GLEN INNES SEVERN COUNCIL DRINKING WATER MANAGEMENT SYSTEM

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DOCUMENT

Glen Innes Severn Council Drinking Water Management System

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EXECUTIVE SUMMARY

The Drinking Water Management System (DWMS) demonstrates Glen Innes Severn Council's (GISC) compliance with the NSW *Public Health Act 2010* and *Public Health Regulation 2012* requirement to develop a Quality Assurance Plan in accordance with the Framework for Management of Drinking Water Quality in the *Australian Drinking Water Guidelines 2011* (ADWG).

This document outlines the range of activities carried out by Council to ensure the provision of safe drinking water to its customers. Several actions to improve the drinking water supply systems were identified through the risk assessment and DWMS development. The improvement plan is to be reviewed regularly as actions are completed and as part of the annual planning process.

ADWG Framework for the Management of Drinking Water Quality

The ADWG 2011 set out the 'Framework for Management of Drinking Water Quality, providing a structured risk-based approach to drinking water management. Glen Innes Severn Council's activities relating to each of the 12 Elements of the ADWG, including references to sections of the DWMS are summarised in Table 1.

Table 1 ADWG Framework for the Management of Drinking Water Quality

ADWG Element	Status	DWMS Reference
Element 1: Commitment to drinking water quality management		
Drinking water quality policy	Council has a Drinking Water Policy. Council is to ensure that the policy is visible, communicated, understood and implemented by employees.	Section 2.1
Regulatory and formal requirements	Regulatory and formal requirements identified and documented. Council has relevant approvals from the NSW Department of Industry (Water). Council currently has an Integrated Water Cycle Management Plan (2009); a Drought Management Plan (2013); and Strategic Business Plan for the water business (2012) as recommended by NSW Department of Industry (Water) Best Practice Management.	Section 2.1.1
Engaging stakeholders	The DWMS identifies and documents relevant stakeholders. NSW Health and Department of Industry (Water) participated in the development of the DWMS.	Section 2.1.2
Element 2: Assessment of the drinking water supply system		
Water supply system analysis	Council supplies drinking water to the townships of Glen Innes and Deepwater. The DWMS documents the key characteristics of the two drinking water supply systems. Flow diagrams are documented for each system. The Glen Innes treatment plant uses flocculation, filtration and chlorine disinfection. Deepwater is a Dissolved Air Flotation and Filtration (DAFF) plant with chlorine disinfection, commissioned in 2011. Neither DWSS currently fluoridates the water however this is being investigated for Glen Innes.	Sections 3.2, 3.3

ADWG Element	Status	DWMS Reference
Assessment of water quality data	The following data was assessed: ▪ Baseline data where available ▪ Operational data for raw and treated water in Glen Innes and Deepwater ▪ Verification data from NSW Health Drinking Water Monitoring Program for both systems	Section 3.2.2, 3.3.2
Hazard identification and risk assessment	Risk assessment workshop completed in 2018 with participation from NSW Health Water Unit, Local Public Health Unit, DoI Water and GISC. The highest residual risks in the Glen Innes scheme were related to inadequate filtration, absence of fluoride dosing, potential groundwater infiltration between clear water tanks, reservoir ingress and backflow. The highest residual risks in the Deepwater scheme were related to sewage pump station overflow leading to contamination of raw water, inadequate filtration, inadequate disinfection, backflow, and failure of monitoring equipment.	Section 4.1, Appendix B
Element 3: Preventive measures for drinking water quality management		
Preventive measures and multiple barriers	Glen Innes Severn Council supports a multi-barrier approach to the safe supply of drinking water. Key barriers in the Glen Innes drinking water supply system are: source water protection, extraction management, coagulation, flocculation, filtration and disinfection. The key barriers in Deepwater drinking water supply system are: source water protection, extraction management, coagulation, flocculation, flotation, filtration and disinfection. Actions to enhance preventive measures included in Improvement Plan.	Section 4.1, Appendix B
Critical control points (CCPs)	CCPs for Glen Innes and Deepwater drinking water supply systems have been identified and documented. Glen Innes CCPs are: ▪ CCP 1: Turbidity in clear water tanks ▪ CCP2: Disinfection at clear water tanks ▪ CCP3: Integrity of reservoirs Deepwater CCPs are: ▪ CCP1: Turbidity in filtered water ▪ CCP2: Disinfection at reservoir outlet ▪ CCP3: Integrity of reservoirs	Section 4.2, Appendix C
Element 4: Operational procedures and process control		
Operational procedures	Key operational procedures for each CCP have been documented. Council keeps hard copies of the O&M manuals for Glen Innes and Deepwater WTP at the treatment plant and in the Council office.	Section 6.1, Appendix C

