MIDCOAST
water services

Drinking Water Quality Management System

Revised June 2018

Version and Document Control

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Record of Document Review

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4	MidCoast Water Services	Full document review. Nabiac WTP incorporated.	June 2018	Director Water Services	12/06/2018

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INTRODUCTION

The historic industry practice of ensuring safe and aesthetically acceptable drinking water by measurements at customer taps for compliance to specific values came under scrutiny about a decade ago. This approach was proven to be insufficient after several cases of outbreaks of diseases resulting from poor performance of public water supply systems in USA and Canada. These outbreaks could have been avoided. Better understanding of risks in relation to water supply and advancement in scientific research into water quality has led to changes in the approach to management of provision of safe drinking water.

This Drinking Water Quality Management System (DWQMS) follows a risk based approach. This includes anticipating potential problems and implementing preventive measures (including barriers, controls and procedures) to prevent them from happening or reduce the risk to an acceptable level. All stages of the drinking water system are considered and detailed in this quality system from drinking water catchments, through the treatment process and to customers' taps.

This document describes the processes used to deliver safe drinking water to customers across the local government area of MidCoast Council. It is based on the *Framework for Management of Drinking Water Quality* under the Australian Drinking Water Guidelines (ADWG). It has been developed to conform to Section 25 of *Public Health Act 2010* and Clause 34 of *Public Health Regulation 2012.* The Act sets out the need for *Quality Assurance Programs* and the Regulation sets out the need for the programs to be consistent with relevant aspects of the *Framework.*

MidCoast Water Services is a division of MidCoast Council responsible for water and sewerage services across the local government area. MidCoast Council operates under the *Local Government Act 1993* and is governed by a board of 11 elected councillors. MidCoast Council was formed on 12 May 2016 through the merger of the former Great Lakes, Greater Taree City and Gloucester Shire Councils. MidCoast Water Services (previously MidCoast Water) became a division of MidCoast Council on 1 July 2017.

The largest water supply operated by Council is the Manning Water Supply Scheme with smaller water supplies in Bulahdelah, Stroud, Tea Gardens and Gloucester. Bulk water is purchased from Hunter Water for distribution to customers at North Karuah.

The figure below shows the MidCoast Council local government area.

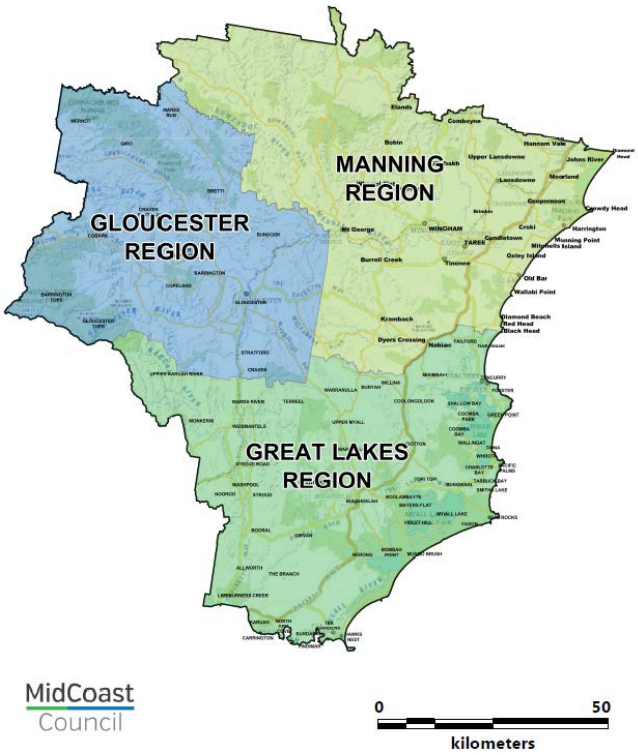

Figure 1: MidCoast Council local government area

The figure below summarises the elements of the ADWG framework which have been used to structure and implement the DWQMS.

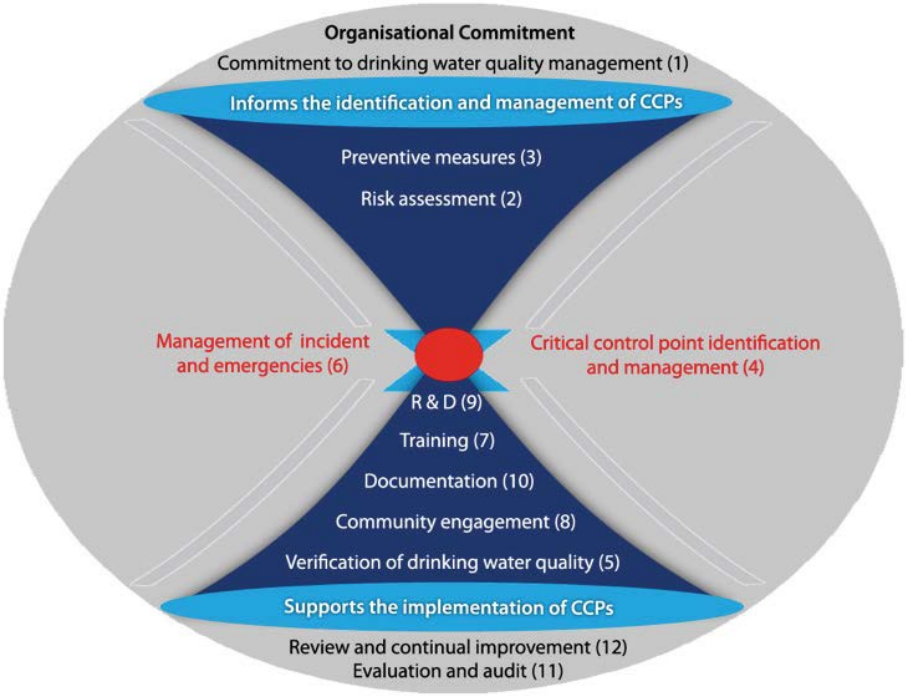

Figure 2: ADWG 2011 Drinking water quality management framework

The current quality system is a continuation and review of

- *MidCoast Water's Drinking Water Quality Management Plan Progress Report No 1 September 2007* (MCWS ID A241209);
- *Drinking Water Quality Management Plan Progress Report No 2 May 2008* (MCWS ID A290034) and;
- *Drinking Water Quality Management Plan 2010-15 Progress Report 1 October 2010* (MCWS ID A287603).

The quality system is scheduled for a formal, independent, external review every five years, with annual internal reviews which will be used to update system information and actions that have occurred.

As this is an overview document, the DWQMS does not contain extensive detailed information. This information is available within a number of other key documents used within Council. These key documents are referred to (and linked where appropriate) in the DWQMS and can be accessed by staff through the electronic document management system.

COMMITMENT TO DRINKING WATER QUALITY MANAGEMENT

An effective drinking water quality management system requires support and commitment from all levels of the organisation; from councillors and management to the operational staff responsible for the day to day running of the systems. The following section describes the organisation's commitment as demonstrated by strategic planning, adherence to drinking water quality policy and relationships with regulators and other stakeholders.

ELEMENT 1: COMMITMENT TO DRINKING WATER QUALITY MANAGEMENT

1.1 PLANNING FRAMEWORK

The New South Wales State Government's Integrated Planning and Reporting (IP&R) framework was introduced in 2010 to enhance strategic planning and reporting requirements for local government councils in NSW. Current IP&R documents can be accessed on MidCoast Council's website www.midcoast.nsw.gov.au/Council/Plans-and-reports and are described in Figure 3 below.

Drinking water quality management is a core aspect of the organisation and aligns with Council's values, in particular;

- We value a connected community. We protect the health and safety of our communities:
  - Continue to develop a sustainable network of water, sewer and storm water systems to meet community needs and health and safety standards;
  - Deliver ongoing service quality and continuity with increasing efficiency and better performance for Water Services and;
  - Implement the long term service delivery strategies and plans (incl. the Integrated Water Cycle Management Plan, Drinking Water Quality Management Plan, and the Asset Class Management Strategy) for Water Services.
- We value our environment. We protect, maintain and restore our natural environment:
  - Protect, maintain and restore water quality within our estuaries, wetlands and waterways.

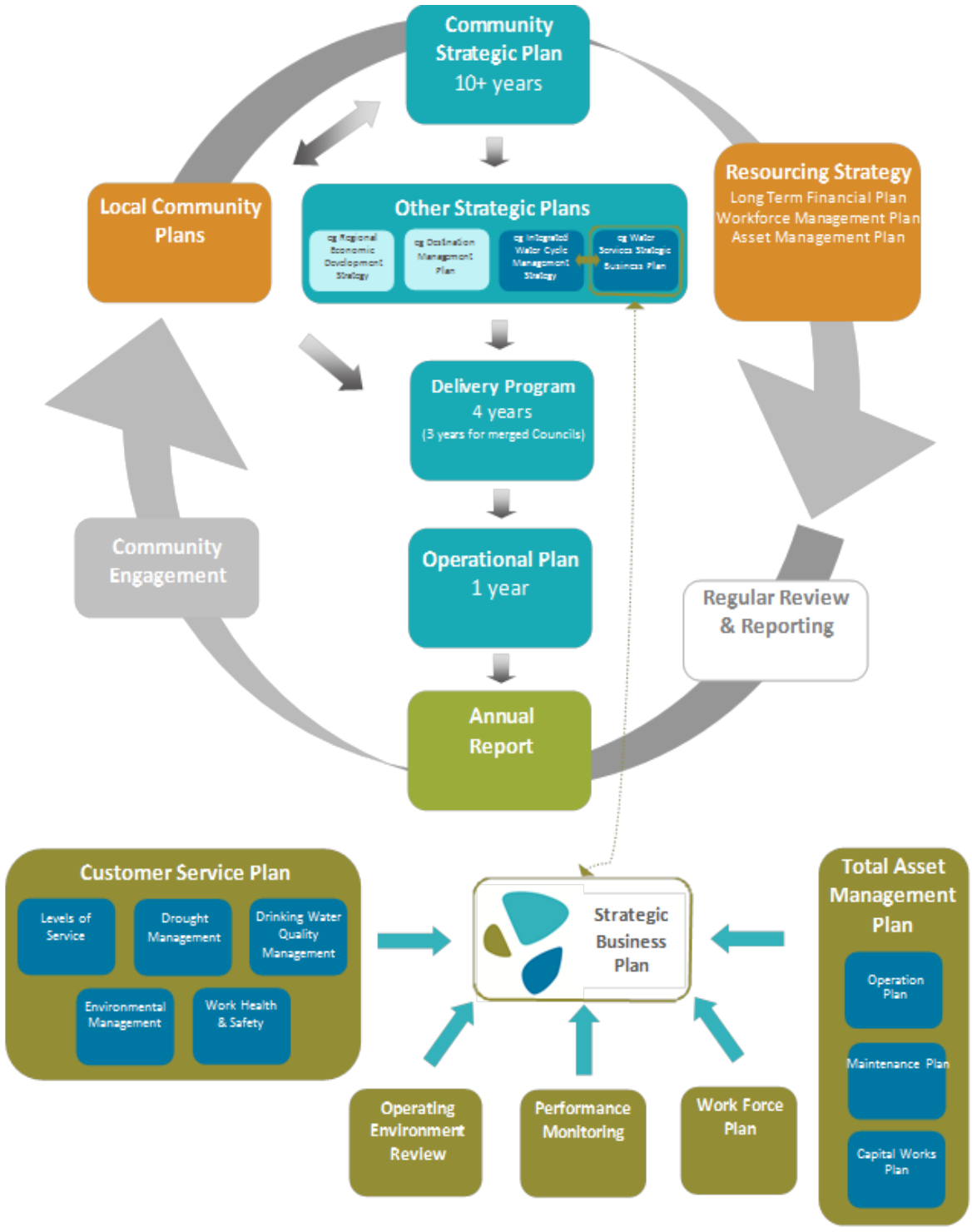

Figure 3: IP&R framework

1.2 DRINKING WATER QUALITY POLICY

Council's *Drinking Water Quality Policy* http://www.midcoastwater.com.au/site/policy-documents was originally adopted in March 2007. It was updated in 2018 and Version 2 was adopted in June 2018 in conjunction with the revision of this quality system. It is implemented throughout the organisation. The policy is communicated to new Water Services' employees during the corporate induction process, along with a summary of the quality system. The policy is available to all staff through the document management system, published on the website and available in hard copy at each water treatment plant.

The policy includes a statement of commitment to supply high quality drinking water which consistently meets ADWG, customer's expectations and regulatory requirements. The delivery of high quality drinking water is achieved by application of a risk-based approach with all potential risks to water quality identified and measures implemented to minimise any threats. Regular water quality monitoring and effective reporting is in place to supply information to customers and regulators.

1.3 REGULATORY AND FORMAL REQUIREMENTS

The provision of water supply and sewerage services to country towns in NSW is the responsibility of local government under the Division 2 Part 3 Chapter 6 of *Local Government Act 1993*. MidCoast Water Services has regulatory and formal requirements relating to the supply of safe drinking water to its customers under the Act.

Other regulatory and formal requirements include the following:

- *Public Health Act 2010;*
- *Public Health Regulation 2012*;
- *Fluoridation of Public Water Supplies Act 1957;*
- *Fluoridation of Public Water Supplies Regulation 2017;*
- NSW Code of Practice for the Fluoridation of Public Water Supplies 2011;
- NSW Health Drinking Water Monitoring Program 2005 (updated October 2011);
- Water Sharing Plan for Lower North Coast Unregulated and Alluvial Water Sources 2009;
- *Protection of the Environment Operations Act 1997;*
- Environmental Protection Licence No 6583 – Bootawa Dam (regulates use of algaecide);
- *Water Management Act 2000;*
- NSW Best Practice Management of Water Supply and Sewerage Guidelines and Framework 2007;
- Plumbing Code of Australia and;
- AUS SPEC 0071 Water supply - Reticulation and pump stations (Design).

NSW Department of Industry and NSW Health are the main regulators in relation to drinking water quality management. Hunter New England Population Health is the local health unit Council reports to directly.

A Memorandum of Understanding (MOU) between NSW Health and MidCoast Water Services was signed in April 2007, reviewed and updated in 2013 and 2018. It is designed to align the long term strategic direction of both organisations in the area of public health protection. Refer to *Memorandum of Understanding between NSW Health and MidCoast Water Services* (http://www.midcoastwater.com.au/client_images/2044689.pdf).

NSW Department of Industry is responsible for managing NSW Safe and Secure Water Program. The department oversees and monitors the performance of local water utilities and promotes best practice management of water supplies.

NSW Department of Industry's Best Practice Management for Water Supply and Sewerage Guidelines 2007, require water utilities to develop Integrated Water Cycle Management (IWCM) strategies. Our Water Our Future is Council's IWCM strategy. It sets the direction for the sustainable management of water and sewer services in the area over the next 30 years. The strategy was reviewed and updated in 2015. Refer to *Our Water Our Future* (http://www.midcoastwater.com.au/site/our-water-our-future).

NSW Department of Industry manages water extraction licences and the development of Water Sharing Plans for water sources across NSW. Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources 2009 includes rules for protecting the environment, water extractions, managing licence holders' water accounts and water trading including Council's' drinking water catchments. Karuah River Water Sharing Plan was developed in 2004 and merged into this plan in 2016 (can be accessed at http://www.legislation.nsw.gov.au/~/view/regulation/2009/348/full).

MidCoast Water Services' stakeholder register is a comprehensive list of all regulators and stakeholders relevant to the provision of drinking water supplies. It describes requirements from the organisation and each stakeholder, contact details and modes of communication. Refer to *MidCoast Water Services Stakeholder Register - Water Supply Services* (MCWS ID A583995).

Reporting requirements are extensive. These are covered in Element 10*: Documentation and Reporting. MidCoast Water Services' Compliance and Reporting Requirements Managed by Strategic and Regulatory Compliance Group* (MCWS ID A549090) lists the requirements of the former Strategic and Regulatory Compliance group (now part of Water Management and Treatment).

1.4 ENGAGING STAKEHOLDERS

There are a large number of stakeholders who affect or are affected by the decisions made by Council. Methods of engaging these stakeholders will vary depending on relationships between the groups. Relationships are maintained with; customers and the wider

community, local landholder groups, irrigator groups, local schools, media, State Forests, National Parks and Wildlife Service and various other groups.

A relationship is maintained with the Aboriginal communities of Tobwabba and Purfleet under NSW Department of Industry's Aboriginal Communities Water and Sewerage Program. The roles, responsibilities and key contacts of these communities, the Local Aboriginal Land Council Chief Executive Officer, MidCoast Water Services, NSW Department of Industry and NSW Health are listed in *Purfleet Aboriginal Water and Sewerage Management Plan* (MCWS ID A441839) and *Tobwabba (Cabarita) Aboriginal Water and Sewerage Management Plan* (MCWS ID A441840).

There are both existing and proposed mining activities within some of Council's drinking water catchments. Council is actively involved in government reviews of mining operations and potential impacts to ensure the protection of drinking water catchments is seen as a priority. This involvement includes;

- Participation in State and Federal Government reviews of mining approval processes, e.g. preparing submissions, taking part in public hearings, participation in workshops called by the NSW Chief Scientist or other bodies, issuing position statements and attending public meetings;
- Involvement in Gloucester Bioregional Assessment. This program is a scientific collaboration run by the Australian Government (Department of the Environment, Bureau of Meteorology and Geoscience Australia) and coordinated by Commonwealth Scientific and Industrial Research Organisation (CSIRO). It aims to provide scientific water resource information associated with coal seam gas and large coal mines and includes input from a large number of stakeholders;
- Participation in Community Consultative Committees of various mines as required and;
- Communication and engagement directly with mines.

Council actively engages with water industry and various utility associations and professional bodies, including active membership with Australian Water Association (AWA), Water Operators Industry Association of Australia (WIOA), Water Directorate and Water Services Association of Australia (WSAA). These activities enable staff to exchange ideas with other professionals who are managing the full range of issues associated with the delivery and management of healthy drinking water supplies. Council has also engaged in strategic research alliances with groups and individuals who can provide insights into challenges that may need to be managed by staff in the future.

Effective communication with customers and the wider community is a high priority. Information relating to Council's operations, quality of the water supply and strategic direction is provided to the community via the website, customer service, community newsletters, community events and media releases. Other methods of receiving customer feedback are utilised and are covered in more detail in Element 8: *Community Involvement and Awareness*.

SYSTEM ANALYSIS AND MANAGEMENT

Effective system analysis requires a comprehensive understanding of the characteristics and processes of drinking water supply systems. The aim is to ensure the safe delivery of drinking water to customers and be in a strong position to manage any emerging water quality issues. The following sections of the quality system describe each water supply system in detail, including hazard analysis and risk assessment.

ELEMENT 2: ASSESSMENT OF DRINKING WATER SUPPLY SYSTEMS

2.1 AUSTRALIAN DRINKING WATER GUIDELINES

The Australian Drinking Water Guidelines (ADWG) have been developed by National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC) of the Australian Government. These guidelines have been updated several times, with the most recent update released in 2011. The ADWG are intended to provide a framework for good management of drinking water supplies that, if implemented, will assure safety at point of use. ADWG are very comprehensive, however they include six overarching guiding principles which provide a useful summary and are as follows:

- *The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised;*
- *The drinking water system must have, and continuously maintain, robust multiple barriers appropriate to the level of potential contamination facing the raw water supply;*
- *Any sudden or extreme change in water quality, flow or environmental conditions (e.g. extreme rainfall or flooding) should arouse suspicion that drinking water might become contaminated;*
- *System operators must be able to respond quickly and effectively to adverse monitoring signals;*
- *System operators must maintain a personal sense of responsibility and dedication to providing consumers with safe water, and should never ignore a customer complaint about water quality and;*
- *Ensuring drinking water safety and quality requires the application of a considered risk management approach.*

Throughout the ADWG two types of guideline values are used. These are:

- **HEALTH-RELATED GUIDELINE VALUE:** *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 and;*

- **AESTHETIC GUIDELINE VALUE:** *concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer; for example appearance, taste and odour (NHMRC, NRMMC 2011).*

2.2 ROLES AND RESPONSIBILITIES

MidCoast Council has in excess of 70 staff who are directly involved in the delivery of drinking water and implementation of the DWQMS. Employing and retaining competent and well trained staff with a commitment to providing safe drinking water is essential in the water industry. Roles of these staff extend from the Director and management team who oversee DWQMS performance, to coordinators, operators, engineers and scientists. The elected councillors oversee the activities of Council including development and implementation of the DWQMS; refer to *Water Services staff and roles involved in implementation of Drinking Water Quality Management System* (MCWS ID A589603).

A water quality team was formed in February 2016 to assist with implementation of the quality system and manage the corrective actions database. Meetings are held as required and progress is reported to Water Services management. Recommendations are made by the team to management according to priorities of corrective actions and progress is reported to management on a quarterly basis.

External contractors and engineers are utilised to assist in the operation of water supplies, and design and construction of new assets such as Nabiac Water Treatment Plant, including review of the DWQMS. These external advisers have a sound understanding of the ADWG 2011 and have their own professional standing within the Australian and international water industry.

2.3 OVERVIEW OF DRINKING WATER SUPPLIES

MidCoast Council is responsible for the operation of five drinking water supply systems; Manning, Bulahdelah, Stroud, Tea Gardens and Gloucester. Bulk water is purchased from Hunter Water to supply a small reticulation scheme at North Karuah.

The largest of these supplies is Manning Water Supply Scheme. It serves a population of approximately 70 000, which accounts for 90% of Water Services' customers. Water is extracted from Manning River, stored at Bootawa Dam and treated at Bootawa Water Treatment Plant (WTP). Nabiac WTP is expected to be commissioned in 2018. Water will be extracted from a bore field at Nabiac Inland Dune Aquifer to supplement Manning Water Supply Scheme. Both Bootawa and Nabiac WTPs are microfiltration plants.

Bulahdelah Water Supply Scheme serves a population of approximately 1 200 in the town of Bulahdelah. Source water comes from Crawford River and is treated at a small conventional WTP located at Bulahdelah.

Stroud Water Supply Scheme draws source water from Karuah River. The water is treated at a small conventional WTP, including an off river storage. The scheme serves a population of approximately 1 000 in the villages of Stroud and Stroud Road.

The residents of Tea Gardens and Hawks Nest, approximately 3 800, are supplied with drinking water from Tea Gardens WTP (microfiltration plant). Source water for this scheme is groundwater from Viney Creek Aquifer north-west of Tea Gardens.

Gloucester Water Supply Scheme sources water from Barrington River. Water is treated at a conventional WTP before being distributed to approximately 3 500 residents of Gloucester and Barrington.

Council purchases bulk water from Hunter Water for distribution to a population of approximately 100 at North Karuah. Monitoring and reporting of water quality in the reticulation system of this supply is the responsibility of Water Services. Water treatment and monitoring through the treatment process is the responsibility of Hunter Water.

These water supply systems vary in size and complexity. A general description of each system is presented in the table below.

Table 1: Description of water supply systems

Water Supply System	Source Water/Catchment	Treatment Process	Towns Supplied	Population Served
Manning	Manning River	Selective pumping, retention and sedimentation in Bootawa Dam, screening, water stabilisation, coagulation, microfiltration, ozonation, BAC filtration, chlorination, fluoridation	Taree, Forster, Tuncurry, Hallidays Point, Wingham, Pacific Palms, Old Bar, Harrington, Coopernook, Crowdy Head, Cundletown, Krambach, Nabiac, Lansdowne, Manning Point, Tinonee and Green Point	70 000
	Nabiac Inland Dune Aquifer	Water stablisation, aeration, coagulation, microfiltration, chlorination, fluoridation		
Tea Gardens	Viney Creek Aquifer	Water stabilisation, aeration, coagulation, microfiltration, pH correction, chlorination, fluoridation	Tea Gardens and Hawks Nest	3 800
Gloucester	Barrington River	pH correction, coagulation, sedimentation, sand filtration, chlorination, fluoridation.	Gloucester and Barrington	3 500
Bulahdelah	Crawford River	pH correction coagulation, sedimentation, sand filtration, chlorination, fluoridation.	Bulahdelah	1 200
Stroud	Karuah River	Selective pumping, coagulation, sedimentation, off river storage, secondary coagulation, sand filtration, chlorination, fluoridation	Stroud and Stroud Road	1 000
North Karuah	Bulk water supplied by Hunter Water – Tomago borefields	Aeration, coagulation, filtration, pH correction, fluoridation, chlorination. Treated by Hunter Water at Lemon Tree Passage WTP.	North Karuah	100

2.4 ASSESSMENT OF MANNING WATER SUPPLY SYSTEM

2.4.1 GENERAL DESCRIPTION AND HISTORY

Manning Water Supply Scheme provides drinking water to towns and villages in the lower Manning River catchment from Crowdy Head to Tarbuck Bay. Manning Water Supply Scheme originated from a combination of several schemes. In the 1960s a river intake and pumping station was constructed at Abbotts Falls on the Manning River. Water was pumped from the river and stored in Bootawa Dam before being distributed as part of Manning Water Scheme.

The original scheme served the main areas of Taree, Wingham, Hallidays Point, Nabiac and Forster. With further population growth the supply extended to Lansdowne, Harrington and Crowdy Head. In 1986 a new reservoir at Irkanda, pump station at Bootawa Dam, reservoir and booster pump at Lantana Crossing were implemented with further augmentation of the system. Manning Water Supply System underwent a major upgrade in 2010 with the construction of a membrane filtration WTP at Bootawa Dam site.

The Nabiac Dune Aquifer Water Supply and WTP are expected to be commissioned in 2018 to augment the Manning supply and improve water security. Water is extracted from a bore field at Nabiac Inland Dune Aquifer, treated at Nabiac WTP and supplied to the southern part of the existing Manning reticulation system.

The major components of the Manning scheme include:

- Manning River intake and pumping station (PS1A) at Bootawa
- Old intake and pump station at Abbotts Falls (not normally used)
- Bootawa Dam, 2250ML capacity
- Bootawa WTP (commissioned in 2010) 60 ML/day
- Bootawa treated water pump station (PS2B)
- 14 production bores at Nabiac Inland Dune Aquifer (commissioned 2018)
- Nabiac WTP (commissioned 2018) 10 ML/day
- Nabiac treated water pump station (commissioned 2018)
- Darawank balance tank and pump station (commissioned 2018)
- Northern district distribution system
- Southern district distribution system

Manning Water Supply Scheme currently serves a population of approximately 70 000, which increases to approximately 80 000 during the holiday months.

