Cook Shire COUNCIL

Cooktown

Drinking Water Quality Management Plan

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+ DOCUMENT CONTROL SHEET

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Term	Definition
ADWG	Australian Drinking Water Guidelines 2011
CSC	Cook Shire Council
RDMW	Department Regional Development, Manufacturing and Water
DWQMP	Drinking Water Quality Management Plan
PHR	Public Health Regulation 2021
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 COOKTOWN

1.1 Overview

Cooktown is the largest of the drinking water schemes in Cook Shire Council. It has a population of 1751, which is projected to grow to 2850 in 10 years. This will increase demand to approximately 2ML/Day. The Annan WTP has a capacity of 3.6 ML/Day (20 hours operation), this can be supplemented by the Duckfarm Borefields that provide contingency during disasters.

1.2 Annan River Catchment

Cooktown's Water is sourced from the Annan Weir on the Annan River. The Annan River catchment area is approximately 37,350ha and due to the terain has very limited human impact. The Annan River originates in rugged mountainous pristine rainforest, from the North or North western sides of Mount Misery, Poverty and Mt Romeo which is North North West of Bloomfield. It then opens up into open woodlands and grasslands. Wallaby Creek is a major tributary of the Annan River with the village of Rossville adjacent to the Wallaby.

The Annan Weir is a mass concrete weir that was built across the Annan River at the treatment plant site in the early 90's to supply the water requirements of Cooktown. The impounded waters have a capacity of approximately 400ML, which is almost Cooktown's annual consumption. Normally the river has a good flow throughout the year. Since the weir was built, the Annan River has stopped flowing twice, both only for a very short duration in two very dry years, and the trigger for water restrictions is when the weir stops overflowing. The Annan Catchment is within a high rainfall area with most of the catchment area receiving on average 3000-4000 mm pa. The Annan River experiences annual flooding with the "Wet Season". When the Annan River floods, the turbidity increases, and requires more operator vigilance to ensure that sedimentation and filtration are effective.

Figure 1 Cooktown Airport Annual Temperatures & Rainfall since 2000

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	311.3	321.9	377.3	167.0	49.8	35.6	21.1	14.8	8.9	23.9	62.2	170.7
Median	241.4	295.3	320.8	109.1	33.2	22.4	15.0	11.2	6.2	16.0	44.5	84.1
Highest Daily	*240.6*	*152.6*	*305.0*	*179.2*	*211.2*	*29.2*	*20.6*	*61.0*	*17.2*	*46.0*	*136.0*	*150.2*

1.3 Land Use

The Annan River Catchment, whilst not protected, has very few land uses that affect water quality. There are large areas of the catchment that are indigenous use areas, or national parks, with only small low-density residential areas, and limited grazing. There is no land use in the rainforest areas.

The Collingwood tin mine is upstream of the Annan Weir, but has not been operational for >13 years. There is no other significant industry in the area and almost nil recreational activities due to the ruggedness of the River. Bush fires do not burn through the rainforest however; they do burn through the lower grasslands, almost annually. CSC conducts controlled burns around the Water Treatment Plant earlier in the year to reduce the fuel for the fires.

The Mulligan Highway crosses the Annan River above the treatment Plant; this is the main highway into & out of Cooktown.

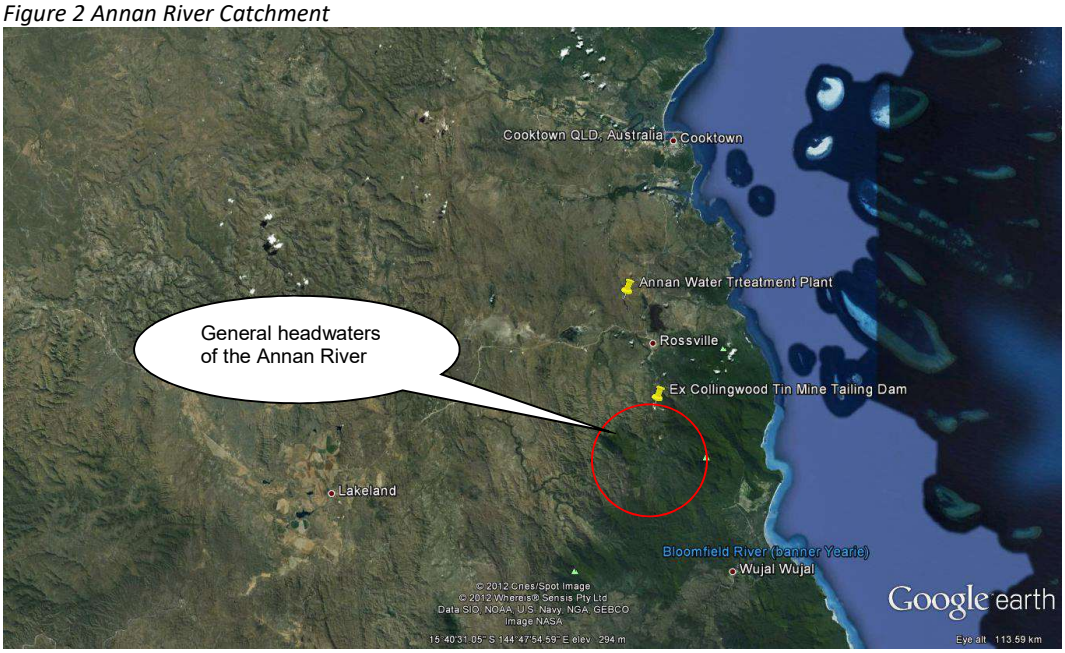
1.3.1 Ex-Collingwood Tin Mine

The ex-Collingwood Tin Mine poses little risk now, but the tailings dam had been considered as a potential problem in the past when the mine was operating, as the tailings dam had threatened to overflow into the Annan River.

DNRME intervened with the ordering of controlled releases by Bluestone Tin from the tailings dam when the river was in flood, accompanyed by a strict sampling regime (to DNRME's requirements) to determine that the releases were not having a detrimental impact on the River. Analyses of the water quality (collected and analysed in a NATA Certified Lab, by Bluestone Tin) had shown at the time that Antimony & Arsenic and to a lesser degree Fluoride & Nickel were elevated in the tailings dam. Cook Shire Council was in close contact with DNRME at the time as Cooktown's water was being drawn off below the discharge point and was a cause of concern. DNRME confirmed with Cook Shire Council that the releases and subsequent sampling had proven that there was was no threat to the Cooktown Water supply as the level of dilution had reduced the parameters in question to be negligable. The mine has not operated now for approximately 13 years, and is not considered to increase the risk of any parameter.

Below the mine, the Wallaby Creek (a major tributary) enters the Annan. There is a very small village (Rossville) that is adjacent to the Wallaby. There is no sewerage system in Rossville so the residents use septic tanks. Below the confluence, the Annan River breaks out of the rainforest and into open woodlands before making its way to the upper limits of the Annan Esturary with still limited human impact in the more accessible areas. Google Earth Map overleaf shows the location of Cooktown, the Annan Treatment Plant, the location of the ex Collingwood Tin mine, and the general Headwaters area of the Annan River

Figure 2 Annan River Catchment



1.4 Duckfarm Borefields

The Borefields consist of 6 production bores and a Treatment Plant.

Table 1 Bore Details

Bore Name	Bore Depth	Bore Capacity	Pump Type
Leons Bore	48.5m	3.0 L/s	Electric Submersible
China 1 Bore	47m	2.0 L/s	Electric Submersible
Gravel Pit Bore	49m	3.0 L/s	Electric Submersible
Tully Bore	55m	4.0 L/s	Electric Submersible
Lovers Bore	52m	3.0 L/s	Electric Submersible
Sykes Bore	48m	1.5 L/s	Electric Submersible

The Cooktown Borefields were part of the original water supply for Cooktown. They have not been a primary source since the early nineties. The Borefields supplemented supply during periods of high Annan river turbidity. Since Borefields were last used after Cyclone Ita in 2014. The installation of the sedimentation tank at the Annan Treatment Plant in 2009, allows the Annan WTP to treat higher turbidity water. In 2021, the raw water pumps and clean water pumps at Leons Bore received an upgrade. Switchboards have been replaced at Leons bore, Tully bore and Lovers bore. Duckfarm Borefield is now being used to supply water for road making and maintenance. Water from the Duckfarm can be chlorinated and feed to town in an emergency. The water meets the ADWG health guidelines but not the iron and manganese aesthetic guideline. Further upgrades will involve iron and manganese removal via filtration. This is funding dependent.

Cooktown's Duckfarm Borefields are situated on Lot 98SP105917 approximately 4.7 km West / South West from the centre of Cooktown and to the East of Mt Tully. The Duckfarm Borefields occupies an area of approximately 5 km^2 and is defined by a physiographic catchment bounded by moderate ridges on the eastern, western & southern sides. The northern boundary of the Borefields is a tidal, mangrove flat associated with Four-Mile creek, which is an estuary of the Endeavour River. The terrain of the Borefields is generally undulating and moderately timbered with restricted public access. There are no forms of human development or activities within the catchment area. The Hodgkinson Formation is the main aquifer underlying the Duckfarm Borefields and acts as a semi confined aquifer. All bores are concrete sealed with the bore casing generally extending 0.6mm above surface level to prevent surface water entering the bore.

1.4.1 Natural recharge

Water Resources conducted extensive water level plots, and collected rainfall data over several years in the mid 80's, and calculated that rainfall events of less than 100mm's had little impact on the ground water levels, however the for the 4 months of the Wet season (Jan – April) when rainfall figures are considerably higher than the 100mm's then the majority of the recharging occurs then. An average natural recharge was calculated to be approximately 275ML over the entire Borefield. The total volume of ground water in storage was calculated to be in the vicinity of 6770ML.

2 INFRASTRUCTURE

2.1 Annan WTP

Catchment to tap and treatment plant schematics for the Cooktown Scheme are provided in the following pages.

The Annan WTP is manned during working hours while its manned so an operator is on hand should something malfunction. The Annan WTP is currently required to run approximately 11 hours per day in the wet season and 14 hours in the dry season daily.

Plant Start up:
The process starts when the Cooktown Reservoir either reaches the “Low Level” set point, or an operator overrides the set point to initiate a fill from the Annan, either method opens a solenoid valve in Cooktown that allow water to gravity feed from the Annan High Level Reservoir to the Cooktown High Level Reservoir.

The Cooktown solenoid valves remains open until either the Cooktown Reservoir is full or an operator overrides the full set point. Left to its own devices the solenoid valve in Cooktown will open and close automatically on demand, whatever time of the day or night, however it is preferable to control the opening (usually early in the morning) so that the operators are working and can monitor treatment processes and perform their daily water quality tests.

The solenoid valve is PLC controlled which allows the Cooktown operators to override the start set point to open the solenoid valve, and they can override the full set point to close the solenoid valve and alternatively, the operators can lockout the solenoid valve to prevent it opening at all. The operators at the Annan WTP can also override the opening set point to open the solenoid provided it’s not “Locked out”

When activated the solenoid valve opens relatively quickly allowing the water to flow but on closing, it takes approximately 10 minutes to close to prevent water hammer.