ADWG Element	Status	DWMS Reference
Operational monitoring	Operational monitoring regimes of both Glen Innes and Deepwater drinking water supply systems have been documented and recorded in the DWMS.	Section 5.1
Corrective action	Key corrective actions are documented for each CCP.	Section 4.2, Appendix C
Equipment capability and maintenance	Council has a water supply asset register that records the age, type, location and material of the water supply assets managed by GISC. Council is in the process of developing a Water Asset Management Plan to define criteria for planned and reactive maintenance.	Section 6.2
Materials and chemicals	Standardised procurement processes are documented in DWMS. Materials and chemicals conform to plumbing code of Australia, Australian Standards and WH&S Regulations for dangerous goods.	Section 6.3
Element 5: Verification of drinking water quality		
Drinking water quality monitoring	Council verifies drinking water quality by participating in NSW Health Drinking Water Monitoring Program. Council WTP operators collect samples for NSW Health Drinking Water Monitoring Program. Sampling frequency is based on population.	Section 5.2
Consumer satisfaction	Council has a Complaints Handling Policy for complaints and action requests submitted by the community. All complaints are recorded in Council's customer management software and allocated to the relevant manager. If a complaint is not actioned in a timely manner, it is automatically escalated to senior management.	Section 5.3
Short-term evaluation of results	Council evaluates water quality data and assessment of trends on receipt of monitoring results. Exceedances of criteria reported and responded as required by NSW Health protocols.	Section 5.4
Corrective action	Corrective Actions have been identified and documented in DWMS. Council follows the NSW Health Response Protocols as required.	Section 5.4 Appendix C
Element 6: Management of incidents and emergencies		
Communication	Council relies on the NSW Health Response Protocols for communication strategies to manage water quality incidents. Council's primary contact for water quality incidents is the on-call water operator on 0418 162 794. The secondary contact is the Manager of Integrated Water and Sustainability Services on 0408 144 251.	Section 7.1

ADWG Element	Status	DWMS Reference
Incident and emergency response protocols	Council responds to incidents and emergencies according to NSW Health Response Protocols. Council has participated in the development of and has representation on the Glen Innes Emergency Management Committee.	Section 7.2
Element 7: Employee awareness and training		
Employee awareness and involvement	WTP operators currently undertake NSW Department of Industry (Water) "Water Treatment Operator Courses" and will transfer to the "National Certification for Operators of Drinking Water Treatment Facilities" as required.	Section 8.1
Employee training	Council is committed to training employees through their Human Resources Policy Statement Register. Council reviews each staff member's need for training in the annual performance appraisal conducted by the employee's immediate supervisor. Training needs are then allocated in the following year's budget.	Section 8.1
Element 8: Community involvement and awareness		
Community consultation and communication	Council addresses the communication and consultation needs of the community through the 2010 - 2013 Community Social Plan. Council encourages community involvement and consultation through Council's ordinary meetings, Council's website and community surveys.	Section 8.2
Element 9: Research and development		
Investigative studies and research	Council undertakes investigative studies and research monitoring on a project basis as required. The DWMS identifies four investigative studies for Glen Innes Severn Council to continuously improve their drinking water quality.	Section 8.3.1
Validation of processes	Validation of new equipment and processes is undertaken through system design against industry standards and guidelines; procurement of equipment/chemicals from approved suppliers; market pre-validation by suppliers. Operation according to CCPs provides ongoing validation of key processes, equipment and chemicals.	Section 8.3.2
Design of equipment	Council relies on NSW Department of Industry (Water) and external consultants to validate the selection and design of new equipment required for upgrades and process improvements.	Section 8.3.2
Element 10: Documentation and reporting		
Management of documentation and records	The DWMS documents all aspects of drinking water quality management. The DWMS is a living document and will be maintained in line with operations and management. All current versions of documents are stored in Council's central register.	Section 8.4.1

