



**Cook Shire**  
**COUNCIL**

**Coen**

# **Drinking Water Quality Management Plan**

**BLIGH**  
**TANNER**

## + DOCUMENT CONTROL SHEET

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## + GLOSSARY

Term	Definition
ADWG	Australian Drinking Water Guidelines 2011
CSC	Cook Shire Council
DERM	Former Department of Environment and Resource Management
DWQMP	Drinking Water Quality Management Plan
PHR	Public Health Regulation 2005
RMIP	Risk Management Improvement Program
QH	Department of Health Queensland
WSR	Water Supply Regulation
WS(SR)A	Water Supply (Safety and Reliability) Act 2010

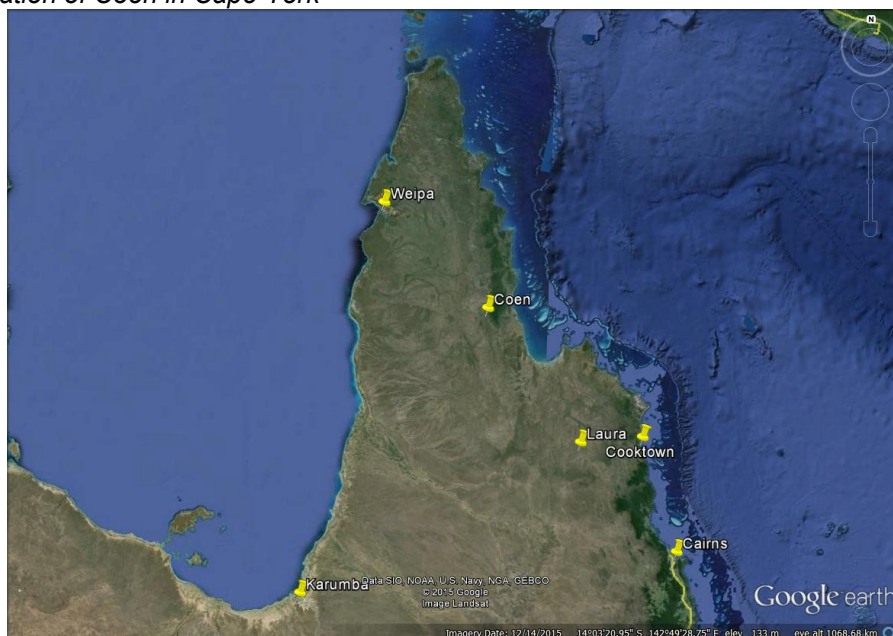
## 1 COEN

### 1.1 Overview

Coen is a small (~250 people) and very remote and isolated community in Cape York, approximately 400 km from Cooktown, and 250 km from Weipa on the unsealed Peninsula Development Road. This road is the main road route into the mining areas around Weipa. Despite its small size, Coen is considered as a service centre for many other smaller communities in the Cape. However, due to the remoteness of Coen, and the proximity to major mining areas, few people with skills and qualifications remain in Coen, with the result that even minor breakdowns can be difficult to rectify. We therefore have a high reliance on the skills of the WTP operators to undertake preventive maintenance, and to identify and rectify faults promptly.

The community of ~250 is expected to grow over the next 10 years to approximately 305, with a corresponding increase in water demand from the current 0.3 ML/day to 0.35 ML/day.

Figure 1 Location of Coen in Cape York



Climate: Coen has distinct wet and dry seasons. During the wet season, Coen is usually isolated by road, and as a result has to be self-sufficient, however, there is an airport that remains open most of the time, unless the Coen River is in flood, and floods the airport. When this occurs, Coen can also be isolated by air. Due to this, the water treatment plant maintains critical spares on site, and stores sufficient water treatment chemicals from November/ December to last for ~4-5 months.

Table 1 Coen Rainfall Statistics (Coen Airport, BOM, 1887 – 2015)

Summary statistics for all years

[Information about climate statistics](#)

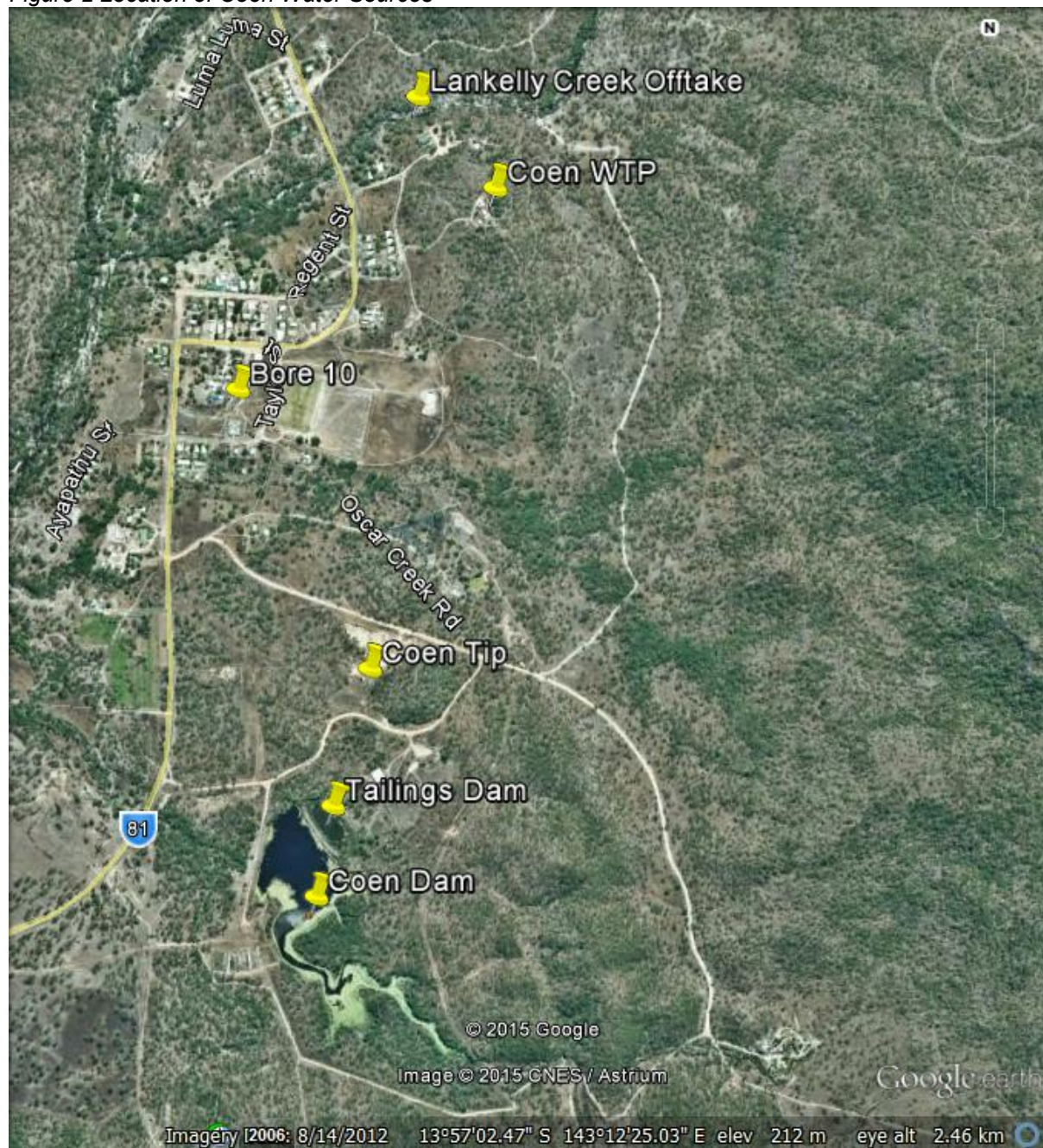
Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	283.1	290.8	249.1	92.3	14.6	9.2	6.4	4.4	3.1	12.9	53.6	157.8	1173.8
Lowest	5.6	8.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	482.4
5th %ile	116.7	73.6	61.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	655.9
10th %ile	132.0	114.4	88.1	7.6	0.0	0.0	0.0	0.0	0.0	0.0	1.1	27.6	799.8
Median	256.5	264.0	219.7	51.1	8.4	4.6	3.0	1.0	0.0	3.0	26.7	135.6	1162.3
90th %ile	473.4	484.7	462.0	227.4	36.5	22.7	17.0	13.7	7.1	40.0	147.8	304.9	1647.6
95th %ile	525.4	559.4	498.5	362.4	45.6	34.5	26.4	20.9	16.2	61.8	174.1	372.3	1719.3
Highest	785.6	781.9	745.4	562.8	119.8	81.0	47.5	44.5	97.0	133.9	451.2	927.2	2035.1



## 1.2 Water Sources

Coen has 3 water sources that supply the towns requirements. These include, in order of preference of use, the Lankelly Creek, Coen Dam, and the Coen bore fields.

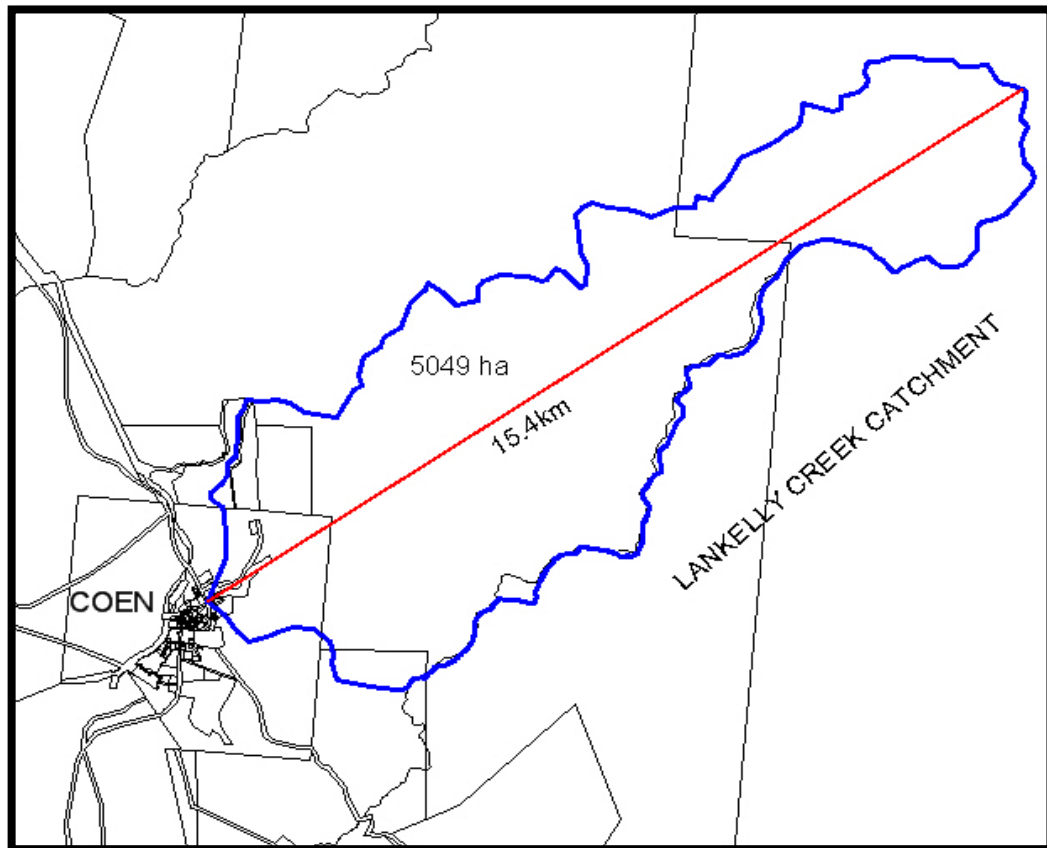
Figure 2 Location of Coen Water Sources



### 1.3 Lankelly Creek

When the Lankelly Creek is running, this is the preferred water source for Coen. However, the Lankelly Creek only runs for ~half the year, depending on the season, as such it provides 40-50% of the Coen water supply. The Lankelly Creek originates high in the rainforest approximately 15km to the east of the township. The catchment area of approx. 5000 ha is in pristine rainforest and due to the terrain has very limited human impact. Nonetheless, there is some activity near the offtake, and there are a few cattle in the catchment.