Once the Cooktown solenoid valve has opened and the water flows through to Cooktown, the level in the Annan High Level Reservoir drops until the level reaches the Treatment Plant Start-up Level which will then start the Treatment Plant. The Treatment Plant operator can also override the start signal without waiting until the Reservoir drops to this point.

The on duty clean water pump starts to pump up to the Annan High Level Reservoir. The clean water pump starts the chlorinator, and the fluoride process. The clean water pumps draw water from the balance 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 tower. Both the clean & raw water pumps auto alternate on fault, and on time run, the operator can also select the pump to run next. As the raw water flow rate ramps up, the entire chemical dosing skid cuts in when the raw water flow reaches 20 L/s, as well as the constant head pumps selected for duty. The chemical dosing skid and the constant head pumps generally start a few seconds after the duty raw water pump starts up.

Figure 3 Catchment to tap schematic - Cooktown

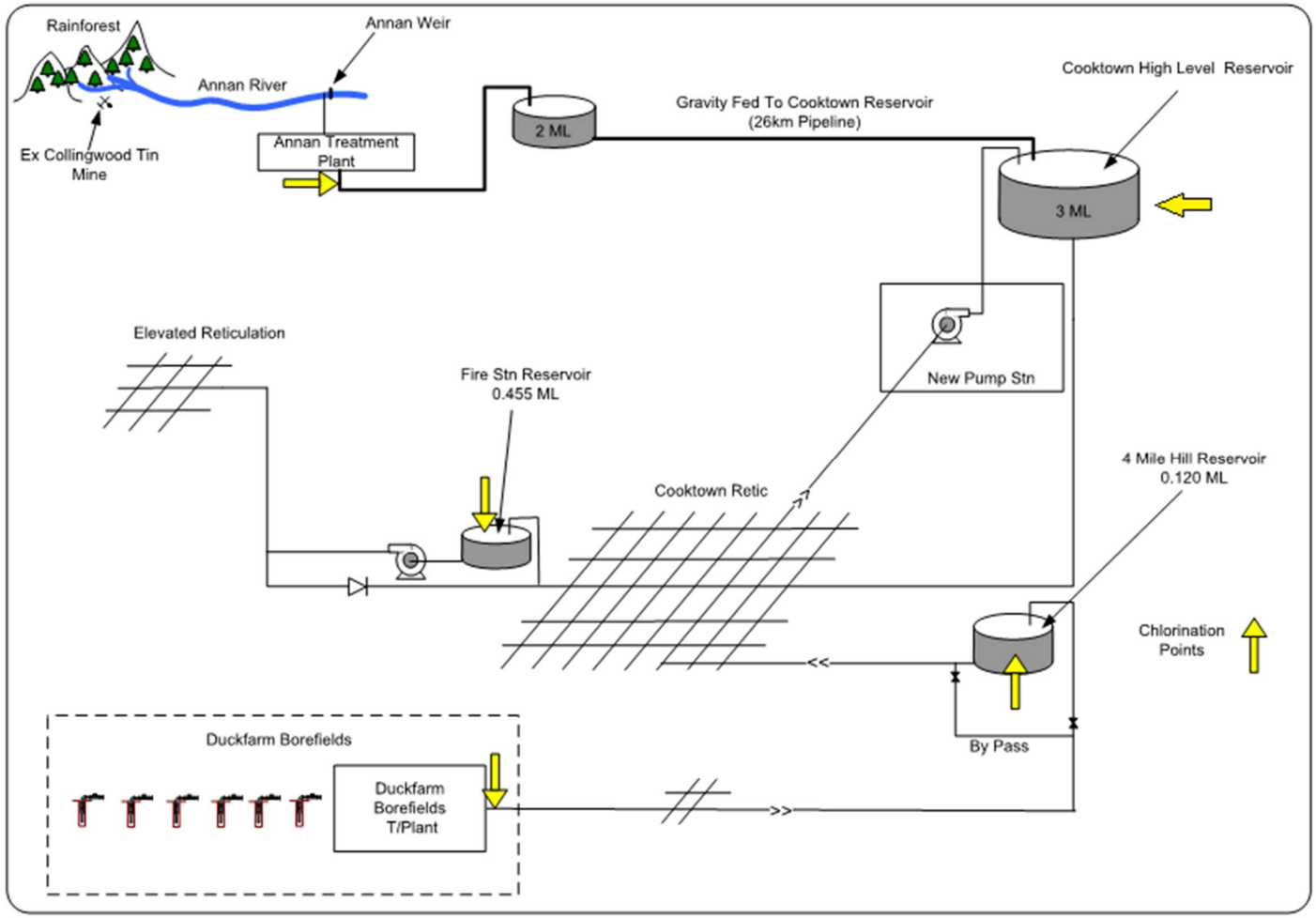


Figure 4 Annan Water Treatment Plant Schematic

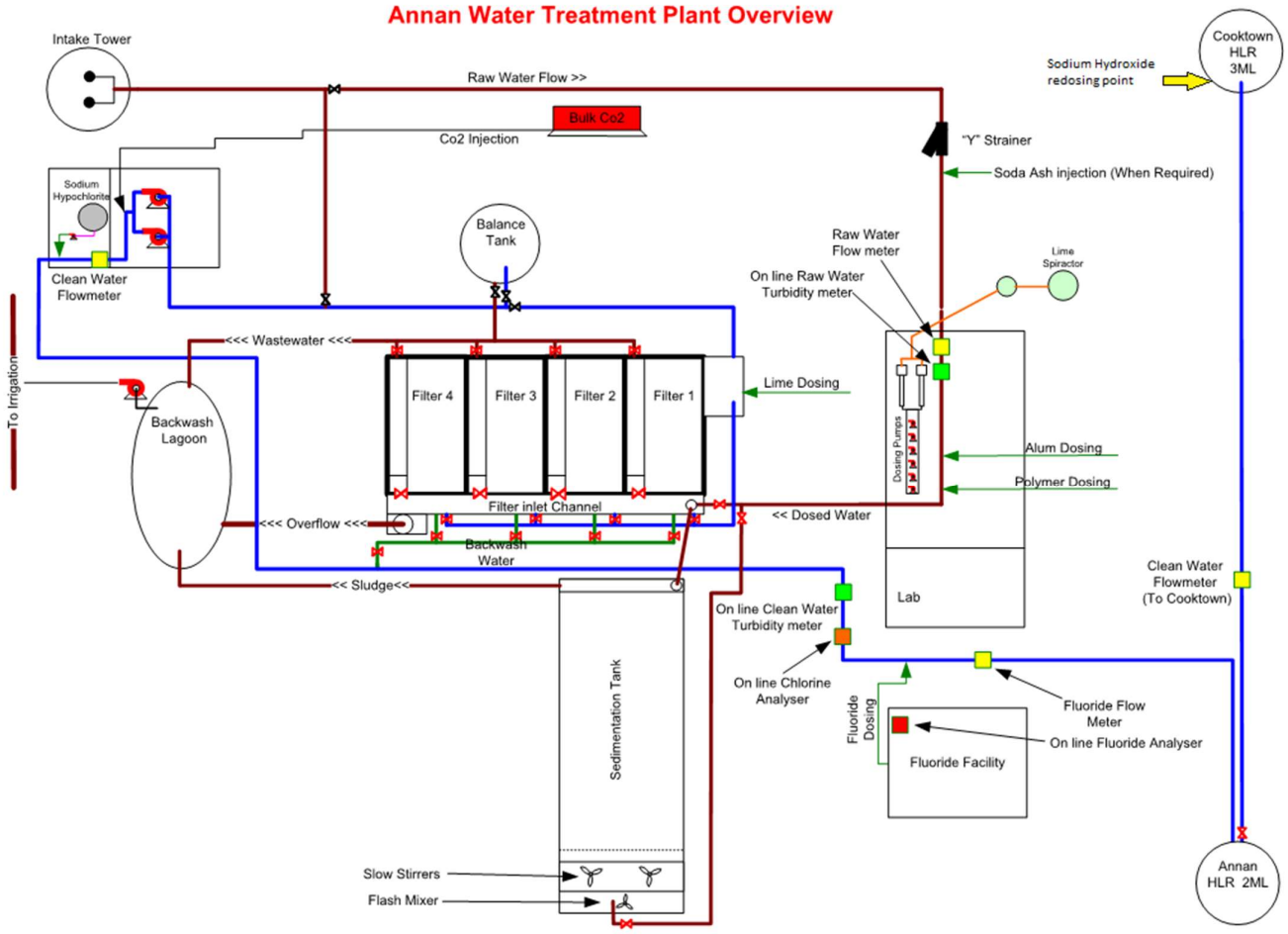


Table 2 Infrastructure Details

Annan WTP	
Raw Water Type	Surface Water
% of supply	100
Reliability	Annan River stopped flowing briefly in 2002-3 during an exceptionally dry period, normally has a good flow all year
Water quality issues	High Turbidity levels after storm events
Sourcing Infrastructure	Intake in the River upstream of a mass concrete weir with approximately 400ML of impounded water
Are there any sources that **do not** undergo treatment prior to supply?	No
Process	Coagulation, Flocculation, Sedimentation, Filtration Chlorination & Fluoridation
Design Capacity	3.6 ML/d
Daily flow range	1.8 ML/d (Wet Season) – 2.3 ML/d (Dry Season)
Chemicals added	Soda Ash (if required),Alum, Polymer, Lime, Carbon Dioxide, Sodium Hypochlorite and Sodium Fluoride
Standby chemical dosing facilities (Y/N)	Standby dosing pumps for: Soda Ash, Alum, Polymer, Lime and Sodium Fluoride.
Water sourced from and %	Water is sourced 100% from the Annan River
% of average day demand provided	100%
% of scheme supply Distribution area supplied	100%
Bypass 1	Sedimentation can be bypassed, reverting back to Direct Filtration (This would have no impact to final water quality in the dry season)
Bypass 2	Raw water can be pumped direct to the Reservoir, bypassing all treatment other than Chlorination and Fluoridation.
Disinfection Annan WTP	
Type	Sodium Hypochlorite Dosing
Dose rate	Unknown (Dosing to maintain target residual level)
Target residual levels	~1.5 mg/L (subject to temperature ~1.2 in winter)
Duty/standby	Yes
Dosing arrangements	PLC controlled with feedback from free chlorine residual analyser
Alarms	Yes chlorine residual under 0.4mg/L
Auto shut-off arrangements	Controlled by PLC via free chlorine residual analyser with control set points, shuts down when Clean Water Pumps Stops
Trended on SCADA	Yes
Fluoridation Annan WTP	
Chemical Type	Sodium Fluoride (Granular)
Dose rate	Variable - Flow Paced with Fluoride flow meter
Target Dose	0.71 mg/L
Duty/standby	Yes
Dosing arrangements	PLC controlled with feedback from on line fluoride analyser
Alarms	Operators alerted via the SCADA or touch screens in Fluoridation building of any Fluoridation related Alarms or Warnings. EDAC will phone out as water quality fault if fluoride is below 0.45mg/L or above 1.10mg/L.