Figure 4: Bootawa Dam

Figure 5: Bootawa Dam tower

Figure 6: Nabiac WTP during construction

Figure 7: Nabiac production bore pump station

The following diagram is a schematic of Manning water supply and distribution system.

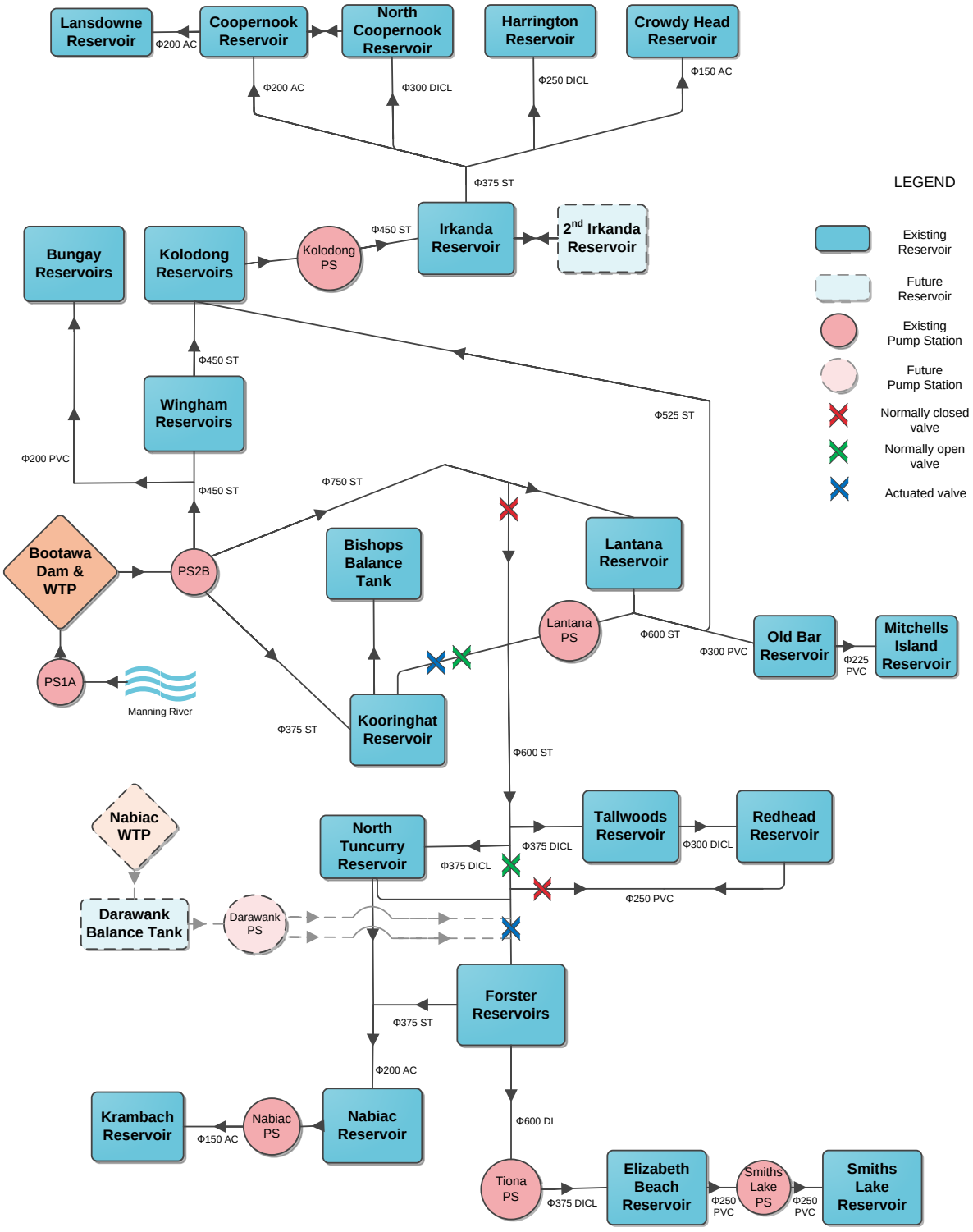

Figure 8: Manning water supply and distribution system

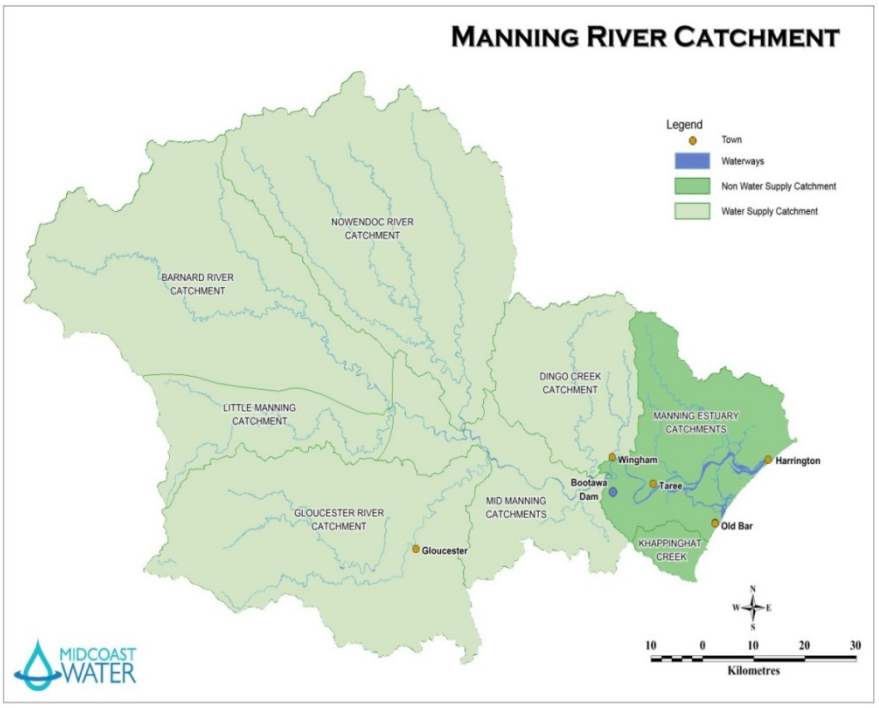

Figure 9: Manning River catchment map

The Manning River drains a catchment area of approximately 8 400km^2. The bulk of population in this catchment area live in the estuary zone, and parts of the upper catchment are very remote and hard to access with predominant land uses of grazing, National Park and Forestry. Other land uses include agriculture, rural residential, residential (villages), tourism, oyster farming and mining. The Manning catchment is home to a number of Aboriginal nations. Biripi country covers most of the catchment. Kamilaroi of the New England Tablelands and Worimi west of Gloucester are also represented (ABC 2014).

Council relies on water sourced from the Manning catchment as the main supply of drinking water for over 90% of its customers (this catchment area includes Gloucester in the upper catchment). The catchment is also an important resource for its environmental, social and economic values. Therefore Council is committed to catchment management to preserve and improve this resource as part of the 'catchment to tap' principle.

A range of research projects have been conducted and/or commissioned to determine priorities for catchment management to preserve and improve water quality and flows in the Manning. In 2011 a Manning River Catchment Management Program was produced which sets guiding principles for the organisation's activities and investment in Manning catchment. The document draws on information from previous studies and water quality monitoring programs (e.g. Barrington River, Nowendoc River, Little Manning River, Barnard River, Dingo Creek and Manning River upstream of intake to WTP) and combines these to recommend activities to help achieve the desired goals of improving overall catchment

health. For more information refer to *Working With Our Catchment: Manning River Catchment Management Program* (MCWS ID A330733).

Figure 10: Offtake site on Manning River

Figure 11: Manning River near Mt George

As part of Council's weed management obligations, *Bootawa Dam Noxious Weeds Management Program* (MCWS ID A414113) was developed in 2013. This plan sets out strict pesticide application procedures and water quality monitoring program (including baseline data collection before application). Samples are to be collected in Bootawa Dam on a seasonal basis after pesticide application to ensure the water supply is not adversely affected. The management program has been approved by NSW Health. As of 2018, there had been no pesticide application within the immediate dam catchment.

Weed control and revegetation has been concentrated just outside the immediate Bootawa Dam catchment with steady gains. The goal is for mixed, native regeneration for ecological values and a forested dam catchment in the future.

MINING ACTIVITIES IN MANNING CATCHMENT

Existing and proposed mining activities in Manning River catchment are mostly located in the upper reaches of the catchment near Gloucester within Avon River catchment. Council is involved in government reviews of mining operations and potential impacts to ensure the protection of drinking water catchments is seen as a priority. Council is also involved in development approval processes for individual mining developments as a government agency. Potential impacts of mining operations are considered during the risk assessment process.

NABIAC INLAND DUNE AQUIFER CATCHMENT

The Nabiac Aquifer is an inland dune aquifer located 6km south east of Nabiac and approximately 4km northwest of Tuncurry, as shown in the figure below. The total area extends over 44km^2 and the majority of the area is Aboriginal land except where it is adjacent with Wallamba River and Coolongolook River. The aquifer is generally flat and low,

recharged by direct rainfall infiltration and storm water runoff from Bundacree Creek in the west of the catchment. This area was mined for sand in the past.

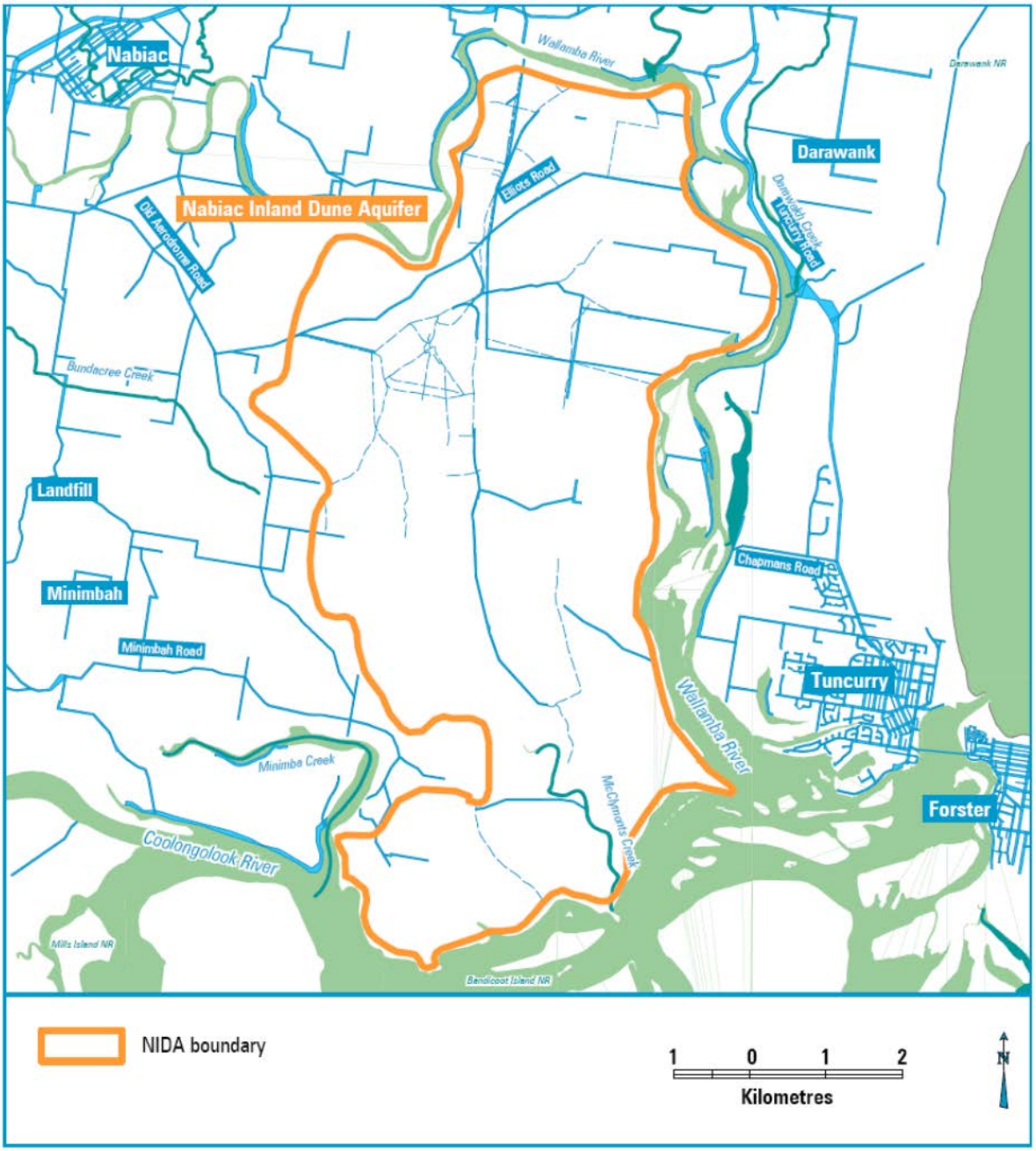

Figure 12: Location of Nabiac Inland Dune Aquifer

Groundwater monitoring including ground water levels, salinity levels and cease to pump conditions will be monitored as described in the Environmental Management Plan for Nabiac Inland Dune Aquifer Bore Field Operation (MCWS ID A442960). This plan identifies and addresses the following:

- Issues requiring the definition of management strategies;

- Measures required to alleviate or eliminate any potential environmental impacts;
- Environmental commitments within the Environmental Impact Assessment;
- Framework for managing all potential environmental impacts and;
- Remedial actions to be undertaken if undesirable impacts are likely to develop.

Water access licences have been granted by NSW Department of Industry for each of the 14 production bores with conditions including monitoring and pumping requirements.

2.4.2 BOOTAWA WATER TREATMENT PLANT

RAW WATER QUALITY - BOOTAWA

To optimise and understand the treatment process it is important to understand the characteristics of water that is to be treated. General raw water characteristics of Manning supply (at Bootawa) are summarised below. These vary depending on whether the water is sourced directly from Manning River under various flow rates, or if it has detention time in Bootawa Dam, so the list below is general.

- Neutral pH;
- Low alkalinity;
- Variable turbidity (when sourced directly from the river);
- Variable suspended solids (can be high when sourced from dam if algae is present);
- Low dissolved organic carbon and;
- Low metal concentrations.

PROCESS DESCRIPTION - BOOTAWA

Bootawa WTP is a membrane filtration plant which currently has the capacity to treat 60 ML/day with the provision to be upgraded to a capacity of 75 ML/day in the future. A control philosophy document for Bootawa WTP is stored onsite, refer to *MA4 1001- IY005 Control Philosophy Rev D 150411* (MCWS ID A329865). It includes a detailed description of all stages of treatment, diagrams, process control and maintenance information.

RAW WATER INTAKE

Bootawa WTP has three modes of raw water operation:

- Mode 1 (Manning River water turbidity <5 NTU). Water from Manning River is pumped by raw water pumps into Bootawa Dam. Water is then gravity fed to the treatment plant;
- Mode 2 (Manning River water turbidity >5 NTU and <50 NTU). Raw water pumps transfer river water to a raw water balance tank, where it gravitates back to the inlet of the WTP and;

- Mode 3 (Manning River water turbidity >50 NTU. Also dependent on phosphorus levels). Water is pumped from Bootawa Dam directly to the WTP with no water being pumped into the dam.

STABILISATION

Prior to screening, raw water is conditioned using lime and carbon dioxide for pH and alkalinity adjustment ensuring stable treated water that is not potentially corrosive to the distribution system. Lime slurry is dosed just after the plant inlet to maximise contact time ensuring complete reaction prior to carbon dioxide dosing. Carbon dioxide (dissolved into a side stream of raw water) is injected after lime, prior to coagulation.

SCREENING

Pre-dosed water is screened before entering the flash mixing tank to remove large particles which could damage the filtration membranes. A rotating drum screen with 2mm screen apertures captures solids into a small waste bin.

COAGULATION (FLASH MIXING)

Screened water is dosed with coagulant aluminium chlorohydrate (ACH) which is vigorously mixed by a vertical mixer in the flash mixing tank. ACH assists in removal of colloidal and suspended particulates from raw water by destabilising particles allowing them to aggregate for removal in the membrane filtration stage.

FLOCCULATION

Dosed water then flows into the inlet channel which provides gentle mixing and required contact time for coagulated suspended particles to agglomerate and form flocs. These flocs are then easily removed in the membrane filtration phase.

MEMBRANE FILTRATION

Flocculated water flows along the membrane inlet channel where it enters under gravity four (provision for five in the future) micro filtration cells. Each cell operates identically and in parallel. Feedwater enters the bottom of each cell and passes over and around the micro-porous hollow fibre membranes. Clean water is drawn through the membrane wall by suction pressure into the centre of each membrane fibre. Filtered water (filtrate) flows from the top of each module rack to the filtrate manifold into a common treated water outlet and passes to storage. The membranes provide a physical barrier for organisms such as cyanobacteria (blue green algae) and protozoa (e.g. *Cryptosporidium parvum*, *Giardia intestinalis*).

Cleaning and maintenance of membranes is carried out routinely in various ways. Frequency of different cleaning methods depends on raw water quality and type of fouling. Backwash removes retained solids from membrane surfaces with the use of pumps and air scour blowers. Clean in place (CIP) is required to maintain long term membrane performance and uses cleaning chemicals including hypochlorite and acid cleaners and soaking the membranes. Chemically enhanced backwash (CEBW) is similar to CIP but with reduced step times and no extended soaking. Compressed air is used for integrity testing and valve operation. Membrane integrity is also monitored via automatic pressure decay test and leak test and is trended on Supervisory Control and Data Acquisition (SCADA) system. Waste

water generated during cleaning processes is drained into a neutralisation tank before being discharged to the wastewater balance tank. Wastewater then passes to clarifiers for further treatment. Sludge is removed, and clear water returns to the head of the plant. For more detailed information on membrane maintenance and wastewater treatment including chemicals used in cleaning processes, refer to the control philosophy.

Filtrate from membrane filters flows into the clear water tank which has two compartments. The main compartment is utilised for provision of backwash water for membrane filters, biologically activated carbon (BAC) filters, CIP make up water and ozone generation cooling water. Water from the second compartment of the clear water tank gravitates to the ozone contact tank. Ozone and BAC processes can be bypassed if not required.

OZONATION

Filtered water is treated with ozone which breaks down taste and odour-causing compounds (e.g. Methly-Isoborneol (MIB) and geosmin, associated with algae). It is also effective against bacteria (e.g. *Escherichia. coli* (*E. coli*)) and viruses. Ozone gas is generated on site and dosed via diffusers configured in a baffle arrangement in the two stage ozone contact tank. This provides sufficient contact time to treat taste and odour compounds. Gas flow is adjusted with valves to meet water quality requirements. Water then gravitates over a weir at the outlet of the contact tank to ensure no residual ozone remains in solution at the end of the process stage.

BIOLOGICALLY ACTIVATED CARBON FILTERS

The ozonised water then flows via gravity to BAC filters. In conjunction with ozonation, BAC filters remove total organic carbon (TOC) and other organics which can contribute to taste and odour problems. BAC filtration process uses naturally occurring micro-organisms to remove organics via bio-assimilation. Organic matter is readily assimilated due to ozone having broken the chemicals into readily consumable forms.

Filtered water flows out the bottom of the tank. Media is cleared periodically to remove organics and excess bio growth with backwashing and air scouring. Backwash water is discharged into the waste water balance tank.

CHLORINE CONTACT TANK

BAC filtered water flows under gravity to the chlorine contact tank (CCT). Water is dosed at the inlet with chlorine gas for disinfection of pathogens (disease causing organisms, e.g. *E. coli* bacteria*)* and fluoride (sodium silicofluoride) is added for dental hygiene. The tank consists of two long chicanes which promote plug flow ensuring a minimum of 30 min contact time. Chlorine is dosed at a level high enough to maintain residual throughout the distribution system. Water passes over the outlet weir and through an underground pipe to the 8.5 ML treated water reservoir.

Treated water is then pumped via treated water pumping station (PS2B) to the distribution system.

The WTP is automatically controlled using Programmable Logic Controllers (PLC) and SCADA systems. These systems allow operators to control the plant remotely as well as record data for all treatment processes.

Figure 13: Bootawa WTP and laboratory

Figure 14: Old treatment building in foreground

FLOW DIAGRAM – BOOTAWA

A flow diagram was produced for the purpose of risk assessment and verified by participants of risk assessment workshops. It was included in the briefing paper produced for the risk assessment workshop held in May 2016, refer to *Briefing paper 2016 Risk Review Workshops* (MCWS ID A579800). Flow diagram for Bootawa WTP is provided in the figure below.

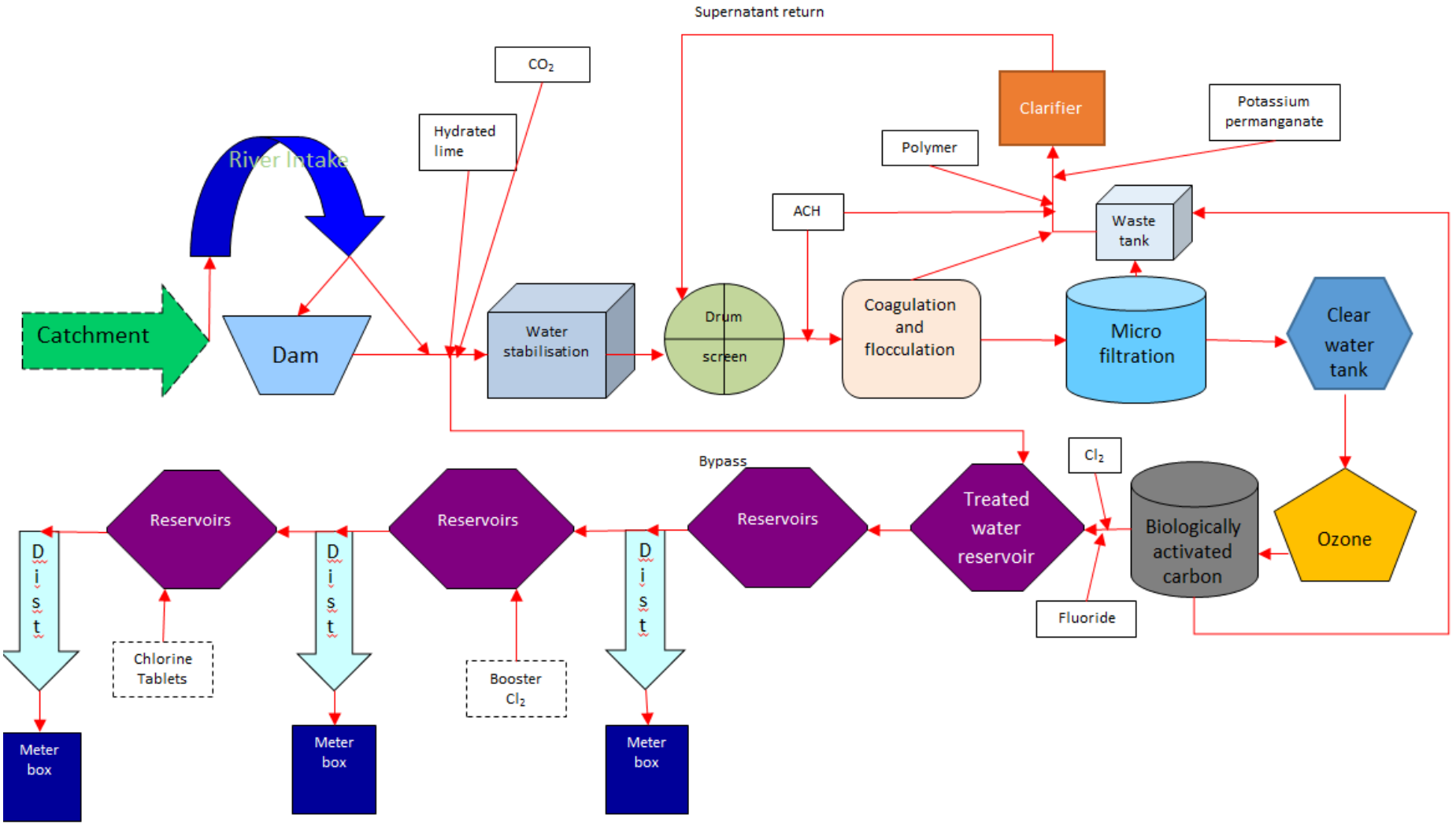

Figure 15: Bootawa WTP flow diagram

2.4.3 NABIAC WATER TREATMENT PLANT

Nabiac WTP will initially have the capacity to produce 12 ML/day; however will be operating at a maximum of 10 ML/day (stage 1). There is the potential in the future to increase this capacity to 24 ML/day if required (stage 2).

RAW WATER QUALITY -NABIAC

General raw water characteristics of Nabiac Inland Dune Aquifer are summarised below:

- Low pH;
- High soluble iron content;
- Low calcium hardness and alkalinity;
- Presence of hydrogen sulphide and carbon dioxide and;
- Low *E.coli* /faecal coliforms.

PROCESS DESCRIPTION - NABIAC

RAW WATER EXTRACTION

Water is extracted from 14 groundwater bores in Nabiac Inland Dune Aquifer. The bores tap the aquifer between 10 and 25 m below the surface and can yield up to 23 L/S. Pump stations transfer water to the header main then to the WTP. All the pumps can supply a modelled maximum of 164 L/S with the target WTP flow of 138 L/S. The overall WTP production or daily raw water supply of 6, 8 or 10ML is based on historical rainfall, groundwater levels and potential saline intrusion. The bore field pumps will operate based on a demand signal from the WTP to maintain a level in the raw water pre-treatment tank.

The bore pump stations are grouped into four zones (1, 2, 3 and 4) and are depicted in figure below. Each zone and pumping station has specific monitoring bores assigned to monitor levels as well as a duty cycle to enable adequate recharging of the aquifer. A detailed operational philosophy of the bore pumps and WTP start up is within the Nabiac WTP Functional Description Specification (FDS), (MCWS ID B508502).