Figure 3 Lankelly Creek Catchment



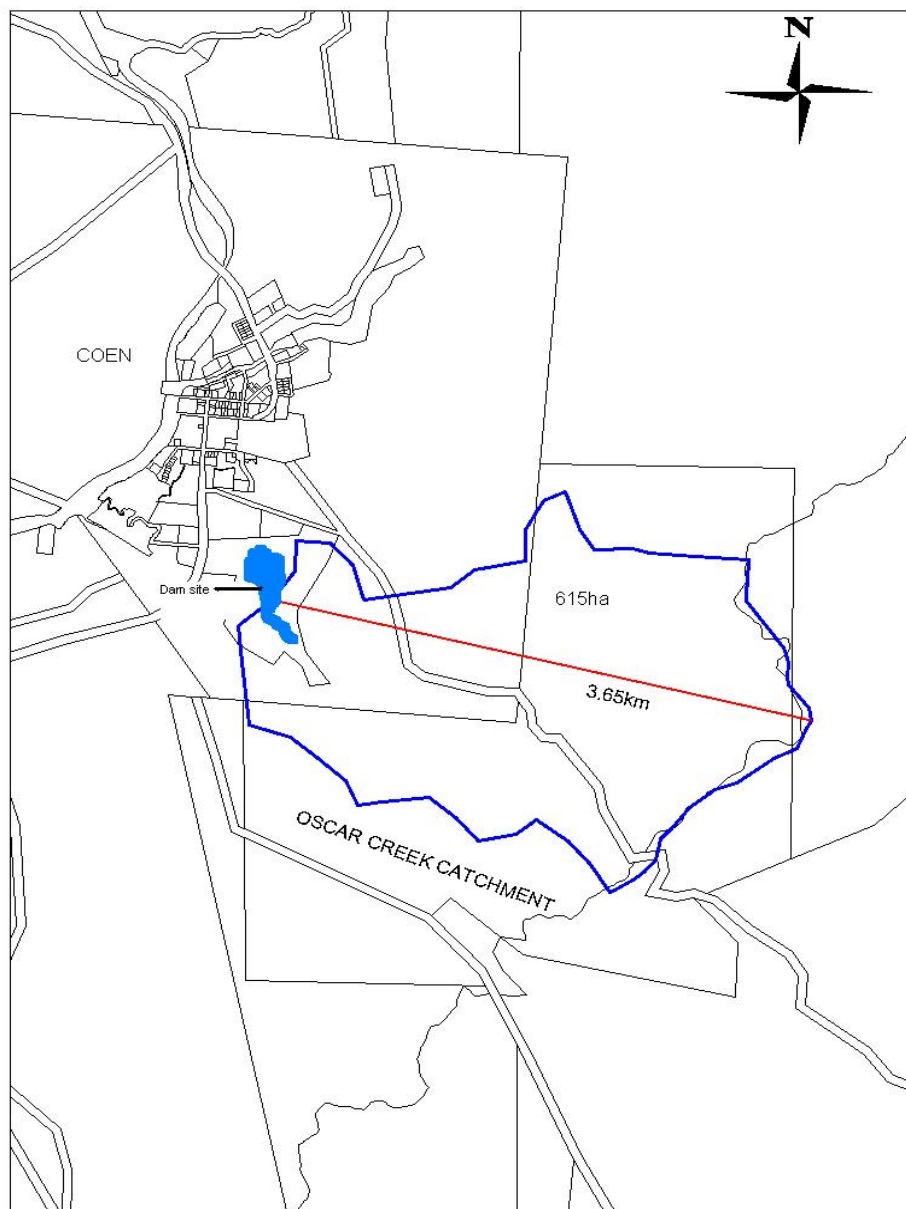


## 1.4 Coen Dam

The Coen Dam is located ~1.5 km South of Coen on the Oscar Creek. The dam was originally built for a gold mine, but was purchased by Council in the 1990s to ensure that Coen had sufficient water supply. The capacity of the dam is not known. The dam fills annually, and the water quality is good. As can be seen in the Google Earth image (Figure 2), the dam has significant amounts of lilies but this is not an issue and coverage has not increased for numerous year. The dam can be subject to blooms of cyanobacteria, but not annually. These are treated with algacide if required.

Figure 2 also shows that the water supply dam has a tailings dam immediately adjacent, and the Coen tip is located in a separate sub-catchment north of the dam.

Figure 4 Coen Dam Catchment



## 1.5 Coen Bore Fields

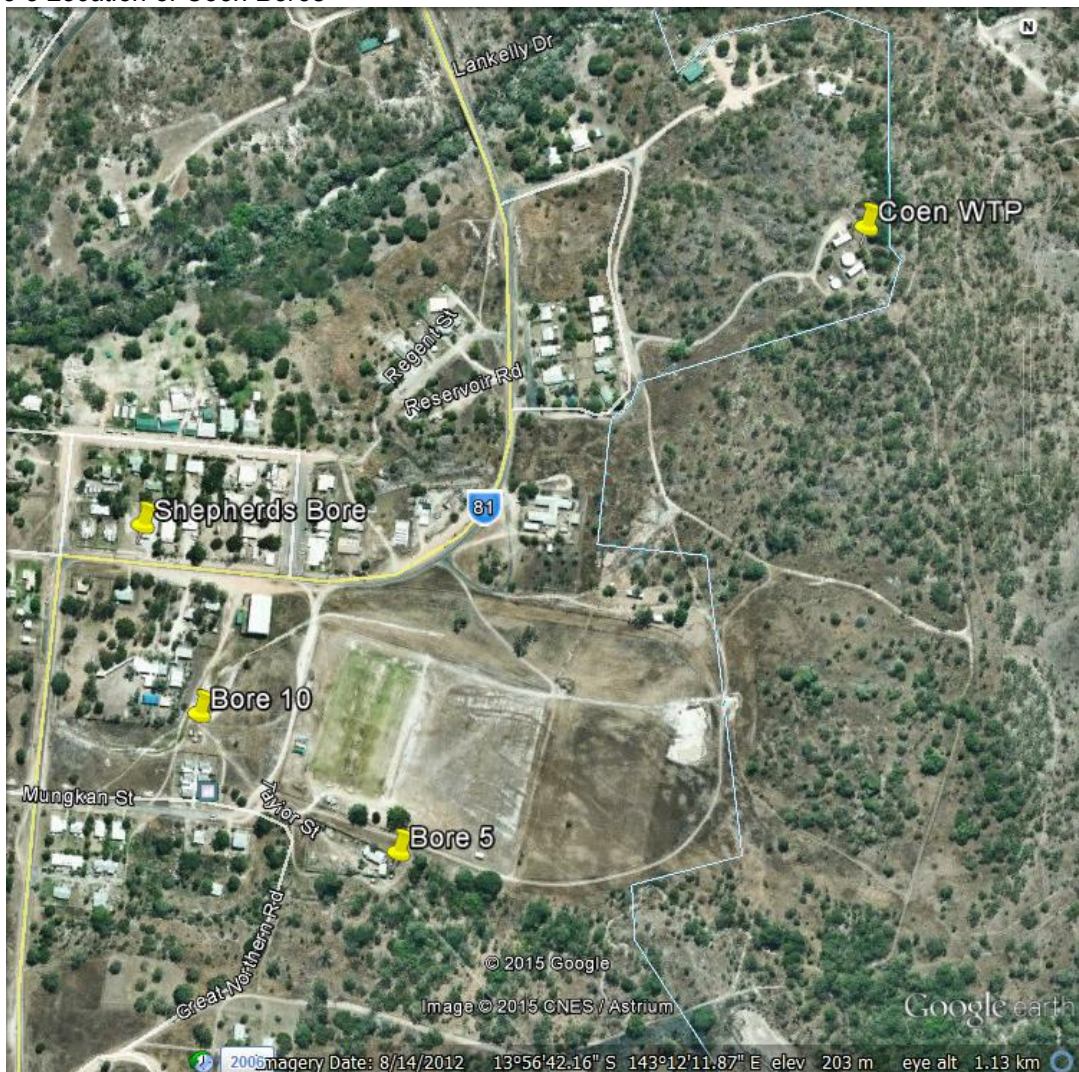
The Coen bores are used to provide water to the town when the Lankelly Creek and Coen Dam turbidity is high after a rain event in the wet season. Bores 5 and 10 have yields of ~2L/s and Shepherd's Bore has a yield of ~1 L/s. The bores are unable to provide the full supply during the dry season.

The bore report cards for these bores contain almost no information on the date drilled, the depth, or the strata. However, all are believed to be ~50-60 m deep, and tapping the Lankelly adamellite.

The bores are all located in sheds, with the borehead elevated ~60 cm above ground level. The bores are sealed. Inspections are done every three months to ensure integrity is maintained at all times.

Bores 5 and 10 are recharged with treated water when the Lankelly Creek supply is used, and records maintained of the volume recharged.

Figure 5 Location of Coen Bores



## 2 INFRASTRUCTURE

### 2.1 Raw water intakes

#### 2.1.1 Lankelly Creek

The Lankelly Creek intake consists of a concrete intake well structure built on the side of the Lankelly Creek. The intake has a Johnston Screen that prevents any debris damaging the two submersible pumps that operate as duty/ standby to pump water to the WTP. In the dry season, the Lankelly Creek is usually low turbidity (<5 NTU) and the DAF plant is bypassed directly into the raw water tank to minimise electricity costs.

At the commencement of flows in the Lankelly Creek, the turbidity can be higher, and in these cases, the Lankelly Creek water is treated through the DAF similar to the situation from Coen Dam.

The selection of treatment is at the discretion of the operator.

#### 2.1.2 Coen Dam

Coen Dam operates two raw water pumps at the Coen Dam (duty standby arrangements). The raw water pumps are submersible type bore pumps that have a shroud fitted for cooling purposes. They are located in pontoons approximately 20 m from the Dam wall.

Coen dam also has a destratification system. It consists of 100m long submerged length of 50mm poly pipe drilled with hundreds of 3mm holes along its entire length. This pipe is connected to two compressors, duty/standby which are located in the control room on the dam wall adjacent to the pontoons. Air is pumped through the pipe to aerate the dam adjacent to the intakes. This process eliminates any stratification near the intakes.

