampling July 2018-June 2023						
Parameter	ADWG			Time Period	No. of Samples	Summary of results				Time Period	No. of Samples	Summary of results				No. of exceed ADWG value
	Health	Aesthetic	Unit			Average Value	Min value	Max value	95th percentile			Average Value	Min value	Max value	95th percentile	
pH	No Value	6.5-8.5	unit	1 year	12	7.61	7.37	7.78	7.769	5 years	60	7.63967	7.08	8.16	7.9005	Nil
Colour (True)	No Value	15 HU	TCU	1 year	12	2.83	1	10.00	7.25	5 years	60	1.78333	1	10	2.05	Nil
Turbidity	<1 NTU	5 NTU	NTU	1 year	12	0.22	0.05	0.50	0.445	5 years	60	0.2	0.05	0.7	0.505	Nil
Electrical Conductivity	No Value	No Value	µS/cm	1 year	12	236.75	170	288.00	286.9	5 years	60	242.7	142	288	300.5	Nil
Total Dissolved Solids	No Value	600 mg/L	mg/L	1 year	12	136.17	100	176.00	170.5	5 years	60	141.533	83	210	180.5	Nil
Chloride	No Value	250 mg/L	mg/L	1 year	12	32.75	21	81.00	59	5 years	60	38.05	15	81	76.1	Nil
Fluoride a	1.5 mg/L	No Value	mg/L	1 year	12	0.07	0.05	0.10	0.1	5 years	60	0.08083	0.05	0.2	0.11	Nil
Nitrate (as N) a	50 mg/L	No Value	mg/L	1 year	12	0.02	0.005	0.12	0.1145	5 years	60	0.17088	0.005	0.6	0.372	Nil
Nitrite (as N) a	3 mg/L	No Value	mg/L	1 year	12	0.22	0.005	0.60	0.446	5 years	60	0.04636	0.0025	0.6	0.2905	Nil
Sulphate	500 mg/L	250 mg/L	mg/L	1 year	12	4.17	2	5.00	5	5 years	60	4.5	2	12	8.05	Nil
Aluminium (Acid Soluble) a	No Value	0.20 mg/L	mg/L	1 year	12	0.01	0.0025	0.03	0.0215	5 years	60	0.00828	0.0025	0.027	0.01605	Nil
Iron (Total) a	No Value	0.30 mg/L	mg/L	1 year	9	0.09	0.0025	0.68	0.418	5 years	57	0.01642	0.0025	0.68	0.025	Nil
Manganese (Total) a	0.50 mg/L	0.10 mg/L	mg/L	1 year	9	0.03	0.0005	0.29	0.176	5 years	57	0.00622	0.00025	0.292	0.00246	Nil
Copper (Total) a	2 mg/L	1 mg/L	mg/L	1 year	9	0.004	0.001	0.007	0.0058	5 years	57	0.00432	0.001	0.012	0.0074	Nil
Lead (Total) a	0.01 mg/L	No Value	mg/L	1 year	9	0.0005	0.0005	0.0005	0.0005	5 years	57	0.00054	0.00022	0.0011	0.000896	Nil
Zinc (Total) a	No Value	3 mg/L	mg/L	1 year	9	0.003	0.0025	0.006	0.0046	5 years	57	0.0026	0.0018	0.006	0.0025	Nil
Calcium (Total)	No Value	No Value	mg/L	1 year	12	14.50	8	20.00	18.35	5 years	60	13.66	8	20	17.05	Nil
Sodium (Total)	No Value	180 mg/L	mg/L	1 year	12	21.17	14	28.00	27.45	5 years	60	20.3	11	28	27	Nil
Potassium (Total)	No Value	No Value	mg/L	1 year	12	4.33	3	6.00	6	5 years	60	3.81333	2	6	6	Nil
Magnesium (Total)	No Value	No Value	mg/L	1 year	12	6.83	4	10.00	9.45	5 years	59	6.65593	3.8	14	9	Nil
Hardness (Total)	No Value	200 mg/L	mg/L	1 year	12	61.58	40	77.00	77	5 years	60	59.95	36	95	77.05	Nil
Alkalinity (Total) as CaCO3	No Value	No Value	mg/L	1 year	12	59.67	32	79.00	79	5 years	60	57.25	32	107	75.2	Nil
Total Organic Carbon a	No Value	No Value	mg/L	1 year	4	1.88	0.5	3.00	2.85	5 years	19	2.96316	0.5	7	5.83	Nil
Trihalomethanes	250 µg/L	No Value	mg/L	1 year	4	34.75	19	50.00	48.2	5 years	19	32.4526	19	51	50.1	Nil
Trihalomethanes - Retic	250 µg/L	No Value	mg/L	1 year	4	146	73	212	204.05	5 years	18	118.106	71.1	212	170.35	Nil
Arsenic a	0.01 mg/L	No Value	mg/L	1 year	6	0.0005	0.0005	0.0005	0.0005	5 years	11	0.00044	0.00005	0.0005	0.0005	Nil
Barium a	2 mg/L	No Value	mg/L	1 year	6	0.0365	0.032	0.0410	0.0405	5 years	11	0.03186	0.0205	0.045	0.043	Nil
Beryllium a	0.06 mg/L	No Value	mg/L	1 year	6	0.0005	0.0005	0.0005	0.0005	5 years	11	0.00042	0.00005	0.0005	0.0005	Nil
Cadmium a	0.002 mg/L	No Value	mg/L	1 year	6	0.00005	0.00005	0.00005	0.00005	5 years	11	0.00005	0.00005	0.00005	0.00005	Nil
Chromium a	0.05 mg/L	No Value	mg/L	1 year	NR	NR	NR	NR	NR	5 years	2	0.00025	0.00025	0.0003	0.00025	Nil
Mercury a	0.001 mg/L	No Value	mg/L	1 year	5	0.00005	0.00005	0.00005	0.00005	5 years	10	0.00005	0.00005	0.00005	0.00005	Nil
Nickel a	0.02 mg/L	No Value	µg/L	1 year	6	0.0007	0.0005	0.001	0.001	5 years	11	0.00062	0.0005	0.001	0.001	Nil
Selenium a	0.01 mg/L	No Value	µg/L	1 year	6	0.005	0.005	0.01	0.005	5 years	11	0.00414	0.00025	0.005	0.005	Nil
Perfluorooctanoic Acid a	0.01 µg/L	No Value	µg/L	1 year	1	0.005	0.005	0.005	0.005	5 years	3.000	0.007	0.005	0.010	0.010	Nil
Sum of PFOS + PFHxS a	0.05 µg/L	No Value	µg/L	1 year	1	0.01	0.005	0.005	0.005	5 years	3.000	0.020	0.010	0.025	0.025	Nil
Chlorate a	No Value	No Value	mg/L	1 year	7	0.02	0.001	0.102	0.0729	5 years	19	0.03375	0.001	0.132	0.1303	Nil
Chlorite a	0.8 mg/L	No Value	mg/L	1 year	7	0.002	0.001	0.005	0.00425	5 years	20	0.00532	0.001	0.027	0.0243	Nil
Cryptosporidium	<1 organism/L	No Value	oocyst/10L	1 year	1	Nil Detected	Nil Detected	Nil Detected	0	5 years	5	Nil Detected	Nil Detected	Nil Detected	0	Nil
Giardia	<1 organism/L	No Value	oocyst/10L	1 year	1	Nil Detected	Nil Detected	Nil Detected	0	5 years	5	Nil Detected	Nil Detected	Nil Detected	0	Nil
Cyanide	0.8 mg/L	No Value	mg/L	1 year	0	NR	NR	NR	NR	5 years	2	0.002	0.002	0.002	0.002	Nil

Raw water quality in the Fitzroy River typically varies seasonally. This variation is usually flow dependent and is perhaps best illustrated by the changes in turbidity as flow events occur and then gradually decline over subsequent months. Figure 3.1 shows data for raw water turbidity during a wet weather event at the Glenmore WTP between May 2022 and April 2023. During this period, the Fitzroy River changed from having low flow and low turbidity to an extended period of flow events and associated high turbidity from late May 2022 until early 2023 before flows gradually reduced. The high and rapidly changing turbidity seen during this period is typical of these flow events which usually occur at least once a year. The Glenmore WTP effectively treats raw water with high turbidity due to its design and the use of the polyaluminium chlorhydrate coagulant. When raw water turbidity decreases to levels less than 20 NTU or an extended period of time, the river can experience algal blooms which have the potential to affect water quality. The coagulant and polymer dosing rates are adjusted during algal bloom events to treat the water and filter operation is managed closely in order to optimise filter run time and performance during these events.

Figure 3.1: Changes in Fitzroy River raw water turbidity based on flow conditions from May 2022 to April 2023 during wet weather events.

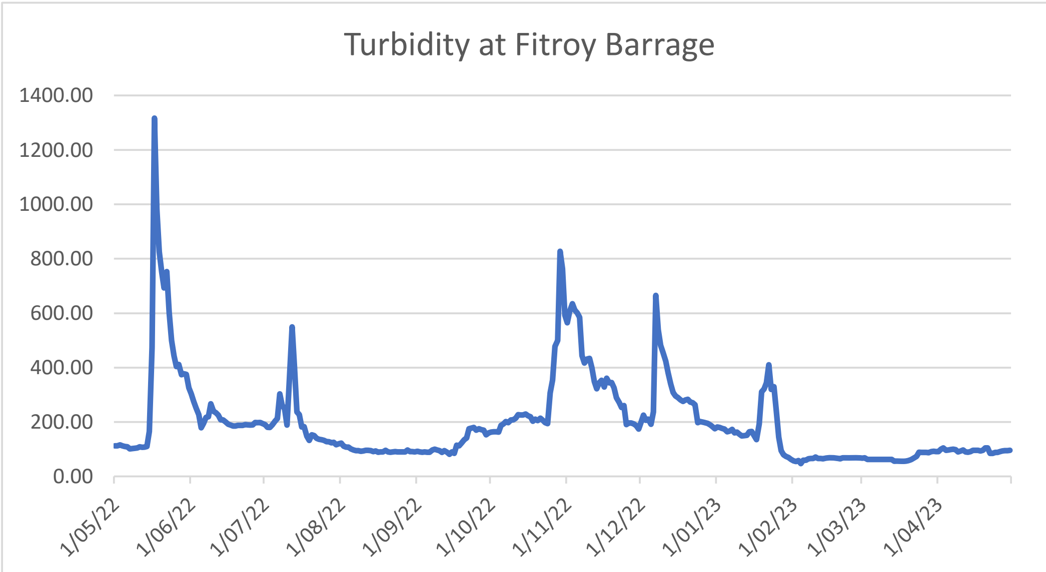
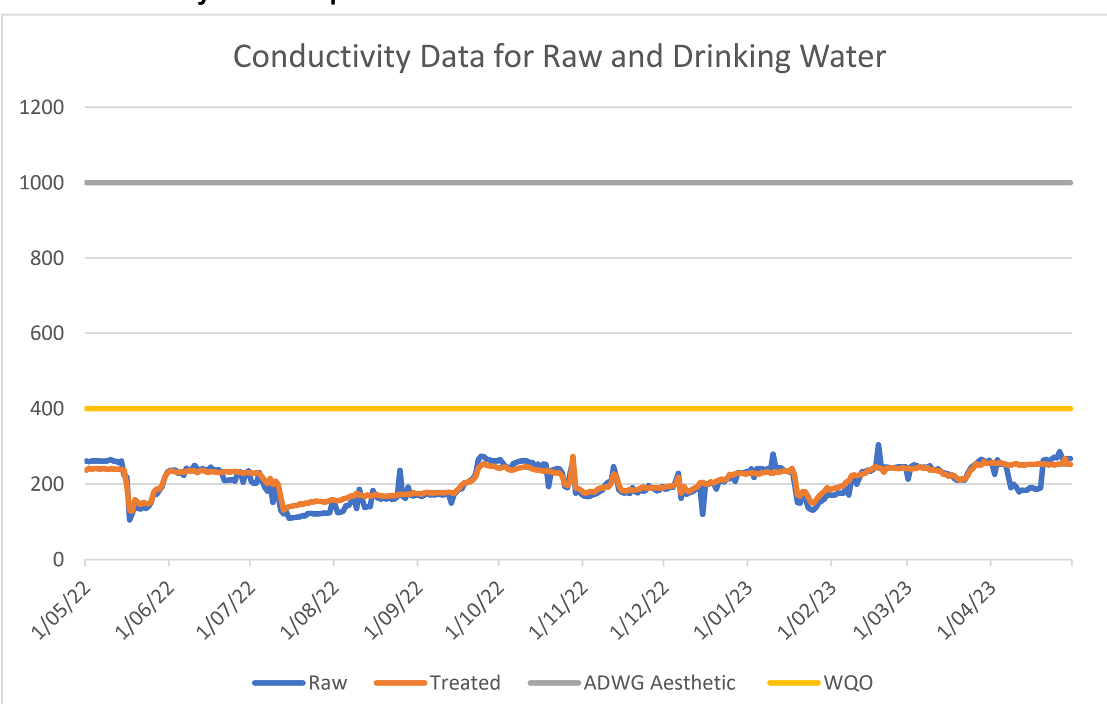


Figure 3.2: Electrical Conductivity comparison data for Raw water and Drinking water at the Glenmore WTP between May 2022 to April 2023.



WQO = Water Quality Objective

The Fitzroy Barrage raw water Electrical Conductivity (E.C.) also changes significantly due to events that occur upstream in the catchment. Figure 3.2 shows the changes in E.C. that occurred during the 12 month period from May 2022 to April 2023. High rainfall in parts of the catchment saw the input of high levels of E.C. into the Fitzroy Basin from rising groundwater with high electrical conductivity. After the peak of the wet weather event, high E.C. waters continued to flow downstream leading to a gradual increase in E.C. in the Fitzroy Barrage Storage.

E. coli testing was performed throughout the Rockhampton network (see Appendix C) at a weekly schedule, there was no detection found in the potable water. There was no testing performed on the raw water through out that period, however, testing of the raw water has commenced on a weekly basis for six weeks to gain a baseline then it will shift to a monthly schedule to align with the DWQMP testing schedule. During the 12-month period from July 22 – July 23 there were monthly samples taken inline with the DWQMP. All samples where within the ADWG.

3.2.2 Mount Morgan Water Supply Scheme

Raw water quality in the available water source No. 7 Dam varies considerably. Source Water monthly sampling is continuing to monitor the water quality. The water quality data is presented below. Elevated concentrations of iron, manganese as well as BGA have challenged the performance of the Mount Morgan WTP. Because of the generally lower quality of No. 7 Dam this source is currently not available to supply raw water for the treatment and supply of drinking water to the Mount Morgan Water Supply Scheme. Treated water from Glenmore Supply Scheme is currently transported in bulk water carriers from Gracemere to Mount Morgan WTP for re chlorination and distribution to the Mount Morgan Supply Scheme.

No 7 Dam Source Water (RAW) Mount Morgan Water Treatment Plant MOUNT MORGAN QLD

(a = L/2 used for < results)

Parameter	Unit	Time Period	No. of Samples	Summary of results (Data obtained from sampling July 2022 - June 2023): Average Value	Min value	Max value	95th percentile	Time Period	No. of Samples	Summary of results (Data obtained from sampling July 2018-June 2023): Average Value	Min value	Max value	95th percentile
pH	Unit	1 year	12	7.74	7.38	7.97	7.9315	5 years	60	8.01	7.38	9.05	8.733
Colour (True)	HU	1 year	12	32.50	15.00	45.00	45	5 years	60	19.03	1	70	50
Turbidity	NTU	1 year	12	8.03	0.20	48.80	25.755	5 years	60	11.16	0.20	72.4	31.355
Electrical Conductivity	µS/cm	1 year	12	330.50	271.00	386.00	384.9	5 years	60	337	180	550	480.4
Total Dissolved Solids	mg/L	1 year	12	191.83	112.00	230.00	228.35	5 years	60	194	66	307.00	276.85
Chloride	mg/L	1 year	12	38.00	29.00	48.00	46.9	5 years	60	43	22	85.00	70.4
Fluoride	mg/L	1 year	12	0.06	0.01	0.1	0.1	5 years	60	0.11	0.01	0.20	0.2
Nitrate (as N)	mg/L	1 year	12	0.01	0.01	0.07	0.048	5 years	60	0.0251	0.00	0.26	0.1505
Nitrite (as N)	mg/L	1 year	11	0.0050	0.0050	0.0050	0.005	5 years	59	0.0052	0.0025	0.0300	0.01115
Sulphate	mg/L	1 year	12	6.42	2.00	12.00	12	5 years	60	12	2	42	29
Aluminium (Acid Soluble) a	mg/L	1 year	12	0.02	0.00	0.129	0.0773	5 years	60	0.1102	0.0025	2.39	0.1847
Iron (Total)	mg/L	1 year	10	0.19	0.00	0.61	0.5785	5 years	59	0.5169	0.0025	4.60	1.663
Manganese (Total) a	mg/L	1 year	9	0.11	0.00	0.208	0.184	5 years	58	0.1711	0.0005	1.67	0.4254
Copper (Total) a	mg/L	1 year	9	0.0018	0.0005	0.005	0.0038	5 years	58	0.0018	0.0005	0.009	0.004405
Lead (Total) a	mg/L	1 year	9	0.0005	0.0005	0.0005	0.0005	5 years	58	0.00035	0.00005	0.001	0.0005
Zinc (Total) a	mg/L	1 year	9	0.02	0.00	0.128	0.0778	5 years	58	0.0062	0.0025	0.128	0.0132
Calcium (Total)	mg/L	1 year	11	23.00	16.00	29.00	28.5	5 years	59	20.16	9	31	29.1
Sodium (Total)	mg/L	1 year	11	27.18	20.00	32.00	31.5	5 years	59	28	12	51	46
Potassium (Total)	mg/L	1 year	11	4.09	4.00	5.00	4.5	5 years	59	2.94	1	5	5
Magnesium (Total)	mg/L	1 year	11	11.73	8.00	14.00	13.5	5 years	59	11.66	6	18	16
Hardness (Total)	mg/L	1 year	10	104.00	90.00	118.00	118	5 years	58	72	13	127	120.75
Alkalinity (Total) as CaCO3	mg/L	1 year	12	94.58	72.00	115.00	114.45	5 years	60	89	55	141	120.1
Total Organic Carbon	mg/L	1 year	4	13.25	11.00	15.00	15	5 years	16	11.78	8	15	15
Arsenic a	mg/L	1 year	6	0.00	0.00	0.00	0.0005	5 years	12	0.0005	0.0005	0.0007	0.000584
Barium	mg/L	1 year	6	0.01	0.01	0.04	0.02925	5 years	12	0.0132	0.0045	0.035	0.0306
Beryllium a	mg/L	1 year	6	0.00	0.00	0.0005	0.0005	5 years	12	0.0004	0.0001	0.0005	0.0005
Cadmium a	mg/L	1 year	7	0.00	0.00	0.00005	0.00005	5 years	13	0.0001	0.00005	5E-05	0.00005
Cyanide	mg/L	1 year	0	NR	NR	NR	NR	5 years	1	0.0020	0.0020	0.002	0.002
Chromium	mg/L	1 year	0	NR	NR	NR	NR	5 years	2	0.00025	0.00025	0.0003	0.00025
Mercury a	mg/L	1 year	5	0.00005	0.00005	0.00005	0.00005	5 years	11	0.00005	0.00005	5E-05	0.00005
Nickel a	µg/L	1 year	6	0.00075	0.00050	0.002	0.001625	5 years	12	0.00058	0.0003	0.0020	0.001175
Selenium a	µg/L	1 year	6	0.0050	0.0050	0.0050	0.005	5 years	12	0.00421	0.0003	0.0050	0.005
Cryptosporidium	oocyst/ 10L	1 year	1	Nil Detected	Nil Detected	Nil Detected	0	5 years	6	Nil Detected	Nil Detected	Nil Detected	0.00
Giardia	oocyst/ 10L	1 year	1	Nil Detected	Nil Detected	Nil Detected	0	5 years	6	Nil Detected	Nil Detected	Nil Detected	0.00
Pesticides	mg/L	1 year	1	0.0000	0.0000	0.0000	0	5 years	3	0.1	0.1	0.1	0.1

Potable Water (Treated) Mount Morgan Water Treatment Plant MOUNT MORGAN QLD

a = L/2 used for < results — Data obtained from sampling July 2022 - June 2023 — Data obtained from sampling July 2018 - June 2023