Status Display	The fluoride room has a touch screen which has both display and control of the fluoridation equipment, includes all tank levels, valve positions (open/closed), dosing pump flow rates, main water line flow rate, which day tank on duty, which dose pump on duty, the actual dose rate (of Fluoride). Various warnings and prompts are displayed, and require an operator to acknowledge i.e. the operator is alerted when say Day tank 1 has only 25% left in it, it will auto alternate duty to Day tank 2 only if Day tank 2 level is greater than the shutdown level. It will alert the operator when the Day tanks have been alternated and require an operator to acknowledge. The operator can then refill the empty Day tank. All the above information is also available and controlled on the treatment plant SCADA screen.
Auto shut-off arrangements	Flow paced with Clean water pumps, controlled by PLC via on line fluoride analyser with control set points, shuts down if fluoride dose reaches a second High / Low set point, shuts down if main water line flow drops below 20 L/s, during a filter backwash, also when Clean Water Pumps Stop Fluoride shuts down if both day tanks are empty, or both dosing pumps fail
Fluoride Dose drift Alarm set points	Low – 0.55 mg/L High – 0.85 mg/L
Fluoride Dosing Shutdown set points	Low – 0.45 mg/L High – 1.10mg/L
Trended on SCADA	Yes
Disinfection New Pump Station	
Type	Sodium Hypochlorite Dosing
Dose rate	Unknown (Dosing to maintain target residual level)
Target residual levels	0.9 mg/L
Duty/standby	Yes
Dosing arrangements	Used only as a Backup system for High Level Reservoir
Alarms	No, Staff on site at least daily
Auto shut-off arrangements	Shuts off if zero flow
Disinfection Four Mile Reservoir	
Type	Sodium Hypochlorite Dosing
Dose rate	Unknown
Target residual levels	0.6 mg/L
Duty/standby	No
Dosing arrangements	Dosing on a timer
Alarms	No. Staff on site at least daily
Auto shut-off arrangements	Timer
Disinfection High Level Reservoir	
Type	Sodium Hypochlorite dosing
Dose rate	Unknown (Dosing to maintain target residual)
Target residual levels	0.9 mg/L
Duty/standby	Yes
Dosing arrangements	Chlorine analyser takes reading from recirculation pump and stops and starts dosing pump to maintain residual.
Alarms	No (No PLC at present)
Auto shut-off arrangements	Dosing pumps shut off when target chlorine residual level is reached.
Disinfection Fire Station Reservoir	
Type	Sodium Hypochlorite Dosing
Dose rate	Unknown (Dosing to maintain target residual level)

Target residual levels	0.6 mg/L
Duty/standby	Yes
Dosing arrangements	Reservoir recirculated. Dosing pumps controlled Timer.
Alarms	No. Staff on site at least daily.
Auto shut-off arrangements	Timer
Distribution and Reticulation System	
Pipe material	A.C. D.I.,UPVC & Poly
Age range	A.C. up to 49 years old All new Water mains installed since 1990 have been UPVC with a few small Poly lines Oldest D.I. is 31 Y.O.
Approximate % of total length	A.C. 38.8% D.I. 31.2% UPVC 18.5% Poly 11.5%
Areas where potential long detention periods could be expected	1 Area along Webber Esplanade has the potential for long detention periods
Areas where low water pressure (eg < 12 m) could be expected during peak or other demand periods)	No areas of low water pressure
Annan Clean Water Reservoir	
Capacity (ML)	2 ML
Roofed (Y/N)	Yes
Vermin-proof (Y/N)	Yes
Runoff directed off roof (Y/N)	Yes
Cooktown High Level Reservoir	
Capacity (ML)	3 ML
Roofed (Y/N)	Yes
Vermin-proof (Y/N)	Yes
Runoff directed off roof (Y/N)	Yes
4 Mile Hill Reservoir	
Capacity (ML)	0.120 ML
Roofed (Y/N)	Yes
Vermin-proof (Y/N)	Yes
Runoff directed off roof (Y/N)	Yes
Fire Station Reservoir	
Capacity (ML)	0.455 ML
Roofed (Y/N)	Yes
Vermin-proof (Y/N)	Yes
Runoff directed off roof (Y/N)	Yes

Raw water intake:

A circular concrete intake tower was built in the river bed, and is fitted with 4 intakes (at 4 different levels) on the downstream side of the tower. The two bottom intakes are blanked off. The second intake from the top is shut and the top intake is used as that's where the best water quality is. This intake has a stainless steel Johnson screen. There are 2 x 50 L/s Submersible Flygt Pumps in the tower. These pumps auto alternate if one faults, and also auto alternates between duty & standby.

Soda Ash Dosing:

Soda Ash is used continuously to adjust pH before alum addition. Soda ash also slightly raises the alkalinity of the raw water. There are 2 (duty / standby) soda ash dosing pumps which auto alternate on fault, and time, and the operator can also select the pump to run next. Soda ash is made into an 8% - 16% solution from 25 kg bags, and made up in a 2500 litre tank, this generally lasts for several weeks.

Coagulation/Sedimentation:
An on-line turbidity meter monitors the raw water turbidity, but this is not used for process control. There are 2 alum dosing pumps with 0.25 L/m capacity. These dose at a point about 15m further along than the soda ash dosing. Liquid alum is used as the primary coagulant.

There are duty / standby alum dosing pumps which auto alternate on fault, and time, and the operator can also select the pump to run. Liquid alum is purchased and supplied in 24 tonne lots as a 47% solution, this is transferred to the alum dosing tank and is diluted with water to produce the desired percentage alum solution.

Polymer:
There are 2 duty / standby 0.25 L/m capacity polymer dosing pumps. Polymer is used as a filter aid and is used continuously. The polymer dosing pumps auto alternate on fault, and time, and the operator can also select the pump. Polymer has the option of being injected in the dosing pit or at the end of the sedimentation tank, prior to filtration.

The dosed water passes through static mixers then on to the sedimentation tank. The sedimentation tank is fitted with a flash mixer however to date hasn't been required. The 2 slow stirrers gently agitate the water to strengthen the floc, the water then travels on through the tank where the heavy floc drops out before reaching the end. Sludge is removed from the floor of the sedimentation tank via an MRI Low Profile Hose less Sludge Collector. The sludge is sent to the backwash lagoon and supernatant is not recycled.

Bypass 1: The sedimentation tank can be bypassed. The trigger to initiate the use of this bypass would be a catastrophic failure of the sedimentation tank or normal cleaning and maintenance of the sedimentation tank. The use of this bypass returns the plant back to its original design (a direct filtration plant) and limits the raw water quality that can be treated to less than 25 NTU.

Filtration:
Water leaves the sedimentation tank and enters the bank of 4 filters along the filter inlet channel then through the individual filter inlet boxes. Filters are a dual media (Sand and Anthracite). The filtration process along with most of the processes are fully automated and controlled by a PLC.

At the Annan Treatment plant filter backwashes can be initiated by:

- Operator initiated
- 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 filters and checking the turbidity. At the Annan treatment plant there are 4 filter cells all of which have a continuous sample line plumbed to the lab so it's very easy to obtain a grab sample from each / any of the filter cells. Monitoring and trending of the head loss on the SCADA is a valuable tool for the operators as shows how the filters have been running historically and also indicates when a backwash is imminent.

All Filter valves are PLC controlled, pneumatically driven. During a filter cell backwash, the Clean water flow from the filters is reduced by ¼ (because 1 cell is off-line (backwashing) to create uniform flows through the plant, the raw water flow is reduced to ¾ of the flow rate immediately prior to the backwash, all chemical dosing pumps are reduced proportionally as well. This method maintains the same hydraulic load on the remaining filter cells during a backwash. Only 1 filter cell can backwash at a time, if a second or third requires backwashing then they queue until the previous cell has completed the backwash cycle

Bypass 2: Filter Bypass. The trigger to initiate the use of this bypass would be a catastrophic failure of the filters, and it would have to apply to all the filter cells, as there is the ability to shut down an individual filter cell for maintenance / repairs. This bypass was used initially in stage 1, prior to the construction of the filters. Since the commissioning of the filters, this bypass has never been used. Both bypasses are more a result of future subsequent works rather than designed bypasses.

Lime and CO_2 dosing:
After filtration, the lime solution is added in a chamber that creates turbulence, thus mixing the lime solution well. There are 2 helical rotor lime dosing pumps dosing a saturated lime solution into the filtered water.

Lime is batched by making a lime slurry in the lime slurry tank from 20kg bags. The slurry is transferred to the lime spiractor in operator adjustable increments of both frequency and duration. The lime spiractor is a cone shaped tank, water is added to the slurry from the bottom, at a tangent, to create a swirling motion with the slurry as the water level rises the cone diameter increases and the upward velocity of the solution decreases creating a saturated lime solution, this solution over flows into the saturated solution tank. This tank supplies the solution for the lime dosing pumps, as the tank is depleted a solenoid valve opens to allow more water into the spiractor thus replenishing the saturated solution tank.

The pipeline that exits the filters leads directly to the clean water pumps with a tee off to the balance tank. So if the clean water pumps are stopped then the water simply fills the balance tank until full then shuts down the raw water pumps, alternatively if the clean water pumps are running then the pumps take what is required, this either slowly fills the balance tank, or slowly depletes it. The pumps, raw and clean water, have been sized to produce the same flow rate, however there has been some minor throttling to fine tune the flows. The balance tank level now remaining fairly constant over a pumping cycle. A level sensor on the balance tank controls the starting and stopping of both the raw pumps.

Immediately after the clean water pumps is the injection point for CO_2, this is injected directly into the main through a diffuser, the CO_2 is pressure regulated and a flow rotameter is fitted to show the rate of flow. Carbon dioxide is stored in a 4 tonne cylinder which has to be refrigerated, CO_2 gas is injected prior to the disinfection but after the lime. Lime & CO_2 dosing can be turned off as a whole, selecting this option stops both lime & CO_2.

Lime with the addition of carbon dioxide forms a calcium carbonate lining on the inside of all the concrete reservoirs and the cement lined pipeline to Cooktown, forming a barrier to the otherwise aggressive nature of the water. After the commencement of using water from the Annan River in the early nineties and prior to lime & carbon dioxide dosing, evidence was clearly visible with the degradation of the internal walls of the concrete reservoirs, both at the Annan and in Cooktown. Lime and carbon dioxide dosing has proven to reverse the destruction of the concrete fixtures. Over the years the Annan pipeline has been cut for various reasons and the calcium carbonate lining has been clearly visible.

Disinfection:
Approximately 20 m downstream of the lime the water is disinfected with sodium hypochlorite. Dual duty/standby dosing pumps provides the chorine dose, which is controlled by a PLC and a chlorine analyser, the chlorine is maintained at the set point level of approximately 1.5 mg/l depending on temperature, with feedback from a chlorine analyser The chlorine dosing pump is interlocked to run only when either of the clean water pumps are running, and shuts down with the clean water pumps

Fluoridation:
A further 60m along the pipeline Fluoride is injected, being a brand new purpose built facility it complies with all requirement in the current version of the Water Fluoridation Code of Practice and the *Water Fluoridation Regulation 2008*. Qld Health's audit team routinely perform audits on the facility. The facility aims to dose fluoride at the required rate of 0.71mg/L with auto shutdowns at 0.45 and 1.1 mg/L.