ADWG Element	Status	DWMS Reference
Reporting	Council prepares quarterly and annual reports. Water quality reports can be produced from the NSW Health Drinking Water Database through the NSW Health website. Performance results are also provided to NSW Department of Industry (Water) for the Water Supply and Sewerage NSW Performance Monitoring Report, annually.	Section 8.4.2
Element 11: Evaluation and audit		
Long-term evaluation of results	NSW Health Drinking Water Monitoring Program data available on via NSW Drinking Water Database. CCPs will be reviewed in a regular manner. If CCP critical limits are reached Council will be required to detail the exceedances and what corrective actions were initiated. Monitoring data is reviewed regularly by Council, NSW Health and Department of Industry (Water). Council will evaluate results annually prior to budget preparation in conjunction with NSW Benchmark reporting, and present a report to Council.	Section 5.2
Audit of drinking water quality management	The DWMS will be internally audited annual by the Manager Integrated Water and Sustainability Services, Risk Manager and Director Development Regulatory and Sustainability Services. The audit is to be conducted in conjunction with the NSW Benchmark reporting. The DWMS will be externally audited through a meeting with NSW Health, NSW Department of Industry (Water) and Council staff.	Section 9.1
Element 12: Review and continual improvement		
Review by senior executive	Review by senior management is undertaken by the Manager Integrated Water and Sustainability Services, Risk Manager and Director Development Regulatory and Sustainability Services annually. Review is undertaken to ensure the effectiveness of management system and underlying policies. A complete review will be undertaken every 4 years alongside the SBP.	Section 9.2
Improvement plan	This DWMS documents an Improvement Plan for Council drinking water supply systems. The Improvement Plan is to be implemented and reviewed annually.	Section 10

Critical Control Points

The Critical Control Points (CCPs) for the Glen Innes Severn Council drinking water supply systems were identified as part of the development of the DWMS. The CCPs are essentially the heart of the Framework, with good management of the CCPs crucial to the DWMS. CCPs were revised in 2018 to better align with published NSW Health guidance 'Critical control points for drinking water management systems' – link active as of 21 January 2019.

Glen Innes CCPs are summarised in Table 2 and Deepwater CCPs in Table 3. Standard operating procedures and corrective actions have been documented for each CCP to guide daily activities and ensure correct operational responses if the alert or critical limits are reached.

Table 2 Glen Innes Critical Control Points Summary

Parameter	Frequency	Target Limit	Alert Limit	Critical Limits
CCP 1 Turbidity (in clear water tank)				
Turbidity (NTU)	Continuous	< 0.2	≥ 0.2	> 0.5
CCP 2 Disinfection (at clear water tank)				
Chlorine residual (mg/L)	Continuous	1.0	< 0.6	< 0.4
CCP 3 Integrity of Reservoirs				
System Integrity (sealed and secure)	Weekly	No evidence of breach or vermin	Visual identification of breach or vermin in reservoir systems	Visual identification of contaminant in reservoirs

Table 3 Deepwater Critical Control Points Summary

Parameter	Frequency	Target Limit	Alert Limit	Critical Limits
CCP 1 Filtered Water				
Turbidity (NTU)	Continuous	< 0.2	≥ 0.2	> 0.5 (> 30min)
CCP 2 Disinfection (at Reservoir outlet)				
Chlorine residual (mg/L)	Daily (at least 5 times per week)	1.0	< 0.7	< 0.5
CCP 3 Integrity of Deepwater Reservoir				
System Integrity (sealed and secure)	Weekly	No evidence of breach or vermin	Visual identification of breach or vermin in reservoir systems	Visual identification of contaminant in reservoirs

GLOSSARY

Term	Definition
ABS	Australian Bureau of Statistics
ADWG	*Australian Drinking Water Guidelines 2011*, published by the National Health and Medical Research Council (NHMRC). Primary guidance for drinking water quality and management within Australia
catchment	area of land that collects rainfall and contributes to surface water (streams, rivers, wetlands) or to groundwater
chlorination	use of chlorine as a means of disinfection
CMA	Catchment Management Authority. From 2014 CMAs will be replaced by regional Local Land Services
coagulation	clumping together of very fine particles into larger particles using chemicals (coagulants) that neutralise the electrical charges of the fine particles and destabilise the particles
consumer	an individual or organisation that uses drinking water
corrective action	procedures to be followed when monitoring results indicate a deviation occurs from acceptable criteria
critical control point (CCP)	An activity, procedure or process at which control can be applied and which is essential to prevent or eliminate a hazard or reduce it to an acceptable level
critical limit	a prescribed tolerance that must be met to ensure that a critical control point effectively controls a potential health hazard; a criterion that separates acceptability from unacceptability
Cryptosporidium	microorganism commonly found in lakes and rivers that is highly resistant to disinfection
C.t.	the product of residual disinfectant concentration (C) in milligrams per litre determined before or at taps providing water for human consumption, and the corresponding disinfectant contact time (t) in minutes
cyanobacteria	bacteria containing chlorophyll and phycobilins, commonly known as 'blue-green algae'
DBP	Disinfection By-Product
DISPLAN	Local Disaster Management Plans, often prepared by Councils in compliance with the State Emergency and Rescue Management Act, 1989.
DWMS	Drinking Water Management System
disinfection	an oxidising agent (eg chlorine, chlorine dioxide, chloramines and ozone) that is added to water in any part of the treatment or distribution process and is intended to kill or inactivate pathogenic (disease-causing) microorganisms
distribution system	a network of pipes, pumps and reservoirs leading from a treatment plant to customers' plumbing system
drinking water	water intended primarily for human consumption
drinking water quality management audit	the systematic and documented evaluation of activities and processes to confirm that objectives are being met, and which includes an assessment of management system implementation and capability
drinking water quality monitoring	the wide-ranging assessment of the quality of water in the distribution system and as supplied to the consumer, which includes the regular sampling and testing performed for assessing conformance with guideline values and compliance with regulatory requirements and agreed levels of service