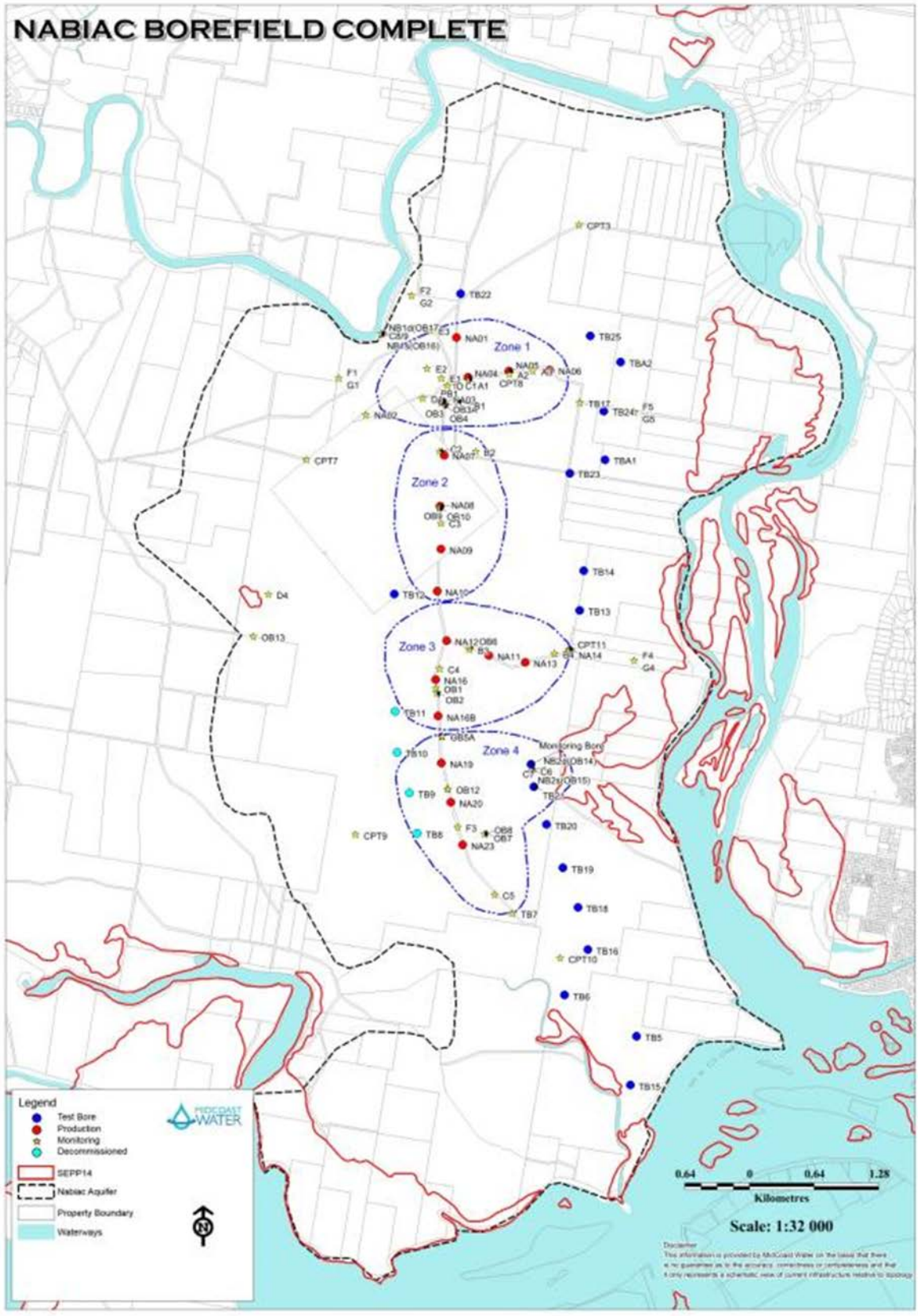

Figure 16: Nabiac aquifer pumping zones

PRE-DOSE CHEMICALS

Prior to water entering aeration towers, pre-treatment chemicals are dosed. Lime slurry is dosed to the raw water via two dosing pumps to increase the naturally low pH and low calcium hardness of groundwater. This increases effectiveness of coagulation.

The WTP has been designed to cater for future dosing of carbon dioxide (CO_2) which may be considered if free CO_2 available in the raw water is lower than anticipated and may impact the raw water pH and removal of hydrogen sulphide. CO_2 dosing system has not been installed.

AERATION TOWER

Pre-dosed water flows through a single aeration tower. Water is sprayed continuously on the top surface of packing media in the tower through a series of trays and weirs arranged to provide even flow over the area of packing media. A fan is installed adjacent to the tower to deliver a forced air flow into the bottom of the tower and upwards through the packing material to form a counter-current to water flow. Water reaches dissolved oxygen saturation, assisting oxidation of dissolved aluminium and iron. The aeration process also removes excess CO_2 and hydrogen sulphide. Gases are stripped from the liquid flow and released to the atmosphere.

The water from the packed aeration tower will be collected in a sump and transferred into the pre-treatment tank. Coagulant (ACH) will be added in line between the aeration tower sump and the pre-treatment tank with rapid mixing through an in line static mixer. As a precautionary measure chlorine gas dosing is also available to be dosed prior to the pre-treatment tank for improved oxidation of soluble metals; however this is not considered best practice as it may increase the likelihood of undesirable chlorine by-products (trihalomethanes) in the treated water.

The WTP design has allowed for future dosing of potassium permanganate between the aeration tower and pre-treatment tank for improved oxidation if required. Potassium permanganate dosing system has not been installed.

The aeration tower has been designed to enable chemical cleaning of the packed media. Citric acid dosed treated water will be batched and distributed over the media to remove any iron or lime deposits to ensure efficient oxidation process and protect media. The resultant water from cleaning and washing will be distributed to the waste system with pH correction if required. The WTP will be offline during the cleaning process.

PRE-TREATMENT TANK

Pre-treated water is stored in a single 400kL tank (stage 1) before being pumped to the membrane filtration system. The tank will provide contact time for coagulant (ACH) allowing optimal coagulation as well as retention time for oxidation. It also provides a location to buffer the return of secondary membrane filtrate.

Chlorine gas dosing is available to assist with oxidation of soluble metals, in particular iron, if considered necessary. Water in the tanks is mixed to maintain oxidised constituents in suspension and prevent sedimentation. The mixer is low energy to promote flocculation.

The pre-treatment tank has been sized for stage 1 of the WTP operation (12ML/day). An additional tank will be required for construction for ultimate plant capacity of 24ML/day (stage 2).

PRIMARY FILTRATION

From the pre-treatment tank, water passes through two primary filters (disk filtration system; Arkal pod filters), prior to entering the membrane microfiltration system. These filters remove larger particles such as sand which could damage membranes. Pore size is 200 micron. Individual pods can be taken off line for backwash cleaning or maintenance.

MEMBRANE FILTRATION

The microfiltration system includes two filter racks with 48 modules in each rack. Each eight inch module has a pore size of 0.1 micron hollow fibres. As feed water travels through the filter, contaminants are separated from the water and accumulate on the outer wall of the fibre. Feedwater enters the bottom of each cell and passes over and around the micro-porous hollow fibre membranes. Clean water is drawn through the membrane wall by pressure from feed pumps into the centre of each membrane fibre. Filtered water (filtrate) flows from the top of each module rack to the filtrate manifold into a common treated water outlet and passes to the next stage of treatment. Membranes provide a physical barrier for organisms such as protozoa (e.g. *Cryptosporidium parvum*, *Giardia intestinalis*).

Cleaning and maintenance of membranes is carried out routinely in various ways. Frequency of different cleaning methods depends on raw water quality and type of fouling. Backwashing by reverse filtration (RF) removes retained solids from membrane surfaces with the use of pumps and air scour blowers. Backwash times are set for regular intervals and transmembrane pressure (TMP) is monitored. Clean in place (CIP) is required to maintain long term membrane performance and uses cleaning chemicals including sodium hypochlorite, sodium hydroxide and citric acid cleaners and soaking the membranes. Enhanced Flux Maintenance (EFM), alternatively known as Chemically Enhanced Backwash (CEBW), is similar to CIP but with reduced step times and no extended soaking. Compressed air is used for daily integrity testing and valve operation. Membrane integrity is also monitored via automatic pressure decay test and leak test and is trended on SCADA system.

The microfiltration system can be bypassed. This would only occur under emergency situations and would require extra barriers and monitoring to ensure water quality is suitable.

POST DOSE CHEMICALS

Filtrate (treated water) from the microfiltration system is dosed with gas chlorination for disinfection. Chlorine will be injected into the filtered water after membrane filtration prior to the treated water reservoir. The filtered water may have a chlorine residual from pre-treatment chlorination. Chlorine dosing will be designed to add up to 5mg/L, and will be

controlled using a flow meter on the filtered water line and feedback control using an on line chlorine analyser.

Fluoride (sodium fluoride) is added to treated water for dental hygiene. Fluoride dosing will be controlled using a flow meter on the filtered water line and feedback control using an on line fluoride analyser. Output to target a finished water fluoride level of 1 mg/L.

TREATED WATER RESERVOIR

Treated water is stored in one tank called the treated water reservoir (TWR) at the WTP with a useable capacity of 7 ML. The overall size of the reservoir is 9.5ML with additional storage used for firefighting and site water services. This provides chlorine contact time and acts as balance tank prior to transfer pumps which pump water to Darawank Pump Station and into the Manning reticulation system.

The transfer of treated water to Darawank Balance Tank is to match the transfer of water from Darawank Pump Station to Manning reticulation system and will be between 152 L/S and 505 L/S. The plant is also designed for efficiencies where some transfer can be initially undertaken by gravity at low flows.

For stage 2 of the Nabiac WTP an additional treated water reservoir will be required to be constructed.

WASTEWATER MANAGEMENT

There are three primary waste streams on site (a fourth stream could potentially be generated from CIP of aeration tower):

- Secondary membrane filter backwash
- Raw water strainers (Arkal filters) backwash
- Neutralised waste (primary membrane cleaning/backwashing and aeration tower cleaning waste).

The first waste stream is generated when the membranes are backwashed with final treated water. The waste stream and water recovered from backwashing is collected and filtered through a secondary membrane filtration system (known as AP3). The AP3 system is the same as larger scale membrane filters used in the water treatment process and increases overall recovery rate from the water treatment process. The AP3 system consists of five modules with hollow fibre pore size of 0.1 micron, with additional space for a further five modules for stage 2. The AP3 system requires the same cleaning process as the primary membrane with backwashing, CIP and EFM.

Backwashing or reverse filtration removes retained solids from membrane surfaces with the use of pumps and air scour blowers. CIP is required to maintain long term membrane performance and uses cleaning chemicals including sodium hypochlorite, sodium hydroxide and citric acid cleaners as well as soaking the membranes. EFM is also used. Compressed air is used for daily integrity testing and valve operation. Membrane integrity is also

monitored via automatic pressure decay tests and leak tests and is trended on SCADA system.

The AP3 filtrate is pumped back to the pre-treatment tank which reduces overall wastewater of the plant. The waste stream produced by the AP3 is sent to the waste tanks, trade waste pit and wastewater pump station to be pumped to the sewer system at Nabiac. The waste tanks act as a detention system for the wastewater pump station to pump low flows into Nabiac sewer system.

The second waste stream is produced from backwash water of the raw water strainers (Arkal filters) which is drained directly to the trade waste pit and wastewater pump station with no chemical cleaning or neutralisation required.

The third waste stream is generated by cleaning processes which use chemicals (CIP and EFM) from cleaning the membrane and AP3 systems as well as the aeration tower cleaning process. All the water is collected in the neutralisation tank. Further chemical treatment to correct pH takes place in this tank (using either sodium hydroxide or sodium metabisulphite) before waste is discharged to the waste tanks, trade waste pit and wastewater pump station to be pumped to the sewer system at Nabiac.

Waste is monitored from the trade waste pit to comply with trade waste licence conditions.

The typical daily waste is expected to be around 100 kL, however this can be variable due to the types of cleaning process. The wastewater pump station can also operate in emergency mode if the AP3 is offline with no wastewater recovery available.

FLOW DIAGRAM – NABIAC

A flow diagram was produced for the purpose of risk assessment and verified by participants of a risk assessment workshop including operators, engineers and scientists. It includes details of the treatment process from catchment to tap, chemical dosing points and bypasses. Flow diagram for Nabiac WTP is provided in the figure below.

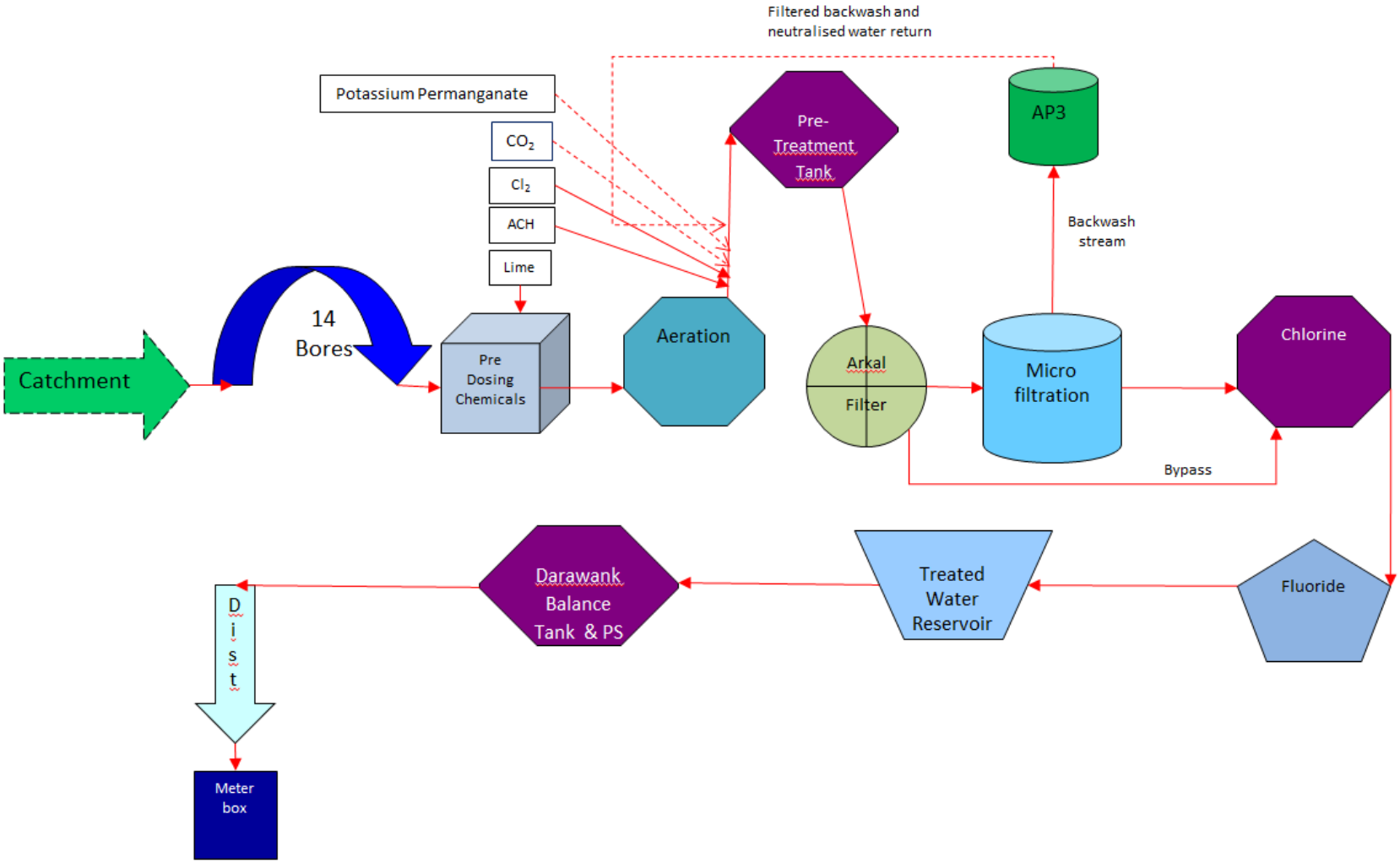

Figure 17: Nabiac WTP flow diagram

2.4.4 MANNING WATER SUPPLY DISTRIBUTION SYSTEM

NORTHERN DISTRIBUTION SYSTEM

Water is distributed to the northern region of Manning Water Supply Scheme from Bootawa WTP via Pump Station 2B to Wingham Reservoirs and Lantana Reservoir, then to towns and villages.

Wingham Reservoirs feed Bungay Road and (3) Kolodong Reservoirs. Two lower Kolodong Reservoirs are part of the northern Manning supply scheme. Water is pumped from lower Kolodong Reservoir to Irkanda Reservoir. From Irkanda Reservoir the system branches out to Cundletown, Harrington and Coopernook. Coopernook Reservoir feeds Lansdowne Reservoir and Harrington Reservoir feeds Crowdy Head Reservoir directly. North Coopernook Reservoir provides for increased demand created by development in Harrington.

Water from Nabiac water supply system can supplement the northern distribution system by supplying treated water to Koorainghat Reservoir from Darawank Pump Station. Water is then fed from Koorainghat to Lantana/Kolodong via manual operation of valves. This is not the normal operating mode and would be considered as emergency mode if Bootawa WTP was offline.

SOUTHERN DISTRIBUTION SYSTEM

The southern region of Manning water supply distributes water from Bootawa WTP via Pump Station 2B or from Nabiac WTP via Darawank Pump Station.

Water is pumped from Bootawa WTP to Lantana Reservoir which feeds through 600 mm steel pipes to the southern regions of the water supply scheme. Water is gravitated via Lantana Reservoir to Taree, Old Bar, Mitchell's Island and Kolodong Reservoirs. Water is gravitated through a 600 mm steel pipe from Lantana Reservoir and branches to a 300 mm pipe to Old Bar and a 525 mm steel pipe to Taree.

Koorainghat Reservoir can feed North Tuncurry Reservoir when Nabiac water supply system is offline or cannot meet demand.

Lantana Pump Station will feed Forster Reservoir through a 600mm steel pipe from Lantana Reservoir when Nabiac WTP is offline or cannot meet demand. Forster Reservoir feeds Nabiac Reservoir. Nabiac Pump Station feeds Krambach Reservoir. It has the highest elevation of the scheme at 118 m. Forster Reservoir also feeds Pacific Palms and Smiths Lake Reservoirs through a 600 mm steel and 300 mm ductile iron (DICL) pipe.

Upon the commissioning of Nabiac water supply system (2018) treated water from Nabiac will be the primary source for most of the southern distribution system. If demand exceeds the available supply from Nabiac then additional water will be supplied via Bootawa WTP. It

is expected this will generally be the case except over peak demand periods. Water from Nabiac WTP will be transferred to Darawank Pump Station which can then distribute treated water to Forster, Tallwoods and North Tuncurry Reservoirs. Darawank Pump Station can also supply to Koorainghat Reservoir to then supply the remainder of the southern distribution system as well as the northern distribution system in the event of emergency where Bootawa WTP and Manning River water supply is not available.

Details of the Manning distribution system are provided in Figure 8: Manning water supply and distribution system.

PUMPING SYSTEMS

The main pumping station of Manning water supply is Pump Station 2B. There are several other pumping stations operating within the water supply scheme. Nabiac water supply is via Darawank Pump Station to supplement the Manning water supply.

PUMP STATION 2B

Pump Station 2B was constructed with the Bootawa WTP in 2010. It delivers water from Bootawa WTP to Wingham, Koorainghat and Lantana reservoirs. The pipeline to Wingham is 450 mm and the pump is capable of pumping 289 L/S. Koorainghat pipeline is 375 mm and the pump is capable of pumping 184 L/S. Lantana pipeline is 600 mm and the pump is capable of pumping 620 L/S.

BOOSTER PUMP STATIONS

The table below describes booster pump stations for Manning Water Supply Scheme.

Table 2: Booster pump stations in Manning water supply system

Name	No. of Pumps	Capacity (L/s)	Head (m)	Pumping to main receiving reservoir
Kolodong	2	208	46	Irkanda Reservoir
Lantana	2	500	114	Forster Reservoir
Nabiac	2	8	100	Krambach Reservoir
Smiths Lake	2	22.5	22	Smiths Lake Reservoir
Tiona	2	45	87	Pacific Palms Reservoir

Name	No. of Pumps	Capacity (L/s)	Head (m)	Pumping to main receiving reservoir
Darawank (stage 1*)	4	379	102	Forster Reservoir

*Note: Stage 2 of the Nabiac WTP and supply system would enable the capacity to increase to 505L/S via utilising all four pumps.

RESERVOIRS

Reservoirs of Manning Water Supply Scheme and their capacities are shown in the table below.

Table 3: Reservoirs in Manning water supply system

Reservoir	Capacity (ML)	Type
Coopernook	0.45	Reinforced concrete
North Coopernook	5.00	Reinforced concrete
Crowdy Head	0.45	Reinforced concrete
Harrington	2.27	Steel
Irkanda	7.00	Pre-stressed concrete
Kolodong 1	1.59	Reinforced concrete
Kolodong 2	4.54	Reinforced concrete
Kolodong 3	9.09	Reinforced concrete

Reservoir	Capacity (ML)	Type
Lansdowne	0.59	Steel
Wingham 1	1.36	Reinforced Concrete
Wingham 2	1.36	Reinforced Concrete
Wingham 3	4.54	Reinforced Concrete
Wingham 4	5.00	Reinforced Concrete
Wingham-Bungay	0.50	Steel
North Tuncurry	5.60	Reinforced Concrete
Forster 1	6.81	Steel
Forster 2	37.50	Steel
Koorainghat	2.27	Reinforced Concrete
Krambach	0.45	Reinforced Concrete
Lantana	15.00	Steel
Mitchells Island	2.50	Reinforced Concrete
Nabiac	0.45	Reinforced Concrete

Reservoir	Capacity (ML)	Type
Old Bar	7.00	Steel
Pacific Palms	3.50	Reinforced Concrete
Redhead	6.60	Reinforced Concrete
Smiths Lake	3.50	Reinforced Concrete
Tallwoods	6.20	Reinforced Concrete
Darawank Balance Tank	2.00	Reinforced Concrete

2.5 ASSESSMENT OF BULAHDELAH WATER SUPPLY SYSTEM

2.5.1 GENERAL DESCRIPTION AND HISTORY

Bulahdelah Water Supply Scheme supplies drinking water to residents of Bulahdelah. The township of Bulahdelah is located at the entrance to Myall Lakes, approximately 98 km north of Newcastle and 74 km south of Taree. Bulahdelah Water Supply Scheme includes:

- Crawford River raw water intake;
- Raw water pump station;
- Water treatment plant;
- Three reservoirs and;
- Distribution pipe network.

This scheme serves a population of approximately 1 200. Bulahdelah Water Supply Scheme originated in the 1960s. The WTP was built in 1988 and upgraded in 1995 and 2006. The current WTP has a capacity to treat 2 ML/day with a reservoir storage capacity of 4.12 ML which is considered adequate to meet future growth.

Bulahdelah WTP was upgraded in 2006 to optimise the treatment process. The process was automated and chemical dosing systems renewed. The intake from the weir pool was raised to 0.5 – 1.0 m below the surface of the water to ensure the best possible raw water quality could be utilised (in relation to dissolved oxygen and metals). Previously, stratification of the weir pool had resulted in raw water of a poorer quality being pumped from lower depths. Due to major road works and diversion of Pacific Highway around the township of Bulahdelah in close proximity to the WTP, the treatment building was enclosed. This reduced contamination by brake dust and other traffic hazards. Enclosing the treatment building has resulted in a more stabilised temperature in the clarifier which has improved the settling process. Coagulant was changed from alum (aluminium sulphate) to ACH and polymer was added. Alkalinity consumption is much less when using ACH compared to alum, and resulting pH correction using soda ash is reduced, therefore optimising the treatment process and reducing chemical usage. Fluoride dosing system was also upgraded.

The process was automated and operators can run the plant through SCADA, including remote operation. Information such as flows, water quality, levels of water in clarifier and clear water tank and chemical dosing are available through SCADA. Alarm systems also optimise process control.

The raw water pump station at Crawford River weir was upgraded to wet well design in 2014 (previously dry well design).

Figure 18: Bulahdelah Reservoirs 1 & 2

Figure 19: Bulahdelah WTP clarifier

CRAWFORD RIVER CATCHMENT MANAGEMENT

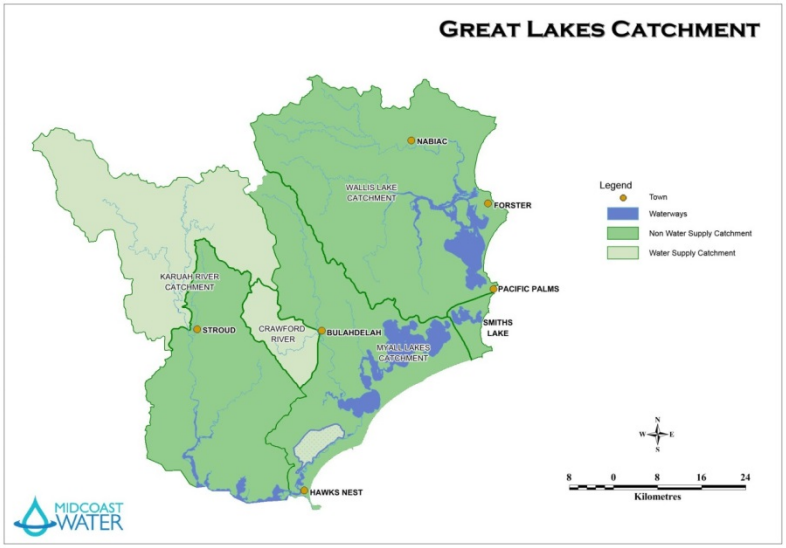

Figure 20: **Great Lakes catchment map**

Crawford River catchment covers an area of approximately 122 km^2. The main water course of the catchment is Crawford River which is fed by several mostly ephemeral water courses (Tyack, 2008). The majority of the upper catchment is forested land managed by National Parks & Wildlife Service and State Forests. Agriculture dominates land use in the lower catchment. Crawford catchment forms part of the tradition land of the Worimi people (ABC, 2014).

