



KEMPSEY
Shire Council

Drinking Water Management System

Annual Water Quality Report
2018-2019

Document control

Document Drinking Water Management System Annual Report

File No F19/2008

Date May 2020

Prepared by Bobbie Brenton, Water Quality Officer Kempsey Shire Council
On behalf of
Wes Trotter, Manager Water and Sewer Kempsey Shire Council

Approved by Robert Fish, Director Operations and Planning Kempsey Shire Council

Revision History

Version	Date	Details	Author	Reviewer
			Name and Position	Name and Position
1	25/05/2020	First Draft	Bobbie Brenton – Water Quality Officer	John Nelson – Process Engineer Water and Sewer Craig Dole – Liquid Trade Waste Officer Mathew Cerutti – Water and Sewer Planning Engineer Jennifer Clohessy – Administration Officer Water and Sewer
2	28/05/2020	Final Draft	Bobbie Brenton – Water Quality Officer	Wes Trotter – Manager Water and Sewer
3	29/05/2020	Final	Bobbie Brenton – Water Quality Officer	Robert Fish - Director Operations and Planning

Executive Summary

The NSW Guidelines for Drinking Water Management Systems (NSW Ministry of Health 2013) provide guidance on the implementation of a Drinking Water Management System, in accordance with the *Public Health Act 2010* (NSW), and the *Public Health Regulation 2012* (NSW). The NSW Guidelines are based on the Framework for Management of Drinking Water Quality, as outlined in the Australian Drinking Water Guidelines (ADWG) (NHMRC 2011).

Kempsey Shire Council (Council) developed a Drinking Water Management System (DWMS) (AECOM 2014), for all its water supply systems in 2014. Council manages a total of eight water supply systems, providing drinking water to Kempsey and the Lower Macleay, Crescent Head, Hat Head, South West Rocks, Stuarts Point, Willawarrin, Bellbrook and the Thungutti Aboriginal Community.

Council has developed this report to provide an annual review of the performance of its water supply systems, for the reporting period of 1 of July 2018 to 30 of June 2019. This report addresses the guideline requirements for continuous evaluation and internal review for Council's DWMS and its water supply systems. Water quality performance is monitored through operational and laboratory testing. Exceptions in water quality are measured as performance against the ADWG limits and Critical Control Points (CCP) that are based on each supply system's operational design and limitations.

In May 2018, VIRIDIS Consultants supported by NSW Health commenced facilitation of an external review of Council's DWMS. The scope of the review includes DWMS documentation (Operational Manual, Supply System Sub Plans, and Standard Operating Procedures), Critical Control Points updated based on confirmation of C.t calculations and historic water quality data, collation and updating of the Risk Register and the Implementation plan. This review was completed in June 2019.

In the 2018-2019 reporting year, Council had an overall 4.1% reduction in the number of CCP exceptions reported compared to the previous 2017-2018 reporting year, despite observed percentage increase in the Crescent Head and South West Rock supply systems. In 2018-2019 a total of three hundred and two (302) Alert Level and six (6) Critical Limit exceptions were recorded from seven thousand, six hundred and fifty-seven (7657) samples.

The Kempsey and Lower Macleay (KLM) and Crescent Head water supply systems are unfiltered supplies and continue to contribute to most water quality issues. Water quality CCP exceptions were dominated by turbidity, pH and chlorine residuals, which are not easily controlled in these unfiltered water supplies.

Six (6) recorded Critical Limits are reported in four (4) separate Water Quality incidents:

- July 2018 in the Crescent Head supply
- October 2018 in the Willawarrin supply
- January 2019 in the Crescent Head supply
- February 2019 in the Crescent Head supply

Eleven (11) positive Total Coliform results across three (3) supply systems were reported by the NSW Forensic & Analytical Science Services (FASS) Laboratory to Council. On each occasion Council undertook microbiological re-sampling, performed a data review to confirm disinfection of the

supply, investigated any anomalies and reported results to the NSW Health Local Public Health Unit (LPHU).

A Drought event was declared by the General Manager (GM) on 21 May 2018; Level 1 Water Restrictions were introduced and Level 2 restrictions introduced on 3 June 2019. Due to the rapidly decreasing flows in the Macleay River, the KLM supply was transferred from the Sherwood borefield to the Stuart McIntyre Dam (SMD) emergency supply on 13 June 2019. Council was in water restrictions for forty-one (41) days, these water restrictions carried over to the next reporting year period.

The increasing drought conditions significantly impacted the Willawarrin supply system that saw a 94.2% increase in ADWG and Water Quality Indicator (WQI) exceptions reported in the distribution system from the 2017-2018 reporting year. Reported exceptions are eighty-four (84) pH, one (1) Turbidity and twenty (20) Manganese. Council is currently undertaking an investigation of Iron and Manganese levels in the raw source water, the results of which will be used to determine the treatment provisions required in a new water treatment facility. This investigation remains ongoing.

A continuous improvement plan was developed as part of the DWMS that documented all improvement actions identified during the risk assessments and subsequent reviews of the DWMS. Council has continued to implement these improvement actions via the Implementation Plan (IP), with twenty-three (23) actions completed in this reporting year. Eighteen (18) new tasks were identified and added to the IP and one hundred and twelve (112) tasks remain to be implemented, including ten (10) very high risks tasks.

Contents

1. Report Purpose	1
2. Scheme Summary	1
3. DWMS Document Review	5
4. Critical Control Points	7
4.1 Data Collection and Monitoring	7
4.2 Non-Compliant Data	9
4.3 Reporting	9
4.3.1 Kempsey and Lower Macleay supply system	13
4.3.2 Crescent Heads supply system	14
4.3.3 Hat Head supply system	15
4.3.4 South West Rocks supply system	15
4.3.5 Stuarts Point supply system	15
4.3.6 Willawarrin supply system	15
4.3.7 Bellbrook supply system	16
4.3.8 Thungutti supply system	16
5. Reservoir Inspections	16
5.1 Data Collection and Monitoring	16
5.2 Reporting	17
6. ADWG and Water Quality Indicators	18
6.1 Data Collection and Monitoring	18
6.2 Non-Compliant Data	18
6.3 Reporting	19
6.3.1 Kempsey and Lower Macleay supply system	19
6.3.2 Crescent Head supply system	20
6.3.3 Hat Head supply system	21
6.3.4 South West Rocks supply system	21
6.3.5 Stuarts Point supply system	22
6.3.6 Willawarrin supply system	22
6.3.7 Bellbrook supply system	22
6.3.8 Thungutti supply system	22
7. Customer Enquires	23
7.1 Kempsey and Lower Macleay supply system	24
7.2 Crescent Head supply system	24
7.3 South West Rocks supply system	24
7.4 Stuarts Point supply system	25
7.5 Willawarrin supply system.....	25
7.6 Bellbrook supply system.....	26
8. Water Quality Incident or Emergency.....	26
9. Monitoring and Testing	28
9.1 Aboriginal Communities Water & Sewage Program.....	28
9.1.1 Pesticide Testing.....	28
9.1.2 Inspections and Water Quality Testing to ADWG.....	29
10. Continuous Improvement – Implementation Plan	29
11. Review of DWMS	42
12. References	43
Appendix A Summary of CCP for each Supply System.....	A-1
Table A.1 CCP Kempsey and Lower Macleay Water Supply	A-1
Table A.1.1 SOP for KLM CCP1 Turbidity at Bore Water Extraction.....	A-2
Table A.1.2 SOP for KLM CCP2 Turbidity at SMD Water Extraction	A-3
Table A.1.3 SOP for KLM CCP3 Algae, Taste and Odour at SMD Water Extraction.....	A-4
Table A.1.4 SOP for KLM CCP4A Free Chlorine at Multiple Reservoirs (Dam Online)	

Table A.1.5 SOP for KLM CCP4B Free Chlorine and pH at Green Hill Reservoir (Dam Offline).....	A-6
Table A.1.6 SOP for KLM CCP5 Reservoir Integrity at all Reservoirs	A-7
Table A.2 CCP Crescent Head Water Supply	A-8
Table A.2.1 SOP for CH CCP1 Turbidity at Front Dam and Rising Main	A-9
Table A.2.2 SOP for CH CCP2 Free Chlorine and pH at Back Beach Reservoir ..	A-10
Table A.2.3 SOP for CH CCP3 Reservoir Integrity at all Reservoirs	A-11
Table A.3 CCP Hat Head Water Supply	A-12
Table A.3.1 SOP for HH CCP1 Turbidity at Raw Water	A-13
Table A.3.2 SOP for HH CCP2 Free Chlorine and pH at outlet of Reservoir	A-14
Table A.3.3 SOP for HH CCP3 Reservoir Integrity at all Reservoirs	A-15
Table A.4 CCP South West Rocks Water Supply	A-16
Table A.4.1 SOP for SWR CCP1 Turbidity at inlet to WTP (Raw Water)	A-17
Table A.4.2 SOP for SWR CCP2 Turbidity at Outlet of filters (Treated Water)	A-18
Table A.4.3 SOP for SWR CCP3 Free Chlorine and pH at Reservoir	A-19
Table A.4.4 SOP for SWR CCP4 Fluoridation at WTP and Reservoir.....	A-20
Table A.4.5 SOP for SWR CCP5 Reservoir Integrity at all Reservoirs	A-21
Table A.5 CCP Stuarts Point Water Supply	A-22
Table A.5.1 SOP for SP CCP1 Turbidity at WTP before disinfection (Raw Water) ..	A-23
Table A.5.2 SOP for SP CCP2 Turbidity at WTP post filtration (Treated Water) ...	A-24
Table A.5.3 SOP for SP CCP3 Free Chlorine at Clear Water Tank	A-25
Table A.5.4 SOP for SP CCP4 Reservoir Integrity at all Reservoirs	A-26
Table A.6 CCP Bellbrook Water Supply	A-27
Table A.6.1 SOP for BB CCP1 Turbidity at Inlet to Plat (Raw Water)	A-28
Table A.6.2 SOP for BB CCP2 Turbidity at WTP post filtration (Treated Water) ...	A-29
Table A.6.3 SOP for BB CCP3 Free Chlorine at outlet of Clear Water Tank	A-30
Table A.6.4 SOP for BB CCP4 Reservoir Integrity at all Reservoirs	A-31
Table A.7 CCP Willawarrin Water Supply	A-32
Table A.7.1 SOP for WW CCP1 Turbidity at Raw Water	A-33
Table A.7.2 SOP for WW CCP2 Free Chlorine at Reservoir	A-34
Table A.7.3 SOP for WW CCP3 Reservoir Integrity at all Reservoirs	A-35
Table A.8 CCP Thungutti Water Supply	A-36
Table A.8.1 SOP for TH CCP1 Turbidity at Raw Water	A-37
Table A.8.2 SOP for TH CCP2 Free Chlorine at Reservoir	A-38
Table A.8.3 SOP for TH CCP3 Reservoir Integrity at all Reservoirs	A-39
Appendix B Stuart McIntyre Dam Algae Monitoring	B-1
Figure B.1 Stuart McIntyre Dam Total Cyanobacteria Biovolume and Alert Levels	B-1
Figure B.2 Total Phytoplankton and Taste and Odour Results	B-2
Appendix C Water Quality Data	C-1
Table C.1 Kempsey and Lower Macleay Water Supply Water Quality Data	C-2
Table C.2 Crescent Head Supply System Water Quality Data	C-3
Table C.3 Hat Head Supply System Water Quality Data	C-4
Table C.4 South West Rocks Supply System Water Quality Data	C-5
Table C.5 Stuarts Pint Supply System Water Quality Data	C-7
Table C.6 Willawarrin Supply System Water Quality Data	C-8
Table C.7 Bellbrook Supply System Water Quality Data	C-9
Table C.8 Thungutti Supply System Water Quality Data	C-10
Appendix D Customer Enquiry Supply Area Description	D-1
Table D.1 Customer Enquiry Supply Area Descriptors for KLN Supply System	D-1

Appendix E Continuous Improvement – Implementation PlanE-1
Figures

Figure 2.1 Macleay River Catchment	1
Figure 2.2 Kempsey Shire Council Water Supply Scheme	3

Tables

Table 2.1 Summary of Kempsey Shire Council Drinking Water Supply	4
Table 3.1 DWMS Document Revision Summary	5
Table 4.1 CCP and Operational Parameters for Councils eight Supply Systems	7
Table 4.2 Summary of Councils supply systems total yearly CCP exceptions .	10
Table 5.1 Reservoir Inspection Report Summary	17
Table 6.1 Total ADWG non-compliance water quality results for Councils eight supply systems	19
Table 7.1 Customer enquired for Councils KLM supply system	23
Table 7.2 Customer enquiries for Councils other supply systems excluding KLM	23
Table 8.1 Summary of Water Quality Incidents and Emergencies	26
Table 9.1 Summary Pesticide monitoring at Aboriginal Communities and selected supply systems.....	29
Table 9.2 Result Summary of Water Quality results conducted during Department of Industry Inspection	29
Table 10.1 Summary of Implementation Plan Review	30
Table 10.2 Progress on activities based on risk value	30
Table 10.3 Summary of completed tasks in Implementation Plan	31
Table 10.4 Summary of removed tasks in Implementation Plan	36

1. Report Purpose

The *Public Health Act 2010* (NSW) requires that “a supplier of drinking water must establish, and adhere to, a quality assurance program that complies with the requirements prescribed by the regulations”. The NSW Guidelines for Drinking Water Management Systems (NSW Ministry of Health 2013) provides guidance on the implementation of a Drinking Water Management System, in accordance with the *Public Health Act 2010* (NSW) and the *Public Health Regulation 2012* (NSW). The NSW Guidelines are based on the Framework for Management of Drinking Water Quality, as outlined in the Australian Drinking Water Guidelines (ADWG) (NRMCC, NHMRC 2011).

Council developed a Drinking Water Management System (DWMS) (AECOM 2014), for all its water supply systems in 2014. It is a requirement of the ADWG that all water suppliers undertake internal reviews of their DWMS. An updated version of Council’s DWMS will take effect for the 2019-2020 reporting year.

Council has developed this report to provide an annual review of the performance of its water supply systems, for the reporting period 1 July 2018 to 30 June 2019. This report addresses the ADWG requirements for continuous evaluation and review of Council’s DWMS and the water supply systems.

2. Scheme Summary

Kempsey Shire Council is located on the north coast of NSW, covering an area of 3,380 square kilometres, between the Pacific Ocean to the east, Five Day Creek in the west, Grassy Head to the north and Kundabung to the south. The Shire encompasses the lower part of the catchment of the Macleay River which extends from the towns of Armidale, Guyra and Walcha from the west to South West Rocks in the east (Figure 2.1).

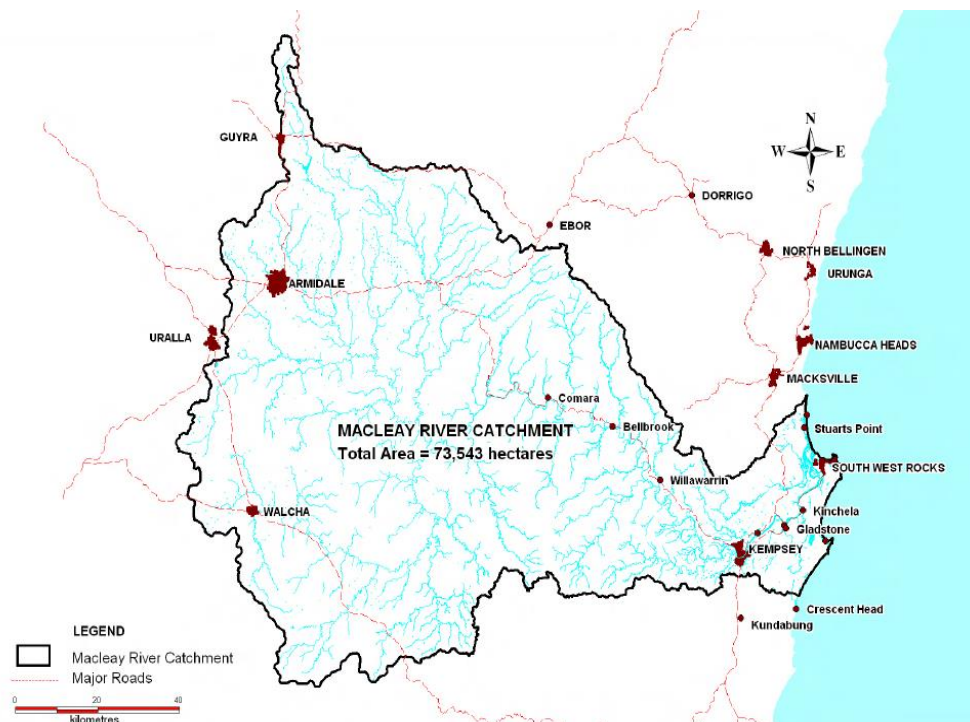


Figure 2.1 Macleay River Catchment

The Council district consists of six (6) town and village centres along the coastal stretch and three (3) villages west along the Macleay River, with its major population centre in Kempsey. The Kempsey Local Government area population, as determined from the 2016 Census, is 28,885 (Census 2016).

Council manages a total of eight (8) water supply systems, providing drinking water to Kempsey and the Lower Macleay, Smithtown, Gladstone, Crescent Head, Hat Head, South West Rocks, Stuarts Point, Willawarrin, Bellbrook and the Thungutti Aboriginal Community. Figure 2.2 provides a map of each of the supply systems for Council, with Thungutti located 4km from Bellbrook village.

The Sherwood borefield is recharged from the Macleay River and local rainfall. There are two supply routes for the Kempsey and Lower Macleay (KLM) drinking water that is extracted from the Sherwood borefield. Raw water can supply directly from the Sherwood borefield via a Lime Plant (pH adjustment and disinfection) to residents. Alternatively, water can be transferred from the Sherwood borefield to Stuart McIntyre Dam (SMD) Emergency Supply for storage, treatment, and supply to residents.

Drinking water for South West Rocks, Hat Head and Crescent Head is sourced from groundwater extracted from the Macleay Coastal Sands Aquifer, which is recharged by rainfall. Drinking water for Stuarts Point is supplied by a separate coastal aquifer and is also recharged by rainfall.

Bellbrook and Willawarrin drinking water is sourced from the Macleay River; Thungutti drinking water is sourced from the Nulla Nulla Creek, a tributary of the Macleay River. Water is extracted for these supplies through shallow bores within or at the river/creek edge.

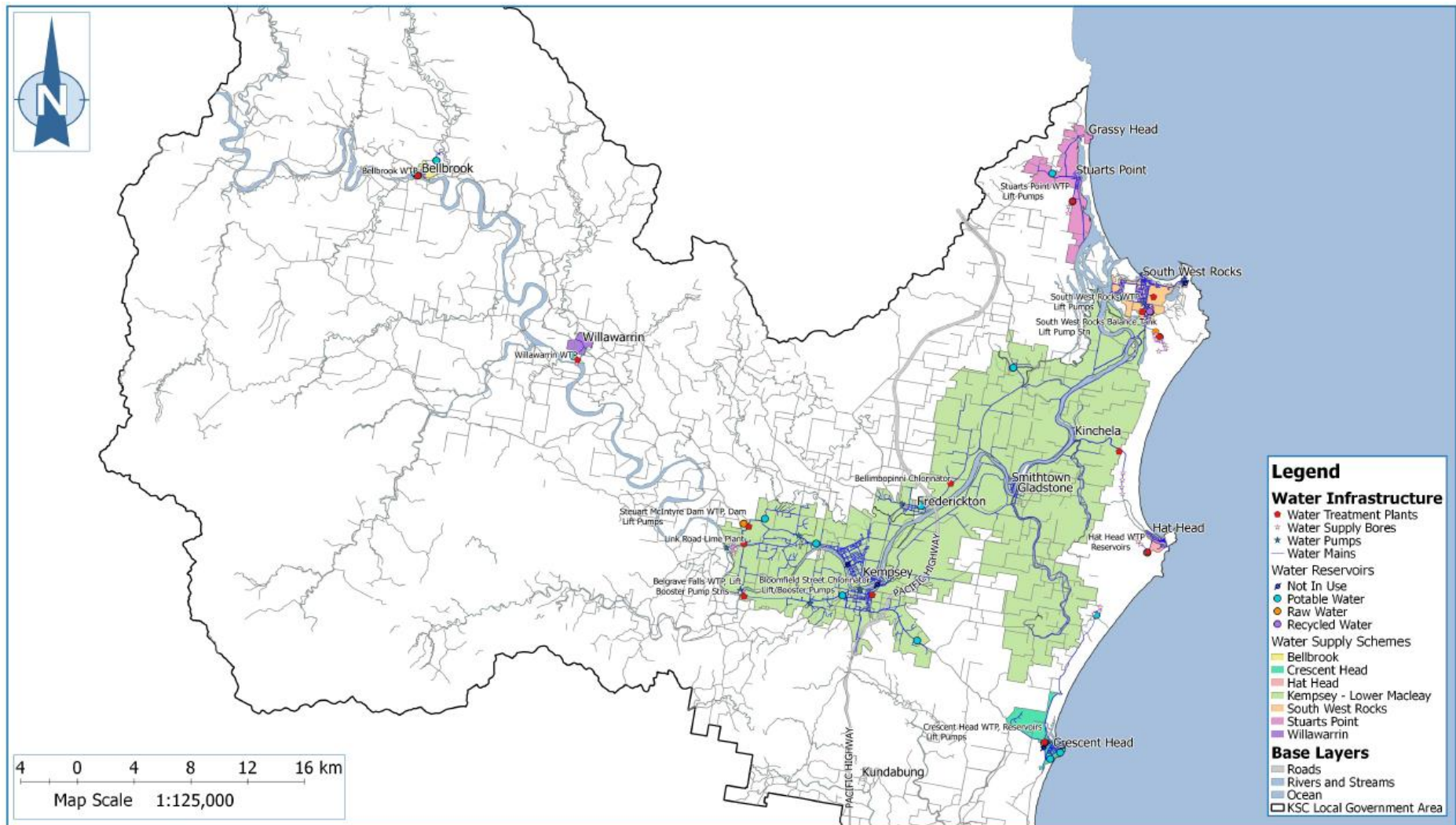


Figure 2.2 Kempsey Shire Water Supply Schemes

Table 2.1 provides a summary of each of the water supply systems and the upgrades that have occurred, or items planned during the reporting year. A detailed description of each supply system can be found in Council's DWMS (AECOM 2014) and the Kempsey and Lower Macleay Drinking Water Supply Description (Aqualift 2014).

Table 2.1. Summary of Kempsey Shire Council Drinking Water Supply Systems

Supply System	Source Water	Treatment	System upgrades in 2018/19
Kempsey and Lower Macleay	Steuart McIntyre Dam	Chlorine (Sodium hypochlorite) dosing.	Concept design for fluoride and gas chlorine dosing upgrade.
	Sherwood (Bypass of Dam)	Gas chlorine for disinfection and lime dosing for pH correction.	Balance tank system integration between Steuart McIntyre Dam and the Sherwood Bore Field.
Crescent Head	Groundwater, Maguires Crossing	Lime and CO ₂ dosing for increasing alkalinity and pH correction. Gas chlorination for disinfection.	Design of a new water treatment plant, incorporating membrane and activated carbon filters has been completed. Grant funding approved in 2017-2018.
Hat Head	Groundwater, Hat Head National Park	Media based aerator for iron removal, soda ash for pH correction and chlorine gas for disinfection.	
South West Rocks	Groundwater, Hat Head National Park	Aeration, membrane filtration, lime for pH correction, chlorine (sodium hypochlorite) and fluoridation.	Strategic plan development continuing for long term upgrade strategy. Membrane renewal and associated system modifications
Stuarts Point	Groundwater	Ferric dosing for coagulation and Iron and arsenic removal, sand filtration and chlorine gas for disinfection.	Refurbishment of chemical, mechanical and electrical systems and building services. Replacement of two new filtration units.
Willawarrin	Surface water from Macleay River (bore on edge of river for gravel bed extraction)	Chlorine (sodium hypochlorite) dosing.	An expression of interest for grant funding has been approved for Filtration Treatment Plant. Preliminary design planning in progress.
Bellbrook	Surface water from Macleay River (bore within river for gravel bed extraction)	Multi-media filtration including arsenic removal, soda ash for pH correction and chlorine (sodium hypochlorite) dosing.	
Thungutti	Surface water from creek (bore on edge of river for gravel bed extraction)	Chlorine (sodium hypochlorite) dosing.	

3. DWMS Document Review

The NSW Guidelines for DWMS require that all water suppliers review their DWMS and major components on an annual basis. The DWMS Annual Water Quality Report ensures that Council manages its DWMS as a quality system and demonstrates continuous review and improvement of the system.

Council have undertaken a number of major reviews of the DWMS since its development in 2014. In May 2018 VIRIDIS Consultants commenced facilitation of an external review of Councils DWMS this includes DWMS Documentation. This review carried over into the 2018 -2019 reporting year; was finalised in June 2019 and adopted by Council in August 2019 with its application to commence in the 2019-2020 reporting year.

Table 3.1 DWMS Document Revision History

Document	Version	Updates	Submitted to NSW Health?	
DWMS	3	Thungutti Water supply added, C.t. calculations completed, updated WQ & customer enquiry analysis, updated Risk Assessment, Implementation Plan & CCP Procedures	Submitted to LPHU - May 2016	
	4	New DWMS Overall Manual and new DWMS Subplans for each supply system. All supply systems c.t calculation verified and updated schematics, includes data analysis review and CCPs updated. Review and updated of Risk Register and Improvement Plan.	Submitted to LPHU - June 2019	
CCP Procedures	Crescent Head	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016
		V2	Draft CCP 2 (disinfection) changed to Free Chlorine instead of chloramination, July 17.	No
		V3	CCP ID numbering aligned with specific Control Point. Aligned pH alert level lower limit to <6.8. Adjusted Turbidity CCP limits for raw water.	Submitted to LPHU - June 2019
Hat Head	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016	
	V2	CCP ID numbering aligned with specific Control Point. Aligned pH alert level lower limit to <6.8.	Submitted to LPHU - June 2019	
South West Rocks	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016	
	V2	CCP ID numbering aligned with specific Control Point. Aligned pH alert level lower limit to <6.8. Removed Reservoir and retic system as a testing location for Fluoridation CCP. Changed Disinfection CCP testing location from reservoir inlet to Reservoir Outlet to meet C.t.	Submitted to LPHU - June 2019	
Stuarts Point	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016	
	V2	CCP ID numbering aligned with specific Control Point. Changed Disinfection CCP testing location from CWT to Reservoir Outlet to meet C.t.	Submitted to LPHU - June 2019	
Kempsey & Lower Macleay	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016	

	V2	CCP ID numbering aligned with specific Control Point. Aligned pH alert level lower limit to <6.8 for “Sherwood Lime Plant in Use”. Development of Water Quality emergency protocols for supply transfer between Sherwood borefield and SMD	Submitted to LPHU - June 2019
Willawarrin	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016
	V2	CCP ID numbering aligned with specific Control Point.	Submitted to LPHU - June 2019
Bellbrook	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016
	V2	CCP ID numbering aligned with specific Control Point.	Submitted to LPHU - June 2019
Thungutti	V1	Updated as per 2015 Audit review outcomes	Submitted to LPHU in DWMS – May 2016
	V2	CCP ID numbering aligned with specific Control Point. Notes: updated regarding C.t for water supplied directly to consumers in high demand times.	Submitted to LPHU - June 2019
Risk Assessment	V1	Updated as per Thungutti Water Supply Risk assessment.	Submitted to LPHU in Thungutti workshop outcomes paper and revised DWMS – April 2016
	V2	August 2018 - Rationalised and consolidated the risk register (former separate KLM and separate other supplies registers into one),	LPHU in attendance of review and update of documentation 22 – 23 Aug 2018
	V2.1	Yearly internal review and update by DWMS risk team.	Submitted to LPHU apart of the 2017-2018 Annual Report
	V2.2	Update of risk register on June 2018 with LPHU and DPI to identify risk with SMD when in use specifically relating to times of Drought for the development SMD Incident Flow Chart and updating CCPs for Dam use	LPHU in attendance of review and update of documentation 28 June 2019
	V2.3	Internal yearly review by Councils DWMS Risk Team September 2019	Submitted to LPHU apart of the 2018-2019 Annual Report
Implementation Plan	4	Reviewed in March 2017 to update status of tasks.	No
	5	Reviewed in August 2018 to update status of tasks, Update of formatting and conciliation of duplicated actions. Facilitated by VIRIDIS as a part of the external DWMS review	LPHU in attendance of review and update 22 – 23 August 2018
	5.1	Internal annual review by the DWMS risk team November 2018	Submitted to the LPHU as part of the 2017-2018 Annual Report
	6	Internal annual review by the DWMS risk team November 2019	Submitted to LPHU apart of the 2018-2019 Annual Report

4. Critical Control Points

A Critical Control Point (CCP) is defined as an “*activity, procedure or process at which control can be applied, and which is essential to prevent a hazard or reduce it to an acceptable level*” (NSW Ministry of Health 2013). These may be processes such as selective abstraction of raw water, filtration, disinfection or reservoir integrity. For each CCP, a parameter, such as chlorine residual, can be measured to verify the effectiveness of the process or identify when corrective action is required.