drinking water supplier	an organisation, agency or company that has responsibility and authority for treating and/or supplying drinking water
drinking water supply system (water supply system) (DWSS)	all aspects from the point of collection of water to the consumer (can include catchments, groundwater systems, source waters, storage reservoirs and intakes, treatment systems, service reservoirs and distribution systems, and consumers)
EPA	Environment Protection Authority
Escherichia coli (*E. coli*)	bacterium found in the gut, used as an indicator of faecal contamination of water
filtration	process in which particulate matter in water is removed by passage through porous media
flocculation	process in which small particles are agglomerated into larger particles (which can settle more easily) through gentle stirring by hydraulic or mechanical means
GL	Gigalitres
groundwater	water contained in rocks or subsoil
guideline value	the concentration or measure of a water quality characteristic that, based on present knowledge, either does not result in any significant risk to the health of the consumer (health-related guideline value), or is associated with good quality of water (aesthetic guideline value).
HU	Hazen Unit (colour)
hazard	a biological, chemical, physical or radiological agent that has the potential to cause harm
Hazard Analysis Critical Control Point (HACCP) system	a systematic methodology to control safety hazards in a process by applying a two-part technique: first, an analysis that identifies hazards and their severity and likelihood of occurrence; and second, identification of critical control points and their monitoring criteria to establish controls that will reduce, prevent, or eliminate the identified hazards
hazard control	the application or implementation of preventive measures that can be used to control identified hazards
hazard identification	the process of recognising that a hazard exists and defining its characteristic (AS/NZS 3931:1998)
hazardous event	an incident or situation that can lead to the presence of a hazard (what can happen and how)
integrated catchment management	the coordinated planning, use and management of water, land, vegetation and other natural resources on a river or groundwater catchment, based on cooperation between community groups and government agencies to consider all aspects of catchment management
Improvement Plan	A Drinking Water Quality Management Improvement Plan as required under Element 12 of the Framework
IWCM	Integrated Water Cycle Management. A water utility's 30-year IWCM
jar test	a laboratory procedure used to estimate the minimum or ideal coagulant dose required to achieve certain water quality goals. A jar test simulates a water treatment plant's coagulation and flocculation units with differing chemical doses, and mixing and settling times
L/s	litres per second
LEP	Local Environment Plan
mg/L	milligrams per litre

ML	megalitre
ML/d	megalitres per day
maximum risk	a risk in the absence of preventive measures
microorganism	organism too small to be visible to the naked eye. Bacteria, viruses, protozoa, and some fungi and algae are microorganisms
multiple barriers	use of more than one preventive measures as a barrier against hazards
NTU	Nephelometric Turbidity Units
O&M	Operation and maintenance
OSSM	On-site sewage management
operational monitoring	the planned sequence of measurements and observations used to assess and confirm that individual barriers and preventative strategies for controlling hazards are functioning properly and effectively
PAC	Powdered Activated Carbon
pathogen	an organism capable of eliciting disease symptoms in another organism
pH	value taken to represent acidity or alkalinity of an aqueous solution; expressed as a logarithm of the reciprocal of the hydrogen ion activity in moles per litre at a given temperature
point of supply	the physical location of the outlet of the water supply scheme at the consumers' tap
preventive measure	any planned action, activity or process that is used to prevent hazards from occurring or reduce them to acceptable levels
quality assurance program	all the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality (AS/NZS ISO 8402:1994)
quality control	operational techniques and activities that are used to fulfil requirements for quality (AS/NZS ISO 8402:1994)
quality management	includes quality control and quality assurance, as well as additional concepts of quality policy, quality planning and quality improvement. Quality management operates throughout the quality system (AS/NZS ISO 8402:1994)
quality system	organisational structure, procedures, processes and resources needed to implement quality management (AS/NZS ISO 8402:1994)
RACC	Regional Algal Coordinating Committee
R&D	Research and development
raw water	the water entering the first treatment process of a water treatment plant; water in its natural state, prior to any treatment
reservoir	any natural or artificial holding area used to store, regulate or control water
residual risk	the risk remaining after consideration of existing preventive measures
risk	the likelihood of a hazard causing harm in exposed populations in a specified time frame, including the magnitude of that harm
risk assessment	the overall process of using available information to predict how often hazards or specified events may occur (likelihood) and the magnitude of their consequence