Bulahdelah Water Supply sources water from Crawford River for treatment and supply to the town. Crawford catchment has been identified as a priority area for further research and on-ground work to improve water quality in the catchment. Extensive water quality monitoring has identified poor raw water quality when compared to other catchment areas in which Council operates, specifically low pH, high turbidity, high colour and elevated levels of nutrients, metals, sediments and faecal coliforms. A holistic approach has been taken aiming

to improve water quality at the catchment level as part of the 'catchment to tap' management approach of operating water supply systems. Refer to *GLC Crawford River Catchment Management Plan V2* (MCWS ID A318857) for further information.

To improve overall health of Crawford catchment, a set of management actions have been recommended. They target both protection and remediation. Some general recommendations include; establishment of riparian reserves, consider establishment of funds to purchase river frontage properties and a focus on the headwaters of Wild Cattle Creek (Tyack, 2008).

Figure 21: Weir pool near offtake

Figure 22: Crawford catchment signage

RAW WATER QUALITY

Water extracted from Crawford River weir is highly variable depending on rainfall in the catchment. The following is a general summary of raw water quality characteristics:

- High concentrations of metals (especially aluminium and iron);
- Elevated nutrients and sediments after rainfall;
- High turbidity and colour after rainfall;
- High total dissolved solids (TDS);
- High dissolved organic carbon (DOC);
- Low pH and;
- High faecal coliforms.

PROCESS DESCRIPTION

RAW WATER EXTRACTION

Raw water is pumped from a rock filled weir pool in Crawford River near Pacific Highway Bridge at Bulahdelah. Total storage of Crawford River weir is approximately 225 ML, representing a capacity of 562 days' supply. Raw water is pumped from the weir pool through a 300 mm diameter pipeline to the WTP.

CLARIFIER

Chemicals are dosed into the raw water line prior to water entering the clarifier. Soda ash (sodium carbonate) can be added to correct pH and assist water stabilisation and effective flocculation. Coagulant (ACH) is added to assist particles to coagulate and settle. ACH dose rate is based on raw water quality and determined through jar testing. Polymer is used to assist flocculation. Chlorine (sodium hypochlorite) is dosed at this point to assist oxidation of metals which can be removed in filters further down the process. By dosing chlorine and soda ash prior to the clarifier sufficient time exists to allow oxidation reactions to take place (at appropriate pH levels). Powdered activated carbon (PAC) will be dosed in the future when the dosing system is recommissioned.

SAND FILTERS

Clear water is drawn from the top of the clarifier which then flows through sand filters to remove smaller particles. There are two sand filters which run together. Zeolite media is used in filters to assist in removal of metals such as iron and manganese. Media is changed approximately every ten years. Sand filters are backwashed as needed, usually twice a week. Backwash water flows to sludge lagoons.

CLEAR WATER TANK

After filtration, water enters the clear water tank and is dosed with sodium hypochlorite to provide disinfection with adequate residual to ensure no recontamination through the distribution system. Chlorine pumps start as water is gravity fed from filters to the clear water tank. There is provision for post dosing of soda ash at this point to correct pH, however this is not required currently.

As final water leaves the clear water tank to pump to service reservoirs, fluoride (sodium fluoride) is added for dental hygiene. Treated water leaves the WTP and travels to three service reservoirs, before being distributed to customers through the reticulation system.

WASTEWATER MANAGEMENT

Wastewater and sludge from the clarifier, filter back wash water and chemical drainage waste flows to two sludge lagoons to allow for settling before de-watering by drying in the sludge lagoons. One sludge lagoon is operational and the other used for sludge drying. During cleaning or wet weather, overflow of water from sludge lagoons is discharged to sewer. Under normal operating conditions, supernatant from sludge lagoons is returned to the head of the plant, where it mixes with raw water and re-enters the treatment system.

Figure 23: Bulahdelah WTP

Figure 24: Bulahdelah WTP sludge lagoons

RESERVOIRS AND DISTRIBUTION SYSTEM

As water leaves Bulahdelah WTP it is pumped to three reservoirs and then out to the distribution system. The following diagram is a schematic of the distribution system of Bulahdelah Water Supply Scheme.

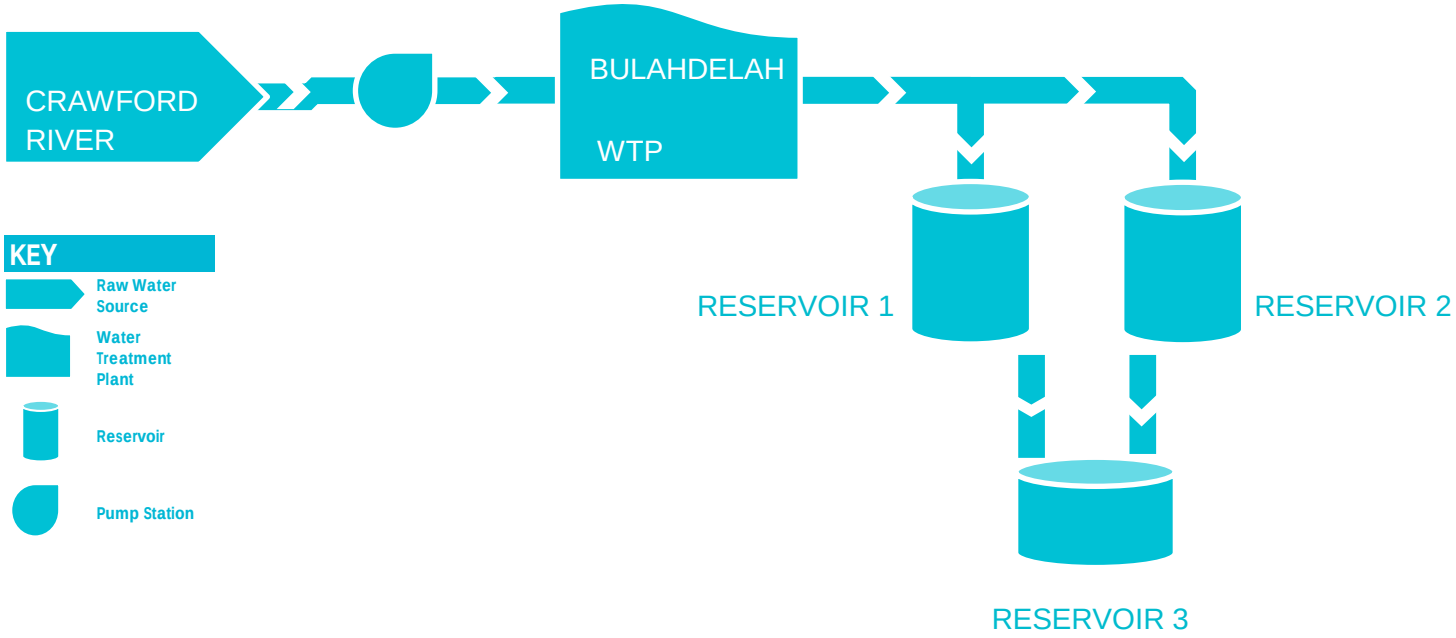

Figure 25: Bulahdelah water supply distribution system

There are three reservoirs in Bulahdelah Water Supply System with a combined capacity of 4.12 ML. They are located adjacent to Pacific Highway at Bulahdelah.

Table 4: Reservoirs in Bulahdelah water supply system

Reservoir	Capacity (ML)	Diameter (m)	Structure Levels (m) TWL	Structure Levels (m) BWL	Operating Levels (m) TWL	Operating Levels (m) BWL	Type
Bulahdelah 1	1.4	15.24	59.58	51.66	59.58	59.21	Reinforced concrete
Bulahdelah 2	2.6	20.65	60.59	52.23	59.58	59.21	Reinforced concrete
Bulahdelah 3	0.12	8.7	72.00	70.00	71.60	71.00	Reinforced concrete

PUMP STATION

A raw water pump station is located at Crawford River intake. The original pump station was installed in 1964 and upgraded in the 1990s. A new pump station was installed in 2014. The pump station transfers water from Crawford River weir pool to the WTP. Details are provided below.

Table 5: Bulahdelah raw water pump station

Name	Type	Number of Pumps	Motor Size	Capacity
Bulahdelah raw WPS	Wet well	2	18.5 kW	25.3L/sec

FLOW DIAGRAM

A flow diagram (provided below) was produced for the purpose of risk assessment and verified by participants of risk assessment workshops. It was included in the briefing paper produced for the risk assessment workshop held in May 2016, refer to *Briefing paper 2016 Risk Review Workshops* (MCWS ID A579800).

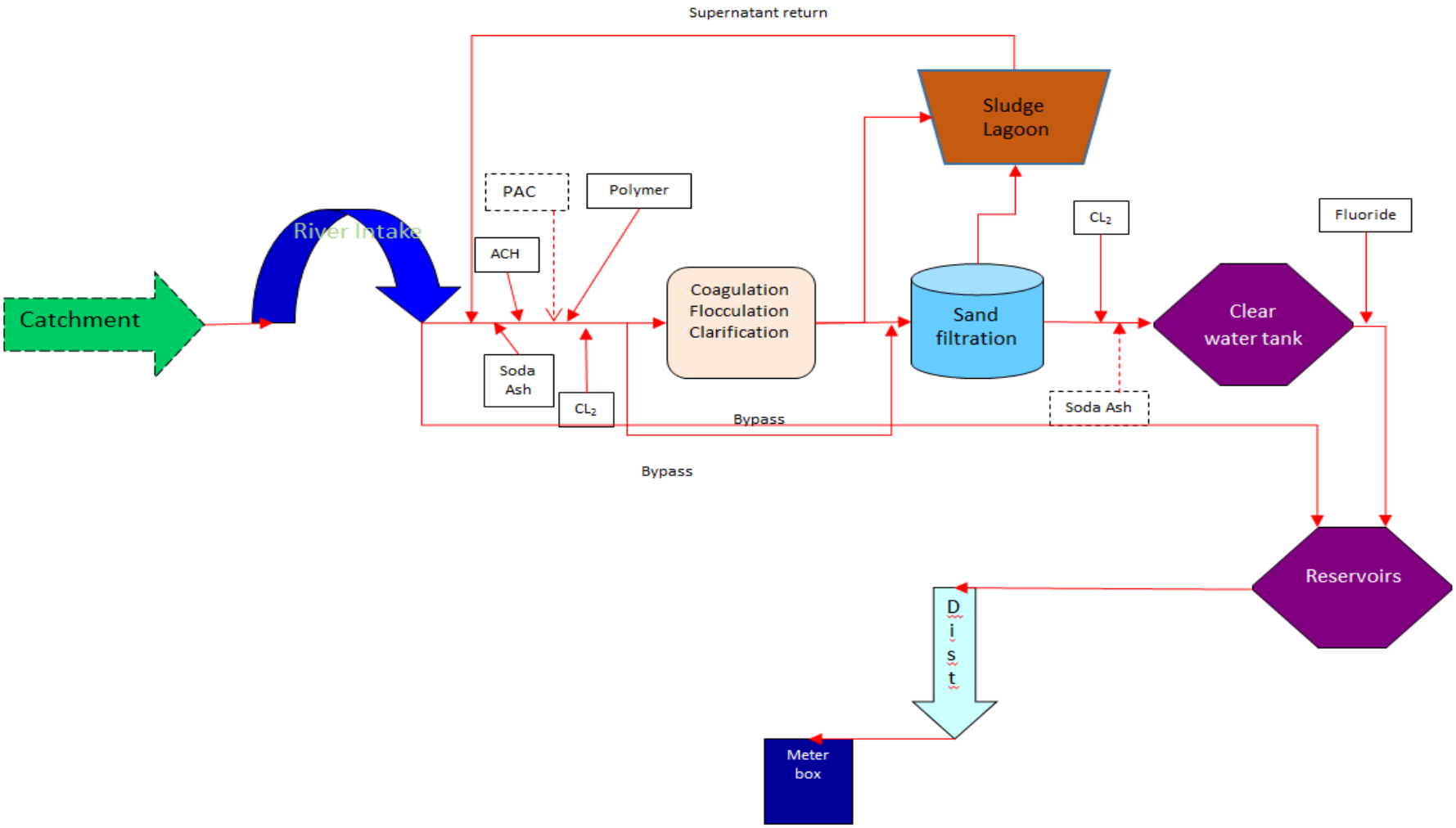

Figure 26: Bulahdelah WTP flow diagram

2.6 ASSESSMENT OF STROUD WATER SUPPLY SYSTEM

2.6.1 GENERAL DESCRIPTION AND HISTORY

Stroud Water Supply Scheme supplies drinking water to residents of Stroud and Stroud Road. The township of Stroud is located in Karuah River catchment. It is approximately 219 km north of Sydney, 75 km north-east of Newcastle and 20 km east of Dungog. The village of Stroud Road is approximately 8 km north of Stroud along the Bucketts Way.

Stroud Water Supply Scheme includes:

- Karuah River raw water intake;
- Raw water pump station;
- Off river storage dam;
- Water treatment plant;
- Three reservoirs;
- Distribution pipe network and;
- Water pump stations.

This scheme serves a population of approximately 1 000. Stroud Water Supply Scheme originated in the 1960s when water was pumped directly from Karuah River to Stroud reservoirs for distribution to homes. Treatment consisted of a screen at the raw water pump and adding chlorine to reservoirs for disinfection. Off river storage and WTP were built in the 1990s. The WTP has a capacity to treat 2 ML/day with reservoir storage capacity of 1.8 ML which is considered adequate to meet the future growth and development for the next 30 years.

The most recent upgrade to the WTP was during 2012 – 2013 when process control systems were upgraded. Fluoride dosing equipment was installed and has been operational since December 2014. Process improvement is ongoing, with trials underway to improve coagulation and filter performance.

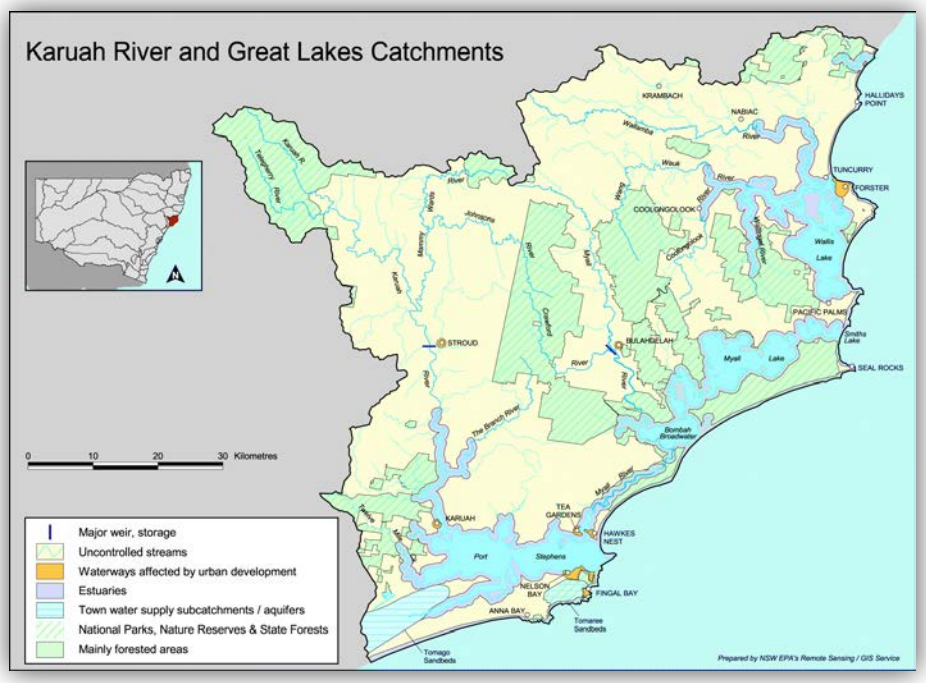

Figure 27: Karuah River catchment map

Karuah catchment covers an area of approximately 4 480 km^2. It is bordered to the north by Manning River catchment and to the south and west by Hunter River catchment. Three major rivers systems drain Karuah River basin; Karuah and Myall Rivers drain south to Port Stephens. Wallamba, Wallinghat, Wang Wauk and Coolongolook Rivers drain east to the northern part of Wallis Lake (NSW Department of Industry, 2014).

Predominant land uses include agriculture (mostly beef cattle with some dairy and poultry farms), NSW State Forests and National Parks and Wildlife Service (NPWS). Tourism, mining and oyster growing are also present in the catchment (NSW Department of Industry, 2014). Karuah catchment forms part of the tradition land of the Worimi people (ABC, 2014).

Council relies on water sourced from Karuah catchment to supply customers of Stroud and Stroud Road with drinking water.

MidCoast Council (former Great Lakes Council) produced a Catchment Management Plan in 2015. The purpose of the plan is to maintain and improve health of Karuah River catchment. A collaborative approach was taken to develop the plan which included input from relevant agencies and stakeholders including Water Services.

There are three themes for future action within the plan. Each theme includes key issues, desired outcomes and management actions (with participating partners detailed for each action). Water Services' shared responsibilities relate to:

WATER

- Assisting with implementation of Groundwater and Drinking Water Catchment Clause in MidCoast Council Standard Local Environment Plan and;
- Water quality monitoring relating to MidCoast Council Waterway and Catchment Report Card.

LANDSCAPE PRODUCTION AND COMMUNITY

- Encourage new and existing mining and large scale extractive industry to achieve a beneficial effect on catchment health and;
- Continue to promote education and awareness of catchment health within the community with the use of communication and social marketing tools.

RESILIENT ECOSYSTEMS

- Undertake platypus community awareness program and platypus status assessment.

For further information, refer to *Karuah Catchment Management Plan* (MCWS ID A533477).

Figure 28: Karuah River weir pool (downstream) Figure 29: Karuah River weir pool (upstream)

MINING ACTIVITIES IN KARUAH RIVER CATCHMENT

There are both existing and proposed mining activities in Karuah River catchment. Mining activities are considered in the hazard analysis and risk assessment process for Stroud drinking water supply.

RAW WATER QUALITY

The following is a summary of raw water characteristics of Stroud supply:

- Low alkalinity and hardness;
- Variable concentrations of metals (iron and aluminium);
- Elevated nutrients following rainfall;
- Elevated faecal coliforms concentrations following rainfall and;

- Neutral pH.

PROCESS DESCRIPTION

RAW WATER EXTRACTION

Water is extracted from Karuah River weir approximately 150 m downstream of a small bridge on Gorton's Crossing Road at Stroud. Karuah River raw water pump station has a submersible pump with a capacity of 25 L/S which pumps water to the WTP.

FLOCCULATION TANK

Chlorine in the form of sodium hypochlorite is dosed in the raw water line before it reaches the WTP. Coagulant ACH is dosed just before water enters the flocculation tank. Mixing occurs in the flocculation tank where the processes of coagulation and flocculation take place. Soda ash for pH adjustment can be added directly to the tank if required. From the flocculation tank, water flows through the inlet chamber into one of two settling lagoons.

SETTLING LAGOONS

Of the two settling lagoons, one is online at a time; the other is used for air drying sludge. Pre-treated water enters the lagoon for a settling period of approximately five days. Water decants from the top of the lagoon and enters the off river storage.

OFF RIVER STORAGE

The off river storage has a dosing point for sodium hypochlorite. Calcium hypochlorite tablets can also be added if required. The off river storage can hold 50 ML and is used as a water source during periods of low flow or poor water quality in the river. This can be bypassed if required. Refer to *Operating Philosophy for Off River Storage at Stroud WTP*, MCWS ID A515355 for specific information on the storage.

SAND FILTER

From the off river storage, water enters the settled water pump station and is pumped to sand filters. Media is changed approximately every ten years. Back wash times are set and adjusted depending on water quality. Each filter is offline for approximately 30 min to complete a backwash cycle. Backwash water goes to the flocculation tank and back to the settling lagoons. Secondary ACH is dosed in settled water pump station.

POST DOSE CHEMICALS

Final chemicals are dosed as water leaves sand filters, before entering the clear water tank at a dose point. Chlorine (sodium hypochlorite) is added for final disinfection. Fluoride (sodium fluoride) is added for dental hygiene. Post dose soda ash can be added if pH adjustment is required.

It is planned to replace sodium hypochlorite with chlorine gas at each of the three dose points in 2018.

CLEAR WATER TANK

Final treated water is stored in the clear water tank. Water leaves the tank on demand to reticulation and service reservoirs at Stroud and Stroud Road. The clear water tank then re-fills in preparation for the next batch required.

WASTE WATER MANAGEMENT

Backwash water from filters goes to the flocculation tank then to settling lagoons where it mixes with pre-treated water and continues through the treatment process. Wastewater from settling lagoons can be sent to sewer if required. Sludge dried in the off line sludge lagoon is taken offsite on a yearly basis or as required.

Figure 30: Stroud settling lagoons

Figure 31: Solar destratifier in off river storage

RESERVOIRS AND DISTRIBUTION SYSTEM

As water leaves Stroud WTP it is pumped to the villages of Stroud and Stroud Road. The following diagram is a schematic of the treatment and distribution system.

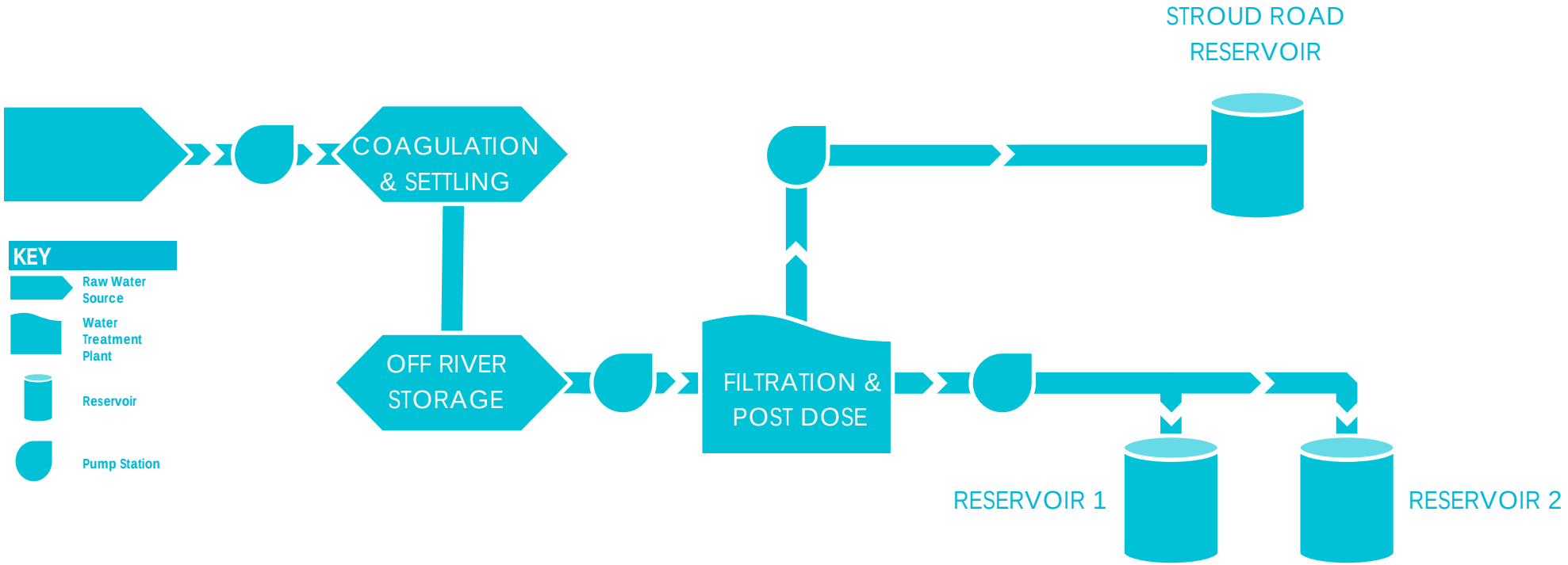

Figure 32: Stroud water supply distribution system

Three reservoirs operate in Stroud Water Supply Scheme. Stroud reservoirs service Stroud and Stroud Road reservoir supplies water to Stroud Road village. Reservoirs and pump stations are described in the following tables.

Table 6: Reservoirs in Stroud water supply system

Reservoir	Capacity (ML)	Diameter (m)	TWL (m)	BWL (m)
Stroud 1	0.68	9.3	77.72	67.50
Stroud 2	0.68	9.3	77.72	67.50
Stroud Road	0.45	10.7	106.68	101.53

Table 7: Pump stations in Stroud water supply system

Pump Station	No. of Pumps	Motor Size	Capacity	Pumps to
Stroud Raw WPS	2	-	25L/s @ 30m	Stroud WTP
Stroud Clear WPS	2	-	28L/s @ 45m 36L/s @ 36.5m	Stroud Reservoir
Stroud Road WPS	2	5.6kW	5.98L/s @ 24m	Stroud Road Reservoir
Stroud High Pressure Zone WPS	2	5.5kW	7.7L/s@ 31.5m	Reticulation

FLOW DIAGRAM

A flow diagram was produced for the purpose of risk assessment and verified by participants of risk assessment workshops. It was included in the briefing paper produced for the risk assessment workshop held in May 2016, refer to *Briefing paper 2016 Risk Review Workshops* (MCWS ID A579800). Flow diagram for Stroud water supply is provided in the figure below.