Parameter	ADWG		Units	Time Period	No. of Samples	Summary of results				Time Period	No. of Samples	Summary of results			
	Health	Aesthetic				Average Value	Minimum value	Maximum value	95th percentile			Average Value	Minimum value	Maximum value	95th percentile
pH	No Value	6.5-8.5	Unit	1 year	12	7.71	7.22	8.00	7.934	5 years	60	7.66	7.14	8.00	7.97
Colour (True)	No Value	15 HU	HU	1 year	12	2.25	2	4	3.45	5 years	60	2	1	5.00	3
Turbidity	<1 NTU	5 NTU	NTU	1 year	12	0.85	0.1	7	3.48	5 years	60	0.44	0	7.00	0.705
Electrical Conductivity	No Value	No Value	µS/cm	1 year	12	245.58	189	294	291.8	5 years	60	338	189	605.00	549.3
Total Dissolved Solids	No Value	600 mg/L	mg/L	1 year	12	143.50	107	185	184.45	5 years	60	194	107	345.00	321.5
Chloride	No Value	250 mg/L	mg/L	1 year	12	36.33	20	87	63.35	5 years	60	39	20	87.00	63.45
Fluoride a	1.5 mg/L	No Value	mg/L	1 year	12	0.014	0.005	0.10	0.0505	5 years	60	0.0468	0.0050	0.2000	0.1
Nitrate (as N)	50 mg/L	No Value	mg/L	1 year	12	0.24	0.12	0.50	0.445	5 years	60	0.18	0.05	0.50	0.4005
Nitrite (as N) a	3 mg/L	No Value	mg/L	1 year	12	0.005	0.005	0.01	0.005	5 years	60	0.0039	0.0025	0.0050	0.005
Sulphate	500 mg/L	250 mg/L	mg/L	1 year	12	4.25	3	7	6.45	5 years	60	33	3	84.00	78.1
Aluminium (Acid Soluble) a	No Value	0.20 mg/L	mg/L	1 year	12	0.0217	0.015	0.041	0.0355	5 years	60	0.08	0.01	0.23	0.17
Iron (Total) a	No Value	0.30 mg/L	mg/L	1 year	9	0.0250	0.025	0.025	0.025	5 years	57	0.0155	0.0025	0.0250	0.025
Manganese (Total) a	0.50 mg/L	0.10 mg/L	mg/L	1 year	9	0.0012	0.0005	0.003	0.0026	5 years	57	0.0124	0.0005	0.1000	0.0338
Copper (Total)	2 mg/L	1 mg/L	mg/L	1 year	9	0.0023	0.001	0.004	0.0036	5 years	57	0.0017	0.0005	0.0070	0.0032
Lead (Total) a	0.01 mg/L	No Value	mg/L	1 year	9	0.0005	0.0005	0.001	0.0005	5 years	57	0.0003	0.0001	0.0005	0.0005
Zinc (Total) a	No Value	3 mg/L	mg/L	1 year	9	0.0042	0.0025	0.009	0.0086	5 years	57	0.0082	0.0025	0.0180	0.017
Calcium (Total)	No Value	No Value	mg/L	1 year	12	14.50	11	17	16.45	5 years	60	15.37	9.20	26.00	22.1
Sodium (Total)	No Value	180 mg/L	mg/L	1 year	12	22.75	17	30	29.45	5 years	60	37	15	81.00	74.2
Potassium (Total)	No Value	No Value	mg/L	1 year	12	4.58	3	7	6.45	5 years	60	3.24	1	7.00	6
Magnesium (Total)	No Value	No Value	mg/L	1 year	12	6.58	5	9	8.45	5 years	60	8	5	15.00	14
Hardness (Total)	No Value	200 mg/L	mg/L	1 year	10	61.20	46	74	73.55	5 years	58	71	43	121.00	110
Alkalinity (Total) as CaCO3	No Value	No Value	mg/L	1 year	12	58.58	38	80	77.8	5 years	60	71	33	145.00	111.05
Total Organic Carbon	No Value	No Value	mg/L	1 year	4	3.25	2	4	4	5 years	20	6	1	12.00	12
Trihalomethanes	250 µg/L	No Value	mg/L	1 year	4	120	77	158	154.4	5 years	22	100.77	48	166.00	157
Trihalomethanes - retic	250 µg/L	No Value	mg/L	1 year	4	139.25	109	193	184.6	5 years	22	125.56	67	235.00	193
Arsenic a	0.01 mg/L	No Value	mg/L	1 year	6	0.0005	0.0005	0.0005	0.0005	5 years	11	0.0005	0.0003	0.0005	0.0005
Barium	2 mg/L	No Value	mg/L	1 year	6	0.0363	0.032	0.0390	0.03875	5 years	11	0.0290	0.0029	0.0400	0.0395
Beryllium a	0.06 mg/L	No Value	mg/L	1 year	6	0.0005	0.0005	0.0005	0.0005	5 years	11	0.0004	0.0001	0.0005	0.0005
Cadmium a	0.002 mg/L	No Value	mg/L	1 year	6	0.0001	5E-05	0.0001	0.00005	5 years	11	0.0001	0.0001	0.0001	0.00005
Chromium	0.05 mg/L	No Value	mg/L	1 year	0	NR	NR	NR	NR	5 years	2	0.00025	0.00025	0.00025	0.00025
Mercury a	0.001 mg/L	No Value	mg/L	1 year	5	0.00005	5E-05	0.00005	0.00005	5 years	10	0.00005	0.00005	0.00005	0.00005
Nickel a	0.02 mg/L	No Value	mg/L	1 year	6	0.00058	0.0005	0.0010	0.00088	5 years	10	0.0005	0.0003	0.0010	0.00083
Selenium a	0.01 mg/L	No Value	µg/L	1 year	5	0.0050	0.0050	0.0050	0.005	5 years	9	0.0039	0.0003	0.0050	0.005
Cryptosporidium	*<1 organism/L*	*No Value*	oocyst/10 L	1 year	1	Nil Detected	Nil Detected	Nil Detected	0.00	5 years	6	Nil Detected	Nil Detected	Nil Detected	0.00
Giardia	*<1 organism/L*	*No Value*	oocyst/10 L	1 year	1	Nil Detected	Nil Detected	Nil Detected	0.00	5 years	6	Nil Detected	Nil Detected	Nil Detected	0.00
Chlorate	0.8 mg/L	No Value	mg/L	1 year	4	0.15	0.113	0.21	0.2024	5 years	7	0.20	0.11	0.39	0.3716
Chlorite	No Value	No Value	mg/L	1 year	4	0.00	0.00	0.00	0.0025	5 years	7	0.0016	0.0010	0.0025	0.0025

Historically, there was very little data obtained for type and number of cyanobacteria in either of the raw water sources. The commencement of regular sampling in the No. 7 Dam in early 2011 detected low levels of the potentially toxic species *Microcystis aeruginosa* and *Cylindrospermopsis raciborskii*. With higher Cyanobacteria levels detected since April 2021 due to low storage level at No 7 Dam, treated water has been tankered to Mount Morgan Treatment Plant Black St Reservoir for distribution to the Water Supply Scheme.

The No. 7 Dam raw water quality is influenced by the flow patterns of the Dee River. Flows in the Dee River lead to increases in raw water turbidity and TDS. Installation of on-line turbidity, pH and electrical conductivity meters provided a better indication of how raw water changes over time. This enabled a better understanding of seasonal or other trends in raw water quality.

Drinking water produced by the MMWTP consistently meets ADWG, with recent upgrades and improvements made to the operation of the WTP. The installation of on-line analysis of key water quality parameters at different stages throughout the plant has enabled improvements to be made in the operation and performance of the WTP. The increased concentration of aluminium and sulphate in the final water compared to the raw water is due to the use of aluminium sulphate as the coagulant.

The formation of disinfection by-products such as THM throughout the Mount Morgan Water Supply Scheme has been profiled. The average concentration of THM in the distribution system is about 120 µg/L. The highest concentration of THM recorded in the distribution system was slightly above the ADWG health guideline value at 259 µg/L. This short-lived exceedance was detected in March 2021 as part of the additional operational monitoring in line with the increasing water quality issues in No. 7 Dam.

There was monitoring of *E. coli* in the Mount Morgan potable water supply (see Appendix C), there was no detection found. There was no testing conducted on the Mount Morgan catchment area, however, this has changed (November 2023) to align with the ADWG, this will be done for six weeks to gain a baseline then switch to a monthly schedule to conform with the current DWQMP sampling. The monitoring of the physical chemistry was conducted in accordance with DWQMP, and it was all with the AWDG.

3.3 Drinking Water Quality Notifications

A number instances occurred resulting in the Regulator being notified in accordance with the *Water Supply (Safety and Reliability) Act* for non-compliances with a water quality criteria. There were also notifications made to the Regulator on drinking water quality events or detections of a parameter with no water quality criteria. Table 3.5 details the notifications made to the Regulator in the 2012-2013, 2014-2015, 2015-2016 and 2020-2021 reporting periods. There were no notifications made to the Regulator in the 2013-2014, 2016-17,2017-18, 2018-2019,2019-2020 and 2021-2022 annual reporting periods.

The *E. coli* detection recorded in the 2012-13 reporting period was attributed to the green tree frogs gaining access to the inside of the service reservoir. A range of preventative actions were implemented to reduce the risk of recurrence in all reservoirs by review of rechlorination, vermin-proofing of reservoirs and regular preventative maintenance checks.

The elevated manganese and THM levels in the 2014-15 reporting period were associated with the Tropical Cyclone Marcia event. In January 2018, a chlorine dioxide generator and dosing system was installed to provide the ability to oxidise manganese and/or iron and enhance the existing disinfection process without leading to significant increases in disinfection by-products.

The short-lived exceedance of THM level in 2020-2021 reporting period was associated with the deteriorating water quality as a result of the decreasing water levels in No. 7 Dam. A range of operational and network optimisation actions were implemented to reduce THM formation and alleviate taste and odour issues but without significant rainfall, these actions will not eliminate the recurrence of disinfection by-products. Since April 2021, Mount Morgan Water Supply Scheme has been 100% supplied with tankered water from Rockhampton Water Supply Scheme.

There was no specific treatment process or other failure specifically identified for the *Giardia* detected in 2015-16 reporting period. To enhance the performance of the treatment process, filters were refurbished and filter media was replaced at the Mount Morgan WTP in mid-2016. A UV disinfection system was also installed in 2017 to provide dual disinfection and to provide an effective treatment barrier for the destruction of protozoan pathogens including *Giardia* and *Cryptosporidium*.

During 2022-23 increased Chlorate testing was commenced as requested by the regulator. This will continue for a 12 month period. Test results are being monitored and testing results will be reported to the regulator after October 2023 results.
The regulator was notified in accordance with the *Water Supply (Safety and Reliability) Act* for possible non-compliance with a water quality criteria occurring October 31 2022. High Chlorine residual reading from online monitoring was recorded. After flushing of all hydrants downstream subsequent onsite testing returned results in the water supply system of 1.10mg/L. No water quality complaints were received.

Table 3.5: Notifications made to the Regulator for Drinking Water Supply Schemes

Reporting Period	Scheme	Nature of Notification	System Location	Key Actions Taken
2012-2013	Mount Morgan	High turbidity	WTP	Flow rate reduced; Adjusted coagulation dose rates
	Rockhampton	Elevated manganese	WTP	Reviewed monitoring and treatment options during major flood events
	Rockhampton	*E. coli* detected	Reticulation	Frog-proofed reservoir; Reviewed rechlorination
2014-2015	Rockhampton	High chlorine	Reservoir	Chlorination ceased, dilution of reservoir; Repair and service of chlorine dosing system
	Rockhampton	Elevated manganese	WTP	Controlled raw water release; Pre-chlorination
	Rockhampton	Elevated THM	Reticulation	Adjusted pre-chlorination; Mains flushing and reservoir scouring; Chlorine dioxide system was installed in January 2018
	Mount Morgan	*E. coli* detected	Reticulation	Inspection and monitoring of reservoir and chlorine dosing facility
	Rockhampton	Cyanobacteria bloom and cylindrospermopsin detected	Source water	WTP chemical dose rates adjusted
2015-16	Mount Morgan	1 *Giardia* cyst detected	Reservoir	Processes and monitoring systems checked for any issues, follow-up testing performed. Filter media replaced and UV disinfection system was installed in 2017
2020-21	Mount Morgan	Elevated THM	Reticulation	Addition of granulated activated carbon on the filter media; Strategic mains flushing; Tankering of potable water from the Rockhampton Water Supply Scheme
2022-2023	Rockhampton and Mount Morgan	Chlorate	Reticulation	Due to queries from Regulator collection of 3 samples quarterly from various water sampling sites tested for Chlorate level commenced. All results have been below Queensland Health interim guidelines value of 0.8mg/L. Recorded values 0.121mg/L to 0.386mg/L
2022-2023	Rockhampton	Free Chlorine Residual	Reticulation	>8.80mg/L Chlorine online residual reading at Yaamba Road Reservoir 23:00 31st October 2022. Retested at 00.00 with result being 1.10mg/L. Water was flushed from all hydrants downstream. No information to suggest that Public Health was impacted. FRW received no water quality complaints or incidents during this period.

3.4 Drinking Water Quality Complaints

Drinking water quality complaints have been received from customers in the drinking water schemes. In most cases these complaints have been due to discoloured water or water containing entrained air bubbles. Table 3.6 shows the number of drinking water quality complaints received for each drinking water scheme.

Table 3.6: Number of Water Quality Complaints for each Drinking Water Scheme

Reporting Period	Rockhampton (per 1000 connections)	Mount Morgan (per 1000 connections)
2012-2013	160 (5.22)	23 (15.6)
2013-2014	54 (1.83)	12 (8.16)
2014-2015	277 (9.8)	9 (6.12)
2015-2016	61 (2.0)	20 (13.6)
2016-2017	42 (1.37)	8 (5.4)
2017-2018	38 (1.0)	11 (7.28)
2018-2019	30 (0.78)	14 (9.27)
2019-2020	28 (0.73)	23 (15.2)
2020-2021	38 (0.99)	106 (70)
2021-2022	32(1.04)	7 (4.68)
2022-2023	28 (0.91)	3 (0.67)

The water quality complaints for the Mount Morgan Water Supply Scheme are typically due to discoloured water complaints associated with iron and manganese in the distributed water. In the 2021-2022 and 2022-2023 reporting periods, the significant drop in complaints is due to treated water being tankered to the Water Treatment Plant.

In the Rockhampton Water Supply Scheme the water quality complaints are more evenly spread between discoloured water and other general quality complaints such as taste, odour or aesthetics. Majority of complaints were found to be internal issues such as galvanised pipes and faulty joined or damaged pipework. Major flood or cyclonic events as seen in 2012-2013 and 2014-2015 reporting periods, led to increased numbers of complaints due to variations in water quality leading to aesthetic changes to the drinking water supplied.

4 HAZARD IDENTIFICATION

The identification of hazards and hazardous events that have the potential to impact water quality is an ongoing process that continues to be conducted by technical, operational and managerial staff within FRW and RRC. See Section 5 below for a more detailed description of the roles of each of the participants in this process.

Table 4.1 contains a list of the specific hazards and hazardous events that have occurred or have the potential to impact water quality across drinking water schemes and provides an indication of the frequency of each event. A more detailed assessment of these hazards for each scheme including an assessment of the level of risk with and without existing or proposed controls is provided below in the section on Assessment of Risks.

Table 4.1: Hazards and Hazardous Events That Have or May Impact Drinking Water Quality

Hazards	Hazardous Events	Has Occurred? (Frequency)	Critical Controls
Catchment/Raw Water Storages			
Bacterial Pathogens	Unrestricted livestock	Yes (ongoing)	Monitoring, Multiple barriers
Protozoan Pathogens	Unrestricted livestock	Yes (ongoing)	Monitoring. Multiple barriers
Toxic cyanobacteria	Stratification, eutrophication	Yes (>1/year)	Monitoring, Multiple barriers
Viral Pathogens	Unrestricted livestock	Unknown	Multiple barriers
Toxic/Radioactive metals	Industrial Spill/Release	No	Monitoring, Multiple barriers
Toxic Pesticides/organics	Agriculture	Yes (ongoing)	Monitoring
Perfluorocarbons	Leaching from contaminated lands	Unlikely	Monitoring
High Iron and Manganese	Flow event iron and manganese rich water	Yes (ongoing)	Monitoring, Pre-treatment oxidation
High E.C. or TDS	Industrial Spill/Release; Rising Groundwater; Flood Event	Yes (>1/year)	Monitoring
Excessive Turbidity	Flood Events/Bushfire	No (>1/year)	Monitoring, Multiple barriers
Treatment			
Bacterial Pathogens	Failure of treatment barrier	Yes (<1/year)	Operator training, Operational monitoring and alarms
Protozoan Pathogens	Failure of treatment barrier	No	Operator training, Operational monitoring and alarms
Toxic cyanobacteria	Failure of treatment barrier	Yes (<1/year)	Operator training, Operational monitoring and alarms
Viral Pathogens	Failure of treatment barrier	Unknown	Operator training, Operational monitoring and alarms
Toxic Pesticide/organics	No effective treatment	Yes (ongoing)	Monitoring
High E.C. or TDS	No effective treatment	Yes (>1/year)	Monitoring
Excessive Turbidity	Failure of treatment barrier	Yes (<1/year)	Operator training, Operational monitoring and alarms
Coagulant Underdose	Equipment/process control failure	Yes (<1/year)	Maintenance, Operational monitoring and alarms
Chlorine Underdose	Equipment/process control failure	Yes (<1/year)	Maintenance, Operational monitoring and alarms
Chemical Contamination	Unapproved chemicals	No	Supply contracts, specified QA
Coagulant Overdose	Equipment/process control failure	No	Operator training, Operational monitoring, Daily chemical usage

Hazards	Hazardous Events	Has Occurred? (Frequency)	Critical Controls
			reporting
Chlorite or Chlorine Dioxide Overdose	Equipment/process control	No	Operator training, Maintenance, Operational monitoring and alarms. Ongoing sampling.
Chlorine Overdose	Equipment/process control failure	Yes (<1/year)	Maintenance, Operational monitoring and alarms
Distribution			
Bacterial Pathogens	Animal access to reservoirs	Yes (>1/year)	Inspections/ Operational monitoring and alarms for chlorine residual
Protozoan Pathogens	Animal access to reservoirs	Yes (>1/year)	Inspections/ Operational monitoring and alarms for chlorine residual
Viral Pathogens	Animal access to reservoirs	Yes (>1/year)	Inspections/ Operational monitoring and alarms for chlorine residual
Microbial pathogens	Water mains break	Yes (<1/year)	Mains break repair procedure
Discoloured water	Pipewall biofilm and sediment mobilisation	Yes (>1/year)	Chlorine residual penetration, reticulation air scouring program
No chlorine residual	Long detention time	Yes (ongoing)	Increase chlorination, operate scheme to reduce water age.
Disinfection by-products	High TOC, rechlorination, long detention time	Yes (ongoing)	Effective Treatment/Monitoring, operate scheme to reduce water age.
Chemical contamination	Sabotage, terrorism	No	Physical Security/Site Inspection
Excessive chlorination	Equipment/process control failure at rechlorination site	Yes (>5/year)	Remote monitoring with alarms, Calibration/Site Inspection
Customers Tap			
Contamination	Inappropriate plumbing	No	Compliance inspections
Contamination	Inappropriate use	No	Education Programs

5 ASSESSMENT OF RISKS

Since the preparation of the original risk assessment in the original approved DWQMP (described below) a review has been undertaken to update the risk assessment accordingly based on recent changes in risk profile due to completion of projects identified in the Risk Management Improvement Program or other events. The original risk assessment was prepared in accordance with the AS/NZS:4360 Risk Management Standard through a series of five workshops and meetings involving key FRW management, technical and operational staff working in association with the RRC Risk Management Coordinator. The following personnel are involved in the assessment and management of risks to drinking water supplies:

- Dan Toon (Manager Water & Wastewater)
- Gavin Challinor (Coordinator Mechanical, Electrical and General Maintenance)
- Paul Dean (Senior Environmental Scientist)
- Evan Davison (Coordinator Network Operations)
- Peter Kofod (General Manager Regional Services)

The Manager Water & Wastewater, in conjunction with experienced treatment plant operators) is responsible for the day-to-day operation of WTPs and other distribution infrastructure. The Senior Environmental Scientist has more than 10 years experience working with drinking water quality monitoring and has relevant tertiary qualifications. The Coordinator Network Operations has more than 10 years experience in the construction and maintenance of water and wastewater networks. The Manager Water & Wastewater has extensive experience in Risk Management in the water industry.