risk management	the systematic evaluation of the water supply system, the identification of hazards and hazardous events, the assessment of risks, and the development and implementation of preventive strategies to manage the risks
SBP	Strategic Business Plan: A 20 to 30 year strategic business plan and financial plan is a utility's peak planning document for water supply and sewerage in accordance with the NSW Water and Sewerage Strategic Business Planning Guidelines 2011 (www.water.nsw.gov.au)
SCADA	Supervisory Control and Data Acquisition system used to monitor, control and alarm water treatment plants
STP	Sewage Treatment Plant
service reservoir	a storage for drinking water, generally within the distribution system, used to meet fluctuating demands, accommodate emergency requirements and/or equalise operating pressures
source water	water in its natural state, before any treatment to make it suitable for drinking
surface water	all water naturally open to the atmosphere (eg rivers, streams, lakes and reservoirs)
target criteria	quantitative or qualitative parameters established for preventive measures to indicate performance
turbidity	the cloudiness of water caused by the presence of fine suspended matter
validation of processes	the substantiation by scientific evidence (investigative or experimental studies) of existing or new processes and the operational criteria to ensure capability to effectively control hazards
verification of drinking water quality	an assessment of the overall performance of the water supply system and the ultimate quality of drinking water being supplied to consumers; incorporates both drinking water quality monitoring and monitoring of consumer satisfaction
WTP	Water Treatment Plant
WU	Water Utility

1 INTRODUCTION

1.1 Overview

NSW Health has provided funding to support Glen Innes Severn Council (GISC) develop a risk-based drinking water management system (DWMS) to fulfil its obligations under Division 1 Section 25 of the NSW *Public Health Act 2010* and Part 5 Section 34 of the *Public Health Regulation 2012*. The *Public Health Act 2010* sets out the requirement for drinking water suppliers to develop and adhere to a quality assurance program also known as a drinking water management system, consistent with the *Australian Drinking Water Guidelines 2011* (ADWG) (NHMRC, NRMMC, 2011).

The ADWG provides the framework for the good management of drinking water supplies that, when implemented, assures safety at point of use. The framework was developed to guide a structured and systematic approach for the management of drinking water quality from catchment to consumer. It incorporates a preventive risk approach or quality assurance program developed specifically for the water industry, and includes elements of HACCP, AS/NZS ISO 9000 and AS/NZS ISO31000:2009.

1.2 Objective

This document aims to support both the Council to provide, and the Glen Innes Severn community to access, a safe quality drinking water supply. Access to safe water is a basic need and is one of the most important contributors to public health.

The overall approach is to provide drinking water system operators and managers with a user-friendly document that supports Council in its management of a safe drinking water supply. It provides an overview of the system and a summary of all relevant documentation and supporting requirements.

This DWMS and its supporting documentation are living documents. They should be reviewed and updated in line with Council's monitoring and reporting procedures and when new processes or changes are introduced.

2 COMMITMENT TO DRINKING WATER QUALITY

2.1 Commitment

Council is committed to managing its drinking water supply systems to provide a safe, high quality drinking water which consistently meets the ADWG, consumer expectations and regulatory requirements.

Glen Innes Severn Council has adopted a Drinking Water Quality Policy that formally documents Council's commitment to drinking water quality. The Glen Innes Severn Council Drinking Water Quality Policy is available in Appendix A.

The development and implementation of this DWMS formalises and demonstrates Council commitment to drinking water quality management throughout the organisation by:

- Defining Council's role and responsibility in regard to providing high quality drinking water
- Identifying and assessing risks associated with the drinking water system and introducing controls, preventive measures, appropriate training, procedures and emergency response plans to protect drinking water quality and public health
- Adopting a measurable Improvement Plan that will increase the integrity of the DWMS
- Reinforces the ongoing and active involvement of all staff and supports senior management to ensure actions and policies support the management of drinking water quality

2.1.1 Regulatory and Formal Requirements

The regulatory and formal requirements relating to drinking water quality in the Glen Innes Severn Shire have been identified and detailed in Table 4.