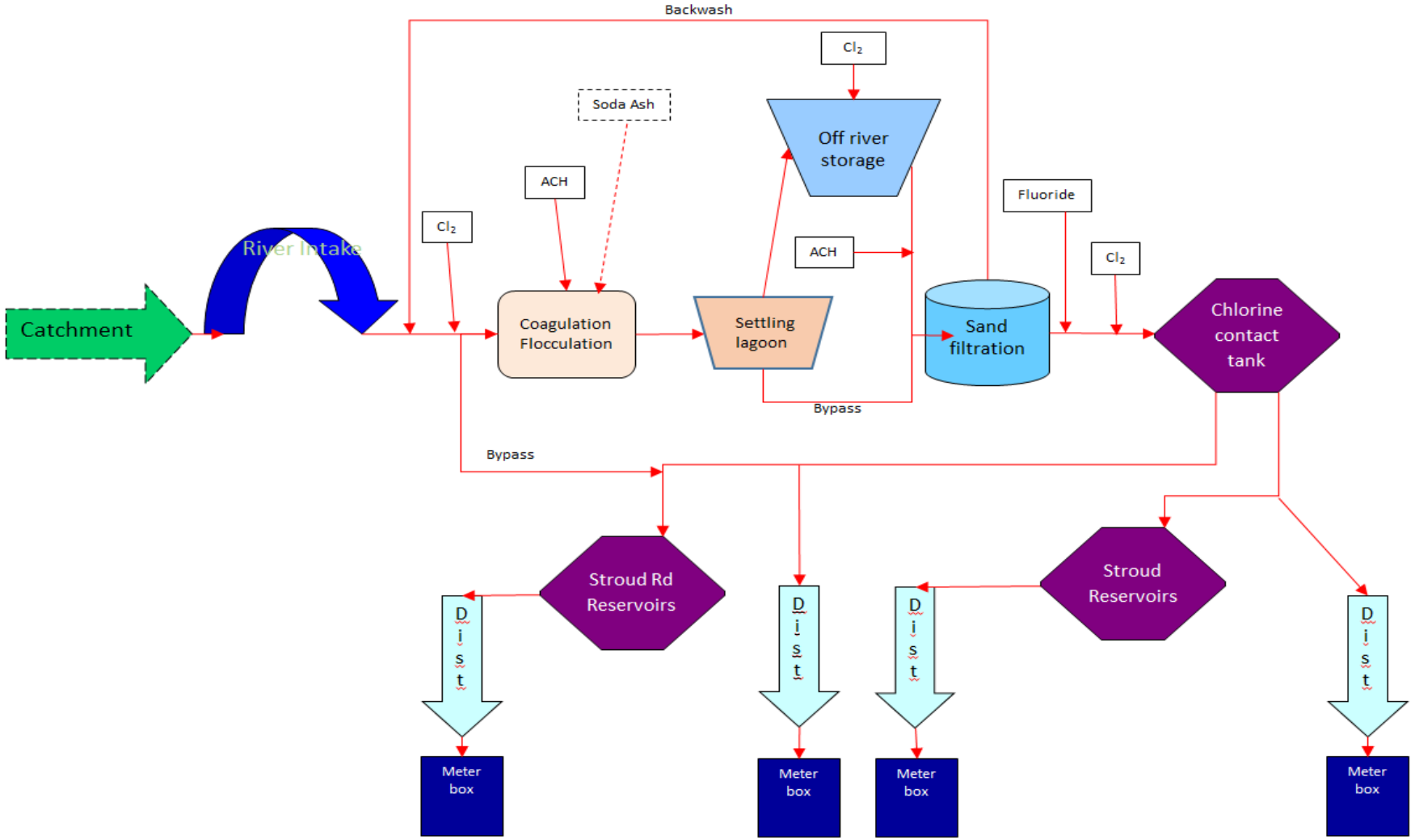

Figure 33: Stroud WTP flow diagram

2.7 ASSESSMENT OF TEA GARDENS WATER SUPPLY SYSTEM

2.7.1 GENERAL DESCRIPTION AND HISTORY

Tea Gardens Water Supply Scheme provides drinking water to residents of Tea Gardens and Hawks Nest. Tea Gardens is located 77 km north east of Newcastle. Hawks Nest is 2 km east of Tea Gardens. The villages are separated by Myall River and bordered by Tasman Sea to the east and Port Stephens to the south.

Tea Gardens Water Supply Scheme includes:

- Ten groundwater bores;
- Header main;
- Water treatment plant;
- High lift water pump stations;
- Three reservoirs AND;
- Distribution pipe network.

The scheme serves a population of approximately 3 800 permanent residents. As it is a popular tourist destination, these numbers increase during holiday periods. Water is sourced from Viney Creek Aquifer, approximately 6 km north west of Tea Gardens. The scheme originated in 1962 and has been upgraded and expanded several times to cater for the region's growing population.

Prior to 2013, the water treatment process consisted of a basic aeration tower and balance tank, pH correction and disinfection. Water was pumped from individual bores through the header main to the top of an aeration tower. Aeration assisted in oxidation of metals and allowed release of hydrogen sulphide and carbon dioxide gases. Water then entered a balance tank for a settling period. Before leaving the plant, water was dosed with soda ash for pH correction and chlorine gas for disinfection then pumped to reservoirs and the distribution system. Chlorine in the form of calcium hypochlorite was dosed into the balance tank and reservoirs when required to ensure chlorine residual remained in the distribution system.

This treatment was not effective in removing soluble metals (iron and aluminium) to levels within aesthetic guidelines of ADWG. Operational control was minimal (ceasing to pump from individual bores with the highest concentrations of soluble metals).

A membrane filtration WTP was built and commissioned in 2013 which supplies the towns with high quality filtered water. The WTP has a capacity to treat 8 ML/day, with potential to increase to 12 ML/day in the future. However peak demand on the WTP is not projected to reach the design production capacity of 12 ML/day until 2038. Fluoride dosing equipment was installed and began operating in February 2015.

VINEY CREEK AQUIFER CATCHMENT

Viney Creek Aquifer extends over 32 km^2 west of Myall River, with the southern boundary located 2.5 km north of Tea Gardens, refer to Figure 20: *Great Lakes catchment map*. It is bounded by hills to the south west, west and north of the catchment, with Myall River bounding the catchment in the east and south east. Pacific Highway runs through the western portion and Viney Creek Rd skirts the southern edge. Other roads for access for agriculture and pine plantations also exist within the catchment.

Viney Creek Aquifer catchment forms part of the tradition land of the Worimi people (ABC, 2014). Major land uses are; pine plantations, agriculture, National Parks, residential and tourism. The area was mined for sand in the past.

Groundwater sources are an important resource in regional Australia. They feed many surface ecosystems and often provide base flow in rivers (NSW DLWC, 1998). Over extraction of groundwater has potential to impact on groundwater quality (salt water intrusion) and groundwater dependent ecosystems. There are currently no cease to pump conditions on groundwater extraction from Viney Creek Aquifer. Investigations have indicated there is sufficient quantity and recharge of water in the aquifer to provide a sustainable water supply for the projected population of Tea Gardens and Hawks Nest. Groundwater levels and recharge are monitored by MidCoast Water Services across three monitoring points in the catchment to ensure water is being harvested in a sustainable manner.

Figure 34: Pump housing for Tea Gardens bore

Figure 35: Tea Gardens bore pump

RAW WATER QUALITY

Raw water characteristics of this groundwater supply are summarised below:

- Low pH;
- High soluble iron content;
- High soluble aluminium content;

- Low calcium hardness and alkalinity;
- Presence of hydrogen sulphide and carbon dioxide and;
- Low *E. coli*/faecal coliforms.

PROCESS DESCRIPTION

RAW WATER EXTRACTION

Water is extracted from ten groundwater bores in Viney Creek Aquifer. The bores tap the aquifer between 17 and 20 m below the surface and can each yield up to 12 L/S. The bore pump stations are laid out in a grid pattern over the water table. Pump stations transfer water through the header main to the WTP. Each bore pump station responds to demand of the WTP. When called upon they pump water at a flow set point while ever there is a minimum level in each of the bore wells.

PRE DOSE CHEMICALS

Prior to water entering aeration towers, pre-treatment chemicals are dosed. Lime slurry is dosed via two dosing pumps to raw water to increase the naturally low pH and low calcium hardness of groundwater. This increases effectiveness of coagulation.

AERATION TOWERS

Pre-dosed water flows through two aeration towers, which can be operated in parallel or as duty / standby. Design of the aeration towers has been redesigned to suit water aeration for the specific removal of hydrogen sulphide, oxidation of iron and removal of carbon dioxide. Water is sprayed continuously on the top surface of packing media in the tower through a series of spray nozzles arranged to provide even flow over the area of packing media. A fan is installed in each tower to deliver a forced draft air flow into the bottom of the tower and upwards through the packing material to form a counter-current to water flow. Water reaches dissolved oxygen saturation, assisting oxidation of dissolved aluminium and iron. The aeration process also removes excess carbon dioxide and hydrogen sulphide. Gases are stripped from the liquid flow and released to the atmosphere. Coagulant ACH is dosed after the aeration towers.

RAW WATER BALANCE TANKS

Pre-treated water is stored in two aerated balance tanks before being pumped to the membrane filtration system. These tanks also provide increased contact time for ACH allowing optimal coagulation. Liquid chlorine (sodium hypochlorite) is dosed directly to balance tanks to assist with oxidation of soluble metals, in particular aluminium. Water in the tanks is mixed to maintain oxidised constituents in suspension and prevent sedimentation. The mixer is low energy to promote flocculation.

PRIMARY FILTRATION

From the raw water balance tanks, water passes through two primary filters (disk filtration system), prior to entering the membrane microfiltration system. These filters remove larger particles such as sand which could damage membranes. Pore size is 200 micron.

MEMBRANE FILTRATION

The microfiltration system includes two filter racks with 34 modules in each rack. Each six inch module has 6 350 hollow fibre filters. Pore size of the hollow fibres is 0.1 micron. As feed water travels through the filter, contaminants are separated from the water and accumulate on the outer wall of the fibre. Feedwater enters the bottom of each cell and passes over and around the micro-porous hollow fibre membranes. Clean water is drawn through the membrane wall by pressure from feed pumps into the centre of each membrane fibre. Filtered water (filtrate) flows from the top of each module rack to the filtrate manifold into a common treated water outlet and passes to the next stage of treatment. Membranes provide a physical barrier for organisms such as protozoa (e.g. *Cryptosporidium parvum*, *Giardia intestinalis*).

Cleaning and maintenance of membranes is carried out routinely in various ways. Frequency of different cleaning methods depends on raw water quality and type of fouling. Backwashing removes retained solids from membrane surfaces with the use of pumps and air scour blowers. Backwash times are set for 30 min intervals unless transmembrane pressure (TMP) changes, in which case backwashes are more frequent. Clean in Place (CIP) is required to maintain long term membrane performance and uses cleaning chemicals including hypochlorite and citric acid cleaners and soaking the membranes. Chemically Enhanced Backwash (CEBW) also referred to as enhanced flux maintenance (EFM) is similar to CIP but with reduced step times and no extended soaking. Citric acid is also used in this cleaning process. Compressed air is used for daily integrity testing and valve operation. Membrane integrity is also monitored via automatic pressure decay test and leak test and is trended on SCADA system.

The microfiltration system can be bypassed. This would only occur under emergency situations and would require extra barriers and monitoring to ensure water quality is suitable.

POST DOSE CHEMICALS

Filtrate from the microfiltration system is dosed with sodium hypochlorite for disinfection. Fluoride (sodium silicofluoride) is added for dental hygiene.

CLEAR WATER STORAGE TANKS

Treated water is stored in two clear water storage tanks at the WTP each with a capacity of 1 ML. These provide chlorine contact time and act as balance tanks prior to high lift pumps which pump water to three reservoirs and into the reticulation system.

WASTE WATER MANAGEMENT

Membrane filters produce two streams; filtrate (clear water) and a waste stream. Membranes are backwashed with final treated water. The waste stream and water recovered from backwashing is collected and filtered through a small membrane filtration system (AP3). This process is the same as larger scale membrane filters used in the water treatment process and increases overall recovery rate from the water treatment process. Filtrate from the AP3 is pumped back to raw water tank. The waste stream produced by the AP3 is sent to sewer.

Water from cleaning processes which use chemicals (CIP and CEBW) is collected in the neutralisation tank. Further chemical treatment to correct pH takes place in this tank (using either sodium hydroxide or sodium bisulphite) before waste is discharged to sewer.

Figure 36: Tea Gardens WTP buildings

Figure 37: Tea Gardens aeration towers

Figure 38: Membrane filtration racks at Tea Gardens WTP

RESERVOIRS AND DISTRIBUTION SYSTEM

As water leaves Tea Gardens WTP it is pumped to three reservoirs and on to distribution systems at Tea Gardens and Hawks Nest. The following diagram is a schematic of the distribution system.

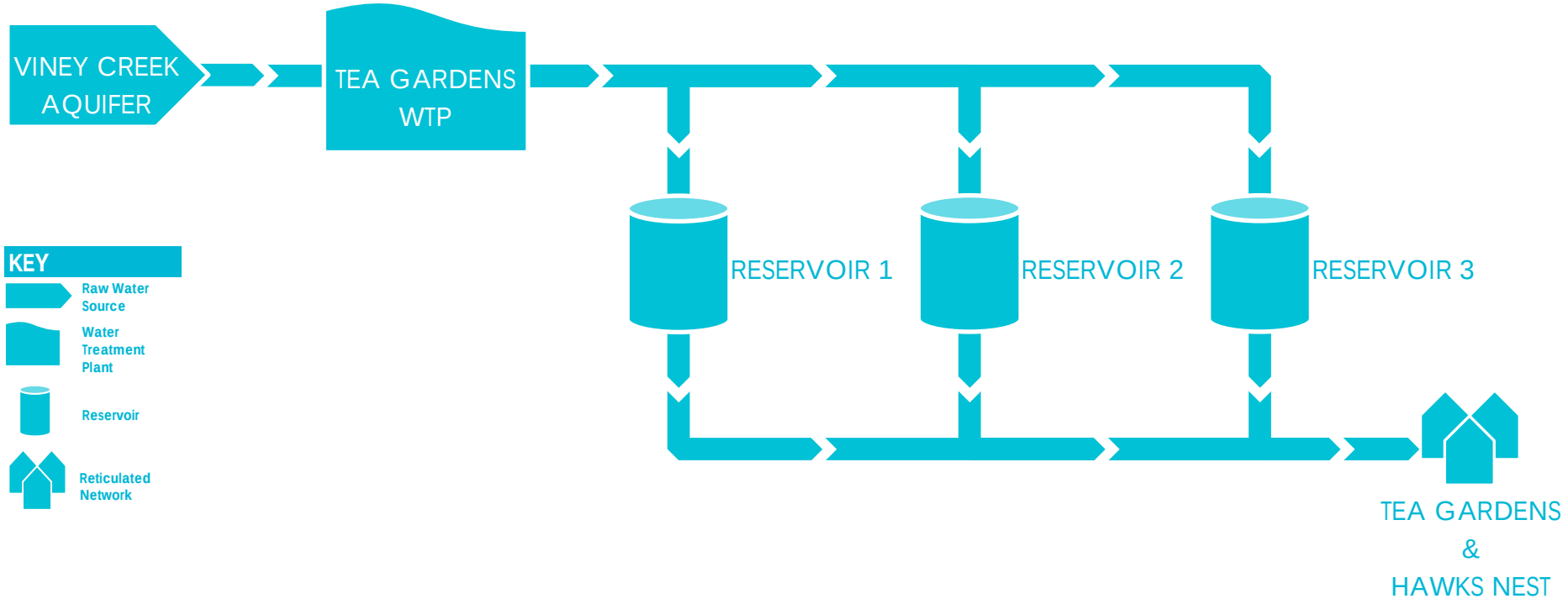

Figure 39: Tea Gardens water supply distribution system

Three reservoirs operate in Tea Gardens Water Supply Scheme, located on Viney Creek Rd. The reservoirs are described in the table below.

Table 8: Reservoirs in Tea Gardens water supply system

Reservoir	Capacity ML	BWL	TWL	Diameter	Height
Tea Gardens 1	1.4	68.65	75.89	15.69	7.24
Tea Gardens 2	5.6	66.55	75.80	27.76	9.25
Tea Gardens 3	8.1	64.40	75.80	30.10	11.40

There are ten bore pump stations in Tea Gardens Water Supply Scheme. Each bore in the bore field has a small pump station, which pumps groundwater to the treatment plant and high lift pump stations before reticulation.

The table below describes high lift pump stations.

Table 9: Tea Gardens high lift pump stations

Pump Stations	No. of Pumps	Motor Size(kW)	Capacity (L/s)	Head(m)
Treated Water PS No 1	2	185	100	63
Treated Water PS No 2	2	185	100	63

Figure 40: Reservoirs in Tea Gardens water supply system

FLOW DIAGRAM

A flow diagram was produced for the purpose of risk assessment and verified by participants of risk assessment workshops. It was included in the briefing paper produced for the risk assessment workshop held in May 2016, refer to *Briefing paper 2016 Risk Review Workshops* (MCWS ID A579800). Flow diagram for Tea Gardens water supply is provided in the figure below.

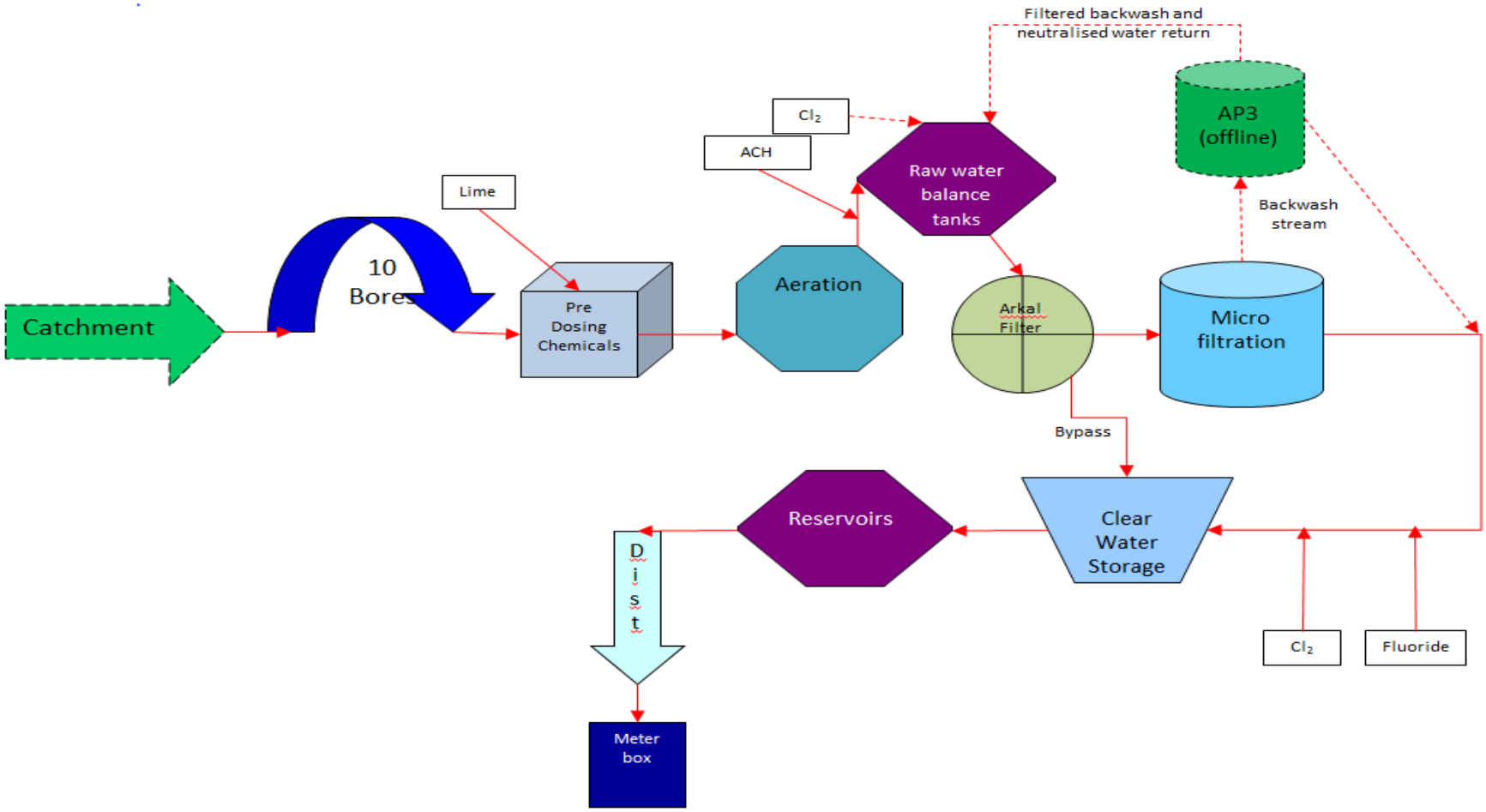

Figure 41: Tea Gardens WTP flow diagram

2.8 ASSESSMENT OF GLOUCESTER WATER SUPPLY SYSTEM

2.8.1 GENERAL DESCRIPTION AND HISTORY

Gloucester Water Supply System supplies drinking water to residents of Gloucester and Barrington. Gloucester is located 145 km north west of Newcastle. Barrington is a small village 5 km north west of Gloucester. Gloucester Water Supply Scheme was first operated by MidCoast Water Services in July 2011, previously operated by MidCoast Council (former Gloucester Shire Council).

Gloucester Water Supply Scheme includes:

- Barrington River raw water intake;
- Raw water pump station;
- Water treatment plant;
- Three reservoirs;
- Distribution pipe network and;
- Seven booster pump stations.

The scheme supplies water to a population of approximately 3 500 at Gloucester and Barrington. Gloucester Water Supply Scheme originated in 1935 and underwent an upgrade in 1981. The conventional water treatment plant has a current capacity of treating 4 ML/day. The scheme has a reservoir storage capacity of 4.35 ML.

Gloucester WTP is being currently being upgraded including; online analysers and plant automation, chemical dosing systems (ACH, soda ash and chlorine complete) and electrical upgrades, control building improvements and ongoing pipe repairs in the reticulation system.

Figure 42: Gloucester WTP buildings

BARRINGTON RIVER CATCHMENT AREA

Council relies on water drawn from Barrington River, upstream of Gloucester for the town water supply. There are three main rivers in Gloucester catchment; Gloucester, Barrington and Avon, and many smaller tributaries which all form part of the larger Manning River catchment area, refer to Figure 9: *Manning River catchment map.* Gloucester and Avon Rivers meet Barrington River downstream of the intake to the WTP.

Barrington River catchment forms part of the tradition land of the Worimi and Biripi people (ABC, 2014). Major land uses in the catchment include beef and cattle agriculture and tourism. Barrington Tops and Gloucester Tops National Parks are popular tourist destinations within the region. There is potential for future mining explorations and activities in the catchment (with existing mining activities in Avon River catchment). Due to this potential, extra parameters were added to the drinking water quality monitoring program for raw water in Barrington River in January 2014 (strontium, cadmium, cyanide and silver).

Figure 43: Barrington River near headwaters

Figure 44: Barrington River near offtake

Figure 45: Barrington River near offtake

MINING ACTIVITIES IN BARRINGTON RIVER CATCHMENT

There is potential for future mining activities in Barrington River Catchment. Potential impacts of mining on drinking water quality in Gloucester have been considered during the risk assessment process.

RAW WATER QUALITY

Raw water characteristics of this surface water supply are summarised below:

- Low alkalinity and hardness;
- Variable concentrations of metals (iron and aluminium);
- Elevated nutrients during high flow;
- Elevated turbidity, colour and faecal coliforms concentrations during high flow and;
- Neutral pH.

PROCESS DESCRIPTION

RAW WATER EXTRACTION

Raw water is extracted from Barrington River upstream from its confluence with Gloucester River. A raw water pump station containing two pumps transfers water via a main to the WTP.

MIXING CHAMBERS

Three mixing chambers are at the head of the plant, where pre dose chemicals are added and flash mixing occurs. Aluminium chlorohydrate (ACH) to promote coagulation, and flocculation aid which helps to increase filter efficiency are dosed in the first chamber. Soda ash (sodium carbonate) to assist water stabilisation and pH correction, and polymer to assist flocculation are dosed in the second chamber. The three mixing chambers allow sufficient contact time for chemicals to achieve optimal coagulation and flocculation in the next stage.

FLOCCULATION CHAMBERS

Pre-dosed water flows over a weir into a series of three flocculation chambers. These chambers are fitted with mixers of varying speeds. Mixing speed decreases through the chambers so when water reaches the final chamber, large floc is formed. Detention time in the flocculation chambers is approximately 20 min.

CLARIFIER

From the flocculation chambers water flows over a baffle wall into the clarifier for settling. A traveling bridge moves along the length of the tank scraping sludge that has settled on the bottom towards four sumps, which then drain sludge to a pit and into sludge lagoons. The traveling bridge runs manually (approximately hourly) when the plant is running. The tank is drained and cleaned four times a year.

SAND FILTERS

From the clarifier, clear water flows over a weir, through a chamber to sand filters. There are two sand filters which run together to assist in removal of small particles. Filters are backwashed as needed, usually twice per week. A gauge in the operational lab shows filter performance and backwashes are scheduled accordingly.

The filters have plenum floors containing 480 nozzles in each, to allow water to pass through and air and water to be used in the backwash process. Backwash water is sent to sludge lagoons.

CLEAR WATER TANK

From filters, water enters the clear water tank (under the treatment building) which has a capacity of 400 KL. Liquid chlorine (sodium hypochlorite) is dosed into the clear water tank for disinfection. Fluoride (sodium fluoride) for dental hygiene is dosed as water leaves the plant and is sent to the distribution system.

WASTEWATER MANAGEMENT

Wastewater from filter backwashing and sludge from the clarifier is pumped to a pit and into one of two sludge lagoons. One lagoon is operational at any time and the other is used for drying. A centrifuge is hired to dewater sludge when required. Supernatant water from sludge lagoons is sent back to the head of plant at a maximum rate of 10 % of raw water volume. Supernatant enters the treatment process in the first mixing chamber.

Figure 46: Gloucester WTP mixing chambers

Figure 47: Gloucester WTP

Figure 48: Traveling arm on clarifier

Figure 49: Gloucester WTP sludge lagoons

RESERVOIRS AND DISTRIBUTION SYSTEM

As final treated water leaves the WTP it is pumped through a main towards Gloucester. The water main then branches, with one arm transferring water to the township of Barrington. There are three reservoirs in Gloucester water supply system. The following diagram shows main features of the water supply system.