The destratification system is currently turned off. Records dating back approximately 20 years show that the dam compressors have run intermittently with no increase in cyanobacteria or arsenic concentrations. The dam will stratify but the intake level is approximately 1.5m below the surface and the dissolved oxygen concentration at the intake is acceptable.

A 100m uPVC pipeline 2 km long delivers this water to the treatment plant (directly to the DAF plant).

### 2.2 Treatment Process

#### 2.2.1 Process Steps - Lankelly Creek

The process starts when the Clean Water Reservoir either reaches the “Low Level” set point, or an operator overrides the set point to initiate a start.

The Treatment Plant will start automatically on demand, whatever time of the day or night, however it is preferred to control the start (usually early in the morning) so that the operators are working and can monitor treatment processes and perform their daily water quality tests.

The first step of the plant start up is the plant feed pump starts draw down the Raw Water Reservoir. The Alum and Caustic chemical dosing pumps start as soon as the plant finishes its first initial start-up backwash.

The primary feed pump draws water from this tank, lowering its level until the Raw Water Start level is reached. This starts the on duty Raw Water pump located in the bottom of the Intake structure in Lankelly Creek.

The chemical dosing skid includes:



- 2x Soda ash dosing pumps
- 2 x Alum dosing pumps
- 2 x Caustic dosing pumps

Soda ash is used intermittently; it may be used for 3 or 6 months, it seems to depend on the seasons. Soda ash is used when the raw water pH is low and needs to be raised to optimise the alum dose; soda ash also slightly raises the alkalinity of the raw water.

There are duty / standby soda ash dosing pumps of 0.065L/m capacity the operator can also select the pump to be on duty. Soda ash is made into an 8% solution from 25 kg bags, and made up in a 1000 litre tank; this generally lasts for several weeks.

There are 2 alum dosing pumps 2 of 0.065 L/m capacity. Alum is used as the primary coagulant. There are 2 caustic dosing pumps (duty/standby) of 0.065L/m capacity. This is dosed as pH correction post filtration.

The duty / standby alum dosing pumps are alternated weekly. This is done manually by the operator. Liquid alum is now used at the Coen T/Plant and is purchased and supplied in 24 tonne lots as a 47% solution and stored in bulk tanks in Cooktown. 1000L bulkbins are transported to Coen during the dry season and 2 of them are stored there as back up over the wet season. A bulk alum (2200L capacity) storage tank is located in the DAF Shed and alum is transferred to the treatment plant via a transfer pump, when the operator requires it, into a 500L holding tank.

Raw water pumped from the raw water reservoir is dosed with alum and soda ash, which then passes through a spiral chemical mixer prior to the roughing filter.

The roughing filter is a pressure vessel approximately half filled with anthracite which is the filter media. From the roughing filter the water then passes through to the feed tank and from there to the Memcor Continuous Micro Filtration unit at a rate of 7 L/s via the secondary plant feed pump. This rate can be varied by the operator as the raw water pumps have a flow rate of 5.5l/s into the raw water tank. From the CMF plant, the treated water is dosed with caustic soda if the pH of the final water is too low.

At the Coen Water Treatment Plant the filtration process is fully automated and controlled by a PLC. The plant is manned during working hours, and is currently required to run an average of 12 hrs daily. Cook Shire Council operates the plant during the day while its manned that way an operator is on hand should something malfunction.

At the Coen Treatment Plant roughing filter backwashes can be initiated:

- Manually
- Filter run time, (Operator can set this time)
- Head loss across the filter.

Granular media filtration performance can be monitored by sampling the effluent from the roughing filter and checking the turbidity.

Backwash water is sourced from the raw water tank as the turbidity is less than 5 NTU straight from the creek.

Backwashes for the CMF are done on time or operator initiated. Air is used to backwash with only a small amount of water from feed tank used to rinse the membranes. The membranes are very sensitive to chlorine and will compromise their integrity if they come into contact with any chlorine. The CMF has annual maintenance program when all maintenance is undertaken.

Final water from the plant goes directly to the clean water reservoir. Two recirculation pumps, duty/standby, are connected to the outlet of this tank and recirculate the water within the reservoir. A sodium hypochlorite injector is located on the outlet side of the pumps as well as a sample point for the chlorine analyser. The hypo pumps are controlled by the analyser to a set point that is operator

controlled, usually between 0.8 to 1.0 mg/L. This system works very efficiently and maintains a constant residual 24 hours a day.

### 2.2.2 Process Steps-Coen Dam

The process starts when the clean water reservoir either reaches the “Low Level” set point, or an operator overrides the set point to initiate a start.

The treatment plant will start automatically on demand, whatever time of the day or night, however it is preferred to control the start (usually early in the morning) so that the operators are working and can monitor treatment processes and perform their daily water quality tests.

The first step of the plant start up is the plant feed pump starts draw down the raw water reservoir. The alum and caustic chemical dosing pumps start as soon as the plant finishes its first initial start-up backwash.

The primary feed pump draws water from this tank, lowering its level until the raw water start level is reached. This starts the on duty raw water pump located at the Coen Dam.

A 100m uPVC pipeline 2 km long delivers this water to the treatment plant and directly to the Dissolved Air Flotation (DAF) inlet chamber. This chamber is injected with liquid alum and has a mixer fitted to ensure the chemical is well blended with the incoming raw water. From the mixing chamber the water passes through two 150mm transfer pipes into the filtrate tank. The outlet side of these pipes have three nozzles which inject an air saturated solution in which the tiny bubbles lift the flocculent particles to the surface of the tank. This saturated solution is formed in a separate pressure vessel (dispersion vessel) where clean water from the end of the filtrate tank is mixed with high pressure air to form the air saturated solution.

The filtered material called scum is then intermittently drawn off by a series of scrapers which ultimately end up in the backwash dam. The scrapers run time and frequency is operator adjusted, depending on the turbidity of the raw water.

The filtered water from the DAF then flows into the raw water tank where it is then drawn off and filtered in the same process described above for the Lankelly raw water.

### 2.2.3 Process Steps-Coen Bores

This system consists of three bores; - Bore 5, Bore 10 and Shephards Bore. All three are approximately 50m deep and are equipped with Grundfos submersible pumps. They all feed into a header tank of approximately 10,000L in capacity which is located adjacent to Bore 10. Bore 5 and 10 have a flow rate of approximately 2L/sec while Shephards bore is only about 1L/sec.

In the shed in which Bore 10 is housed are two Southern Cross centrifugal lift pumps which draw the water from the header tank and pump it directly into the town reticulation network. The water is injected with sodium hypochlorite on the outlet manifold of these pumps and the level monitored by the operator to the desirable set point, usually between 0.5mg/L and 0.7mg/L.

The water that is not used by the consumers makes its way back to the clean water reservoir and if it reaches full capacity, will send a signal via telemetry back to the lift pumps and turn them off. This system is fully automated, but due to the output over demand usually doesn't keep up with the usage. This system is basically used as a backup to the other two supplies and is used to either blend with one of the others so it gets use each year, or is used if either one of the other supplies is offline due to maintenance requirements.

Each year whilst on the Lankelly Creek supply, each bore is recharged for several months to ensure each aquifer has sufficient supply for later in the year when the bores are more likely to be used.

No treatment of the bore water is necessary as each one meets the ADWG.