Table 4 Regulatory and Formal Requirements for Supply of Drinking Water

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
Commonwealth Legislation		
Water Act 2007	Provides for the management of the ground and surface water resources of the Murray-Darling Basin, with particular focus on managing extractions to "protect, restore and provide for the ecological values and ecosystem services of the Murray-Darling Basin".	Murray Darling Basin Authority
Competition and Consumer Act 2010	Replaces the Trade Practices Act 1974 and incorporates Schedule 2 - The Australian Consumer Law. As a "seller" of water, the local council is subject to provisions of Consumer transactions and Consumer guarantees, which guarantees that the goods supplied are reasonably fit for purpose.	Australian Competition and Consumer Commission

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
NSW Legislation		
Catchment Management Authorities Act 2003	Natural resource management, from planning to operations, is to be undertaken at the catchment level. State-wide standards are to be applied. Catchment Action Plans are used to define key themes for each catchment, each with specific catchment and management targets.	Border Rivers - Gwydir Local Land Services (LSS) Natural Resources Commission
Dam Safety Act 1978 No 96	Owners of prescribed dams are required to operate, maintain, extend and report on prescribed dams to the Dams Safety Committee to ensure the safety of their dams. Beardy Waters Weir is a prescribed dam.	NSW Government – Dams Safety Committee
Environmental Planning & Assessment Act 1979	Requires that the environmental impacts of projects be studied at all stages on the basis of scale, location and performance. Under Part 3 of the Act, Local Environmental Plans (LEPs) are developed to establish what forms of development and land use are permissible and/or prohibited. LEPs ensure that drinking water quality is considered when assessing development applications. The Glen Innes Severn LEP (2012) applies to all lands within the Glen Innes Severn Shire.	NSW Department of Planning and Infrastructure
Fluoridation of Public Water Supplies Act 1957, Regulation and Code of Practice	Requirements for testing and reporting where water supplies are fluoridated. Fluoridation is currently offline; however consideration is given to future dosing.	NSW Health NHMRC
Local Government Act 1993	Local councils have the responsibility for the provision of water supply to consumers, in accordance to the NSW Best-Practice Management of Water Supply and Sewerage Guidelines.	NSW Government Division of Local Government
NSW Groundwater Quality Protection Policy 1998	Manages groundwater resources for sustainable economic, social and environmental uses, with a specific principle to protect town water supplies against contamination. A key recommendation is to develop wellhead protection plans.	NSW Department of Industry (Water)
Protection of the Environment (Operations) Act 1997	Requires licences for activities with potentially significant environmental impacts. Prosecution may be carried out under this act for any chemical leakage, spill, and disposal of wastes or similar.	NSW EPA

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
Public Health Act 2010 *Public Health Regulation 2012*	Requires all water authorities to develop Drinking Water Management Systems. Bestows certain powers on NSW Health with respect to provision of safe drinking water, including ability to enter treatment facilities, order mandatory testing or obtain information about the drinking water and powers to close a water supply. Council is required to issue public advice regarding the water supply when directed by the Chief Health Officer of NSW Health.	NSW Health
Water Act 1912	Licences to extract water outside of areas covered by water-sharing plans. Affecting alterations to the quantity or quality of water in certain circumstances is an offence. Council holds six licences for extractions from: ▪ Beardy Waters extraction of water from weir ▪ Beardy Waters extraction of water from pump-hole ▪ Mann River extraction of water from weir ▪ Rocky Ponds Creek parks and sporting fields irrigation ▪ Deepwater Water Supply ▪ Red Range Road Bore Water Act 1912 is being progressively phased out and replaced by Water Management Act 2000.	NSW Department of Industry (Water)
Water Management Act 2000	Provides the basis for water planning, the allocation of water resources and water access entitlements. Licences for extraction for the three systems are governed by the provisions of this Act. Groundwater extractions are governed by the "Water Sharing Plan for the NSW Border Rivers Unregulated and Alluvial Water Sources" (2012).	NSW Department of Industry (Water)
Work, Health & Safety Act 2011	Specifies conditions for storage and handling of chemicals on-site at water treatment plants.	WorkCover Authority of NSW
Guidelines and Programs		
Australian Drinking Water Guidelines 2011	Ensures the accountability of drinking water managers and operators and health authorities and auditors for the supply of safe, good quality drinking water to consumers.	NSW Health