Operational Target, Alert Level and Critical Limits are determined for each CCP parameter to identify normal and out of normal operational conditions. The Operational Target identifies the normal operational conditions, the Alert Limit indicates that the parameter is outside the normal conditions and corrective action may be required, and the Critical Limit, if exceeded, indicates that process control has been lost and safe water quality can no longer be guaranteed.

4.1 Data Collection and Monitoring

Monitoring of CCPs is undertaken throughout Council’s eight supply systems, as per the requirements of Council’s Drinking Water Management System (DWMS). System specific CCP Standard Operating Procedures (SOP) Tables (Appendix A) have been established for:

- Raw water/abstraction and treated water / filtration (Turbidity),
- Algae, Toxins, Taste and Odour, (Steuart McIntyre Dam only)
- Filtration (Turbidity)
- Disinfection (Free Chlorine and pH)
- Fluoridation (South West Rocks at WTP and Gregory St Reservoir)
- Reservoirs (Reservoir Integrity)

Monitoring includes sample collection and analysis using laboratory and field instruments and real-time monitoring of online instrumentation for pre and post treated water (Table 4.1). Council’s ClearSCADA system also enables operators to remotely monitor the treatment plants and online instrumentation. Where online probes are used for monitoring, manual tests, calibration, and routine maintenance are undertaken to ensure the online probes are reading correctly.

Algae, MIB & Geosmin samples are collected by Council on a routine basis. This sampling program, designed in 2016 and updated in June 2019, considers local conditions, historic data and aligns with the Blue-Green Algae Alert Level Framework. Samples are sent to the Port Macquarie Hastings Council Laboratory for analysis.

Table 4.1 Critical Control Point and Operational Monitoring Parameters for Councils’ Eight Supply Systems

System	Parameters	Monitoring Location	Monitoring Frequency
Kempsey and Lower Macleay	Chlorine residual*	Outlet of Reservoirs and distribution	Daily
	Turbidity	Raw water (Bores)	Continuous (online) & 5 days/week
	Turbidity	Outlet of reservoirs and distribution	Daily
	pH	Raw water, Outlet of reservoirs and distribution	Daily
	Algae Biovolume, MIB & Geosmin	SM Dam	Weekly/ fortnightly/ Monthly (BGA Alert level framework)

System	Parameters	Monitoring Location	Monitoring Frequency
	Tank integrity	Reservoirs	Daily
Crescent Head	Chlorine residual*	Trunk Main, Rising Main	6 days / week
	Chlorine residual*	Reservoirs and distribution	Daily
	Turbidity	Raw water	4 days / week
	Turbidity	Trunk Main, Rising Main, reservoir and distribution	6 days / week
	pH	Raw Water, Trunk Main, Rising Main, Reservoir and distribution	6 days / week
	Vermin inspection	Reservoirs	Monthly
Hat Head	Chlorine residual*	Outlet of Clear water tank	6 days / week
	Chlorine residual*	Reservoirs and distribution	6 days / week
	Turbidity	Raw water	6 days / week
	Turbidity	Outlet of clear water tank, reservoirs and distribution	6 days / week
	pH	Raw water, Outlet of clear water tank, reservoirs and distribution	6 days / week
	Tank integrity	Reservoirs	Monthly
South West Rocks	Chlorine residual*	Leaving the WTP	Continuous (online) & Daily
	Chlorine residual*	Reservoir and distribution	Daily
	Turbidity	Raw water	Continuous (online) & Daily
	Turbidity	Clear water, reservoir and distribution	Daily
	pH	Raw Water	Daily
	pH	Outlet of clear water tank	Continuous (online)
	pH	Reservoir and distribution	Daily
	Fluoride	Outlet of the WTP and reservoir	Daily
	Tank integrity	Reservoirs	Monthly
Stuarts Point	Chlorine residual*	Outlet of clear water tank	6 days / week
	Chlorine residual*	Reservoir and distribution	6 days / week
	Turbidity	Raw water	3 days / week
	Turbidity	Outlet of clear water tank, reservoir and distribution	6 times / week
	pH	Raw Water, Outlet of clear water tank, reservoir and distribution	3 times / week
	Tank integrity	Reservoirs	Monthly
Willawarrin	Chlorine residual*	Reservoir and distribution	6 days / week
	Turbidity	Reservoir and distribution	6 days / week
	pH	Reservoir and distribution	6 days / week
	Tank integrity	Reservoirs	Monthly
Bellbrook	Chlorine residual*	Outlet of clear water tank	Continuous (online), Daily
	Chlorine residual*	Reservoir and distribution	5 days / week

System	Parameters	Monitoring Location	Monitoring Frequency
	Turbidity	Raw water	Continuous (online), Daily
	Turbidity	After filters at WTP	Continuous (online)
	Turbidity	Reservoir and distribution	5 days / week
	pH	Outlet of clear water tank	Continuous (online)
	pH	Reservoir and distribution	5 days / week
	Vermin inspection	Reservoirs	Monthly
Thungutti	Chlorine residual*	Reservoir and distribution	Online (dial in) & 3 days / week (manual)
	Turbidity	Reservoir and distribution	Online (dial in) & 3 days / week (manual)
	pH	Reservoir and distribution	3 days / week
	Tank integrity	Reservoirs	Monthly

Note * Chlorine residuals, both free and total chlorine is measured

4.2 Non-Compliant Data

The CCP exceptions, either Alert Level or Critical Limit, are managed by the Water Operators by undertaking corrective actions following the CCP SOP Tables and through communications with the Team Leader Water Process. Water Operators enter operational monitoring results into system specific operational spreadsheets that highlight any Alert Level or Critical Limit exception. This is used for reporting in conjunction with the additional details the Water Operators provide in the “Initial Incident Notification form”, that is stored in the “Initial Incident Report Database”. The incident report provides a record of the reason for the exceptions, the corrective actions undertaken and whether any further actions are required to ensure this exception does not occur again. For reporting purposes Alert Levels and Critical Limits are recorded as a discrete number, i.e. once a CCP falls outside of the Alert Level range and is in the Critical Limit range it is recorded at a Critical Limit only and is not counted in the Alert Level totals.

4.3 Reporting

There was an overall 4.1% reduction in the number of CCPs reported to the previous 2017-2018 report year. In 2018-2019 a total of three-hundred and two (302) Alert Level and six (6) Critical Limit exceptions were recorded from seven thousand six hundred and fifty-seven (7657) samples (Table 4.2).

Of Councils’ eight (8) water supply systems, five (5) systems experienced CCP exceptions. CCP exceptions for the year are discussed for the supply systems in which they occurred in, with reference to the details provided in Table 4.2. CCP SOP tables for each supply system that are provided in Appendix A.

Table 4.2 Summary of Councils' supply systems total 2018-2019 yearly Critical Control Point exceptions with comparison to 2017-2018 totals

Supply System	CCP Numbers	Control Point	Hazard	Control Parameter	2017-2018			2018-2019			% of CCP reduced/Increased			
					Alert Level	Critical Limit	Total No samples	Alert Level	Critical Limit	Total No samples	Alert Level	Critical Limit	Combined Total	
Kempsey and Lower Macleay	KLM CCP1	Raw Water Abstraction (Bores)	All Pathogens	Turbidity	2	0	360	0	0	329				
	KLM CCP2	Raw Water Abstraction (SMD)	All Pathogens	Turbidity	8	18	35	0	0	17				
	KLM CCP3	Raw Water Abstraction (SMD)	Toxins	Algae Biovolume	5	0	8*	0	0	3**				
				Taste & Odour	MIB	0	0	2*	0	0	3**			
				Geosmin	0	0	2*	0	0	3**				
	KLM CCP4A	Disinfection (SMD)	Chlorine sensitive pathogens	Free Chlorine	1	0	35*	21	0	36**				
				Chemicals	pH	13	19	35*	0	0	36**			
	KLM CCP4B	Disinfection (Bores)	Chlorine sensitive pathogens	Free Chlorine	3	0	319	2	0	339				
				Chemicals	pH	213	2	318	29	0	339			
	KLM Combined Total					247	39	1109	52	0	1105			
KLM % to number of Samples					22.3%	3.5%	25.8%	4.7%	0%	4.7%	-17.6%	-3.5%	-21.1%	
Crescent Head	CH CCP1	Raw water Abstraction	All Pathogens	Turbidity										
					Front Dam	32	0	93	68	3	209			
					Rising Main	75	0	375	107	0	357			
					Sub Total	107	0	452	175	3	566			

Supply System	CCP Numbers	Control Point	Hazard	Control Parameter	2017-2018			2018-2019			% of CCP reduced/Increased		
					Alert Level	Critical Limit	Total No samples	Alert Level	Critical Limit	Total No samples	Alert Level	Critical Limit	Combined Total
	CH CCP2	Disinfection	Chlorine sensitive pathogens	Free Chlorine	25	0	359	57	2	362			
					5	0	359	4	0	362			
	CH Combined Total				137	0	1170	236	5	1290			
	CH % to number of Samples				11.7%	0%	11.7%	18.2%	0.3%	18.5%	+6.5%	+0.3%	+6.8%
Hat Head	HH CCP1	Raw Water Abstraction	All Pathogens	Turbidity	0	0	316	0	0	260			
					2	0	316	0	0	260			
	HH CCP3	Disinfection	Chlorine sensitive pathogens	Free Chlorine	8	0	314	0	0	260			
HH Combined Total				10	0	946	0	0	780				
HH % to number of Samples				1%	0%	1%	0%	0%	0%	-1%	0%	-1%	
South West Rocks	SWR CCP1	Raw Water Abstraction	All Pathogens	Turbidity	0	0	309	0	0	236			
					0	0	308	0	0	234			
	SWR CCP2	Filtration	All Pathogens	Turbidity	0	0	361	4	0	352			
					0	0	204	0	0	325			
	SWR CCP3	Disinfection	Chlorine sensitive pathogens	Free Chlorine									
SWR CCP4	Fluoridation	Chemical	Fluoride	0	0	789	1	0	997				
SWR Combined Total				0	0	1971	5	0	2144				
SWR % to number of Samples				0%	0%	0%	0.2%	0%	0.2%	+0.2%	0%	+0.2%	
Stuarts Point	SP CCP1	Raw Water Abstraction	All Pathogens	Turbidity	1	0	250	0	0	245			
					3	4	250	0	0	245			
	SP CCP2	Filtration	All Pathogens	Turbidity	3	0	250	0	0	245			
SP CCP3	Disinfection	Chlorine Sensitive pathogens	Free Chlorine	3	0	250	0	0	245				
SP Combined Total				7	4	750	0	0	735				

Supply System	CCP Numbers	Control Point	Hazard	Control Parameter	2017-2018			2018-2019			% of CCP reduced/Increased		
					Alert Level	Critical Limit	Total No samples	Alert Level	Critical Limit	Total No samples	Alert Level	Critical Limit	Combined Total
SP % to number of Samples					0.9%	0.5%	1.4%	0%	0%	0%	-0.9%	-0.5%	-1.4%
Willawarrin	WW CCP1	Raw Water Abstraction	All Pathogens	Turbidity	3	4	260	1	1	272			
	WW CCP2	Disinfection	Chlorine sensitive pathogens	Free Chlorine	8	0	260	2	0	293			
	WW Combined Total				11	4	520	3	1	565			
	WW % to number of Samples					2.1%	0.7%	2.8%	0.4%	0.1%	0.5%	-1.7%	-0.6%
Bellbrook	BB CCP1	Raw Water Abstraction	All Pathogens	Turbidity	3	0	222	0	0	273			
	BB CCP2	Filtration	All Pathogens	Turbidity	0	0	227	0	0	287			
	BB CCP3	Disinfection	Chlorine Sensitive pathogens	Free Chlorine	19	8	250	6	0	287			
	BB Combined Total				22	8	699	6	0	847			
BB % to number of Samples					3.1%	1.1%	4.2%	0.7%	0%	0.7%	-2.4%	-1.1%	-3.5%
Thungutti	TH CCP1	Raw Water Abstraction	All Pathogens	Turbidity	0	0	250	0	0	279			
	TH CCP2	Disinfection	Chlorine sensitive pathogens	Free Chlorine	0	0	250	0	0	272			
	TH Combined Total				0	0	500	0	0	551			
TH % to number of Samples					0%	0%	0%	0%	0%	0%	0%	0%	0%
All Supply Systems	Total Sum all Critical Control Points				568	55	7665	302	6	7657			
	% to number of Samples					7.4%	0.7%	8.1%	3.9%	0.1%	4.0%	-3.5%	-0.6%

Note 1: Multiple exceptions occurring on the same day are recorded as discrete events at each CCP point as they occur. The Total Alert Level, Critical Limit and Combined Yearly Total is the sum of each discrete exception occurrence on any given day from each individual category.

Note 2: Once a CCP exceeds the Alert Level value it is recorded at a Critical Limit only and is not counted in the Alert Level totals.

Note 3: * KLM CCP3 and KLM CCP4A - 2017-2018 SMD in use for 35 days only from 1 July 2017 to 4 August 2017

Note 4: ** KLM CCP3 and KLM CCP4A – 2018-2019 SMD in use for 18 days only from 13 June 2019 to 30 June 2019

4.3.1 Kempsey and Lower Macleay (KLM) Supply System

The KLM supply System had a 21.1% reduction in the number of CCP exceptions from the 2017-2018 reporting year with the main improvement of no Critical Limit occurrences and the significant reduction of pH Alert Level exceptions from KLM CCP4B from two hundred and thirteen (213) to twenty-nine (29) (Table 4.2).

A total of fifty-two (52) Alert Level exceptions occurred from one thousand one hundred and five (1105) samples from the disinfectant CCP (KLM CCP4A & KLM CCP4B) (Table 4.2).

There was an increase in the number of Alert Level exceptions for Free Chlorine CCP (KLM CCP4A) from four (4) in 2017-2018 to twenty-three (23) for this reporting year. This increase is attributed to the transfer of supply from the Sherwood borefield to the SMD Emergency supply on 13 June 2019. When supply is from SMD, Free Chlorine results from John Lane and Potters Hill reservoirs are included as disinfectant CCP locations along with Greenhill reservoir. At the time of supply transfer to SMD chlorine dosing was increased as a precaution to ensure disinfection remained in the supply system, as a result a total of twenty-one (21) high Alert Levels ($> 2.2 \text{ mg/L} - < 5 \text{ mg/L}$) from the Greenhill and John Lane reservoirs were recorded between 15 -30 June 2019. The highest result was 3.4 mg/L on 16 June 2019.

The two (2) remaining Free Chlorine low ($< 1 \text{ mg/L}$) Alert levels were:

1. A single marginal result of 0.99mg/L recorded on 20 February 2019; System checks using CCP SOP were followed and warranted no further action being taken.
2. The change in CCP location to John Lane reservoir on 13 June 2019; the result of 0.81 mg/L was attributed to the result from tail end water supplied from the Sherwood borefield and not from new supply source.

Twenty-nine (29) pH exceptions (results $< 7 \text{ pH}$) were sourced directly from the Sherwood borefield via the Lime plant (KLM CCP4B). Eleven (11) of these were attributed to the intermittent poor mixing of lime into the supply water due to the breakdown of the mechanical shaker on the Lime Silo. The corrective action involved repairs to the shaker and flushing the lime plant dosing line to break up undiluted lime lumps to ensure adequate lime for pH correction.

During February, six (6) pH Alert Level exceptions occurred from two (2) separate mechanical failures.

1. A blocked screw resulted in low pH between 19 to 21 February (6.74 pH, 6.54 pH, 6.85 pH respectively). Corrective action involved clearing the blockage.
2. A pressure relief valve at the Lime Plant was found to be stuck in the open position resulting in exceptions between 26 to 28 February (6.85 pH, 6.92 pH, 6.84 pH respectively). The Water Operator cleared the valve and created a work order for repair.

The remaining twelve (12) pH exceptions from Sherwood borefield supply were marginal (no less than 6.8 pH); no operations faults were identified during investigations and the pH self-corrected within a couple of days, which warranted no further action.

An external review of Council's DWMS by VIRIDIS Consultants commenced in May 2018 with adoption for use to begin in the 2019-2020 reporting year. Council is anticipating a further reduction in the number of pH CCP exceptions when the Sherwood borefield supply is in use with the modification of the Alert Level from the current $< 7 \text{ pH}$ to a revised level of $< 6.8 \text{ pH}$.

4.3.2 Crescent Head Supply System

The Crescent Head supply system had a 6.8% increase in CCP exceptions from the 2017-2018 reporting year. Alert Levels increased by 6.5% and Critical Limits by 0.3% (Table 4.2).

The five (5) Critical Limits; three (3) Raw Water Abstraction (Turbidity) and two (2) Disinfection (Free Chlorine) are discussed in Section 8: Water Quality Incident or Emergency, as two (2) Incident events.

Two hundred and thirty six (236) Alert Level exceptions from one thousand two hundred and ninety (1290) samples were reported, one hundred and seventy five (175) from the combined Raw Water Abstraction Control Point (Front Dam and Rising Main) parameter Turbidity, along with fifty seven (57) Free Chlorine and four (4) pH exceptions at the Back Beach Reservoir Disinfection Control Point (Table 4.2).

High Turbidity in the raw water from the Maguires Crossing borefield is an ongoing issue and the cause for one hundred and seventy five (175) Alert Level exceptions recorded at the dual Control Points in this supply system. A review of this supply system's CCPs has identified that the Rising Main CCP does not reflect the purpose of this Control Point (Raw Water Abstraction) and will be omitted from the updated version that takes effect for the 2019-2020 reporting year.

The naturally occurring high Turbidity influences the operational targets of other parameters including Free Chlorine and pH. Of the fifty seven (57) Free Chlorine Alert Level exceptions, 95% were all triggered from sample results being above the operational upper limit of 1.9mg/L; the maximum recorded value was 2.7mg/L on 26 December 2018. Water Operators in this supply system endeavour to maintain Free Chlorine residuals at the reservoir at 1.5mg/L to ensure disinfection in the turbid waters and to maintain chlorination at the extremities of long lines that are prone to chlorine decay (Loftus Road and Stewart St). When Free Chlorine residuals are compromised at these locations, Water Operators perform flushing and increase dosing. Due to the naturally occurring high turbidity, maintaining adequate chlorine residual is challenging and can result in fluctuations based on the raw water quality, this can push the upper Free Chlorine operations Target above the 1.9mg/L Alert Level threshold. The low Alert Level Free Chlorine results (<0.9 mg/L) coincide with the reported Critical Limits and are discussed in Section 8: Water Quality Incident or Emergency.

The operation target for pH at this CCP is 7.8 pH. The four (4) pH exceptions occurred in the upper Alert Level range that is activated at 8.3 pH. These exceptions occurred in two (2) separate months; three (3) in October 2018 and one (1) in January 2019. All are the result of balancing this supply systems raw water that is naturally low in pH (yearly average 6.50 pH) against maintaining the water at an optimal Total Alkalinity of between 30 ppm and 40 ppm. To achieve this, lime is dosed to increase pH after the Front Dam storage, Carbon Dioxide (CO₂) gas is injected into the water to lower the increase buffering effect of the lime to achieve desired Total Alkalinity range. At times, this balancing act pushes pH into the upper Alert Level range.

Ongoing corrective action to mitigate the high turbidity whilst balancing Free Chlorine and pH within the Crescent Head supply system, includes continuous monitoring of the borefield to determine the best bore for water extraction, continuous monitoring of the front dam and reticulation system and gravity feed to the front dam from the borefield. Geofabric bags were installed prior to the front

dam in January 2019 to help further reduce turbidity inputs. Future proposed action is to include a pre-treatment process of the source water from Maguires with membranes and Granular Activated Carbon (GAC) for suspended solids and organics removal. Construction of a Water Treatment Plant for Crescent Head is in the design planning stage.

4.3.3 Hat Head Supply System

No Alert Level or Critical Limit exceptions occurred in the Hat Head supply system during the 2018-2019 reporting year (Table 4.2).

4.3.4 South West Rocks Supply System

The South West Rocks supply system had an 0.2% increase in Alert Level CCPs exceptions from the 2017-2018 reporting year with five (5) Alert Levels recorded (Table 4.2). No Critical Limit exceptions occurred in this supply system.

Four (4) Disinfection Alert level exceptions for high Free Chlorine at the inlet to Gregory St Reservoir were recorded in January 2019.

On 2nd, 3rd and 9th January, results of 2.5mg/L, 2.6mg/L and 2.3mg/L respectively were from increasing chlorine dosing to maintain disinfection upon flow increases to meet water demand of peak summer holiday usage and emerging drought conditions. Dosing corrections achieved balance from 10 January; The Alert Level for high chlorine is activated when Free Chlorine residuals are >2.2 mg/L.

High Free Chlorine 2.4mg/L exception reported on 22 January was due to a new batch of Chlorine, corrective action taken was lowering of the dosing levels; tests performed on 23 January confirmed the return to operations targets (Free Chlorine result of 1.91 mg/L).

A low Fluoride Alert Level exception of 0.86 mg/L was reported on 5 March at the Daily Calculated CCP location when Fluoride levels were <0.9 mg/L for 72hours. Investigation found a blockage in the delivery Hopper. Corrective action involved the breakup of the observed small lumps of fluoride in the hopper.

4.3.5 Stuarts Point Supply System

No Alert Level or Critical Limit exceptions occurred in the Stuarts Point supply system during the 2018-2019 reporting year (Table 4.2). This is a 1.4% reduction from the previous reporting year.

4.3.6 Willawarrin Supply System

The Willawarrin supply system had a reduction of 2.3% in CCP exceptions from the 2017-2018 reporting year. Four (4) exceptions were reported from five-hundred and sixty-five (565) samples; two (2) in the Raw Water Abstraction CCP (an Alert Level and Critical Limit) that are discussed in Section 8: Water Quality Incidents and Emergencies. Two (2) Alert Levels for the disinfection CCP parameter Free Chlorine was reported (Table 4.2).

The two (2) low Alert Level Disinfection exceptions were recorded at the reservoir on 13 and 19 March (0.57 mg/L and 0.5 mg/L respectively). Alert Levels for low Free Chlorine is reported when values are recorded at <0.6mg/L. Dosing was adjusted and system checks performed using CCP SOP. The Disinfection CCP was back within operational target the next day on both occasions with results being 0.63 mg/L and 1 mg/L respectively.

4.6.7 Bellbrook Supply System

The Bellbrook supply system had no Critical Limit exceptions. Six (6) Alert Level exceptions occurred at the Disinfect CCP. Eight-hundred and forty-seven (847) tests were performed during the year, with a reduction in the number of CCP exceptions of 3.5% from the previous reporting year.

Low Alert Level notification occurs at this CCP for a Free Chlorine result of <1 mg/L and high Alert Level at >2.2 mg/L.

Two non-fault finding low Free Chlorine events were identified. One on 25 October where the online analyser returned a result of 0.98m mg/L and grab confirmation of 0.93mg /L the second on 4 February with an online analyser result of 0.87 mg/L confirmed by a grab sample result of 0.92 mg/L. For both events, the dosing was adjusted, and system checks performed following the CCP SOP. The Disinfection CCP was back within the operational target the next day.

A Free Chlorine Alert Level exception was recorded on 5 November (0.91 mg/L) at the online analyser, a grab sample confirmed the result (0.91 mg/L). Investigation revealed a leak on the chlorine pump and corrective action taken included fixing of leak and priming of pump.

Two (2) low Free Chlorine Alert Level exceptions were recorded on the 3rd and 27th December (both 0.91 mg/L) at the online analyser, grab samples confirmed the results (0.92 mg/L). Investigation revealed an air lock occurred from gas build up in the hypo pump resulting in under chlorination, corrective action involved degassing the hypo pump.

A high Free Chlorine Alert Level exception result of 2.3 mg/L was recorded via the online analyser on 31 January and confirmation grab sample result of 2.5mg/L. The exception was caused from the combined use of a fresh batch of chlorine and the chlorine dose rate left at a high set point to raise chlorine residual at the reservoir; corrective action involved lowering the dosing set point.

4.3.8 Thungutti Supply System

No Alert Level or Critical Limit exceptions occurred from five-hundred and fifty-one (551) tests in the Thungutti Supply System during the 2018-2019 reporting year.

5. Reservoir Inspections

Council has sixteen (16) above ground storage reservoirs. Maintaining Reservoir integrity is included as a CCP for each of Council's water supplies, as this is the last point of contact with the water, where control can be affected prior to distribution. Maintaining reservoir integrity is critical to a water supply system, to ensure that no contaminants, such as vermin, stormwater or bird faeces, can freely access the treated stored water. Cleaning and inspection of the reservoirs is crucial to water supply ensuring that the water quality is not contaminated, or sediments are not disturbed.

5.1 Data Collection and Monitoring

Council's reservoirs are inspected on a monthly basis by operational staff who complete the "Reservoir Inspection Check List" that is stored on Council's F: Drive as per the CCP procedures. Any identified issues are reported to the Team Leader Water Process for actioning. Reservoirs are also inspected by contractors, for cleaning and detailed internal and external integrity inspections. These findings are collated, reported and tracked within the live working document titled "Condition Report -Reservoirs Draft" (2018). This report collates the contractor's written condition reports into a single document that is stored on their ASAM system. This document allows Council to track the upgrade, service and refurbishment needs to ensure the water quality and structural integrity is

maintained, as well as identifying and reducing safety issues surrounding the operation of Council's reservoirs.

5.2 Reporting

Fifteen (15) of the sixteen (16) reservoirs have been inspected and cleaned within the last twelve months, with the exception of the Green Hill reservoir (inspected only) which is unable to isolate for cleaning purposes. Previous inspections were undertaken in 2015 and 2017. Table 5.1 lists the findings from the previous and most recent inspections that still require rectification or were rectified in 2018-2019. All other issues identified in the previous reporting years that have been rectified prior to 2018-2019, have not been included in the report.

Table 5.1 Reservoir Inspection Report Summary

Date	Reservoirs	Findings	Corrective actions
12/05/2015	Crescent Head Big Nobby	Several roof sheets @ 12 o'clock are poorly attached and will blow off in a strong wind event	In Progress - No action has been undertaken to date on this issue. Roof access is restricted due to radiation from the radio tower. Council is currently working with the Communication Authorities to enable access as a priority. A planned clean was completed at the end of 2017.
9/7/17	South West Rocks Gregory Street Reservoir	The centre cap requires securing to prevent leaf litter building up and entering the tank.	Completed – Centre cap repaired 2018. Further work is programme when radio antenna is removed from roof in 2018/2019.
13/05/2015	Stuarts Point	The edges of the roof sheets have not been screwed down and they are likely to be damaged in a storm event. Corrosion present on the internal ladder.	Completed – Roof Sheets repaired in 2017 In Progress – Internal Ladder to be replaced/repared in conjunction with in planned internal refurbishment 2019/2020.
7/7/17	Thungutti No1	The level sensor is not secure or sealed around the edges.	In Progress – Level sensor has a covered lid installed to stop contamination ingress. A full re-design of the level sensor and housing to be completed in 2018/2019.
7/7/17	Willawarrin	There is no secure compound around the tank. The centre roof flashing is lifting and there is an unsealed hole around the level sensor	Completed – Repaired of unsealed hole in 2017. In Progress - Planning occurring for a WTP at Willawarrin and the construction will include the construction of a secure compound for the WTP and Reservoir (2019/2020).

6. ADWG and Water Quality Indicators

The Australian Drinking Water Guidelines (ADWG) (NHMRC 2011) provide an authoritative reference that defines what is safe and good water quality and how this can be achieved and assured, using the latest and best available scientific evidence. The ADWG provide detailed information on the measurable characteristics of drinking water, including microbiological, physical and chemical aspects, and these are grouped into two different types:

- A **health guideline** value – that is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption.
- An **aesthetic guideline** value – that is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, such as, appearance, taste and odour.

Additional water quality indicators (WQI) recommended by NSW Health include Total Coliforms and Free Chlorine residuals. A positive Total Coliforms result when used in operational monitoring, may indicate inadequate treatment, breakdowns in system integrity, or the presence of biofilms. Low Free Chlorine of <0.2mg/L is an indication that disinfection of the system may be compromised or lost.

Fluoride is monitored as per the Fluoridation Code (NSW Health 2018); an overdosing incident is the result of the fluoride concentration exceeding the ADWG of 1.5 mg/L in the treated water entering the distribution system and operational exceptions is defined by any failure to maintain the fluoride concentration above 0.9 mg/L.

6.1 Data Collection and Monitoring

Council participates in NSW Health's sponsored Drinking Water Monitoring Program; reticulation monitoring is undertaken on a routine basis to ensure that Council's customers receive safe and acceptable water quality. Council tests drinking water for thirty-two (32) health, aesthetic and other recommended characteristics. These samples are taken from twenty-five (25) sample sites within the Council's area of operation, all of which are post-treatment. The water quality characteristics that are monitored as part of this program are specified by NSW Health. Council liaises with NSW Health regarding the total number of samples required for each supply system and the frequency of collection; a yearly sampling schedule is produced by Council to ensure the expected frequency of sampling is met. Results are recorded in the NSW Drinking Water Database and reported against the ADWG and NSW Health recommended indicators. A summary of the water quality data for each supply system, obtained directly from the NSW Drinking Water Database, is provided in Appendix C.