Figure 6 Catchment to tap schematic – Coen

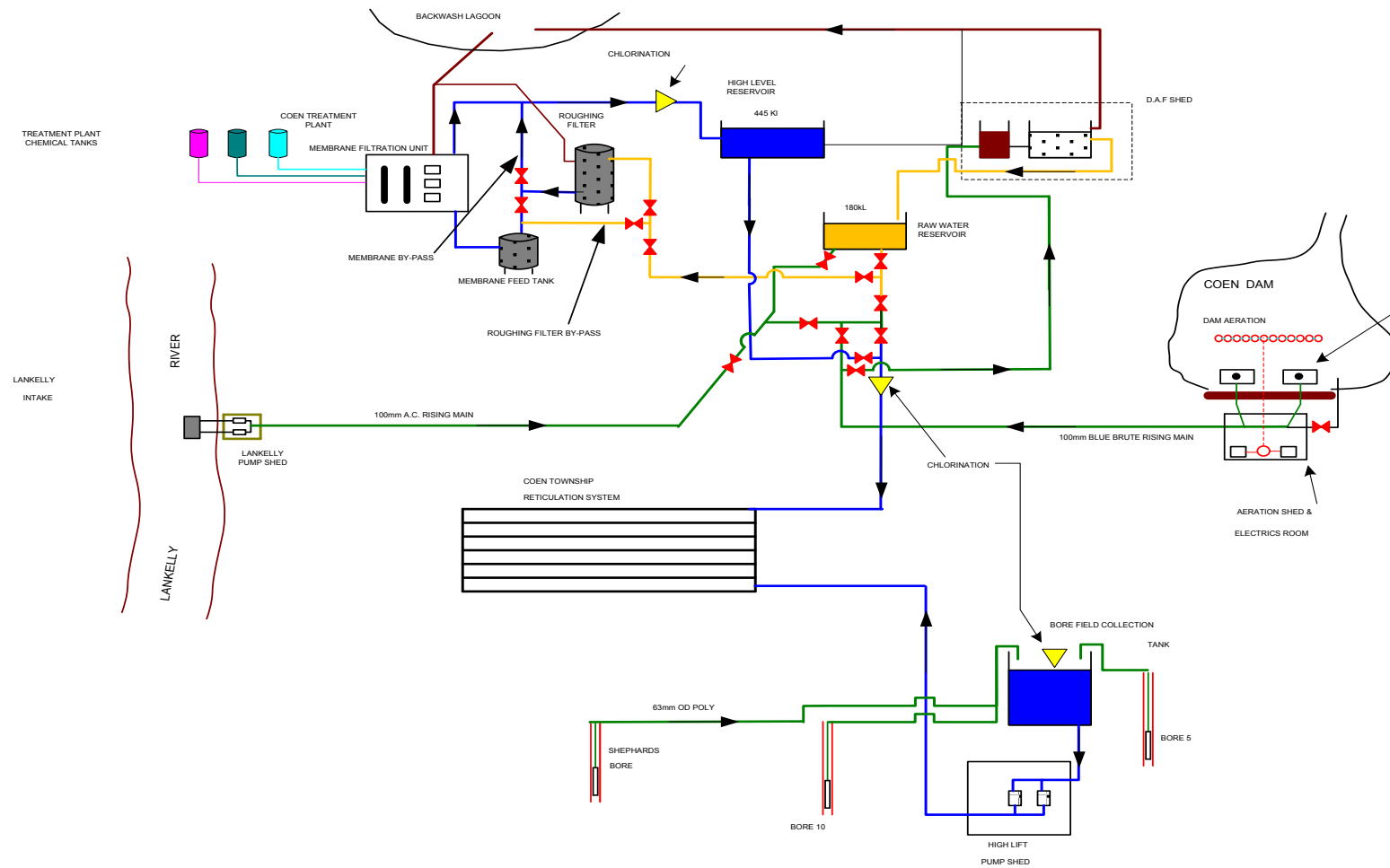


Figure 7 Coen Water Treatment Plant Schematic Overview

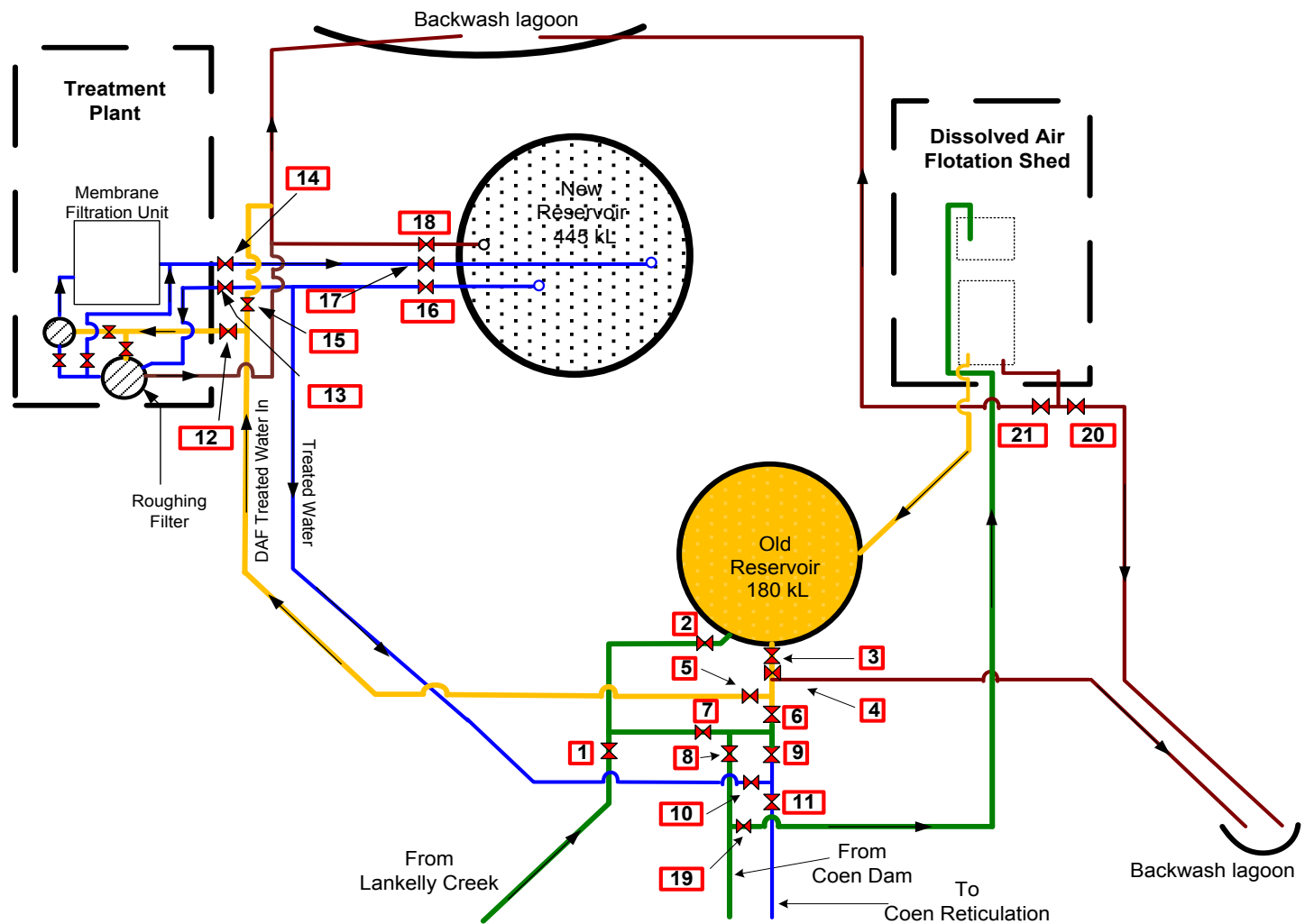


Figure 8 Coen Treatment Plant Process Overview

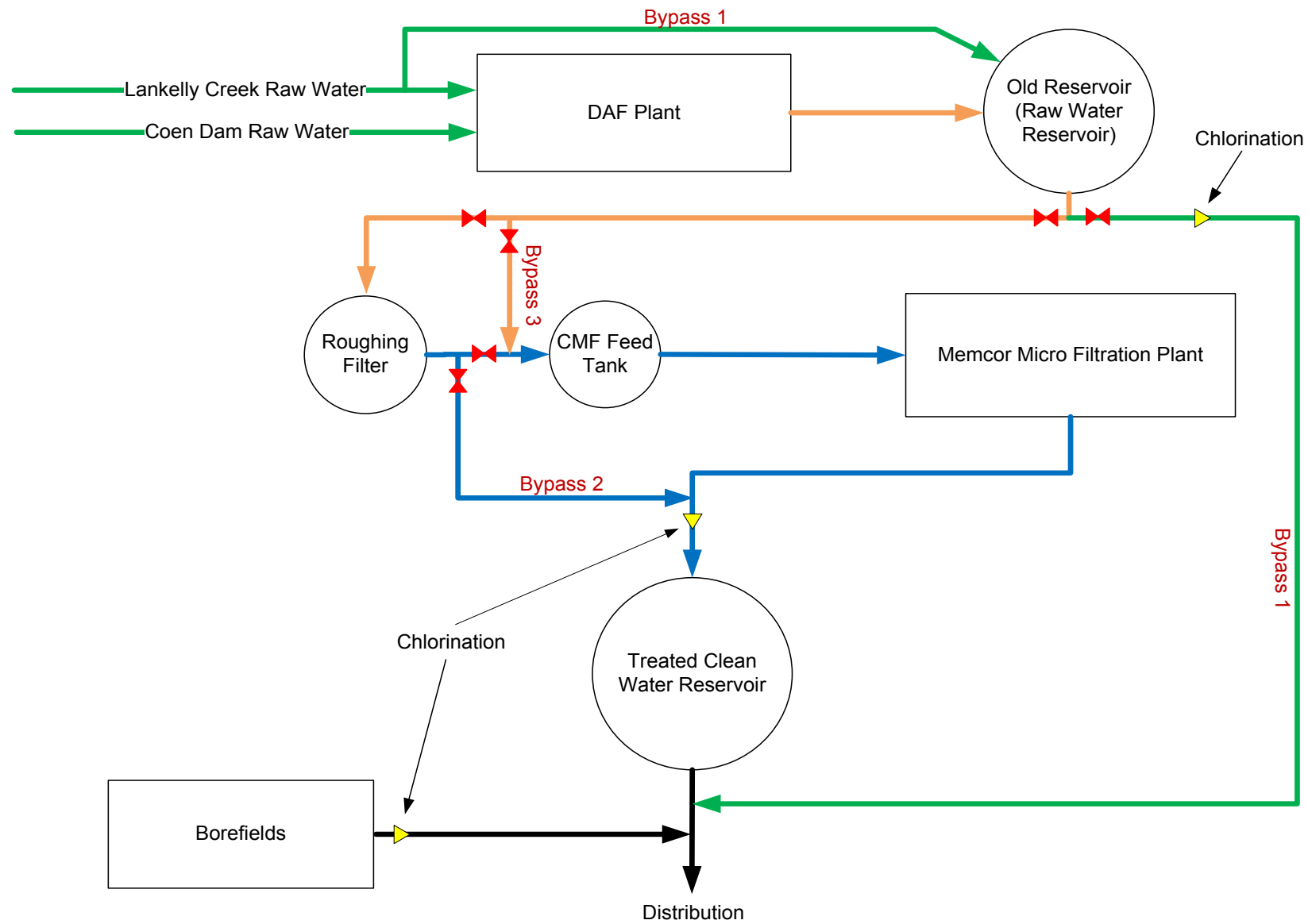




Figure 9 Google map image of Coen WTP (not all infrastructure is shown in the old imagery)





### 2.3 Valving arrangements for different supply options

The Valve arrangement at the Old Coen Reservoir and at the T/Plant is quite complex, but allows for different intake scenario's, and treatment options. Raw water comes from either the Lankelly Creek or the Coen Dam, or the Borefields can be supplied direct into the distribution with chlorination.

The Lankelly Creek can be treated either using the DAF plant (usually when the raw water has high turbidity's – Wet season) or without the DAF plant (usually when the raw water has low turbidity's – Dry Season). Considerable power savings can be made by not using the DAF plant during the dry season as the Lankelly Creek water quality is particularly good and requires little treatment.

The DAF plant is always used when treating the Coen Dam water as organic material in the Coen Dam water tends to seriously reduce the roughing filter run times, whereas the DAF plant removes the organic material entirely prior to the roughing filter, followed by the membrane micro filtration plant.

*Table 2 Scenario 1 Treat Raw Water from the Lankelly Using the DAF Plant*

Valve No	Valve Position	Comments
1	Open	Allows Raw Water from the Lankelly
2	Closed	Prevents Raw water entering the Old Reservoir
3	Open	Allows DAF Treated Water out of the Old Reservoir
4	Closed	Only opened when Scouring / Draining the Old Reservoir
5	Open	Allows DAF Treated Water out of the Old Reservoir and on to the Treatment plant
6	Closed	Prevents DAF Treated water from entering the Reticulation as well as preventing Lankelly Raw water from entering the Old Reservoir
7	Open	Allows Lankelly Raw water to travel to the DAF Plant
8	Open	Allows Lankelly Raw water to travel to the DAF Plant
9	Closed	Prevents Raw water from entering the Reticulation
10	Open	Allows Treated water into the Reticulation
11	Open	Allows Treated water into the Reticulation
12	Open	Allows DAF Treated water into the T/Plant
13	Open	Allows Treated water from the New Reservoir back to the Roughing Filter for Backwashing
14	Open	Allows Treated water into the New Reservoir
15	Closed	Allows DAF Treated water through to the Backwash Lagoon
16	Open	Allows Treated water out of the New Reservoir
17	Open	Allows Treated water into the New Reservoir
18	Closed	Only opened when Scouring / Draining the New Reservoir
19	Open	Allows Lankelly Raw water to travel to the DAF Plant
20/21	Open / Closed	Either 20 or 21 open the other closed depending on which B/wash lagoon is being used

*Table 3 Scenario 2 Treat Raw Water from the Lankelly without using the DAF Plant*

Valve No	Valve Position	Comments
1	Open	Allows Raw Water from the Lankelly
2	Open	Prevents Raw water entering the Old Reservoir
3	Open	Allows Raw Water out of the Old Reservoir
4	Closed	Only opened when Scouring / Draining the Old Reservoir
5	Open	Allows Raw Water out of the Old Reservoir and on to the Treatment plant
6	Closed	Prevents Raw water from entering the Reticulation
7	Closed	Allows Lankelly Raw water to travel to the DAF Plant
8	Closed	Prevents Lankelly water from going back to the Coen Dam
9	Closed	Prevents Raw water from entering the Reticulation
10	Open	Allows Treated water into the Reticulation
11	Open	Allows Treated water into the Reticulation
12	Open	Allows Raw water into the T/Plant
13	Open	Allows Treated water from the New Reservoir back to the Roughing Filter for Backwashing
14	Open	Allows Treated water into the New Reservoir
15	Closed	Allows DAF Treated water through to the Backwash Lagoon
16	Open	Allows Treated water out of the New Reservoir
17	Open	Allows Treated water into the New Reservoir
18	Closed	Only opened when Scouring / Draining the New Reservoir
19	Closed	Prevents Lankelly Raw water to travel to the DAF Plant
20/21	Open / Closed	Either 20 or 21 open the other closed depending on which B/wash lagoon is being used