Regulatory or Formal Requirement	Relevance to Drinking Water Quality	Agency
NSW Best-Practice Management of Water Supply and Sewerage Guidelines 2007	Provides for appropriate, affordable and cost- effective services to meet community needs while protecting public health and the environment and making best use of regional resources. Requires a Strategic Business Plan (SBP), including a Financial Plan and associated asset management plans, reviewed and updated every four years; a 30-year Integrated Water Cycle Management (IWCM) plan. Council has an IWCM, but not yet an SBP for their water business.	NSW Department of Industry (Water)
NSW Health Drinking Water Monitoring Program 2005	NSW Health provides analysis of drinking water samples for water utilities, providing an independent analysis of water at point of supply.	NSW Health
NSW Health Response Protocol for management of microbial quality of drinking water 2011	Guides Public Health Units and water utilities in their joint response to rapidly changing source water quality, treatment failure or microbial contamination.	NSW Health
NSW Health Response Protocol for management of physical and chemical quality 2004	Guides Public Health Units and water utilities in their joint response following the detection of physical and chemical water characteristics that exceed the Guidelines. Aesthetic and health related guideline values are considered.	NSW Health
National Partnership Agreement on Water for the Future	The COAG Strategy on Water and Wastewater Services in Remote Communities in New South Wales aims to provide water infrastructure and build the capacity of the Council to improve the management and overall security of water in remote communities.	Australian Government NSW Department of Industry (Water)
Plumbing Code of Australia	Specifications for plumbing in drinking water systems, to be complied with by administrators, plumbing Licensees, developers and property owners/occupiers.	Office of Fair Trading

2.1.2 Engaging Stakeholders

Stakeholders involved in the provision of a safe reliable drinking water supply have been identified and are listed in Table 5. NSW Health Water Unit, Local Public Health Unit and NSW Department of Industry (Water) participated in the development of this DWMS.

Table 5 Stakeholders in Drinking Water Quality Management

Stakeholder	Role	Participation
NSW Health	Provides expert advice and support to Council in achieving their regulatory requirements	Provides water analysis through the NSW Health Drinking Water Monitoring Program. NSW Health response protocol to microbial and physical and chemical exceedances Representatives from the Local Public Health Unit and NSW Health Water Unit participated in site visits and the Risk Assessment Workshop as part of the development of the DWMS.
NSW Department of Industry (Water)	Technical support on investigations, design, construction, operation, maintenance and management	Inspector visits and assesses WTPs compliance every three months. Technical support on investigations, design, construction, operation, maintenance and management Annual Reporting on Water Supply performance Participated in Site Visits and Risk Assessment Workshops as part of the Glen Innes Severn DWMS Barwon Regional Algal Coordinating Committee (RACC) provides algal alerts
Northern Tablelands Local Land Services	Natural resource management and emergency management	It is recommended that Council liaises with Local Land Services regarding the management of water quality in the drinking water catchment
Murray Darling Basin Authority	Catchment Management	Assists in management of algal blooms through varying flows

3 DRINKING WATER SUPPLY SYSTEMS

3.1 Overview

Glen Innes Severn Council operates two drinking water supply systems. A summary of these drinking water systems is detailed in Table 6 below.

Table 6 Overview of Glen Innes Severn Water Supply Systems

Category	Glen Innes	Deepwater
Catchment	Border Rivers Catchment Macintyre Alluvium Groundwater Source	Border Rivers Catchment
Source Water	Raw water is sourced from the Beardy Waters Weir, which flows from Beardy Waters Red Range Road Bore (supplementary supply in drought conditions)	Raw water is sourced from the Deepwater River
Treatment	Treatment process at Glen Innes Water Treatment Plant: ▪ Flocculation ▪ Filtration ▪ Disinfection	Treatment process at Deepwater Water Treatment Plant: ▪ Dissolved Air Flotation and Filtration (DAFF) ▪ Disinfection
Reservoirs	Three clear water storage tanks at Water Treatment Plant (combined capacity of 6.4 ML) One Service Reservoir (capacity 0.91 ML)	One distribution reservoir (capacity 0.6 ML)
Reticulation	Population of approximately 6,284 people in the township of Glen Innes.	Population of approximately 350 people in the village of Deepwater

3.2 Glen Innes Drinking Water Supply System Analysis

3.2.1 Description

The Glen Innes water supply scheme was originally commissioned in the 1930s. The scheme consists of an extraction point at Beardy Water Weir on the Beardy Waters and a Water Treatment Plant (WTP) that provides drinking water that has undergone flocculation, clarification, filtration, and disinfection via chlorination.

3.2.1.1 Drinking Water Catchment

Glen Innes drinking water supply is sourced from the Glen Innes Water Supply Catchment, which covers an area of 227 square kilometres, in the south-eastern region of the Border Rivers Catchment, as shown in Figure 1.