Appendix A contains the Likelihood and Consequence Ratings tables, the Risk Rating Matrix and an Uncertainty Ratings table that were used in to prepare this Risk Assessment.

This more public health-specific risk assessment is presented in Tables 5.1 to 5.3. These risk assessments provide a description of the key risks that have the potential to impact each drinking water scheme at the catchment, treatment plant and distribution system stages of each scheme, including, some whole of service risks that are more broadly applicable across all schemes. All risks with a Residual Risk Rating above Low are considered unacceptable. In each case Proposed Actions are listed to further mitigate these unacceptable risks. These Proposed Actions are captured in the Risk Management Improvement Program (see Section 12).

Table 5.1: Assessment of Risks with the Potential to Impact Drinking Water Quality in the Rockhampton Water Supply Scheme

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
Source, Raw Water Intake	No, low or high flow conditions in Fitzroy Barrage Storage, contamination via discharge release or access e.g. grazing livestock, industry water discharge (unprotected surface water catchment)	Bacterial pathogens	5	5	E25	• Catchment monitoring and regular inspection of river intake structure for obvious contaminating material • Stakeholder engagement towards preventing any high risk activities that might pose a threat.	3	1	L3	Confident	• Alarms in place for monitoring of raw water turbidity to alert operator of any significant changes. • No apparent change in risk during no, low or high flow events.	R01
		Protozoan pathogens	5	3	H15	• Catchment monitoring and regular inspection of river intake structure for obvious contaminating material • Stakeholder engagement towards preventing any high risk activities that might pose a threat.	3	1	L3	Reliable	• Alarms in place for monitoring of raw water turbidity to alert operator of any significant changes. • No *Cryptosporidium* or *Giardia* detected in GWTP raw or final water in the last 8 years. • No apparent change in risk during no, low or high flow events.	R02
		Toxic cyanobacteria	5	3	H15	• Catchment monitoring to detect toxic blooms. • Variable depth intake to avoid surface scum during bloom events. • Pre-treatment chlorination available to destroy toxic cyanobacteria. • Powdered activated carbon dosing if required to remove toxins.	3	1	L3	Reliable	• Cyanobacteria season highly dependent on river flow season and origin of flows in the upper catchments. • Good engagement with local university to keep up to date with latest local research on cyanobacteria in the catchment.	R03
		Viral pathogens	5	4	E20	• Catchment monitoring and regular inspection of river intake structure for obvious contaminating material • Stakeholder engagement towards preventing any high risk activities that might pose a threat.	3	1	L3	Reliable (based on chlorination performance)	• Alarms in place for monitoring of raw water turbidity to alert operator of any significant changes. • No apparent change in risk during no, low or high flow events.	R04
		Toxic or Radioactive Metals	5	1	M6	• Catchment monitoring and regular inspection of river intake structure for obvious contaminating material • Stakeholder engagement towards preventing any high risk activities that might pose a	3	1	L3	Reliable	• Constant engagement with other Fitzroy Basin stakeholders about water quality. • No metals or radioisotopes detected at concentrations close to ADWG in last 3 years.	R05

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
						threat. • Pre-treatment oxidation available if required						
		High Iron and Manganese	3	2	M6	• Catchment and raw water monitoring • Pre-treatment oxidation with chlorine gas or chlorine dioxide is available if required	3	1	L3	Reliable	• Fitzroy River raw water does not usually contain high iron and manganese. • This event only occurs during major flooding events	R06
		Toxic Pesticides or Organics	5	1	M6	• Pre-treatment chlorination using chlorine gas or chlorine dioxide is available to oxidise organics and pesticides if required. • Powdered activated carbon dosing if required to remove soluble compounds	3	1	L3	Reliable	• Constant discussion with other Fitzroy Basin stakeholders about water quality. • No pesticides detected at concentrations close to ADWG in last 8 years	R07
		Excessive E.C. or TDS	3	4	H12	• Stakeholder engagement and catchment monitoring. • No additional controls and no effective treatment process	3	3	M9	Confident	• The combination of natural and artificial inputs of E.C. and sodium has led to the possibility that raw water will become unacceptable quality for treatment using conventional processes. • **Proposed action: continue to lobby regulator for tighter water quality limits on mine water discharges.**	R08
		Excessive Turbidity	3	2	M6	• On-line analysis of raw water turbidity with alarms in place to alert operator of significant changes in turbidity. • Robust treatment plant and treatment process design. • Stakeholder engagement and upstream monitoring of flow events.	2	1	L2	Confident	• GWTP capable of 4-log removal of turbidity and can handle raw water >2000 NTU.	R09
Treatment, Multiple Barriers, Process Control	Failure of Treatment Barrier, Lack of effective treatment, Process control failure	Bacterial pathogens	5	5	E25	• Coagulation/sedimentation barrier with on-line monitoring of turbidity pre-filtration to assess effectiveness. • Filtration performance closely monitored to backwash at >0.2 NTU. • Filter to waste valves used for ripening of filters after backwash to ensure turbidity	3	1	L3	Confident	• Alarms in place for monitoring of turbidity pre- and post-filtration to ensure process effectiveness. • Alarms also in place to ensure effective chlorine residual achieved in clear water reservoirs. • Individual filter turbidity rarely above 0.3 NTU. • No *E. coli* detected in GWTP final water in the last 8 years.	R10

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
						<0.2 NTU. • Gas chlorination closely monitored to ensure effective disinfection.					• No difference in performance during no, low or high flow events.	
		Protozoan pathogens	5	3	H15	• Coagulation/sedimentation barrier with on-line monitoring of turbidity pre-filtration to assess effectiveness. • Filtration performance closely monitored to backwash at >0.2 NTU. • Filter to waste valves used for ripening of filters after backwash to ensure turbidity <0.2 NTU.	3	1	L3	Reliable	• Alarms in place for monitoring of turbidity pre and post filtration to ensure process effectiveness. • Filter to waste valves prevent turbidity spikes following backwash. • Individual filter turbidities rarely above 0.3 NTU. • No *Cryptosporidium* or *Giardia* detected in GWTP raw or final water in the last 8 years. • No difference in performance during no, low or high flow events.	R11
		Toxic cyanobacteria	5	3	H15	• Coagulation/sedimentation barrier with on-line monitoring of turbidity pre-filtration to assess effectiveness. • Pre-coagulation chlorination available to destroy toxic cyanobacteria. • Powdered activated carbon dosing if required to remove toxins.	3	1	L3	Reliable	• Effective removal of *Cylindrospermopsis raciborskii* using sedimentation and filtration validated at GWTP. • Increased coagulant dose very effective under high bloom conditions. • Very little if any penetration of cyanobacteria through to final water during blooms events over the last 5 years.	R12
		Viral pathogens	5	4	E20	• Coagulation/sedimentation barrier with on-line monitoring of turbidity pre-filtration to assess effectiveness. • Filtration performance closely monitored to backwash at >0.2 NTU. • Filter to waste valves used for ripening of filters after backwash to ensure turbidity <0.2 NTU. • Gas chlorination closely monitored to ensure effective disinfection.	3	1	L3	Reliable (based on chlorination performance)	• Alarms in place for monitoring of turbidity pre- and post-filtration to ensure process effectiveness. • Alarms also in place to ensure effective chlorine residual achieved in clear water reservoirs. • Individual filter turbidities rarely above 0.3 NTU. • No difference in performance during no, low or high flow events.	R13
		Toxic or Radioactive Metals	5	1	M6	• Coagulation/sedimentation barrier with on-line monitoring of turbidity pre-filtration to assess effectiveness.	3	1	L3	Reliable	• Constant discussion with other Fitzroy Basin stakeholders about water quality. • No metals or radioisotopes detected at concentrations close to ADWG in last 3	R14

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
											years. • Very effective sedimentation process with 4-log turbidity removal.	
		Toxic Pesticides or Organics	5	1	M6	• Pre-coagulation chlorination available to oxidise organics and pesticides if required. • Powdered activated carbon dosing if required to remove soluble compounds.	3	1	L3	Reliable	• Constant discussion with other Fitzroy Basin stakeholders about water quality. • No pesticides detected at concentrations close to ADWG in last 8 years.	R15
		Excessive E.C. or TDS	3	4	H12	• Stakeholder engagement and catchment monitoring. • No additional controls and no effective treatment process	3	1	L3	Confident	• The combination of natural and artificial inputs of E.C. and sodium has led to the possibility that raw water will become unacceptable quality for treatment using conventional processes.	R16
		Excessive Turbidity	3	2	M6	• Robust treatment plant and treatment process design. • Coagulation/sedimentation barrier with on-line monitoring of turbidity pre-filtration to assess effectiveness. • Filtration performance closely monitored to backwash at >0.2 NTU. • Filter to waste valves used for ripening of filters after backwash to ensure turbidity <0.2 NTU.	2	1	L2	Confident	• GWTP capable of 4-log removal of turbidity and can handle raw water >2000 NTU. • In addition, the sedimentation and filtration processes and their controls are reliable and robust.	R17
	Equipment or Process control failure, Chemical underdosing	Coagulant Underdose	4	3	H12	• Coagulation/sedimentation barrier with on-line monitoring of turbidity pre-filtration to assess effectiveness. • Filtration performance closely monitored to backwash at >0.2 NTU. • Duty/Standby dosing pumps available	2	2	L4	Reliable	• The on-line turbidity analysis has alarms set to alert operator to any problems with effectiveness of sedimentation process and possible coagulant underdosing. • The PACL coagulant is a very effective product and not readily susceptible to underdosing issues	R18
		Chlorine Underdose	5	3	H15	• Duplicate on-line chlorine analysers used to monitor effectiveness of chlorine dosing with low and low low alarms to alert of possible underdosing • Duty/Standby chlorinators in place	3	1	L3	Confident	• The robust design and good performance of the filtration and disinfection systems at the GWTP as well as the relevant SCADA alarms being in place provide good management of this risk	R19

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
	Contaminated chemicals, Use of unapproved treatment chemical	Toxic Metals, Toxic Chemicals	5	1	M6	• Chemical supply contracts in place with stringent quality assurance and chemical analysis specifications required.	3	1	L3	Reliable	• Low chemical dose rates and the associated monitoring and daily checking of chemical usage generally prevents any inadvertent overdosing of chemicals that may lead to water quality problems.	R20
	Equipment or Process control failure, Chemical overdosing	Coagulant Overdose	3	3	M9	• Trained operators and on-line monitoring of process performance alerts operator of possible overdose • Daily reporting of chemical consumption helps operator to identify potential overdosing • Verification monitoring used to check for any overdosing of coagulant leading to high aluminium in potable water	3	1	L3	Confident	• The PACL coagulant used at GWTP allows for effective treatment at lower aluminium concentrations than alum sulphate helping to avoid any possible impacts from overdosing. • Verification monitoring data shows no evidence of any significant overdosing events leading to high aluminium in potable water.	R21
		Fluoride Overdose	4	2	M8	• PLC interlocks to shutdown fluoride dosing prior to achieving harmful dose. • High concentration alarms to warn operator of potential problem. • Redundancy of flow metering and on-line analysis for fluoride.	3	1	L3	Reliable	• Fluoride dosing system PLC separate to main WTP PLC and operates independently. • High concentration alarms and daily manual testing and instrument calibration help to reduce the risk of any problems associated with high dosing or incorrect fluoride concentration measurements.	R22
		Chlorine Overdose	4	2	M8	• PLC interlocks to shutdown chlorine dosing and highlift pump station prior to achieving harmful dose. • High concentration alarms to warn operator of potential problem. • Redundancy of on-line analysis for chlorine.	3	1	L3	Confident	• GWTP high chlorine interlock shuts the WTP highlift pumps down before free chlorine residual exceeds 2.0 mg/L. • High concentration alarms and daily manual testing and instrument calibration help to reduce the risk of any problems associated with high dosing or incorrect chlorine concentration measurements.	R23
Distribution system, trunk infrastructure, reservoirs, reticulation.	Contamination due to animals accessing reservoirs.	Bacterial Pathogens	5	3	H15	• Automated rechlorination or manual rechlorination at most reservoirs. • Appropriate roof design to prevent animal access or contaminant entry via roof run-off (except Mt Charlton Reservoir). • Regular inspection program to	4	1	M5	Reliable	• Automated rechlorination maintains >0.5 mg/L free chlorine with a setpoint target of 1.0 mg/L. • Remote monitoring and low level alarms used to identify and rectify any dosing faults. • Standard roof design being specified for all new reservoirs to prevent animal ingress.	R24

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
						check reservoir integrity and measure free chlorine residual. • Reliable rechlorination with alarms to indicate dosing faults.					• **Proposed action: repair and/or replace roof of identified high risk reservoirs to prevent animal access or contaminant entry via roof run-off** **Proposed action: install remote monitoring on manually re-chlorinated reservoirs to allow continuous free chlorine residual monitoring and alarming to alert operator of underdosing**	
		Protozoan Pathogens	5	3	H15	• Appropriate roof design to prevent animal access or contaminant entry via roof run-off. • Regular inspection program to check reservoir integrity	3	1	L3	Reliable	• Standard roof design being specified for all new reservoirs to prevent animal ingress.	R25
		Viral Pathogen	5	3	H15	• Automated rechlorination or manual rechlorination at all reservoirs. • Appropriate roof design to prevent animal access or contaminant entry via roof run-off (except Mt Charlton Reservoir). • Regular inspection program, Reliable rechlorination with alarms to indicate dosing faults.	4	1	M5	Reliable (Based on chlorination performance)	• Automated rechlorination maintains >0.5 mg/L free chlorine with a setpoint target of 1.0 mg/L. • Remote monitoring and low level alarms used to identify and rectify any dosing faults. • Standard roof design being specified for all new reservoirs to prevent animal ingress. • **Proposed action: repair and/or replace roof of identified high risk reservoirs to prevent animal access or contaminant entry via roof run-off** **Proposed action: install remote monitoring on manually re-chlorinated reservoirs to allow continuous free chlorine residual monitoring and alarming to alert operator of underdosing**	R26
	Contamination via water mains break or reservoir maintenance activity	Microbial Pathogens	5	4	E20	• Procedures in place to minimise the entry of contaminating material into broken water mains or reservoirs during reactive or planned maintenance activities. • Chlorination and flushing carried out as part of these procedures.	3	1	L3	Reliable	• Procedures are based on AWWA methods for chlorination of water mains and reservoirs to ensure effective disinfection.	R27
	Increased water age,	Excessive disinfection	3	3	M9	• Effective treatment processes to remove organic carbon,	3	1	L3	Reliable	• This hazard is somewhat subject to the prevailing scientific literature, or the	R28

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
	multiple rechlorination and high total organic carbon	by-products				reticulation monitoring for disinfection by-product formation. • Use of modelling to manage water age. • Use of chlorine dioxide to oxidise organic carbon and reduce chlorine usage					perception of risk based on health guideline values which vary significantly around the world. • Efforts are continuing to keep up to date with changes in strategies to prevent or manage disinfection by-product formation.	
	Increased water age due to long pipelines and lack of nearby rechlorination	No chlorine residual leads to unsafe water	4	4	H16	• Increased chlorination where required to boost penetration of residual • System operation optimised to reduce water age and aid in residual penetration	3	1	L3	Reliable	• Most of the reticulation consistently receives water with free chlorine residual >0.2 mg/L, however, this level of protection is not likely to provide an effective barrier against significant quantities of contaminating material.	R29
	Act of sabotage or terrorism	Toxic agent	5	2	M6	• Adequate physical security and regular site inspection program. • Internal tracking of security keys. • Some CCTV at sites with higher risk of unauthorised access.	4	1	M5	Reliable	• Signage, physical security and CCTV upgrades were made at various reservoirs to prevent unauthorised access, but are unlikely to be effective against a deliberate act of sabotage or terrorism.	R30
	Equipment or Process control failure at reservoir rechlorination site	Chlorine Underdose	4	3	H12	• Remote monitoring using on-line chlorine analysers with low and low low alarms to trigger rectification action • Duty/Standby dosing pumps and critical spares kept • Regular equipment servicing and regular monitoring and calibration of chlorine on-line analysers.	3	1	L3	Reliable	• These measures listed here as well as the focus placed on regular inspection of reservoirs to prevent animal access and contamination provides good management of this risk.	R31
		Chlorine Overdose	4	2	M8	• High alarms on chlorine residual concentrations to trigger rectification action, • Regular equipment servicing and regular monitoring and calibration of chlorine on-line analysers.	3	1	L3	Reliable	• Maintaining a regular inspection and calibration program is an essential part of ensuring that the on-line analysers read correctly and prevent any over-dosing of chlorine.	R32
Customers Tap	Contamination via backflow or cross connection	Microbial pathogens	5	2	H10	• Good penetration of free chlorine residual to most parts of the reticulation, • Plumbing Inspection team to ensure plumbing and network	3	1	L3	Reliable	• Most of the reticulation consistently receives water with free chlorine residual >0.2 mg/L, however, this level of protection is not likely to provide an effective barrier against significant	R33

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
						assets are constructed to meet legislative and standard requirements.					quantities of contaminating material. • Prevention using backflow prevention devices or good regulation is the preferred approach.	