Reticulation:
Treated water is pumped to the Annan High Level Reservoir (at the WTP) from where it water gravity feeds via the 26 km 300 mm DICL pipeline to the Cooktown High Level Reservoir at 50 L/s, in Cooktown, as required via telemetry signals. There are 12 residences connected to the main between the Annan Reservoir and the High Level reservoir. These residences experience daily pressure fluctuations, lower pressure as the Reservoir fills, and higher pressure when the Reservoir is filled. Cook Shire has not received any water pressure complaints from those residences. These residents were required to sign a waiver regarding water pressure when they connected to the pipeline.

The Cooktown Reservoir directly supplies water to the water reticulation system after being re-chlorinated at the High Level Pump Station. Dual pumps are controlled by a chlorine analyser.

Chlorine can be added if required at the New Pump Station. Dual chlorine dosing pumps, are controlled by a PLC and inject a flow paced set dose, the dosing pumps auto alternate on fault, as well as Duty / Standby.

The Fire Station Reservoir is filled from a major water main in the reticulation, and is now only used as the suction storage for the booster pumps which boost the pressure to the elevated reticulation. A non-return valve allows water to pass through to the elevated sites during periods of "Loss of Mains Power".

The Fire Station Reservoir is equipped with a chlorine dosing pump run on a timer.

2.2 Duckfarm Borefields

The Duckfarm Borefields can supply water directly to the 4 Mile Hill Reservoir, supplying a handful of residents on the way. The 4 Mile Hill Reservoir is directly connected to the reticulation, water can be pumped from the 4 Mile Hill Reservoir to the High Level Reservoir through the reticulation, and via the pumps at the New Pump Station. The Borefields have now become a backup supply in the event of a major supply issue from the Annan. The bore fields can produce 0.8 ML of water per day. The switchboard at Leons Bore, Tully Bore and Lovers Bore were replaced. The pumps in the holding tank have been replaced and pumps in the pump shed which pump up to Four Mile Reservoir have been replaced. The Bore Water is chlorinated only. The refurbishment of the aeration system and sand filter was not funded. Funding will continue to be sort to upgrade the aeration and filtration system. Until then, the water supplied is over the ADWG in iron and manganese. Water is currently being used for roads to ensure that the system is used on a regular basis.

When operational, control floats in the 4 Mile Hill Reservoir initiate a start for the Borefields at reaching the pre-set level, this starts all the Bores simultaneously, which fill up the below ground holding tank, upon reaching the required "Start level" the "On duty" submersible pump starts to pump the water to the treated water tank. When the required "Start level" is reached the "On duty" centrifugal lift pump starts to pump the water to the 4 Mile Hill Reservoir until the "Stop Level" is reached.

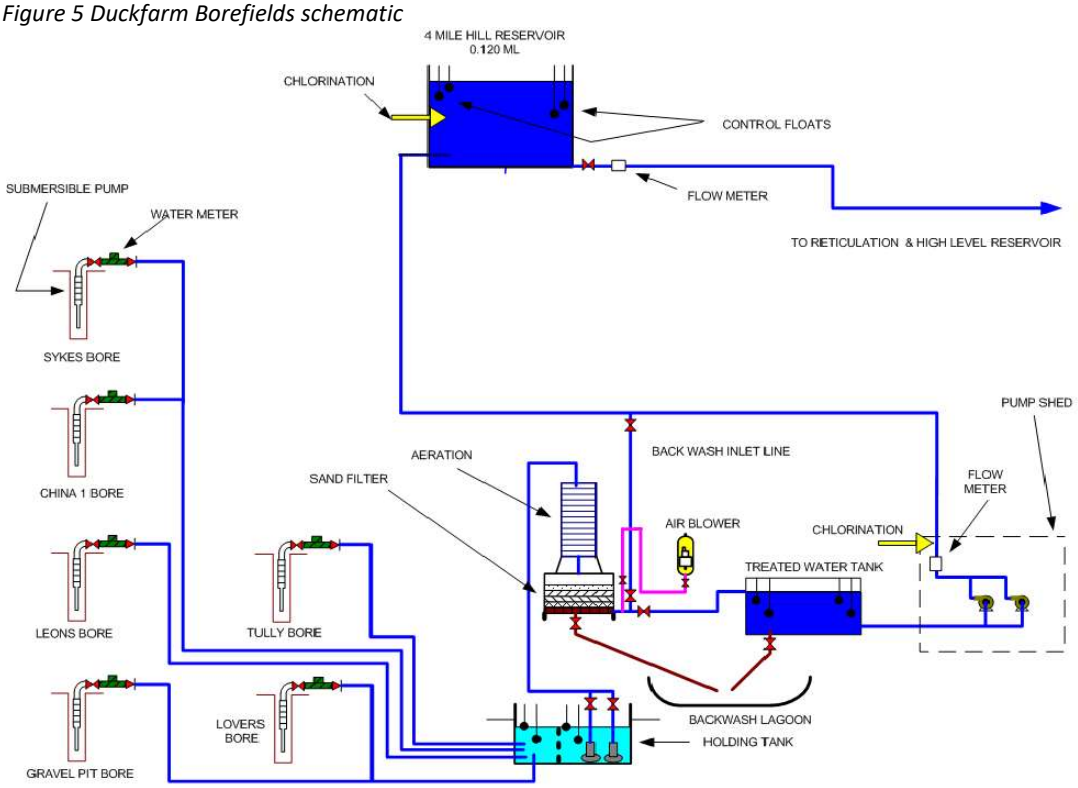
The single hypochlorite dosing pump is interlocked with the centrifugal lift pumps, so that when either of the lift pumps run so does the dosing pump. The centrifugal lift pumps pump at a fixed rate that doesn't vary, as does the dosing pump to produce a downstream chlorine residual of 0.6 mg/l

Upon reaching the "Stop Level" in the 4 Mile Hill Reservoir a signal is transmitted via telemetry to the Borefields which stops all the bores simultaneously, everything else continues to run, as the below ground holding tank becomes depleted of water, the "Stop Level" is reached, stopping the submersible pumps, this in turn then depletes the water level in the treated Water tank as the centrifugal lift pump continues pumping but only until the "Stop Level" is reached in the treated water Tank. With the centrifugal lift pumps stopped the Borefields remain idle until the next Start signal is received. A manual start signal can also initiate a Borefields start up.

The Borefields uses reverse logic (by leaving the process tanks empty until the next start) compared to everything else in the Shire.

Water can be pumped from the 4 Mile Hill Reservoir to the Cooktown High Level Reservoir through the Reticulation mains, as there is no dedicated trunk main from the 4 Mile Hill Reservoir to the New Pump Station. Centrifugal pumps at the "New Pump Station" (Still named "New Pump Station" even though it's nearly 30 years old) lift the water from the reticulation mains to the High Level Reservoir with a level sensor at the 4 Mile Hill Reservoir controlling the Stop / Start functions of the centrifugal pumps at the "New Pump Station". The pumps at the "New Pump Station" have been refurbished.

Figure 5 Duckfarm Borefields schematic



Since the introduction of Fluoride into Cooktown's water we now back supply water from the 4 Mile Hill Reservoir as far as the Borefields to give all the residents fluoridated water. The Borefields supply is not fluoridated, and if used, no fluoride will be provided in the water supply. Four Mile Hill Reservoir fills through the reticulation, and is re-chlorinated as required.

The Cooktown Reticulation Network is a mixture of A.C. (56%), uPVC (27%), and Poly (17%) The Cooktown Reticulation was initially installed in the early 70's and was entirely A.C., this was the normal practice until the early 90s when use of A.C. was discontinued. All new and replacements water main are done using uPVC pipes. The water mains are scoured annually to promote "Healthy mains". Chlorine residual readings are collected from the reticulation network and stored in a database daily.

Table 3 Borefields infrastructure details

Duckfarm Bores	
Duckfarm Borefields	6 bores at an Av. depth of 50 metres are equipped with Electric submersible pumps. Combined water is Aerated, Sand Filtered and Chlorinated before distribution.
Are there any sources that **do not** undergo treatment prior to supply?	No
Process	Chlorination
Design Capacity (20 hr operation)	0.8 ML/d
Daily flow range	Limited to 1 ML per day
Chemicals added	Sodium Hypochlorite
Standby chemical dosing facilities (Y/N)	No
Water sourced from and %	Water is sourced 100% from the Borefields
% of average day demand provided	0%
% of scheme supply Distribution area supplied	0% (Backup Water supply)
Bypasses / Variations	No Bypasses
Year Bores Sunk	1982
Bore Casing Size	150 mm
Bore Casing material	Class 12 PVC
Sealed to prevent surface water ingress	Yes, All the bore casings are typically 600mm above surface level & encased in concrete preventing surface water ingress
Sealed to prevent vermin (frogs / snakes etc.) from entering bore	Yes, All bores sealed to prevent vermin (frogs / snakes etc.) from entering the bore
Disinfection Duckfarm Borefields	
Location	Borefields Pump Room
Type	Sodium Hypochlorite Dosing
Dose rate	Unknown (Dosing to maintain target residual level)
Target residual levels	0.6 mg/L
Duty/standby	No
Dosing arrangements	Interlocked with Clean Water Pumps
Alarms	No
Auto shut-off arrangements	Shuts down when Clean Water Pumps Stop
Disinfection Four Mile Hill Reservoir	
Location	4 Mile Hill chlorinator Shed
Type	Sodium Hypochlorite Dosing
Dose rate	Unknown (Dosing to maintain target residual level)
Target residual levels	0.6 mg/L
Duty/standby	No
Dosing arrangements	A small maintenance dose is added at this site to maintain the chlorine residual. The dosing pump is controlled via 24 Hr programmable timer Typically set at 15 minutes @ 8Hr intervals
Alarms	No, Staff on site minimum daily, usually more frequently
Auto shut-off arrangements	Shuts down when timer is off

3 RISK ASSESSMENT

3.1 Cooktown Mitigated Risk Assessment

Following the hazard identification and unmitigated risk assessment detailed in the overarching plan, the Cooktown 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.

Cooktown 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			2022/2023	2023/2024	2024/2025
Catchment	Animals in catchment	bacteria and virus	Extreme 20	disinfection	coagulation filtration	Catastrophic	Rare	Medium 6	Certain	considered as whole of treatment in absence of failure			
Catchment	Present in catchment - animals	protozoa	Extreme 20	filtration	coagulation	Catastrophic	Rare	Medium 6	Confident	considered as whole of treatment in absence of failure			
Catchment	Annan stops flowing, and algal bloom	taste and odour	Medium 8	coagulation/ filtration		Moderate	Rare	Low 3	Reliable	doesn't happen every year, but can then be present for weeks at a time			
Bores	Ingress into bore	bacteria and virus	Extreme 20	disinfection	borehead sealed	Catastrophic	Rare	Medium 6	Certain	Backup supply rarely used. Inspection program every six months.			
Bores	Ingress into bore	protozoa	Extreme 20	borehead sealed	Inspection program every six months	Catastrophic	Rare	Medium 6	Confident	Backup supply rarely used.			