In addition to monitoring undertaken as part of NSW Health's Drinking Water Monitoring Program, Council also independently monitors water quality parameters as part of our daily operations (pre- and post-treatment at the water supply systems). Results are recorded within individual supply system operational spread sheets.

6.2 Non-Compliant data

For the NSW Health sponsored monitoring, NSW Forensic & Analytical Science Services (FASS) Laboratory advises Council immediately via email of any health guideline limit exceptions including positive results for Total Coliforms following sample analysis. For microbiological exceptions Council's standard procedure is to investigate and undertake immediate re-sampling and notify NSW Health Local Public Health Unit (LPHU).

Anomalies found outside of the ADWG and WQI in relation to the daily operations monitoring are acted upon and reported into Council's Initial Incident database and communicated internally from the Water Operators directly to the Team Leader Water Process. External communication to the NSW Health LPHU of daily results is limited to a gross and/or consistent exceedance.

All exceptions, the reasons for the exception and corrective actions are collated by Council's Water Quality Officer and reported monthly, in the Monthly Water Quality Report to the Manager Water and Sewer which is used as reference material for notifications to the Director and Council as required.

6.3 Reporting

A total of one hundred and fifty eight (158) ADWG and WQI exceptions from both reporting platforms were recorded across Councils' Water Supply systems (Table 6.1). This is a 46.8% reduction from the two hundred and ninety seven (297) exceptions recorded in the previous reporting year. The two main contributing factors to this reduction were supply for the KLM was solely from the Sherwood borefield via the Lime Plant for three hundred and twenty four (324) days opposed to supply from SMD and a reduction in the amount of Fluoride exceptions reticulation system from daily operational monitoring and monitoring reported to NSW Health via Form 4 in the South West Rocks supply.

The KLM supply had seven (7) exceptions, Crescent Head twenty-five (25), Hat Head eleven (11), South West Rocks eight (8) and Willawarrin one hundred and five (105). The Bellbrook and Thungutti supplies recorded no exceptions in this reporting year (Table 6.1). The ADWG and WQI exceptions are discussed for the supply systems in which they occurred.

Table 6.1 Total ADWG and NSW Health recommended indicators non-compliant water quality results for Councils eight water supply systems

Supply Area	Parameter								Total
	*Total Coliforms	**Free Chlorine	pH	Turbidity	Fluoride	Iron	Manganese	Nickel	
Kempsey & Lower Macleay	4	0	0	2	N/A	0	0	1	7
Crescent Head	4	14	1	0	N/A	6	0	0	25
Hat Head	0	2	0	0	N/A	9	0	0	11
South West Rocks	3	1	0	1	3	0	0	0	8
Stuarts Point	0	0	0	0	N/A	1	0	1	2
Willawarrin	0	0	84	1	N/A	0	20	0	105
Bellbrook	0	0	0	0	N/A	0	0	0	0
Thungutti	0	0	0	0	N/A	0	0	0	0
Combined Total	11	17	85	4	3	16	20	2	158

*Total Coliform no ADWG set however a positive result is an indicator for further investigation

**Free Chlorine no minimum ADWG set however minimum level of 0.2 mg/L recommend for maintaining disinfection

6.3.1 Kempsey and Lower Macleay (KLM) Supply System

The KLM had a seven (7) exceptions during 2018-2019. This is a 90% reduction from the previous year's seventy one (71) exceptions. The exceptions are made up of four (4) Total Coliforms, two (2) Turbidity and a single (1) Nickel (Table 6.1).

Four (4) Total Coliform WQI exceptions from one hundred and seventy one (171) samples were recorded as a part of NSW Health monitoring programme (Appendix C: Table C.1).

- 2 January 2019; KS01 – 432 Gowings Hill Road result of 31 mpn/100mL

- 2 January 2019; KS01 – 126 South Kempsey Service Centre, result of 6 mpn/100mL
- 26 February 2019; KS01 – 348 Settlers Way, result of 4 mpn/100mL
- 25 June 2019; KS01 – 128 Aldavilla zone, result of >200 mpn/100mL

On receiving notification from FASS, Council conducted investigations that included confirmation of water quality at the exception locations and from the supply reservoirs, LPHU notification and consultation within 24hrs, and microbiological resampling. All resample results returned <1 mpn mg/L for both E. coli and Total Coliform; no further action was warranted.

The investigation at KS01 – 128 Aldavilla Zone found that the high Total Coliform result >200 mpn mg/L coincided with the cut in of a new main to the Correction Centre. In this instance Council expanded re-sampling to capture the surrounding supply. Confirmation resample results of < 1 mpn mg/L for both E. coli and Total Coliforms at KS1- 128 Aldavilla zone, KS01 – 129 Mahogany Crescent and KS01 – 342 Correctional Centre.

Two (2) Turbidity ADWG aesthetic exceptions were reported during operations monitoring of the distribution. A single exception at KS01 – 799 Lawson St on 11 April 2018 (15.3 NTU) caused from contractual work at the Macleay Valley Nursing Home and an exception at a non-Health monitoring location at Boyters Lane (13 NTU) that is located at the end of the reticulation system in the Lower MacLeay past Jerseyville. Rectifying actions for both instances was a flush of the line until results were under 5 NTU.

A Nickle ADWG Health exception of 0.03 mg/L occurred on 30 April 2019 at KS01 – 126 South Kempsey Service Centre. The LPHU was notified and a re-sample was performed. The secondary result was within the ADWG Health Guideline Value of 0.02 mg/L. No further action was taken.

6.3.2 Crescent Head Supply System

The Crescent Head supply had twenty five (25) exceptions during 2018-2019. This is the same amount as the previous reporting year. The exceptions breakdown is four (4) Total Coliforms, fourteen (14) Free Chlorine, one (1) pH and six (6) Iron (Table 6.1).

Four (4) Total Coliform WQI exceptions from sixty-four (64) samples were recorded as a part of NSW Health monitoring programme (Appendix C: Table C.2).

- 13 November 2018; KS05 – 321 Loftus Road result of 3 mpn/100mL
- 22 January 2019; KS05 – 321 Loftus Road result of 1 mpn/100 mL
- 26 February 2019; KS05 – 122 Stewart St result of 3 mpn/100mL
- 5 March 2019; KS05 – 123 Caravan Park result of 6 mpn/100mL

On receiving notification from FASS, Council conducted investigations that included confirmation of water quality at the exception locations and from the supply reservoirs, LPHU notification and consultation within 24hrs, and microbiological resampling. All resample results returned <1 mpn mg/L for both E. coli and Total Coliform; no further action was warranted

A combination of NSW Health sponsored monitoring and routine operational monitoring saw Fourteen (14) Free Chlorine (below 0.2mg/L) and one (1) pH ADWG aesthetic exceptions recorded during the reporting year at KS05-321 Loftus Road and/or KS05-122 Stewart St, Crescent Head, a reduction of eight (8) occurrences from the previous reporting year. Ongoing high turbidity and high levels of dissolved organic carbon in the supply system from poor source water quality, lack of filtration and long detention times make it difficult to maintain a chlorine residual at the extremities of the mains in the Crescent Head supply system. Immediate corrective action included checking of dosing equipment, pigging and flushing of affected mains and monitoring the distribution system downstream of the reservoir. An NSW Health directive for a regular flushing program of this system

has been implemented at Loftus Road to help maintain chlorine levels in the extremities of the distribution system and design tender plans of a multiple barrier filtration WTP has begun.

In January 2019, six (6) ADWG aesthetic Iron exceptions (>0.3 mg/L) were recorded during routine operational monitoring at the outlets of Back Beach and Big Nobby reservoirs. The exceptions, induced by low water levels at the front dam were all marginal, (between 0.31 mg/L to 0.34 mg/L) and coincided with the water incident discussed in section 8: January 2019 - Crescent Head Supply.

6.3.3 Hat Head Supply System

The Hat Head supply had eleven (11) exceptions during 2018-2019. This is an 80.4% reduction from the previous year's fifty-six (56) exceptions. The exceptions breakdown is two (2) Free Chlorine and nine (9) Iron (Table 6.1).

Free Chlorine below the WQI of 0.2 mg/L was recorded two (2) times in the Hat Head supply system on 3 July 2018, KS08-122 Marlin Court during routine monitoring and KS08-121 Tennis Courts during NSW Health sponsored monitoring program. Both locations returned a result of 0.08 mg/L. Corrective actions taken included checking the dosing equipment, flushing of the line and monitoring the chlorine levels in the distribution system downstream of the reservoir.

Routine monitoring of the supply returned nine (9) Iron ADWG aesthetic exceptions (>0.3 mg/L); eight (8) from the Clear Water Outlet and a single occurrence from KS08-121 Tennis Courts, resulting in an 82% reduction from the previous reporting year. The Iron exception results range was between 0.31 mg/L to 0.36 mg/L. Hat Head's drinking supply is sourced from the Macleay Coastal Sands Aquifer via three bores, the aquifer has naturally occurring Iron concentrations consistently above the ADWG aesthetic value of 0.3 mg/L (maximum recorded Total Iron value from the aquifer is 0.75 mg/L with a yearly average of 0.46 mg/L). Preventive measures taken to mitigate against the Iron exceedances involve maintenance cleaning of the aeration tank and the isolation of Bore 2 after being identified as having higher Total Iron concentrations than Bores 1 and 3.

6.3.4 South West Rocks Supply System

The South West Rocks supply had eight (8) exceptions during 2018-2019. A 94.2% reduction from the previous year's one-hundred and thirty-six (136) exceptions. The exceptions breakdown is three (3) Total Coliforms, one (1) Free Chlorine, one (1) Turbidity and three (3) Fluoride (Table 6.1).

Three (3) Total Coliform WQI exceptions from sixty-one (61) samples were recorded as a part of NSW Health monitoring programme (Appendix C: Table C.4).

- 9 September 2018; KS07 – 127 Gordon Young Drive result of 1 mpn/100mL
- 2 April 2019; KS07 – 128 Arakoon Cardwell result of 4 mpn/100 mL
- 4 June 2019; KS07 – 126 Little Bay result of 8 mpn/100mL

On receiving notification from FASS, Council conducted investigations that included confirmation of water quality at the exception locations and from the supply reservoirs, LPHU notification and consultation within 24hrs, and microbiological resampling. All resample results returned <1 mpn mg/L for both E. coli and Total Coliform; no further action was warranted.

The single ADWG Turbidity (12.2 NTU) and single Free Chlorine WQI (0.08 mg/L) both occurred at KS07 – 126 Little Bay. The Turbidity exception occurred on 28 August 2018 and was caused from repairs to a broken main in the Arakoon area. The Free Chlorine exception occurred on 2 January 2019 due to low water usage from being at the end of a distribution line. Both instances were rectified by a line flush.

Only three (3) Fluoride exceptions were recorded in the reporting year compared to the one hundred and thirty-six (136) occurrences in the previous year. The significant reduction is attributed to fewer plant shutdowns than in the 2018-2019 reporting year. In 2017-2018 the plants larger than normal shutdown regime was due to increased storm activities that knocked out the PLC on two separate occasions, and an intense program of asset maintenance, upgrades, and system repairs. These shutdowns had a cumulative effect in the reduced Fluoride concentration in the reticulation system as the Fluoride dosing system was non-operational during these periods and the lag of two to three days for the concentration to increase back to the operation target range of 0.9 to 1.2 mg/L (in line with the Fluoridation Code) out of the reservoirs after the fluoride systems was re-activated after each shutdown event.

6.3.5 Stuarts Point Supply System

The Stuarts Point supply had two (2) exceptions during 2018-2019. A single ADWG Iron (0.53 mg/L) and a single ADWG Nickel (0.04) exception from a sample taken on the 20 May 2019 at KS06 - 121 Memorial Avenue during the NSW Health sponsored monitoring program. Council notified the LPHU and conducted a resample; secondary results both returned within their respective ADWG limits.

6.3.6 Willawarrin Supply System

The Willawarrin supply had one-hundred and five (105) exceptions during 2018-2019. An increase of 94.2% from the previous year's six (6) exceptions. The exceptions breakdown is eighty-four (84) pH, one (1) Turbidity and twenty (20) Manganese (Table 6.1).

The majority of the low-level pH exceptions from the Reservoir outlet and reticulation sites (KS04-121 Football Grounds, KS04-122 St Thomas Church and KS04-123 Primary School) occurred in the summer period. The pH averages at the Reservoir dropped in value with the onset of warmer weather; October 6.73 pH, November 6.35 pH, December 6.41 pH, January 6.38 pH and February 6.46 pH. In contrast between 1 October and 31 January the water temperature average had increased by 6.26^{oC}. This relationship may account for the drop in pH levels below the ADWG aesthetic (6.5-8.5 pH) as a weak acid solution exposed to an increase in temperature, may give a lower pH value due to increased hydronium ion formation. Increase in drought conditions also impacted the recharge of the source water which may exacerbate the lowering of the pH.

A single ADWG Turbidity (19.9 NTU) occurred on 28 June 2019 at KS04 – 121 Football Grounds as a result of manganese build up in the main; a main flush was performed to remove the manganese that reduced turbidity levels.

Twenty (20) Manganese ADWG exceptions were reported; exceptions were reported at the Reservoir outlet and all the three reticulation NSW Health monitoring locations. The onset of drought conditions reduced catchment rainfall and Macleay River flows; this impacted the quality of water sourced from the river bores, increasing the concentrations of the naturally occurring Manganese.

No corrective action is available as the Willawarrin Supply system does not have filtration options or pH correction mechanisms. Future WTP upgrades are to include these facilities. Water Carting from the KLM system is an option if water quality continues to decline into the future.

6.3.7 Bellbrook Supply System

No ADWG or WQI exceptions were recorded in the Bellbrook supply system.

6.3.8 Thungutti Supply System

No ADWG or WQI exceptions were recorded in the Thungutti supply system.

7. Customer Enquires

Customer enquiries are received by Council's Customer Services Section. Customer enquiries are recorded and saved in Civic View, which automatically notifies the Team Leader Water Process who delegates responsibilities to action as appropriate. Where appropriate, a Water Process Operator will contact the customer, attend the location, undertake sampling and testing and provide feedback to the customer on the results. The operator will then coordinate a response to these results as appropriate to ensure that the drinking water continues to meet the ADWG guidelines and NSW Health recommended indicators. Each customer enquiry, including the rectifying measures taken by Council, are collated and reported in the Monthly Water Quality Report.

Table 7.1 provides a summary of the customer enquiries for the KLM water supply system and Table 7.2 provides a summary of the customer enquiries for Council's other seven water supply systems. Appendix D provides descriptors for each supply area within the KLM supply system.

Table 7.1 Customer Enquires for the KLM Water Supply System 2018/2019

KLM Supply Areas	Dirty	Air or Cloudy	Taste & Odour	Illness	Loss of Supply	Annual Total
Kempsey	1	0	0	0	1	2
West Kempsey	9	0	0	0	9	18
Aldavilla	2	0	0	0	2	4
Smithtown/Gladstone	0	0	0	0	3	3
Belmore River	0	0	0	0	0	0
Kinchella	0	1	0	0	1	2
Frederickton	2	0	0	0	0	2
South Kempsey	2	0	0	0	14	16
East Kempsey	0	0	0	0	3	3
KLM Total	16	1	0	0	33	50

Table 7.2 Customer Enquires for Council's Water Supply Systems excluding KLM 2018/2019

Supply System	Dirty	Air or Cloudy	Taste & Odour	Illness	Loss of Supply	Annual Total
Crescent Head	5	0	0	0	1	6
Hat Head	0	0	0	0	0	0
South West Rocks	3	2	0	0	1	6
Stuarts Point	6	0	0	0	0	6
Willawarrin	4	0	0	1	0	5
Bellbrook	1	0	0	0	0	1
Thungutti	0	0	0	0	0	0
Combined Total	19	2	0	1	2	24

A total of seventy-four (74) customer enquiries were recorded by Council for this reporting year. The majority of these were in the KLM supply system with fifty (50) enquires received. No customer enquiries were recorded in the Hat Head and Thungutti water supply systems. Recorded customer

enquiries for all other supply systems for the year are discussed within the supply systems in which they occurred.

7.1 Kempsey and Lower Macleay Supply System

The KLM supply system had fifty (50) customer enquiries. Loss of supply had the highest number with thirty-three (33). South Kempsey recorded fourteen (14), West Kempsey nine (9), East Kempsey and Smithtown three (3), Aldavilla two (2) and Kempsey and Kinchella areas one (1) each (Table 7.1).

Sixteen (16) dirty water customer enquires with the majority of these in the West Kempsey area (nine (9)), Aldavilla, Frederickton and South Kempsey areas all recorded two (2) and a single (1) report in the Kempsey area. The Kinchella area had the only air or cloudy enquiry (Table 7.1).

The main contributing element to the received enquiries of loss of supply and dirty water were multiple broken mains throughout the KLM supply system and programmed main renewal projects. In particular for the South Kempsey region, a broken main behind Lika Drive had significant impacts on the 25 and 26 December. Water diversions were put in place for repair of the main break and the creation of a new interconnection. Normal service pressure to the impacted regions was restored on 27th December.

7.2 Crescent Head supply system

The Crescent Head supply system received six (6) customer enquiries for the year. Five (5) dirty water and a single (1) loss of supply.

The dirty water enquiries were 5 separate events (July, August, September, October and December) and were resolved by on site water quality testing after a line flush at the meter for 15 minutes.

A single loss of supply reported as a pressure loss on 15 February was resolved with a flush of the line to draw through after repairs had been completed the previous day.

The Crescent Head supply system is unfiltered and Council struggles to maintain turbidity levels within operations targets. A new Water Treatment Plant with pre-treatment, including filtration is in the design phase.

7.3 South West Rocks Supply System

Six (6) customer enquires in the South West Rocks supply system were reported. Three (3) dirty water, two (2) air or cloudy and a single loss of supply

A main repair on 27 August in Arakoon resulted in dirty and cloudy water enquires made on the 28 and 30 August. Multiple water quality tests were performed over several hours whilst a system flush was performed to draw through the dirty water. The resident reporting the cloudy water was advised to turn inside taps on to draw through water so that the air trapped in the line exhumed restoring water clarity.

Two (2) dirty water enquiries (February and March), were resolved with water quality results conducted at each location instigating lines flushing to the meter at each residence.

In April a customer reported that her water pipes are noisy and “it’s like there was air in them”. Rectifying action was a flush at the meter for 15 minutes with the resident advised to turn inside taps on after the flush was performed to help draw water through.

Pressure drop enquiry on 30 May was caused by a cut in at the Settlers Ridge subdivision. A line flush to draw water through the system resolved the loss in pressure.

7.4 Stuarts Point Supply System

The Stuarts Point supply system had six (6) dirty water customer enquires (Table 7.2)

On the 28th July, two corresponding dirty water complaints were received from 448 and 450 Fishermans Reach Road, Fishermans Reach. Both callers advised Council that water at all taps was a yellow/brown colour. Council attended the location and flushed the line past the properties until the water ran clear. Preventative action is to maintain a regular flushing programme.

Dirty water enquiries were also received in November, December, January and February. For each instance, Council attended site and conducted water quality testing and proceeded to flush the line at the water meter for at least 15 minutes or until the water ran clear to resolve the problem.

During the December enquiry the resident advised Council that their dirty water (brown in colour) was a re-occurring issue. A review of Council's water enquiries register over an eighteen-month period found no entries for dirty water issues at the resident's address.

7.5 Willawarrin Supply System

The Willawarrin system received five (5) customer enquiries during the reporting year. Four (4) dirty water and an illness enquiry.

The four (4) dirty water enquires occurred in August, October, February and April. All four events were reported from Main St, Willawarrin. For each occurrence Water Operators attended site performed water quality tests and flushed the line.

The Willawarrin supply is unfiltered, and the source water is naturally high in iron and manganese that can cause discolouration. During the reporting year Willawarrin Turbidity results from the reticulation system returned a single occurrence of an ADWG exceedance in June caused from manganese build up in the main. Water quality tests at the reservoir outlet and reticulation sampling locations returned twenty (20) manganese ADWG aesthetic exceedances (>0.1 mg/L). Council is currently investigating designs for pre-treatment process in this supply system.

On 6 November, a Willawarrin resident came to Customer Services to make a complaint regarding the water supply along Main St, Willawarrin. She advised that seven (7) people have contracted Giardia within the past week. When asked where this information came from, she replied that she is a nurse and knows what to look for. She was extremely upset regarding the lack of communication from Council to the community in advising that Council water could make them sick.

In response Council contacted NSW Health to advise the Health authority of the complaint and request additional information if any concerns have been made to NSW Health regarding the quality of the Willawarrin Supply system. NSW Health advised (by phone and email) that there had not been any notified Giardia or Crypto cases (notified by laboratories or Doctors) from the Upper Macleay in all of 2018.

Council also reviewed collected data obtained from the supply system for the period 1 July 2018 to 6 November 2018.

No positive results were recorded for biological monitoring (Total Coliforms and E .coli), and disinfection was confirmed to be 100% compliant with Free Chlorine residuals >0.2 mg/L at the distribution sampling locations; no CCP exceptions were recorded at the reservoir. Reticulation sampling locations data averages:

- KS04-121 Football Grounds - average Free Chlorine 1.02 mg/L and average Turbidity 0.84 NTU
- KS04 – 122 St Thomas Church – average Free Chlorine 1.02 mg/L and average Turbidity 0.82 NTU
- KSO4 – 123 Primary School – average Free Chlorine 0.98 mg/L and average Turbidity 0.96 NTU
- KSO4 - Disinfection CCP Reservoir – average Free Chlorine 1.16 mg/L (Target 1 mg/L; Alert Level <0.6mg/L). Average Turbidity 1.02 NTU.

7.6 Bellbrook Supply System

The Bellbrook supply system had a single dirty water enquiry on 27 November from a resident located on Main St, Bellbrook. The resident advised Council of brown water in all their taps. Council attended site and performed water quality tests and proceeded to flush the customer's line at the meter until the water ran clear.

8. Water Quality Incident or Emergency

A water quality incident or emergency is an event where a controlled response is required to ensure that Council continues to protect public health. Although preventative strategies, such as CCP procedures, have been developed by Council, some events cannot be anticipated or controlled. These events need a managed response to ensure the incident is responded to adequately, investigated following the event, and preventative actions are implemented to reduce the risk of the event re-occurring.

Kempsey Shire Council had six (6) recorded Critical Limits in four (4) separate incidents for this reporting period. Council also began monitoring drought conditions and a Drought Event was declared in May 2019 due to water supply security concerns; these are summarised in Table 8.1.

Table 8.1 Summary of Water Quality Incident or Emergency

Details of incident/emergency	Investigation & recommendations	Preventive action undertaken
<p>July 2018 – Crescent Head Supply A single Critical Limit abstraction CCP of 5.13 NTU was recorded at the Front Dam on 31 July 2018. SOP CCPs were followed and confirmed that no impacts on supply water were observed. High turbidity in the raw water from the Maguires Crossing Bore Fields is an ongoing issue in this supply system.</p>	<p>Ongoing corrective action includes continuous monitoring of the bore fields to determine the best bore for water extraction, continuous monitoring of the front dam and reticulation system and gravity feed the front dam from the bore fields. Future preventative action is to include a pre-treatment process of the source water from Maguires with membranes and Granular Activated Carbon (GAC) for suspended solids and organics removal.</p>	<p>Testing performed on 31 July 2018 confirmed secondary turbidity CCP Rising Main result within operational target; result of 2 NTU and disinfection confirmed at CCP Back Beach Reservoir with Free Chlorine within operational target; result of 1.33 mg/L.</p> <p>Testing performed on 1 August 2018 all within operations target CCP Front Dam turbidity = 2.51 NTU CCP Rising main turbidity = 1.76 NTU CCP Back Beach Reservoir Free Chlorine = 0.96 mg/L</p>
<p>October 2018 – Willawarrin Supply A rain event on 14 to 16 October 2018 caused increase turbidity in the Macleay River posing health and infrastructure risks to the up-river supply of Willawarrin. Water carting to the supply commenced on 17 October when Critical Limit of 5.2 NTU was recorded at the CCP Abstraction location. Bellbrook and Thungutti systems were closely monitored. Bellbrook's filtration system allowed</p>	<p>No investigations conducted. Water Operators followed the CCP SOPs for each of the up-river supply systems eliminating both potential public health and infrastructure risks.</p>	<p>Bores isolated and water carting from the Kempsey & Lower Macleay supply (Greenhill Reservoir) for three days. Normal supply resumed on 20 October after testing of the borefield confirmed turbidity returned to operational target of <0.6 NTU (test result of 0.47 NTU).</p>

<p>the plant to remain operational and Thungutti raw water supply from Nulla Nulla Creek did not see the turbidity increases of the Macleay River.</p>		
<p>January 2019 – Crescent Head Supply Two (2) Critical Limit abstraction CCP exceptions occurred at the Front Dam on 14 and 15 January 5.67 NTU and 5.56 NTU and a single Critical Limit exception at the disinfection CCP Back Beach Reservoir for low Free Chlorine 0.45 mg/L on 16 January.</p> <p>All three (3) Critical Limits coincided the installation of Geo Fabric filter bags just prior to the Front Storage Dam and a scour of the water main. This stirred up sediments in the Front Dam causing the Critical Limits at the CCPs. The bags were installed as a remediation measure to remove suspended solids and Iron when Council re-fills the dam after scouring the raw water main.</p> <p>Dam levels were lower than normal due to pre-Christmas storms that knocked out the Hat Head borefield. Electrical parts were taken from Crescent Head borefield to fix Hat Head. Crescent Head borefield was non-operation for 1 week until replacement parts were sourced and reinstalled, this caused the Front Dam level to drop significantly. Unprecedented peak holiday consumption made it difficult to re-fill Front Dam levels to an optimal level (ideally >90%).</p>	<p>Secondary dosing of the Reservoirs is required when turbidity at CCP is elevated, and particularly if the WTP is turned off to maintain disinfection.</p> <p>Leading into peak holiday period Front Dam should be >90% before December.</p> <p>Equipment critical spares need to be available for breakdowns.</p> <p>Communication protocols within Council reviewed.</p> <p>Communication protocols between Council and the LPHU reviewed.</p> <p>Debrief conducted on 15 Feb 2019 and report sent to LPHU.</p>	<p>The WTP was shut down overnight on 15 January to let turbidity settle after raw water scour event, however this caused chlorine residuals to drop in the Back-Beach Reservoir.</p> <p>Extra monitoring conducted on the 16th of January at Korogora St, Skyline Crescent and Noongah Terrace.</p> <p>Adjustments have been made in the way Water Operators communicate CCP, this includes email notification to the email address waterprocessmanagement@kempsey.nsw.gov.au and Water Management Team to notify LPHU within 24hrs.</p> <p>Water Operators were tool boxed on 21 January by the Team Leader.</p>
<p>February 2019 - Crescent Head Supply A malfunctioning chlorinator (vacuum fault) was identified on 18 February 2019 from the investigation of an Alert Level result (0.5 mg/L) at Back Beach reservoir. Constant monitoring at the Back Beach reservoir during the period whilst the chlorinator was being repaired identified a Critical Limit result of 0.48mg/L on 19 February at 7.30am noting that additional Sodium Hypochlorite had already been organised and was on route to the Crescent Head supply for additional dosing when the Critical Level result recorded. The system returned to operational targets that afternoon after system slug dosing and chlorinator repairs completed.</p>	<p>Water Operators followed the CCP SOPs; the issue was quickly identified at the Alert Level stage on 18 February and rectifying actions implemented. The system moved into Critical Limit on 19 February at 7:30am and was resolved by 2pm. Detailed sequence of events and preventative actions were documented, including communication with the LPHU.</p>	<p>18 February 2019 Identified malfunctioning chlorinator, start of repairs</p> <p>Free Chlorine at Back Beach Reservoir at 12pm Free Chlorine 0.80 mg/L</p> <p>WTP shut down over night, unable to complete repairs</p> <p>Back Beach Reservoir tested at 4pm Free Chlorine 0.5mg/L (Alert Level result); Slug dosed reservoir calculated to increase to Free Chlorine 1.9mg/L after consultation with Team Leader</p> <p>19 February 2019 6am test Back Beach Reservoir, Free Chlorine result 0.62mg/L (still within Alert Level of <0.7 mg/L) – Team leader called; arrangement made for Sodium Hypochlorite to be delivered from South West Rocks to Crescent Head</p> <p>7.30am re-test Back Beach Reservoir, Free Chlorine result of 0.47mg/L (Critical Limit <0.5mg/L); Team leader called and confirm slug dose of 20ltrs of Sodium Hypochlorite to bring Free Chlorine residuals up</p>

		<p>Begin testing sites in distribution to confirm no loss of disinfection has occurred. Test Result at K055 - Community Hall Free Chlorine 2.6mg/L; KS05 – 123 Caravan Park Free Chlorine 0.95 mg/L; KS05 – 321 Loftus Rd Free Chlorine 2.9 mg/L.</p> <p>NSW Health notified (phone and email)</p> <p>Malfunctioning chlorination issue rectified and WTP back online at 10am (tariff off peak electricity activation).</p> <p>Continued monitoring at Reservoir and distribution to ensure Free Chlorine residuals are maintained but also to monitor that the system is not over chlorinated (high Free Chlorine Alert Level >1.9mg/L and Critical Limit set at 4mg/L). Adjustments in dosing made based on monitoring results to maintain operational targets.</p> <p>System stabilised by 2pm</p>
--	--	--

Drought Watch and Drought Emergency

During 2018 – 2019 all of NSW was in Drought or Drought Affected, which placed pressure on Council's water supplies as the water cycle relies on rain fall in the Armidale, Walcha, and Guyra regions.