Table 5.2: Assessment of Risks with the Potential to Impact Drinking Water Quality in the Mount Morgan Water Supply Scheme

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
Source, Raw Water Intake	No, low or high flow conditions in No.7 Dam, contamination via discharge release or access e.g., grazing livestock, (unprotected surface water catchment)	Bacterial pathogens	5	5	E25	• Catchment for No.7 Dam relatively undisturbed and well forested, however, still technically an unprotected surface water storage • Catchment monitoring and on-line raw water turbidity monitoring alerts operator to changes in turbidity. • Gas chlorination closely monitored manually to ensure effective disinfection.	3	1	L3	Reliable	• Raw water turbidity rarely above 10 NTU throughout periods with no flow in the Dee River. • No *E. coli* detected in WWTP final water in the last 8 years.	MM01
		Protozoan pathogens	5	3	H15	• Catchment for No.7 Dam relatively undisturbed and well forested, however, still technically an unprotected surface water storage. • Catchment monitoring and on-line raw water turbidity monitoring alerts operator to changes in turbidity.	3	1	L3	Reliable	• Raw water turbidity rarely above 10 NTU throughout periods with no flow in the Dee River. • No *Cryptosporidium* or *Giardia* detected in MMWTP raw or final water in the last 8 years.	MM02
		Toxic cyanobacteria	5	3	H15	• Catchment monitoring to detect toxic blooms. • Pre-treatment chlorination possible if required to destroy cyanobacteria • Some ability to vary the intake depth at No.7 Dam to avoid surface scums.	3	1	L3	Reliable	• Cyanobacteria have not posed a significant issue in No. 7 Dam during the last 3 years.	MM03
		Viral pathogens	5	4	E20	• Catchment for No.7 Dam relatively undisturbed and well forested, however, still technically an unprotected surface water storage. • Catchment monitoring and on-line raw water turbidity monitoring alerts operator to changes in turbidity. • Sedimentation and filtration barriers are generally quite reliable although improved performance is being targeted.	3	1	L3	Estimate	• Raw water turbidity rarely above 10 NTU throughout periods with no flow in the Dee River.	MM04

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
		Toxic or Radioactive Metals	5	1	M6	• Catchment for No.7 Dam relatively undisturbed and well forested, however, still technically an unprotected surface water storage. • Catchment monitoring program provides indication of changes to raw water quality	3	1	L3	Reliable	• No metals or radioisotopes detected at concentrations close to ADWG in last 3 years.	MM05
		High Iron and Manganese	3	2	M6	• Catchment monitoring program provides indication of changes to raw water quality • Pre-treatment oxidation available if required	3	1	L3	Reliable	• Although No. 7 Dam raw water can have periodic increases in levels of iron and manganese, MMWTP potable water has consistently concentrations of iron and manganese beneath ADWG aesthetic guidelines.	MM06
		Toxic Pesticides or Organics	5	1	M6	• Catchment for No.7 Dam relatively undisturbed and well forested, however, still technically an unprotected surface water storage. • Catchment monitoring program provides indication of changes to raw water quality • Pre-treatment chlorination available to oxidise organics and pesticides if required. • Powdered activated carbon dosing if required to remove soluble compounds	3	1	L3	Reliable	• No pesticides detected at concentrations close to ADWG in last 5 years.	MM07
		Excessive E.C. or TDS	3	3	M9	• Catchment monitoring program provides indication of changes to raw water quality • Naturally high background E.C. and TDS in raw water means that customers are used to this water quality.	3	1	L3	Confident	• Raw water E.C. and TDS average 227 µS/cm and 271 mg/L respectively.	MM08
		Excessive Turbidity	3	2	M6	• Catchment monitoring program provides indication of changes to raw water quality • On-line monitoring of raw water turbidity with alarms to alert of any large increases in turbidity	2	1	L2	Reliable	• Raw water turbidity rarely above 10 NTU throughout periods with no flow in the Dee River. •	MM09

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
Fletchers Creek Emergency Source, Raw Water Intake (all hazards except for Iron and Manganese as per above for No.7 Dam)	No, low or high flow conditions in No.7 Dam, contamination via discharge release or access e.g., grazing livestock, (unprotected surface water catchment)	High Iron and Manganese	3	4	H12	• Catchment monitoring program provides indication of current raw water quality • Source water only used in an emergency which is very unlikely • Pre-treatment oxidation available to assist with iron and manganese removal	3	1	L3	Estimate	• With the storage capacity in No.7 much greater than in previous years when Fletchers Creek was more commonly used, it is unlikely that this water source will be used again. • Nevertheless monitoring and infrastructure maintenance continues should the need arise to use this water source.	MM10
Tankered Potable Water Emergency Source	No, low or high flow conditions in No.7 Dam and Fletchers Creek	High Total Organic Carbon; Objectionable taste and/or odour	3	1	L3	• Catchment monitoring program provides indication of changes to raw water quality • Powdered activated carbon dosing to remove soluble compounds • Tankered potable water delivered post filtration to blend with treated water or as a 100% emergency water source	2	1	L2	Estimate (Contracts with bulk potable water carriers commenced in April 2021)	• Total organic carbon (TOC) and cyanobacteria data during the last 5 years are available to provide better understanding of raw water changes when No. 7 Dam's supply dwindles to very low levels. • Newly installed tankered water inlet butterfly valve to enable approved potable tankers to deliver water post filtration	MM11
Treatment, Multiple Barriers, Process Control	Failure of Treatment Barrier, Lack of effective treatment, Process control failure	Bacterial pathogens	5	5	E25	• Coagulation/sedimentation and filtration barriers reasonably reliable and effective. • Gas chlorination closely monitored manually to ensure effective disinfection. • UV disinfection installed with an online monitoring to measure UV intensity and ensure system performance.	3	1	L3	Reliable	• Alarms in place for monitoring of turbidity post-filtration to ensure process effectiveness.	MM12
		Protozoan pathogens	5	3	H15	• Coagulation/sedimentation and filtration barriers reasonably reliable and effective. • On-line analysis of filtered water turbidity with alarms in place to alert operator of poor performance. • UV disinfection installed with an online monitoring to	3	1	L3	Reliable	• Alarms and process interlocks in place for monitoring of turbidity post filtration to help optimise and control sedimentation and filtration performance.	MM13

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
						measure UV intensity and ensure system performance.						
		Toxic cyanobacteria	5	3	H15	• Coagulation/sedimentation and filtration barriers reasonably reliable and effective. • On-line analysis of filtered water turbidity with alarms in place to alert operator of poor performance. • Pre-coagulation chlorination available if required to destroy toxic cyanobacteria. • Powdered activated carbon dosing if required to remove toxins. • UV disinfection system installed with an online monitoring UV intensity to ensure system performance.	3	1	L3	Reliable	• **Alarms and interlocks**	MM14
		Viral pathogens	5	4	E20	• Coagulation/sedimentation and filtration barriers reasonably reliable and effective. • Installed on-line analysis of filtered water turbidity with alarms in place to alert operator of poor performance. Automated gas chlorination to ensure effective disinfection. •	4	2	M8	Reliable (Based on chlorination and filtration performance)	• Alarms in place to ensure effective free chlorine residual is achieved in the clear water reservoir. • Alarms in place for monitoring of turbidity post-filtration to ensure process effectiveness. • Process interlocks in place to stop WTP operation if treated or final water turbidity exceeds 1 NTU for 15 min or if free chlorine residual is <0.5 mg/L for 15 min. • **Proposed action: perform testing for viruses for further confirmation of process effectiveness.**	MM15
		Toxic or Radioactive Metals	5	1	M6	• Coagulation/sedimentation and filtration barriers reasonably reliable and effective. • Catchment for No.7 Dam relatively undisturbed and well forested, however, still technically an unprotected	3	1	L3	Reliable	• No metals or radioisotopes detected at concentrations close to ADWG in last 3 years.	MM16

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
						surface water storage.						
		Toxic Pesticides or Organics	5	1	M6	• Pre-coagulation chlorination available to oxidise organics and pesticides if required. • Powdered activated carbon dosing if required to remove soluble compounds. • Catchment for No.7 Dam relatively undisturbed and well forested, however, still technically an unprotected surface water storage.	3	1	L3	Reliable	• No pesticides detected at concentrations close to ADWG in last 5 years.	MM17
		Excessive E.C. or TDS	3	2	M6	• On-line monitoring of raw water and final water E.C. used to alert operator of changes to water quality.	3	1	L3	Reliable	• Customers are historically adapted to periods of potable water having elevated E.C. and TDS. • There does not appear to be any need to further reduce this risk.	MM18
		Excessive Turbidity	4	2	M8	• Coagulation/sedimentation and filtration barriers reasonably reliable and effective. • On-line water quality analysis of raw and filtered water provides operational monitoring of barrier effectiveness • Filter refurbishment and media replacement • UV disinfection system installed with an online monitoring UV intensity to ensure system performance.	3	1	L3	Reliable	• On-line monitoring of filtration performance and filtered water turbidity with alarms to alert operator or any reduced performance	MM19
	Process failure leads to sludge return to inlet of WTP from sludge lagoons	Excessive Turbidity	4	2	M8	• Return of supernatant from sludge lagoons is a fully manual process that is monitored visually to prevent sludge draw-off • Automated process interlocked with WTP operation very low flow only	3	1	L3	Reliable	• Manual process reliable but further risk mitigation possible.	MM20
	Equipment or Process control failure, Chemical	Coagulant Underdose	4	3	H12	• On-line water quality analysis of raw and filtered water provides operational monitoring of barrier	3	1	L3	Reliable	• The on-line turbidity analysis has alarms set to alert operator to any problems with effectiveness of sedimentation process and	MM21

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
	underdosing					effectiveness • Duty/Standby dosing pumps available • PLC interlocks to shutdown the WTP process in the event of chemical dosing failure.					possible coagulant underdosing. • Coagulant dosing using liquid alum for online flow metering and better measurement of chemical usage commenced in April 2018.	
		Chlorine Underdose	5	3	H15	• Automated gas chlorination installed with good on-line monitoring and control • Alarms generated if chlorine dosing problem with remote monitoring of system to detect any issues.	3	1	L3	Reliable	• System highly effective with chlorine residual typically between 1 and 1.5 mg/L with a long contact time in the clear water reservoir.	MM22
	Contaminated chemicals, Use of unapproved treatment chemical	Toxic Metals, Toxic Chemicals	5	1	M6	• Chemical supply contracts in place with stringent quality assurance and chemical analysis specifications required.	3	1	L3	Reliable	• Verification monitoring data shows no evidence of any overdosing events leading to reduce quality potable water.	MM23
	Equipment or Process control failure, Chemical overdosing	Coagulant Overdose	3	3	M9	• Trained operators and on-line monitoring of process parameters such as pH alerts operator to possible overdose • Daily reporting of chemical consumption helps operator to identify potential overdosing • Verification monitoring used to check for any overdosing of coagulant leading to high aluminium in potable water	3	1	L3	Confident	• Verification monitoring data shows no evidence of any significant overdosing events leading to high aluminium in potable water. • Coagulant dosing using liquid alum for online flow metering and better measurement of chemical usage commenced in April 2018.	MM24
		Chlorine Overdose	4	2	M8	• Automated gas chlorination installed with good on-line monitoring and control • Alarms generated if chlorine dosing problem with remote monitoring of system to detect any issues.	3	1	L3	Reliable	• System highly effective with chlorine residual typically between 1 and 1.5 mg/L with a long contact time in the clear water reservoir. •	MM26
		Microbial Pathogen,	5	1	M6	• Bulk potable water cartage contracts in place with	2	1	L2	Estimate (Contracts with	• Dedicated filling point thru an inlet butterfly valve located post	MM27

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
		Toxic Agent				stringent quality assurance specifications. • Contractor site induction and supervision • Specified potable water filling areas in parts of the RWSS network.				bulk potable water carriers commenced in April 2021)	filtration and pre-disinfection Carted potable water is disinfected with chlorine gas as it enters the clear water reservoir	
	Contamination due to delivery of tankered water	Bacterial Pathogens	5	3	H15	• Automatic rechlorination with on-line monitoring. • Appropriate roof design to prevent animal access or contaminant entry via roof run-off. • Regular inspection program to check reservoir integrity and measure free chlorine residual.	4	1	M5	Reliable	• Standard roof design specified for North Street Reservoir to prevent animal ingress. Automated rechlorination maintains >0.5 mg/L free chlorine with a setpoint target of 1.0 mg/L. • Remote monitoring and low level alarms used to identify and rectify any dosing faults. • **Proposed action: repair and/or replace Black Street Reservoir roof to prevent animal access or contaminant entry via roof run-off**	MM28
Distribution system, trunk infrastructure, reservoirs, reticulation.	Contamination due to animals accessing reservoirs.	Protozoan Pathogens	5	3	H15	• Appropriate roof design to prevent animal access or contaminant entry via roof run-off. • Regular inspection program to check reservoir integrity	3	1	L3	Estimate	• Standard roof design specified for North Street Reservoir to prevent animal ingress. • Automated rechlorination maintains >0.5 mg/L free chlorine with a setpoint target of 1.0 mg/L. • Remote monitoring and low level alarms used to identify and rectify any dosing faults.	MM29
		Viral Pathogen	5	3	H15	• Automatic rechlorination with on-line monitoring. • Appropriate roof design to prevent animal access or contaminant entry via roof run-off. • Regular inspection program to check reservoir integrity and measure free chlorine residual.	4	1	M5	Estimate	• Standard roof design specified for North Street Reservoir to prevent animal ingress. • Automated rechlorination maintains >0.5 mg/L free chlorine with a setpoint target of 1.0 mg/L. • Remote monitoring and low level alarms used to identify and rectify any dosing faults. **Proposed action: repair and/or replace Black Street Reservoir roof to prevent animal access or contaminant entry via roof run-off**	MM30

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
		Microbial Pathogens	5	4	E20	• Procedures in place to minimise the entry of contaminating material into broken water mains or reservoirs during reactive or planned maintenance activities. • Chlorination and flushing carried out as part of these procedures. •	3	1	L3	Reliable	• Procedures are based on AWWA methods for chlorination of water mains and reservoirs to ensure effective disinfection.	MM31
	Contamination via water mains break or reservoir maintenance activity	Excessive disinfection by-products	3	3	M9	• Effective treatment processes to remove organic carbon, reticulation monitoring for disinfection by-product formation. • Use of modelling to manage water age.	3	1	L3	Reliable	• This hazard is somewhat subject to the prevailing scientific literature or the perception of risk based on health guideline values which vary significantly around the world. • Efforts are continuing to keep up to date with changes in strategies to prevent or manage disinfection by-product formation.	MM32
	Increased water age, multiple rechlorination and high total organic carbon	Objectionable taste and/or odour	3	1	L3	• Effective treatment processes to remove organic carbon and reticulation monitoring • Strategic flushing of mains • Tankered potable water to blend with existing water supply or as a 100% water source	2	1	L2	Reliable	• Newly installed tankered water inlet butterfly valve to enable approved potable tankers to deliver water to Mount Morgan WTP	MM33
		Objectionable taste and/or odour	3	1	L3	• Effective treatment processes to remove organic carbon and reticulation monitoring • Strategic flushing of mains • Tankered potable water to blend with existing water supply or as a 100% water source	2	1	L2	Reliable	• Newly installed tankered water inlet butterfly valve to enable approved potable tankers to deliver water to Mount Morgan WTP	MM34
	Increased water age due to long pipelines and lack of nearby rechlorination	No chlorine residual leads to unsafe water	4	4	H16	• Increased chlorination where required to boost penetration of residual • System operation optimised to reduce water age and aid in residual penetration	3	1	L3	Reliable	• The reticulation consistently receives water with free chlorine residual >0.2 mg/L, however, this level of protection is not likely to provide an effective barrier against significant quantities of contaminating material.	MM35

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
	Act of sabotage or terrorism	Toxic agent	5	2	M6	• Adequate physical security and regular site inspection program. • Internal tracking of security keys.	4	1	M5	Reliable	• Signage, physical security and CCTV help to prevent unauthorised access, but are unlikely to be effective against a deliberate act of sabotage or terrorism. • Funding approved to install CCTV at high risk sites with completion December 2023. • Access to all areas to be upgraded to Authorised Swipe Card with completion December 2023	MM36
		Chlorine Underdose	4	3	H12	• Remote monitoring using on-line chlorine analysers with low and low low alarms to trigger rectification action • Duty/Standby dosing pumps and critical spares kept • Regular equipment servicing and regular monitoring and calibration of chlorine on-line analysers.	3	1	L3	Reliable	• These measures listed here as well as the focus placed on regular inspection of reservoirs to prevent animal access and contamination provides good management of this risk.	MM37
	Equipment or Process control failure at reservoir rechlorination site	Chlorine Overdose	4	2	M8	• High alarms on chlorine residual concentrations to trigger rectification action, • Regular equipment servicing and regular monitoring and calibration of chlorine on-line analysers.	3	1	L3	Reliable	Maintaining a regular inspection and calibration program is an essential part of ensuring that the on-line analysers read correctly and prevent any over-dosing of chlorine.	MM38
	Mobilisation of Pipewall Biofilm or Sediments	Discoloured Water	3	4	H12	• Increased free chlorine residual penetration through distribution system • Air scouring program to clear reticulation 'hot spots'	2	2	L4	Reliable	The air scouring program has been shown to be effective where applied to date. This work will continue as required.	MM39
Customers Tap	Contamination via backflow or cross connection	Microbial pathogens	5	2	H10	• Good penetration of free chlorine residual to most parts of the reticulation, • Plumbing Inspection team to ensure plumbing and network assets are constructed to	3	1	L3	Reliable	• Most of the reticulation consistently receives water with free chlorine residual >0.2 mg/L, however, this level of protection is not likely to provide an effective barrier against significant quantities of	MM40

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
						meet legislative and standard requirements.					contaminating material. • Prevention using backflow prevention devices or good regulation is the preferred approach.	

Table 5.3: Assessment of Whole of Service Risks with the Potential to Impact Drinking Water Quality in Each Drinking Water Scheme

Scheme Component	Hazardous Event	Hazard	CR	LH	IRR	Existing Preventative Measure/Barrier	CR	LH	RRR	Uncertainty	Comment/Proposed Further Risk Mitigation	Risk No.
Whole of Service	Extended Loss of Power to Infrastructure	No chlorine dosing at Reservoir Rechlorination Sites	4	3	H12	• Hypochlorite in stock for manual dosing if required • Portable pumping systems available to pump hypochlorite	3	1	L3	Reliable	• In an extended power outage scenario, mobile gensets would be used if required to assist with operation of rechlorination sites	W01
		Inability to Treat Water to Potable Standard	4	3	H12	• Emergency Genset at GWTP. • 3-5 days storage in reservoirs for emergency supply	3	1	L3	Reliable	• In a power outage all electrical systems would stop including pumps resulting in untreated water not entering distribution system	W02
	Loss of Radio Telemetry	Unsafe exceedances not detected	4	3	H12	• Rapid response to reinstate telemetry, communications links • Most critical systems have localised control if comms are lost • Critical spares kept for all communications systems	3	1	L3	Reliable	• Highly trained competent staff available internally to attend to communications faults	W03
	Lack of qualified and competent staff	Poor decision making, low competency leads to unsafe practices	4	3	H12	• Training provided as appropriate to relevant staff • Exposure of staff to industry events and technical developments	3	1	L3	Reliable	• Attracting suitably qualified staff will always prove to be somewhat of a challenge	W04
	Lack of availability of chemical supplies	Critical chemical processes cease leading to unsafe water	4	3	H12	• Backup stocks and storages for critical treatment chemicals • Alarms on storage vessels to indicate when they need restocking • Good chemical supply contracts	3	1	L3	Reliable	• Regular checking of chemical inventories done to ensure chemical availability.	W05
	No information management system	Loss of important information	4	3	H12	• Manual document system in place • Electronic archiving in use	3	1	L3	Reliable	• Continuous improvement is undertaken through revision of critical information	W06
	Internal or External Cyberattack of SCADA	Loss of Process or Water Quality Control	4	3	H12	• Secure SCADA Architecture post vulnerability assessment • Regular system checks • Mirror back-up off-site for reboot	3	1	L3	Reliable	Physical security continually upgraded at key sites to control and monitor access. FRW under took a vulnerability assess again at the end of last year using a company call Cyber CX. The outcome of this assessment was that we had to harden our software system and implement a cyber white listing (work completed by Honeywell)	W07

6 MANAGING RISKS

The assessment of risks for each drinking water scheme and the whole of service risks outlined above also provide a description of the existing risk treatments that minimise the risk posed by each hazard or hazardous event. The existing risk treatments include (but are not limited to), Operation and Maintenance (O&M) Manuals and procedures, water quality monitoring programs, preventative maintenance programs, redundancy in design, critical spares inventory, stringent quality assurance specifications in chemical supply and bulk water supply contracts, physical security, inspection programs, staff training and awareness, on-line monitoring and SCADA alarming, multiple treatment barriers, stakeholder engagement and asset management planning. These risk treatments are described in more detail in the following sections of the DWQMP. A number of risks continue to have an unacceptable albeit only moderate Residual Risk Rating. These risks and the proposed additional treatments are described in Table 6.1.

6.1 Unacceptable Risks to Drinking Water Quality

Of the 79 individual risks that were rated, 8 of the risks were considered to be unacceptable levels of risk as they have a moderate Residual Risk Rating (see Table 6.1). Proposed Actions have been identified to further mitigate each risk. The Proposed Actions being taken to mitigate these unacceptable risks form part of the Risk Management Improvement Program (see Section 12).

Table 6.1: Unacceptable Risks Identified from Risk Assessments and Proposed Treatments

Risk No.	Component-Event-Hazard	RRR	Proposed Action
Rockhampton Water Supply Scheme			
R08	Source – Contamination of raw water Excessive E.C. or TDS	**M9**	Continue to lobby regulator for tighter water quality limits on mine water discharges.
R24	Reservoir – Contamination due to animals accessing reservoirs Bacterial Pathogen	**M5**	Repair and/or replace roof of identified high risk reservoirs to prevent animal access or contaminant entry via run-off; Install remote monitoring on manually re-chlorinated reservoirs to allow for continuous free chlorine residual monitoring and alarming to alert operator of underdosing
R26	Reservoir – Contamination due to animals accessing reservoirs Viral Pathogen	**M5**	Repair and/or replace roof of identified high risk reservoirs to prevent animal access or contaminant entry via run-off; Install remote monitoring on manually re-chlorinated reservoirs to allow for continuous free chlorine residual monitoring and alarming to alert operator of underdosing
R30	Distribution – Sabotage or Terrorism Toxic agent	**M5**	Identify high risk sites and install CCTV at these sites.
Mount Morgan Water Supply Scheme			
MM15	Treatment – Lack of effective treatment Viral Pathogen	**M8**	Perform testing for viruses for further confirmation of process effectiveness.
MM28	Reservoir – Contamination due to delivery of tankered water Bacterial Pathogen	**M5**	Repair and/or replace Black Street Reservoir roof to prevent animal access or contaminant entry via roof run-off
MM30	Reservoir – Contamination due to animals accessing reservoirs	**M5**	Repair and/or replace Black Street Reservoir roof to prevent animal access or contaminant

Risk No.	Component-Event-Hazard	RRR	Proposed Action
	Viral Pathogen		entry via roof run-off
MM36	Distribution – Sabotage or Terrorism Toxic agent	**M5**	Identify high risk sites and install CCTV at these sites.