Cooktown 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			2022/2023	2023/2024	2024/2025
Bores	Bore switchboard failure	failure of supply	High 10			Major	Unlikely	Medium 8	Reliable	Backup supply, but could be required in Disaster. 6 separate bores		Reinstate Borefields for emergency supply Stage 2 (Funding dependent)	Reinstate Borefields for emergency supply Stage 2 (Funding dependent)
Bores	Bore pump failure	Failure of supply	High 10	Multiple bores, would still be able to supply		Major	Rare	Medium 5	Certain				
Raw Water Feed	Raw water main break	Failure of supply	High 10	5 ML in treated water reservoirs two days' supply	mains break procedure WS 0002	Moderate	Rare	Low 3	Confident	Crews available to fix critical issues			
Raw Water Feed	Raw water pump failure	Failure of supply	High 10	5 ML in treated water reservoirs – two days' supply	Duty/duty standby	Major	Rare	Medium 5	Certain	Contract with Xylem to service pumps bi-annually. 3 pumps onsite			
Raw Water Feed	Low raw water hardness	Corrosive water	High 15	Addition of lime		Moderate	Unlikely	Medium 6					
Coagulation	Under dose alum	Protozoa, turbidity	Extreme 20	coagulation	Sedimentation basin monitoring, EDAC alarm on NTU over 15 from Sed basin. Filtration	Minor	Possible	Medium 6	Confident	Plant run when operators on site. SCADA			
Coagulation	Overdose alum	Aluminium	Medium 6	Sed. tank monitoring	EDAC alarm on NTU over 15	Minor	Possible	Medium 6	Confident	Plant run when			

Cooktown 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			2022/2023	2023/2024	2024/2025
					from Sed basin. Filtration					operators on site. SCADA			
Coagulation	Poor floc due to low alkalinity	Protozoa	Extreme 20	soda ash dosing when required	Filters still pick up floc	Major	Unlikely	Medium 8		SCADA alarm for combined turbidity from filters. Individual filter turbidity done daily			
Coagulation	Bypass	Protozoa	Extreme 20	bypass not used in normal operations	direct filtration	Catastrophic	Rare	Medium 6		Requires manual opening of bypass valves. maintenance not done in wet season			
Filtration	Filter breakthrough	Protozoa	Extreme 20	combined filtrate monitored on SCADA continuously, daily checks	Combined filtrate will ring EDAC above 1.5NTU; Filter media replaced in 2017	Major	Unlikely	Medium 8	Reliable	SCADA monitoring and alarms through auto dialler. EDAC alarm on Sed. basin lowers the risk.			
Filtration	Filter breakthrough	turbidity	Medium 6	continuous clarifier monitoring	EDAC alarm on combined filters	Minor	Possible	Medium 6	Confident				
Filtration	Asset ageing	System failure	Extreme 20	Maintenance	Capital renewals as required	Catastrophic	Rare	Medium 6	Estimate	Filters have been recoated internally to prevent concrete degradation			

Cooktown 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			2022/2023	2023/2024	2024/2025
										and media replaced			
Disinfection	Overdose	Chlorine	High 15	Daily checks at WTP and Reservoirs.	EDAC alarm in place for high chlorine over 2.5mg/L	Moderate	Rare	Low 3	Confident	SCADA monitoring, and daily monitoring at plant, 25 km of pipeline, pumps would struggle to reach 5 mg/L.			
Disinfection	Insufficient dose	bacteria/virus	Extreme 25	Daily checks at WTP and Reservoirs. Coagulation and filtration at WTP.	EDAC alarm in place for low chlorine under 0.8mg/L	Major	Unlikely	Medium 8	Reliable	Duty/Standby pumps available with automatic change over			
Disinfection	Ineffective disinfection due to turbidity	bacteria	High 10	Disinfection, re-dosing at High level reservoir in Cooktown	Filtration. EDAC alarms on Sedimentation basin and final water.	Major	Unlikely	Medium 8	Confident				
Disinfection	Chemical breakdown	chlorate	High 12	Chlorate and THM sampling in reticulation system		Moderate	Unlikely	Medium 6	Unreliable	4 years of data with 1 exceedance	If chlorate is found, investigate solutions.		
Fluoridation	Under dose fluoride	fluoride	Low 3	daily checks		Insignificant	Unlikely	Low 2	Confident	Under dose is an issue under Fluoridation Act, but not a public health issue			

Cooktown 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			2022/2023	2023/2024	2024/2025
Fluoridation	Overdose fluoride	fluoride	High 12	fluoride interlocks, auto shutdown,	Daily monitoring	Moderate	Rare	Low 3	Reliable	interlocks, and design makes this nearly impossible			
Treated water storage/ Reservoirs	Ingress into reservoirs	bacteria/virus	Extreme 20	Integrity and sealing	Residual chlorine. Four mile reservoir is new.	Catastrophic	Rare	Medium 6	Confident	No recorded ingress into reservoirs	Funding secured to replace High Level Reservoir roof		
Treated water storage/ Reservoirs	Ingress into reservoirs	Protozoa	Extreme 20	Integrity and sealing	Fire station reservoir has been relined.	Catastrophic	Rare	Medium 6	Reliable	No recorded ingress into reservoirs			
Treated water storage/ Reservoirs	Ingress of amoeba	amoeba	High 12	Integrity and sealing	Residual chlorine	Major	Rare	Medium 5	Reliable				
Reticulation	Ingress of contaminated water / mains breaks	bacteria/virus	Extreme 20	network pressure, residual disinfection	mains break procedure WS 0002; Low chlorine flushing procedure WS006	Major	Unlikely	Medium 8	Confident		Funding secured to replace 80mm AC water main in Helen Street	On-going funding required to replace existing failing 80mm AC.	On-going funding required to replace existing failing 80mm AC.
Reticulation	Ingress of contaminated water	protozoa	Extreme 20	network pressure	mains break procedure WS 0002	Major	Unlikely	Medium 8	Reliable				
Reticulation	biofilm growth	opportunistic pathogens	Medium 6	Flushing program and SOP for flushing on low residual		Major	Rare	Medium 5	Reliable				
Reticulation	change in flow rate, reservoir run low, disturbing	turbidity	Medium 6	mains break procedure WS 0002, pressure constant		Insignificant	Possible	Low 3	Confident				

Cooktown 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			2022/2023	2023/2024	2024/2025
	sediment in pipe												
Reticulation	Failure of storage capacity	loss of supply	High 15	restrictions can be imposed to manage supply		Major	Unlikely	Medium 8	Reliable	5 ML in treated water reservoirs - two days supply.		Borefields supply as back up	
Reticulation	turbidity from resuspending lime in reservoir	turbidity	Medium 6	Bi-annual reservoir clean	minimum operating level	Minor	Unlikely	Low 4	Confident				
Reticulation	long water age	Disinfection By-products	Medium 9	Water age is two days in dry season and three in wet season	Coagulation and filtration to remove organic matter before disinfection	Moderate	Rare	Low 3	Confident	One exceedance in 4 years of sampling			
Reticulation	Backflow	Protozoa	Extreme 20	System integrity. Backflow prevention on meters.		Catastrophic	Rare	Medium 6	Estimate	Taggle meters investigated and not currently economically viable for Cook Shire	Replace meters at 15 years	Replace meters at 15 years	Replace meters at 15 years
Reticulation	Ageing hydrants & valves	Infrastructure issues	High 15	system maintenance		Moderate	Possible	Medium 9	Reliable	Valve and hydrants maintenance and replacement as required			

Cooktown 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			2022/2023	2023/2024	2024/2025
System Wide	Power failure	Failure of supply	High 15	Generator at Annan can produce water, mobile generators can be used for re-chlorination		Catastrophic	Rare	Medium 6	Confident				
System Wide	WTP Fire	Failure of supply	Medium 6	Activate DMP. Fire breaks around Annan WTP		Catastrophic	Rare	Medium 6	Reliable				
System Wide	Drought	Failure of supply	High 10	Restrictions leading to Wet season if supply low.	Weir has stopped overflowing twice in 33 years.	Catastrophic	Rare	Medium 6	Reliable				
System Wide	Flood	Failure of supply	High 10	Generally only impacts raw water quality	Coagulation, flocculation, sed basin and filtration.	Catastrophic	Rare	Medium 6	Reliable				
System Wide	Cyclone	Failure of supply	High 15	DMP; Cyclone preparation procedure WS0032.		Catastrophic	Rare	Medium 6	Reliable	Borefields can supply emergency water		Sort funding for Stage 2 – Borefields upgrade	Sort funding for Stage 2 – Borefields upgrade
System Wide	operator error	any	High 12	training, experienced operators, mentoring	All current operators have Cert III in water operations and new staff are currently doing a Cert III	Major	Unlikely	Medium 8	Estimate	All current operators have Cert III and over 3 years of experience	On-going training for new staff	On-going training for new staff	On-going training for new staff

Cooktown 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			2022/2023	2023/2024	2024/2025
System Wide	Cybersecurity	Cyber attack	High 12	Gateway software	Anti-virus and threat detection software	Major	Unlikely	Medium 8	Reliable				

3.2 Cooktown Risk Management Improvement Plan

Table 4 Coen Risk Management Improvement Plan

Process Step/Component	Hazard	Risk Management Improvements	Priority	Responsible Person	Year
Bores	Bore switchboard failure	• Stage 1 of the Borefields upgrade has been completed. Stage 1 involved the upgrade of the switchboard at Leons Bore, Tully Bore and Lovers Bore. Stage 2 will involve upgrade of filter facilities at Leons Bore, switchboard upgrades for the remaining bores and pre-chlorination to remove iron and manganese.	High	Manager and Team Leader Water and Wastewater	2023/2024 Funding dependant
Reticulation	Chlorates	• One exceedance in 4 years of sampling. This is believed to have been caused by using old chlorine in a spray bottle to sterilize tap as chlorates samples were taken the same time as the E. coli samples. Three samples were taken in the reticulation system and the other two	Low (on-going)	Manager Water and Wastewater	Sampling on-going. See chlorate Management Plan

		were considerably under the interim value.			
Reticulation	Ingress into treated reservoir. Bacteria and viruses.	• Four mile reservoir has been replaced. • Fire station reservoir has been relined and roof replaced 7 years ago. • Annan reservoir and roof are in good condition. • High Level Reservoir rood needs replacing.	High	Manager Water and Wastewater/Buildings and Facilities Manager	2022/2023 Funding secured to replace reservoir roof
Reticulation	Ingress into water mains. Bacteria and viruses.	• On-going program to replace 80 mm AC water main in Cooktown. • Funding secured to replace a section of water main on Helen Street from Furneaux Street to Hogg Street	High	Manager and Team Leader Water and Wastewater	2022/2023 Funding secured to replace water main
Reticulation/Backflow	Protozoa	• Replace water meters when they reach 15 years of age	Low – on-going	Manager and Team Leader Water and Wastewater	On-going each year
System Wide	Operator error	• Ongoing Certificate III training for staff • Some new staff have done micro-credentials course through Qldwater • Certificate III in water operations is organized for October 2022 with other FNQ councils. • Currently, all operators are ticketed as well as 5 other members of the team.	Low	Manager and Team Leader Water and Wastewater	2022/2023

3.3 Cybersecurity

The Cook Shire Council's network is set up to detect cybersecurity breaches. The breach is identified through the internal network security monitoring tools which includes gateways and anti-virus threat detection.