Council began to closely monitor water flow volumes in the Macleay River and Catchment in July 2018 as river levels had dropped to the 80%ile trigger of 235M/Day. An executive team meeting was held on the 13 August 2018 facilitated by the Manager of Water and Sewer that gave notice to the Executive Leadership Team (ELT) of the developing drought and potential impact on water resources security across the Local Government Area (LGA). The development of an updated Drought Management Plan commenced (adopted in August 2019), and an interim Drought Management Team was formed to ensure if water restrictions needed to be activated an interim steering management team was in place.

Level 1 water restrictions were implemented on 21 May 2019 and Level 2 restrictions on 3 June 2019. The KLM supply was transferred from the Sherwood borefield to the SMD emergency supply on 13 June 2019 due to the rapidly decreasing flows in the Macleay River.

For the 2018-2019 reporting year Council was in water restrictions for 41 days, that continued into the next reporting year.

9. Monitoring and Testing

9.1 Aboriginal Communities Water & Sewage Program

Five (5) discrete Aboriginal Communities are identified within the drinking water supply areas of Council. Council partnerships with DPIE and NSW Health to deliver the NSW Aboriginal Communities Water and Sewer Program for the following communities:

- Bellbrook (Thungutti)
- Greenhill (West Kempsey)
- Burnt Bridge (South Kempsey)
- Loftus Rd (Crescent Head)
- Figtree (South West Rocks)

9.1.1 Pesticide Testing

Pesticide monitoring from water supplies servicing discrete Aboriginal communities is funded by the NSW Aboriginal Communities Water and Sewer Program every five (5) years.

For this reporting year pesticide testing was conducted at the Loftus Road Community at Crescent Head. Table 9.1 provides a summary of last conducted monitoring and when next schedule sampling is due for each community. Pesticide analysis testing includes:

- Acidic Herbicides – Method CET8B
- Glyphosate – Method CET17A

- Organochlorine & Organophosphorus by LCMSMS – Method CET43A
- Organochlorine, Organophosphorus & Synthetic Pyrethroid Pesticides by GCMSM – Method CET7D
- Triazines/Phenylurea & Carbamates – Methods CET19C

Council has additionally tested for pesticides in the past in the KLM and Stuarts Point supply systems. Past pesticide monitoring has detected low concentration of Glyphosate and Permethrin in the KLM supply system. All of Councils others supply systems has had no pesticide detection.

Table 9.1 Summary Pesticide Monitoring at Aboriginal communities and selected supply systems

Catchment	Location	Last Sampled	Comments	Scheduled Next
Thungutti	Reticulation	2017	No Pesticides Detected from 1 sample	2022
Crescent Head	Reticulation (Loftus Rd)	2019	No Pesticides Detected from 1 sample	2024
South West Rocks	Reticulation (Figtree)	Feb 2017 to Dec 2017	No Pesticides Detected from 12 samples	2022
KLM	Burnt Bridge or Green Hill	Dec 2017	No Pesticides Detected	2022

9.1.2 Inspections and Water Quality Testing to ADWG

Along with pesticide monitoring, the water supply and sewerage systems at the Aboriginal communities are inspected by the Department of Industry (DoI) (now Department of Planning, Industry, and Environment (DPIE)). The water quality results for each of the communities taken during the inspections (Table 9.2) indicate that the water meets the required ADWG and NSW Health recommended indicators for the parameters tested.

Table 9.2. Result Summary of Water Quality results conducted during Department of Industry Inspection

Community	Sample Location	Date Inspected	Turbidity (NTU)	Free Chlorine (mg/L)	pH
Fig Tree	R8 SPS	5/07/2018	0.62	1.36	7.38
New Burnt Bridge	SPS K25	6/07/2018	1.50	1.17	7.07
Green Hill	SPS 29	6/07/2018	1.15	0.62	6.92
Loftus Road	Standpipe at SPS C4	5/07/2018	0.24	0.30	7.00
Thungutti	Reservoir	24/10/2018	0.21	0.94	6.92
	Reservoir	12/06/2019	0.37	1.18	N/A
	Reticulation	12/06/2019	0.28	1.28	N/A

10. Continuous Improvement – Implementation Plan

Council's Implementation Plan (IP) was developed as part of the DWMS to document the improvement actions identified during the detailed risk assessment of the drinking water supplies. The Improvement Plan encompasses Element 12 of the DWMS and demonstrates Council's commitment to continual improvement of its water supply services from a quality and safety perspective.

Since completion of the DWMS in 2014, the IP has been reviewed yearly by the Risk Management Team. Table 10.1 provides an overview of the IP reviews with a summary of progress of the actions.

Table 10.1. Summary table of Implementation Plan Reviews

Review Date	Removed*	Completed	In progress	Ongoing (no change in status)	Not Started	Items Added	Total Ongoing
Nov 2014 & Jan 2015	4	7	49	Not Reported	111	23	171
Aug & Sept 2015	4	8	75	Not Reported	83	0	157
April 2016	N/A	N/A	N/A	N/A	N/A	16	173
March 2017	N/A	24	73	64	65	0	202
August 2018	14	54	51	27	28	0	106
Oct 2019	48	23	63	24	7	18	112

*Removed items are the number of items that have been completed in the previous year review. The figures from "Completed" and "Removed" may not match due to confirmation in the current review year that the task has been completed. If an item is deemed "not-completed" its status is changed back into "in progress"

A summary of the ongoing actions in the DWMS IP has been included in Appendix E that includes the risk ranking, status of tasks, progress, and comments. It indicates the dates where tasks have been added and references the reason for the addition or removal from the plan.

The IP has been further analysed to determine the progress on tasks by risk ranking; this is provided in Table 10-2. During the October 2019 review a total of forty eight (48) tasks were removed as they were confirmed as completed from the August 2018 review. Eighteen (18) of these tasks had a risk ranking of high to very high-risk. A further twenty-three (23) tasks were assessed as completed, which eight (8) were rated as high or very high-risk.

Of the one hundred and twelve (112) ongoing tasks, thirty one (31) tasks (ongoing & not started) did not change in status as no progress was undertaken since the previous review; There are no "very high" risk ratings for the tasks that have yet to be started.

To date, a total of ten (10) very high risks tasks are outstanding.

Table 10.2. Progress on actions based on risk value (October 2019)

Residual Risk	Removed	Completed	In progress	Ongoing (no change in status)	Not Started	New	Total	Tasks Remaining
Very High	5	2	7	2	0	1	17	10
High	13	6	28	6	3	9	65	46
Medium	20	6	17	9	2	8	62	36
Low	10	9	11	7	2	0	39	20
Total	48	23	63	24	7	18	183	112

Internal reviews of the IP progress will continue to be undertaken annually by Council in conjunction with the annual review of the Risk Register. Any new actions that are identified in the Risk Register are added into the IP. As actions are completed their status is changed to "completed" and remain in the IP for one review cycle before being marked as "remove" and taken off the IP. Table 10.3 provides a summary of the actions that have been completed and Table 10.4 provides a summary of those removed from the last review undertaken in October 2019.

Table 10.3 Summary of Completed tasks in Implantation Plan (October 2019)

Action No.	Supply System	Residual Risk	Outstanding Actions	When Added	Comments
1.01	All	L	<p>Develop a KSC Drinking Water Policy and integrate into the Strategic Business Plan.</p> <p>Gain formal endorsement and support of the DWMS from senior executive and Council, including ensuring that organisation activities support effective water quality management such as providing appropriate staffing, financial and training resources.</p> <p>Ensure all staff are made aware of the Drinking Water Policy and the DWMS and ensure it is visible to all staff and the community and included in induction for all new staff.</p>	2012	DWMS full review completed in June 2019 with Water Policy updated to include Thungutti and signed by GM and Mayor - Singed off by Council Aug 19 meeting
1.02	All	L	<p>Develop a comprehensive stakeholder/relevant agencies list which identifies all stakeholders who could affect, or be affected by, decisions or activities of the drinking water supplier, identifying the accountabilities and responsibilities of relevant agencies. The list should be stored in the TRIM DWMS document register and referenced in the DWMS and the IERP.</p> <p>Develop a regular review process to update the list of stakeholders</p>	2012	Completed in 2019 DWMS update list of stakeholders in Overall Manual. All documents stored in Councils record management system
2.18	Kem	L	Update the SMD Management Plan Alert Level Framework to include Bio volumes and cell numbers notification, and T&O alert levels, sampling guidelines for seasons and alert levels	2012	This was completed during the 2019 DWMS update
2.3	Kem	L	Review and update the SMD Bushfire prevention plan.	2012	Completed apart of the DWMS review and flow chart for Water Supply triggers

1.07	All	H	Incident & Emergency Response Plan to be developed which includes communication, responses and reporting requirements and provide appropriate training for all staff on the introduction of the Plan. Identify an appropriate person to handle all incident and emergency communications and ensure they are appropriately trained. The Plan is to identify key supply zones and detailed emergency contact list. Identify possible water quality related incidents and emergency scenarios. Develop a process for investigation following incidents and emergencies and document this process. Include in this process a mechanism for revision of any emergency protocols, where an investigation demonstrates it is required. Establish a rapid communication system (for internal and external communication) to deal with unexpected events.		Business Continuity Plan will capture a lot of these elements, currently being undertaken for the whole of Council. 30/10/2019 - BCP plan updated in 2019 and DWMS updated in June 2019 which contains incident response place and stakeholder contacts – Water Operators were apart of the review process and implementing the current DWMS.
2.31	Kem	L	To monitor animal numbers and introduce an 'animal control' program in the secured SMD area when required.	2012	Number of Kangaroos decreased, inspections undertaken, fenced and blocked off, ongoing task 1/11/2019 - sufficient controls are in place and kangaroo numbers have been reduced and numbers are continually monitored
2.32	Kem	L	Include SMD perimeter and water surface inspections into site management procedures to monitor and minimise native and feral animal access to storage.	2012	As above 4/11/2019 - will be added to WaterOutlook SMD O&M
2.87	All	VH	Procurement controls to be introduced through stores to ensure that all sourced materials are fit for contact with potable water, conform to plumbing regulations, and industry standards and practices, to guide product selection and installation.	2012	Under procurement Mid ROC process, checklist to be developed, 7/11/2019 - this is already incorporated in procurement and is always under constant review. Check list not feasible to be devolved under a system outside of council single control.

2.95	ALL	M	Develop a formal requirement register covering all responsibilities water related activities, including requirements for the management of water quality. This register should then be referenced in this section of the DWMS and stored in TRIM. Develop, document and implement a formal process for reviewing formal requirements every 12 months or where there are any changes to councils' activities of formal requirements.	2014	Will be included in the DWMS document as a table. 7/11/2019 - this has been captured in the review process and signed off by council in August 2019
2.97	ALL	M	Ensure all staffs position descriptions include the relevant formal requirements for the management of water quality, including responsibilities under the DWMS and ensure they are reviewed annually with performance reviews	2014	Currently being reviewed 7/11/2019 - KSC as a whole have updated all PDs in early 2019.
3.27	All	H	Develop an SOP for commissioning procedures to limit potential taste and odour issues possibly due to new coatings or pipework.	2014	19-11-2019 this action is to be removed as it will be covered in SOP for new main commissioning. Coatings are not used in internal mains lining and Council has two NACE coating inspectors
3.31	ALL	H	KSC to develop a Document Register within TRIM that includes responsible person and review date triggers. This register should be updated in the DWMS when changed. Develop a procedure or system within TRIM that manages document control for all DWMS documentation (i.e. ensure the currency, accessibility and appropriate review DWMS documents).	2014	Being undertaken through TRIM No escalation, may be a process, needs to be checked 19/11/2019 All documents relating to the management of the DWMS are recorded in the DWMS document register. This register is maintained by the WQO and updated in TRIM when updates are made.
3.33	ALL	M	Where operational manuals for treatment plants do not exist, Council should develop these and/or replace out of date manuals. Include all of the newly developed operational procedures in the existing operations manual.	2014	O&M manuals exist for every plant being reviewed, in conjunction with SOPs 19/11/2019 - Operations are linked in the GIS system and there are hard copies available on the F: Drive. SOP are separate to the operational manuals as these are technical schematics supplied by the plant manufacturer

3.57	ALL	M	Council may consider developing a process where customer feedback is directly integrated into the daily monitoring spreadsheet, which also captures daily water quality data.	2014	Customer complaint database must be developed. Currently actions aren't captured, Water section must work with customer service to develop this. 19/11/2019 - Water Quality complaints are captured and reported on in the Monthly and Yearly Reports. Other feedback when it occurs is filtered to the team via the MWS, and WTL and reported on as it occurs. No other process deemed necessary for development.
3.68	ALL	M	Consider the implementation of a Long term operator competency program	2014	Workshops for WIOA attended. 19/11/2019 National certification scheme for operators is being used by council. This action has been implemented and can be closed off
3.77	ALL	L	As part of councils' review of the DWMS risk assessment, review and discuss the effectiveness of existing processes and procedures in managing water quality. The review should draw on external research and information, the risk assessment, water quality analysis and organisational experience. With any changes in conditions, processes and procedures should be revalidated.	2014	Currently undertaken as part of implementation project 2018 19/11/2019 - this action is already being performed during the DWMS annual review and ad hoc reviews as required
3.79	ALL	L	Develop a policy on validation of new or upgraded water supply infrastructure. This should include witness, demonstration and commissioning requirements that are designed to ensure the infrastructure delivers the expected water quality results.	2014	All new upgrades must be approved by DoI, section 60. Whenever a new project is commenced, a checklist is used at inception. Also captured under tender specification. Ensure appropriate legal and contractual arrangements in place. 19/11/2019 Inspections are carried out by Council for new private main connections. Validation of designed, construction and commissioning of new supply infrastructure is captured in the tender process and contracts. Council has a standardised specification standard. This section also is captured in Councils Project Management Framework.

3.83	ALL	L	Review existing documentation on the water supply systems and ensure all are captured on councils' document management system. Verify documents are up to date.	2014	Need for a technical officer to undertake this 19/11/2019 - All DWMS documents are recorded on the DWMS document register. This is maintained by the WQO. Other Water documents for Maintenance and Operations are listed in the "where do I find it register.
3.94	ALL	M	Redundant sample sites (i.e. with no data attached to them) to be removed from NSW Health sampling database.	2014	21//11/2019 - data not deleted but placed in archive. During the 2018/2019 review samples sites were changed and this has been updated in the NSW Health database and archived data as required
3.99	BB	H	Chlorine dosing system needs to be set up with the capability to do chlorine dose flow checks and calibrations BB	Dec-14	Chemical audit sheet to be considered/actioned 21/11/2019 this has been done
4.07	KLM	H	Chlorine samples are currently being collected at the outlet to the reservoirs, this needs to be changed to the inlet to the reservoir on the rising main for each reservoir	Dec-14	Will be confirmed with C.t. calculations (Viridis) 21/11/2019. C.t calculations has been confirmed and samples remain mostly on the outlet of the Reservoirs as most act as a Clear Water Tank
5.09	Th	H	Council to review & summarise the pathogen testing done for Thungutti in a previous NSW Health Project and include the testing results in the DWMS	Apr-16	Council to investigate 21/11/2019 - Thungutti formally adopted into DWMS in 2019
5.15	Th	VH	Ensure that CCP & Sample monitoring locations appropriately labelled Water quality problems and reporting - all of community - likely to mention it to people that work in the area rather than report it to Council so consider a community education program	Apr-16	Council be investigated 21/11/2019 - Past facilitation events have been conducted with contact numbers provide to the community. There is also a quarterly meeting where representatives invited. Where all current issues are discussed

Table 10.4 Summary of removed tasks in Implantation Plan (October 2019)

Action No.	Supply System	Residual Risk	Outstanding Actions	When Added	Comments
1.03	All	H	A number of procedures for corrective actions at operational sites need to be developed for each of the supply areas. Develop detailed procedures for corrective actions regarding control of CCPs (using the corrective actions identified in the workshop as a starting point). These procedures need to include details such as required adjustments, additional monitoring, recording, reporting and responsibilities and authorities (relating to things such as notifications within the organisation and externally).	2012	CCP procedures have been developed and include all actions as identified in this task. Initial incident investigation form has been developed
2.03	All	M	Introduce a Community education program to raise awareness of the need to minimise pollution to water bodies.	2012	Waterwise is in place for water usage, mainly delivered as a school program. Council to look into including pollution program as part of Waterwise.
2.06	Kem	M	Establish MoU with adjacent land holders on WQ protection zones (for pathogen control and agricultural chemicals) and notification procedures for flood and bushfire impact concerns.	2012	Already captured in 2.15
2.08	KLM, BB, WW	M	Consider a PHU project to investigate pathogen, antimony and arsenic load levels during normal conditions and flood events and determine correlation with available indicators. Consider developing operational management procedures for pathogens, antimony and arsenic (including SP for Arsenic).	2012	Testing has been done. Council to confirm completion.
2.11	Kem	L	Continue to support CMA land improvement projects in the river buffer zones to help control nutrient runoff.	2012	
2.14	Kem	L	SOP to be developed on the operation of the bores and recharge channel.	2012	This action has been incorporated 4.12
2.2	Kem	L	Upgrade the SMD Operational weekly task list to include visual Algae monitoring.	2012	Should be included in ongoing implementation plan

2.23	Kem	M	Routine operational monitoring of Raw Water for turbidity to be initiated at WTP with preference to online meters.	2012	Completed
2.27	Kem	L	Incorporate inspection of and recording of operational hours of the SMD aeration line blowers into the SMD site procedure.	2012	Completed
2.34	Kem	M	Require the installation of Chlorine dosing interlocks with delivery pumps.	2012	
2.36	Kem	L	Critical spares to be sourced for Sherwood Lime dosing system.	2012	Advised by Ian that they keep critical spares for this system
2.43	Kem	H	Installation of a secure compound for the Lime dosing site at the Sherwood Lime Plant.	2012	Fencing installed around whole facility
2.45	Kem	M	Secure Greenhill Reservoir from bird activity and Potters Hills with secure mesh as reported in Reservoir inspection program.	2012	Completed in early 2018
2.47	All	M	KSC to have an electronic document pathway for storing reports on assets (e.g. Reservoir inspections).	2012	ASAM used for detailed document review and history of SR's and transcribed in Condition Report – Reservoirs. Monthly Inspections stored in F drive
2.48	Kem	M	To prevent unauthorised access to reservoirs, security compounds are required for John Lane (vandalised), Potters Hill, and an upgrade of the external ladder access for all reservoirs.	2012	Completed in late 2017/early 2018
2.51	All	VH	Top up disinfection dosage rates/regimes need to be documented and available on site, for all Reservoirs to overcome low or inadequate disinfection levels. Include quality control checks prior to top up dosing.	2012	Calculation sheets have been developed
2.53	Kem	VH	Clybucca Res to have a motorised valve installed to improve water level turnover.	2012	Completed in late 2017/early 2018
2.57	All	VH	Installation of directional nozzles/mixers in priority Reservoirs.	2012	Done at Back Beach, Big Nobby, Clybucca, and Billy Goat Hill Reservoirs

2.63	All	VH	KSC to enforce a regular back flow inspection and maintenance program based on priority and risk, with a priority on booster pump station supply areas. Consider backflow prevention device inspection program	2012	Completed
2.69	All	H	Work Order Action sheet to be modified to include valve maintenance issues identified and conduct training for staff on identifying the condition rating of the mains.	2012	Training completed, valve maintenance issue to be captured in asset register
2.86	All	VH	Council to have a list of preferred providers that are appropriately trained and competent.	2012	Completed as per procurement procedures and policy
2.88	Kem	L	Ensure that <u>all</u> online and portable instrumentation is included in the cyclic maintenance program.	2012	Programs in place
2.98	ALL	M	Develop appropriate mechanisms for stakeholder commitment and involvement. Formalise an engagement process for water supply decision making (including partnership agreements or MoUs).	2014	Captured in DMP, key stakeholders (DoI & Health) are in close contact
3.01	ALL	M	The water supply system analysis, including the flow charts and catchment characteristics, will be reviewed internally in 12 months, and upon any significant changes to any of the water supply systems. The review process and records of the outcomes of these reviews should be documented.	2014	Review completed Aug 2018
3.02	ALL	M	The assessment of the water quality performance data should be reviewed every 12 months, and upon any significant changes to any of the water supply systems. Review will assess any seasonal trends, consistent exceedances or other potential water quality issues. Develop long term water quality performance evaluation procedures. The formal review process and records of the outcomes of these reviews should be documented and incorporated into annual DWMS review.	2014	Reported in Monthly and Annual WQ reports

3.03	ALL	M	The hazard identification and risk assessment should be reviewed every five years, and upon any significant changes to any of the water supply systems. This review should include evaluation of preventative measures and consider whether they are appropriately document and formalised. The review process and records of the outcomes of these reviews should be documented.	2014	Done as part of DWMS annual review via the Risk Register
3.05	HH	M	Council to investigate options for improved solids removal. i.e. additional baffle on collection chamber or additional treatment (HH)	2014	Investigation undertaken, found to be unfeasible
3.06	CH	M	Council should investigate options for organics removal and hence remove the need for chlorination for THM control and to improve chlorine residuals at reservoirs or consider alternative supply/treatment options (e.g. linking coastal supplies)	2014	New Treatment approved. Operational due date mid-2020.
3.07	BB	H	Remove connection between Raw water tank and clear water tank - BB	2014	
3.1	ALL	L	The identified CCPs and Critical Limits should be reviewed every year, and upon any significant changes to any of the water supply systems. The formal review process and records of the outcomes of these reviews should be documented. The DWMS documentation should also be updated accordingly. CCP documents provided to operators should include version control information to ensure they have the latest version.	2014	This is undertaken as part of the DWMS document review
3.11	ALL	H	Relevant staff members must be trained to ensure they understand what the CCPs are and why they are important. This training should include use of the HACCP Summary Tables, associated target, Alert and Critical Limits, as well as the monitoring requirements to ensure the CCPs remain in control. The HACCP Summary Tables should be made readily accessible to operators on treatment sites	2014	All staff attended TAFE module for DWMS risk assessment.

3.34	ALL	M	Copies of all up to date daily check sheets and electronic monitoring spreadsheets to be saved into Document Register in TRIM.	2014	Saved in F drive
3.35	ALL	M	Develop formal monitoring protocols which identify target criteria for each of the preventative measures being monitored (including CCPs), monitoring records to be kept, responsibilities, authorities and required communication protocols. Combine documented protocols into a formal Operational Monitoring Plan.	2014	Completed and reviewed as part of the DWMS
3.47	CH	H	Council to continue to undertake investigations to improve turnover of water in the Big Nobby Reservoir – options could include further mains isolations, reservoir mixing or a dedicated rising main.	2014	Mixer installed and tablet container on mixer to ensure chlorine residual is maintained. 19/11/2019 rising main transferred to a new action
3.74	HH, CH	H	Consider a PHU project on DBP's in HH to determine the likely causes	2014	Project completed
3.78	ALL	H	Review and confirm the various data gaps in Table 10, Section 9.2 of the DWMS to calculate CT for all supply systems.	2014	C.t Calculation verified by Viridis in August 2018
3.87	ALL	H	Capture all handwritten water quality data into electronic spreadsheets.	2014	
3.91	ALL	L	Develop external audit procedures in consultation with NSW Public Health Unit.	2014	Annual Review meetings with Health and DoI
4.03	KLM	M	Operators to confirm that the RW turbidity analyser, set up at the Sherwood lime dosing plant, is working and that it is displaying on the Clear SCADA	Dec-14	Available on Clear SCADA
4.06	KLM	H	Ensure all operational laboratory testing is being undertaken daily and include in electronic spreadsheets, not currently done daily.	Dec-14	Reviewed and reported on in the Monthly water Quality report
4.12	All	L	Update all flow diagrams to include CCP sample locations.	Dec-14	New Schematics developed during 2018 review by Viridis
4.13	All	H	Ensure that validation of the online analyser versus manual readings is included in the electronic spreadsheets and ensure that cross checks are undertaken.	Dec-14	Spread sheets updated and manual grabs are used as validation on CCPs reporting

4.16	KLM	M	Sherwood lime system needs controls to be set up to allow operators to do a drop test	Dec-14	Already being done
5.01	CH	H	It is recommended that Council commence operation of the Carbon Dioxide system, and the hardness of the water is increased.	Apr-16	Completed
5.07	WW	M	A permanent pipe should be installed for tanker filling that does not require the hatch to be opened and needs to be protected from contamination.	Apr-16	Completed
5.08	All	H	Consider establishing a risk category for proximity to drinking water source water as part of the Septic Inspection programs undertaken by Councils Sustainable Environment Section	Apr-16	information provided in a layer in this GIS system
5.1	Th	M	Online analyser on rising main to be used as an interlock shutdown according to C.t. calculations, to ensure adequate C.t. at first residents house at all times when plant is operating.	Apr-16	No interlock shutdown, however lower chlorine limit ensures that C.t. is met
	Th	L	Reservoir diagrams of online analysers		Schematic in sub -plan completed in DWMS review

11. Review of DWMS Implementation

Council adopted a DWMS in September 2014, an internal DWMS Implementation review was conducted in March 2017 by Aqualift Project Delivery (in-house contractor). In May 2018 VIRIDIS Consultants on behalf of NSW Health commenced facilitation of an external review of Councils DWMS with completion in June 2019. The DWMS 2019 will take affect for future reporting years commencing on the 1 July 2019.