7 OPERATION AND MAINTENANCE PROCEDURES

7.1 Manuals and Procedures for Drinking Water Schemes

Operation and Maintenance (O&M) Manuals exist for all WTP and many of their unit processes (e.g. chemical dosing systems) although most of these are not fully up to date due to changes since amalgamation in 2014. Table 7.1 contains a list of relevant manuals and procedures, the date they were prepared, the date for their next revision (if applicable) and the responsible officer. FRW is currently (2023) in the process of reviewing and renewing all WTP manuals and converting them into a standard O&M format (WTP template document released by the Queensland Water Directorate (QWD)) to allow for consistency of process description and to facilitate the ongoing updating of these manuals as changes are made to infrastructure or operating procedures. Once updated in electronic form manuals will be added to the Honeywell Experion SCADA system with active links to the manuals via the click of a button on the relevant SCADA screens.

Table 7.1: Operation and Maintenance Manuals and Relevant Procedures for Managing Drinking Water Infrastructure

Document	Date Prepared	Last Reviewed	Date For Revision	Responsible Officer
Water Plan (Fitzroy Basin) Amendment Plan 2021	2021	2013	2031	N/A
Glenmore WTP O&M Manual (QWD template)	In preparation.	N/A	Commenced internally May 2023. Waiting for commissioning to be completed after WTP Upgrade. Upgrade due for completion in April 2024	Manager FRW
Mount Morgan WTP O&M Manual (Original)	1993	1993	Not planned	Manager FRW
Mount Morgan WTP O&M Manual (QWD template)	In preparation	N/A	Planned once current upgrade and commissioning completed	Manager FRW
Rockhampton to Yeppoon Pipeline O&M Manual	2010	2010	Not planned	Manager FRW
Lucas St Reservoir, Pump Station O&M Manual	2003	2003	Not planned	Coordinator MEG Maintenance
Mount Morgan WTP Chemical Dosing O&M Manual	2018	2018	Not planned	Manager FRW
Mount Morgan WTP UV Disinfection Manual	2017	2018	Not planned	Manager FRW

Rogar Avenue Re-Chlorination O&M Manual	2017	2018	Not planned	Manager FRW
Activated Carbon Loading Procedure	2010	2010	Pending completion of current upgrading project	Manager FRW
Mains Break Repair Procedure	2020	2020	2025	Coordinator Network Operations
Mains Commissioning Procedure	In preparation	N/A	Ongoing	Coordinator Network Operations
Reservoir Disinfection and Inspection Procedure	2020	2020	2025	Manager FRW
Water Mains Air-Scouring Procedure	2010	In progress	2024	Coordinator Network Operations
Cyanobacteria Monitoring Protocol	2009	2021	2026	Manager FRW

N/A = not applicable

Standard operating procedures are used for the operation of unit processes or associated equipment (e.g. powdered activated carbon bulk bag unloading system) to ensure they are operated according to manufacturer's specifications. Similarly, procedures for the operation and calibration of on-line and bench top analytical instrumentation are also in place. In most cases these procedures are as supplied by the manufacturer but in some instances the procedures are reproduced in a format that allows co-location next to the equipment being operated to help ensure correct operation occurs. Procedures are also in place for the disinfection of reservoirs, new water mains and broken water mains and for the regular reservoir inspection program and reticulation network air-scouring. Often these procedures are prepared in checklist format to document the completion of tasks for archiving purposes. FRW is currently reviewing and allocating numbers to all procedures to ensure that a register of current procedures is kept up to date.

The WTP O&M Manuals listed in Table 7.1 form the basis of the operating parameters coded into PLC codes or SCADA control setpoints used to control all key process treatment steps. The reviewing of these manuals is being done to ensure that there is consistency of information between the manuals and all the current operational settings used in PLC programs and SCADA settings. Since amalgamation, a large amount of capital upgrade work has been completed in all schemes and work is currently underway to ensure that all these infrastructure changes are captured in the relevant O&M manuals and procedures.

The upgrades being conducted at Glenmore WTP that are listed in Table 7.1 are as follows; filters replacement currently at approx. 60% complete. MGO dosing system 85%, Carbon dosing system 95%, Polymer dosing system 60% and Lime dosing system 90%. The forecasted completion of works is currently April 2024. The upgrades (Table 7.1) for Mount Morgan WTP are currently at the pre-commission stage with just the swapping of mains and chemical analysis of raw water, the commissioning set for late January early February 2024.

7.2 Preventative Maintenance Program

A preventative maintenance program is currently in place for drinking infrastructure within each supply scheme. The R1 software system is used to manage planned and reactive maintenance activities. More than 130 planned maintenance tasks are conducted by FRW staff and/or external contractors each year to ensure the continued reliable operation of a range of mechanical, electrical and process control system components. Table 7.2 provides an overview summary of the main types of preventative maintenance activities that are conducted and their frequency.

Table 7.2: Overview of Preventative Maintenance Program for Drinking Water Infrastructure

Equipment Category	Specific Task	Frequency
Electrical	Backup generator servicing	yearly
	Switchboard thermography testing	yearly
	Chlorine gas sensor testing and servicing	2 weekly
	Uninterruptible Power Supply servicing	6 monthly
Mechanical	WPS pump servicing and greasing	3 monthly
	WTP Air compressor and blower servicing	3 monthly
	WTP coagulant dose pump servicing	3 monthly
	Chlorinator and vacuum regulator servicing	6 monthly
	Low lift pump intake screen cleaning	monthly
Process Control	pH, Electrical conductivity and turbidity meter calibrations	weekly
	Benchtop and online analytical equipment service	yearly
	Chlorine analysers servicing	6 monthly
	Chlorine analysers calibration	monthly
	Chlorine gas facilities service	yearly
	Chlorine dioxide facility service	yearly
Reservoirs	Site, security and animal ingress inspection	monthly

7.3 Reactive Maintenance Management

All reactive maintenance requirements are managed using a standard approach. Upon discovery of a process or component fault or an excursion from normal operational performance, an internal work order is raised using the R1 software system by the WTP Operator or staff member who discovers the issue. The nature and location of the issue is described in the work order together with an indication of the urgency of the maintenance request. The document is then electronically generated and allocated to the actioning staff or relevant supervisor involved in the operation and maintenance of drinking water infrastructure to provide the opportunity for comment on the fault or its urgency rating to optimise the prioritisation of reactive maintenance activities. At the same time a reactive maintenance worker is dispatched to attend and rectify the issue. Reporting of the progress made against the reactive maintenance targets is conducted to ensure tasks are completed in a timely manner.

8 MANAGEMENT OF EMERGENCIES, INCIDENTS, OR EXCURSIONS FROM NORMAL PERFORMANCE

8.1 Emergency Response Plan

FRW has in place an Emergency Response Plan (ERP) that details the approach for managing the response to, and recovery from, emergency situations e.g., natural disasters. The ERP has recently been reviewed and updated following the prolonged major flooding event that occurred during the 2010-2011 summer season. Mock emergency scenarios and desktop exercise alert workshops are held to provide training to key staff involved in the management of emergency situations.

8.2 Managing Drinking Water Incidents or Excursions from Normal Operational Performance

Drinking water incidents including reportable drinking water quality incidents or excursions from normal operational performance are rated and managed using the information provided Table 8.1 and Figure 8.1. An additional flow-charted procedure is in place for the management of microbiological water quality incidents following the detection of non-compliances within the drinking water schemes. Table 8.1 also provides information about the response and rectification time targets to return to normal safe operating status.

Members of the Treatment and Quality team within FRW together with other key stakeholders play different roles in the management of drinking water quality incidents or any excursion from normal operational performance. For example, an excursion from normal operating range is usually identified by a WTP Operator through a SCADA alarm whereas a non-compliance detected through verification monitoring (e.g. *E. coli* detection) is normally identified by the Senior Environmental Scientist or Manager FRW through the receipt of a non-compliant test result from an external laboratory. Depending on the nature of the excursion or non-compliance, each of these team members will attempt to take any action possible to immediately resolve the matter or alternatively, a work order will be submitted electronically for dispatch to maintenance staff according to the Priority Ratings given in Table 8.1.

The Maintenance and Dispatch Officers or WTP Operators are responsible for confirming the Priority Rating and dispatching the work order to the maintenance staff. This tasking is currently done using the R1 software system. In either case, the matter will be reported immediately to either the Senior Environmental Scientist or Manager FRW. These officers are responsible for assessing any action taken or for formulating a plan of further action (e.g., resampling) if required to address or investigate the non-compliance and for directing staff to complete these actions.

Table 8.1: Priority Ratings of Possible Drinking Water Incidents or Events and the associated Response and Rectification Time Targets

Consequences (always rate using consequence with greatest potential impact)			
Generic Description	Negative public perception Prevention of normal operations Increased reactive maintenance Disruption to normal staff duties Loss of critical spares or supplies	Public complaint or environmental spill Reduction in service level Loss of normal design operating status Loss of preventative maintenance Unacceptable civil or site condition	Possible public health impact Loss of service or non-compliance Loss of SCADA control or monitoring Loss of whole treatment barrier Security or structural breach
Examples	*Site left untidy or poorly signed* *Process shutdown required* *Increased need for fault resetting* *Normal planned tasks disrupted* *No spare parts or store chemicals*	*Widespread drinking water complaint* *Significant drop in reticulation pressure* *Low or high alarm, loss of duty standby* *On-line instrumentation not calibrated* *Reservoir roof structure damaged*	*Reservoir contamination detected* *Exceedance of ADWG health value* *No radio telemetry or local comms* *Chlorine dosing failure* *Unauthorised access to WTP*
Likelihood			
Within 1 to 7 days	**P2 – Moderate Impact/Risk**	**P1 – High Impact/Risk**	**P1 – High Impact/Risk**
Within 7 to 28 days	**P3 – Low Impact/Risk**	**P2 – Moderate Impact/Risk**	**P1 – High Impact/Risk**
Not within 28 days	**P3 – Low Impact/Risk**	**P3 – Low Impact/Risk**	**P2 – Moderate Impact/Risk**

Response and Rectification Time Targets			
Priority Rating	**Response Time to Site**	**Rectification Time**	**Maximum Tolerable Outage**
P1	**1 hour**	**5 hours**	**5 hours**
P2	**2 hours**	**24 hours**	**24 hours**
P3	**24 hours**	**5 days**	**5 days**

In the event of a notifiable water quality incident, the incident will be reported to the Department of Regional Development, Manufacturing and Water and simultaneously to Queensland Health and then investigated by either the Senior Environmental Scientist and/or the Manager FRW. Upon completion of the investigation the incidents are reported in writing to the Department of Regional Development, Manufacturing and Water (DRDMW) and to Queensland Health. Once fully resolved, the incident reporting is completed and any long term actions or preventative measures are incorporated into O&M Manuals or procedures or incorporated into future Capital Works Programs in order to prevent further incidents or excursions from normal operational performance targets.

Examples of specific actions that may be taken for events with different ratings are:

P1 Rating

- Resampling for further chemical or microbiological testing
- Manual dosing of sodium hypochlorite to boost disinfection
- Draining or isolation of reservoirs or issuing boil water alerts to avoid impact on public health
- Sourcing water from alternative supplies
- Install critical spare for chemical dosing pump

P2 Rating

- flushing of mains to clear a discoloured water event,
- scouring of reservoirs,
- changes made to treatment chemical dosing rates (e.g., coagulant dose),
- process control settings (e.g., changes to PID loops on chlorination systems)

P3 Rating

- air-scouring of water mains to remove sediment or biofilm

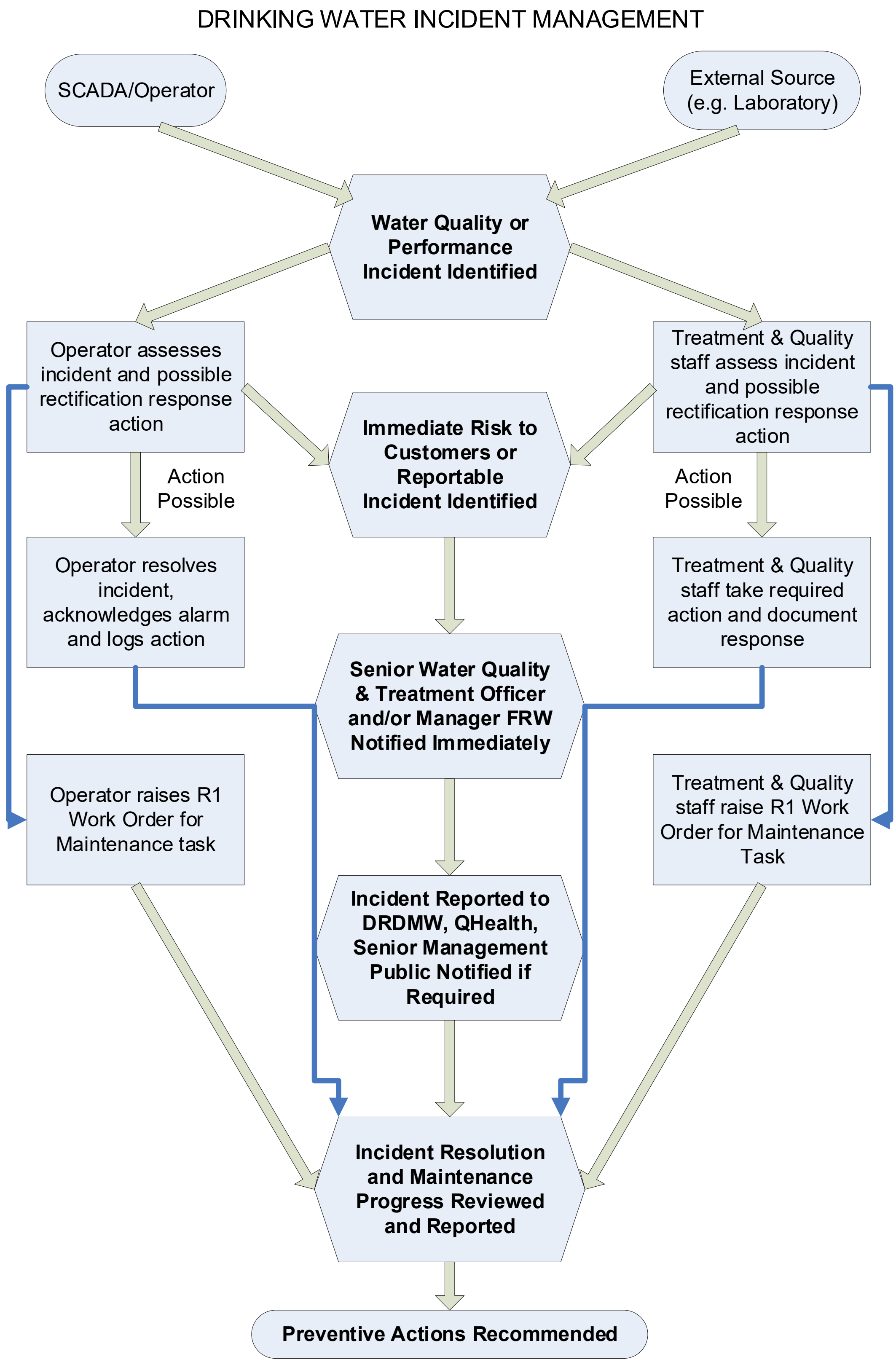
8.3 Emergency Contact Information

Table 8.2 identifies key personnel or stakeholders involved in managing drinking water incidents including FRW staff and officers within the Queensland Government. The positions in bold have in-depth knowledge of water treatment processes and/or water quality biology and chemistry and will engage with State Government officers if required to manage drinking water quality incidents.

Table 8.2: FRW or other Personnel Involved in Managing Drinking Water Incidents

Name	Position	Role	Phone Number
Dan Toon	Manager FRW	Overall Responsibility	1300 22 55 77
Gavin Challinor	Coordinator Mech, Elec and Gen Maintenance	Managing Responses	1300 22 55 77
Paul Dean	Senior Environmental Scientist	Sampling, Reporting, Investigating	1300 22 55 77
Evan Davison	Coordinator Network Operations	Responding to and reporting on networks	1300 22 55 77
Vacant	Senior Asset and Maintenance Planner	Rectification Actions	1300 22 55 77
Department of Regional Development, Manufacturing and Water	Regulator for Drinking Water	Regulator, Management of Incident Response	1300 59 67 09
Queensland Health	Regulator for Public Health	Incident Response	4920 6895

Figure 8.1: Flow Chart Showing Approach to Drinking Water Incident Management



9 SERVICE WIDE SUPPORT – INFORMATION MANAGEMENT

Record keeping, information management and reporting activities are currently performed in a number of different ways depending on the type and source of the information and its intended use. The overarching approach to record keeping and record retention requirements is prescribed in Council's Recordkeeping Policy (Policy No. POL.F4.7).

9.1 Information Management Systems

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. Table 9.1 provides a listing of the software systems that are currently in use and provides an indication of how current or up to date the information is in each system. O&M Manuals and procedure documents are also 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. In addition, information is presented on noticeboards and important safety information provided to team members in document wallets that accompany each of the work vehicles used by staff. If required email is used to distribute important information about drinking water operations and performance data.

Table 9.1: Software Systems Used for Management of Drinking Water Associated Information

System	Function	Group Responsible	Currency
R1 Suite	Asset management including work orders, asset inventory and maintenance schedules; financials, supply chain and ECM. ECM is used for archiving of all business critical documents including internal and external correspondence	RRC, FRW Asset Management, FRW Admin	Current
Pathway	Management of all customer engagements including complaints and information requests	RRC and FRW Admin	Current
GeoCortex	Management of Council-wide GIS and asset location information	RRC and FRW Asset Management	Current
Experion SCADA	Archiving of all on-line monitored operational data for drinking water infrastructure	FRW Treatment and Quality Team	Current
Guardian	Management of Council-wide emergency events	RRC	Current
Microsoft Excel	Management of all water quality monitoring information	FRW Treatment and Quality Team	Current
SwimLocal	Management and reporting of all water quality monitoring information	FRW Treatment and Quality Team	In progress

9.2 Reporting Activities

Currently all reporting activities are managed by a number of teams within FRW although predominantly members of the Treatment and Quality Team are responsible for all reporting related to drinking water quality. Information for reporting purposes is obtained from Microsoft Excel files (e.g. drinking water quality testing results), SCADA archives (e.g. WTP performance metrics, flow measurements and on-line drinking water quality results), Pathway archives (e.g. customer complaints), ECM (e.g. operation and maintenance manuals) and R1 archives (e.g. maintenance activities).

Reports are prepared by key members of the Treatment and Quality Team (e.g. Senior Water Quality and Treatment Officer) and are reviewed by other members of the team and the Manager FRW prior to submission. In this manner, the many different internal and external reporting requirements associated with drinking water (e.g. Council reports, internal team operational performance reports, FRW Website reports for customers, drinking water quality compliance reports and drinking water quality incident reports) are generated to meet business and legislative obligations.

10 OPERATIONAL AND VERIFICATION MONITORING PROGRAMS

A comprehensive water quality monitoring program is in place to ensure that operational performance is maintained to a sufficiently high level in order to consistently produce drinking water that meets ADWG. Table 10.1 provides an overview of the water quality monitoring program in its entirety. The same monitoring program is applied across all drinking water schemes. The ADWG values for health and aesthetics are used as the compliance targets for the water quality monitoring program. The sampling locations and frequency recommended in the ADWG serve as the basis for the locations and sampling frequency applied for each water quality parameter in the monitoring program. Raw water sources are monitored in accordance with a Cyanobacteria Monitoring Protocol based on best industry practice recommendations.

Unless specified, samples are grab samples and are delivered to external laboratories where required. Water quality staff use standard methods for sampling and sample handling with specialised containers and instructions supplied by analytical service providers incorporated in the sampling program. Additional detail on the operational monitoring conducted at each WTP and the detailed program for microbiological sampling across the drinking water schemes is provided below.

Excursions detected during operational or verification monitoring are managed according to the information outlined in the Section 8.

10.1 Operational Monitoring Within Drinking Water Scheme

Operational monitoring is performed at different stages in each drinking water scheme from catchment through to the distribution system. In particular, monitoring of the performance of key treatment barriers is a key focus of the operational monitoring conducted at each WTP. Table 10.2 provides a breakdown of the operational monitoring that is conducted within each drinking water scheme including information on how the sampling is performed, its frequency and where defined, the operational targets or ranges (if applicable) for each parameter tested. Where stated in Table 10.2, ranges reflect the values between the high and low alarms around the SCADA setpoint for a given on-line operating parameter or water quality parameter. Values outside of this range therefore trigger an alarm which is responded to as described in Section 8.