Table 4 Scenario 3 Treat Raw Water from the Coen Dam using the DAF Plant

Valve No	Valve Position	Comments
1	Closed	Isolates Raw Water from the Lankelly
2	Closed	Prevents Raw water entering the Old Reservoir
3	Open	Allows DAF Treated Water out of the Old Reservoir
4	Closed	Only opened when Scouring / Draining the Old Reservoir
5	Open	Allows DAF Treated Water out of the Old Reservoir and on to the Treatment plant
6	Closed	Prevents DAF Treated water from entering the Reticulation
7	Closed	Controls flow Direction
8	Closed	Prevents Dam water from going any further forcing Dam water to the DAF Plant via valve 19
9	Closed	Prevents DAF Treated water from entering the Reticulation and prevents Treated water from entering the Old Reservoir
10	Open	Allows Treated water into the Reticulation
11	Open	Allows Treated water into the Reticulation
12	Open	Allows DAF Treated water into the T/Plant
13	Open	Allows Treated water from the New Reservoir back to the Roughing Filter for Backwashing
14	Open	Allows Treated water into the New Reservoir
15	Closed	Allows DAF Treated water through to the Backwash Lagoon
16	Open	Allows Treated water out of the New Reservoir
17	Open	Allows Treated water into the New Reservoir
18	Closed	Only opened when Scouring / Draining the New Reservoir
19	Open	Allows Lankelly Raw water to travel to the DAF Plant
20/21	Open / Closed	Either 20 or 21 open the other closed depending on which B/wash lagoon is being used

## 2.4 Bypasses

### 2.4.1 The Lankelly can bypass all filtration treatment processes

Bypass Trigger: Total Treatment Failure

Most Probable cause: Lightning Strike / Sever Electrical or Mechanical Fault

From the early 80's to the mid 90's Coen's Water came solely from the Lankelly creek, untreated but chlorinated and or from the Borefields, again untreated but chlorinated. In the event of a total treatment failure, then the Lankelly Creek water can be supplied directly into the reticulation with chlorination, this method is not a normal practice, but can be achieved in an emergency and will be done in consultation with Queensland Health as a Boil Water Alert may be required. This method of Supply from the Lankelly Creek can only be used during the "Dry Season". This bypass requires constant monitoring of the Chlorine residuals in the Reticulation with chlorine dose rate adjustments, as required.

### 2.4.2 The Raw Water or DAF Treated water can be filtered through the Roughing Filter bypassing the Membrane Filtration Unit

Bypass Trigger: Membrane Filtration Unit Failure

Most Probable cause: Electrical / Mechanical Fault

Again this is not a normal practice, but can be achieved during a mechanical or in most cases an electrical failure, and including lightning strikes which seems to happen quite frequently during the "Wet Season"

The remoteness of Coen often extends the time that a mechanical or electrical fault can be repaired as there is limited technical and electrical expertise in Coen. The Wet season adds an accessibility problem into the equation as well, as the road to Coen usually becomes totally closed due to flooding or wet & boggy conditions during the wet.

The ability to bypass the membrane filtration plant has proven in the past to be very useful.

*Table 5 Membrane Filter ByPass Valve configuration*

Valve No	Valve Position	Comments
AV 4.3	Closed	This valve configuration enables the Membrane Filter to be Bypassed. (To disable the Bypass the valve positions are reversed i.e. Valve AV 4.3 is to be Open & Valve AV4.7 is to be Closed)
AV 4.7	Open	

### 2.4.3 The raw water or DAF treated water can be filtered through the Membrane Filtration Unit (CMF) bypassing the roughing filter

Bypass Trigger: Roughing Filter control, or ancillary equipment failure

Most Probable cause: Electrical / Mechanical Fault

The roughing filter has its own PLC, pumps, valves etc, and is independent from the membrane filtration plant, this has been an advantage in the past as there are not a lot of conditions that affect both plants, except total power failure. Generally this part of the plant is less complex than the membrane filtration unit and is easier to work on, whereas the membrane plant requires specialist annual servicing and at times specific replacement parts.

The ability to bypass the roughing filter has also proven in the past to be very useful.

Table 6 Roughing Filter ByPass Valve configuration.

Valve No	Valve Position	Comments
22	Open	This valve configuration enables the Roughing Filter to be Bypassed. (To disable the Bypass the valve positions are reversed i.e. Valve 22 is to be Closed & Valve AV4.5 is to be Open)
AV 4.5	Closed	

Table 7 Infrastructure Details – Coen

Component		Coen
Sources	Name	<i>Lankelly Creek</i>
	Type	<i>Surface Water</i>
	% of supply	<i>40-50</i>
	Reliability	<i>Lankelly Creek stops flowing each year between July to November, depending on the preceding Wet Season</i>
	Water quality issues	<i>High Turbidity levels after Storm events / Flooding</i>
	Name	<i>Coen Dam</i>
	Type	<i>Dam</i>
	% of supply	<i>50-60</i>
	Reliability	<i>Dam fills up after every Wet Season. Only used after Lankelly stops flowing or is too turbid.</i>
	Water quality issues	<i>Seasonal Blue-Green algae (Not every year), naturally occurring Arsenic &amp; Iron</i>
	Name	<i>Coen Borefields</i>
	Type	<i>Network of Bores</i>
	% of supply	<i>Backup Only</i>
	Reliability	<i>Recharged annually whilst pumping from Lankelly Creek</i>
	Water quality issues	<i>Total Hardness &amp; TDS Higher than Desirable</i>

Component		Coen
Bore Head Details (Bore 5, Bore10)	Year Bore/s Sunk	<i>Approx 1978</i>
	Bore Casing size	<i>150mm</i>
	Bore Casing Material	<i>PVC</i>
	Sealed to prevent surface water ingress	<i>Yes, Located inside a building</i>
	Sealed to prevent vermin (frogs / snakes etc.) from entering bore	<i>Yes</i>
	Aquifer Name	<i>Lankelly Adamellite</i>
Bore Head Details (Shephards)	Year Bore/s Sunk	<i>Unknown</i>
	Bore Casing size	<i>150mm</i>
	Bore Casing Material	<i>PVC</i>
	Sealed to prevent surface water ingress	<i>Yes, Located inside a building</i>
	Sealed to prevent vermin (frogs / snakes etc.) from entering bore	<i>Yes</i>
	Aquifer Name	<i>Lankelly Adamellite</i>
Sourcing Infrastructure	Lankelly	<i>Fixed concrete intake in the creek with two electric submersible pumps pumped through to the Coen Reservoir</i>
Sourcing Infrastructure	Dam	<i>Two floating pontoons with electrical submersible pumps anchored to fixed position</i>
Sourcing Infrastructure	Bores	<i>Electrical equipped submersible pumps fitted in each Bore, bore depths are less than 50 metres</i>
Are there any sources that <b>do not</b> undergo treatment prior to supply?		<i>Coen Bores are disinfected only.</i>
Coen Treatment Plant	Process	<i>Process comprises of aeration (Coen dam only) dissolved air floatation (DAF) pressure filtration, micro filtration, and chlorination</i>
	Design Capacity (20 hr operation)	<i>0.45 ML/day</i>
	Daily flow range	<i>0.13 ML/d (Wet Season) - 0.35ML/d (Dry Season)</i>
	Chemicals added	<i>Soda Ash (if required), Liquid Alum, Sodium Hypochlorite and Caustic Soda if required</i>
	Standby chemical dosing facilities (Y/N)	<i>Yes</i>
	Water sourced from and %	<i>Water is sourced 60% from the Coen dam and 40% from the Lankelly Creek, and the bores are generally used as a standby</i>
	% of average day demand provided	<i>100%</i>
	% of scheme supply Distribution area supplied	<i>100%</i>



Component		Coen
	Bypass 1	<i>The Lankelly can bypass all filtration treatment by manual operation of several valves to achieve the bypass. The Raw water from the intake is pumped to the raw water reservoir. From there it can be directed into the reticulation system via several manual valves where it is chlorinated before leaving the T/Plant grounds</i>
	Bypass 2	<i>The Raw Water or DAF Treated water can be filtered through the Roughing Filter and bypass the Membrane Filtration Unit (CMF)</i>
	Bypass 3	<i>The Raw Water or DAF Treated water can be filtered through the Membrane Filtration Unit (CMF) bypassing the Roughing Filter</i>
Are there any sources that <b>do not</b> undergo disinfection prior to supply?		<i>No</i>
Disinfection Coen T/Plant	Location	<i>Coen Treatment Plant</i>
	Type	<i>Sodium Hypochlorite Dosing</i>
	Target residual levels	<i>0.9 mg/L</i>
	Duty/standby	<i>Yes</i>
	Dosing arrangements	<i>Controlled by the feedback from free chlorine residual analyser</i>
	Alarms	<i>No, Staff on site during working hours and weekends</i>
Distribution and Reticulation System	Auto shut-off arrangements	<i>Controlled by the free chlorine residual analyser with control set points.</i>
	Trended on SCADA	<i>No</i>
	Pipe material	<i>A.C. UPVC &amp; Poly</i>
	Age range	<i>A.C. up to 30 Y.O. All new Water mains installed since 1995 have been UPVC with a few small Poly lines</i>
	Approx % of total length	<i>A.C. 80%, UPVC 10%, Poly 10%</i>
	Areas where potential long detention periods could be expected	<i>1 Area near National Parks Offices has the potential for long detention periods</i>
Reservoir A	Areas where low water pressure (eg < 12 m) could be expected during peak or other demand periods)	<i>No areas of low water pressure</i>
	Name	<i>Coen Clean Water Reservoir</i>
	Capacity (ML)	<i>0.445 ML</i>
	Roofed (Y/N)	<i>Yes</i>
	Vermin-proof (Y/N)	<i>Yes</i>
Reservoir B	Runoff directed off roof (Y/N)	<i>Yes</i>
	Name	<i>Coen Raw Water Reservoir</i>
	Capacity (ML)	<i>0.18ML</i>
	Roofed (Y/N)	<i>Yes</i>
	Vermin-proof (Y/N)	<i>Yes</i>

Component		Coen
	Runoff directed off roof (Y/N)	Yes
Reservoir C	Name	Bore 10 Reservoir
	Capacity (ML)	~5 kL
	Roofed (Y/N)	Yes
	Vermin-proof (Y/N)	Needs replacement
	Runoff directed off roof (Y/N)	Some pooling on roof

### 3 RISK ASSESSMENT

#### 3.1 Coen Mitigated Risk Assessment

Following the hazard identification and unmitigated risk assessment detailed in the overarching plan, the Coen Scheme risk assessment was undertaken, following the same methodology. Individual process failures were considered, and the mitigated risks calculated. The risk assessment is presented below.

Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
Coen Dam Catchment	Animals in catchment	bacteria and virus	Extreme 20	disinfection	Coen Dam fenced, DAF, filtration, MF	Catastrophic	Rare	Medium 6	Certain	considered as whole of treatment in absence of failure			
	Present in catchment - animals	protozoa	Extreme 20	MF	Coen Dam fenced DAF, filtration, MF	Catastrophic	Rare	Medium 6	Confident	considered as whole of treatment in absence of failure			
	cross contamination from Coen Landfill.	hazardous waste	Medium 9	Landfill is in a different catchment area		Moderate	Unlikely	Medium 6	Estimate	Groundwater contamination most likely issue.			
	hydrocarbons in Coen Dam	hydrocarbons	High 12			Moderate	Rare	Low 3	Estimate	Car bodies, pump and drums previously in catchment area have been removed			
	Cyanobacterial bloom	Cyanobacteria	Medium 8	DAF and coagulation, flocculation	filtration, MF, disinfection	Minor	Rare	Low 2	Reliable	small blooms most years,			

Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
										but not every year			
	Cyanobacterial toxins	Toxins	High 12	multiple supplies, oxidation (chlorine)		Moderate	Rare	Low 3	Reliable	toxin not common			
Lankelly Creek Catchment	Animals in catchment	bacteria and virus	Extreme 20	disinfection	(DAF) filtration, MF	Catastrophic	Rare	Medium 6	Certain	considered as whole of treatment in absence of failure			
	Present in catchment - animals	protozoa	Extreme 20	MF	(DAF) filtration	Catastrophic	Rare	Medium 6	Confident	considered as whole of treatment in absence of failure			
Bores	Ingress into bore	bacteria and virus	Extreme 20	disinfection	borehead sealed	Catastrophic	Rare	Medium 6	Certain	backup supply, rarely used			
	Ingress into bore	protozoa	Extreme 20	Bore-head sealed		Catastrophic	Rare	Medium 6	Confident		Inspection program		
	Bore pump failure	Failure of supply	High 10	multiple supplies		Major	Rare	Medium 5	Confident				
Recharge	Bore Recharge	chemical	Medium 6	Recharge on Lankelly only		Moderate	Unlikely	Medium 6		chemical risks minimal			
	Bore Recharge	protozoa	Extreme 20	Recharge on Lankelly only		Catastrophic	Rare	Medium 6	Reliable	Need procedure to only use when Lankelly AND roughing plus MF.	develop recharge procedure		
Raw Water Feed	Raw water main break	Failure of supply	High 10	3 sources.	mains break procedure,	Catastrophic	Rare	Medium 6	Confident	Crews available to fix critical			

Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
										issues			
	Raw water pump failure	Failure of supply	High 10	3 sources.	duty standby	Catastrophic	Rare	Medium 6	Certain	spare pumps available on site			
DAF	Under dose alum	Protozoa, turbidity	Extreme 20	Coagulation available in plant	clarifier monitoring, MF	Major	Unlikely	Medium 8	Confident			Investigate online turbidity meter	
	Overdose alum	Aluminium	Medium 6	clarifier monitoring	MF	Minor	Possible	Medium 6	Confident				
	poor floc due to low alkalinity	Protozoa	Extreme 20	soda ash dosing when required		Catastrophic	Rare	Medium 6		not used all the time - changes depending on raw water. Operators monitor alkalinity and determine when required.			
	overflow of DAF sludge into raw water tank	Protozoa	Extreme 20	daily monitoring	Roughing filter and MF treatment following DAF	Moderate	Possible	Medium 9	Estimate	undertake investigation to determine how to rectify this		Install an overflow pipe to the side of the sludge tank	
	Bypass	Protozoa	Extreme 20	Manual change valves. Valve configuration	MF	Catastrophic	Rare	Medium 6	Reliable	When supply from Lankelly can bypass DAF and			



Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
				documented.						maintain water quality. Rely on operator experience to not use when Coen Dam water is in use.			
Roughing Filtration (when MF operating)	Filter breakthrough	Protozoa	Extreme 20	MF	roughing filter	Catastrophic	Rare	Medium 6	Reliable	Serves as a prefilter. Main barrier is MF.			
	Filter breakthrough	turbidity	Medium 6	MF	roughing filter	Minor	Rare	Low 2	Confident				
	Filter bypass	Protozoa	Extreme 20		MF	Catastrophic	Rare	Medium 6	Reliable				
Roughing filter (No MF)	Filter breakthrough	Protozoa	Extreme 20	conventional filtration		Catastrophic	Rare	Medium 6	Reliable	Online turbidity meter. Current daily monitoring.		online monitoring of process with autodialler callouts	
	Filter breakthrough	turbidity	Medium 6	disinfection	roughing filter	Minor	Unlikely	Low 4	Confident				
	Filter bypass	Protozoa	Extreme 20	Valve configurations are documented		Major	Unlikely	Medium 8	Reliable				

Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
Microfiltration	Filter breakthrough	Protozoa	Extreme 20	membrane integrity (Pressure decay tests), Roughing filter	TMPs monitored	Catastrophic	Rare	Medium 6	Confident	Annual servicing of membranes. Membranes replaced in 2016/2017 financial year			
	Filter breakthrough	turbidity	Medium 6	membrane integrity (Pressure decay tests)		Minor	Rare	Low 2	Confident	as above			
Disinfection	overdose	Chlorine	High 15	Daily checks at WTP and Reservoirs. Online analyser.	PLC plus SCADA/autodialler for high chlorine	Minor	Unlikely	Low 4	Confident				
	insufficient dose	bacteria/virus	Extreme 25	Daily checks at WTP and Reservoirs. Online analyser. MF	two pumps, but no auto changeover. PLC plus SCADA/autodialler for low chlorine	Moderate	Unlikely	Medium 6	Confident				
	Dosing pump failure	bacteria/virus	Extreme 25	Dual hypo pumps		Moderate	Unlikely	Medium 6	Reliable			Investigate Automatic change over	
	ineffective disinfection due to turbidity	bacteria	High 10	disinfection	filtration	Catastrophic	Rare	Medium 6	Confident				
	chemical breakdown	chlorate	High 12			Moderate	Likely	High 12	Unreliable			Begin THM sampling of final water	If chlorate is found, investigate

Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
													solutions.
Bore Disinfection	overdose	Chlorine	High 15	Daily checks , fixed rate dosing		Moderate	Unlikely	Medium 6	Confident				
	insufficient dose	bacteria/virus	Extreme 25	Daily checks at WTP and Reservoirs.	Sealed bores	Moderate	Unlikely	Medium 6	Confident	dosing line should be put inside PVC pipe to protect from sunlight/ breakage.	reconfigure dosing line	Additional SCADA EDAC autodialler	
	Dosing pump failure	bacteria/virus	Extreme 25	Daily checks, spare on site	Sealed bores	Moderate	Possible	Medium 9	Reliable	spare pump available at Coen, Additional SCADA will include free chlorine concentration at the reservoir		Additional SCADA EDAC autodialler	
Treated water storage/ Reservoirs	Ingress into reservoirs	bacteria/virus	Extreme 20	Integrity and sealing	residual chlorine	Catastrophic	Rare	Medium 6	Confident				
	Ingress into Bore 10 Tank	bacteria/virus	Extreme 20	Integrity and sealing	residual chlorine	Catastrophic	Rare	Medium 6	Confident	bore 10 tank is compromised, relies on disinfection to	seal reservoirs, inspection program Replace bore 10 tank (in		

Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
										manage risk	capital for this year)		
	Ingress into reservoirs	Protozoa	Extreme 20	Integrity and sealing		Catastrophic	Rare	Medium 6	Reliable	main treated water reservoir is new, and integrity is good.	seal reservoirs, inspection program		
	Ingress into reservoirs	Protozoa	Extreme 20	Integrity and sealing		Catastrophic	Possible	High 15	Reliable		seal reservoirs, inspection program Replace bore 10 tank (in capital for this year)		
	ingress of amoeba	amoeba	High 12	disinfection as above items	integrity	Major	Rare	Medium 5	Reliable				
Reticulation	ingress of contaminated water	bacteria/virus	Extreme 20	network pressure, residual disinfection	mains break procedure	Major	Unlikely	Medium 8	Confident				
	ingress of contaminated water	protozoa	Extreme 20	network pressure	mains break procedure	Major	Unlikely	Medium 8	Reliable				
	biofilm growth	opportunistic pathogens	High 15	flushing program		Moderate	Rare	Low 3	Confident				
	Power failure	Failure of supply	High 15	Coen has independent power supply (generators)	1-2 days treated water supply available to gravity feed	Moderate	Rare	Low 3	Confident	Ergon responsible			







Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
				) but can still lose for short periods									
	change in flow rate, reservoir run low, disturbing sediment in pipe	turbidity	Medium 6	mains flushing		Minor	Possible	Medium 6	Confident				
	long water age	DBPs	High 12	coagulation / filtration	Disinfection. Three water sources, 2 with low risk of THMs.	Minor	Unlikely	Low 4	Reliable	THMs unlikely in Coen dam as used when high water demand meaning formation unlikely to be above guideline.			
	backflow	protozoa	Extreme 20	system integrity, backflow prevention on new installations		Catastrophic	Rare	Medium 6	Estimate	Has not happened, will replace meters over time.			Taggle meters
System Wide	WTP Fire	Failure of supply	high 10	Activate DMP.		Catastrophic	Rare	Medium 6	Reliable	Coen probably highest risk			
	Drought	Failure of supply	High 10	3 sources		Catastrophic	Rare	Medium 6	Estimate				


Coen Water													
Process Step	Hazardous Event	Hazards managed by same barriers	Unmitigated Risk	Primary preventive measure	Other Preventive Measures	Mitigated			Uncertainty	Comments	Risk Management Improvements		
						Consequence	Likelihood	Risk			Immediate (17/18 FY)	2018/2019 FY	19/20 or later
	Flood	Failure of supply	High 10	Generally only impacts raw water quality		Catastrophic	Rare	Medium 6	Reliable				
	Lightning Strike	Interference with electronic equipment											
	Cyclone	Failure of supply	High 15	DMP		Catastrophic	Rare	Medium 6	Reliable				
	Operator error	any	Extreme 25	training, experience, mentoring	operational limits documented	Moderate	Unlikely	Medium 6	Estimate				
	Complete plant bypass	protozoa and bacteria	Extreme 25	Staff training	Valve configuration plans available on site	Major	Unlikely	Medium 8	Confident	Has not happened accidentally, bypass used in case of major failures.	Consider manually locking valve to prevent accidental opening		
	Missing procedures	All	Extreme 25	SCADA limits partially mitigate.		Moderate	Possible	Medium 9		Procedures need to be updated.	Procedures need to be updated.		

## 4 OPERATIONAL PROCEDURES

In general CSC has few specific documented procedures for each process step as required under the ADWG. However, the operational limits are well defined, and actions are understood by the WTP operators. The following table forms the basis of more comprehensive operational procedures that will be developed over time.

Table 8 Operational Limits used by operators.