12. References

1. NSW Government (2010), *Public Health Act 2010*, NSW Government Parliamentary Counsel's Office.
2. NSW Ministry of Health (2013), *NSW Guidelines for Drinking Water Management Systems*, NSW Ministry of Health
3. NHMRC (2011) *Australian Drinking Water Guidelines*, National Water Quality Management Strategy, National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.
4. AECOM (2014), *Kempsey Shire Council Drinking Water Management System* AECOM, Sydney NSW
5. Aqualift (2014), *Kempsey and Lower Macleay Drinking Water Supply Description*, Aqualift Project Delivery, 2014
6. Census 2016
http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/LGA14350?opendocument
7. *Population Forecast for Kempsey Shire* - <http://forecast.id.com.au/kempsey/home>
8. NSW Government (2012), *Public Health Regulation 2012*, NSW Government Parliamentary Counsel's Office
9. NSW Health (2018) *New South Wales Code of Practice for Fluoridation of Public Water Supplies, Fluoridation of Public Water Supplies Act 1957*, NSW Health
10. Peter Anderson (2018) *Condition Report – Reservoirs*, Kempsey Shire Council (in Draft)
11. Water Directorate (2014), *Blue-Green Algae Management Protocols 2014*, Water Directorate, 2014
12. Tasleem Hasan (2018), *Drinking Water Management System - Overall Manual*, prepared for Kempsey Shire Council by Viridis Consultants Pty Ltd. (In Draft)
13. Bobbie Brenton (2019), *Kempsey Shire Council DWMS Risk Register V.2.3*. Kempsey Shire Council
14. Bobbie Brenton (2019) *Kempsey Shire Council DWMS Implementation Plan Update Review V.6*. Kempsey Shire Council
15. Bobbie Brenton (2017-2018) *Kempsey Shire Council DWMS Annual Water Quality Report*. Kempsey Shire Council
16. NSW Government (2018) and (2019) *Kempsey LALC Aboriginal Communities Water Supply and Sewerage Systems Periodical Inspection*, Report and minutes, NSW Government, Department of Industry

Appendix A Summary of Critical Control Points (CCP) for each Supply System

Table A.1 CCP Kempsey and Lower Macleay Water Supply

CCP ID	Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
KLM CCP1	Bore water extraction	All pathogens	Turbidity	<1 NTU	1 NTU	2 NTU
KLM CCP2	SM Dam water extraction	All pathogens	Turbidity	<1 NTU	2 NTU	5 NTU
KLM CCP3	SM Dam water extraction	Taste & Odour, Algae, & Toxins	Algae	No detectable T & O or Algae biovolume below detection limit	Noticeable T & O or MIB/Geosmin > 2 ug/L or Algae biovolume at Alert Level 1	MIB/Geosmin > 10 ug/L or Algae biovolume at Alert Level 2
KLM CCP4A	Disinfection from Steuart McIntyre Dam	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine	1.4 mg/L	<1 or >2.2 mg/L	<0.6 or >5 mg/L
KLM CCP4B	Disinfection from Sherwood Lime Plant	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine & pH	1.4 mg/L pH 7.5	<1 or >2.2 mg/L pH <7 or >8	<0.6 or >5 mg/L pH <6.5 or >8.5
KLM CCP5	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.1.1 SOP for KLM CCP1 Turbidity at Bore Water Extraction

Water Supply System	Kempsey & Lower Macleay		
CCP ID	KLM CCP1		
What is the control point?	Bore Water Extraction to supply Steuart McIntyre Dam or Greenhill Reservoir via Sherwood Lime Plant	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Online & SMD Inlet race -manual test 3 times / week when supply to dam
Monitoring location	Continuous online turbidity monitoring at Sherwood Lime Plant, and manual test of raw water at SM Dam inlet race (when is use)		
What will initiate response?	Online Tb alarms or manual test on turbidity grab sample from SMD inlet race		
Responsibility	Operator Water Process		
Target <1 NTU	Alert Level 1 NTU	Critical Limit 2 NTU	
<ul style="list-style-type: none"> Observe weather and flood warnings Conduct routine Bore maintenance program to ensure bore casing intact & bore pump functioning is suitable Monitor and measure raw water turbidity Visual checks on incoming water to Steuart McIntyre dam inlet race when in use Equipment correlation checks (Plant record is maintained with cross checks against bench meters and records stored in WQ Data Base/Plant sheets) Instrument calibration and records maintained Bore field site checks Individual Bore testing 1/fortnight 	<p>Corrective actions</p> <ul style="list-style-type: none"> Check Recharge Channel for any water quality impacts, such as flooding Clean online analyser and check against portable unit Check Bore field for signs of damage to bore or any impacts to sites areas around bores Investigate operating bores in use at time of sampling to identify source of increased Tb levels Contact TO Make arrangements for isolation & repairs to problem bore Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Contact TO (WPTO) Cease bore water extraction (alternative supply from SMD) Follow all Alert Level steps TO to inform Manager Management to consider the need to initiate an incident response. Manager to contact PHU where required Complete 'Initial Incident Report Form' 	

Table A.1.2 SOP for KLM CCP2 Turbidity at Steuart McIntyre Dam Water Extraction

Water Supply System	Kempsey & Lower Macleay		
CCP ID	KLM CCP2		
What is the control point?	Steuart McIntyre Dam water extraction	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Daily (5 days /week), when dam in use Note: future online Tb to be installed
Monitoring location	Manual test on SM Dam outlet from an active transfer pump		
What will initiate response?	Online levels		
Responsibility	Operator Water Process		
Target <1 NTU	Alert Level 2 NTU		Critical Limit 5 NTU
<ul style="list-style-type: none"> Maintain dam at approximately 53m AHD (96% level) when possible Observe weather warnings Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) Weekly shore line monitoring for points of erosion (by boat and vehicle) Routine testing from Dam (pH, Temperature, & DO and Algae monitoring) Routine monitoring of compressor run times (7days/wk) and visual checks and maintenance of Aeration line Aeration system to be run for approx. 7 hours during night to mix water body Instrument calibration and records maintained Follow bore extraction protocols for high nutrients under “Steuart McIntyre Dam Management Plan” 	<p>Corrective actions</p> <ul style="list-style-type: none"> Repeat sample and confirm level. Check SMD inlet race Tb levels/& online Tb levels Query impact from local weather conditions Contact Tech Officer Increase shore line and downwind surface observations Check online temperature trends to determine if dam has inverted Increase monitoring (for algae & Tb) from different levels of offtakes. Select the most suitable offtake level Identify source of elevated turbidity and if not found, check aeration line for correct operation Adjust aeration system operational times Increase algae monitoring if algae detected ** Adjust disinfection levels at treatment site. Check Sherwood Lime plant in readiness for operation Record actions taken on electronic spreadsheets Complete ‘Initial Incident Report Form’ 		<p>Corrective actions</p> <ul style="list-style-type: none"> Follow all Alert Limit actions Contact Tech Officer TO to inform Manager Management to consider starting Sherwood Lime Plant (alternative supply) Manager to contact PHU Continue to monitor Dam when alternative water source is in use Complete ‘Initial Incident Report Form’

** Algae monitoring program as per the KSC BGA Notification and Response Procedure

Table A.1.3 SOP for KLM CCP3 Algae, Taste and Odour at Steuart McIntyre Dam Water Extraction

Water Supply System	Kempsey & Lower Macleay		
CCP ID	KLM CCP3		
What is the control point?	Steuart McIntyre Dam water extraction	What are the hazards?	Taste and Odour compounds, Algae levels and Toxins
What is being monitored?	Algae Counts, Taste & Odour, & MIB/Geosmin levels	Monitoring Frequency:	Monthly to weekly – refer to “KSC BGA Notification and Response Procedure” #
Monitoring location	Manual sampling and analysis of dam profile		
What will initiate response?	Operator (in field monitoring) or Technical Officer (in response to Laboratory results)		
Responsibility	Operator Water Process/ Water Technical Officer (review of laboratory results)		
Target No detected T&O or Algae biovolume below detection limit	Alert Level Noticeable T& O or MIB/Geosmin > 2 ug/L Algae biovolume at Alert Level 1	Critical Limit MIB/Geosmin > 10 ug/L or Algae biovolume at Alert Level 2	
<ul style="list-style-type: none"> Maintain dam at approximately 53m AHD (96% level) when possible. Observe weather warnings Weekly shore line monitoring for algal blooms (boat and vehicle) Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets for DO, pH, Tb from outlet of dam) BGA seasonal monitoring program and response Weekly Operator odour test from grab sample (conducted at same time Tb test) Routine monitoring of compressor run times Aeration system to be run for approx.7 hours during night to mix water body Instrument calibration and records maintained Routine monitoring for nutrients of raw water entering the dam (both in-house and external laboratory testing) 	<p>Corrective actions</p> <ul style="list-style-type: none"> Contact TO Increase shore line and downwind surface observations Conduct in-house odour testing of raw & boiled water by operational staff Consider reviewing the aeration operation rates in consultation with the Laboratory. Consider benthic algae inspection and sampling Increase visual monitoring for the formation of surface scum Conduct Algae monitoring as directed by TO/Laboratory Select the most suitable offtake level Adjust aeration system operational times TO to refer to “KSC BGA Notification and Response Procedure” for monitoring and response requirements Check Sherwood Lime plant in readiness for operation Record actions taken on electronic spreadsheets Complete ‘Initial Incident Report Form’ 	<p>Corrective actions</p> <ul style="list-style-type: none"> Contact TO Follow all Alert Level steps TO to inform Manager Manager to contact PHU Management to consider starting Sherwood Lime Plant (alternative supply) Continue to monitor dam, as per ‘KSC BGA Notification and Response Procedure’ when alternative water source is in use Complete ‘Initial Incident Report Form’ 	

Table A.1.4 SOP for KLM CCP4A Free Chlorine at Multiple Reservoirs (Dam Online)

Water Supply System	Kempsey & Lower Macleay		
CCP ID	KLM CCP4A		
What is the control point?	Disinfection (Sodium Hypochlorite – SMD)	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free Chlorine residual	Monitoring Frequency:	Daily, when SMD in use
Monitoring location	Manual sampling from outlet of Reservoirs – Greenhill, John Lane and Potters Hill Note: Future monitoring is required prior to entry to Reservoirs		
What will initiate response?	In response to low free chlorine residual		
Responsibility	Operator Water Process		
Target 1.4 mg/L	Alert Level <1.0 and >2.2mg/L	Critical Limit <0.6 and >5.0mg/L	
<ul style="list-style-type: none"> • Routine site and equipment checks at Steuart McIntyre Dam WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) • Chemical dosing pump rate checks • Disinfection residual checks performed at the outlet of Reservoirs (future monitoring at inlet to Reservoirs) • Instrument calibration and records maintained • Chemical storage tanks levels • Chemical procurement and delivery requirements • Redox probes within Reservoirs • Chemical dosing pump maintenance • Online chlorine analyser to be installed prior to Reservoirs 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Validate Chlorine levels (using high ranges or dilution methods if required) • Contact Tech Officer • Check integrity of Reservoirs for any breaches or unauthorised access • Check primary dosing equipment (pumps, injection point and lines, & draw down check) and hypo concentration • Check disinfection levels from primary dosing and adjust as required • Perform top up dosing to maintain adequate residuals or scour and turnover supply if levels are high (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) • Check raw water (SMD or Bores) conditions • Detailed system inspection and increased monitoring from key locations • Increase sampling and flushing in the distribution network as necessary and Complete <i>'Initial Incident Report Form'</i> 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Follow all Alert Level actions • Contact Tech Officer • Consider scouring to increase turn over in Reservoir where appropriate • TO to inform Manager. • Consider taking microbiological samples if low disinfection levels • Manager to contact PHU • Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert) • Complete <i>'Initial Incident Report Form'</i> 	

Table A.1.5 SOP for KLM CCP4B Free Chlorine and pH at Green Hill Reservoir (Dam Offline)

Water Supply System	Kempsey & Lower Macleay		
CCP ID	KLM CCP4B		
What is the control point?	Disinfection Chlorine gas –Sherwood Lime Plant & Lime	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free Chlorine residual & pH	Monitoring Frequency:	Daily when Sherwood Lime plant is running
Monitoring location	Manual sampling from outlet of Reservoir – Greenhill Note: Future monitoring is required prior to entry to Reservoir		
What will initiate response?	In response to low or high free chlorine residual		
Responsibility	Operator Water Process		
Target 1.4 mg/L pH 7.5	Alert Level <1.0 and >2.2mg/L pH <7 or >8	Critical Limit <0.6 and >5.0mg/L pH <6.5 or >8.5	
<ul style="list-style-type: none"> Routine site and equipment checks at Sherwood Lime Plant (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) Sherwood Chlorine gas rotameter maintenance checks Disinfection residual checks performed at the inlet/outlet of Greenhill Reservoir Instrument calibration and records maintained Servicing and maintenance of Sherwood chlorine gas regulators and auto change over operation Chemical procurement and delivery requirements Flow meter checks Redox probes within reservoirs Online chlorine analyser to be installed prior to Reservoir 	<p>Corrective actions</p> <ul style="list-style-type: none"> Validate Chlorine and pH levels (using high ranges or dilution methods if required) Contact TO Check integrity of Reservoir for any breaches or unauthorised access Check primary dosing equipment (circulation pumps, injection point and lines, & gas delivery system) Check disinfection levels from primary dosing and adjust as required Perform top up dosing to maintain adequate residuals or scour and turnover supply if levels are high (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Check raw water (Bores) conditions Detailed system inspection and increased monitoring from key locations Increase sampling and flushing in the distribution network as necessary Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow all Alert Level actions Contact TO Consider scouring to increase turn over in Reservoir where appropriate TO to inform Manager Consider taking microbiological samples if low disinfection levels Manager to contact PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert) Complete '<i>Initial Incident Report Form</i>' 	

Table A.1.6 SOP for KLM CCP45 Reservoir Integrity at all Reservoirs

Water Supply System	Kempsey & Lower Macleay		
CCP ID	KLM CCP5		
What is the control point?	Reservoirs	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	Reservoirs within KLM system		
What will initiate response?	Any sign of Reservoir integrity breach		
Responsibility	Operator Water Process		
Target No breach of reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning and inspection program 	Corrective actions <ul style="list-style-type: none"> Conduct visual inspection (outside/inside) Check chlorine residual Dose chlorine to Reservoir and/or increase dose at plant, if needed (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Contact Technical Officer Repair breach of integrity Increase inspections until repaired Complete '<i>Initial Incident Report Form</i>' 	Corrective actions <ul style="list-style-type: none"> Follow Alert Level corrective actions Take micro-sample if required Remove contaminants, if safe to do so Inform TO TO to contact Manager Manager to contact PHU where required Management to consider the need to initiate an incident response Complete '<i>Initial Incident Report Form</i>' 	

Table A.2 CCP Crescent Head Water Supply

System	CCP ID	Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Crescent Head	CH CCP1	Raw water abstraction / Rising Main	All pathogens	Turbidity	2 NTU	3 NTU	5 NTU
	CH CCP2	Disinfection	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine & pH	1.5 mg/L Free Chlorine pH 7.8	<0.7 or >1.9 mg/L Free Chlorine pH 8.3	<0.5 or >4 mg/L Free Chlorine pH <6.5 or >8.5
	CH CCP3	Reservoirs	All pathogens and All chemicals	Reservoir integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.2.1 SOP for CH CCP1 Turbidity @ Front Dam and Rising Main

Water Supply System	Crescent Head		
CCP ID	CH CCP1		
What is the control point?	Raw water abstraction / Rising Main	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Rising main grab sample 7days /wk when WTP operational.
Monitoring location	Front Dam grab sample (or after raw tanks if in use) (Future online Tb meter prior to Lime dosing)		
What will initiate response?	Test on turbidity grab sample		
Target 2 NTU	Alert Level 3 NTU	Critical Limit 5 NTU	
<ul style="list-style-type: none"> Routine site and operational checks Equipment correlation checks (Plant record is maintained with cross checks against bench meters and records stored in WQ Data Base/Plant sheets) Combined Bore testing (Tb) Individual Bore test 1/ftnht Front Dam testing 1/wk (Conductivity Total Fe, Mn, Tb, pH temp, DO, Apparent Colour) Visual Inspections for Algae in Dam daily with odour checks when required Algae monitoring program as per the <i>KSC BGA Notification and Response Procedure</i> 	<p>Corrective actions</p> <ul style="list-style-type: none"> Repeat manual tests to confirm levels Monitor for algae levels if algal growth evident. Investigate bore integrity and aeration tank for contamination Test turbidity for each bore and aeration tank and isolate problem bore if required. Notify Tech Officer Check turbidity of rising main and Back Beach Reservoir. Check Chlorine levels at Back Beach Reservoir Increase Total Chlorine dose at plant, if needed Initiate an incident algae monitoring program in Front Dam if required. Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Isolate and contain source of high turbidity Shutdown the treatment plant Contact TO Consider alternative water supply/storage where possible (i.e. Onsite Raw water tanks) TO to inform Manager Check if high turbidity is in distribution and flush mains if appropriate Maintain appropriate disinfection levels in the network Manager to call PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert or water carting) Complete '<i>Initial Incident Report Form</i>' 	

Table A.2.2 SOP for CH CCP2 Free Chlorine and pH at Back Beach Reservoir

Water Supply System	Crescent Head		
CCP ID	CH CCP2		
What is the control point?	Disinfection and pH correction (Lime and CO ₂)	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free Chlorine residual & pH	Monitoring Frequency:	Manual test 7d/wk
Monitoring location	Back Beach Reservoir (Outlet in sample pit) - future online chlorine monitoring		
What will initiate response?	In response to low or high Monochloramine & Total Chlorine residual & pH		
Target 1.5 mg/L Free Chlorine pH 7.8	Alert Level <0.7 or >1.9 mg/L Free Chlorine pH 8.3	Critical Limit <0.5 or >4 mg/L Free Chlorine pH <6.5 or >8.5	
<ul style="list-style-type: none"> Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) Chemical procurement and delivery requirements Chemical dosing rate checks Instrument calibration and records maintained 	<p>Corrective actions</p> <ul style="list-style-type: none"> Validate readings (using high ranges or dilution methods if required) Check primary dosing equipment and gas cylinder weight Check disinfection levels (Free chlorine, & pH) from primary dosing and adjust as required as Sample upstream and downstream of sample to confirm Check raw water conditions e.g. Turbidity Check storage dam for any signs of contamination if in use. Increase chlorine dose at plant if needed Contact Tech Officer Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Inform Tech Officer Take micro-sample if low disinfection levels or nitrification suspected. Consider dosing Reservoir if needed TO to contact manager Manager to contact PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert) Complete 'Initial Incident Report Form' 	

Table A.2.3 SOP for CH CCP3 Reservoir Integrity at all Reservoirs

Water Supply System	Crescent Head		
CCP ID	CH CCP3		
What is the control point?	Reservoir	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	At Reservoirs (Back Beach & Big Nobby)		
What will initiate response?	Any sign of Reservoir integrity breach		
Target No breach of Reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning and inspection program 	<p>Corrective actions</p> <ul style="list-style-type: none"> Visual inspection (outside/inside of Reservoir) Check disinfection levels Increase dose at plant, if needed Contact Tech Officer Repair breach of integrity Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Inform Tech Officer Take micro-sample if required Remove contaminants, if safe to do so Dose disinfectant to reservoir if needed Tech Officer to contact manager Manager to contact PHU Management to consider the need to initiate an incident response. Complete 'Initial Incident Report Form' 	

Table A.3 CCP Hat Head Water Supply

System	CCP ID	Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Hat Head	HH CCP1	Raw Water Abstraction	Pathogens	Turbidity	<1.0 NTU	2 NTU	5 NTU
	HH CCP2	Disinfection	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine pH	1 mg/L pH 7.5	<0.6 or >1.8 mg/L pH <6.9	<0.5 or >4 mg/L pH <6.5
	HH CCP3	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.3.1 SOP for HH CCP1 Turbidity at Raw Water

Water Supply System	Hat Head		
CCP ID	HH CCP1		
What is the control point?	Raw Water Abstraction	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Continuous Online
Monitoring location	Raw Water Inlet		
What will initiate response?	Online turbidity probe prior to Aeration Tower		
Target <1 NTU	Alert Level 2 NTU	Critical Limit 5 NTU	
<ul style="list-style-type: none"> Routine site and operational checks Instrument calibration and records maintained Equipment correlation checks (Plant record is maintained with cross checks against bench meters and records stored in WQ Data Base/Plant sheets) Bore maintenance program Individual Bore testing 1/fortnight (pH, Fe, NTU, Mn, EC Colour) Aeration tower and Collection tank maintenance (note: the impact of AT and CT is after the online monitoring) 	<p>Corrective actions</p> <ul style="list-style-type: none"> Cross check online turbidity with portable instrument Undertake at a minimum, 3 manual tests Investigate bore integrity Test turbidity for each bore and isolate problem bore Check turbidity and chlorine levels in Reservoirs Notify Tech Officer Dose chlorine to Reservoirs and/or increase dose at plant, if needed Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Contact Tech Officer TO to inform Manager Shutdown the treatment plant Isolate & scour the Reservoir/s if turbidity >5 NTU Check turbidity in distribution and flush mains if Reservoir Tb level is within levels Manager to call PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert or water carting) Complete '<i>Initial Incident Report Form</i>' 	

Table A.3.2 SOP for HH CCP2 Free Chlorine and pH at outlet of Reservoirs

Water Supply System	Hat Head		
CCP ID	HH CCP2		
What is the control point?	Disinfection (Gas Chlorine & Soda Ash)	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free Chlorine residual & pH	Monitoring Frequency:	Online monitoring
Monitoring location	Outlet of ON-LINE Reservoir/s		
What will initiate response?	In response to low Chlorine residual and pH levels		
Target 1 mg/L pH 7.5	Alert Level <0.6 or >1.8 mg/L pH <6.9	Critical Limit <0.5 or >4 mg/L pH <6.5	
<ul style="list-style-type: none"> Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) Dosing rate and usage checks (of Chlorine Gas, & Soda Ash calibration drop test) Manual disinfection residual & pH checks performed at the outlet of Reservoirs in use Instrument calibration and records maintained. Maintenance (external contractor) of duty standby/auto change for Chlorine gas and service pump Chemical procurement and delivery requirements 	<p>Corrective actions</p> <ul style="list-style-type: none"> Validate pH & Chlorine levels (using high ranges or dilution methods if required) Check primary dosing equipment and gas supply Check disinfection levels from primary dosing and adjust as required Check raw water conditions (pH & Turbidity) Check integrity of Reservoirs for any breaches or unauthorised access Check chlorine residuals at the reservoir (refer to chlorine SOP) Top up dose chlorine to Reservoir/s and/or increase dose at plant, if needed. Contact Tech Officer Sampling and flushing in the distribution network as necessary Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Contact Tech Officer TO to inform Manager Consider taking micro-sample for low disinfection levels Manager to contact PHU Management to consider the need to initiate an incident response. Complete 'Initial Incident Report Form' 	

Table A.3.3 SOP for HH CCP3 Reservoir Integrity at all Reservoirs

Water Supply System	Hat Head		
CCP ID	HH CCP3		
What is the control point?	Reservoirs	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	Reservoirs No 1 & No 2		
What will initiate response?	Any sign of Reservoir integrity breach		
Target No breach of Reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning and inspection program 	<p>Corrective actions</p> <ul style="list-style-type: none"> Conduct a visual inspection (outside & inside) Check Chlorine residual Check disinfection levels in Reservoir and top up if required (Refer Reservoir Manual Chlorine Dose Calculator) increase chlorine dose at plant, if needed Contact Tech Officer Repair breach of integrity Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Take micro-sample if required Remove contaminants, if safe to do so Inform TO TO to contact manager Manager to contact PHU Management to consider the need to initiate an incident response Complete 'Initial Incident Report Form' 	

Table A.4 CCP South West Rocks Water Supply

System	CCP ID	Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
	SWR CCP1	Raw Water Abstraction	All pathogens	Turbidity	<5 NTU	>10 NTU	>20 NTU
South West Rocks	SWR CCP2	Filtration	All pathogens	Turbidity	0.1 NTU	0.5 NTU	>1 NTU
	SWR CCP3	Disinfection	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine pH	2 mg/L pH 7.5	<1.5 or > 2.2 mg/L pH >8.4	<1 or >4 mg/L pH > 8.6
	SWR CCP4	Fluoridation	Fluoride	Fluoride	1 mg/L (leaving WFP, leaving Reservoir and throughout distribution system)	<0.9 mg/L or >1.1 mg/L (calculated daily concentration) OR 1.2 – 1.5 mg/L (concentration leaving Reservoir) OR >1.5 mg/L (concentration leaving WFP)	>1.5 mg/L (calculated daily concentration) OR >1.5 mg/L (concentration leaving Reservoir)
	SWR CCP5	Reservoir	All pathogens and all chemicals	Reservoir integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.4.1 SOP for SWR CCP1 Turbidity at Inlet to WTP (Raw Water)

Water Supply System	South West Rocks		
CCP ID	SWR CCP1		
What is the control point?	Raw Water Abstraction	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Continuous online
Monitoring location	Inlet to WTP		
What will initiate response?	Online Turbidity levels		
Target <5 NTU	Alert Level >10 NTU	Critical Limit >20 NTU	
<ul style="list-style-type: none"> • Routine site and operational checks • Instrument calibration and records maintained • Monitor and measure raw water turbidity • Equipment correlation checks (Plant record is maintained with cross checks against bench meters and records stored in WQ Data Base/Plant sheets) • Calibration of online instruments (Programmed) Instrument Maintenance Program conducted by Instrument Technicians) • Visual checks at Bore sites and Bore water monitoring program • Individual Bore testing 1/fortnight • Aeration system maintenance & operation • Collection/Balance Tank cleaning program 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Cross check online turbidity with portable instrument and clean if needed • Contact Tech Officer • Check Collection Tank for Tb and Iron levels • Check diffuser/ aeration operation within Collection Tank • Check individually production Bores for Tb & Iron and isolate where required • Consider shutting WTP down • Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Follow Alert Level steps • Contact Tech Officer • TO to inform Manager • Ensure automatic interlock has shut down the treatment plant, otherwise shutdown the system • Check Turbidity levels downstream to validate any infiltration to WTP*if automatic shutdown has failed • Consider isolation & scour the Balance Reservoir • Manager to call PHU • Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert or water carting) • Complete '<i>Initial Incident Report Form</i>' 	

Table A.4.2 SOP for SWR CCP2 Turbidity at Outlet of filters (Treated Water)

Water Supply System	South West Rocks		
CCP ID	SWR CCP2		
What is the control point?	Membrane Filtration	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Continuous online
Monitoring location	After filters at WTP / On main after Transfer pump		
What will initiate response?	Online turbidity monitoring at WTP		
Target 0.1 NTU	Alert Level 0.5 NTU	Critical Limit >1 NTU	
<ul style="list-style-type: none"> Routine site and operational checks Instrument calibration and records maintained Calibration of online instruments (Programed Instrument Maintenance Program conducted by Instrument Technicians) Daily automatic backwashing and extended backwashing of membranes Regular MIT and Manual initiated clean, membrane replacement and repair program is current and up to date Actions related to coagulants, pH correction, screen at head of plant, pH correction of membrane sump, etc. Note: Results are recorded and actioned as per GE membrane recommendations Chemical procurement and delivery requirements 	<p>Corrective actions</p> <ul style="list-style-type: none"> Cross check online turbidity with manual instrument Check trans-membrane pressure and initiate a CIP if required Check turbidity of raw water into plant Check upstream chemical dosing Isolation of modules that may be leaking and repair ASAP to ensure full treatment capacity of membrane train Contact Tech Officer Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Notify Tech Officer TO to notify Manager Automatic shutdown of treatment plant Check Reservoir Turbidity*if automatic shutdown has failed Consider isolation & scour of the Reservoir where appropriate Check turbidity in distribution and flush mains if appropriate Management to consider the need to initiate an incident response. Complete '<i>Initial Incident Report Form</i>' 	

Table A.4.3 SOP for SWR CCP3 Free Chlorine and pH at Reservoir

Water Supply System	South West Rocks		
CCP ID	SWR CCP3		
What is the control point?	Disinfection (Sodium Hypochlorite) and pH correction (Lime)	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free chlorine residual & pH	Monitoring Frequency:	Continuous online
Monitoring location	Trunk main after transfer pumps (manual chlorine residual test to inlet of Reservoir)		
What will initiate response?	In response to low or high pH or Chlorine residual		
Target 2 mg/L pH 7.5	Alert Level <1.5 or >2.2 mg/L pH >8.4	Critical Limit <1 or >4 mg/L pH > 8.6	
<ul style="list-style-type: none"> Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) Lime and Sodium Hypochlorite dose rate checks Disinfection residual checks performed at the outlet of Reservoir Instrument calibration and records maintained Chemical procurement and delivery requirements Calibration of online instruments (Programed Instrument Maintenance Program conducted by Instrument Technicians) Regular inspection of the lime dosing system including cleaning of injection lines for change over Chemical storage levels monitoring 	<p>Corrective actions</p> <ul style="list-style-type: none"> Validate disinfection levels (using high ranges or dilution methods if required) Check primary dosing equipment and hypo concentration and adjust as required Contact Tech Officer Check disinfection levels from primary dosing and adjust as required Check upstream processes (mixing tanks, pH correction, membrane filters) Check raw water conditions Check disinfection levels in Reservoir and top up if required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Check integrity of Reservoir for any breaches or unauthorised access Consider scouring, flushing and sampling in the network where appropriate Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Contact Tech Officer TO to inform Manager Consider taking micro-sample for low disinfection levels Manager to contact PHU Management to consider the need to initiate an incident response Complete '<i>Initial Incident Report Form</i>' 	

Table A.4.4 SOP for SWR CCP4 Fluoridation at WTP and Reservoir

Water Supply System	South West Rocks		
CCP ID	SWR CCP4		
What is the control point?	Fluoridation	What are the hazards?	Over or under-dose of fluoride
What is being monitored?	Fluoride concentration (daily sampling at WFP and Reservoir, daily concentration calculation)	Monitoring Frequency:	Daily/weekly
Monitoring location	Monitoring out of the plant, out of the Reservoir and throughout distribution system		
What will initiate response?	In response to low or high fluoride concentration		
Target Leaving WFP, leaving Reservoir and throughout distribution system 1.0 mg/L	Alert Level Calculated daily concentration 0.9 or >1.1 mg/L OR Concentration leaving Reservoir 1.2 – 1.5 mg/L OR concentration leaving WFP > 1.5 mg/L	Critical Limit Calculated daily concentration >1.5 mg/L OR Concentration leaving Reservoir >1.5 mg/L	
<ul style="list-style-type: none"> • Visual inspection of the system • Raw water testing as required • Daily measurement of volume treated, and weight fluoride dosed with calculation of average daily fluoride concentration • Daily testing at outlet to water filtration plant (after transfer pumps) and outlet from Gregory St reservoir • Flow meter calibrations (MCT & KSC Techs) • Chemical procurement and delivery requirements • Weekly testing in distribution system • Weight records for Fluoride dosing • Regular service by contractor (to be initiated) 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Confirm calculations or resample and test • Conduct screw feeder and pump drop tests • Confirm current WTP flow rate and fluoride dosing rate • Adjust fluoride powder screw feeder • Test concentration leaving WTP more frequently • Consider temporarily shutting down fluoride dosing system • Contact Tech Officer (TO) • Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Shutdown fluoride dosing system • Test fluoride in Reservoirs and reticulation • Identify cause & rectify problem • Contact Tech Officer (TO) • TO to contact Manager <p>Consider contacting the following for advice:</p> <ul style="list-style-type: none"> • DPI Water Regional Officer: Graham Campbell (Ph: (02) 4904 2517, Mb: 0419 620 990), Public Health Unit (PHU): Kerry Lawrance (Ph: (02) 6588 2750, AH: 0428 882 805) • Refer to Fluoride Response Plan • Management to consider the need to initiate an incident response. • Complete 'Initial Incident Report Form' 	

Table A.4.5 SOP for SWR CCP5 Reservoir Integrity at all Reservoirs

Water Supply System	South West Rocks		
CCP ID	SWR CCP5		
What is the control point?	Reservoir	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	At South West Rocks Reservoir, No 2 (Off Gregory St)		
What will initiate response?	Any sign of Reservoir integrity breach		
Target No breach of Reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning and inspection program 	Corrective actions <ul style="list-style-type: none"> Conduct a visual inspection (outside & inside) Check disinfection levels in Reservoir and top up if required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Increase dose at plant, if needed Contact Tech Officer Repair breach of integrity Complete '<i>Initial Incident Report Form</i>' 	Corrective actions <ul style="list-style-type: none"> Follow Alert Level corrective actions Take micro-sample if required Remove contaminants, if safe to do so Inform TO TO to contact Manager Manager to contact PHU Management to consider the need to initiate an incident response Complete '<i>Initial Incident Report Form</i>' 	