Manual sampling listed as daily is also conducted more frequently on an event-related basis as required.

10.2 Verification Monitoring within Drinking Water Schemes

In addition to the verification monitoring program described in Table 10.1, drinking water is sampled weekly throughout each drinking water scheme for *E. coli,* free chlorine residual testing and other physico-chemical testing described below. Each week 12 drinking water samples are tested for *E. coli*. A sample is collected from each WTP (Glenmore, Mount Morgan) and 10 samples (Rockhampton 8, Mount Morgan 2) are collected from 61 possible sampling sites located throughout the two distribution systems. Table 10.3 provides a list of all the sampling sites that the weekly sampling schedule is rotated through. Appendix C shows a typical *E. coli* verification monitoring schedule. For example, each week a sample is collected from each of eight different supply zones within the Rockhampton Water Supply. The following week another seven supply zones, with some overlap with the preceding week, are sampled in order to rotate through all the different individual sampling sites over an extended period of time. A breakdown of the sampling locations based on supply zones and scheme is provided in Table 10.3 and Appendix D. These supply zones are also identified in the water supply scheme schematics shown in Figures 2.1 and 2.3. Selection of the number and location of sampling sites was done in accordance with recommendations in the ADWG.

Table 10.1: Overview of Water Quality Monitoring Program for Each Drinking Water Scheme

Water Quality Parameter	ADWG Health Guideline	ADWG Aesthetic Guideline	Location Sampled[*]	Sampling Frequency[#] (ADWG Guide)
E. coli	0 cfu	No value	P, T, R	W, E (W)
Cryptosporidium	<1 organism/L	No value	S, P	Y, E, M (E)
Giardia	<1 organism/L	No value	S, P	Y, E (E)
Cyanobacteria	No value	No value	S, P	M[+], E (M)
Cyanobacteria Toxin	Varies**	No value	S, P	E
pH	No value	6.5-8.5	S, P	C, D, (D, W)
Chlorine	5 mg/L	0.6 mg/L	P, T, R	C, D, (D, W)
Electrical Conductivity	No value	No value	S, P, R	C, D, M, (W, M)
Total Dissolved Solids	No value	600 mg/L	S, P	M
Colour	No value	15 HU	S, P	D, M, (W, M)
Turbidity	<1 NTU[&]	5 NTU	S, P, R	C, D, M, (D, W)
Total Hardness	No value	200 mg/L	S, P	M, (M)
Total Alkalinity	No value	No value	S, P	M, (W, M)
Sulphate	500 mg/L	250 mg/L	S, P	M, (Q)
Chlorate[×]	No value	No value	P, R	M, (Q)
Chlorite[×]	0.8 mg/L	No value	P, R	M, (Q)
Chloride	No value	250 mg/L	S, P	M, (Q)
Calcium	No value	No value	S, P	M, (Q)
Magnesium	No value	No value	S, P	M, (Q)
Sodium	No value	180 mg/L	S, P	M, (Q)
Potassium	No value	No value	S, P	M, (Q)
Aluminium (acid-soluble)	No value	0.2 mg/L	S, P	M, (D, W)
Copper	2 mg/L	1 mg/L	S, P	M, (M)
Lead	0.01 mg/L	No value	S, P	M, (M)
Manganese	0.5 mg/L	0.1 mg/L	S, P	M, (F)
Zinc	No value	3 mg/L	S, P	M, (M)
Iron	No value	0.3 mg/L	S, P	M, (M)
Fluoride	1.5 mg/L	No value	S, P	M (C, W)
Nitrite	3 mg/L	No value	S, P	M, (M)
Nitrate	50 mg/L	No value	S, P	M, (M)
Total Organic Carbon	No value	No value	S, P	Q, (M, Q)
Trihalomethanes	0.25 mg/L	No value	P, R	Q, (M)
Taste/odour compounds	No value	No value	S, P	E, (W, M)
Heavy Metals[>]	Various	No values	S, P	E, Y
Pesticides[>]	Various	No values	S	E, Y (M, E)
PFOS + PFHxS [~]	0.07 µg/L	No value	S, P	E, Y
PFOA [~]	0.56 µg/L	No value	S, P	E, Y
Radionuclides	Various	No values	S	E, (5 years)

cfu = colony forming unit, HU = Hazen units, NTU = nephelometric turbidity units, PFOS = perfluorooctane sulphonate, PFHxS = perfluorohexane sulphonate, PFOA = perfluorooctanoic acid
S = raw water source, P = treatment plant, T = transmission, R = reticulation
[#] C = continuous (online), D = daily, W = weekly, F = fortnightly, M = monthly, Q = quarterly, Y = yearly, E = event related, ** Microcystins - <1.3 µg/L, no guideline value for other toxins, [>]See Appendix B for details of the heavy metals and pesticide testing, [&] <1 NTU target is for effective disinfection only with <0.2 NTU the target for filtration of protozoan pathogens, [~] Rockhampton WSS only, [×] When Glenmore WTP chlorine dioxide facility is in use, [+] Dependent on catchment flow and water quality and in accordance with the Cyanobacteria Monitoring Protocol

Table 10.2: Operational Monitoring Conducted within Each Drinking Water Scheme

Parameter	Location[a]	Frequency[b]	Target Values or Range
Rockhampton Water Supply Scheme			
Turbidity	RW, PS, PF, DW	D, On-line	PS (<1.5 NTU), PF (<0.3 NTU)
pH	RW, PF, PC, DW	D, On-line	PC & DW (pH 7.6-8.2)
Colour (true)	RW, DW	W, As required	DW (<5 HU)
Dissolved Oxygen	RW, DW	D	Not defined
Electrical Conductivity	RW, PF, DW	D, On-line	<400 µS/cm
Alkalinity	RW, DW	As required	RW (>30 mg/L)
Total Dissolved Solids	RW, DW	D	Not defined
Temperature	RW, DW	D, On-line	Not defined
Taste and Odour	RW, DW	D	Not objectionable
Streaming Current	CD	On-line	Deviation monitoring
Free Chlorine	CW, DW, SR	D, On-line	DW (1.0mg/L), SR (0.5 -1.5mg/L)
Chlorine Dioxide*	PF	D, On-line	<0.3 mg/L
Mount Morgan Water Supply Scheme			
Turbidity	RW, PF, DW	D, On-line	DW (<1.0 NTU)
pH	RW, PF, DW	D, On-line	CD (6.5-7.0), DW (pH 7.8)
Colour (true)	RW, DW	D	DW (<5 HU)
Dissolved Oxygen	RW, DW	D	Not defined
Alkalinity	RW, DW	As required	DW (30 mg/L)
Electrical Conductivity	RW, DW	D, On-line	<400 µS/cm
Temperature	RW, DW	D	Not defined
Taste and Odour	RW, DW	D	Not objectionable
Free Chlorine	DW, SR	D, On-line	DW (1.0 mg/L), SR (0.5-1.5mg/L)
UV Transmissivity	PF, DW	D, On-line	>85%

[a]RW = raw water, PS = post-sedimentation, PF = post-filtration, DW = final drinking water from outlet of clear water reservoir, CD = pre-filtration coagulant-dosed water, FD = fluoride dosed filtered water, CW = clear water inlet, SR = service reservoir, PC = post-pH correction
[b]D = daily manual sampling, W = Weekly, *when the chlorine dioxide facility is in use

Care has been taken to select a range of different sampling points so that there is good coverage of areas with different attributes. For example, points towards the extremity of reticulation supply zones have been chosen in some instances due to long water age or known areas of limited free chlorine residual penetration. Examples of these sites include site NS1 in Baree on the Mount Morgan Water Supply Scheme, site BS2 on River Street in Mount Morgan, site ND1 on Norman Road in Norman Gardens, site MH4 on Somerset Rd in Gracemere or site MA1 at Sleipner St on Mt Archer in North Rockhampton. One site in Mount Morgan was chosen as the area occasionally experiences low pressure as well as being at the extremity of the reticulation system. This BS3 site on Smalls Rd provides a good indication of the penetration of free chlorine residuals in the Mount Morgan Water Supply Scheme. In contrast, areas of known good free chlorine residual have also been selected so that the maximum levels of free chlorine reaching the customer's tap are able to be monitored in some instance.

Each week 12 samples are collected randomly from the designated reticulation sampling sites in each scheme for *E. coli* and free chlorine residual testing. Four (4) samples are also collected randomly from reticulation sampling sites located in North and South Rockhampton, Gracemere and Mount Morgan for pH, colour, turbidity and electrical conductivity measurements. This is to determine any gross changes in water quality at different locations in the distribution system. In this way, areas where water quality changes significantly due to events that occur in the distribution system will be identified and an investigation of possible causes commenced. Appendix D shows the sampling sites for weekly verification monitoring relative to the reservoir supply zones.

FRW spends a significant amount of time and effort responding to customer water quality complaints or comments about changes in water quality. This is done in order to provide the best means of addressing the root cause of the water quality issue rather than only addressing the nature of the complaint. FRW receives a relatively low number of drinking water quality complaints from customers but understands the importance of using this information to help understand events or changes that occur in water quality and within the water distribution infrastructure.

The verification monitoring program in place is commensurate with the level of risk that exists within each of the water supply schemes based on the recent records of drinking water quality incidents or the frequency of drinking water quality complaints. Despite this, FRW intend to keep reviewing this monitoring program following some revision of the sections in the ADWG 2011 relevant to monitoring and also to further maximise the quality of drinking water supplied to customers. As with operational monitoring, if non-compliances or exceedances are detected during the verification monitoring program action is taken as described in Section 8.

Table 10.3: Drinking Water Distribution System Sampling Sites for Weekly Verification Monitoring (Supply Zone codes are labelled on reticulation areas in Figures 2.1 and 2.3, Appendix D)

Site Code	Reservoir Supply Zone	Address
Rockhampton Water Supply Scheme		
AL1	Agnes St Low Pressure System	O'Connell St
AL2		Cambridge St
AL3		Exhibition Rd
AL4		Ann St
AL5		Gladstone Rd
AL6		Hunter St
AL7		Wandal Rd
AL8		Port Curtis Rd
AL9		Derby St
AL10		Denham St
AL11		Old Capricorn Hwy
AH1	Agnes St High Pressure System	Nathan St
AH2		North St
AH3		Herbert St
AH4		Jessie St
YR1	Yaamba Road Reservoir System	Bruigom St
YR2		Main St
YR3		Macallister St
YR4		Beaney St
YR5		Norman Rd
YR6		Maloney St
YR7		Rachel Drv
YR8		Robison St
TR1	Thozet Road	Earl St
TR2		Lucas St

Site Code	Reservoir Supply Zone	Address
TR3	Reservoir System	Joiner St
TR4		Berserker St
TR5		O'Shanesy St
TR6		Lakes Creek Rd
MH1	Mawdesley Hill Reservoir System	O'Shanesy St
MH2		Ranger St
MH3		James St
MH4		Somerset Rd
LS1	Lucas St Reservoir System	Cherryfield Rd
LS2		Lillypilly Ave
LS3		Johnson Rd
LS4		Donovan Crs
LS5		Huff St
RA1	Rogar Ave Reservoir System	Eichelberger St
RA2		Frenchville Rd
FR1	Forbes Ave Reservoir System	Aldridge Ave
ND1	Nagle Drv Reservoir System	Norman Rd
ND2		Selwyn Crs
ND3		Alyssa Court
PH1	Parkhurst Trunk Main System	McMillan Ave
PH2		Yaamba Rd
LC1	Lakes Ck Main	Emu Park Rd
MA1	Mount Archer	Sleipner St
SC1	Samuel Cres Reservoir System	Samuel Crs
SC2		Gremalis Dr
BD1	Birkbeck Dr Reservoir System	Bush Crs
BD2		Springbrook Cl
RC1	Ramsay Creek Pumped Main	Yaamba Rd
BH1	Boundary Hill Reservoir System	Yeppoon Rd
Mount Morgan Water Supply Scheme		
BS1	Black Street Reservoir System	Dee St
BS2		River St
BS3		Smalls Rd
BS4		Limerick Ln
NS1	North Street Reservoir System	Creek St
NS2		Gordon Ln
NS3		East St Ext

11 BEST PRACTICE INITIATIVES

FRW is actively engaged in a number of activities and initiatives which demonstrate an approach consistent with industry best practice for drinking water quality management. These activities include an ongoing commitment to drinking water quality management through stakeholder engagement towards improved catchment management, initiation and sponsoring of research and development projects and staff awareness and training activities. A commitment to the implementation of an approach that includes ongoing review and continual improvement is outlined in the RMIP detailed above.

11.1 Commitment to Drinking Water Quality Management

FRW is involved in a number of key stakeholder initiatives designed to provide guidance to the overall management and monitoring of water quality and environmental health in the Fitzroy Basin. This Fitzroy River Basin is a very important part of Central Queensland with the vast majority of residents within RRC now dependent on the provision of safe drinking water sourced from the Fitzroy River. Management of the health of the catchment and the minimisation of the impact of catchment land use activities is therefore a key priority. FRW's ongoing involvement in the Fitzroy Water Quality Advisory Group established following the Ensham Mine discharge event in 2008, and its active participation in the Strategic Working Group of the Fitzroy Partnership for River Health underpins this commitment.

11.2 Research and Development Activities

Over the last eight years FRW has strengthened its collaborative ties with researchers at Central Queensland University. FRW has been involved in the initiation and funding of two research projects. The first project focused on developing an understanding of the diversity and abundance of micro-fungi within parts of the Rockhampton Water Supply Scheme. This PhD project generated very useful data related to the prevalence of micro-fungi and the role of frogs and aerosols in the contamination of service reservoirs.

The second project focused on the optimisation of treatment chemicals and associated processes for the optimisation of the removal of toxic species of cyanobacteria from the Fitzroy River raw water. Through this project FRW gained an insight into the effectiveness of different treatment options for the removal of the known toxin producer *Cylindrospermopsis raciborskii* – one of the more abundant population members during cyanobacterial blooms in the Fitzroy River.

Recently, Fitzroy River Water commenced working with colleagues in the Water Quality and Health Network (Water Services Association of Australia) to review the options and impacts of the implementation of health-based targets for pathogens in the schemes operated by Fitzroy River Water. This involves participating in surveys and completing a review of existing treatment process performance.

More recently the Department of Environment and Science (DES) established a mutual collaboration with FRW to manually collect water quality samples at the

GWTP inlet structure which represents the Fitzroy River end-of-system site of the Great Barrier Reef loads monitoring program. Data collected from the sampling program continues to provide an insight on suspended solids, nutrients and pesticides concentrations during baseflow and high flow event conditions. FRW is also working closely with Commonwealth Scientific and Industrial Research Organisation (CSIRO) to provide real time water quality data of the lower Fitzroy River catchment. FRW is the custodian of a water quality station installed on the inlet of Glenmore WTP to provide data on this part of the catchment. The real time data is accessible to FRW and is also used in the operational monitoring of river water quality.

11.3 Staff Awareness and Training

The importance of drinking water quality and the role of team members at FRW in the delivery of safe and reliable drinking water to the community is a topic that is emphasised regularly at staff Toolbox Meetings and during day to day activities. As continual improvements are made to operating procedures or infrastructure upgrades are completed, the significance of these changes with respect to improvements in water quality and levels of service are discussed and relevant training is provided. Equally, the importance of delivering a high quality drinking water service is emphasised to promote a culture of proactive behaviour, innovation and ownership of service delivery.

12 RISK MANAGEMENT IMPROVEMENT PROGRAM

FRW and RRC are committed to delivering safe and reliable drinking water services to the community. To ensure that this is achieved, and to minimise the risks posed to the current drinking water services, a Risk Management Improvement Program has been prepared that comprises five elements. These are:

- Element 1 - Infrastructure Upgrades and Improved Infrastructure Performance
- Element 2 - Optimisation of Information Management and Reporting Capabilities
- Element 3 - Enhanced Engagement with Stakeholders Associated with Drinking Water Infrastructure Management
- Element 4 - Improved Service Through Staff Awareness and Training
- Element 5 - Enhanced Water Quality Performance

Table 12.1 provides an overview of the outputs, priority level, timeframe for completion and availability of funding for each of the five Elements identified in the Risk Improvement Management Program. Table 12.2 provides a specific detail for each action identified as being required to mitigate the unacceptable residual risk ratings listed in Table 6.1 and also other areas where further actions have been identified as being required. The current status and timeframes and person responsible for the completion of these actions are also listed.

Table 12.1: Risk Management Improvement Program for Drinking Water Services

Element	Outputs	Priority Level	Timeframe for Completion	Funding Availability
Element1 Infrastructure Upgrades and Improved Infrastructure Performance	Complete all capital upgrades to water supply infrastructure to mitigate unacceptable risks identified in Table 6.1	High	Ongoing	Yes
Element 2 Information Management and Reporting Capability Enhancement	Consolidated and streamlined information management and reporting processes	High	Ongoing	Yes
Element 3 Enhanced Stakeholder Engagement	Influence on stakeholders delivers improved management of catchments and other water infrastructure	High	Ongoing	Yes
Element 4 Improved Service through Staff Awareness and Training	Deliver the DWQMP to staff and develop culture of awareness of drinking water quality management. Deliver appropriate training	High	Ongoing	Yes
Element 5 Enhanced Water Quality Performance	Deliver ongoing improvements to drinking water quality, safety and reliability.	High	Ongoing	Yes

Table 12.2: Specific Actions Identified to Mitigate Unacceptable Risks to Drinking Water Quality and Information Describing these Actions.