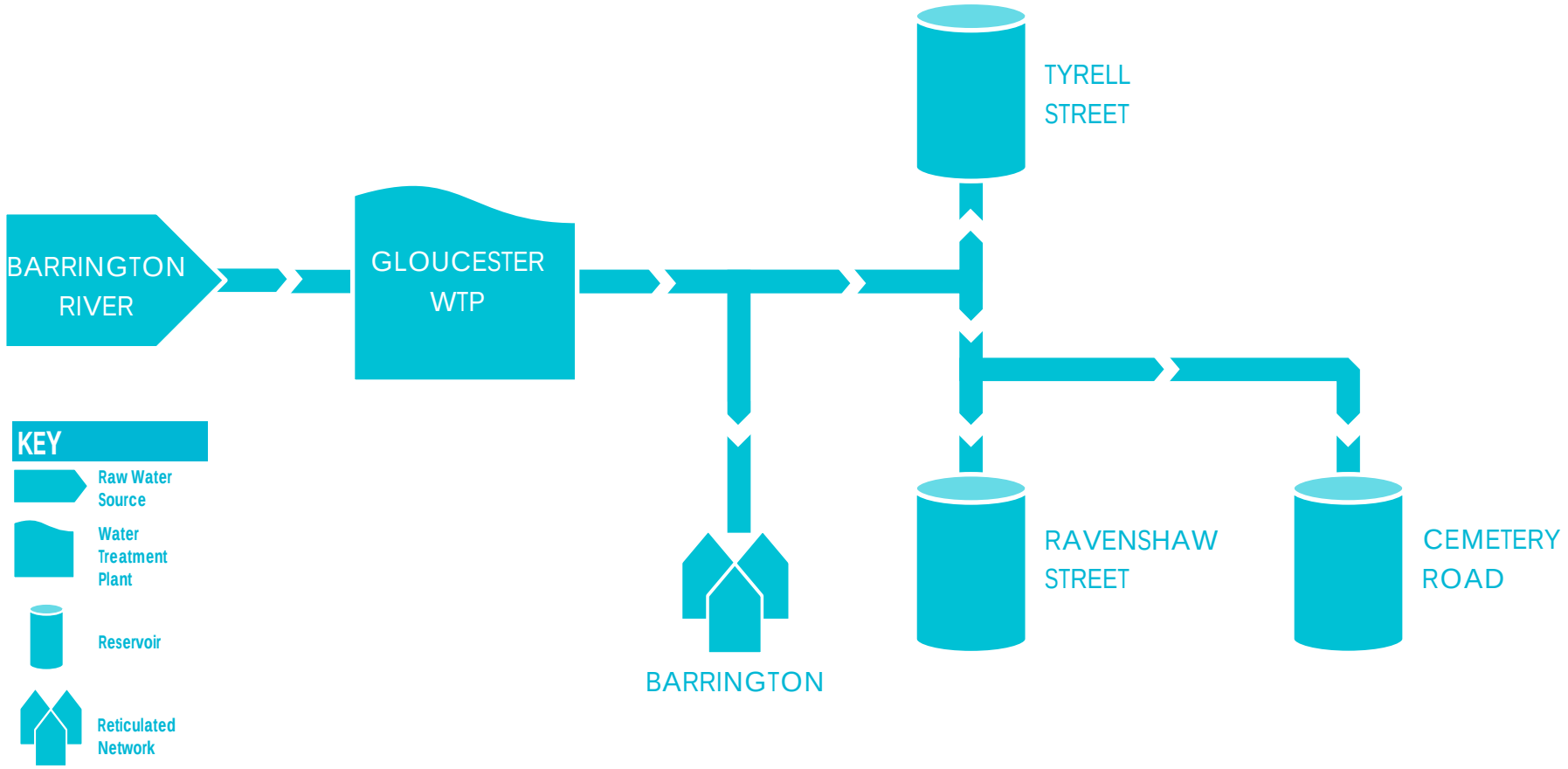

Figure 50: Gloucester water supply distribution system

Three reservoirs operate in Gloucester Water Supply Scheme and are described in the table below.

Table 10: Reservoirs in Gloucester water supply system

Reservoir	Capacity (ML)	BWL (mAHD)	TWL (mAHD)	Diameter (m)
Gloucester 1 Tyrell Street	0.55	125.5	126.5	9.1
Gloucester 2 Ravenshaw Street	2.3	122.9	126.8	18.5
Gloucester 3 Cemetery Road	1.5	141.59	142.5	14.2

The table below describes pump stations in Gloucester Water Supply Scheme.

Table 11: Pump stations in Gloucester water supply system

Pump Stations	Pump make and model	Duty Flow (L/S)	Duty Head (m)	Elevation – approx. (mAHD)
Clear water		49	62.8	100.16
WPS 1 – Ravenshaw Street	Wilo IL 125-300-18/5-4-LI	40	34	118.64
Ravenshaw Street booster	Lowarra SV9203-2F185, 3 pumps			118.86

Pump Stations	Pump make and model	Duty Flow (L/S)	Duty Head (m)	Elevation – approx. (mAHD)
WPS 2 – Jacks Road	Lowarra SV6005F150, 2 pumps			124.72
WPS 3 – Rogers Street	LP50-125/142			120.61
WPS 5 – Showground Road	SV6006F-150, 2 pumps SV6603-F185/2 1 pump			105.94
Tyrell Street Reservoir	Lowarra SV9203-F220 (1.2-185), 3 pumps			112.50

FLOW DIAGRAM

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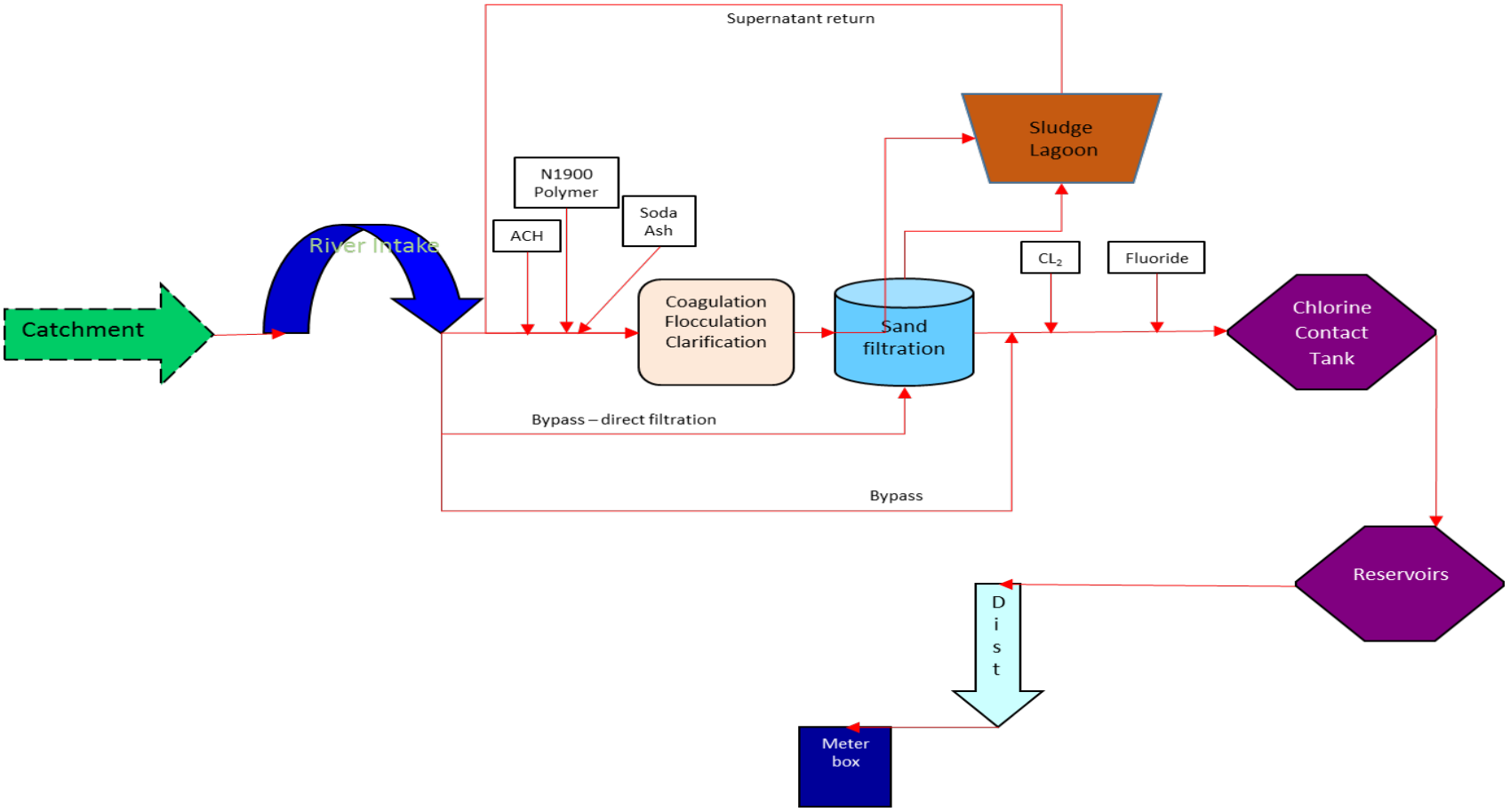


Figure 51: Gloucester WTP flow diagram

2.9 ASSESSMENT OF NORTH KARUAH DISTRIBUTION SYSTEM

2.9.1 GENERAL DESCRIPTION AND HISTORY

Council purchases bulk water from Hunter Water to supply residents of North Karuah with reticulated drinking water.

Drinking water for this scheme is sourced from Tomago bore fields and treated at Lemon Tree Passage WTP. Water is then supplied to Karuah zone reticulation system. Water extraction, treatment and operational monitoring at the WTP, and verification monitoring of Karuah zone is the responsibility of Hunter Water. Council is responsible for verification monitoring in North Karuah reticulation system, including the water main on the bridge over Karuah River (Tarean Rd) and the reticulation system north of the bridge.

A notification protocol between MidCoast Water Services and Hunter Water describes criteria which require notification between the two organisations. These include circumstances which have potential to impact water quality and/or supply to residents of North Karuah. Refer to *Notification Protocol between MidCoast Water Services and Hunter Water* (MCWS ID A590828).

PROCESS DESCRIPTION

Lemon Tree Passage WTP treats water from the north-eastern end of Tomago sand beds and provides a peak supply capacity of 5 ML/day. The treatment plant uses two-stage filtration, and includes the following processes:

- Aeration;
- Coagulation / flocculation;
- Two stage filtration;
- pH correction;
- Disinfection and;
- Fluoridation.

DISTRIBUTION SYSTEM

Drinking water is supplied to a population of approximately 100 in North Karuah. There are no reservoirs or pump stations within Council's area of supply.

FLOW DIAGRAM

A flow diagram was produced for the purpose of risk assessment and verified by participants of risk assessment workshops (provided below) It includes basic details of the treatment process and distribution system It was included in the briefing paper produced for the risk assessment workshop held in May 2016, refer to *Briefing paper 2016 Risk Review Workshops* (MCWS ID A579800).

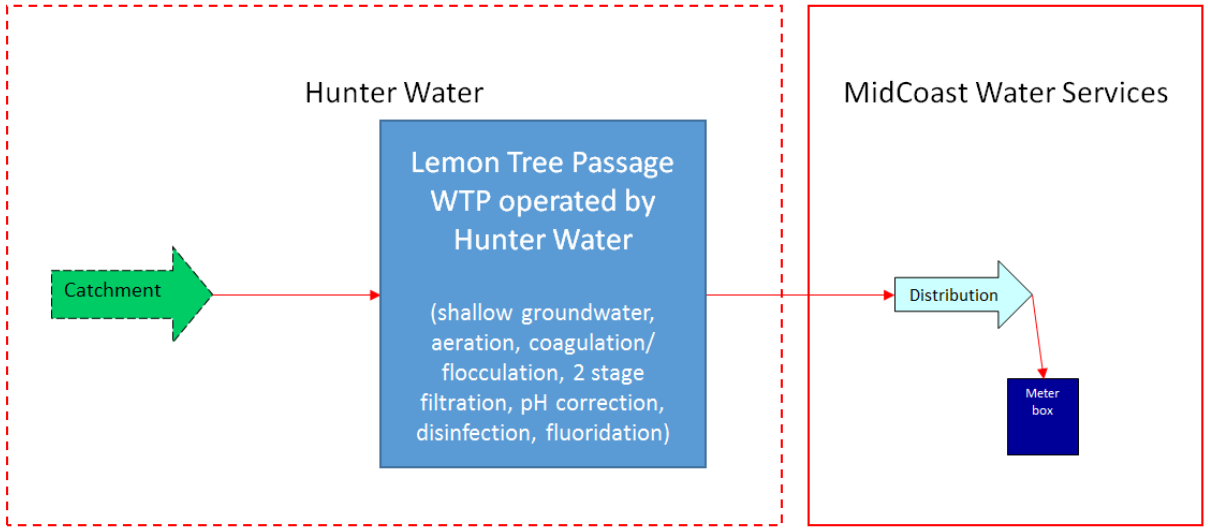


Figure 52: North Karuah water supply system flow diagram

2.10 ASSESSMENT OF WATER QUALITY DATA

Water quality data for each scheme was assessed for the purpose of risk assessment. This included historical data from source water, treatment plants and water provided to consumers. Three years of water quality data from verification monitoring points was included in the briefing paper, provided to workshop participants. Other water quality data and trends were available to view during the risk assessment workshop. Details of risk assessment methodology (including assessment of water quality data) are provided in the following section, *Hazard Identification and Risk Assessment*.

2.11 HAZARD IDENTIFICATION AND RISK ASSESSMENT

The purpose of this step is to identify and document all potential hazards, hazardous events and sources so associated risks can be estimated and prioritised. This section describes how this process was achieved for each water supply system.

2.11.1 PREVIOUS RISK ASSESSMENTS

For details of previous risk assessments refer to;

- *Hazard Analysis and Risk Assessment Workshop Participants – Manning WSS 2009* (MCWS ID A460942)
- *Manning District Water Supply Scheme – Hazard Analysis and Risk Assessment 2009* (MCWS ID A231007). Bootawa WTP was commissioned in November 2010.
- *2012 HACCP Workshop Participants – Manning WSS* (MCWS ID A547767)
- *Manning WSS Hazard Analysis & Risk Assessment – updated 2013* (MCWS ID A401018)
- *Bulahdelah hazard analysis and risk assessment workshop participants 2013* (MCWS ID A579813)
- *Bulahdelah WSS Hazard Analysis and Risk Assessment* (MCWS ID A434147)
- *Stroud hazard analysis and risk assessment workshop participants 2013* (MCWS ID A579815)
- *Stroud WSS Hazard Analysis & Risk Assessment* (MCWS ID A443669)
- *Tea Gardens hazard analysis and risk assessment workshop participants 2014* (MCWS ID A579819)
- *TG WSS Hazard Analysis & Risk Assessment* (MCWS ID A459083)
- *Gloucester hazard analysis and risk assessment workshop participants 2014* (MCWS ID A579874)
- *Gloucester WSS Hazard Analysis & Risk Assessment* (MCWS ID A459085).

2.11.2 RISK ASSESSMENT REVIEW 2016

Risk review workshops for all water supplies (except Nabiac as it was prior to commissioning) were undertaken in May 2016, facilitated by a contractor from Bligh Tanner (funded by NSW Health). Assessment of North Karuah system was included in these

workshops. Risk assessment methodology, risk matrix, flow diagrams and water quality data are included in *Briefing Paper 2016 Risk Review Workshops* (MCWS ID A579800). Workshop participants, methodology (hazard analysis and risk assessment HACCP) and risk outcomes are included in *MidCoast Water Services Risk Report May 2016* (MCWS ID A562361).

WORKING TEAM

A working team was formed to undertake the hazard analysis and risk assessment process. The team included engineers, scientists, WTP operators, maintenance and response crew (reticulation system), environmental officers and managers with various water quality management expertise and roles in water supply operations, planning and regulatory compliance. Participants from NSW Health and NSW Department of Industry were invited to attend (list included in Risk Report referred to in previous section).

BRIEFING PAPER

Prior to the workshops, a briefing paper was produced and sent to participants. This included a system flow diagram for each supply including details of the treatment process from catchment to tap, chemical dosing points and bypasses (provided in previous sections; *Assessment of Water Supply System*). Water quality data of verification monitoring was provided in the briefing paper. In addition to this, data was available on screen during the workshop including; historical data and trends for source water, treatment plants (operators logs), verification, system specific and project monitoring and exceedances. Chlorine contact times were evaluated by Bligh Tanner prior to the workshop to ensure lower critical control point limits are appropriate.

MidCoast Water Services risk matrix, likelihood and consequence table, as well as risk methodology examples (based on ADWG requirements) were included in the briefing paper.

RISK ASSESSMENT METHODOLOGY

Council supplies water to the general population. Water supplied is intended for drinking. Dermal exposure through washing of bodies and clothes, inhalation from showering and boiling are also exposure routes for waterborne hazards. Food may be prepared from the water.

Intended consumers do not include those who are significantly immuno-compromised or using water for dialysis. Water may be not suitable for industries with special water quality needs e.g. dairy farms, abattoirs. These groups of consumers are advised to provide additional point-of-use treatment.

Unmitigated risk (maximum risk with no preventive measures in place) was assessed for all schemes. This was assessed separately for surface water and groundwater schemes.

For each scheme, hazards, sources and hazardous events were identified and barriers and control measures that are in place identified. Mitigated (residual) risks were then evaluated. Whole of system risks were also evaluated; e.g. east coast low (or other significant weather event), operator error and sabotage/terrorism.

In accordance with MidCoast Water Services' risk matrix, the acceptable level of risk is considered to be low or medium where medium risk is as low as reasonably practicable (ALARP).

Critical control points and operational control points were discussed during the workshop to ensure they were appropriate.

In accordance with ADWG, levels of uncertainty were assigned to each risk, to ensure consideration is given to further investigation where necessary.

A preliminary risk assessment for Nabiac WTP (design and construction stage) was undertaken by a working group from MidCoast Water Services 25 May 2016 using the same format; refer to *Nabiac WTP – Preliminary Risk Assessment 2016* (MCWS ID A562099).

2.11.3 RISK ASSESSMENT OUTCOMES

From hazard analysis and risk assessment workshops, a risk report was produced. It detailed all hazards that were identified throughout each step in water supply management from catchment to customers' taps, preventive measures in place and risk assigned to each hazard. Refer to *MidCoast Water Services Risk Report May 2016* (MCWS ID A562361).

Where risks are ranked as medium (and not ALARP) or higher, risk improvement measures were identified that could mitigate these risks if implemented. These measures are included in the corrective actions database (which also includes other improvement actions), refer to *Drinking Water Quality Management System Corrective Actions Database* (MCWS ID A574044). The database allows for stronger ability to monitor, report and review risk profile. It also captures historical data and monitors trends. Actions have been ranked according to risk level from low to extreme. Accountability has been delegated and status is updated quarterly as actions are progressed or closed out. Priorities for risk management are determined by level of risk.

Progress of actions in the database is reviewed and reported to Water Services' management on a quarterly basis. An update is provided to NSW Health in an annual report presented at the Joint Strategic Group (JSG) meeting each October.

2.11.3 NABIAC RISK ASSESSMENT PROCESS

A preliminary risk assessment was undertaken in May 2016 while Nabiac WTP was in the construction phase. The same methodology was used as risk assessments of other water supply systems. For further information on workshop participants and background information provided, refer to Nabiac WTP Health Based Risk Assessment Workshop –

background information (MCWS ID A633420). This workshop included identification of critical control points. Risks identified in this workshop were addressed (reduced to ALARP) through design and construction of the WTP. Refer to Nabiac WTP – Preliminary Risk Assessment May 2016 (MCWS ID A562099) for details.

Hunter H2O is responsible for the handover and proof of performance testing of Nabiac WTP. Prior to commissioning, Nabiac Scheme Commissioning Risk Assessment Workshop was conducted, February 2018. It focussed on potential high level risks during the commissioning phase. Representatives from NSW Health and NSW Department of Industry participated in this workshop. Outcomes from this workshop were managed by Hunter H2O and Water Services to reduce risks to ALARP prior to commissioning. An action list was prepared to track progress after this workshop (MCWS ID B548990).

HACCP risk assessment review will be undertaken within the first year of operation of the Nabiac scheme to ensure all risks have been identified and managed accordingly. Outcomes from this risk assessment will be incorporated into, and managed within the corrective actions database for the DWQMS.

ELEMENT 3: PREVENTIVE MEASURES FOR DRINKING WATER QUALITY MANAGEMENT

It is important to incorporate multiple barriers throughout drinking water supply systems. Failure of one barrier can be compensated by effective operation of remaining barriers. Examples of preventive measures and barriers include catchment management, water treatment, maintenance of the distribution system and appropriate operational practices.

3.1 PREVENTIVE MEASURES AND MULTIPLE BARRIERS

System specific preventive measures to reduce hazards in each water supply scheme were identified during the risk assessment process. All hazards and preventive measures were considered throughout each step from catchment to tap. These preventive measures are documented in *MidCoast Water Services Risk Report May 2016* (MCWS ID A562361).

3.2 CRITICAL CONTROL POINTS

A critical control point (CCP) is defined as a point, step or procedure at which control can be applied and a hazard can be prevented, eliminated or reduced to acceptable levels. All significant hazards identified through the risk assessment process need to be managed to ensure the risk is reduced to an acceptable level.

CCPs for all water supply systems were documented in 2014 (except Nabiac which was documented in 2018). Refer to:

- Bootawa WTP *Critical Control Points for Manning Water Supply System – updated 2014* (MCWS ID A452939);
- *Critical Control Points for Bulahdelah Water Supply System* (MCWS ID A452940);
- *Critical Control Points for Stroud Water Supply System* (MCWS ID A452943);
- *Critical Control Points for Tea Gardens Water Supply System* (MCWS ID A459084)and;
- *Critical Control Points for Gloucester Water Supply Scheme* (MCWS ID A459087).

These procedures were reviewed and updated in 2016 by Water Services and NSW Health, with assistance from contractors funded by NSW Health, refer to *Critical Control Points: MidCoast Water Services' Water Supply Systems* (MCWS ID # A575578). This followed the risk assessment review process to ensure appropriate identification of CCPs. The main changes to CCPs were:

- Including integrity of service reservoirs;
- Including fluoridation and;
- Reducing critical limits of turbidity after filtration at Stroud, Gloucester and Bulahdelah to 1 NTU to ensure effective disinfection.

Operators record test results daily into operator's logs. If results are over alert or critical levels, they are automatically highlighted in this spreadsheet. This data is reviewed by operators, co-ordinators and Process Engineer. Exceedances of critical limits are notified to regulators by Product Quality Systems Officer using reporting template *CCP Notification Template* (MCWS ID A122871). Hard copies of current CCPs are displayed at WTPs.

Implementation of CCPs including training operators and other relevant staff is undertaken Manager Water Management and Treatment and has been documented in the corrective actions database.

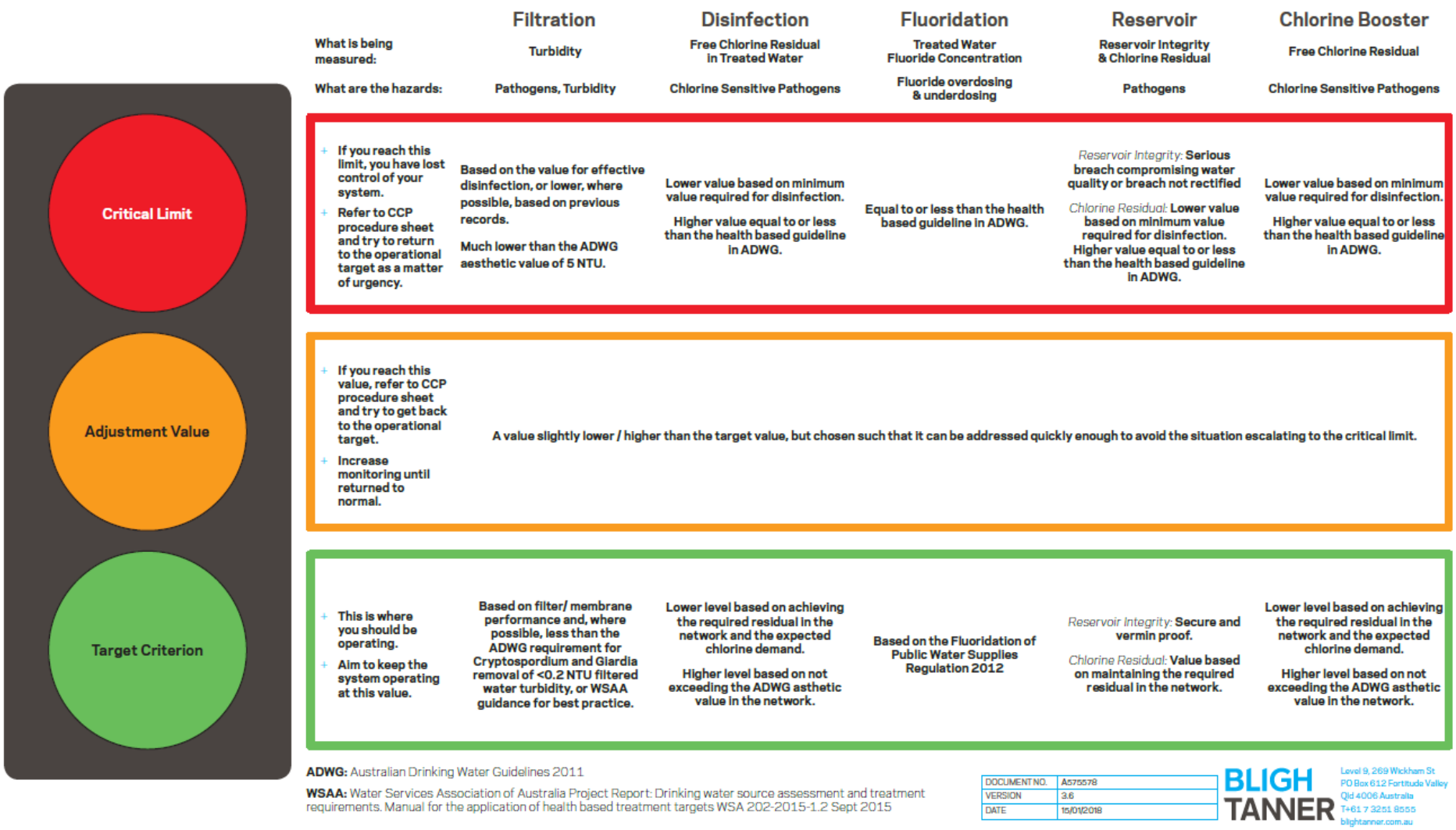
CCPs for Nabiac were developed during the design phase of the WTP (similar to Bootawa). Nabiac CCPs are for the WTP only, as the reticulation system is part of the Manning supply. This was approved internally and discussed with NSW Health and NSW Department of Industry.