Table A.5 CCP Stuarts Point Water Supply

System	CCP ID	Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Stuarts Point	SP CCP1	Bore Water Abstraction	All pathogens	Turbidity	<0.5 NTU	3 NTU	5 NTU
	SP CCP2	Filtration	All pathogens	Turbidity	0.3 NTU	>0.8 NTU	>1 NTU
	SP CCP3	Disinfection	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine	1.3 mg/L	<1 or >2.2 mg/L	<0.5 or >5 mg/L
	SP CCP4	Reservoir	All pathogens and all chemicals	Reservoir integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.5.1 SOP for SP CCP1 Turbidity at WTP before disinfection (Raw Water)

Water Supply System	Stuarts Point		
CCP ID	SP CCP1		
What is the control point?	Bore Water Abstraction	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	3 times/week (Grab sample)
Monitoring location	Raw Water Sample point (Prior to pH and pre disinfection) ##		
What will initiate response?	Test on turbidity grab sample		
Target <0.5NTU	Alert Level 3 NTU	Critical Limit 5 NTU	
<ul style="list-style-type: none"> Routine site and operational checks Instrument calibration and records maintained Bore maintenance program Individual Bore testing 1/fortnight <p>##Ensure recirculation return line from reject water is OFF and not compromising results. Line to be relocated in future</p>	<p>Corrective actions</p> <ul style="list-style-type: none"> Identify and isolate problem Bore Notify Tech Officer Re-adjust chemical dosing to accommodate lowered flow rate if appropriate Check Tb levels through the rest of the WTP Complete '<i>Initial Incident Report Form</i>' <p>Future: online turbidity prior to the collection tank post filtration should be configured to stop the plant at Alert level</p>	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Shutdown treatment plant** Contact TO TO to inform Manager Check Reservoir turbidity Consider isolation & scour the reservoir Check turbidity in distribution and flush mains if appropriate Manager to call PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert or water carting) Complete '<i>Initial Incident Report Form</i>' 	

Table A.5.2 SOP for SP CCP2 Turbidity at WTP post filtration (Treated Water)

Water Supply System	Stuarts Point		
CCP ID	SP CCP2		
What is the control point?	Filtration	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Online continuous when plant (transfer pumps) running
Monitoring location	Post Filtration (Inlet to Collection Tank)		
What will initiate response?	Test on turbidity grab sample		
Target 0.3 NTU	Alert Level >0.8 NTU	Critical Limit >1 NTU	
<ul style="list-style-type: none"> • Routine site and operational checks • Instrument calibration and records maintained • Calibration of online instruments (Programmed Instrument Maintenance Program conducted by Instrument Technicians) • Maintenance cleaning of collection tank (12 months) • Chemical procurement and delivery requirements • Ferric Chloride dosing equipment and dosage rate checks 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Test raw water coming into plant • Visually check water quality on top of filters • Adjust air-line and check air-line is working • Check for filter blockage • Check upstream chemical dosing • Notify Tech Officer • Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Follow Alert Level steps • Notify Technical Officer • TO to notify Manager • Manager to call PHU • Shutdown treatment plant • Check Reservoir turbidity • Consider isolation & scour the reservoir • Check turbidity in distribution and flush mains if appropriate • Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert or water carting) • Complete 'Initial Incident Report Form' 	

Table A.5.3 SOP for SP CCP3 Free Chlorine at Clear Water Tank

Water Supply System	Stuarts Point		
CCP ID	SP CCP3		
What is the control point?	Disinfection (Chlorine Gas) & pH control (Soda Ash) when in operation	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free chlorine residual	Monitoring Frequency:	5days / wk
Monitoring location	Clear Water Tank (CWT) outlet on rising main (grab sample) Note: Future monitoring to inlet of Reservoir		
What will initiate response?	In response to low chlorine residual		
Target 1.3 mg/L	Alert Level <1 or >2.2 mg/L	Critical Limit <0.5 or >5 mg/L	
<ul style="list-style-type: none"> • Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) • Maintaining pre chlorine dosing equipment • Online chlorine monitoring at Stuarts Point Reservoir • Dosing rate checks • Disinfection residual checks performed at the outlet of Reservoir • Instrument calibration and records maintained • Chemical procurement and delivery requirements 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Validate Chlorine levels (using high ranges or dilution methods if required). • Check primary dosing equipment and settings • Check pre and post chlorine dosing • Check the flow rates coming into plant • Contact Water Process Technical Officer • Check disinfection levels from primary dosing and adjust as required • Check raw water conditions • Check upstream processes (coagulation, pH correction, filtration) • Check disinfection levels in Reservoir and top up if required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) • Check integrity of CWT for any breaches or unauthorised entry • Consider reticulation scouring or flushing • Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> • Follow Alert Level corrective actions • Take micro-sample if levels are low • Tech Officer to contact Manager • Manager to contact PHU • Management to consider the need to initiate an incident response. • Complete '<i>Initial Incident Report Form</i>' 	

Table A.5.4 SOP for SP CCP4 Reservoir Integrity at all Reservoirs

Water Supply System	Stuarts Point		
CCP ID	SP CCP4		
What is the control point?	Reservoir	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	Stuarts Point Reservoir		
What will initiate response?	Any sign of Reservoir integrity breach		
Target No breach of Reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning and inspection program 	<p>Corrective actions</p> <ul style="list-style-type: none"> Conduct a visual inspection (outside & inside) Check disinfection levels in Reservoir and top up if required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Contact Tech Officer Increase dose at plant, if needed Repair breach of integrity Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Take micro-sample if required Remove contaminants, if safe to do so Inform TO TO to contact Manager Manager to contact PHU Management to consider the need to initiate an incident response. Complete '<i>Initial Incident Report Form</i>' 	

Table A.6 CCP Bellbrook Water Supply

System	CCP ID	Critical Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Bellbrook	BB CCP1	Catchment and Abstraction	All pathogens	Turbidity	<5 NTU	>5 NTU for more than 20 min	20 NTU
	BB CCP2	Filtration	All pathogens	Turbidity	<0.5 NTU	0.8 NTU for more than 10 min	1 NTU
	BB CCP3	Disinfection	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine	1.5 mg/L	<1 or >2.2 mg/L	<0.8 or >5 mg/L
	BB CCP4	Reservoirs	All pathogens and all chemicals	Reservoir integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.6.1 SOP for BB CCP1 Turbidity at Inlet to Plat (Raw Water)

Water Supply System	Bellbrook		
CCP ID	BB CCP1		
What is the control point?	Catchment and Abstraction	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	5d/week site checks of continuous online analyser (Teamviewer used to remotely access trend data). Weekend remote access only
Monitoring location	Inlet to Treatment Plant prior to Raw Water Tank.		
What will initiate response?	Online Raw Water Turbidity Analyser		
Target <5 NTU	Alert Level >5 NTU for more than 20min	Critical Limit 20 NTU	
<ul style="list-style-type: none"> Observe weather and flood warnings Conduct routine Bore maintenance program Routine site and operational checks Instrument calibration and records maintained Monitor and measure raw water turbidity Equipment correlation checks (Plant record is maintained with cross checks against bench meters and records stored in WQ Data Base/Plant sheets) Calibration of online instruments (Programmed Instrument Maintenance Program conducted by Instrument Technicians) Annual checks for plant auto shut down 	<p>Corrective actions</p> <ul style="list-style-type: none"> Attend site and check turbidity alarm from Bellbrook online raw water turbidity monitor Cross check online turbidity with portable instrument. Check River for any water quality impacts, such as flooding. Check bore for signs of damage to bore or any impacts to sites areas around bores. Make arrangements for isolation & repairs to problem bore (if issue). Increase monitoring of raw water turbidity levels until system returns to normal If flooding is impacting the River, make plans to commence water carting and consider early shutdown of plant. Contact Technical Officer. Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Ensure automatic interlock has shut down the treatment plant, otherwise shutdown the system. Ensure that Bore pumps are stopped (and are unavailable to automatic start up). Contact Technical Officer. TO to inform manager. Follow Alert Level steps. Commence water carting, if not already commenced Management to consider the need to initiate an incident response Complete 'Initial Incident Report Form' 	

Table A.6.2 SOP for BB CCP2 Turbidity at WTP after filters (Treated Water)

Water Supply System	Bellbrook		
CCP ID	BB CCP2		
What is the control point?	Filtration	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	5d/week sites checks of continuous online (Teamviewer used to remotely access trend data) Weekend remote access only
Monitoring location	After filters at WTP		
What will initiate response?	Online turbidity monitoring at WTP		
Target <0.5 NTU	Alert Level 0.8 NTU for more than 10 min	Critical Limit 1 NTU	
Monitoring Systems <ul style="list-style-type: none"> • Routine site and operational checks • Instrument calibration and records maintained • Media replacement program (as required) • Calibration of online instruments (programmed Instrument Maintenance Program conducted by Instrument Technicians) • Annual checks for plant auto shut down 	Corrective actions <ul style="list-style-type: none"> • Cross check online turbidity with portable instrumentation. • Look at pressure differentials across filters • Verify turbidity of Raw water • Check upstream chemical dosing • Notify Technical Officer • Complete 'Initial Incident Report Form' 	Corrective actions <ul style="list-style-type: none"> • Follow Alert Level steps • Notify Technical Officer • TO to notify Manager • Verify turbidity in Clear Water Tank, and if it exceeds 1 NTU, consult with TO on actions required (e.g. empty and scour tank) • Check turbidity in Bellbrook Reservoir and if exceeds 1 NTU consider actions with TO • Manager to notify PHU • Management to consider the need to initiate an incident response. • Complete 'Initial Incident Report Form' 	

Table A.6.3 SOP for BB CCP3 Free Chlorine at out of Clear Water Tank

Water Supply System	Bellbrook		
CCP ID	BB CCP3		
What is the control point?	Disinfection (Sodium Hypochlorite)	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free Chlorine residual	Monitoring Frequency:	Online monitoring
Monitoring location	CWT outlet		
What will initiate response?	In response to low chlorine residual (online monitoring leaving CWT)		
Target 1.5 mg/L	Alert Level <1 or >2.2 mg/L	Critical Limit <0.8 or >5 mg/L	
<ul style="list-style-type: none"> Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) Dosing rate checks Disinfection residual checks performed at the outlet of CWT Instrument calibration and records maintained Chemical procurement and delivery requirements 	<p>Corrective actions</p> <ul style="list-style-type: none"> Validate disinfection levels (using high ranges or dilution methods if required) Check primary dosing equipment and hypo concentration and adjust as required Contact Technical Officer Check raw water conditions Check upstream processes (pH correction & filtration) Check disinfection levels in Reservoir and top up if required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Check integrity of Clear Water Tank for any breaches or unauthorised access Conduct sampling and flushing in the network as required Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Inform Tech Officer Consider taking micro-sample for low disinfection levels TO to contact Manager Manager to contact PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert) Complete 'Initial Incident Report Form' 	

Table A.6.4 SOP for BB CCP4 Reservoir Integrity at all Reservoirs

Water Supply System	Bellbrook		
CCP ID	BB CCP4		
What is the control point?	Reservoir	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	Bellbrook Reservoir		
What will initiate response?	Any sign of Reservoir integrity breach		
Target No breach of reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning and inspection program 	<p>Corrective actions</p> <ul style="list-style-type: none"> Conduct a visual inspection (outside & inside) Check chlorine residual Dose chlorine to Reservoir and/or increase dose at plant, if needed (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Contact Tech Officer Repair breach of integrity Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Take micro-sample if required Remove contaminants, if safe to do so Inform Tech Officer TO to contact Manager Manager to contact PHU Management to consider the need to initiate an incident response Complete 'Initial Incident Report Form' 	

Table A.7 CCP Willawarrin Water Supply

System	CCP ID	Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Willawarrin	WW CCP1	Catchment and Abstraction	All pathogens	Turbidity	0.6 NTU	1 NTU	2 NTU
	WW CCP2	Disinfection	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine	1 mg/L	<0.6 or >2.0 mg/L	<0.4 or >5 mg/L
	WW CCP3	Reservoir	All pathogens and all chemicals	Reservoir Integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.7.1 SOP for WW CCP1 Turbidity at Raw Water

Water Supply System	Willawarrin		
CCP ID	WW CCP1		
What is the control point?	Catchment and Abstraction	What are the hazards?	All pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Manual test 5d/wk
Monitoring location	Manual test on raw water rising main prior to Chlorine injection at Willawarrin treatment facility		
What will initiate response?	Test on turbidity grab sample		

<u>Target</u> 0.6 NTU	<u>Alert Level</u> 1 NTU	<u>Critical Limit</u> 2 NTU
<ul style="list-style-type: none"> Weather and flood warning observations Monitoring of Bellbrook WTP river and raw water turbidity online instruments (via Teamviewer) Routine site and operational checks Instrument calibration and records maintained Operational requirement to maintain Willawarrin Reservoir as full as possible at close of business day 	<p>Corrective actions</p> <ul style="list-style-type: none"> Check Turbidity and disinfection levels in Reservoir Attend site and check river quality and river levels Manually test raw water turbidity Check Tb levels of individual bores (scour to waste during tests) Conduct a visual inspection of Bores (2 off) Shutdown bore pumps if required Contact Tech Officer Flush rising main to remove highly turbid water (using scour at plant) Initiate water carting protocol Complete <i>'Initial Incident Report Form'</i> 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Contact Tech Officer TO to inform Manager Continue water carting until raw water turbidity drops to below 1 NTU Manager to call PHU Management consider implementation of Incident Plan of Action Complete <i>'Initial Incident Report Form'</i>

Table A.7.2 SOP for WW CCP2 Free Chlorine at Reservoir

Water Supply System	Willawarrin		
CCP ID	WW CCP2		
What is the control point?	Disinfection (Sodium Hypochlorite)	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free Chlorine residual	Monitoring Frequency:	Manual test 5d/wk (additional online instrument at Reservoir)
Monitoring location	Willawarrin Reservoir		
What will initiate response?	In response to low or high Chlorine residual		
Target 1 mg/L	Alert Level <0.6 or >2.0 mg/L	Critical Limit <0.4 or >5 mg/L	
<ul style="list-style-type: none"> Routine site and equipment checks at WTP (Equipment correlation with bench meters and records stored in WQ Data Base/Plant sheets) Dosing rate checks Disinfection residual checks performed at the outlet of Reservoir Instrument calibration and records maintained Chemical procurement and delivery requirements Sodium Hypochlorite chemical handling and dilution 1:5 requirements 	<p>Corrective actions</p> <ul style="list-style-type: none"> Validate disinfection levels (using high ranges or dilution methods if required) Check primary dosing equipment and hypo concentration and adjust as required Contact Tech Officer Check raw water conditions Check disinfection levels in Reservoir and top up if required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Check integrity of Reservoir for any breaches or unauthorised access Sampling and flushing in the network as required Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Contact Tech Officer TO to inform Manager Consider taking micro-sample for low disinfection levels Manager to contact PHU Management to consider the need to initiate an incident response Complete '<i>Initial Incident Report Form</i>' 	

Table A.7.3 SOP for WW CCP3 Reservoir Integrity at Reservoir

Water Supply System	Willawarrin		
CCP ID	WW CCP3		
What is the control point?	Reservoir	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	Willawarrin Reservoir		
What will initiate response?	Any sign of reservoir integrity breach		
Target No breach of Reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning and inspection program <p>Note: Water caters have access to Reservoir during high turbidity events</p>	<p>Corrective actions</p> <ul style="list-style-type: none"> Conduct visual inspection (outside & inside) Check disinfection levels in Reservoir and top up if required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Increase dose at plant, if needed Contact Tech Officer Repair breach of integrity Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Take micro-sample if required Remove contaminants, if safe to do so Inform Tech Officer TO to contact Manager Manager to contact PHU Management to consider the need to initiate an incident response Complete '<i>Initial Incident Report Form</i>' 	

Table A.8 Thungutti Water Supply

System	CCP ID	Control Point	Hazard	Control Parameter	Target	Alert Level	Critical Limit
Thungutti	TH CCP1	Catchment and Abstraction	Cryptosporidium	Turbidity	<0.5 NTU	>0.8 NTU	>1 NTU
	TH CCP2	Disinfection	Chlorine sensitive pathogens & Chemical (Chlorine)	Free Chlorine	1.5 mg/L	<0.8 or >3.0 mg/L	<0.3 or >5 mg/L
	TH CCP3	Reservoir	All pathogens and all chemicals	Reservoir Integrity	No breach of integrity	Any sign of integrity breach	Evidence of contamination

Table A.8.1 SOP for TH CCP1 Turbidity at Inlet to WTP (Raw Water)

Water Supply System	Thungutti		
CCP ID	TH CCP1		
What is the control point?	Catchment and Abstraction	What are the hazards?	Cryptosporidium and all pathogens
What is being monitored?	Turbidity	Monitoring Frequency:	Continuous (remote dial in required, no alarm SMS)
Monitoring location	Inlet to Treatment Plant		
What will initiate response?	Online Raw Water Turbidity Analyser		
Target <0.5 NTU	Alert Level >0.8 NTU for more than 15 mins	Critical Limit >1 NTU for more than 5 mins	
<ul style="list-style-type: none"> Weather and flood warning observations Monitoring of raw water turbidity online instrument (via Teamviewer) Routine site and operational checks Instrument calibration and records maintained Instrumentation cross checks with manual tests Routine bore management program 	<p>Corrective actions</p> <ul style="list-style-type: none"> Attend site and check turbidity levels Check turbidity and disinfection levels in reservoir Cross check turbidity with manual test of raw water turbidity Check creek for any water quality impacts, such as flooding Conduct a visual inspection of Bore Shutdown bore pumps (if required) and organise repairs (if required) Contact Tech Officer Consider flushing rising main to remove highly turbid water Consider early shutdown of plant and initiate water carting protocol Complete <i>'Initial Incident Report Form'</i> 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level steps Ensure that automatic interlock has shut down the Treatment Plant, otherwise stop bore pump Contact Tech Officer TO to inform Manager Commence and continue water carting until raw water turbidity drops to below 1 NTU Manager to call PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert or water carting) Complete <i>'Initial Incident Report Form'</i> 	

Table A.8.2 SOP for TH CCP2 Free Chlorine at Inlet Reservoir

Water Supply System	Thungutti		
CCP ID	TH CCP2		
What is the control point?	Disinfection (Sodium Hypochlorite)	What are the hazards?	Chlorine sensitive pathogens & Chemical (Chlorine)
What is being monitored?	Free chlorine residual	Monitoring Frequency:	Continuous (remote dial in required, no alarm SMS)
Monitoring location	Inlet to Reservoirs		
What will initiate response?	In response to low or high chlorine residual		
Target 1.5 mg/L	Alert Level <0.5 or >3.0 mg/L for more than 15 mins	Critical Limit <0.4 or >5 mg/L for more than 5 mins	
<ul style="list-style-type: none"> Routine site and operational checks Monitoring of chlorine on retic and at inlet to Reservoir online instrument (via Teamviewer) Instrument calibration and records maintained Instrumentation cross checks with manual tests Dosing rate checks Disinfection residual checks performed at the inlet of Reservoir Chemical procurement and delivery requirements Sodium Hypochlorite chemical handling and dilution SOP* 	<p>Corrective actions</p> <ul style="list-style-type: none"> Validate disinfection levels (using high ranges or dilution methods if required) Check primary dosing equipment and hypo concentration and adjust as required (refer chlorine SOP*) Contact Technical Officer Check raw water conditions Check disinfection levels in Reservoir and top up where required (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) For high chlorine consider running system to overflow Reservoir, scour and water carting or dechlorinating (Note: do not shandy with unchlorinated water due to combined rising & distribution main) Check integrity of Reservoir for any breaches or unauthorised access Sampling and flushing in the network as required Complete '<i>Initial Incident Report Form</i>' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow all Alert Level corrective actions Inform TO Consider taking micro-sample for low disinfection levels TO to contact Manager Manager to contact PHU Management consider implementation of Incident Plan of Action – refer to Incident and Emergency Response Plan (e.g. boil water alert) Complete '<i>Initial Incident Report Form</i>' 	

Table A.8.3 SOP for TH CCP3 Reservoir Integrity at Reservoir

Water Supply System	Thungutti		
CCP ID	TH CCP3		
What is the control point?	Reservoir	What are the hazards?	All pathogens and all chemicals
What is being monitored?	Reservoir integrity	Monitoring Frequency:	Monthly
Monitoring location	Thungutti Reservoirs		
What will initiate response?	Any sign of Reservoir integrity breach		
Target No breach of reservoir integrity	Alert Level Any sign of integrity breach	Critical Limit Evidence of contamination	
<ul style="list-style-type: none"> Reservoir inspection program (routine) with records maintained Scheduled contractor reservoir cleaning program Note: Water caters have access to Reservoir during high turbidity events 	<p>Corrective actions</p> <ul style="list-style-type: none"> Conduct visual inspection (outside & inside) Check chlorine residual Dose chlorine to Reservoir and/or increase dose at plant, if needed (Refer <i>Reservoir Manual Chlorine Dose Calculator</i>) Contact Tech Officer Repair breach of integrity Increase inspections until repaired Complete 'Initial Incident Report Form' 	<p>Corrective actions</p> <ul style="list-style-type: none"> Follow Alert Level corrective actions Take micro-sample if required Remove contaminants, if safe to do so Inform TO TO to contact Manager Manager to contact PHU Management to consider the need to initiate an incident response Complete 'Initial Incident Report Form' 	

Appendix B Stuart McIntyre Dam Algae Monitoring

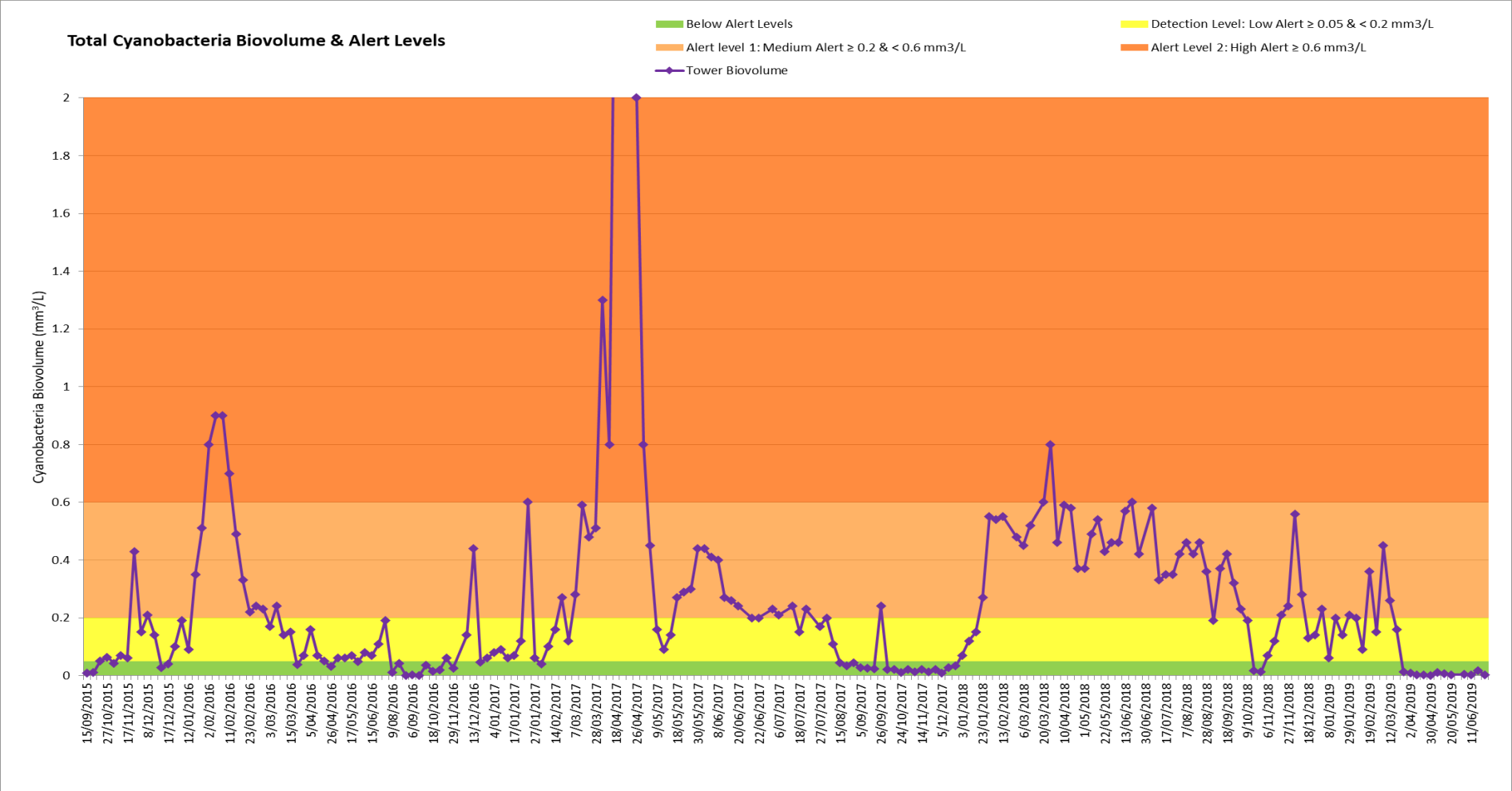


Figure B.1: Stuart McIntyre Dam Total Cyanobacteria Biovolume and Alert Levels (Sep 2015 to June 2019)

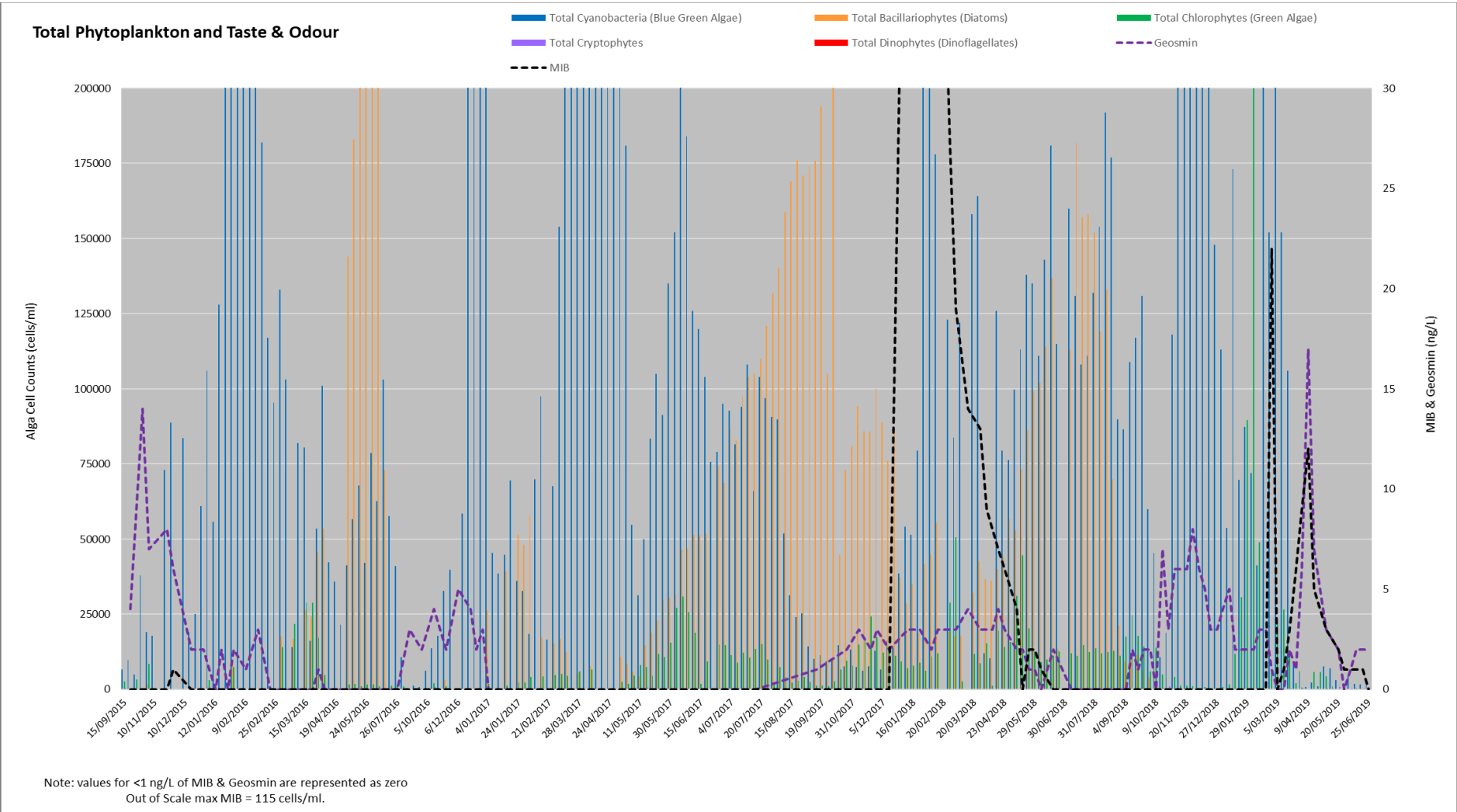


Figure B.2: Total Phytoplankton and Taste and Odour Results at Tower Intake (July 2015 to June 2019). Algae samples taken from boat using 5 m integrated collection method.