Risk No.	Component-Event-Hazard	RRR	Proposed Action	Responsible Officer	Status	Completion Date
Rockhampton Water Supply Scheme						
R08	Source – Contamination of raw water Excessive E.C. or TDS	M9	Continue to lobby regulator for tighter water quality limits on mine water discharges.	Manager FRW	Ongoing	N/A
R24	Reservoir – Contamination due to animals accessing reservoirs Bacterial Pathogen	M5	Repair and/or replace roof of identified high risk reservoirs; Roof replacement capital upgrade is underway on one of the identified reservoirs	Manager FRW	Ongoing	
R26	Reservoir – Contamination due to animals accessing reservoirs Viral Pathogen	M5	Repair and/or replace roof of identified high risk reservoirs; Roof replacement capital upgrade is underway on one of the identified reservoirs	Manager FRW	Ongoing	
R30	Distribution – Sabotage or Terrorism Toxic agent	M5	Identify high risk sites and install CCTV at these sites.	Process Systems Technician	In progress. A number of sites completed.	31/12/2023
Mount Morgan Water Supply Scheme						
MM15	Treatment – Lack of effective treatment Viral Pathogen	M8	Perform testing for viruses for further confirmation of process effectiveness.	Senior Water Quality and Treatment Officer	Ongoing	31/12/2023
MM28	Reservoir – Contamination due to delivery of tankered water Bacterial Pathogen	M5	Repair and/or replace Black Street Reservoir roof	Manager FRW	Ongoing	
MM30	Reservoir – Contamination due to animals accessing reservoirs Viral Pathogen	M5	Repair and/or replace Black Street Reservoir roof	Manager FRW	Ongoing	
MM36	Distribution – Sabotage or Terrorism Toxic agent	M5	Identify high risk sites and install CCTV at these sites.	Process Systems Technician	Ongoing	

N/A = Not applicable

APPENDIX A

Likelihood Rating Table

Likelihood	Description
5. Almost Certain	Occurs more often than once per week (52/yr)
4. Likely	Occurs more often than once per month (12/yr) and up to once per week (52/yr)
3. Possible	Occurs more often than once per year and up to once per month (12/yr)
2. Unlikely	Occurs more often than once every five years and up to once per year
1. Rare	Occurs less than or equal to once every five years

Consequence Rating Table

Consequence	Description
5. Catastrophic	Potential acute health impact, declared outbreak expected
4. Major	Potential acute health impact, no declared outbreak expected
3. Moderate	Potential widespread aesthetic impact or repeated breach of chronic health parameter
2. Minor	Potential local aesthetic, isolated exceedance of chronic health parameter
1. Insignificant	Isolated exceedance of aesthetic parameter with little or no disruption to normal operation

Risk Rating Matrix

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

Uncertainty Ratings

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

APPENDIX B

Example Sample Testing Results

CERTIFICATE OF ANALYSIS

Environmental

Accredited for compliance with ISO/IEC 17025 - Testing

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Sample ID*	Glenmore Raw	Mt Morgan Potable	No. 7 Dam Raw	Glenmore Potabe	Creek Street
			Sampling date / time	18-Jan-2023 00:00	18-Jan-2023 00:00	18-Jan-2023 00:00	18-Jan-2023 00:00	18-Jan-2023 00:00
Compound	*CAS Number*	*LOR*	*Unit*	ET2300329-001	ET2300329-002	ET2300329-003	ET2300329-004	ET2300329-005
				Result	Result	Result	Result	
EA005P: pH by PC Titrator								
pH Value	—	0.01	pH Unit		7.80	7.38	7.69	---
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	—	1	gS/cm		257	271	241	---
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	—	10	mg/L		148	112	143	---
EA041: Colour (True)								
Colour (True)	----	1	PCU	140	3	45	10	----
pH Colour	----	0.01	pH Unit	7.31	7.59	7.43	7.56	----
Turbidity	—	0.1	NTU		0.2	5.7	0.2	_--
Total Hardness as CaCO3	—	1	mg/L		69	95	70	_--
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	—
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	50	60	82	59	----
Total Alkalinity as CaCO3	—	1	mg/L	50	60	82	59	---
ED041G: Sulfate (Turbidimetric) as SO4 2-	by DA							
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		7	4	5	---
Chloride	16887-00-6	1	mg/L		31	31	28	----
Calcium	7440-70-2	1	mg/L	10	17	16	20	—
Magnesium	7439-95-4	1	mg/L	11	7	8	10	----
Sodium	7440-23-5	1	mg/L	18	23	20	23	----
Potassium	7440-09-7	1	mg/L	4	6	5	3	---
EG020-MF: Acid-Soluble Metals following Microfiltration								
Acid Soluble Aluminium	ACID_SOL_AL	0.005	mg/L		0.041	0.026	0.027	---
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	<0.001	<0.001	—
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Barium	7440-39-3	0.001	mg/L	0.065	0.038	0.035	0.008	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
EG020T: Total Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	0.009	0.002	0.005	0.001	—
Lead	7439-92-1	0.001	mg/L	0.002	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	0.124	0.001	<0.001	0.292	----
Nickel	7440-02-0	0.001	mg/L	0.052	0.001	0.002	0.002	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L	0.018	0.009	<0.005	<0.005	----
Iron	7439-89-6	0.05	mg/L	8.67	<0.05	<0.05	0.68	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8						0.1	—
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0						<0.01	—
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8						0.29	—
Nitrite + Nitrate as N	—						0.29	---
Total Organic Carbon	—						3	---
Biochemical Oxygen Demand	—						---	---
EP068A: Organochlorine Pesticides (OC)								
alpha-Endosulfan	959-98-8	0.5	Mg/L	<0.5	----	<0.5	----	----
beta-Endosulfan	33213-65-9	0.5	Mg/L	<0.5	----	<0.5	----	----
Endosulfan sulfate	1031-07-8	0.5	MQ/L	<0.5	---	<0.5	---	---
EP074G: Trihalomethanes								
Chloroform	67-66-3	5	Mg/L	—	117	—	34	157
Bromodichloromethane	75-27-4	5	Mg/L	—	33	----	16	30
Dibromochloromethane	124-48-1	5	Mg/L	—	8	----	<5	6
Bromoform	75-25-2	5	Mg/L	—	<5	----	<5	<5
[A] Total Trihalomethanes	—	5	MQ/L	---	158	---	50	193
Azinphos-ethyl	2642-71-9	0.02	Mg/L	<0.02	—	<0.02	—	—
Azinphos-methyl	86-50-0	0.02	Mg/L	<0.02	----	<0.02	----	----
Bromophos-ethyl	4824-78-6	0.10	Mg/L	<0.10	----	<0.10	----	----
Carbofenothion	786-19-6	0.02	Mg/L	<0.02	----	<0.02	----	----

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Glenmore Raw	Mt Morgan Potable	No. 7 Dam Raw	Glenmore Potabe	Creek Street
			Sampling date / time	18-Jan-2023 00:00	18-Jan-2023 00:00	18-Jan-2023 00:00	18-Jan-2023 00:00	18-Jan-2023 00:00
Compound	*CAS Number*	*LOR*	*Unit*	ET2300329-001	ET2300329-002	ET2300329-003	ET2300329-004	ET2300329-005
EP234A: OP Pesticides - Continued								
Chlorfenvinphos	470-90-6	0.02	^g/L	<0.02	----	<0.02	----	----
Chlorpyrifos	2921-88-2	0.02	^g/L	<0.02	----	<0.02	----	----
Chlorpyrifos-methyl	5598-13-0	0.2	^g/L	<0.2	----	<0.2	----	----
Coumaphos	56-72-4	0.01	^g/L	<0.01	----	<0.01	----	----
Demeton-O & Demeton-S	298-03-3/126-75-	0.02	^g/L	<0.02	----	<0.02	----	----
Demeton-S-methyl	919-86-8	0.02	^g/L	<0.02	----	<0.02	----	----
Diazinon	333-41-5	0.01	^g/L	<0.01	----	<0.01	----	----
Dichlorvos	62-73-7	0.20	^g/L	<0.20	----	<0.20	----	----
Dimethoate	60-51-5	0.02	^g/L	<0.02	----	<0.02	----	----
Disulfoton	298-04-4	0.05	^g/L	0.10	----	<0.05	----	----
Ethion	563-12-2	0.02	^g/L	<0.02	----	<0.02	----	----
EPN	2104-64-5	0.05	^g/L	<0.05	----	<0.05	----	----
Ethoprophos	13194-48-4	0.01	^g/L	<0.01	----	<0.01	----	----
Fenamiphos	22224-92-6	0.01	^g/L	<0.01	----	<0.01	----	----
Fenchlorphos (Ronnel)	299-84-3	10	^g/L	<10	---	<10		
Fenitrothion	122-14-5	2	^g/L	<2	----	<2	----	----
Fensulfothion	115-90-2	0.01	^g/L	<0.01	----	<0.01	----	----
Fenthion	55-38-9	0.05	^g/L	<0.05	----	<0.05	----	----
Malathion	121-75-5	0.02	^g/L	<0.02	----	<0.02	----	----
Mevinphos	7786-34-7	0.02	^g/L	<0.02	----	<0.02	----	----
Monocrotophos	6923-22-4	0.02	^g/L	<0.02	----	<0.02	----	----
Omethoate	1113-02-6	0.01	^g/L	<0.01	----	<0.01	----	----
Parathion	56-38-2	0.2	^g/L	<0.2	----	<0.2	----	----
Parathion-methyl	298-00-0	2.0	^g/L	<2.0	----	<2.0	----	----
Phorate	298-02-2	0.1	^g/L	<0.1	----	<0.1	----	----
Pirimiphos-ethyl	23505-41-1	0.01	^g/L	<0.01	----	<0.01	----	----
Pirimiphos-methyl	29232-93-7	0.01	^g/L	<0.01	----	<0.01	----	----
Profenofos	41198-08-7	0.01	^g/L	<0.01	----	<0.01	----	----
Prothiofos	34643-46-4	0.1	^g/L	<0.1	----	<0.1	----	----
Sulfotep	3689-24-5	0.005	^g/L	<0.005	----	<0.005	----	----
Sulprofos	35400-43-2	0.05	^g/L	<0.05	----	<0.05	----	----
Terbufos	13071-79-9	0.01	^g/L	<0.01	----	<0.01	----	----
Temephos	3383-96-8	0.02	^g/L	<0.02	----	<0.02	----	----
Tetrachlorvinphos	22248-79-9	0.01	^g/L	<0.01	----	<0.01	----	----
Triazophos	24017-47-8	0.005	^g/L	<0.005	----	<0.005	----	----
EP234A: OP Pesticides - Continued								
Trichlorfon	52-68-6	0.02	^g/L	<0.02	----	<0.02	----	----
Trichloronate	327-98-0	0.5	^g/L	<0.5	----	<0.5	----	----
EP234B: Thiocarbamates and Carbamates								
Aldicarb	116-06-3	0.05	^g/L	<0.05	----	<0.05	----	----
Bendiocarb	22781-23-3	0.10	^g/L	<0.10	----	<0.10	----	----
Benomyl	17804-35-2	0.01	^g/L	<0.01	----	<0.01	----	----
Carbaryl	63-25-2	0.01	^g/L	<0.01	----	<0.01	----	----
Carbofuran	1563-66-2	0.01	^g/L	<0.01	----	<0.01	----	----
3-Hydroxy Carbofuran	16655-82-6	0.02	^g/L	<0.02	----	<0.02	----	----
Methiocarb	2032-65-7	0.01	^g/L	<0.01	----	<0.01	----	----
Methomyl	16752-77-5	0.01	^g/L	<0.01	----	<0.01	----	----
Molinate	2212-67-1	0.1	^g/L	<0.1	----	<0.1	----	----
Oxamyl	23135-22-0	0.01	^g/L	<0.01	----	<0.01	----	----
Thiobencarb	28249-77-6	0.01	^g/L	<0.01	----	<0.01	----	----
Thiodicarb	59669-26-0	0.01	^g/L	<0.01		<0.01		
EP234C: Dinitroanilines								
Pendimethalin	40487-42-1	0.05	^g/L	<0.05	----	<0.05	----	----
Trifluralin	1582-09-8	10.0	^g/L	<10.0	----	<10.0	----	----
EP234D: Triazinone Herbicides								
Hexazinone	51235-04-2	0.02	^g/L	<0.02	—	<0.02	—	—
Metribuzin	21087-64-9	0.02	^g/L	<0.02	----	<0.02	----	----
EP234E: Conazole and Aminopyrimidine Fungicides								
Cyproconazole	94361-06-5	0.02	^g/L	<0.02	—	<0.02	—	—
Difenoconazole	119446-68-3	0.02	^g/L	<0.02	----	<0.02	----	----
Flusilazole	85509-19-9	0.02	^g/L	<0.02	----	<0.02	----	----
Hexaconazole	79983-71-4	0.02	^g/L	<0.02	----	<0.02	----	----
Paclobutrazole	76738-62-0	0.05	^g/L	<0.05	----	<0.05	----	----
Penconazole	66246-88-6	0.01	^g/L	<0.01	----	<0.01	----	----
Propiconazole	60207-90-1	0.05	^g/L	<0.05	----	<0.05	----	----
Tebuconazole	107534-96-3	0.01	^g/L	<0.01	----	<0.01	----	----
Cyprodinil	121552-61-2	0.01	^g/L	<0.01	----	<0.01	----	----
Pyrimethanil	53112-28-0	0.02	^g/L	<0.02	----	<0.02	----	----
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides								
Diuron	330-54-1	0.02	^g/L	0.03		<0.02		
Fluometuron	2164-17-2	0.01	mq/l	<0.01	—	<0.01	—	—
Tebuthiuron	34014-18-1	0.02	mq/l	3.01	----	0.02	----	----
Bromacil	314-40-9	0.02	mq/l	<0.02	----	<0.02	----	----
Chlorsulfuron	64902-72-3	0.2	fjg/L	<0.2	---	<0.2	---	---
Metolachlor	51218-45-2	0.01	mq/l	0.16	---	<0.01	---	---
Ametryn	834-12-8	0.01	mq/l	<0.01	—	<0.01	—	—
Atrazine	1912-24-9	0.01	mq/l	0.05	----	<0.01	----	----
Cyanazine	21725-46-2	0.02	mq/l	<0.02	----	<0.02	----	----
Cyromazine	66215-27-8	0.05	mq/l	<0.05	----	<0.05	----	----
Prometryn	7287-19-6	0.01	mq/l	<0.01	----	<0.01	----	----
Propazine	139-40-2	0.01	mq/l	<0.01	---	<0.01	---	---
Simazine	122-34-9	0.02	mq/l	<0.02	----	<0.02	----	----
Terbuthylazine	5915-41-3	0.01	mq/l	0.08	----	<0.01	----	----
Terbutryn	886-50-0	0.01	mq/l	<0.01	---	<0.01	---	---
Diclofop-methyl	51338-27-3	0.05	mq/l	<0.05	—	<0.05	—	—
Fenarimol	60168-88-9	0.02	mq/l	<0.02	----	<0.02	----	----
Irgarol	28159-98-0	0.002	mq/l	<0.002	----	<0.002	----	----
Oxyfluorfen	42874-03-3	1.0	mq/l	<1.0	----	<1.0	----	----
Thiamethoxam	153719-23-4	0.02	mq/l	<0.02	----	<0.02	----	----
Imidacloprid	----	0.01	mq/l	<0.01	----	<0.01	----	----
Dibromo-DDE	21655-73-2	0.5	%	68.9		78.5	---	---
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	72.7		82.9	---	---
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	5	%		106	—	109	108
Toluene-D8	2037-26-5	5	%		97.1	----	98.6	95.4
4-Bromofluorobenzene	460-00-4	5	%		105	----	105	102
EP074G: Trihalomethanes								
Chloroform	67-66-3	5	mq/l	159	----	----	—	—
Bromodichloromethane	75-27-4	5	mq/l	43	_--	-_-	—	—
Dibromochloromethane	124-48-1	5	mq/l	10	----	----	—	—
Bromoform	75-25-2	5	mq/l	<5	----	----	—	—
^ Total Trihalomethanes	----	5	mq/l	212	----	----	—	—
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	5	%	107	—	—	—	—
Toluene-D8	2037-26-5	5	%	96.3	----	----	—	—
4-Bromofluorobenzene	460-00-4	5	%	101	----	----	—	—

APPENDIX C

Example of *E. coli* verification monitoring program schedule

Week No.	Week Start	Glenmore WTP	Agnes Street Low Pressure System											Agnes Street High Pressure System				Yaamba Road Reservoir System							
			AL1 O'Connell St	AL2 Cambridge St	AL3 Exhibition Rd	AL4 Ann St	AL5 Gladstone Rd	AL6 Hunter St	AL7 Wandal Rd	AL8 Port Curtis Rd	AL9 Derby St	AL10 Denham St	AL11 Old Capricorn Hwy	AH1 Nathan St	AH2 North St	AH3 Herbert St	AH4 Jessie St	YR1 Bruigom St	YR2 Main St	YR3 Macallister St	YR4 Beaney St	YR5 Norman Rd	YR6 Maloney St	YR7 Rachel Drv	YR8 Robison St
1	02-Jan-17	x								x						x						x			
2	09-Jan-17	x									x						x						x		
3	16-Jan-17	x										x		x										x	
4	23-Jan-17	x											x		x										x
5	30-Jan-17	x	x													x		x							
6	06-Feb-17	x		x													x		x						
7	13-Feb-17	x			x									x						x					
8	20-Feb-17	x				x									x						x				
9	27-Feb-17	x					x									x						x			
10	06-Mar-17	x						x									x						x		
11	13-Mar-17	x							x					x										x	
12	20-Mar-17	x								x					x										x
13	27-Mar-17	x									x					x		x							
14	03-Apr-17	x										x					x		x						
15	10-Apr-17	x											x	x						x					
16	17-Apr-17	x	x												x						x				
17	24-Apr-17	x		x												x						x			
18	01-May-17	x			x												x						x		
19	08-May-17	x				x										x								x	
20	15-May-17	x					x										x								x
21	22-May-17	x						x						x				x							
22	29-May-17	x							x						x				x						
23	05-Jun-17	x								x						x				x					
24	12-Jun-17	x									x						x				x				
25	19-Jun-17	x										x		x								x			
26	26-Jun-17	x											x		x								x		
27	03-Jul-17	x	x													x								x	
28	10-Jul-17	x		x													x								x
29	17-Jul-17	x			x									x				x							
30	24-Jul-17	x				x									x				x						
31	31-Jul-17	x					x									x				x					
32	07-Aug-17	x						x									x				x				
33	14-Aug-17	x							x					x								x			
34	21-Aug-17	x								x					x								x		
35	28-Aug-17	x									x					x								x	
36	04-Sep-17	x										x					x								x
37	11-Sep-17	x											x	x				x							
38	18-Sep-17	x	x												x				x						
39	25-Sep-17	x		x												x				x					
40	02-Oct-17	x			x												x				x				
41	09-Oct-17	x				x								x								x			
42	16-Oct-17	x					x								x								x		
43	23-Oct-17	x						x								x								x	
44	30-Oct-17	x							x								x								x
45	06-Nov-17	x								x				x				x							
46	13-Nov-17	x									x				x				x						
47	20-Nov-17	x										x				x				x					
48	27-Nov-17	x											x				x				x				
49	04-Dec-17	x	x											x								x			
50	11-Dec-17	x		x											x								x		
51	18-Dec-17	x			x											x								x	
52	25-Dec-17	x				x											x								x

Example of *E. coli* verification monitoring program schedule (continued)

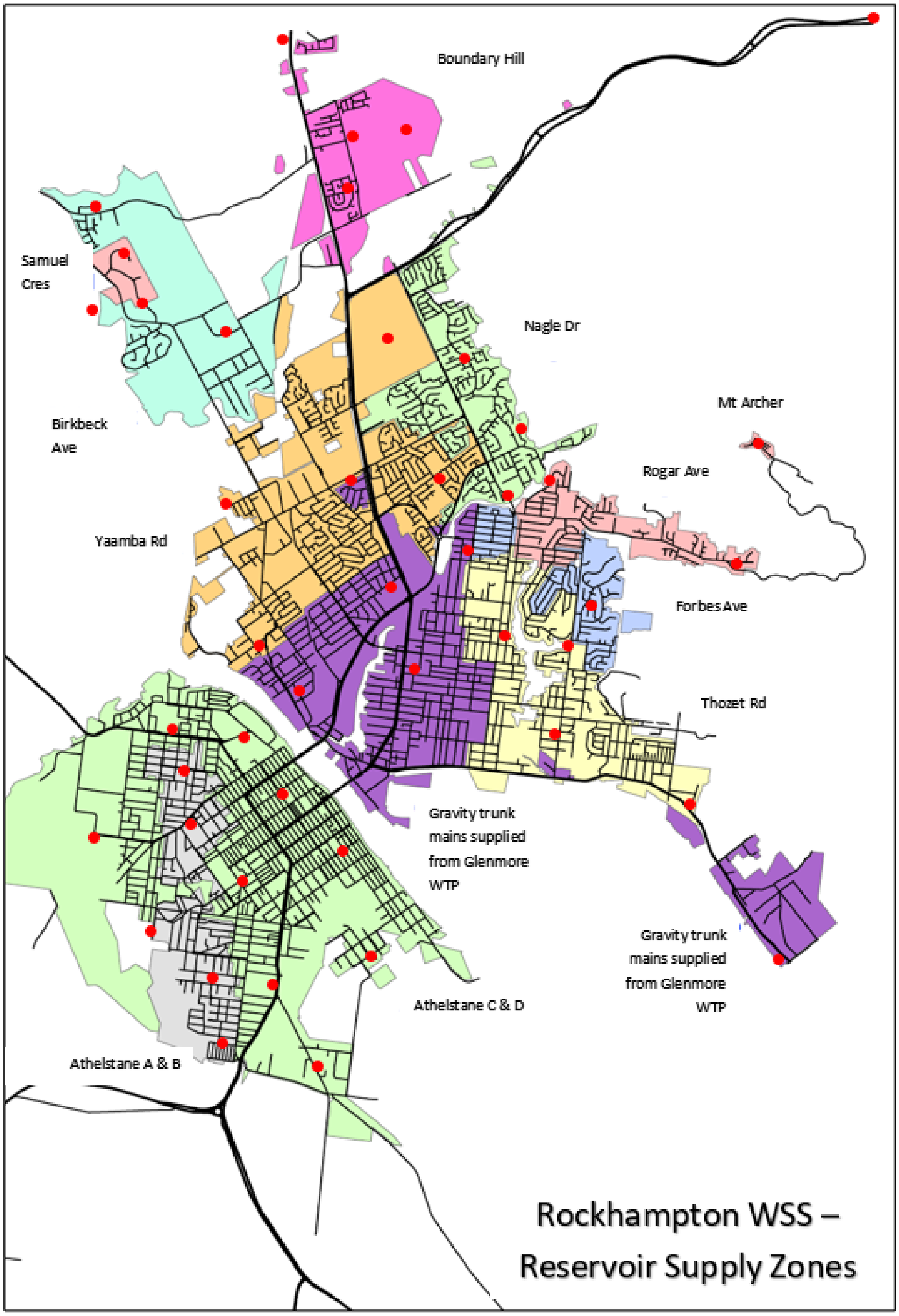
Thozets Road Reservoir System						Forbes Ave Reservoir System	Rogar Avenue Reservoir System		Nagle Drive Reservoir System			Parkhurst Trunk Main System		Lakes Creek Main	Mount Archer	Samuel Cres		Birkbeck Reservoir System
TR1	TR2	TR3	TR4	TR5	TR6	FR1	RA1	RA2	ND1	ND2	ND3	PH1	PH2	LC1	MA1	SC1	SC2	BD1
Earl St	Lucas St	Joiner St	Berserker St	O'Shanesy St	Lakes Creek Rd	Aldridge Ave	Eichelberger St	Frenchville Rd	Norman Rd	Selwyn Crs	Alyssa Court	McMillan Ave	Yaamba Rd	Emu Park Rd	Sleipner St	Samuel Crs	Gremalis Dr	Bush Crs
	x						x			x								
		x											x	x				
			x												x		x	
				x														x
					x			x			x							
x												x		x				
	x														x	x		
		x																x
			x			x			x									
				x									x	x				
					x										x		x	
x																		x
	x						x			x								
		x										x		x				
			x												x	x		
				x														x
					x			x			x							
x													x	x				
	x														x		x	
		x																x
			x			x			x									
				x								x		x				
					x										x	x		
x																		x
	x						x			x								
		x											x	x				
			x												x		x	
				x														x
					x			x			x							
x												x		x				
	x														x	x		
		x																x
			x			x			x									
				x									x	x				
					x										x		x	
x																		x
	x						x			x								
		x										x		x				
			x												x	x		
				x														x
					x			x			x							
x													x	x				
	x														x		x	
		x																x
			x			x			x									
				x								x		x				
					x										x		x	
x																		x
	x						x			x								
		x											x	x				
			x												x	x		
				x														x