A list of CCPs at each water supply system is provided in the table below.

Table 12: CCPs for each water supply system

Water supply	WTP	CCP1	CCP2	CCP3	CCP4	CCP5	CCP6
Manning	Bootawa	Filtration	Disinfection	Fluoridation	Reservoirs	Lantana chlorine booster station	Kolodong and Forster chlorine booster stations
	Nabiac	Filtration	Disinfection	Fluoridation			
Bulahdelah	Bulahdelah	Filtration	Disinfection	Fluoridation	Reservoirs		
Stroud	Stroud	Filtration	Disinfection	Fluoridation	Reservoirs		
Tea Gardens	Tea Gardens	Filtration	Disinfection	Fluoridation	Reservoirs		
Gloucester	Gloucester	Filtration	Disinfection	Fluoridation	Reservoirs		

The figure below shows the executive summary of CCPs, including what is measured, where and how it is measured and the relevant hazards.



	Filtration	Disinfection	Fluoridation	Reservoir	Chlorine Booster
What is being measured:	Turbidity	Free Chlorine Residual in Treated Water	Treated Water Fluoride Concentration	Reservoir Integrity & Chlorine Residual	Free Chlorine Residual
What are the hazards:	Pathogens, Turbidity	Chlorine Sensitive Pathogens	Fluoride overdosing & underdosing	Pathogens	Chlorine Sensitive Pathogens
+ If you reach this limit, you have lost control of your system. + Refer to CCP procedure sheet and try to return to the operational target as a matter of urgency.	Based on the value for effective disinfection, or lower, where possible, based on previous records. Much lower than the ADWG aesthetic value of 5 NTU.	Lower value based on minimum value required for disinfection. Higher value equal to or less than the health based guideline in ADWG.	Equal to or less than the health based guideline in ADWG.	*Reservoir Integrity*: Serious breach compromising water quality or breach not rectified *Chlorine Residual*: Lower value based on minimum value required for disinfection. Higher value equal to or less than the health based guideline in ADWG.	Lower value based on minimum value required for disinfection. Higher value equal to or less than the health based guideline in ADWG.
+ If you reach this value, refer to CCP procedure sheet and try to get back to the operational target. + Increase monitoring until returned to normal.	A value slightly lower / higher than the target value, but chosen such that it can be addressed quickly enough to avoid the situation escalating to the critical limit.				
+ This is where you should be operating. + Aim to keep the system operating at this value.	Based on filter/ membrane performance and, where possible, less than the ADWG requirement for Cryptospordium and Giardia removal of <0.2 NTU filtered water turbidity, or WSAA guidance for best practice.	Lower level based on achieving the required residual in the network and the expected chlorine demand. Higher level based on not exceeding the ADWG asthetic value in the network.	Based on the Fluoridation of Public Water Supplies Regulation 2012	*Reservoir Integrity*: Secure and vermin proof. *Chlorine Residual*: Value based on maintaining the required residual in the network.	Lower level based on achieving the required residual in the network and the expected chlorine demand. Higher level based on not exceeding the ADWG asthetic value in the network.

ADWG: Australian Drinking Water Guidelines 2011

WSAA: Water Services Association of Australia Project Report: Drinking water source assessment and treatment requirements. Manual for the application of health based treatment targets WSA 202-2015-1.2 Sept 2015

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VERSION	3.6
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Figure 53: Executive summary of critical control points

ELEMENT 4: OPERATIONAL PROCEDURES AND PROCESS CONTROL

The components of this element are managed within Water Management and Treatment, and Planning and Assets.

4.1 OPERATIONAL PLANS AND PROCEDURES

Operational procedures formalise activities that are essential to supply of safe, clean drinking water and help to ensure consistency across the organisation, minimising risk to staff, the community and consumers. Procedures are developed and documented with participation of operators and other relevant staff and are compiled into Operations and Maintenance Manuals. This action is included in the corrective actions database. These are stored electronically and at WTP sites. Refer to the following documents for details;

- Bootawa WTP Operation and Maintenance Manual (MCWS folder ID fA17691)
- MA4 1001- IY005 Control Philosophy Rev D 150411 (MCWS ID A329865)
- Bootawa Dam Operations and Maintenance Manual (MCWS ID A321748)
- MidCoast Water Services Bootawa Dam Cyanobacterial Monitoring and Management Plan 2005 (MCWS ID # A225013).
- Nabiac WTP Functional Description Specification is stored in Objective (MCWS ID B508502).
- Bulahdelah Operating and Maintenance Instructions Volume 1 & 2 (MCWS ID A436801 and A446850
- Stroud Operations and Maintenance Manual (MCWS ID A346798)
- *Operating philosophy for off river storage at Stroud WTP* (MCWS ID A515355)
- Tea Gardens WTP Operation and Maintenance Manual (MCWS folder ID fA17710)
- Gloucester Shire Council WTP O & M Manual October 1981 (MCWS ID A460561),
- Gloucester Shire Council WTP O & M Manual Soda Ash & Alchlor Dosing System – Gloucester WTP (MCWS ID A460564),
- Gloucester Shire Council WTP Fluoride Dosing System – Saturator System with Metering Pumps (MCWS ID A460567),
- Gloucester WTP Backwash Pump Wilo – EMU 1301-sec (MCWS ID A410874)
- Gloucester WTP Clearwater Pump (MCWS ID A410872)
- Gloucester Water Treatment Plant Working Procedure (MCWS ID A456602).

4.1.1 INTEGRATED SITE MANAGEMENT PLANS

Each WTP has an Integrated Site Management Plan. The purpose of these plans is to provide an integrated document comprising elements of safety, quality and environmental management of the WTP and address compliance through policy, procedures and effective management control systems. There are four main sections of each plan;

- General description of the site and facilities
- Work health and safety management

- Quality management
- Environmental management

Refer to;

- *Bootawa WTP Facility – Integrated Site Management Plan, Construction Integrated Management Plan, May 2015* (MCWS ID B482349)
- *Bulahdelah WTP Facility – Integrated Site Management Plan, May 2015* (MCWS ID B480717)
- *Stroud WTP Facility – Integrated Site Management Plan, May 2015* (MCWS ID B489484)
- *Tea Gardens WTP Facility – Integrated Site Management Plan* (MCWS ID B465361)
- *Gloucester WTP Facility – Integrated Site Management Plan, May 2015* (MCWS ID B491879).

Nabiac Integrated Site Management plan will be developed in the future.

4.1.2 STANDARD OPERATING PROCEDURES AND WORK METHOD STATEMENTS

Water Services operational staff utilise standard operating procedures (SOPs), work method statements and risk management procedures for guidance to ensure tasks are completed safely and to an acceptable level. Current SOPs are stored electronically and can be printed. Manager Water Management and Treatment ensures operators have access to, and follow the current version. Procedures are updated as required and approved by section leaders/coordinators. SOPs have been developed for all procedures relating to CCPs at WTPs.

Improved documentation of work method statements and SOPs is an ongoing process and has been identified as a priority for the organisation. This action has been included in the corrective actions database.

4.2 OPERATIONAL WATER QUALITY MONITORING AND CORRECTIVE ACTIONS

All details relating to operational water quality monitoring and corrective actions for each water supply scheme are covered in the current *Drinking Water Quality Monitoring Plan* (MCWS folder ID fA27690). The monitoring plan is based on the *Framework for Drinking Water Quality Management* from ADWG. A central aspect of the risk based approach to drinking water quality systems is the use of monitoring to confirm the effectiveness of preventive measures and barriers to contamination, and to enhance understanding of system performance. The monitoring plan is based on these principles.

Nabiac WTP monitoring has been included in this monitoring plan since 2018.

4.3 EQUIPMENT CAPABILITY AND MAINTENANCE

Council has an organisational approach to asset management. Equipment capability and maintenance is covered in the Strategic Asset Management System, described below.

4.3.1 STRATEGIC ASSET MANAGEMENT FRAMEWORK

The Strategic Asset Management Framework has been developed to provide vision, ensure consistency and set a common ideology for all existing and future asset management practices across the organisation, refer to *MidCoast Water Services Strategic Asset Management Framework* (MCWS ID A542908).

In January 2014 International Organisation for Standardisation (ISO) released a newly created standard suite (ISO5500x) which describes the best practice approach to establishing an asset management system. Leveraging off this standard, many technical bodies around the world adapted their technical material and literature to better articulate the standard into real world terms. The Global Forum on Maintenance and Asset Management; comprising of the Australian, UK, US and European asset management technical bodies, has developed a Landscape document which presents the best practice ISO5500x asset management system into six core subject areas with 39 competence subject groups.

In ensuring that Council is working towards best practice asset and business management, the Strategic Asset Management Framework utilises the principles outlined within the Global Forum on Maintenance and Asset Management, the ISO, Asset Management Council BoK and the Institute of Asset Management to develop a Strategic Framework relevant to Water Services.

MAINTENANCE PLANNING AND SCHEDULING

As part of the Strategic Asset Management Framework, maintenance schedules have been reviewed and improved. Nominated assets which require maintenance and frequency of scheduling are determined based on criticality. This includes equipment at all treatment plants, reservoirs, pump stations and reticulation systems, including some monitoring equipment. The improved maintenance schedules are integrated within the Enterprise Business Management System (MC1) and currently being deployed, with initial focus on WTPs. Categories within maintenance schedules include:

- Asset number and name;
- Frequency required for maintenance;
- Trades required to complete work (including when subcontractors are required);
- Responsible person;
- Managing person;
- Links to financial requirements and;
- Standard and site specific instructions and tasks required to carry out maintenance.

Work orders are generated and delegated to responsible officers on a quarterly basis. When work has been carried out and inspection points completed, work orders are closed out with reports attached as required.

Progress on work orders can be tracked. It is the responsibility of relevant coordinators and managers to follow up any outstanding work orders. Measureable data can be produced, and any issues identified will be incorporated into the issues and failures register for prioritisation and rectification.

Routine operator tasks are not included in the maintenance schedule. These activities are recorded on check lists by operators and stored electronically within operator's logs. Activities include routine checks such as calibration checks, visual inspections, checking backwash times etc.

SERVICING AND CALIBRATION OF MONITORING EQUIPMENT

Online equipment at WTPs is serviced and calibrated routinely by an external contractor. This equipment includes online chlorine, fluoride and turbidity monitoring equipment. Servicing and calibration records are stored electronically in folder fA24619. These calibration activities are included in the preventive maintenance program.

Field and test room equipment is serviced and calibrated annually by external technicians This is co-ordinated by Environmental Scientist Quality and Source and includes monitoring equipment for chlorine, turbidity, pH, fluoride, dissolved oxygen etc. Equipment is collected at central locations where servicing and calibrations take place. These records are stored electronically (fA27514).

If any monitoring equipment requires servicing or calibrating more frequently than annually, or specialist attention, it is sent to service providers as required.

Calibration process compliance of high priority flow monitoring equipment is reported annually to NSW Department of Industry under Water Utility Performance reporting. As part of the reporting process calibration records are checked during an external audit every three years.

FAILURES AND ISSUES REGISTER

A key initiative in the organisation's approach to asset management is the Failures and Issues Register. The intent of this process is to capture failures, issues and defects that are or could be associated with assets or their configuration. Following this process allows issues to be raised and a needs determination undertaken to understand the extent of the problem and potential rectifications considering both asset and non-asset solutions. The failures and issues process categorises issues using the MidCoast Water Services risk matrix and provides a risk profile across the Water Services asset base.

Capturing water quality issues through this process allows the formal investigation and future allocation of funding (if required) for that specified issue resolution. Water quality issues are nominally considered regulatory in nature.

Forms are available on the intranet and are submitted by coordinators or managers for addition to the failures and issues register.

ASSET RENEWAL PROGRAMS

Asset renewal programs are being introduced to provide for strategically targeted renewals within Water Services. Projects are captured through asset management planning to determine a project need and classify it against a given driver. These projects look at a business need from a renewal, regulatory, growth or efficiency/improvement context. These works are captured within Asset Class and Strategic Asset Management Plans. *MidCoast Water Services Capital Investment Prioritisation Model* (MCWS ID B503447), and *MidCoast Water Services Sustaining Works Investment Framework* (MCWS ID B525570) are used to make informed, risk based decisions to determine priority of projects and allocation of investment.

4.4 MATERIALS AND CHEMICALS

Water Services has a Procurement Management Policy (MCWS ID A484383) and accompanying Procurement Management Plan (MCWS ID A484393) in place. The objective is to establish clear, consistent, ethical guidelines for all procurement activities undertaken by staff. This includes the purchase of materials and chemicals.

For documented procedures for delivery and storage of chemicals. Refer to the following SOPs:

- Chemical system routine performance monitoring (MCWS ID A512473) and;
- Unloading chemicals into storage at treatment plants (MCWS ID A513402).

Information on chemical usage in the water supply system is stored in Chemicals in Water and Sewage Treatment (MCWS Folder ID qA4005) with details of daily usage on operators' logs. Details include chemical specification, guideline requirements, maximum allowed dosage at WTPs and impurities. Chemical dosing system audits are undertaken, and any issues are reported to the failures and issues register. Other information available in this folder includes; safety data sheets, pricing, certificate of analysis and conformance.

ELEMENT 5: VERIFICATION OF DRINKING WATER QUALITY

5.1 DRINKING WATER QUALITY MONITORING AND CORRECTIVE ACTIONS

All details relating to drinking water quality monitoring including; verification and operational monitoring program, customer satisfaction, short term evaluation of results and corrective actions are covered in the current Drinking Water Quality Monitoring Plan (MCWS folder ID fA27690). This document is reviewed annually and the updated version is sent to NSW Health. Monitoring at Nabiac WTP has been included since 2018

5.1.1 NSW ABORIGINAL COMMUNITIES WATER & SEWERAGE PROGRAMS

Council participates in NSW Department of Industry Aboriginal Water and Sewerage Program, which began in 2011. The aim of the program is to ensure water and sewerage services are provided to local Aboriginal communities of Purfleet and Tobwabba at an equivalent standard to the wider community. For details refer to Purfleet Aboriginal Water and Sewerage Management Plan (MCWS ID A441839) and Tobwabba (Cabarita) Aboriginal Water and Sewerage Management Plan (MCWS ID A441840). The management plans include water quality monitoring at reticulation sites within these communities. These sites have a dedicated testing program under NSW Department of Industry. Parameters tested include *E. coli*, key physical and chemical parameters, disinfection by-products and pesticides. These reticulation sites are incorporated in Water Services' regular drinking water quality monitoring program. The program is reviewed by NSW Department of Industry on an annual basis. Management plans also include roles and responsibilities of the Aboriginal communities of Purfleet and Tobwabba, respective Local Aboriginal Land Council Chief Executive Officers, MidCoast Water Services, NSW Department of Industry and NSW Health. It also includes key contacts and their contact details.

ELEMENT 6: MANAGEMENT OF INCIDENTS AND EMERGENCIES

Despite best management practices and implementation of risk based protocols, there is still potential for incidents and emergencies to affect the water industry. By undertaking detailed risk assessments and identifying and developing preventive measures for each water supply system, the organisation aims to minimise incidents and emergencies. However, in practical terms, unpredictable circumstances can arise and incidents may occur which could affect the integrity of drinking water systems.

An Incident and Emergency Management Framework is under development, which will form part of the Business Resilience Program. The Incident and Emergency Management Framework is the foundation for effective management of incidents (including higher scale incidents and more serious emergencies) affecting all Water Services facilities and operations. Key aspects of this plan are; incident and emergency prevention, preparation, response and recovery. Details of this action are included in the corrective action data base.

6.1 COMMUNICATING DURING INCIDENTS AND EMERGENCIES

Efficient and clear communications are essential to the successful management of, and risk reduction from any incident. Water Services has established communication protocols with key stakeholders for likely incidents and emergencies it will face as a water supply operator. The aim is to ensure all communication with media is consistent, well-informed, timely and appropriate. These policies will be integrated into organisation wide policies in the future. Current policies relating to communication with customers and the wider community during an incident or emergency include:

- Media Policy (MCWS ID A455122);
- External Communications Procedure (MCWS ID A498327);
- Communicating Major Service Outages Procedure (MCWS ID A542120);
- Communicating in Times of Crisis – Media Contingency Plan (MCWS ID A270424);
- Social Media Policy (MCWS ID A448743);
- Social Media Procedure (MCWS ID A448788) and;
- Boil Water Alert Communication Plan (MCWS ID A576600).

While the primary focus of incident management is to contain the extent and rectify any deviations from normal operational performance, communication with local stakeholders and customers is important. Good working relationships have been developed with media outlets (print, radio and television) which to assist in informing the community of any health risks and actions required to protect consumers from sub-standard drinking water services. If boil water advice is determined to be the best course of action after consultation between Water Services and NSW Health, including the Water Unit, or if the organisation is directed to issue advice by Public Health Unit Director, advice will be issued to consumers through strategies developed by Water Services. These strategies take into account the number of customers

affected and geography of the location. Information relating to incidents and notifications are also displayed on Council's website with links to further information where appropriate.

6.2 INCIDENT AND EMERGENCY RESPONSE PROTOCOLS

Response protocols related to drinking water incidents and emergencies are listed below:

- NSW Health Response Protocol is followed to protect public health during drinking water incidents. Refer to NSW Health Drinking Water Monitoring Program 2005 Updated October 2011 (MCWS ID A408944). The most current version is sourced directly from NSW Health website: http://www.health.nsw.gov.au/environment/water;
- Drinking Water Incident Reporting Template (MCWS ID A229934);
- MidCoast Water Services Bootawa Dam Cyanobacterial Monitoring and Management Plan (MCWS ID A225013);
- NSW Code of Practice for Fluoridation of Drinking Water Supplies – *Fluoridation of Public Water Supplies Act 1957* (MCWS ID A322675);
- CCP exceedance (MCWS ID A575578) and;
- Standard Operating Procedure - Boil Water Alert Incident Management (MCWS ID A589660).

Response protocols related to other incidents/emergencies include:

- Pollution Incident Response Management Plan (MCWS folder ID fA20684) for each Waste Water Treatment Plant;
- Sewer Overflow Notification Protocol (MCWS ID A396627) and;
- Public Health Incident Notification Protocol – Recycled Water (MCWS ID A421490).

MidCoast Council has a Workplace Health and Safety Committee (WHSC) with representatives from various sections within the organisation. Issues of health and safety are discussed at regular meetings and reported to all employees. A working group of Health and Safety Representatives (HSR) from Water Services meet regularly to discuss any issues specific to working within the water division.

It has been identified that improvement is required in the area of emergency and incident response. Actions relating to this are included in the corrective actions database.

SUPPORTING REQUIREMENTS

ELEMENT 7: EMPLOYEE AWARENESS AND TRAINING

It is essential for Council employees to have appropriate qualifications and be aware of current issues of importance for the water industry, so water supply systems can be run efficiently and safely. The organisation is committed to ensuring employees and contractors are provided with appropriate training and avenues for open communication.

7.1 EMPLOYEE AWARENESS

Awareness of drinking water quality management is addressed at initial stages of employment as part of the requirements of the position description for appropriate positions (Water Services staff). Working knowledge of water and sewerage system operation, treatment and the regulatory environment of the water industry are essential to be acquired and maintained within appropriate timeframes for these positions.

New staff participate in corporate inductions as well as specific site inductions where required. The Drinking Water Quality System is included in this induction.

All MidCoast Council employees have access to corporate policies, strategic, business and management plans, including the Drinking Water Quality Management System through the intranet and document management systems. Staff are kept up to date on current organisational and water industry issues by regular updates on the intranet.

Water Industry Operators Association of Australia (WIOA) is a professional organisation facilitating the collection, development and exchange of quality information between people undertaking operational roles in the water industry. Water Services operators are actively involved in the organisation including contributing to research, presenting at conferences and seminars and participating as committee members.

Two way communications are important within the organisation to establish paths for continuous improvement. Employees are encouraged to participate in workplace communication through involvement in Workplace Consultative Committee (WCC) and Workplace Health and Safety Committee (WHSC). Meetings are held regularly and minutes are distributed to all staff.

Important decisions are made at monthly Council meetings which effect employees throughout the organisation. Staff participate in these meetings by preparing reports for business papers. Minutes of these meetings are available to employees and are discussed with managers.

Employees are encouraged to become familiar with new and existing MidCoast Water Services facilities, e.g. recycled water schemes, sewerage treatment plants and water treatment plants. When Bootawa WTP was officially opened and began operation all staff

were invited to attend tours of the WTP to increase their knowledge on the treatment process and importance of supplying safe drinking water to the community.

7.2 EMPLOYEE TRAINING

All Water Services employees are trained to current water industry standards to perform their duties to an acceptable level. Employees are kept up to date of training opportunities and updates in the water industry. A computer based training register documents progress, qualifications and requirements of employees.

One of the objectives of implementation of the Drinking Water Quality Management System is to increase awareness amongst staff in regard to drinking water quality management requirements. During 2015, training sessions were run for all Water Services staff to undertake a module from Certificate II Water Operator course through Technical and Further Education (TAFE); 'Demonstrate knowledge of the risk management principles of the Australian Drinking Water Guidelines'. Specific information relating to this quality system was incorporated in to the course, which has raised awareness of the importance of safe drinking water. It is the responsibility of coordinators and group managers to ensure all employees who report to them are aware of the DWQMS and continue to implement the system in their day to day duties.

Council reports annually on the level of qualification for all water and sewerage treatment plant operators to NSW Department of Industry under the Local Water Utilities Performance Reporting program. Specific training is provided to staff who are directly involved in the operation and treatment of water supply systems, e.g. optimising treatment processes, sampling, monitoring and analysis, interpretation and recording of results, maintenance of equipment, emergency and incident response. Operator qualifications were previously obtained through NSW Department of Industry or TAFE. A national certification program is being implemented to ensure consistency across Australia. WTP operators must undertake specific modules of training (provided by AWA or other suitably qualified organisations) to be fully qualified to operate each plant. Certifications need to be updated every five years to keep current with changes in technology and regulations. Council is in the process of converting qualifications to the new national accreditation scheme.

Requirements relating to operator certification for fluoridation of drinking water supplies are stringent, as stated in NSW Code of Practice for Fluoridation of Public Water Supplies. Operators must hold a Fluoride Plant Operator's Certificate issued by NSW Health. On the job training must also be provided under direct supervision of a qualified operator. All relevant operators within Water Services hold this qualification or are in the process of undertaking training to acquire the certification.

Staff attend relevant workshops, conferences and training e.g. participation in water industry specific training presented by NSW Department of Industry, IWES (International Winter Environmental School), AWA, WIOA and water workshops presented by NSW Health. Striving for continuous improvement, de-brief meetings are held with relevant staff and

managers after incidents (e.g. *E. coli* detected in the water supply) to discuss cause and prevention of the problem and any way to better respond to similar incidents in the future.

Training in record keeping requirements is covered in Element 10: *Management of Documentation and Records*. A contractor program is in place to ensure all contractors engaged by Council have the correct insurances, skills, have been inducted to the contractor program and comply with all legislative and Council requirements.

ELEMENT 8: COMMUNITY INVOLVEMENT AND AWARENESS

Playing a role in community life is a key theme of Council's Community Strategic Plan; *MidCoast 2030: Shared Vision, Shared Responsibility* (www.midcoast.nsw.gov.au/Council/Plans-and-reports). This is highlighted in the vision and values of the plan (summary provided bleow):

OUR VISION

We strive to be recognised as a place of unique environmental and cultural significance. Our strong community connection, coupled with our innovative development and growing economy, builds the quality of life we value.

OUR VALUES

- our unique, diverse and culturally rich communities
- a connected community
- our environment
- our thriving and growing economy
- strong leadership and shared vision

Council works to assist the community to understand where their water comes from, its treatment and distribution process. The organisation also aims to provide customers with information they need to make informed and responsible choices about water conservation.

8.1 COMMUNITY CONSULTATION

Customers and the wider community are engaged as important stakeholders in decisions made by Council and future directions the organisation takes to ensure water quality decisions are aligned with desired outcomes of the community.

Examples of community consultation strategies are described in both MidCoast Water Services' Strategic Business Plan and Integrated Water Cycle Management Plan; *Our Water, Our Future*. The community engagement process was crucial during the development of these plans and has allowed the community and stakeholders to help shape the future of water supply in the local area. Community engagement activities included; comment and feedback from the community through newsletters, community information displays at markets and libraries, website, media releases, newspaper advertisements, online and in person surveys, project reference group and social media.

8.1.1 CONSULTATION WITH LOCAL ABORIGINAL COMMUNITIES

With regards to the Aboriginal communities of Purfleet and Tobwabba, the Chief Executive Officers (CEO) of the Local Aboriginal Land Councils will, in consultation with MidCoast Water Services be responsible for all community consultation and communication and be the

first point of contact for the community. Upon receipt of an issue, CEO will notify Water Services which will record and respond to the issues within its area of responsibility.

Local Aboriginal Land Council CEOs will obtain a list of recent issues from Water Services and present the list for review at meetings every four months. Contact details for Aboriginal communities and details of responsibilities are covered in Purfleet Aboriginal Water and Sewerage Management Plan (MCWS ID A441839) and Tobwabba (Cabarita) Aboriginal Water and Sewerage Management Plan (MCWS ID A441840).

8.1.2 COMMUNITY PROGRAMS

Through a twinning arrangement that has been supported by Asian Development Bank, Water Services is supporting development of both Tonga Water Board and Samoa Water Authority. Working with communities in neighbouring Pacific islands is a way in which Council can support developing nations improve their water management practices, and help to achieve long term vision of being leaders in the water industry. Details of the twinning program are provided on the website.

8.2 COMMUNITY AND CUSTOMER EDUCATION

The organisation's education program is designed to target a cross section of the community aiming to promote awareness of source water protection and demand management. Water conservation messages are primarily delivered through the mascot 'Whizzy the Water Drop'; whilst catchment education messages are delivered through council programs such as Waterwatch.