In the instance of a cybersecurity attack that gets through, the Council IT department would try to detect its origin, look at removing the computer from the network, restore information from backups.

To date, there have been no detectable cyber-attacks on our SCADA systems in Council

Issues that needs to be addressed in the cyber security space include: separate log in for individual employees when logging onto the SCADA system and the end of support for Windows 7 which will force Council to migrate SCADA control software to Windows 10 operating system.

All cyber security incidents/breaches are reported to the QGCIO. The details for the QGCIO are:
Queensland Government Information Security Virtual Response Team (QGISVRT).
Phone: 07 3215 3951
Email: qgisvrt@qld.gov.au
Website: www.qgcio.qld.gov.au

3.4 Outcome of recent incidents

Recent incidents for the Cooktown Water Scheme from 01 January 2020 to 31 March 2022.

Table 5 Recent water quality incidents

Date sample taken	Place	Parameter	Concentration	Action Plan
12 July 2021	Mobil Service Station	Chlorate	1.36 mg/L	Use alcohol wipes or take chlorate sample before spraying tap with chlorine for disinfection.

3.5 Chlorate Management Plan

The chlorate management plan below is based on the qldwater Chlorate Fact Sheet – Managing Chlorate Residuals.

Table 6 Chlorate Management Plan

Potential mitigation action	**Action**	**Future Action**
Reduce age of chlorine		
Bulk chlorine is delivered to the Annan WTP	Annan operators perform a chlorine strength and a pH test on the delivered chlorine.	Continue
Work with supplier to reduce chlorate in source material	Cooktown does not have high chlorate levels, therefore, it is assumed that the bulk supply does not have high levels of chlorate.	No action

Work with supplier to minimise the time from manufacture to delivery and use	Cooktown is a remote community in Cape York. This would be difficult to achieve.	No action
Increase turn-over/delivery of hypochlorite	Cooktown is a remote community in Cape York. This would be difficult to achieve.	No action
Replace oversized tanks	The current tank size is sufficient and has excess for the times when the tankers cannot get to Cooktown in the wet season.	No action
Reduce rate of chlorate formation prior to use		
Dilute stock concentrations	Bulk solution is not diluted. Do not have space to dilute bulk solution.	No action
Store solution in cool area and out of direct sunlight	Cooktown chlorination shed is well ventilated and the storage tanks are out of direct sunlight.	No action
Control the pH of stored hypochlorite solutions at pH 11-13, even after dilution	Action: This option will be investigated.	Investigate
Rinse sodium hypochlorite storage tanks between refills	When chlorine levels are low. Chlorine can be pumped into one tank and the other two tanks can be rinsed out.	Continue
Ensure processes and maintenance are optimized		
Optimise the chlorination process to avoid high doses of chlorine	Set points for Chlorine disinfection levels in Cooktown is between 1.2 and 1.5mg/L. This cannot be lower and still maintain disinfection to the end of the mains.	No action
Optimize the coagulation, flocculation, sedimentation, filtration processes to reduce chlorine demand	Cooktown Annan WTP produces water that 0.02 NTU turbidity for most of the year.	No action
Reduce chlorine demand of reservoirs and networks caused by biofilm and sediment	Cooktown reservoirs are cleaned every when required but generally every two years. Water mains are flushed once a year. The water team does not have the capacity to increase the frequency of these options.	No action
Explore alternative disinfection options		
Converting to disinfection using chlorine gas	This option is considered too dangerous. Qldwater Disinfection Options for Water Service Providers Guidance Paper lists chlorine gas as high risk for very small remote places.	No action
Convert to onsite generation of chlorine	Cooktown Annan WTP would require too much chlorine to be generated. As the chlorate issue is not bad in Cooktown water, this is considered not an option at the moment.	No action
Additional Council Actions		
Chlorate samples taken every three months	Sampling includes E. coli and therefore the tap is sterilized before samples are taken. Staff have two options. Option 1 is the use of alcohol wipes to sterilize the tap. Samples can then be taken (including chlorate) or Option 2 is to take the chlorate sample, then sterilize the tap with liquid chlorine and then take the E. coli sample last.	Continue
Chlorate detected	If chlorate is detected, the regulator and QH will be notified	Continue

Chlorate detected in two consecutive samples	If chlorate is detected in two consecutive samples then a “do not consume” notice will be discussed with QH. This is considered a long-term exceedance.	Continue

4 OPERATIONAL PROCEDURES

Operational limits for the Annan WTP are listed below:

Table 7 Operational Limits used by operators/ SCADA.

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	 <6.6 and > 8.4 <6.6 and >8.4 6.6 – 7.6	Daily	<6.6 – >8.4	<6.6 or >8.4	• pH above 8.4 – check lime dosing equipment and slurry levels. Check CO_2 dosing system as malfunction of this system will cause pH to rise. • pH below 6.6 – check lime dosing equipment and slurry levels. Malfunction of lime system will cause the pH to decrease. • Lime and CO_2 dosing can be disabled on the SCADA.
	Alkalinity	Y	–	Generally Daily	-	-	• Coagulation with Alum is best with 0.45 mg/L of alkalinity / mg/L of Alum. Operator to maintain this ratio with the addition of Soda Ash. Natural alkalinity is generally <12mg/L
	Turbidity	Y	 > 2 0.3 – 1 NTU < 0.2 NTU	Daily	>0.2	>3 NTU	• If turbidity is over 0.2 NTU, chemical dosing may not be correct. Corrective action include: ○ check alum pump, ○ check dose rate, ○ perform jar testing ○ reset plant to new dose if required ○ retest turbidity. • Plant will shut down at 2 NTU
	Colour	Y	 > 12.Hu 2 – 12 Hu <2 Hu	Daily	0 – 12 Hu	>12 Hu	• 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
	Total Hardness	Y	 >60 mg/L as $CaCo_3$ >55 mg/L as $CaCo_3$ 35-55 mg/L as $CaCo_3$	Generally Daily	0 – 60 mg/L as $CaCo_3$	>60 mg/L as $CaCo_3$	• Lime and CO_2 added to form calcium carbonate lining on the cement reservoir and the cement lined pipeline to town. Can be turned off

Process Step / Location in System	Parameter	Operational Monitoring	Target Range	Monitoring Frequency	Operator Intervention Range	Report to Supervisor Range	Corrective Actions/ Comments
							completely for short periods. No additional benefit with levels above 60 mg/L as $CaCo_3$
	Chlorine - Residual	Y	 <0.4 >3mg/L 0.4 – 0.6 and 2.5 mg/L 0.6 -1.8 mg/L	Daily in laboratory. Online analyser	<0.6 and >2.5 mg/L	<0.4 and >3 mg/L	• If chlorine is above 2.5mg/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. • 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.
	Aluminium	Y	 >0.15 mg/L 0 .05 - 0.15 mg/L 0.0 -0.05 mg/L	Weekdays	0 – 0.15 mg/L	>0.15 mg/L	• 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
	Fluoride*	Y	 >0.9 mg/L >0.6 – 0.8 mg/L 0.68 mg - 0.72 mg/L	Daily	>0.6 – 0.68 and 0.72 - 0.9 mg/L	<0.6 and >0.9 mg/L	• Check operation of Fluoride dosing equipment • Check Fluoride Day Tank Levels • Check Fluoride analyser operation • Check online analyser against benchtop analyser • Check Fluoride Maintenance schedule • Increase / Decrease dose rate

Documented procedures, as listed below.

Table 8 Formal documented procedures used by CSC

Number	Documented Procedure Name	Date of last revision	Area
WS 0001	Safe Handling of Sodium Hypochlorite	2021	All
WS 0002	Water Main Repairs	2021	Reticulation
WS 0003	DWQMP Annual Report Creation	2021	Admin
WS 0004	SWIM Annual Report Creation	2021	Admin
WS 0005	E. Coli Detection Reporting	2021	Admin
WS 0006	Water Mains Flushing and flushing for Low reticulation free chlorine residual	2021	Reticulation
WS 0007	Water Reservoir Cleaning	2021	Reticulation
WS 0008	Water Sampling	2021	Reticulation
WS 0009	Water Testing Coliforms & E.coli Analysis	2021	Annan Lab
WS 0010	Water Service - New Installation	2021	Reticulation
WS 0011	Water Mains - New Installation	2021	Reticulation
WS 0012	CIP Procedure Laura	2021	Treatment
WS 0013	Water Service Repairs	2021	Reticulation
WS 0014	Operation Procedure for Lakeland WTP	2021	Reticulation
WS 0015	Chlorine Analysers Maintenance Procedure	2021	Treatment
WS 0016	Jar Testing Procedure	2021	Treatment
WS 0017	Incident Notification	2021	Admin
WS 0018	Coagulation & Flocculation	2021	Treatment
WS 0019	Flow meter Calibration	2021	Admin
WS 0020	Working around sewage	2021	Sewage
WS 0021	High Pressure Sewer Cleaning	2021	Sewage
WS 0022	Troubleshooting DAF Plant Coen	2021	Treatment
WS 0023	Running the Coen Bore field	2021	Treatment

WS 0024	Recharging the Coen Bores	2021	Treatment
WS 0025	Using Hydrochloric Acid (Splash Park)	2021	Reticulation
WS 0026	Wastewater Sampling at the Coen STP (NATA lab)	2021	Sewage
WS 0027	Cleaning Baskets	2021	Sewage
WS 0028	Dealing with high flow at the Cooktown STP	2021	Sewage
WS 0029	Lakeland WTP Generator	2021	Treatment
WS 0030	Cooktown STP Generator	2021	Sewage
WS 0031	Detection of a chemical parameter above ADWG	2021	Admin
WS 0032	Splash Park Procedure	2021	Reticulation
WS 0033	Cyclone Preparation procedure - Lakeland, Laura and Cooktown (Using bore fields)	2021	Reticulation/Treatment
WS 0034	Cyclone Preparation procedure - Lakeland, Laura and Cooktown (not using the bore fields)	2021	Reticulation/Treatment
WS 0035	Cyclone Preparation procedure - Coen	2021	Reticulation/Treatment
WS 0036	Procedure in the event of environmental Incident	2021	Sewage
WS 0037	Boiled water alert (Media coordinator)	2021	Media liaison
WS 0038	Fire Service configuration and metering procedure	2021	Admin and Reticulation
WS 0039	E. coli analysis using Idexx	2021	Annan and Coen WTPs
WS 0040	High Level new chlorine analyser maintenance at the High Level Reservoir	2021	Reticulation
WS 0041	Power Outage at the Cooktown STP	2021	Cooktown Sewage
WS 0042	Pressure Decay Test Coen WTP	2021	Coen WTP
WS 0043	Pressure Decay Test Laura WTP	2021	Laura WTP
WS 0044	Lock out, tag out procedure	2021	All
WS 0045	Chemical Batching – Soda Ash – Annan WTP	2021	Annan WTP
WS 0046	Chemical Batching – Lime – Annan WTP	2021	Annan WTP
WS 0047	Chemical Batching – Alum – Annan WTP	2021	Annan WTP
WS 048	Running the Annan Generator	2021	Annan WTP

WS 0049	Activating bypass of two filters during	2021	Annan WTP
WS 0050	Sludge removal from the Annan sedimentation basin	2021	Annan WTP
WS 0051	Chemical Batching – Poly – Annan WTP	2021	Annan WTP
WS 0052	Run Annan WTP on 2 filters	2021	Annan WTP
WS 0053	Change or modify ABB drawers at Cooktown STP	2021	Cooktown STP
WS 0054	Water meter reading	2021	Reticulation/Rates
WS 0055	Sodium Hypochlorite concentration test	2021	Annan WTP
WS 0056	Annan Water Treatment Plant – Water testing procedure	2021	Annan WTP
WS 0057	Water sampling process for One Drive	2021	Reticulation and Treatment Plants
WS 0058	Clean Y strainer	2021	Annan WTP
WS 0059	Bore Flushing	2021	Bores
WS 0060	Septic waste disposal at the Cooktown STP	2021	Cooktown STP
WS0061	DAF Maintenance Procedure	2021	Coen WTP
WS 0062	Calibrate 4670 Turbidity meter	2021	Water Treatment Plants

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 at reservoirs and in the reticulation network. These are detailed below.