Appendix C Water Quality Data

Data from Kempsey Shire Council reticulation sampling sites has been collected from NSW Health Database covering the eight drinking water supply systems. Results in each monitoring programme (Physical-Chemical Monitoring, Microbiological Monitoring and Fluoride Monitoring) are attributed to specific sampling regimes. Turbidity, pH and Fluoride are monitored in two sections, due to the difference in sampling regimes (indicated by the sample count) results of the analysts vary between monitoring programmes.

Fluoride is tested in all supply systems as a standard chemical test as a part of the Physical-Chemical Monitoring and is noted as * Fluoride – Calculated from all supply systems (includes fluoride dosed and non-dosed systems). Fluoride Monitoring only occurs in the fluoride dosed supply system of South West Rocks and is noted as ** Fluoride – Calculated from the South West Rocks supply fluoride dosed system only.

Table C.1 Kempsey & Lower Macleay Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.03	0.01	0.07	11	0	100.00
Antimony	0.003	mg/L	0.001	0.0005	0.001	11	0	100.00
Arsenic	0.01	mg/L	0.0006	0.0005	0.001	11	0	100.00
Barium	2	mg/L	0.013	0.009	0.019	11	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	11	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	11	0	100.00
Calcium	10000	mg/L	26.14	19.1	31	11	0	100.00
Chloride	250	mg/L	15.7	0.5	19	11	0	100.00
Chromium	0.05	mg/L	0.0028	0.0025	0.006	11	0	100.00
Copper	2	mg/L	0.0204	0.0025	0.05	11	0	100.00
*Fluoride	1.5	mg/L	0.05	0.05	0.1	11	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.02	11	0	100.00
Iron	0.3	mg/L	0.029	0.005	0.08	11	0	100.00
Lead	0.01	mg/L	0.0012	0.001	0.002	11	0	100.00
Magnesium	10000	mg/L	5.02	3.71	6.12	11	0	100.00
Manganese	0.5	mg/L	0.0025	0.0025	0.0025	11	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.0004	11	0	100.00
Molybdenum	0.05	mg/L	0.0028	0.0025	0.006	11	0	100.00
Nickel	0.02	mg/L	0.0073	0.005	0.03	11	1	90.91
Nitrate	50	mg/L	2.5	0.5	5	11	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.1	11	0	100.00
pH	6.5 - 8.5		7.6	7.3	8.1	11	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	11	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	11	0	100.00
Sodium	180	mg/L	14.4	12	19	11	0	100.00
Sulfate	500	mg/L	6.9	6	8	11	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	117.3	98	132	11	0	100.00
Total Hardness as CaCO3	200	mg/L	85.9	63	102.6	11	0	100.00
True Colour	15	Hazen Units	0.8	0.5	3	11	0	100.00
Turbidity	5	NTU	0.25	0.05	0.7	11	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	11	0	100.00
Zinc	3	mg/L	0.02	0.005	0.09	11	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	171	0	100.00
Total Coliforms	0	mpn/100 mL	1.42	0	201	171	4	97.66
Free Chlorine	0.2 - 5	mg/L	0.97	0.52	2.9	171	0	100.00
Total Chlorine	5	mg/L	1.08	0.56	3.3	171	0	100.00
pH	6.5 - 8.5		7.336	6.67	8.34	171	0	100.00
Temperature	30	C	21.4	15.7	29.3	165	0	100.00
Turbidity	5	NTU	0.66	0.12	3.23	171	0	100.00

Table C.2 Crescent Head Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.12	0.03	0.2	3	0	100.00
Antimony	0.003	mg/L	0.0007	0.0005	0.001	3	0	100.00
Arsenic	0.01	mg/L	0.0005	0.0005	0.0005	3	0	100.00
Barium	2	mg/L	0.0068	0.0025	0.013	3	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	3	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	3	0	100.00
Calcium	10000	mg/L	16.4	13.7	21.4	3	0	100.00
Chloride	250	mg/L	33.3	20	43	3	0	100.00
Chromium	0.05	mg/L	0.0025	0.0025	0.0025	3	0	100.00
Copper	2	mg/L	0.0055	0.0025	0.009	3	0	100.00
*Fluoride	1.5	mg/L	0.07	0.05	0.1	3	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.01	3	0	100.00
Iron	0.3	mg/L	0.13	0.01	0.24	3	0	100.00
Lead	0.01	mg/L	0.001	0.001	0.001	3	0	100.00
Magnesium	10000	mg/L	2.68	1.71	4.45	3	0	100.00
Manganese	0.5	mg/L	0.0033	0.0025	0.005	3	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.00005	3	0	100.00
Molybdenum	0.05	mg/L	0.0025	0.0025	0.0025	3	0	100.00
Nickel	0.02	mg/L	0.005	0.005	0.005	3	0	100.00
Nitrate	50	mg/L	1.0	0.5	2	3	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.05	3	0	100.00
pH	6.5 - 8.5		7.3	6.9	7.7	3	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	3	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	3	0	100.00
Sodium	180	mg/L	15.7	13	18	3	0	100.00
Sulfate	500	mg/L	3.0	1	7	3	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	100.0	91	116	3	0	100.00
Total Hardness as CaCO3	200	mg/L	52.0	42	71.8	3	0	100.00
True Colour	15	Hazen Units	3.8	0.5	6	3	0	100.00
Turbidity	5	NTU	0.7	0.2	1.1	3	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	3	0	100.00
Zinc	3	mg/L	0.012	0.005	0.02	3	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	64	0	100.00
Total Coliforms	0	mpn/100 mL	0.2	0	6	64	4	93.75
Free Chlorine	0.2 - 5	mg/L	0.68	0.01	2.6	64	6	90.63
Total Chlorine	5	mg/L	0.87	0.05	2.7	64	0	100.00
pH	6.5 - 8.5		7.45	6.72	9.8	64	1	98.44
Temperature	30	C	21.2	13.1	29.2	64	0	100.00
Turbidity	5	NTU	2.0	0.2	3.86	64	0	100.00

Table C.3 Hat Head Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.13	0.09	0.17	2	0	100.00
Antimony	0.003	mg/L	0.0005	0.0005	0.0005	2	0	100.00
Arsenic	0.01	mg/L	0.001	0.001	0.001	2	0	100.00
Barium	2	mg/L	0.013	0.012	0.014	2	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	2	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	2	0	100.00
Calcium	10000	mg/L	1.7	1.6	1.7	2	0	100.00
Chloride	250	mg/L	62	57	67	2	0	100.00
Chromium	0.05	mg/L	0.0025	0.0025	0.0025	2	0	100.00
Copper	2	mg/L	0.0025	0.0025	0.0025	2	0	100.00
*Fluoride	1.5	mg/L	0.05	0.05	0.05	2	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.01	2	0	100.00
Iron	0.3	mg/L	0.255	0.15	0.36	2	0	100.00
Lead	0.01	mg/L	0.001	0.001	0.001	2	0	100.00
Magnesium	10000	mg/L	3.85	3.42	4.27	2	0	100.00
Manganese	0.5	mg/L	0.006	0.006	0.006	2	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.00005	2	0	100.00
Molybdenum	0.05	mg/L	0.0025	0.0025	0.0025	2	0	100.00
Nickel	0.02	mg/L	0.005	0.005	0.005	2	0	100.00
Nitrate	50	mg/L	0.5	0.5	0.5	2	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.05	2	0	100.00
pH	6.5 - 8.5		7.05	6.9	7.2	2	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	2	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	2	0	100.00
Sodium	180	mg/L	41.5	40	43	2	0	100.00
Sulfate	500	mg/L	6.5	6	7	2	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	124.5	124	125	2	0	100.00
Total Hardness as CaCO3	200	mg/L	20.0	18.3	21.6	2	0	100.00
True Colour	15	Hazen Units	5.5	3	8	2	0	100.00
Turbidity	5	NTU	0.9	0.3	1.5	2	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	1	0	100.00
Zinc	3	mg/L	0.01	0.01	0.01	2	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	27	0	100.00
Total Coliforms	0	mpn/100 mL	0	0	0	27	0	100.00
Free Chlorine	0.2 - 5	mg/L	0.9	0.08	1.45	27	1	96.30
Total Chlorine	5	mg/L	0.99	0.14	1.55	27	0	100.00
pH	6.5 - 8.5		7.51	7.09	8.19	27	0	100.00
Temperature	30	C	21.0	14.5	26.6	27	0	100.00
Turbidity	5	NTU	0.54	0.24	1.34	27	0	100.00

Table C.4 South West Rocks Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.03	0.01	0.09	13	0	100.00
Antimony	0.003	mg/L	0.0005	0.0005	0.0005	13	0	100.00
Arsenic	0.01	mg/L	0.001	0.001	0.002	13	0	100.00
Barium	2	mg/L	0.012	0.007	0.014	13	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	13	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	13	0	100.00
Calcium	10000	mg/L	13.3	10.9	15.2	13	0	100.00
Chloride	250	mg/L	32	31	36	13	0	100.00
Chromium	0.05	mg/L	0.0025	0.0025	0.0025	13	0	100.00
Copper	2	mg/L	0.0093	0.0025	0.029	13	0	100.00
Fluoride	1.5	mg/L	0.92	0.83	1.04	13	0	100.00
Fluoride (WU result)	1.5	mg/L	0.99	0.97	1.01	12	0	100.00
Fluoride Ratio	0.8 - 1.2	mg/L	1.08	0.95	1.18	12	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.01	13	0	100.00
Iron	0.3	mg/L	0.023	0.005	0.09	13	0	100.00
Lead	0.01	mg/L	0.001	0.001	0.001	13	0	100.00
Magnesium	10000	mg/L	1.65	0.87	1.93	13	0	100.00
Manganese	0.5	mg/L	0.0028	0.0025	0.006	13	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.0001	13	0	100.00
Molybdenum	0.05	mg/L	0.0025	0.0025	0.0025	13	0	100.00
Nickel	0.02	mg/L	0.005	0.005	0.005	13	0	100.00
Nitrate	50	mg/L	0.5	0.5	0.5	13	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.05	13	0	100.00
pH	6.5 - 8.5		7.6	7.4	8	13	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	13	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	13	0	100.00
Sodium	180	mg/L	20	18	22	13	0	100.00
Sulfate	500	mg/L	3	2	5	13	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	92	83	100	13	0	100.00
Total Hardness as CaCO3	200	mg/L	39.9	32.9	45.9	13	0	100.00
True Colour	15	Hazen Units	0.8	0.5	2	13	0	100.00
Turbidity	5	NTU	0.25	0.05	1.5	13	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	13	0	100.00
Zinc	3	mg/L	0.009	0.005	0.01	13	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	61	0	100.00
Total Coliforms	0	mpn/100 mL	0.2	0	8	61	3	95.08
Free Chlorine	0.2 - 5	mg/L	0.76	0.08	1.37	61	1	98.36
Total Chlorine	5	mg/L	0.86	0.11	1.46	61	0	100.00
pH	6.5 - 8.5		7.46	7.15	8.18	61	0	100.00

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Temperature	30	C	21.2	15.3	27.3	59	0	100.00
Turbidity	5	NTU	0.5	0.1	12.2	61	1	98.36
Fluoride Operational Monitoring								
Fluoride (daily WU)	0.9 - 1.5	mg/L	1.0	0.0	1.16	350	3	99.14
Fluoride (weekly WU)	0.9 - 1.5	mg/L	0.99	0.93	1.07	95	0	100.00

Table C.5 Stuarts Point Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.007	0.005	0.03	13	0	100.00
Antimony	0.003	mg/L	0.0005	0.0005	0.0005	13	0	100.00
Arsenic	0.01	mg/L	0.0011	0.0005	0.003	13	0	100.00
Barium	2	mg/L	0.014	0.013	0.016	13	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	13	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	13	0	100.00
Calcium	10000	mg/L	53.5	42.8	60.2	13	0	100.00
Chloride	250	mg/L	34	31	38	13	0	100.00
Chromium	0.05	mg/L	0.0031	0.0025	0.01	13	0	100.00
Copper	2	mg/L	0.0143	0.0025	0.027	13	0	100.00
*Fluoride	1.5	mg/L	0.05	0.05	0.05	13	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.01	13	0	100.00
Iron	0.3	mg/L	0.066	0.005	0.53	13	0	100.00
Lead	0.01	mg/L	0.001	0.001	0.004	13	0	100.00
Magnesium	10000	mg/L	3.17	2.56	4.12	13	0	100.00
Manganese	0.5	mg/L	0.0028	0.0025	0.006	13	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.0004	13	0	100.00
Molybdenum	0.05	mg/L	0.003	0.0025	0.009	13	0	100.00
Nickel	0.02	mg/L	0.008	0.005	0.04	13	1	92.31
Nitrate	50	mg/L	0.5	0.5	0.5	13	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.05	13	0	100.00
pH	6.5 - 8.5		7.7	7.6	7.9	13	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	13	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	13	0	100.00
Sodium	180	mg/L	17	14	22	13	0	100.00
Sulfate	500	mg/L	5	4	7	13	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	184	174	195	13	0	100.00
Total Hardness as CaCO3	200	mg/L	146.6	117.4	167.3	13	0	100.00
True Colour	15	Hazen Units	0.8	0.5	3	13	0	100.00
Turbidity	5	NTU	0.17	0.05	1.1	13	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	13	0	100.00
Zinc	3	mg/L	0.05	0.02	0.07	13	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	52	0	100.00
Total Coliforms	0	mpn/100 mL	0	0	1	52	0	100.00
Free Chlorine	0.2 - 5	mg/L	0.82	0.45	1.15	52	0	100.00
Total Chlorine	5	mg/L	0.9	0.5	1.2	52	0	100.00
pH	6.5 - 8.5		7.58	7.44	7.73	52	0	100.00
Temperature	30	C	22.8	15.2	28.6	41	0	100.00
Turbidity	5	NTU	0.3	0.1	0.9	52	0	100.00

Table C.6 Willawarrin Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.012	0.005	0.04	12	0	100.00
Antimony	0.003	mg/L	0.001	0.001	0.001	12	0	100.00
Arsenic	0.01	mg/L	0.002	0.001	0.004	12	0	100.00
Barium	2	mg/L	0.0103	0.008	0.012	12	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	12	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	12	0	100.00
Calcium	10000	mg/L	13.85	11.3	16.6	12	0	100.00
Chloride	250	mg/L	15	12	19	12	0	100.00
Chromium	0.05	mg/L	0.0025	0.0025	0.0025	12	0	100.00
Copper	2	mg/L	0.0375	0.015	0.075	12	0	100.00
*Fluoride	1.5	mg/L	0.05	0.05	0.05	12	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.02	12	0	100.00
Iron	0.3	mg/L	0.031	0.005	0.07	12	0	100.00
Lead	0.01	mg/L	0.002	0.001	0.003	12	0	100.00
Magnesium	10000	mg/L	4.79	4.08	5.53	12	0	100.00
Manganese	0.5	mg/L	0.0235	0.0025	0.043	12	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.0002	12	0	100.00
Molybdenum	0.05	mg/L	0.0025	0.0025	0.0025	12	0	100.00
Nickel	0.02	mg/L	0.005	0.005	0.005	12	0	100.00
Nitrate	50	mg/L	1.04	0.5	4	12	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.05	12	0	100.00
pH	6.5 - 8.5		7.02	6.9	7.2	12	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	12	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	12	0	100.00
Sodium	180	mg/L	13	12	16	12	0	100.00
Sulfate	500	mg/L	6	3	9	12	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	86	79	96	12	0	100.00
Total Hardness as CaCO3	200	mg/L	54.3	47.2	64.2	12	0	100.00
True Colour	15	Hazen Units	1.1	0.5	3	12	0	100.00
Turbidity	5	NTU	0.48	0.05	1.7	12	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	11	0	100.00
Zinc	3	mg/L	0.0167	0.005	0.04	12	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	26	0	100.00
Total Coliforms	0	mpn/100 mL	0.7	0	0	26	0	100.00
Free Chlorine	0.2 - 5	mg/L	0.91	0.36	1.3	26	0	100.00
Total Chlorine	5	mg/L	1.05	0.49	1.48	26	0	100.00
pH	6.5 - 8.5		6.65	6.09	6.99	26	8	69.23
Temperature	30	C	20.6	14	27.3	23	0	100.00
Turbidity	5	NTU	0.6	0.19	2.83	26	0	100.00

Table C.7 Bellbrook Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.011	0.005	0.05	12	0	100.00
Antimony	0.003	mg/L	0.001	0.001	0.002	12	0	100.00
Arsenic	0.01	mg/L	0.0005	0.0005	0.0005	12	0	100.00
Barium	2	mg/L	0.009	0.007	0.012	12	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	12	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	12	0	100.00
Calcium	10000	mg/L	9.8	8.2	11	12	0	100.00
Chloride	250	mg/L	17	14	24	12	0	100.00
Chromium	0.05	mg/L	0.0025	0.0025	0.0025	12	0	100.00
Copper	2	mg/L	0.0139	0.0025	0.029	12	0	100.00
*Fluoride	1.5	mg/L	0.05	0.05	0.05	12	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.01	12	0	100.00
Iron	0.3	mg/L	0.006	0.005	0.01	12	0	100.00
Lead	0.01	mg/L	0.001	0.001	0.001	12	0	100.00
Magnesium	10000	mg/L	3.88	3.31	4.34	12	0	100.00
Manganese	0.5	mg/L	0.0025	0.0025	0.0025	12	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.0002	12	0	100.00
Molybdenum	0.05	mg/L	0.0025	0.0025	0.0025	12	0	100.00
Nickel	0.02	mg/L	0.005	0.005	0.005	12	0	100.00
Nitrate	50	mg/L	0.5	0.5	0.5	12	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.05	12	0	100.00
pH	6.5 - 8.5		7.65	7.4	7.8	12	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	12	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	12	0	100.00
Sodium	180	mg/L	16	13	22	12	0	100.00
Sulfate	500	mg/L	5	3	6	12	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	79	65	91	12	0	100.00
Total Hardness as CaCO ₃	200	mg/L	40.4	35.6	44.4	12	0	100.00
True Colour	15	Hazen Units	0.7	0.5	1	12	0	100.00
Turbidity	5	NTU	0.29	0.05	0.8	12	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	11	0	100.00
Zinc	3	mg/L	0.013	0.005	0.03	12	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	26	0	100.00
Total Coliforms	0	mpn/100 mL	0	0	0	26	0	100.00
Free Chlorine	0.2 - 5	mg/L	1.05	.055	1.78	26	0	100.00
Total Chlorine	5	mg/L	1.15	0.66	1.96	26	0	100.00
pH	6.5 - 8.5		7.45	7.14	7.77	26	0	100.00
Temperature	30	C	21.0	13.8	29.3	22	0	100.00
Turbidity	5	NTU	0.19	0.11	0.48	25	0	100.00

Table C.8 Thungutti Supply System Water Quality Data

Characteristic	Guideline Value	Units	Mean	Min	Max	Sample Count	Exception Count	% Meeting Guidelines
Chemistry								
Aluminium	0.2	mg/L	0.005	0.005	0.005	2	0	100.00
Antimony	0.003	mg/L	0.0005	0.0005	0.0005	2	0	100.00
Arsenic	0.01	mg/L	0.0005	0.0005	0.0005	2	0	100.00
Barium	2	mg/L	0.015	0.013	0.016	2	0	100.00
Boron	4	mg/L	0.05	0.05	0.05	2	0	100.00
Cadmium	0.002	mg/L	0.0003	0.00025	0.00025	2	0	100.00
Calcium	10000	mg/L	9.4	9.1	9.7	2	0	100.00
Chloride	250	mg/L	19	19	19	2	0	100.00
Chromium	0.05	mg/L	0.0025	0.0025	0.0025	2	0	100.00
Copper	2	mg/L	0.053	0.039	0.067	2	0	100.00
*Fluoride	1.5	mg/L	0.05	0.05	0.05	2	0	100.00
Iodine	0.5	mg/L	0.01	0.01	0.01	2	0	100.00
Iron	0.3	mg/L	0.008	0.005	0.01	2	0	100.00
Lead	0.01	mg/L	0.001	0.001	0.001	2	0	100.00
Magnesium	10000	mg/L	5.055	4.61	5.5	2	0	100.00
Manganese	0.5	mg/L	0.0025	0.0025	0.0025	2	0	100.00
Mercury	0.001	mg/L	0.0001	0.00005	0.00005	2	0	100.00
Molybdenum	0.05	mg/L	0.0025	0.0025	0.0025	2	0	100.00
Nickel	0.02	mg/L	0.0075	0.005	0.01	2	0	100.00
Nitrate	50	mg/L	0.5	0.5	0.5	2	0	100.00
Nitrite	3	mg/L	0.05	0.05	0.05	2	0	100.00
pH	6.5 - 8.5		7.05	7	7.1	2	0	100.00
Selenium	0.01	mg/L	0.001	0.001	0.001	2	0	100.00
Silver	0.1	mg/L	0.001	0.001	0.001	2	0	100.00
Sodium	180	mg/L	16	15	17	2	0	100.00
Sulfate	500	mg/L	9	7	11	2	0	100.00
Total Dissolved Solids (TDS)	600	mg/L	80	80	80	2	0	100.00
Total Hardness as CaCO ₃	200	mg/L	44.3	41.7	46.9	2	0	100.00
True Colour	15	Hazen Units	0.5	0.5	0.5	2	0	100.00
Turbidity	5	NTU	0.5	0.1	0.9	2	0	100.00
Uranium	0.017	mg/L	0.0025	0.0025	0.0025	2	0	100.00
Zinc	3	mg/L	0.008	0.005	0.01	2	0	100.00
Microbiology								
E. coli	0	mpn/100 mL	0	0	0	26	0	100.00
Total Coliforms	0	mpn/100 mL	0	0	0	26	0	100.00
Free Chlorine	0.2 - 5	mg/L	1.16	0.77	1.68	26	0	100.00
Total Chlorine	5	mg/L	1.26	0.88	1.71	26	0	100.00
pH	6.5 - 8.5		6.78	6.59	7.13	26	0	100.00
Temperature	30	C	21.0	14.2	27.6	23	0	100.00
Turbidity	5	NTU	0.2	0.1	0.31	25	0	100.00

Appendix D Customer Enquiry Supply Area Descriptions

Table D.1 Customer Enquiry Supply Area Descriptions for KLM Supply System

Supply System	Supply Areas
Kempsey	Kempsey CBD
West Kempsey	West Kempsey & Greenhill
Aldavilla	Aldavilla & Yarravel
Smithtown/Gladstone	Smithtown, Gladstone, Bellimbopinni, Austral Eden
Belmore River	Belmore River
Kinchella	Kinchella, Jerseyville, Rainbow Reach, Summer Island, Seven Oaks & Plumbers Lane
Frederickton	Frederickton, Everinghams Lane, Clybucca
South Kempsey	Dondingalong, Euroka, Burnt Bridge, SK Service Centre
East Kempsey	East Kempsey, Verges Creek

Appendix E Continuous Improvement - Implementation Plan as of October 2019

Action No.	Supply System	Residual Risk	Outstanding Actions	When Added	Status	Comments	Action
1.04	All Kem	H	KSC is to prepare a chemical supply contract that incorporates quality assurance program for the supply of treatment chemicals, and an SOP for the acceptance and delivery of chemicals to treatment sites, including check sheet. Develop a program to undertake spot checks of chemical quality compliance	2012	Ongoing	Under procurement mid ROC process, checklist to be developed, and chemical quality SOP to be developed including QC testing 30/10/19 - SOP currently being developed - Need to make a list of Chemicals that can be spot tested and develop procedure.	
1.05	All	H	KSC to prepare a drinking water monitoring/verification program that identifies the verification and operational monitoring conducted on the water supply. Documented drinking water quality monitoring controls to be incorporated Standard operational procedures are to be prepared on the sampling and testing program.	2012	Ongoing	Work undertaken; however usable spreadsheets need to be developed & reviewed 30/10/2019 - WaterOutlook look currently being rolled out to capture operational WQ data. Table 3 in each Sup plan captures WQ operational requirements with target levels - SOP are currently being developed for operational and verification monitoring	
2.01	Kem	L	KSC to address the long term need for the Belgrave Falls facility and to remove redundant infrastructure if deemed non-operational.	2012	Ongoing	Needs to be fenced, more water quality testing to be undertaken. Decision to be made whether or not to decommission this. Some concerns regarding salinity, Alkalinity, also iron. SWA analysis to be undertaken. 31-10-2019 further discussion about the act's future based on pending WQ testing	31/10/2019 - need to confirm with Wes on actions plan for this asset TLW - to arrange WQ Chemistry sampling at this asset whilst in drought conditions

2.02	Kem	L	Management to determine the viability of maintaining Kinchela as an emergency supply as the site has operational issues and cannot become operational in a short term.	2012	Ongoing	Still under consideration, issues with high metals in bores, and pressure issues. Last time it was run was around 2004. Studies undertaken, pipes upgrades are being rolled out in that area, so capacity increase could allow the use of this. 30-10-2019 - WQ testing current being undertaken due to drought conditions - initial results indicate Bore 1 is not viable due high salinity however other bores seem OK - pending completion of full sampling schedule this assts will most likely be kept and assts maintained and upgraded for use	TLW - to arrange radiological samples for final confirmation
2.04	All	M	Develop a map of high-risk septic tank locations within the catchment for review by DC (Development and Compliance) for integration into their Septic Tank monitoring program.	2012	Ongoing	Work undertaken, awaiting finalisation 31-10-2019 - Outside Water department this sits with Development and Compliance	WQO - to chase up with Jack if this has been completed
2.05	All	M	Upgrade existing GIS mapping systems with water infrastructure such as pipelines, easements, valve locations, sampling locations Develop a GIS mapping layer identifying high priority risk zones within catchment.	2012	Ongoing	Will be captured by new GIS	TLW - create spreadsheet of sample sites and give to WO to fill out GPS locations. Completed spreadsheet to go to Anna to create sample locations in New GIS system
2.07	Kem	M	Develop and implement a catchment risk program to identify pathogens of concern in conjunction with NSW Health	2012	Ongoing	Work undertaken, summary not written, and awaiting finalisation. Council to contact Water Futures to discuss finalisation.	PE & MWS - to chase up with Water Futures so this can be closed off.