Process Step / Location in System	Parameter	Operational Monitoring	Target Range	Monitoring Frequency	Operator Intervention Range	Report to Supervisor Range	Corrective Actions/ Comments
Treatment Plant Final Filtered Water	pH	Y	 <p>&lt;6.6 and &gt; 8.4 6.6 - 6.8 and 7.6 - 8.4 6.8 – 7.6</p>	Generally daily	6.6 – 8.4	<6.6 or >8.4	<ul style="list-style-type: none"> <li>If low pH, check caustic dosing pump (or soda ash) Malfunction of caustic pump will cause pH to fall.</li> <li>If high pH, check caustic dosing pump (or soda ash). The caustic dose rate may be too high. Check alum pump. If alum pump malfunctions and caustic is still being pumped then pH will be high.</li> </ul>
	Turbidity	Y	 <p>&gt; 3 0.5 – 3 &lt;0.1 NTU</p>	Generally daily	0.5 – 3 NTU	>3 NTU	<ul style="list-style-type: none"> <li>If turbidity is over 0.5NTU, chemical dosing may not be correct, check alum pump dose rate, perform jar testing to determine correct chemical doses, reset plant to new dose, retest turbidity.</li> </ul>
	Chlorine - Residual	Y	 <p>&lt;0.4 &gt;3mg/L 0.4 – 0.6 and 2 - 3mg/L 0.6 -1.8 mg/L</p>	Generally daily	0.6 – 2.0 mg/L	<0.4 and >3 mg/L	<ul style="list-style-type: none"> <li>If chlorine is above 2.0mg/L - Check operation of Chlorine dosing equipment. Check chlorine analyser is reading accurately using hand held analyser. Decrease chlorine dose as chlorine may have been added without dilution.</li> <li>If chlorine is below 0.4mg/L - Check operation of chlorine dosing equipment, ensure no air bubbles in chlorine line. Check chlorine tank levels to ensure sufficiently chlorine. Check chlorine analyser using hand held unit. Increase chlorine dose.</li> </ul>
	Colour	Y	 <p>&gt; 12.Hu 2 – 12 Hu &lt;2 Hu</p>	Generally weekly	0 – 12 Hu	>12 Hu	<ul style="list-style-type: none"> <li>Chemical Dosing not correct / Coagulation pH not at optimum point (5.8-6) perform jar testing to determine correct chemical doses, reset plant to new dose, retest Colour</li> </ul>

	Aluminium	Y	 >0.15 mg/L 0.05 - 0.15 mg/L 0.0 - 0.05 mg/L	Generally weekly	0 – 0.15 mg/L	>0.15 mg/L	<ul style="list-style-type: none"> <li>Chemical Dosing not correct / Coagulation pH not at optimum point (5.8-6) perform jar testing to determine correct chemical doses, reset plant to new dose, retest Aluminium</li> </ul>
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There are some documented procedures, as listed below.

*Table 9 Formal documented procedures used by CSC*

Location	Documented procedure Name	S.O.P. No	Last Revision or Implementation	Process for implementing the procedure Activity and Frequency	Comments
Treatment	Chlorine Analyser Maintenance Procedure	WS0005	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Safe Handling of sodium hypochlorite	WS0001	12/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
Reticulation	Water main new installation	WS0011	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water mains repairs	WS0002	18/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water service repairs	WS0013	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Mains Flushing / Scouring	WS0006	23/3/2012	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Sampling	WS0008	10/12/2012	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Reservoirs – Cleaning	WS0007	2/10/2012	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water Service – New installation	WS0010	19/12/2017	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	Water testing for Coliforms and E.coli	WS0009	31/01/2018	Distributed to Relevant staff and training records through toolbox talks	This is a current Procedure
	E.Coli detection reporting (to regulator)	WS0015	31/01/2018	Reporting by Manager only	This is a current Procedure



## 5 OPERATIONAL AND VERIFICATION MONITORING

Operational monitoring is the monitoring undertaken by CSC to ensure that the water treatment barriers are operating effectively. This monitoring provides confidence that we are producing safe water. Operational monitoring is conducted by the WTP operators. Where any value exceeds the ADWG health guideline in treated or reticulated water, the Manager Water and Wastewater is immediately informed – this initiates a Medium level incident.

Verification monitoring is undertaken to ensure that the water that we supplied to our customers did meet the ADWG health guideline values. *E coli* sampling is predominantly internal, and all other monitoring is undertaken externally. Certificates of analysis are reviewed immediately upon receipt, and if a value exceeds the ADWG Health Guideline value, the Manager Water and Wastewater is informed, and the incident and emergency response activated (this is defined as a Medium level incident). Verification monitoring data is reported in our annual report.

### 5.1 Sampling Locations

Operational monitoring occurs at a number of steps through the WTP process, and these are identified in the tables that follow.

Additionally, there are sample locations for both operational and verification monitoring that are located on the trunk main, at reservoirs, and in the reticulation network. These are detailed below.

Table 10 Reticulation sample locations

Sample Location Name	Street Name	Site Chosen Because	GPS Coordinates *
Kindy Corner	Cnr Peninsular Dev. Rd and Reservoir Rd	Water Main “Tees” at this point and close to the Kindy	13°56'38.31"S - 143°12'11.52"E
Heritage House	Regent Street	Ease of access and in the centre of the town	13°56'39.41"S - 143°11'56.84"E
Coen School	Taylor Street	Central, and close to the School	13°56'43.83"S - 143°11'59.12"E
Cultural Centre	Shephard Street	Towards the “End of Line”	13°56'58.55"S - 143°11'53.53"E
Guest House	Regent Street	Central and “Ease of Access”	13°56'39.19"S - 143°12'2.22"E
Old National Parks Office	Coleman Close	Towards the “End of Line”	13°56'23.50"S - 143°11'57.44"E
Lutheran Church	Off Port Stewart Road	Towards the “End of Line”	13°56'58.37"S - 143°12'1.14"E
CSC Depot	Lankelly Drive	Towards the “End of Line”	13°56'27.13"S - 143°12'17.21"E
Okalaka Street	Okalaka Stret	Across bridge on the northern side of town	13°56'24"S - 143°12'05"E

- \* GPS co-ordinates extracted from Google Earth

The above sample locations give a good cross section of the town including the dead end areas as shown in the figure below.

Figure 10 Reticulation sampling locations



Table 11 Operational monitoring tables

Process Step / Location in System	Parameter	Sampling			Is this sample Verified by a NATA registered Lab	Operational Monitoring Comments
		Location	Frequency	Type		
Treatment Plant Raw water	pH	Coen Lab	Daily	Grab	Y	Analysed by Cook Shire Council staff at the Coen WTP. Verified monthly by NATA registered lab
	Alkalinity	Coen Lab	Daily	Grab	Y	
	Turbidity	Coen Lab	Daily	Grab	Y	
	Colour	Coen Lab	Daily	Grab	Y	
	Electrical Conductivity	Coen Lab	Daily	Grab	Y	
Treatment Plant Raw water	<b>Physical / Chemical Analysis.</b> Includes parameters: pH, Electrical Conductivity, Alkalinity, Sulphate, Chloride, Ca, Mg, Na, K, Fluoride, Total Hardness, SAR, L.I., Turbidity, Colour apparent, TDS, Salinity & Silica	Coen Raw Water	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	<b>Metals Analysis</b> Includes parameters: As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, V, Zn	Coen Raw Water	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
Treatment Plant Final Filtered Water	pH	Coen Lab	Daily	Grab	Y	Analysed by Cook Shire Council staff at the Coen WTP. Verified monthly at a NATA registered lab
	Alkalinity	Coen Lab	Weekly	Grab	Y	
	Turbidity	Coen Lab	Daily	Grab	Y	
	Colour	Coen Lab	Daily	Grab	Y	
	Electrical Conductivity	Coen Lab	Weekly	Grab	Y	
	Free Chlorine Residual	Coen Lab	Daily	Continuous / Grab	N	Verified Twice a year by NATA registered lab Chlorine residual on display on Chlorine analyser in dosing room
	Aluminium	Coen Lab	Weekly	Continuous / Grab	Y	
	Free Chlorine Residual	Coen Lab	On Line	Continuous/ Grab	N	N.A.T.A. Certified Lab
	<b>Physical / Chemical Analysis.</b> Includes parameters: pH, Electrical Conductivity, Alkalinity, Sulphate, Chloride, Ca, Mg, Na, K, Fluoride, Total Hardness, SAR, L.I., Turbidity, Colour apparent, TDS, Salinity & Silica	Coen Final Treated Water	Quarterly	Grab Sample	Y	
	<b>Metals Analysis</b> Includes parameters: As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, V, Zn	Coen Final Treated Water	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	<b>Total Coliforms and E. Coli</b>		Weekly	Grab Sample	Y	Analysed by NATA

Coen Reticulation	Chlorine Residual	9 Locations in Coen Systematically rotated through sites in table 10. One site per month	Monthly	Grab Sample	Y	Analysed by Cook Shire Council staff at the Coen WTP. Verified quarterly by NATA registered lab
	pH		Monthly	Grab Sample	Y	
	Turbidity		Monthly	Grab Sample	Y	
	Colour		Monthly	Grab Sample	Y	
	Electrical Conductivity		Monthly	Grab Sample	Y	
	Total Dissolved Solids		Monthly	Grab Sample	Y	
	Dissolved Oxygen		Monthly	Grab Sample	Y	
	Alkalinity		Monthly	Grab Sample	Y	
	<b>Physical / Chemical Analysis.</b> Includes parameters: pH, Electrical Conductivity, Alkalinity, Sulphate, Chloride, Ca, Mg, Na, K, Fluoride, Total Hardness, SAR, L.I., Turbidity, Colour apparent, TDS, Salinity & Silica		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	<b>Metals Analysis</b> Includes parameters: As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Se, V, Zn		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	<b>Total Coliforms and E. Coli</b>		Weekly	Grab Sample	Y	N.A.T.A. Certified Lab

Samples that are verified in a NATA registered Lab for physical/chemical are split in half. Half is analysed by CSC staff at the Coen WTP and the other half is sent to a NATA certified laboratory.

All water samples are collected by either the Reticulation staff, or the Water Treatment Plant operators all of which have had the appropriate training to collect water samples. Samples collected for verification are transported to Cairns by Air / Road Transport, and analysed by NATA accredited Laboratories, currently Cairns Regional Council.



## 6 WATER QUALITY CHARACTERISATION

### 6.1 Review of the Coen Raw Water data

Data in the following tables represents water quality from 01 July 2015 to 30 June 2017.