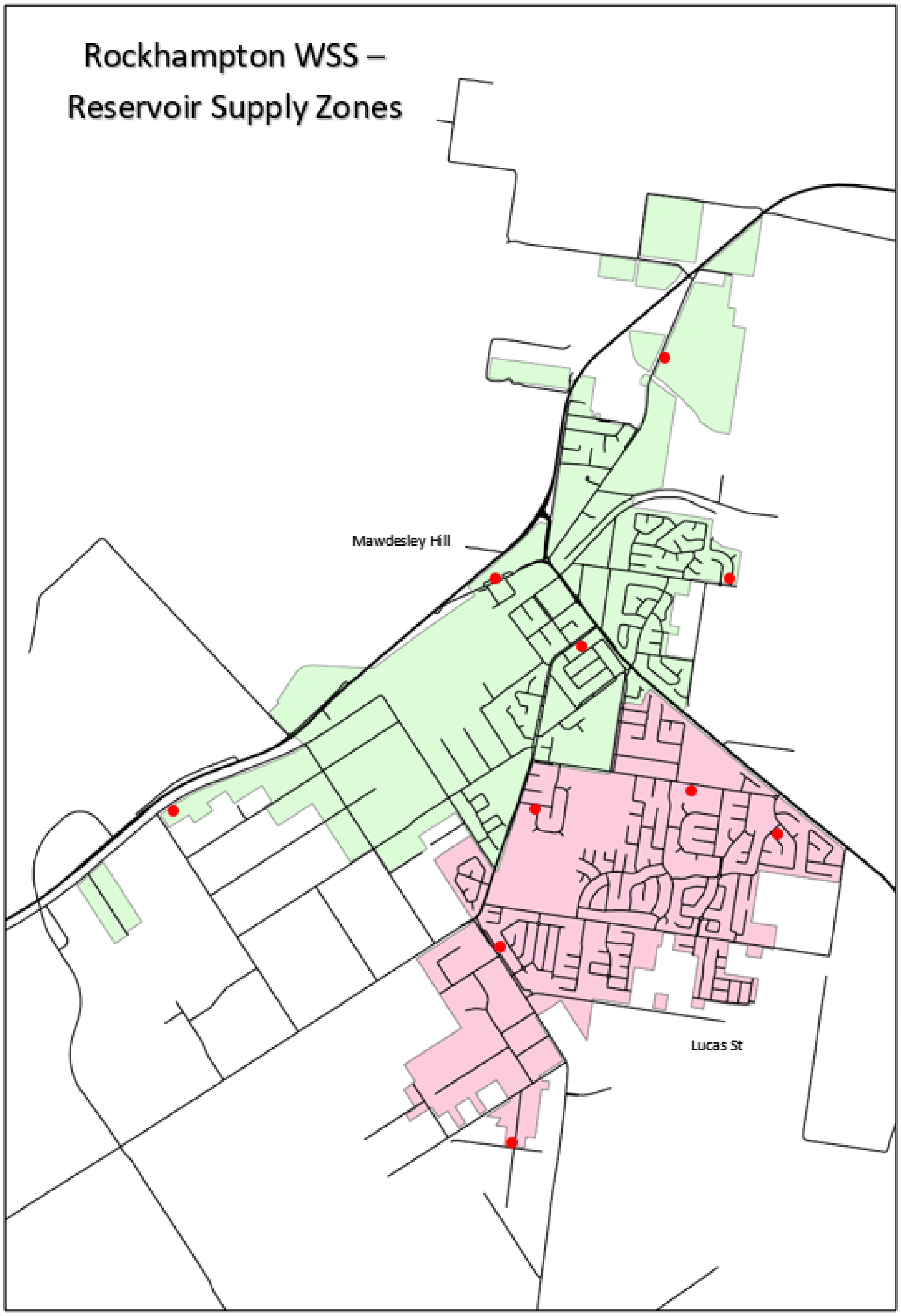
Example of *E. coli* verification monitoring program schedule (continued)

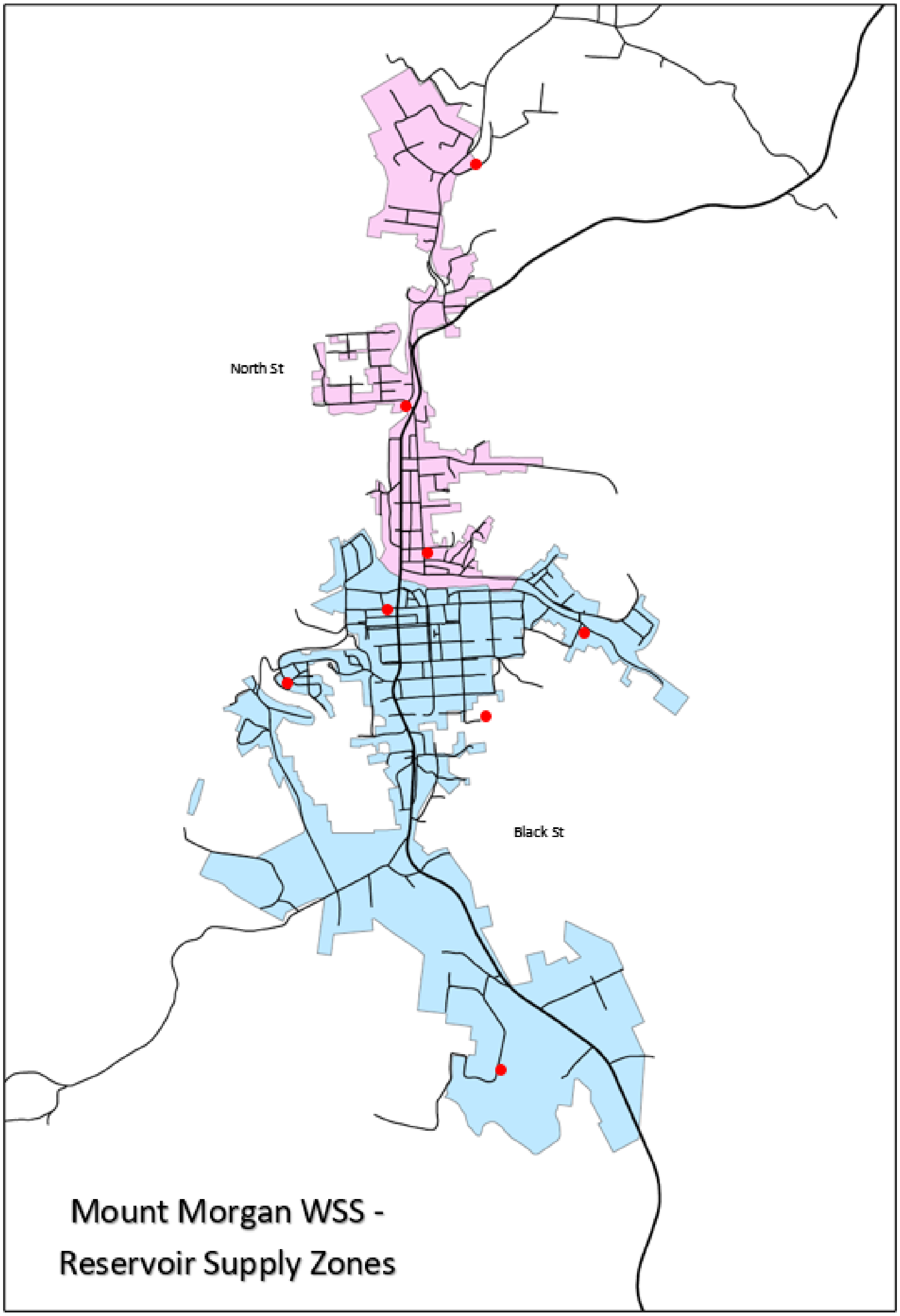
Ramsay Creek Pumped	Mawdesley Hill Reservoir System				Lucas Street Reservoir System				Mt Morgan WTP	Black Street Reservoir System				North Street Reservoir System			Total Number of Samples
RC1	MH1	MH2	MH3	MH4	LS1	LS2	LS3	LS4		BS1	BS2	BS3	BS4	NS1	NS2	NS3	
Yaamba Rd	O'Shanesy St	Range St	James St	Somerset Rd	Cherryfiled Road	Lillypilly Ave	Johnson Rd	Donovan Crs		Dee St	River St	Smalls Rd	Limerick Ln	Creek St	Gordon Lane	Byrnes Pde	
				x		x			x	x					x		12
	x						x		x		x					x	12
		x						x	x			x		x			12
x			x		x				x				x		x		12
				x		x			x	x						x	12
	x						x		x		x			x			12
		x						x	x			x			x		12
x			x		x				x				x			x	12
				x		x			x	x				x			12
	x						x		x		x				x		12
		x						x	x			x				x	12
x			x		x				x				x	x			12
				x		x			x	x					x		12
	x						x		x		x					x	12
		x						x	x			x		x			12
x			x		x				x				x		x		12
				x		x			x	x						x	12
	x						x		x		x			x			12
		x						x	x			x			x		12
x			x		x				x				x			x	12
				x		x			x	x				x			12
	x						x		x		x				x		12
		x						x	x			x				x	12
x			x		x				x				x	x			12
				x		x			x	x					x		12
	x						x		x		x					x	12
		x						x	x			x		x			12
x			x		x				x				x		x		12
				x		x			x	x						x	12
	x						x		x		x			x			12
		x						x	x			x			x		12
x			x		x				x				x			x	12
				x		x			x	x				x			12
	x						x		x		x				x		12
		x						x	x			x				x	12
x			x		x				x				x	x			12
				x		x			x	x					x		12
	x						x		x		x					x	12
		x						x	x			x		x			12
x			x		x				x				x		x		12
				x		x			x	x						x	12
	x						x		x		x			x			12
		x						x	x			x			x		12
x			x		x				x				x			x	12
				x		x			x	x				x			12
	x						x		x		x				x		12
		x						x	x			x				x	12
x			x		x				x				x	x			12
				x		x			x	x					x		12
	x						x		x		x					x	12
		x						x	x			x		x			12
x			x		x				x				x		x		12

APPENDIX D

Reservoir water supply zones and sampling points




Rockhampton WSS –
Reservoir Supply Zones
Mawdesley Hill
Lucas St


North St
Black St
Mount Morgan WSS -
Reservoir Supply Zones

Appendix E

Chlorine Free (mg/L)

Sampling Date	Glenmore WTP	Agnes St LP (AL)	Agnes St HP (AH)	Yaamba Rd (YR)	Thozet Rd (TR)	Forbes/Rogar (FR)	Forbes Ave (FA)	Rogar Ave (RA)	Nagle Drive (ND)	Parkhurst (PH)	Lakes Creek (LC)	Mt Archer (MA)	Samuel Cres (SC)	Birkbeck Dr (BD)	Mawdesley Hill (MH)	Lucas Street (LS)	Boundary Hill Res (BH)	Ramsay Creek (RC)	Mount Morgan WTP	Black Street (BS)	North Street (NS)
04-Jul-23	1.03	0.48	0.56	0.35	0.48									0.60	0.94	0.28	0.83	0.50	0.92	0.08	0.10
11-Jul-23	1.05	0.34	1.08	0.86	0.51	0.71			0.28						0.98	1.15		0.05	1.18	0.80	0.04
18-Jul-23	1.07	1.30	1.26	0.67	1.01					0.52	0.64				1.10	0.79		0.58	1.14	0.28	0.85
25-Jul-23	1.07	1.17	0.89	0.61	0.90							1.23	1.05		0.98	1.03			1.14	0.42	0.96
01-Aug-22	0.51	0.39	1.25	0.59	0.23									1.07	1.41	1.07	1.14		1.13	0.45	1.07
08-Aug-22	0.77	0.88	0.75	0.90	0.39	0.32			0.74						0.82	0.65			0.82	0.70	0.71
15-Aug-22	0.51	0.76	0.60	0.85	0.68						0.12				0.82	0.89			0.86	0.19	0.93
22-Aug-22	0.78	0.98	0.55	1.15	0.25							0.62	1.24		0.59	0.90			0.77	0.58	0.35
29-Aug-22	0.76	0.28	0.78	0.34	0.32									0.99	0.76	0.11	1.13		0.82	0.27	0.90
06-Sep-22	0.83	0.06	0.60	1.22	0.42			0.87	0.90			0.77				0.64			0.74	0.69	1.07
12-Sep-22	1.01	1.00	0.97	0.72	0.22					0.52	0.18				1.45	0.93			0.84	0.60	1.32
20-Sep-22	0.71	0.43	0.33	0.66	0.28							0.49	0.98		0.46	0.76			0.86	0.34	0.01
27-Sep-22	0.62	0.86	0.93	0.44	0.57									1.13	0.53	0.66	1.01		0.51	0.33	0.78
04-Oct-22	0.57	0.80	0.77	0.84	0.56			0.51	0.76						0.74	0.00			0.58	0.58	1.08
11-Oct-22	0.66	0.80	0.69	0.74	0.16						0.41				0.94	0.51		0.46	0.91	0.14	0.07
18-Oct-22	0.66	0.24	0.13	1.00	0.30							0.85	0.63		0.69	0.91			0.95	0.59	1.07
24-Oct-22	1.02	0.23	0.58	0.31	0.04									0.70	0.99	1.02	0.99		0.83	0.07	1.42
04-Nov-22	0.88	0.46	0.65	0.62	0.46	0.43			0.06						0.99	0.94			0.88	0.46	1.02
07-Nov-22	0.50	0.82	0.66	0.39	0.72					0.41	0.73				1.56	1.66			0.53	0.07	0.75
14-Nov-22	0.92	1.23	0.80	0.97	0.36							0.81	0.50		0.10	0.71			0.77	0.25	1.04
21-Nov-22	0.88	0.04	0.02	1.05	0.64									0.93	0.62	0.76	0.65		0.62	0.00	0.00
05-Dec-22	0.94	0.63	1.04	1.15	0.23					0.79	0.57				0.87	0.86			1.03	0.33	1.21
13-Dec-22	0.74	0.09	0.02	1.02	0.17							0.22	0.99		0.26	0.36			0.62	0.66	0.73
19-Dec-22	0.88	1.11	0.51	0.48	1.23									0.91	0.85	0.72	0.89		0.83	0.06	0.51
28-Dec-22	0.85	0.72	0.79	0.70	0.55			0.86	0.81						0.24	0.67			0.55	0.56	0.55
04-Jan-23	0.63	0.14	0.75	0.35	1.09						1.31				0.68	0.72		0.85	0.80	0.03	0.33
09-Jan-23	0.99	0.20	0.90	0.88	0.46							1.48	1.35		0.67	0.66			0.73	0.10	0.46
17-Jan-23	0.73	0.67	0.51	0.43	0.78									0.82	0.56	0.60	0.86		0.92	0.58	1.01
24-Jan-23	1.21	0.77	1.01	1.12	0.86	0.59			0.05						0.99	0.46			0.33	0.33	0.22
31-Jan-23	0.66	0.96	0.47	0.13	0.44					0.12	0.99				0.98	0.95			0.94	0.71	0.74
06-Feb-23	2.31	1.24	<0.01	2.41	0.95							2.71	1.22		1.24	1.72			1.81	<0.01	2.56
13-Jan-23	0.81	0.65	0.63	0.16	0.57									0.19	0.73	0.79			0.86	1.15	0.84
20-Feb-23	0.80	0.49	0.20	0.17				0.72	0.39						0.67	0.81	0.80		0.94	0.27	1.35
27-Feb-23	0.73	0.41	0.24	0.48	0.48					0.40	0.42				1.03	1.04			0.84	0.92	0.05
06-Mar-23	0.88	0.74	0.44	0.28	0.29							0.81	0.91		0.45	0.83			0.98	0.16	0.72
13-Mar-23	0.92	0.85	0.71	0.41	0.55									1.01	0.50	0.68	0.98		0.89	0.60	0.55
20-Mar-23	0.99	0.37	0.71	0.90	0.51			0.46	0.64						0.74	0.67			0.92	0.84	1.04
27-Mar-23	0.71	0.87	0.97	0.72	0.69						0.61				0.71	0.84		0.73	1.14	0.33	0.30
03-Apr-23	0.89	0.41	0.67	0.64	0.51							0.54	0.65		0.49	0.34			0.92	0.19	0.61
11-Apr-23	0.83	0.52	0.49	0.41	0.29									0.97	0.84	0.81	1.05		0.95	0.65	0.77
19-Apr-23	1.06	0.88	0.67	0.59	0.39	0.77			0.85						1.05	1.12			0.95	0.60	0.38
24-Apr-23	0.80	0.85	0.97	0.69	0.29					0.90	0.31				1.10	0.80			1.02	0.66	0.70
02-May-23	0.83	0.69	0.61	0.74	0.71							0.62	0.84		0.79	0.75			0.77	0.28	0.65
08-May-23	1.00	0.58	0.61	0.79	0.88									0.85	0.83	0.75	1.20		1.05	0.45	0.29
16-May-23	0.91	0.61	0.72	0.75	0.70			0.81	0.69						0.85	0.87			0.96	0.82	0.71
22-May-23	0.91	0.35	1.05	0.76	0.69					0.75	0.64				0.95	1.03			1.15	0.25	0.97
30-May-23	1.02	0.59	0.81	0.86	0.75							0.71	0.91		0.79	0.82			0.94	0.31	0.63
06-Jun-23	0.91	0.84	0.70	0.98	1.07									1.08	1.03	1.07	1.19		1.09	0.90	0.98
13-Jun-23	0.75	0.79	0.75	1.04	1.13			1.02	1.06						0.93	0.89			0.87	0.92	0.93
20-Jun-23	0.88	0.99	1.04	1.06	1.07						1.09			1.06	1.11	1.13			1.08	0.45	0.59
27-Jun-23	0.92	0.54	0.70	0.76	0.53							0.63	0.87		0.81	0.84			0.90	0.43	0.92
03-Jul-23	0.93	0.65	0.96	0.70	0.75									1.11	0.92	0.88	1.03		1.01	0.94	1.13
10-Jul-23	0.84	0.34	0.54	0.69	0.63	0.61			0.71						0.72	0.78			1.01	0.96	0.90
18-Jul-23	0.92	0.89	0.87	0.71	0.74					0.72	0.69				0.90	0.87			0.98	0.94	1.02
23-Jul-23	0.99	0.81	0.71	0.85	0.73							0.69	0.98		0.77	0.74			0.95	0.35	0.89
31-Jul-23	0.95	0.86	0.82	0.77	0.81									0.92	0.89	0.84	0.94		0.92	0.88	0.79