2.09	Kem	M	Water treatment plant installation for KLM to control pathogens, turbidity, agricultural chemicals and algae.	2012	Ongoing	Expression of interest being completed for concept design for Safe & Secure 31-10-2019 - Funding for emergency plant of 10ML waiting for NSW gov approval. Plant is designed for ease of future expansion to 20ML - If funding granted plant potentially operational by end of July 2020	
2.12B2 0:L20	All	M	KSC to prepare a flood response protocol for the protection of the water supply (including Bore operation). SOP to be developed on the operation of the bores and recharge channel.	2012	Ongoing		TLW - to assign the development of a SOP
2.15	Kem	M	KSC to purchase land surrounding the bore field when the opportunity arises, to isolate external risks.	2012	Ongoing	31/10/2019 - This is a long-term action	
2.16	All	M	Fencing around bore pumps to restrict animal access. Restrict use of bores where animal access is possible until fencing able to be undertaken	2012	Ongoing	Pending on land purchase.	
2.17	All	H	Initiate a Bore inspection and preventative maintenance program.	2012	Ongoing	31-10-2019 - The Bore Inspections have been captured as a monthly task in WaterOutLook which is in the rollout stage To be developed and actioned by Maintenance team - testing currents, checking the low levels, checking for hot spots, flow switches etc	ME - To be developed and actioned by Maintenance team - testing currents, checking the low levels, checking for hot spots, flow switches etc

2.19	Kem	L	Program regular maintenance for the SMD off-take gates.	2012	Ongoing	no mechanisms for these operate to maintain tasks to be documented, 31/10/2019 - Council yet decide of an Asset management system platform, decision pending in the next 6 months	MWS to provide update once Council Decision Made SMD O&M
2.21	Kem	M	Consider undertaking a monthly monitoring program for indicator microbiological levels at take-off point of SMD,	2012	ongoing	Has been done, will be formalised 31/10/2019 - Check schedule and then close off once confirmed	TLW - to update sampling schedule to capture Bacto sampling in SMD - once completed can removed
2.25	Kem	M	Revegetation around SMD to reduce sediment and nutrient loads during wind and rainfall events.	2012	In progress	2017 comments relevant 31/10/2019 Rip Rap wall installed on dam foreshore - ongoing some area yet to be completed	TO provide update 1-2-2020
2.26	Kem	M	Include the selection of off takes in to the SMD Operational Manual.	2012	In progress	Work has been done, however needs to be documented 31-10-2019 - notes - offtake is determined by WQ gates are locked in set levels built at time of construction 31/10/2019 - When Dam is online the water off take level is to be captured in WaterOutLook - When KLM system is operation in WaterOutLook this action can be removed	WQO & TLW ensure field is available in the WaterOutLook app to capture SMD water off take level

2.28	Kem	L	A routine maintenance schedule for the SMD aeration line blowers to be developed and incorporated into the AMS	2012	In progress	Will be captured in AMS, maintenance schedules on hard copies, will be integrated electronically	ME - To provide update quarterly
2.29	Kem	L	Develop a response procedure for changes in source water quality.	2012	In progress	SOP written, requires review	
2.35	All	H	Online monitoring to be installed at Sherwood Lime plant & Greenhill Reservoir to measure and control chlorine dosing. Chlorine gas cylinder scales need to be installed and connected SCADA for remote monitoring. And automatic shutoff for chlorine cylinders	2012	In progress	4/11/2019- further information regarding if we need to have online chlorine at Sherwood (potential new plant and asset no longer needed. Still need online for Green Hill	ME - to provide update n progress
2.37	Kem	L	Install online pH monitoring after treatment at the Sherwood Lime plant.	2012	To be started	4/11/2019 - on hold until confirmation of new plant at dam -	if so, will no longer be required
2.38	Kem	M	Alarms to be installed on SMD Hypo dosing pumps including the installation of automated duty standby dosing pumps.	2012	Ongoing	Alarms currently in place and duty standby not considered as a requirement due to upgrade. 4/11/2019 - standby pumps do need to be installed, check that alarms are operational	ME - standby pumps do need to be installed, check that alarms are operational SMD O&M Plan
2.39	All	VH	Introduce a 'permit to work' approval system for all maintenance and isolations at key dosing sites. Improve communications between KSC business units for prior notification for all contractor works programmed and include training of all staff on the prior notification of works programmed and site visiting requirements - access permit introduction.	2012	Ongoing	4/11/2019 - Waiting on AMS and MMS to be confirmed and rolled out	SAP - Erin to provide update of timeline for implementation

2.4	Kem	L	Introduce a treatment chemical stocktake system to monitor chemical stocks and turnover rates.	2012	Ongoing	Stock is ordered as needed, will be in ongoing list 4/11/2019 - This will be captured in WaterOutLook and removed shortly	TLW - to roll out into WaterOutlook
2.41	Kem	L	Install automatic level sensors and alarms for Critical low level on Hypochlorite storage tanks or replace hypo system with chlorine gas system.	2012	In progress	SMD chlorine upgrade project underway	MWS to provide project update ME - to complete low level alarms and scaling
2.42	Kem/All	H	Back to base security alarm system required for all treatment facilities.	2012	In progress	4/11/2019 - BMS into SCADA investigation - scoping yet to begin	PE & ME - begin scoping process
2.44	Kem	H	Investigate the possibility of emergency power sources for chemical dosing and transfer pumps to maintain supply and dosing for major reservoirs.	2012	In progress	SWR set up for generator, however investigation outcome was that due to the size required, generators are unrealistic 4/11/2019 - new plant at KLM designed for generator backup Additional consultation needed between Council and Power supplier regarding maximum time that power can be interrupted Future scoping of additional booster pump station for Green Hill Res water security.	ME & PE - Additional consultation needed between Council and Power supplier regarding maximum time that power can be interrupted Future scoping of additional booster pump station for Green Hill Res water security.
2.49	All	M	Include inspections after all storm event within the Reservoir Inspection Procedure.	2012	In progress	Will be captured in an SOP 4/11/2019 - SOPs are currently being developed and Storm event to be included on the Reservoir Inspection SOP	TLW - to pass info onto water operators who are writing the SOPs

2.5	All	L	Modification required of inlet/outlets on reservoirs or installation of diversion plates, to prevent sediment disturbance.	2012	In progress	Mixer at Clybucca and John Lane completed, back beach nozzle also installed. This Action is ongoing as new issues are identified	TO - to provide quarterly updates
2.52	Kem	M	Develop priority planning for online chlorine monitoring and secondary dosing at key reservoirs and implement into capital works program.	2012	In progress	ORP probes installed, chlorine analysers on three reservoirs 4/11/2019 - Scoping being undertaking to include integration of secondary dosing at all Res yet to have this ability	PE & ME - to compare scoping process with assistance from TO
2.54	Kem	H	Interlock control placed on all primary disinfection systems where there is online monitoring of chlorine installed on the reservoirs.	2012	In progress	Investigation required, may not be feasible	PE & ME to investigate and scope
2.56	All	VH	Flow meter monitoring or derived flow monitoring on outlet of reservoirs.	2012	In progress	Need to be confirmed 4/11/2019 - Captured current outlet meters in WaterOutlook, Scope installing of flow meters in identified gaps	PE, ME & OE - Captured current outlet meters in WaterOutlook, Scope installing of flow meters in identified gaps TLW - capture meter locations to ensure capture into WaterOutlook
2.58	Kem	VH	Propose a water carting fill station installation at Clybucca to encourage turnover of reservoir.	2012	In progress	Investigation is ongoing 4/11/2019 - MWS working on grants - for water stations for one per scheme	MWS - to provide update as required

2.59	All	VH	To formulate a WQ induction program for all contract staff that have access to water supply facilities and conduct in house training for maintenance staff on WQ protection.	2012	In progress	Is undertaken, however may not be formalised 4/11/2019 - SOPs to be developed for maintenance/operational staff Investigate if WIOA PowerPoint and other documentation for training day for water caters	OE - SOPs to be developed for maintenance/operational staff TO - Investigate if WIOA PowerPoint and other documentation for training day for water caters
2.6	Kem	H	Include SOP for alternative or emergency supplies or water restriction implementation if taking Greenhill Res offline in an emergency.	2012	In Progress	SOP to be developed 4/11/2019 - A desk top plan needs to be completed - then a system check A GIS layer needs to be added for isolation valves of supply water system	PE & OE A desk top plan needs to be completed including asset capabilities-then a system audit check A plan to be confirmed and in place by 30/6/2020
2.62	All	H	Upgrade telemetry at reservoir sites and include a review of the critical levels set and associated alarms for individual reservoirs.	2012	In progress	Council is currently undertaking related work, will be applied to water section 4/11/2019 All Reservoir levels done except for Thungutti - Ongoing review of critical levels	PE & ME - Res levels at Thungutti needed - Ongoing review of critical levels
2.64	All	VH	KSC to maintain an up to date register of high-risk connections.	2012	In progress	4/11/2019 - this could have already been completed - MWS and WQO to try and locate	MWS and WQO to try and locate

2.65	All	VH	KSC to ensure compliance to plumbing codes for back flow prevention and high-risk areas via a reporting system Consider backflow prevention device inspection program for external/private customers, including maintaining a register	2012	In progress	4/11/2019 - to provide annual report on backflow Compliance Compliance section - external customers are responsible for maintaining and confirming the backflow devices are compliant by having a plumber check and certify them. These records are kept with the compliance section and chase up and ensure requirements are being met and maintained a register of compliance	WQO - to Chase up with DC
2.66	All	H	Maintenance crews require separate repair equipment and clothing for water main works and wash down & disinfection procedures TBD for equipment that cannot be duplicated.	2012	In progress	SOP to be developed and regularly truck audits conducted to ensure disinfection carried and used	OE - SOP to be developed and regularly truck audits conducted to ensure disinfection carried and used
2.67	All	H	Storage of water main repair & installation materials to be improved to prevent contamination from vermin, debris and faecal material.	2012	In progress	SOP to be developed 7/11/2019 - SOP still in the development stage	OE - SOP to be developed
2.68	All	H	Develop an SOP for chlorination of mains after repairs, to include a sampling and testing regime after repair work is completed. Train staff on SOP	2012	In progress	SOP to be developed	OE - SOP to be developed need to include what post test are feasible and equipment required
2.72	Kem	H	Alternative power to be installed for power outages on pressurised zones (Burnt Bridge, Bloomfield St & Everingham's Lane) or investigate alternative water supplies (i.e. tank on tower).	2012	In progress	7/11/2019 - to be implemented need to check for power point for generator and/or permanent on site back up power supplier	ME - to action comments 7/11/2019

2.73	All	H	KSC to initiate a routine maintenance program for all supply pressure pumps and records to be stored in appropriate storage location.		In progress	7/11/2019 - this is being captured in the WaterOutLook rollout	TLW - to action comments dated 7/11/2019
2.75	All	H	Maintenance staff to be trained on valve operation and flushing after repairs including an implementation of a valve 'Check Sheet' with tagging system.	2012	In progress	Training completed, tagging system not completed 7/11/2019 - lock out tag out been implemented - however training yet to be performed and the check sheet has been included in the work order completion sheet	OE - SOP still needs to be developed and all training for LOTO
2.76	All	H	Control biofilm levels within the distribution by conducting a regular mains cleaning program. Problem areas to be placed on routine flushing programs with the linking of mains where possible and 'dead ends' minimised in new developments.	2012	Ongoing	Some mains cleaning undertaken in known problem areas 7/11/2019 - pigging program being implemented Flushing programme has yet to be developed and placed on temporarily hold whilst water restriction is in place	OE - on hold to after drought finishes
2.77	All	H	Review customer complaints to identify dirty main areas.	2012	Ongoing	Tracked in Monthly WQ report 7/11/2019 - yet to be developed - potential for the tracking of problem clusters for preventative maintenance to be actioned	ME & WQO - to be added into Water Outlook and then sent to for GIS layer build
2.8	Kem	L	KSC to investigate a notification procedure to inform carters if there is a main breaks or supply issue for fill stations (4 fill stations for all of KSC). DC to inform Water division of auditing of carters.	2012	In progress	7/11/2019 - this is two separate actions 1. develop and formalized communication between Water team and Rates for water carters notification when supply issues from Reservoirs 2. Devolvement and Compliance to report on audits of water carters	OE - 1. develop SOP for communication to TLW and rates of supply loss 2. WQO to contact Development and Compliance about obtaining water caters audit results

2.81	All	L	Communication procedure to be initiated between KSC and Rural Fire services for prior notification of RFS exercises to prevent disturbances of mains.	2012	To be started	MoU existed, however requires update	TOW - to provide update
2.82	All	VH	All new mains to be inspected and have a disinfection program and verification before connection.	2012	In progress	SOP to be developed 7/11/2019 this is being done however SOP needs to be created	OE - develop SOP based on current work practices
2.84	Kem	H	Introduce a 'water by agreement' (WBA) to customers on rising main that the WQ may be variable for drinking (highly chlorinated). Annual notification sent to customers reminding them of the WBA.	2012	To be started	Needs to be confirmed	MWS - to provide update as required
2.85	All	H	Upgrade the telemetry and SCADA system and online monitoring for all sites to improve operational monitoring capabilities and response times. On call staff to regularly check SCADA for system alarms. Duplicate (mirrored service) for monitoring for key sites. To increase in-house staff knowledge of the system and introduce security access levels.	2012	In progress	Staff Knowledge completed, rest to be undertaken 7/11/2019 - ongoing	ME - to provide update n progress
2.89	All	H	Asset Management Condition Assessment and Replacement program to include the whole of supply. Continue developing the existing asset registers to develop an electronic database that includes details such as; age of infrastructure; expected life; last service date; maintenance frequency; manufacturer; recorded failures; responsibility for maintenance; operational procedures; and records for maintenance of	2012	In progress	Water maintenance own water assets and this will be incorporated into a new AMS and MMS	MWS - to provided update

			equipment. This should include any monitoring instrumentation. Develop capability of AMS to integrate with trades maintenance schedules, and to provide notification when scheduled maintenance due.				
2.9	Kem	H	Develop a program for installation of Security (CCTV) on high risk sites, on priority basis and implement into Capital works program.	2012	To be started	Long term action, will be considered as budget is secured.	MSW - to provide update based on budget availability and risk assessment of what is a high-risk site
3.08	All	H	Consider additional filling points (backflow prevention compliant) for water carters and tankers (with future recycled water filling option i.e. non-potable). Consider a strategy for community information.	2014	To be started		MWS - to provide update
3.13	ALL	H	CCP monitoring locations should be identified and appropriately labelled on each treatment site	2014	In Progress	7/1/2019 - in progress and inclusion of retic monitoring sites	TLW - facilitate with WO about roll out of signage
3.14	All (bores)	H	SOP required around the monitoring and selection of best water quality bores	2014	In Progress	SOP to be developed	TLW - to provide update on SOP development
3.15	HH	H	Develop an SOP for maintenance of aeration towers and cleaning procedure for the Hat Head aeration tower that includes: * adequate isolation procedures * sufficient flushing prior to recommissioning	2014	In Progress	SOP to be developed	TLW - to provide update on SOP development
3.18	SWR, HH, SP, BB	H	Develop an SOP for Soda ash batching	2014	In Progress	SOP to be developed	TLW - to provide update on SOP development

3.19	SWR, SP, BB	H	Develop an SOP for chlorine top-up dosing into clear water tanks		In Progress	SOP in development	TLW - to provide update on SOP development
3.21	SWR	H	SOP is required for neutralising after soak clean	2014	In Progress	SOP in review, a high priority	TLW - to provide update on SOP development
3.22	HH, SP, CH, SWR	H	Develop SOP for managing increased water demand/supply during holiday periods	2014	In Progress	SOP for demand management	TLW - to provide update on SOP development
3.28	All	H	Council should consider doing a review of existing SOPs to identify where SOP's are required and where gaps are. This review should include a review of existing control measures documented in the Risk Assessments and ensure that these are adequately documented or identified as gaps if not documented. Ensure that all documents are registered into the Document Register in TRIM. Staff will need to undertake competency-based training on all SOP's	2014	In Progress	Will be undertaken as part of review 2018 19/11/2019 this task will be closed off once the SOPs have been developed. The DWMS review that was completed in June 2019 covered the identification of SOP gaps	WQO - to oversee the development of SOPs across the operations, process and maintenance groups
3.29	All	H	Council should develop or review daily task lists at each treatment plant to ensure general operations are covered.	2014	In Progress	Will be included in Water Outlook system, connected with electronic check sheets 19/11/2019 - WaterOutlook transfer has started and operational tasks have been reviewed in the 2019 DWMS	TLW and WQO to facilitate
3.3	All	M	A high turnover of staff can result in loss of operational knowledge resulting in operational gaps. Council should develop a procedure for succession planning for key staff members.	2014	In Progress	Succession planning is a whole of Council and is being considered 19/11/2019 informal system in place to upskill staff in acting positions. Council is in the process of developing a succession plan.	MWS - to provide updates as required

3.38	CH, HH, SP	M	Consider upgrading the chlorine dosing systems to include automatic shutdowns, flow switches, scales etc., and integration with SCADA system and automation	2014	In Progress	19/11/2019 - upgrades have started at this water plants	
3.47	CH	L	Council to undertake investigations of a dedicated rising main for Big Nobby Reservoir.	Aug-19	In progress	21/11/2019 - MWS to provide update is this is feasible	MWS - to provide update as required
3.48	All	M	Continue removal or replacement of internal ladders with FRP	2014	In progress	All concrete reservoirs been done, good progress (NE, HH, BB, NB, WW done in 2017/18), ladders will be done when refurbishments are undertaken 19/11/2019 - this project is ongoing and progress and schedules are captures in both ASAM and councils reservoir progress document	TO - to continue to provide updates as required
3.6	ALL	M	Develop a comprehensive public and media communications strategy and include draft public and media notifications and leverage, where possible, existing mechanisms by which council communicates with the community. Define communication protocols with the involvement of relevant agencies and include in the protocols a contact list of relevant agencies and businesses and their relevant key people and update contact details (also include in DWMS).	2014	To be started	Council to investigate and check if community strategic plan. Social media (FB) used currently. 19/11/2019 -	MWS to liaise and develop with Community Partnerships.

3.7	ALL	L	Council may consider providing water quality data on resident's rates notices and/or publishing some of this data on their website	2014	Ongoing	Used to be on the website, but was removed when NSW Health removed theirs, decision to be made by GM 19/11/2019 decision yet to made	MWS - to discuss with Operations Director and GM
3.76	ALL	M	Council should strongly consider investing in online monitoring at all CCPs. This would provide greater process control, as immediate notification would be provided in the event an alert limit is exceeded. Importantly, it would also provide the opportunity of an immediate response in the event a critical limit is exceeded (such as triggering a plant shut down). Online monitoring would also provide useful data for analysis of performance of processes used to control hazards at CCPs and would improve understanding of the WTP's effectiveness more generally.	2014	In progress	19/11/2019 - this is ongoing with some of the CCPs having already been captured onto Clear SCADA	ME - to provide ongoing status update
3.84	ALL	L	Council should consider implementing a monthly water quality performance report to be supplied to councillors and uploaded to Councils website.	2014	Ongoing	currently undertaken, summary provided Director only	WQO, TLW & PE to discuss what data and what format to be web displayed
3.88	ALL	L	Develop internal audit procedures and schedules appropriate to functionality of council and the water supply systems. Identify appropriate personnel to undertake the internal audit and provide training in auditing.	2014	Ongoing	Undertaken informally, systems continuously audited, SOP for internal audit to be developed to ensure process is documented 21/11/2019 - Water Systems currently done informally Council has recently hired an Internal Auditor and systems at a higher level are currently being develop	MSW - to provide advice on how auditing in the water systems to be implemented

3.97	ALL	M	An SOP for plant start up following a period of shutdown needs to be developed	Dec-14	In progress	SOP to be developed	TLW - to provide status update
3.98	BB	M	Current location of final turbidity analyser to be confirmed, and relocated if required to sample location, post filters and prior to pH correction. BB	Dec-14	In progress	21/11/2019 - This will be captured and actioned when the plant is upgraded	TLW - to provide status update
4.01	All	H	Operators to ensure that reservoir inspections are occurring monthly as required, currently they are not occurring regularly	Dec-14	In progress	Monthly inspection sheets are stored in F: Drive and Reviewed by WQO 21/11/2019 - this is also being transferred into WaterOutlook	TLW & WQO to continue to check inspections sheets and transfer into the WaterOutlook program
4.04	KLM	M	Confirm that the HMI trends at SM Dam are available and establish a setup of downloading trend data regularly and recording, for historical purposes, until Clear SCADA is established at this site.	Dec-14	In progress	Clear SCADA established 21/11/2019 - this is set up however "ME" to confirm data capture is historized	ME - to confirm data capture is historized
4.05	KLM	L	New raw water sample location to be established in pump room on Greenhill line, prior to disinfection dosing. Could use existing soda ash dosing point. Currently sampling from 8 m sample at dam which is not ideal.	Dec-14	In progress	Soda Ash point currently being used, permanent point will be put in as upgrades are done 21/11/2019 - A dedicated sample location to be identified and installed	TLW - to identify sample tap location and organise installation
4.09	All	H	Council needs to ensure that a log is kept of all changes to SCADA limits and ensure that security controls are in place for changes to CCP levels. Council should also consider an approval process for making these process adjustments.	Dec-14	In progress	All changes logged automatically, including who changed it (the event page) 21/11/2019 - Need to double check that dosing set points affecting the CCPs are clamped and that alarms are reviewed	ME - Need to double check that dosing set points affecting the CCPs are clamped and that alarms are reviewed

4.01	All	H	Operators to ensure that reservoir inspections are occurring monthly as required, currently they are not occurring regularly	Dec-14	In progress	Monthly inspection sheets are stored in F: Drive and Reviewed by WQO 21/11/2019 - this is also being transferred into WaterOutlook	TLW & WQO to continue to check inspections sheets and transfer into the WaterOutlook program
4.04	KLM	M	Confirm that the HMI trends at SM Dam are available and establish a setup of downloading trend data regularly and recording, for historical purposes, until Clear SCADA is established at this site.	Dec-14	In progress	Clear SCADA established 21/11/2019 - this is set up however "ME" to confirm data capture is historized	ME - to confirm data capture is historized
4.05	KLM	L	New raw water sample location to be established in pump room on Greenhill line, prior to disinfection dosing. Could use existing soda ash dosing point. Currently sampling from 8 m sample at dam which is not ideal.	Dec-14	In progress	Soda Ash point currently being used, permanent point will be put in as upgrades are done 21/11/2019 - A dedicated sample location to be identified and installed	TLW - to identify sample tap location and organise installation
4.09	All	H	Council needs to ensure that a log is kept of all changes to SCADA limits and ensure that security controls are in place for changes to CCP levels. Council should also consider an approval process for making these process adjustments.	Dec-14	In progress	All changes logged automatically, including who changed it (the event page) 21/11/2019 - Need to double check that dosing set points affecting the CCPs are clamped and that alarms are reviewed	ME - Need to double check that dosing set points affecting the CCPs are clamped and that alarms are reviewed
4.1	All	L	Council currently only have one test kit for testing hypo strength, and this is located at the Dam. Council should consider purchasing another kit for the upriver sites.	Dec-14	In progress	Will be ordered, may be required for each plant that uses hypo 21/11/2019 -confirmation of purchase of additional kits required	TLW - kits to be purchased

4.11	All	M	Council to contact Port Macquarie Lab to determine protocols for micro sampling on weekends if required during a CCP failure.	Dec-14	In progress	Protocol to be discussed, formalising process will be considered 21/11/2019 - Process in place with Port Lab. Need to develop SOP for confirmation of steps in the event of CCP failure and taking a non-routine micro sample on the weekend	TLW & WQO - Process in place with Port Lab. Need to develop SOP for confirmation of steps in the event of CCP failure and taking a non-routine micro sample on the weekend
4.14	All	M	Develop a list of priority meters and power supplies that should be maintained by Council to be used during incident response if required	Dec-14	In progress	Develop a list of emergency power needed by Council during incident response 21/11/2019 - ongoing	ME - to provide status update on sites required generators in emergency times
4.15	All	M	Clear SCADA to include reservoir volume as well as level	Dec-14	In progress	Will be incorporated into Clear SCADA, 21/11/2019 - ongoing ME to investigate	ME- to investigate and action
4.17	All	M	An audit of all chemical dosing interlocks for each treatment plant should be undertaken	Dec-14	In progress	Already undertaken, actions to be followed up 21/11/2019 - Need to re-check all then actions developed and actioned	TLW, PE & ME - Need to re-check all then actions developed and implemented
4.18	All	M	Consider developing an SOP which is a risk-based approach to determining whether a Bacto sample is warranted following a mains break.	Dec-14	To be started	SOP will be developed 21/11/2019 - not started yet	OE - to develop and provide progress update
5.02	All	H	There was no Hazardous substances register, Pollution Incident Response Management Plan or emergency documentation stored on site. A MSDS register was on site but it was out of date. The PIRMP needs to be distributed to all WTP's and in the vehicles of the operators. A Hazardous substance register and updated MSDS's also need to be provided on this site. Explore the capabilities to utilise KMS.	Apr-16	In Progress	21/11/2019v - need to locate or developed a hazardous substance register. Council BCP recently updated that covers pollution incident responses and emergency protocols The rest needs to develop	TLW & PE - to review and develop

5.03	HH	L	There were no instructions on site for number of soda ash bags to be loaded when batching up the soda ash and the operator was not clear on how many to use. A simple SOP, or work instruction, should be developed for this and be available on site.	Apr-16	In progress	SOP for batching up will be developed 21/11/2019 - SOP yet to be developed	TLW - to delegate to WO for development
5.04	HH	M	Investigations should also be made into the condition of the Zeolite filter at the base of the aeration tower, which is unlikely to have ever been replaced and should be replaced routinely, as per the directions in the O&M Manuals. The Zeolite will help to absorb iron prior discharge into the balance tank	Apr-16	In Progress	Council to investigate if this is required 21/11/2019 - ongoing	PE - to investigate and provide update
5.05	BB	M	Proper signage should be displayed in the chemical storage areas instead of marker pen written signage on the storage tanks and hazardous chemical signage should be improved	Apr-16	In progress	21/11/2019 - TLW & PE to conduct an audit of all signage to confirm all correct signage is in place	TLW & PE to conduct an audit of all signage to confirm all correct signage is in place
5.06	BB, Th, WW	L	The dilution instructions for the Hypo are written on the storage container and the manual backwash instructions for the arsenic filter is taped to the filter. These should be developed into controlled SOP's and maintained in the O&M Manual	Apr-16	In progress	SOP to be developed 21/11/2019 - Hypo SOP has been started Arsenic filter SOP yet to be started	TLW - to provide update
5.11	Th	VH	Permanent ladder access to both reservoirs Safety rail around second reservoir and replace swimming pool fencing on first reservoir and replace with safe access railing (pool fence collects debris on top of the reservoir) Consider security fencing around reservoirs	Apr-16	Ongoing	Overflow completed, rest to be undertaken 21/11/2019 - consultation to occur at next quarterly meeting with Health and Dol	PE -to raise at next meeting and then provide update

			Overflow is an open hole with a mesh covering, this needs to be fixed.				
5.12	Th	L	Reservoir diagrams of all valves, taps, pipes, scouring options and interconnections required Separate scours for each reservoir required (to be done)	Apr-16	In progress	21/11/2019 - PE investigate scouring options at Reservoir	PE - to investigate and provide update
5.13	Th	H	Consider Security fencing around Treatment Plant Buildings	Apr-16	In progress	21/11/2019 - consultation to occur at next quarterly meeting with Health and Dol	PE - to investigate and provide update
5.14	Th	H	Integrate SCADA onsite & Door alarms connected to SCADA	Apr-16	In progress	21/11/2019 - this will be incorporated with the roll out of upgrades across all sites	ME - to provide status update
6	KLM, CH, SP, WW BB Th	M	Chemicals from agricultural runoff near bores - Consult with NSW Health for sponsored sampling programme to test all bores 6monthly over 2 year period to develop base line for protection actions. This could include hydrocarbon testing to capture potential fuel ingress	Nov-19	NEW	Develop a project brief and send to NSW Health if not approved by Health consider adding into our sampling monitoring program	TLW & WQO to action
6.01	KLM	H	Investigate installation of online monitoring at SMD for nutrients e.g. TN & TP	Nov-19	NEW	To re-assess pending approval of emergency treatment plant. May need to consider move to balance tank	
6.02	ALL	H	Development of SOP for testing methodologies of Arsenic, Antimony(remove), Iron Manganese etc	Nov-19	NEW	Development of all spot field methodologies	TLW - to pass onto WO
6.03	SMD	H	Investigate options for Destratification (other than aeration)	Nov-19	NEW	Re-visit based on outcome of emergency treatment plant at SMD	MWS & PE

6.04	SMD	H	Confirm inspections For SMD are included in the site management procedure - relating to access and contamination from animals	Nov-19	NEW	inspections to be included in site management procedure. (JN to confirm - then remove 16/09/19)	TLW to confirm
6.05	HH	H	Aeration at Hat Head - update maintenance programme to a 6 monthly frequency opposed to yearly	Nov-19	NEW	6 month inspection to be added with a separate yearly clean. This is to be captured in the plant SOP	TLW to Action
6.06	SWR	M	Failure of blowers affecting downstream process Development of SOPs for Blower inspections and investigate automatic plant shut down on interlocks into Clear SCADA	Nov-19	NEW		ME - investigate SCADA interlocks TLW - to action development of SOP
6.07	SWR	M	Maintenance practises leading to increased pressure and breakthrough of sand. Add shutdown control of plant operations into Clear SCADA & (remove) Regular Scour programme of delivery line into WTP from borefield	Nov-19	NEW	Develop scour programme - Some engineering controls need to be developed for capture of contaminated water EPA happy with filter bag to stormwater	PE, OE & TLW to collaborate
6.08	BB, SWR, SP	M	Update and/or development of SOPs for use of coagulants and other chemicals at treatment plants. This Should include the process for Jar Testing	Nov-19	NEW		TLW - to action
6.09	SWR	M	Manganese & Iron issue in borefield Long term options are WTP extension with the inclusion of additional pre-treatments	Nov-19	NEW		MWS to investigate
6.1	SP	M	reject water from the clarifier enters inlet stream investigate corrective actions to minimise reject water entering clarifier.	Nov-19	NEW	PE - need to install E1 pump station for reject water ME - trades to investigate leak	PE & ME - action as per comments

6.12	SWR	H	investigation required for SWR for CIP - Consider installation of new membrane cleaning tank with hot water	Nov-19	NEW	quotes received for new tank and bund and prep work on chemical storage area	PE - ongoing
6.13	SWR	M	Fluoride - Investigation of design limit so system cannot overdose and set at that level	Nov-19	NEW	ME - is investigating	ME- ongoing
6.14	WW	M	When filling Willawarrin reservoir from a tanker, the tanker should have a spray nozzle diffuser attached/installed to reduce sediment stirring	Nov-19	NEW		
6.16	All	H	investigate having the hatch alarms connected to SCADA for all locations - NEW TASK to be added	Nov-19	NEW		ME & TLW to action
6.17	ALL	VH	review optimal operating water levels to confirm accuracy (report recently undertaken) to be checked then remove task F:\UTILITIES\DRAFT New Water Services\WATER SCHEMES\POTABLE WATER\RESERVOIRS	Nov-19	NEW	PE to confirm data and update if required	PE - to investigate and provide update
6.19	All	H	Consider a notification through customer service/Facebook to customers that will experience loss of supply due to power outages at booster pump stations and consider emergency power generation role out plan	Nov-19	NEW	Collaboration between PE, ME and Comms group. Plan to be developed for emergency generator rollout across critical assets	PE & ME to action
6.2	ALL	H	Review old flushing program and remodel - initiate after drought breaks	Nov-19	NEW		TLW