Table 9 Reticulation sample locations

Sample Location Name	Street Name	Site Chosen Because	GPS Coordinates *
Mobil Service Station	Endeavour Valley Road	Towards the end of the line.	15°28'21.81"S - 145°13'13.98"E
Powder Magazine	Webber Esplanade	Towards the end of the line.	15°27'27.49"S - 145°15'14.33"E
Lions Park	Charlotte St	Ease of access	15°27'51.65"S - 145°15'2.91"E
Cooktown Library	Helen St	Centrally located in Residential area	15°28'16.08"S - 145°14'57.80"E
Simmo's	Furneaux St	Residential area	15°28'13.02"S - 145°15'22.46"E
Water Depot	Boundary St	Towards the end of the line.	15°28'29.80"S - 15°28'29.80"S
Cemetery	Charlotte	Ease of access	15°28'38.90"S - 145°14'30.40"E
Cooktown Hospital	Hope St	Close to Hospital & Medical Services	15°28'40.87"S - 145°14'58.82"E
Cooktown Kindergarten	Charles St	Close to Kindergarten and Schools	15°28'52.40"S - 145°15'10.27"E
Royce's Paddock	Ida St	Towards the end of the line.	15°28'51.64"S - 145°15'31.98"E
Ambrose old Service Racecourse Rd	Racecourse Rd	Centrally located in Residential area	15°28'51.85"S - 145°14'22.21"E
Peninsular Pump Station	Howard St	Towards the end of the line.	15°28'34.25"S - 145°15'26.40"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 6 Reticulation sampling locations

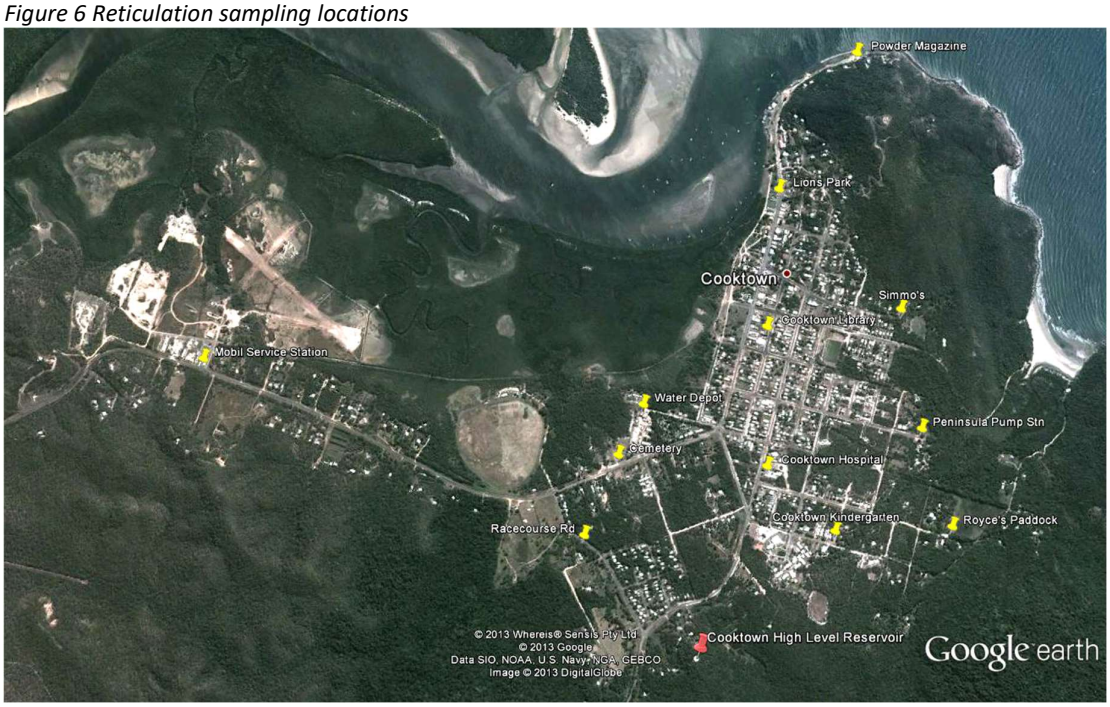


Table 10 Operational/Verification monitoring tables

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	Annan WTP Lab	Daily	Grab	Y	Analysed by Cook Shire Council staff at the Annan WTP. Verified quarterly by a NATA certified lab
	Alkalinity	Annan WTP Lab	Daily	Grab	Y	
	Turbidity	Annan WTP Lab	Daily	Grab	Y	
	Colour	Annan WTP Lab	Daily	Grab	Y	
	Electrical Conductivity	Annan WTP Lab	Daily	Grab	Y	
	Total Hardness	Annan WTP Lab	Weekdays	Grab	Y	
	Fluoride	Annan WTP Lab	Monthly	Grab	N	Analysed by Cook Shire Council staff at the Annan WTP
	Turbidity	Annan WTP Lab	Continuous	On-line analyser	N	
	pH	Annan WTP Lab	Continuous	On-line analyser	N	
	E. coli	Annan WTP Lab	Weekly	Grab	N	
Treatment Plant Raw water	**Physical / Chemical Analysis**: Silicon, Ca, Mg, Na, Total Hardness, Colour, EC, pH, Total alkalinity, Turbidity, Fluoride & Salinity	Annan Raw Water	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis: As, Cr, Cu, Fe, Pb, Mn, Zn	Annan Raw Water	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
Borefields Raw Composite	**Physical / Chemical Analysis.** Includes parameters: Silicon, Ca, Mg, K, Na, Total Hardness, Colour, EC, pH, Total alkalinity, Turbidity, Fluoride, Sulphate, Chloride & salinity	Borefields Composite sample	Twice a year	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis Includes parameters: As, Cu, Fe, Mn, Hg, Zn	Borefields Composite sample	Twice a year	Grab Sample	Y	N.A.T.A. Certified Lab
Dosed Water Pre filter	pH	Outflow from sedimentation basin	Weekdays	Grab Sample	N	Analysed by Cook Shire Council staff at the Annan WTP
	Turbidity		Weekdays	Grab Sample	N	
	Colour		Weekdays	Grab Sample	N	

Post Filter	Turbidity	Filter outflow	Weekdays	Grab sample	N	
Treatment Plant Final Filtered Water	Free chlorine residual	Annan WTP Final Tap	Daily	Grab	N	Analysed by Cook Shire Council staff at the Annan WTP
	Total chlorine		Weekly	Grab	Y	Analysed by Cook Shire Council staff at the Annan WTP and verified quarterly at a NATA certified lab. Aluminium verified bi-annually.
	pH		Daily	Grab	Y	
	Alkalinity		Daily	Grab	Y	
	Turbidity		Daily	Grab	Y	
	Colour		Daily	Grab	Y	
	Electrical Conductivity		Daily	Grab	Y	
	Aluminium		Weekdays	Grab	Y	
	Calcium Hardness		When required	Grab	Y	
	Fluoride		Daily	Grab	Y	
	Total Hardness		Weekdays	Grab	Y	
	Free Chlorine Residual	Annan WTP Lab	On-line analyser	Continuous	N	
	Turbidity	Annan WTP Lab	On-line analyser	Continuous	N	
	Physical / Chemical Analysis: Silicon, Ca, Mg, Na, Total Hardness, Colour, EC, pH, Total alkalinity, Turbidity, Fluoride & Salinity	Annan WTP Final Tap	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis: As, Cr, Cu, Fe, Pb, Mn, Zn		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	E.Coli and Total Coliforms		Weekly	Grab Sample	Y	Analysed by Annan Staff using Idexx method. Verified quarterly in NATA registered lab.
Cooktown Reticulation	Chlorine Residual	3 sites per day	Daily	Grab Sample	N	Analysed by reticulation staff using hand held colorimeter
	pH	12 Locations in Cooktown Systematically rotated through sites in table 7. Three sites per month	Monthly	Grab Sample	Y	Analysed by Cook Shire Council staff at the Annan WTP. Verified quarterly at a NATA registered lab
	Turbidity		Monthly	Grab Sample	Y	
	Colour		Monthly	Grab Sample	Y	
	Electrical Conductivity		Monthly	Grab Sample	Y	
	Alkalinity		Monthly	Grab Sample	Y	
	Fluoride	2 sites	Weekly	Grab Sample	Y	Analysed by the Cook Shire Council Staff at the Annan WTP. Verified monthly at a N.A.T.A Certified Lab
	Physical / Chemical Analysis: Silicon, Ca, Mg, Na, Total Hardness, Colour, EC, pH, Total alkalinity, Turbidity, Fluoride & Salinity	12 Locations in Cooktown Systematically rotated through sites in table 7.	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Metals Analysis: As, Cr, Cu, Fe, Pb, Mn, Zn		Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab

	Trihalomethanes: Chloroform, Bromodichlormethane, Dibromochloromethane, Bromoform and Total Trihalomethanes. **Oxyhalides** including chlorate.	Three sites per quarter	Quarterly	Grab Sample	Y	N.A.T.A. Certified Lab
	Total Coliforms and E. Coli	12 Locations in Cooktown Systematically rotated through sites in table 7. Three sites per week	Weekly	Grab Sample	Y	Analysed at the Annan WTP using Idexx. Verified at a N.A.T.A. Certified Lab quarterly.