Table 12 Summary of Coen Water Quality Details (Coen Bores) (Analysed by CRC)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				Min. Value	Avg. Value	Max. Value		
Calcium	Coen Bores Sampled from the Bores	1 July 2015 to 30 June 2017	7	39.0	56.3	71		
Chloride			7	110	205.4	250	250	0
Colour Apparent			7	5.0	10.8	25.0		
Electrical Conductance			7	600	1113	1400		
Fluoride			7	0.29	0.82	1.10	1.5	0
Total Hardness			7	160	242	310	200	5
Magnesium			7	16	24.9	32		
pH			7	7.3	7.5	7.8	6.5 – 8.5	0
Potassium			7	1.4	1.85	2.9		
Salinity			7	390	706.5	880		
Silica - Reactive			7	41.0	49.5	56.0	80	0
SAR			7	1.70	3.17	3.90		
Sodium			7	51	70	150	180	0
Total Dissolved Solids			7	360	651	820	600	4
Sulphate			7	8.7	16.1	20	250	0
Turbidity			7	0.5	0.6	9.3	5	1

Table 13 Summary of Coen Raw Water quality details (Coen Dam) (Analysed by SGS, S&amp;B, CRC)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				Max. Value	Avg. Value	Min. Value		
Ammonia Nitrogen	Coen Dam Raw Water Sampled from the Dam	1 July 2015 to 30 June 2017	17	0.005	0.005	0.013		
Total Kjeldahl Nitrogen			17	1.80	0.72	0.05		
Total Nitrogen			17	1.80	0.74	0.05		
Nitrite (NO <sub>2</sub> )			17	0.005	0.005	0.005		
Nitrate (LIMS CALC)			17	0.150	0.05	0.05		
Filtered Reactive Phosphorus			15	0.400	0.055	0.005		
Total Phosphorus			17	0.16	0.05	0.02		
Silica – Reactive			8	12.0	8.45	3.2		
Silicon			8	5.4	3.95	1.5		
Arsenic mg/L			17	0.020	0.011	0.001	0.01 mg/L	7
Barium mg/L			11	0.027	0.017	0.010	2.0 mg/L	0
Beryllium mg/L			11	0.0020	0.0003	0.0001	0.06 mg/L	0
Cadmium mg/L			17	0.0013	0.0003	0.0001	0.002 mg/L	0
Chromium mg/L			17	0.0010	0.0010	0.0010	0.05 mg/L	0
Cobalt mg/L			11	0.001	0.001	0.001		
Copper mg/L			17	0.025	0.007	0.001	1.0 mg/L	0
Iron mg/L			17	0.420	0.167	0.005	0.3 mg/L	2
Lead mg/L			17	0.002	0.001	0.001	0.01 mg/L	0
Manganese mg/L			17	0.017	0.005	0.005	0.1 mg/L	0
Nickel mg/L			17	0.001	0.003	0.001	0.02 mg/L	0
Selenium mg/L			17	0.003	0.003	0.003	0.01 mg/L	0
Zinc mg/L			17	0.170	0.019	0.005	3.0 mg/L	0
Tin mg/L			22	0.005	0.003	0.001		
Mercury mg/L			22	0.0006	0.0002	0.00005	0.001 mg/L	0
Zinc mg/L			17	0.170	0.031	0.005		

Table 14 Summary of Coen Raw Water quality details (Lankelly) (Analysed by CRC &amp; SGS)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				Max. Value	Avg. Value	Min. Value		
Alkalinity	Coen Lankelly Raw Water Sampled from the River	1 July 2015 to 30 June 2017	5	110	24.8	6.0		
Calcium			5	1.3	0.9	0.5		
Chloride			5	14.0	13.1	12.0	250	0
Colour Apparent			5	70.0	39.1	15.0		
Electrical Conductance			5	67.0	57.9	50.0		
Fluoride			5	0.08	0.06	0.05	1.5	0
Total Hardness			5	7.0	5.65	5.0		
Magnesium			5	1.1	0.9	0.7		
pH			5	8.3	7.1	6.5	6.5 – 8.5	0
Potassium			5	1.6	1.2	1.0		
Silica- Reactive			5	21.0	15.9	12.0		
Sodium			5	9.2	1.2	1.0		
Total Dissolved Solids			5	40.0	34.5	30.0		
Sulphate			5	1.5	1.1	0.7		
Turbidity			5	6.5	2.4	0.8		
Arsenic mg/L			5	0.003	0.002	0.001	0.01 mg/L	0
Barium mg/L			5	0.011	0.008	0.001	2.0 mg/L	0
Beryllium mg/L			5	0.0002	0.0001	0.0001	0.06 mg/L	0
Cadmium mg/L			5	0.0001	0.0001	0.0001	0.002 mg/L	0
Chromium mg/L			5	0.0010	0.0008	0.0001	0.05 mg/L	0
Cobalt mg/L			5	0.001	0.001	0.001		
Copper mg/L			5	0.001	0.001	0.002	1.0 mg/L	0
Iron mg/L			5	0.230	0.141	0.001	0.3 mg/L	0
Lead mg/L			5	0.001	0.001	0.001	0.01 mg/L	0
Manganese mg/L			5	0.005	0.004	0.001	0.1 mg/L	0
Nickel mg/L			5	0.001	0.001	0.001	0.02 mg/L	0
Selenium mg/L			5	0.003	0.002	0.001	0.01 mg/L	0
Vanadium mg/L			5	0.010	0.002	0.001		
Zinc mg/L			5	0.010	0.005	0.001	3.0 mg/L	0

## 6.2 Review of the Coen Treated Water data

Table 15 Summary of Treated Water quality details – Coen Final Water (Analysed by CRC & SGS)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				Max. Value	Avg. Value	Min. Value		
Alkalinity - mg/L CaCO <sub>3</sub>	Coen Final Treated Water Sampling Tap	1 July 2015 to 30 June 2017	11	56.0	26.15	10.0		0
Calcium - mg/L			11	4.5	2.5	0.7		0
Chloride - mg/L			11	23.0	18.9	16.0	250 - mg/L	0
Colour Apparent - Pt- Co			11	8.0	5.2	5.0	15 – Pt/Co	0
Electrical Conductance			11	160	119.8	83.0		0
Fluoride - mg/L			11	0.22	0.13	0.05	1.5 - mg/L	0
Total Hardness - mg/L CaCO <sub>3</sub>			11	19.0	11.3	5.0	200 - mg/L	0
Magnesium - mg/L			11	1.7	1.2	0.7		0
pH			11	8.10	7.34	6.90	6.5 – 8.5	0
Potassium - mg/L			11	2.2	1.4	0.8		0
Salinity			11	100	77.42	76.83		0
SAR by Calculation			11	3.10	2.50	1.70		0
Silica – Reactive - mg/L			11	19.0	12.5	5.6		0
Total Dissolved Solids - mg/L			11	95.0	71.7	50.0	600 - mg/L	0
Sulphate - mg/L			11	20.0	10.1	6.3	250 - mg/L	0
Turbidity – NTU			11	0.5	0.5	0.5	≤5 - NTU	0
Arsenic mg/L			22	0.011	0.003	0.003	0.01 - mg/L	0
Barium mg/L			7	0.020	0.016	0.012	2.0 - mg/L	0
Beryllium mg/L			8	0.0050	0.0020	0.0001	0.06 - mg/L	0
Cadmium mg/L			22	0.0001	0.0001	0.0002	0.002 - mg/L	0
Chromium mg/L			22	0.001	0.001	0.001	0.05 - mg/L	0
Cobalt mg/L			7	0.001	0.001	0.001	0.01 - mg/L	0
Copper mg/L			22	0.023	0.004	0.001	2.0 - mg/L	0
Iron mg/L			16	0.190	0.018	0.005	0.3 - mg/L	0
Lead mg/L			22	0.001	0.001	0.001	0.01 - mg/L	0
Manganese mg/L			16	0.005	0.005	0.005	0.1 - mg/L	0
Nickel mg/L			22	0.001	0.001	0.001	0.02 - mg/L	0
Selenium mg/L			22	0.003	0.003	0.003	0.01 - mg/L	0
Vanadium mg/L			8	0.010	0.004	0.001		0
Zinc mg/L			17	0.012	0.005	0.005	3.0 - mg/L	0
Tin mg/L			14	0.002	0.002	0.002		0

*Table 16 Summary of Treated Water quality details (All Sources Coen) (Analysed by CSC Coen Water Treatment Plant)*  
 Date Range covered 01/07/2015 to 30/06/2017

	pH	Temperature °C	Turbidity NTU	Colour Pt/Co Units	Alkalinity mg/L	Aluminium mg/L	Electrical Conductivity uS/cm <sup>2</sup>
Count	730	106	106	698	86	78	12
Max	7.92	29.90	6.96	14	32.0	0.28	238
Min	6.06	21.30	0	0	3.0	0	136.4
Avg	6.96	25.95	0.40	1.15	14.55	0.066	156.5

The table above shows that the Final Treated Water is high quality with no exceedances of the ADWG for the period stated with the exception of pH. There were four instances where the pH was below 6.5.

The treatment plant is capable of treating almost any quality of raw water.



### 6.3 Review of the Coen Reticulation Water data

Table 17 Summary of Treated Water quality details Coen Reticulation (Analysed by CRC & SGS)

Parameter	Sampling Location	Time Period	No of samples taken in time period	Summary of results			Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				Max. Value	Avg. Value	Min. Value		
Alkalinity - mg/L CaCO <sub>3</sub>	Various Locations within the Coen Reticulation	1 July 2015 – 30 June 2017	6	32.0	15.8	10.0		0
Calcium - mg/L			6	6.3	3.7	0.6		0
Chloride - mg/L			6	21.0	19.0	14.0	250 - mg/L	0
Colour Apparent - Pt- Co			6	20	9.4	5.0	15 – Pt/Co	1
Electrical Conductance			6	150.0	128.4	52		0
Fluoride - mg/L			6	0.2	0.13	0.05	1.5 - mg/L	0
Total Hardness - mg/L CaCO <sub>3</sub>			6	20.0	13.5	4.0	200 - mg/L	0
Magnesium - mg/L			6	1.5	1.0	0.7		0
pH			6	7.9	7.49	6.8	6.5 – 8.5	0
Potassium - mg/L			6	2.8	1.6	1.0		0
Silica – Reactive - mg/L			6	21.0	14.1	5.1		0
Sodium - mg/L			6	23.0	18.5	8.4	180 - mg/L	0
Total Dissolved Solids - mg/L			6	87.0	43.5	31.0	600 - mg/L	0
Sulphate - mg/L			6	0.8	9.45	0.8	250 - mg/L	0
Turbidity – NTU			6	2.6	1.15	0.5	≤5 - NTU	0
Arsenic mg/L			10	0.004	0.003	0.003	0.01 mg/L	0
Barium mg/L			9	0.028	0.011	0.001	2 mg/L	0
Beryllium mg/L			10	0.0001	0.0001	0.0001	0.06 mg/L	0
Cadmium mg/L			10	0.0001	0.0001	0.0001	0.002 mg/L	0
Chromium mg/L			10	0.0010	0.0009	0.0001		
Cobalt mg/L			10	0.001	0.001	0.001		
Copper mg/L			10	0.026	0.007	0.001	2 mg/L	0
Iron mg/L			10	0.100	0.034	0.001		
Lead mg/L			10	0.001	0.001	0.001	0.01 mg/L	
Manganese mg/L			9	0.011	0.005	0.001	0.5 mg/L	0
Nickel mg/L			10	0.001	0.001	0.001	0.02 mg/L	0
Selenium mg/L			10	0.003	0.003	0.001	0.01 mg/L	0
Vanadium mg/L			10	0.005	0.001	0.001		
Zinc mg/L			10	0.019	0.006	0.001		

*Table 18 Summary of Total Coliforms & E.coli Coen Reticulation (Analysed by CRC & SGS)*

Parameter	Sampling Location	Time Period	No of samples analysed in time period	Summary of results		Australian Drinking Water Guidelines guideline value (2011)	No of samples exceeding Australian Drinking Water Guidelines guideline value
				No of Samples where E.coli was Detected	No of Samples where Total Coliforms were Detected		
Escherichia coli	Various Locations within the Coen Reticulation	01/07/2015 – 30/06/2017	306	0	-	Escherichia coli should not be detected in any 100 mL sample of drinking water.	0

*Table 19 Summary of Coen Reticulation daily chlorine residual Readings (Analysed by CSC Staff)*

Date Range: 01/07/2015 to 30/06/2017

	Various Locations in Reticulation system
Count	729
Max	2.92
Min	0.24
Avg	0.96

Cook Shire Reticulation staff conducts daily chlorine residual readings from various locations in Coen reticulation as well as daily monitoring of the disinfection equipment