Whizzy the Waterdrop campaign has several components. Preschool children receive visits from the Whizzy character who teaches them five water saving tips. These five messages are also delivered in television advertising targeted at this age group. For primary school students 'Whizzy's water school' online, program and associated resource book 'Who We Are and What We Do' is available. This builds on five water saving tips and introduces students to the scope of Council's operations with information about the water cycle, drinking water reticulation system and sewerage system.

High school students, tertiary students and the wider community have access to education of operations through tours of the facilities, presentations on request by specialist staff, information stalls at community events, and the website. Water saving education is included graphically on every water account, and through the summer water saving campaign; 'Don't Spray in the Middle of the Day'. This campaign is predominantly run through media channels, as well as community newsletters, and has been found to be very effective.

8.2.2 ENVIRONMENTAL EDUCATION

Environmental education programs try to engage the whole community in protecting water quality and catchment health. MidCoast Council coordinates the Waterwatch Program in

Manning and Great Lakes catchment areas, with assistance from Hunter LLS. The program involves supporting volunteer groups who monitor water quality by providing Waterwatch monitoring kits, training on their use and interpretation of results. NSW Waterwatch operates a public website to store and share data collected by volunteers. Groups who participate in this program include schools, farmers, community groups (such as Landcare and environmental groups). Waterwatch also provides education to the broader community using a variety of methods including workshops (e.g. farmer's workshop – 'How Healthy is your Dam?'), presentations, field days/events (e.g. Platypus Festival, World Wetlands Day), and stalls at community events.

The Waterwatch program also links in with other educational programs for the wider community by working with other stakeholders. An example is a catchment model as an educational tool which demonstrates how the water cycle operates in the local area, and highlights what impact human activities can have on water quality. The model is taken to schools and community events.

8.2.3 OTHER FORMS OF COMMUNITY EDUCATION

Guided tours are offered to community groups at some WTPs. Information is available for these tours on the website. Some facilities are opened to the public for open days especially during Water Week each October. These open days are advertised in local media and Council's website. Guest speakers are provided to community groups interested in learning more about water and sewerage services and projects.

Drinking water quality data is reported to customers and the wider community via the website. A summary of results from routine water quality testing is provided in a table updated quarterly. A link is provided to the current Annual Report Summary which is also presented to MidCoast Councillors.

8.3 COMMUNICATION POLICIES AND PROTOCOLS

Council recognises community consultation as fundamental to the role of service provider. Relevant policies and procedures are listed below:

- MidCoast Water Services' Community Consultation Policy (MCWS ID A501058);
- Community Consultation Guidelines (MCWS ID A547318);
- MidCoast Water Services' Media Policy (MCWS ID # A455122);
- External Communications Procedure (MCWS ID A498327) and;
- Communicating Major Service Outages Procedure (MCWS ID A540634).

Communication during incidents and emergencies is described in Section 6.1 Communicating during Incidents and Emergencies, and will be referred to in the Incident and Emergency Management Plan including communicating with customers during a boil water alert. MidCoast Water Services is in the process of integrating policies and procedures with other divisions of MidCoast Council.

8.4 CONSUMER FEEDBACK AND WATER QUALITY COMPLAINTS

In order to effectively communicate with customers and the wider community, Council provides options of two way communication. This is achieved by informing the community and providing education so customers can make informed decisions in relation to water use, and catchment management issues as well as providing avenues for feedback and input from the community. A wide range of information is provided on the website including water rates, water quality, new projects, strategic plans, educational programs and details of council meetings (which are open to the public) including minutes from each council meeting. There is an option for customers to submit feedback by email through links on the website. These emails are then forwarded to appropriate staff to follow up. Customer Service Centres provide information to the community by phone or face to face contact during office hours and a 24 hour phone line to cover any after-hours issues.

8.4.1 WATER QUALITY COMPLAINTS AND OTHER FEEDBACK

Recording and analysing the number and nature of customer enquiries and requests can provide useful information to inform of potential water quality issues, which can assist timely response and rectification. Any rapid or noticeable change in conditions including water quality, pressure etc. may be detected by customers. This monitoring forms part of verification of water supply performance. More details are provided in the current *Drinking Water Quality Monitoring Plan* (MCWS folder ID fA27690), *Section 4.9 Customer based monitoring*.

Social media comments on the organisation's Facebook pages are tracked and responded to as appropriate, as another form of feedback from customers and the wider community.

ELEMENT 9: RESEARCH AND DEVELOPMENT

Various research projects relating to drinking water quality are undertaken with the aim of increasing knowledge and improving management of water supply systems. These include environmental flow investigations and catchment projects. As a water utility and associate member of Water Services Association of Australia (WSAA), MidCoast Water Services also has access to research undertaken by bigger urban utilities. Staff participation in specialised water industry workshops and conferences adds to availability of research.

9.1 INVESTIGATIVE STUDIES AND RESEARCH

The following section describes some of the investigative studies Water Services is undertaking (or participating in) in relation to drinking water management.

9.1.1 CATCHMENT INVESTIGATIONS

Through sustainable water cycle management strategies Water Services collects and analyses data on drinking water catchments and the urban water cycle. Catchment objectives have been identified and are being implemented to obtain environmental improvements in both water quality and quantity. The initial focus has been on Manning River catchment and its main tributaries, Barrington and Barnard Rivers as these rivers have the greatest flow, greatest potential to create erosion and as a result greatest sediment load impact on Manning River. Water quality in Schofield Creek, Back River (tributaries of the Barnard River) and Nowendoc River has also been investigated. With the aims of environmental improvements, catchment programs focus on improving severe bank erosion, off river stock watering and restricting cattle access to rivers. This practical research and on ground works not only benefits Council by improving water quality, but will benefit the environmental condition of the Manning River catchment as a whole. Details of these investigations and achievements are discussed in Section 2.4 Assessment of Manning Water Supply System.

Efforts have also been concentrated on the Crawford River catchment including providing off river watering to encourage cattle out of rivers, fencing off sections of the river including Bulahdelah weir pool, assisting in dairy effluent management and river bank erosion improvements. Details of these investigations and achievements are discussed in Section 2.5 Assessment of Bulahdelah Water Supply System.

9.1.2 PESTICIDES PROJECT

An investigative study was undertaken on raw water in the catchments of Stroud, Bulahdelah, Tea Gardens and Gloucester water supplies focusing on pesticides in 2013. This study was designed to increase the understanding of raw water characteristics of water supply systems. NSW Health assisted in the project by undertaking analyses at Forensic and Analytical Science Services (FASS) laboratory. The study did not detect any pesticides in the drinking water catchments over a 12 month period. Full details are provided *Pesticides*

Project and *MidCoast Water Services Pesticides Project Final Report* (MCWS ID A440548). A similar project will be undertaken over a 12 month period with assistance from NSW Health during 2018-2019.

9.1.3 CRYPTOSPORIDIUM AND GIARDIA INVESTIGATIONS

During 2014, short term investigations were undertaken into the potential for raw water sources and backwash water from WTPs to contain protozoa (*Crytposporidium parvum* and *Giardia intestinalis*). This helped to gain a better understanding of raw water quality and level of risk associated with returning backwash water to the treatment process. It also provides background data for potential future framework of health based targets.

Sample collection and testing methodology was developed by Sydney Water and adapted by MidCoast Water Services laboratory. A filter was used to reduce amount of water required for the sample. Prior to this method being developed, 100 litres of sample was required to be sent to Sydney Water laboratory to test for protozoa, which was difficult and expensive to transport. This method requires 20 L of water to be pumped through the filter. The filter is then sent externally to Sydney Water laboratory for extraction and analysis.

For quality control, this method requires a colour seed to be used in a control sample. This is an internal calibration standard for *Cryptosporidium* and *Giardia* testing and contains 100 inactivated cysts or oocysts, all permanently labelled with red fluorescent dye. Number of colour seed detected in control samples provides a percentage recovery achieved in the sample. For further information, refer to *Cryptosporidium and Giardia Results MASTER FILE* (MCWS ID A446632).

9.1.4 ACCESSING AND INPUT INTO WATER INDUSTRY RESEARCH

As a member of WIOA, AWA, WSAA and the Water Directorate, research undertaken by major water utilities across Australia, can be accessed, including updates on emerging water quality issues, challenges, solutions, equipment and treatment options.

Water Research Australia (WRA) publishes papers and research reports providing scientific information on critical topics in drinking water quality. Technical facts sheets covering disinfection, blue-green algae, micro pollutants and pathogen movement in environment are of particular interest. *Health Stream* newsletters provide updates on the drinking water related research and investigation reports on water quality incidents.

Workshops and conferences are attended by employees to keep up to date with new developments and providing input into drinking water quality management on state or national levels. Information and knowledge gained at these workshops and conferences is used to improve management of water supply systems.

Water Services employees have published technical papers in AWA Water magazine and given presentations at water industry conferences on topics including; purified water and rebates for water saving devices.

Council provides input into review of relevant industry processes by participation in workshops or by preparing submissions on various proposals. Recently a submission was lodged to National Health and Medical Research Council regarding the *Australian Drinking Water Guidelines; Draft Framework on microbial health based targets.* Refer to *MCW submission to NHMRC* (MCWS ID A579075).

9.2 VALIDATION OF PROCESSES

The aim of process validation is to ensure effective operation and control of hazards. It ensures that treatment processes and operational criteria produce appropriate results under conditions specific to each water supply system.

9.2.1 NABIAC WTP PROOF OF PERFORMANCE

Prior to water production from Nabiac WTP, a two week proof of performance testing period will be undertaken (led by Hunter H2O). Refer to MCWS ID B542021 for details.

Proof of Performance (POP) involves testing processes and equipment to demonstrate that the scheme can be operated reliably to achieve the output water quality and quantity deliverables as specified in the related design and planning documents.

The POP plan establishes baseline requirements for the successful delivery and handover of the scheme to Council. This allows for consideration of design change proposals against the intended scheme functionality. Change requests can be considered against their impact on the ultimate goal being the scheme performance objectives as well as against individual contractual requirements and durability.

Upon completion of the POP test, a preliminary POP test report shall be completed by Hunter H2O and supplied to Council. The intent of this preliminary report is to provide a recommendation on the continuation of supply, or not, to the network based on the information available at this point. The test report will include:

- Statement on the attainment or otherwise of the qualitative and quantitative criteria;
- Evidence to support statements on performance;
- Summarised test results for each day of the performance test;
- The results of daily activities, as well as information captured in the minutes of the daily and weekly performance test meetings;
- Copies of the daily operator log entries;
- A summary of the equipment trouble reports or defect notifications, plant SCADA alarms, historical process trends indicating production flow rates, online analyser readings, and plant laboratory water quality results;
- Third-party laboratory test results and;

- Any excursions along with a detailed explanation.

When all requirements have been met and it has been demonstrated that Nabiac WTP and associated infrastructure is producing water as per design, notification will be made to NSW Health and production will begin.

9.2.2 CHLORINE CONTACT TIME

As part of validation of barrier performance, it is recommended chlorine contact time (Ct) is calculated before the first consumer. This is a measure of free chlorine residual concentration (C) and contact time (t). These values were calculated for each WTP in 2015 by Atom Consultants, while reviewing CCPs and confirmed by Bligh Tanner in May 2016, refer to *MidCoast Water Services Chlorine Contact Times May 2016* (MCWS ID A584007). The calculations determine there is adequate contact time to provide effective disinfection in all water supplies. This information was used to support the lower level limits of chlorine identified in CCPs.

9.3 DESIGN OF EQUIPMENT

A proposal to construct or modify a WTP must have NSW Department of Industry's approval under Section 60 of the *Local Government Act 1993*. This includes the addition of fluoride. All requirements must be satisfied before final approval is given and operations can begin. NSW Department of Industry may also direct corrective actions under Section 61 of the Act which should be carried out after consultation with NSW Health and NSW Department of Industry.

The design stage of new infrastructure involves a rigorous validation process, e.g. design and construction of a new WTP. Pilot scale research is undertaken to ensure the treatment process is effective before recommendations are made on design of the process. Design specifications are established and target criteria set which is followed throughout the entire process of development and validated to ensure initial goals have been met. These requirements need to be flexible enough to accommodate any change in circumstance throughout the process without compromising overall control and quality.

The Strategic Asset Management Framework has been developed to provide vision, ensure consistency and set a common ideology for all existing and future asset management practices across the organisation. Refer to *Strategic Asset Management Framework* (MCWS ID A542908) for details. This includes a lifecycle delivery approach and engineering management plans to include requirements of piping and instrumentation diagrams (P&IDs), functional descriptions, process descriptions, mass balances etc during design of new and upgraded assets.

ELEMENT 10: DOCUMENTATION AND REPORTING

10.1 MANAGEMENT OF DOCUMENTATION AND RECORDS

Council is required to fulfil its obligations and statutory requirements under the following records management legislation and policies:

- MidCoast Water Services Records Management Policy (MCWS ID # A388329);
- *State Records Act 1998;*
- *Public Health Act 2010;*
- *Government Information (Public Access) Act 2009* and the *Amended Act 2012 (GIPA);*
- Records may also be required by Royal Commissions, Ombudsman, courts, auditors and other people or bodies to who or which they may be subject and;
- NSW Code of Practice for Fluoridation of Public Water Supplies.

The organisation meets its obligations for compliance with all relevant legislation by:

- Maintaining records through an electronic document management system;
- Managing records in accordance with Australian Standard – AS ISO 15489;
- Managing records in accordance with MidCoast Water Services' *Records Management Procedures* (MCWS ID A394223);
- Implementing and monitoring Records Management Procedures to ensure ongoing legislative compliance;
- Preserving, maintaining and managing any record and where required ensuring their timely transfer to State Records NSW and;
- Maintaining appropriate records of water fluoridation and making them available to NSW Health.

10.1.1 DOCUMENT MANAGEMENT SYSTEMS

MidCoast Water Services utilises a computerised, internal and secure document management system, which allows users to save documents with different levels of access and security. Changes and versions of documents are traceable. Documents can be stored in files and folders for ease of access. A series of folders have been created to store information relating to this DWQMS.

All documents are profiled with information including author, date of creation, description, type of document, security access and external reference or correspondent if relevant. A variety of applications can be saved to the system including Word, Excel, PDF, emails with

attachments, PowerPoint presentations, photos, and Publisher files. The system has a powerful search tool to locate relevant documents created and saved into the system. Renditions and publishing features allow for word or excel documents to have a PDF rendition (copy) created so it can be linked to the intranet or internet, or used for distribution without allowing users to modify the document. Objective contains a version control feature which allows multiple versions of a document to be retained. This means that previous versions can be opened and viewed to check changes made, and also allows the option to revert to an old version if needed. Version control displays a list of all versions created with the option to add a comment as to why it was created. The latest three versions of a document will be retained unless corporate value is added, then all versions with corporate value will be retained. This is recommended on vital documents, e.g. policies, corporate procedures, legal documents and financial records that are regularly updated.

Each object within the records system has been assigned a disposal in accordance with the State Records General Disposal Authority GA39 for Local Government Records. This disposal determines how long a document is to be retained and whether it can be destroyed or made a state record and how it is recommended to be destroyed. The system is also backed up daily to our internal servers. Objective contains other features such as reviews and approvals. These allow documents to be sent to users for review and approval of drafts prior to the document being published.

Water Services has developed a *Records Management Procedure* (MCWS ID A394223) to guide employees on what is constituted as a record and *Record Keeping Responsibilities of Staff* (MCWS ID A421505) assists employees with how to use and capture records and metadata into the corporate record keeping system.

As MidCoast Water Services continues to integrate into MidCoast Council, new systems will be introduced to streamline processes and ensure consistency.

Operational data generated by process controllers at WTPs is entered into operator's logs including who sampled and tested, time and date.

The web based NSW Drinking Water Database developed and operated by NSW Health securely stores verification testing results with effective and user friendly reporting systems. t Water Services staff enter microbiological results weekly and fluoride results monthly to the database.

Systems continue to be integrated into MidCoast Council to streamline processes which will be an ongoing process.

10.2 REPORTING PROCEDURES

There are extensive reporting requirements relating to water quantity and water quality performance data. Internal reports are presented to managers and elected Councillors for updating and decision making purposes. External reporting requirements vary depending on the regulator.

10.2.1 INTERNAL PERFORMANCE REPORTING

Council meetings are held every month for the purposes of reporting activities including; projects, budgets and performance monitoring data which assists in decision making for future projects, policies and guiding the strategic direction of the organisation. Managers meetings are held weekly.

Reports from Water Management and Treatment to management and Councillors consist of:

MONTHLY

- Water consumption and;
- Water quality results not meeting ADWG.

QUARTERLY

- Water quality data and trends and;
- Update of corrective actions database.

ANNUALLY

- Drinking Water Quality Management System Annual Report Summary;
  - Water supply system description;
  - Upgrade and system improvements;
  - Water quality;
  - Customer complaints;
  - Water quality incidents;
  - Review of drinking water quality management system implementation and continuous improvement and;
  - Reservoir inspections.

10.2.2 EXTERNAL REPORTING REQUIREMENTS

External reporting requirements relating to the DWQMS are set by regulators. Details are contained in *Compliance and Reporting Requirements S&RC Group* (now part of Water Management and Treatment) (MCWS ID A549090). A summary of reporting requirements relating to drinking water is provided below:

- Develop, implement and maintain a risk based quality assurance system for drinking water quality according to Drinking Water Quality Framework specified in ADWG;
  - Quarterly meetings with NSW Health;
  - Annual report;
  - Notification of water quality results outside ADWG or CCP;
  - Maintain NSW Health Drinking Water Quality Database and;
  - Publishing water quality information on website.
- Ensure all drinking water supplied to public is safe to drink and complies with ADWG guidelines in regards to:
  - Drinking water quality;
  - Water quality management;

  - Drinking water quality monitoring and;
  - Drinking water quality reporting.
- Fluoridation of water supply performance reporting;
- Notification of incidents/exceedances including blue green algae in storages;
- NSW Aboriginal Communities Water and Sewerage Program;
- Urban Water Utilities Performance Reporting;
  - Water extraction, usage, quality and compliance, customer requests, leakages, assessments and population served, incidents etc;
- Water extraction licences;
- Provision of water information to the Bureau of Meteorology and;
- National Pollution Inventory reporting.

ELEMENT 11: EVALUATION AND AUDIT

To measure performance against objectives of this DWQMS, long term evaluation of drinking water quality results and management are undertaken. The following sections describe long term evaluation of results and the audit process of this quality management system.

11.1 LONG TERM EVALUATION OF RESULTS

Drinking water quality data is continually monitored, with a quarterly internal report compiled, as well as an annual report to satisfy requirements of external parties and regulators. Long term evaluation of results is included in these reports and is an accurate way to determine the effectiveness of this management system to ensure objectives are being met, refer to *Drinking Water Quality Management System Annual Report 2016 - 2017* (MCWS ID A617726).

Elements of review include:

- Water quality data (operational and verification monitoring results) and measuring water quality results against ADWG for each water supply system;
- Water usage;
- Performance of critical control points and;
- Number of customer complaints relating to water quality for each water supply system.

Reviews of operational water quality results are undertaken by Process Engineer and Manager Water Management and Treatment with assistance from operators/coordinators on a six monthly to annual basis. Water quality results are part of a wider review of plant performance including, optimising treatment processes, chemical dosage and financial review.

By evaluating water quality and management over the long term, trends can observed to determine the effectiveness of treatment processes and management practices. From this, improvements may be recommended for consideration by management.

Each year Water Services prepares Triple Bottom Line Performance Report according to NSW Water Utility Performance Monitoring System requirements developed by NSW Department of Industry. The report includes an assessment of drinking water quality results for each water supply system. The *NSW Water Supply and Sewerage Benchmarking Report* developed from the reporting is utilised to compare performance with standards, guidelines and other water utilities across the state.

11.2 AUDIT OF THE DRINKING WATER QUALTY MANAGEMENT SYSTEM

A schedule of internal and external audits has been developed to maintain the DWQMS, confirm its effectiveness and identify areas for improvement, refer to *Drinking Water Quality Management System Audit and Review Schedule* (MCWS ID A590864).

External audits are carried out by suitably qualified independent auditors, in consultation with NSW Health every five years or as otherwise directed by regulators.

Formal audit and review results are compiled in a report and communicated to relevant stakeholders, e.g. *Risk Edge – MidCoast Water Services DWQMP Review Report Final* (MCWS ID A554329) and *MidCoast Water Services Risk Report May 2016* (MCWS ID A562361). Where improvements are identified, actions are recorded in the corrective actions database for follow up. This includes details of where the recommendation originated and the manager responsible for implementing the action. Progress of each action is updated quarterly and a summary report is presented to the Water Services management team.

The water quality team oversees the corrective actions database to ensure actions are prioritised and progressed as required. Regular meetings are held and minutes recorded, refer to *DWQMS Implementation Team (Water Quality Team)* (MCWS folder ID # fA25030). Recommendations are made to the management team by the water quality team to support this, refer to *20160609: Recommendations to Steering Committee* (MCWS ID A562028).

ELEMENT 12: REVIEW AND CONTINUAL IMPROVEMENT

The water industry is dynamic and continually evolving. As legislation and regulatory requirements change, technologies improve and opportunities for water providers increase, Council will also need to evolve, and it is committed to doing so. Therefore this DWQMS is not designed to be a static document. It is a dynamic quality system which is reviewed by operational staff, and managers regularly. Details of the review process are summarised in the following section.

This section also includes details of the DWQMS corrective actions database. Updates and improvements will be required to allow the quality system to continually evolve as changes occur within:

- Water supply systems;
- Operational processes and procedures;
- New infrastructure and equipment;
- Increase in customer numbers;
- Emerging new monitoring techniques;
- Research and development opportunities and;
- Changes within local government and the water industry.

12.1 REVIEW BY THE MANAGEMENT TEAM

To ensure continual improvement, this DWQMS is reviewed by Water Services' management team after any significant changes are made. This supports the development of plans and allocation of resources where required to improve overall management system.

Results of annual internal and external reviews are reported to the management team; refer to Section 11.2 *Audit of the Drinking Water Quality Management Plan* for details. If significant changes are made, the management team may present them to the elected Council for adoption/approval. This includes adoption of revised CCPs and risk assessment reviews.

12.2 DRINKING WATER QUALITY MANAGEMENT IMPLEMENTATION AND IMPROVEMENT PLAN

A Drinking Water Quality System Corrective Actions Database (MCWS ID A574044) addresses identifies need for improvement and implementation of the quality system. These improvements have been determined through internal and external reviews. Responsibilities are assigned for each action including timeframes and progress. Risk rank is included for each action to allow for prioritisation. Reporting mechanisms allow progress to be tracked over time. Quarterly updates are provided to the management team, and annual updates are provided to NSW Health.

Improvements that are related to assets or require significant capital expenditure are transferred to the failures and issues register; refer to Section 4.3.1: Strategic Asset Management Framework for further details. Reporting of progress of the issues register is undertaken by Manager Planning and Assets.

REFERENCES

ABC (2014). *Indigenous Language Map* (Online) Available from: www.abc.net.au/indigenous/map (Accessed 27th August 2013).

Department of Industry (2014). *Karuah Catchment* (Online) Available from www.water.nsw.gov.au/Water-management/Basins-and-catchments/Karuah-catchment/Karuah-catchment (Accessed 13th August 2013).

Hrudey, S.E and E.J (2004). *Safe Drinking Water. Lessons from Recent Outbreaks in Affluent Nations*. IWA Publishing, London.

MidCoast Council (former Great Lakes Council) (2015). *Karuah River Catchment Management Plan*. MidCoast Council, Forster.

NHMRC, NRMMC (2011). *Australian Drinking Water Guidelines Paper 6, National Water Quality Management Strategy*. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

NSW DLWC (1998) *Aquifer Risk Assessment Report*. NSW Department of Land & Water Conservation, Sydney.

NSW Office of Environment and Heritage (2014). *Karuah River and Great Lakes Catchments* (Online) Available from www.environment.nsw.gov.au/ieo/Karuah/maplg.htm (Accessed 13th August 2013).

Tyack (2008). *Crawford River Catchment Management Plan*. MidCoast Council (former Great Lakes Council), Forster.

ABBREVIATIONS AND ACRONYMS

Table 1: Abbreviations and acronyms

Abbreviation	Name
ACH	Aluminium chlorohydrate
ADWG	Australian Drinking Water Guidelines
ALARP	As low as reasonably practicable
AWA	Australian Water Association
BAC	Biologically activated carbon
CAT	Catchment and Treatment
CCP	Critical control point
CCT	Chlorine contact tank
CEBW	Chemically enhanced backwash
CEO	Chief Executive Officer
CIP	Clean in place
CO_2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Ct	Chlorine contact time
DICL	Ductile iron pipe
DPI	Department of Primary Industries
DWQMS	Drinking Water Quality Management System
E. coli	*Escherichia. coli* (bacteria)
EFM	Enhanced flux maintenance
FASS	Forensic and Scientific Services
GIPA	Government information public access
HACCP	Hazard analysis and critical control points
HIRAC	Hazard identification, risk assessment and control
HSR	Health and safety representative
IP&R	Integrated planning and reporting
ISO	International Organisation for Standardisation
IWCM	Integrated water cycle management
IWES	International Winter Environmental School – Trademark of University of Qld environmental short courses
JOG	Joint operational group
JSG	Joint strategic group
LLS	Local land services (formerly Catchment Management Authority)
MCW	MidCoast Water Services
MIB	Methyl-Isoborneol
MOU	Memorandum of understanding
NaF	Sodium fluoride
NHMRC	National Health and Medical Research Council
NIDA	Nabiac Inland Dune Aquifer
NPWS	National Parks and Wildlife Service
NRMMC	National Research Management Ministerial Council
NTU	Nephelometric turbidity units
PAC	Powdered activated carbon
PLC	Programmable logic control
POP	Proof of performance
P&ID	Piping and instrumentation diagram

Abbreviation	Name
RF	Reverse filtration
SCADA	Supervisory Control and Data Acquisition
SOP	Standard operating procedure
SRC	Strategic and Regulatory Compliance
TAFE	Technical and Further Education
TMP	Transmembrane pressure
TOC	Total organic carbon
WCC	Workplace consultative committee
WHSC	Work health and safety committee
WIOA	Water Industry Operators Association
WRA	Water Research Australia
WSSA	Water Services Association of Australia
WTP	Water treatment plant