6 WATER QUALITY CHARACTERISATION

Table 11 Annan Raw water quality details (NATA Lab)

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	Max Value	Avg Value		
Alkalinity mg/L	Annan Raw Water	1 January 2018 to 31 March 2022	18	5.5	120.0	15.1		
Calcium mg/L			18	0.74	1.70	1.10		
Chloride mg/L			18	13.0	19.0	14.3		
Colour Apparent Pt/Co			18	12.0	150.0	44.6		
Electrical Conductance µS/cm			18	57.0	94.0	68.9		
Fluoride mg/L			18	0.03	0.42	0.05		
Total Hardness mg/L			18	6.4	13.0	8.6		
Magnesium mg/L			18	1.1	2.1	1.4		
Potassium mg/L			18	1.1	2.1	1.4		
pH			18	6.9	7.4	7.4		
SAR			18	1.2	1.6	1.4		
Salinity			18	30	90	40		
Sodium mg/L			18	7.8	13.0	9.09		
Total Dissolved Solids mg/L			18	38.0	99.0	57.5		
Sulphate mg/L			18	1.2	2.4	1.9		
Turbidity NTU			18	1.1	410.0	55.66		
Arsenic *mg/L*		1 January 2017 to 31 March 2022	19	0.001	0.002	0.001	*0.01 mg/L*	0
Barium *mg/L*			19	0.003	0.026	0.005	*2.0 mg/L*	0
Beryllium *mg/L*			19	0.0001	0.001	0.0003	*0.06 mg/L*	0
Cadmium *mg/L*			19	0.0001	0.0002	0.0001	*0.002 mg/L*	0
Chromium *mg/L*			19	0.0002	0.0037	0.0006	*0.05 mg/L*	0
Cobalt *mg/L*			19	0.0005	0.0014	0.0006		
Copper *mg/L*			19	0.001	0.004	0.002	*1.0 mg/L*	0
Iron *mg/L*			19	0.129	2.98	0.356	*0.3 mg/L*	0
Lead *mg/L*			19	0.0005	0.0024	0.0007	*0.01 mg/L*	0
Manganese *mg/L*			19	0.0016	0.0571	0.0091	*0.1 mg/L*	0
Mercury *mg/L*			18	0.00006	0.00006	0.00006	*0.006 mg/L*	0
Nickel *mg/L*			19	0.0005	0.0028	0.0007	*0.02 mg/L*	0
Selenium *mg/L*			19	0.002	0.005	0.002	0.01 mg/L	0
Vanadium *mg/L*			19	0.0002	0.0045	0.0007	0.1 mg/L	0
Zinc *mg/L*			19	0.005	0.022	0.010	3.0 mg/L	0

Table 12 Annan Raw water quality (CSC Annan Lab)

Results	Date	Alkalinity as mg/L $CaCO_3$	pH	Electrical Conductance uS/cm	Turbidity NTU	Colour Pt/Co Units	Total Hardness as mg/L CaCO3
Count	01 January 2017 to 31 March 2022	1,725	1,724	1,718	1,724	1,714	1,196
Min		3.5	5.2	35.1	0.50	0	4.0
Max		99.0	7.7	167	741.0	2450	99
Avg		9.64	6.67	74.6	10.1	80	9.6

Table 13 Annan Treated water quality (NATA Lab)

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	Max Value	Avg Value		
Alkalinity - *mg/L CaCO3*	Annan Final Treated Water Sampling Tap	1 January 2018 to 31 March 2022	26	9.0	54.0	32.6		
Calcium - *mg/L*			26	1.2	19.0	9.6		
Chloride - *mg/L*			26	12.0	24.0	17.3	≤250 - *mg/L*	0
Colour Apparent - *Pt- Co*			26	1.0	1.2	1.0	≤15 – *Pt/Co*	0
Electrical Conductance			26	92.0	210.0	156.37		
Fluoride - *mg/L*			26	0.03	0.76	0.69	≤1.5 - *mg/L*	0
Total Hardness - *mg/L CaCO3*			26	8.2	54.0	30.3	≤200 - *mg/L*	0
Magnesium - *mg/L*			26	1.1	2.5	1.5		
pH			26	6.9	7.9	7.4	6.5 – 8.5	0
Potassium - *mg/L*			26	0.82	2.00	1.17		
Salinity mg/L			25	20	100	80		
SAR			26	0.85	3.0	1.55		
Silicon *mg/L*			26	7.6	14.0	10.7		
Sodium - *mg/L*			26	8.7	27.0	16.8	≤180 - *mg/L*	0
Total Dissolved Solids - *mg/L*			26	56.0	120.0	90.1	≤600 - *mg/L*	0
Turbidity NTU			26	0.1	0.7	0.2	<5 NTU	0
Sulphate - *mg/L*			26	7.2	34.0	13.3	≤250 - *mg/L*	0
Arsenic *mg/L*		1 January 2017 to 31 March 2022	19	0.0002	0.0010	0.0006	0.01 - *mg/L*	0
Barium *mg/L*			19	0.003	0.013	0.0052	2.0 - *mg/L*	0
Beryllium *mg/L*			19	0.0001	0.0001	0.0003	0.06 - *mg/L*	0
Cadmium *mg/L*			19	0.0001	0.0002	0.00011	0.002 - *mg/L*	0
Chromium *mg/L*			19	0.0002	0.0013	0.0005	0.05 - *mg/L*	0
Cobalt *mg/L*			19	0.0005	0.001	0.0006	0.01 - *mg/L*	0
Copper *mg/L*			19	0.001	0.003	0.0011	2.0 - *mg/L*	0
Iron *mg/L*			19	0.008	0.019	0.110	0.3 - *mg/L*	0
Lead *mg/L*			19	0.0005	0.001	0.0006	0.01 - *mg/L*	0
Manganese *mg/L*			19	0.0009	0.0233	0.0043	0.1 - *mg/L*	0
Mercury *mg/L*			18	0.00006	0.00010	0.00006	0.006 mg/L	0
Nickel *mg/L*			19	0.0005	0.001	0.0006	0.02 - *mg/L*	0
Selenium *mg/L*			19	0.002	0.005	0.003	0.01 - *mg/L*	0
Vanadium *mg/L*			19	0.0001	0.001	0.0004		
Zinc *mg/L*			19	0.005	0.013	0.008	3.0 - *mg/L*	0

Table 14 Annan Treated water quality (CSC Annan Lab)

1 Jan 2017 to 31 March 2022	Alkalinity as mg/L CaCO3	pH	Aluminium mg/L	Electrical Conductance uS/cm	Turbidity NTU	Colour Pt/Co Units	Total Hardness as mg/L CaCO3	Free Chlorine mg/L
Count	1,728	1,725	1,259	1,726	1,714	1,725	1,182	1,725
Min	1.0	6.1	0.00	1.06	0.01	0.0	6.0	0.93
Max	75.0	7.9	0.20	1818.6	1.5	8.0	67.0	4.14
Avg	36.9	7.9	0.002	162.49	0.07	0.10	35.1	1.49

Table 15 Cooktown Reticulation (NATA lab)

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	Max Value	Avg Value		
Alkalinity - mg/L CaCO3	12 Locations in Cooktown Systematically rotated through sites in Table 7. Three sites sampled per sampling run	01 January 2018 to 31 March 2022	45	13.0	56.0	42.4		
Calcium - mg/L			45	4.0	20.0	14.8		
Chloride - mg/L			45	14.0	21.0	17.0	≤250 mg/L	0
Colour Apparent - Pt- Co			48	0	21.0	1.88	≤15 Pt/Co	1
Electrical Conductance			48	110.0	220.0	172.1		
Fluoride - mg/L			45	0.63	0.76	0.69	≤1.5 mg/L	0
Total Hardness - mg/L CaCO3			48	13.0	94.0	41.7	≤200 mg/L	0
Magnesium - mg/L			45	0.54	2.2	1.24		
pH			48	7.5	8.1	7.8	6.5 8.5	0
Potassium - mg/L			45	0.84	11.0	1.38		
SAR			45	0.82	3.0	1.3		
Sodium - mg/L			45	14.0	67.0	18.6	≤180 mg/L	0
Total Dissolved Solids - mg/L			48	67.0	130.0	99.1	≤600 mg/L	0
Sulphate - mg/L			45	7.0	33.0	12.9	≤250 mg/L	0
Turbidity – NTU			48	0.0	9.9	0.47	≤5 NTU	0
Arsenic mg/L		01 January 2017 to 31 March 2022	58	0.0002	0.003	0.0007	0.01 mg/L	0
Barium mg/L			58	0.001	0.008	0.005	<2 mg/L	0
Beryllium mg/L			58	0.0001	0.001	0.0003	<0.06 mg/L	0
Cadmium mg/L			58	0.0001	0.001	0.0001	0.002 mg/L	0
Chromium mg/L			58	0.0002	0.0022	0.0005	0.05 mg/L	0
Cobalt mg/L			58	0.0005	0.001	0.0006	0.01 mg/L	0
Copper mg/L			58	0.001	0.079	0.0096	2.0 mg/L	0
Iron mg/L			58	0.005	0.15	0.013	<0.3mg/L	0
Lead mg/L			58	0.0005	0.0050	0.0007	0.01 mg/L	0
Manganese mg/L			58	0.0001	0.0050	0.0007	0.5 mg/L	0
Mercury mg/L			58	0.00006	0.00010	0.00006	0.006 mg/L	0
Nickel mg/L			58	0.0005	0.0010	0.0006	0.02 mg/L	0
Selenium mg/L			58	0.002	0.005	0.003	0.01 mg/L	0
Vanadium mg/L			58	0.0001	0.002	0.0004		
Zinc mg/L			58	0.005	0.029	0.009	3.0 mg/L	0

Table 16 Cooktown Reticulation E. coli (Annan lab)

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 Cooktown Reticulation**	01/01/2017 – 31/03/2022	595	0	-	**Escherichia coli should not be detected in any 100 mL sample of drinking water.**	0

Cook Shire Council uses the IDEXX Colisure quantification test equipment and all operators have completed the subsequent training in the use of the equipment. Verification samples are done quarterly by a NATA registered laboratory.

Table 17 Chlorine Residual in Cooktown Reticulation (Annan lab)

		NPS	4 Mile Hill	Fire Stn Res.	Site 1	Site 2
Count	01 January 2017 to 30 March 2022	1,733	1,729	1,721	1,482	1,445
Min		0.41	0.26	0.35	0.26	0.12
Max		1.50	1.88	3.40	2.12	1.33
Avg		0.91	0.76	0.80	0.83	0.54

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

Site 1 and Site 2 are taken at 12 Locations in Cooktown systematically rotated through sites in Table 7.

Table 18 Trihalomethanes and Chlorates in Cooktown Reticulation (NATA lab)

Date Sampled – 01/01/2018 – 31/03/2022								
Parameter	**Unit**	**No of Samples collected**	**Summary of Results**			**ADWQ Guidelines Value (2011)**	**No of Samples exceeding ADWG or WHO**	
			Min. Value	**Max. Value**	**Avg. Value**		**Health**	**Aesthetic**
Chloroform	µg/L	38	6	56	20	<250 µg/L	0	-
Bromodichloromethane	µg/L	38	5	19	10	<250 µg/L	0	-
Dibromochloromethane	µg/L	38	5	8	6	< 250 mg/L	0	-
Bromoform	µg/L	38	5	5	5	<250 µg/L	0	-
Total Trihalomethanes	µg/L	38	11	72	33	<250 µg/L	0	-
Chlorate	mg/L	38	0.045	1.360	0.438	<0.8 mg/L	1	-

Table 19 Raw water E. coli (Annan lab)

Parameter	**Sampling Location**	**Time Period**	**No of samples analysed in time period**	**Summary of Results**		
				Min. Value	**Max. Value**	**Avg. Value**
Escherichia coli	**Raw Annan River Water**	1 July 2017 to 31 July 2022	183	0	201	25