The Border Rivers catchment covers 49,500 km^2, extending from Warrenbayne in southern Queensland to Inverell in northern NSW. Glen Innes' primary water supply is drawn from Beardy Waters Weir, located to the east of the Glen Innes Township. Mann River to the east of Glen

Innes has previously been used as a backup water supply for the Glen Innes drinking water supply, but has been decommissioned.

The main impacts on water quality within the Border Rivers catchment are from agricultural and mining activities as well as residential, industrial, commercial and rural development that are undertaken within the catchment. Agriculture, which is the leading industry in the Glen Innes Local Government Area (LGA), can impact water quality through application of pesticides, nutrient-rich run-off from fertiliser application, erosion and salinity, which can be found in certain areas within the LGA. Land-use in the LGA is primarily agricultural grazing on improved pastures which, combined with the highly fertile basalt catchment, can cause source waters to become nutrient-rich. Mining within the LGA has the potential to contaminate drinking water supplies with arsenic and sulphur, whilst residential, industrial, commercial and rural development can introduce litter and pollutants (Melaleuca Enterprises, 2009).

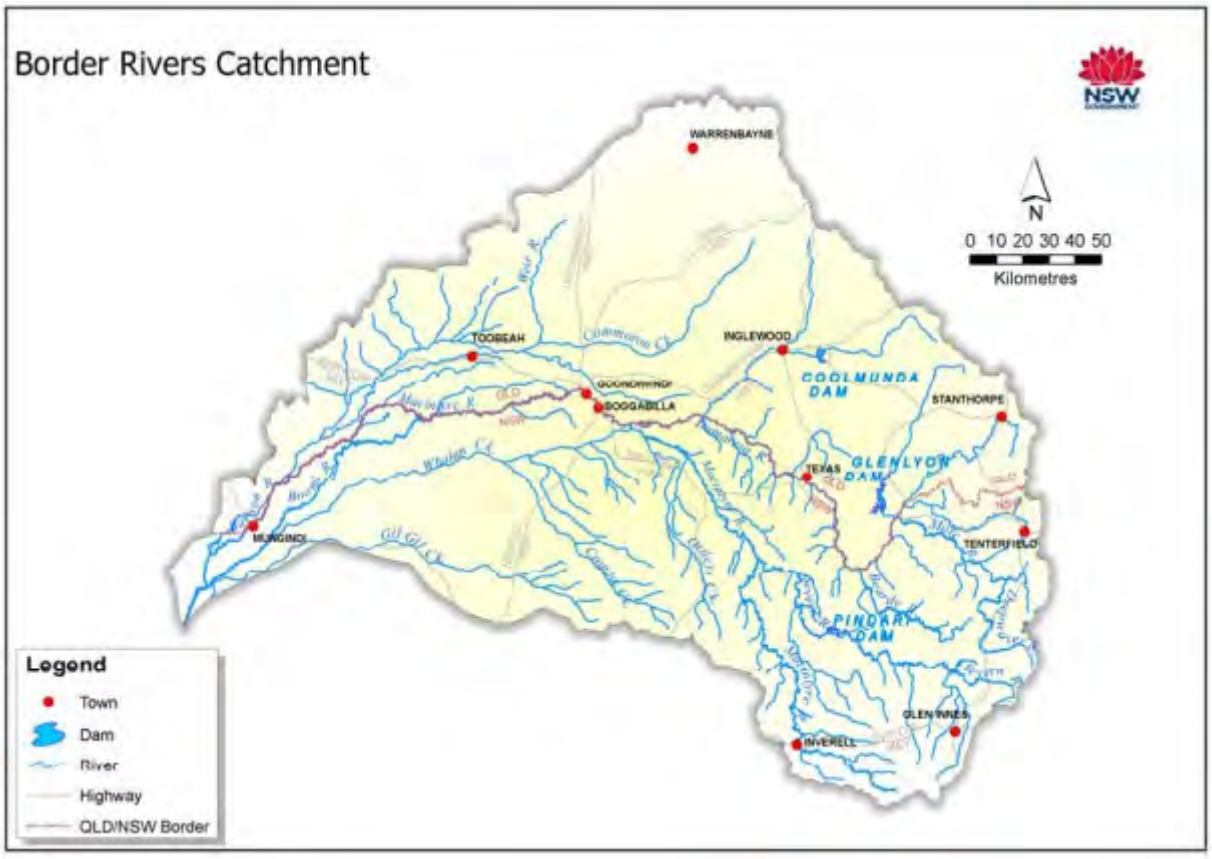

Figure 1 Border Rivers Catchment

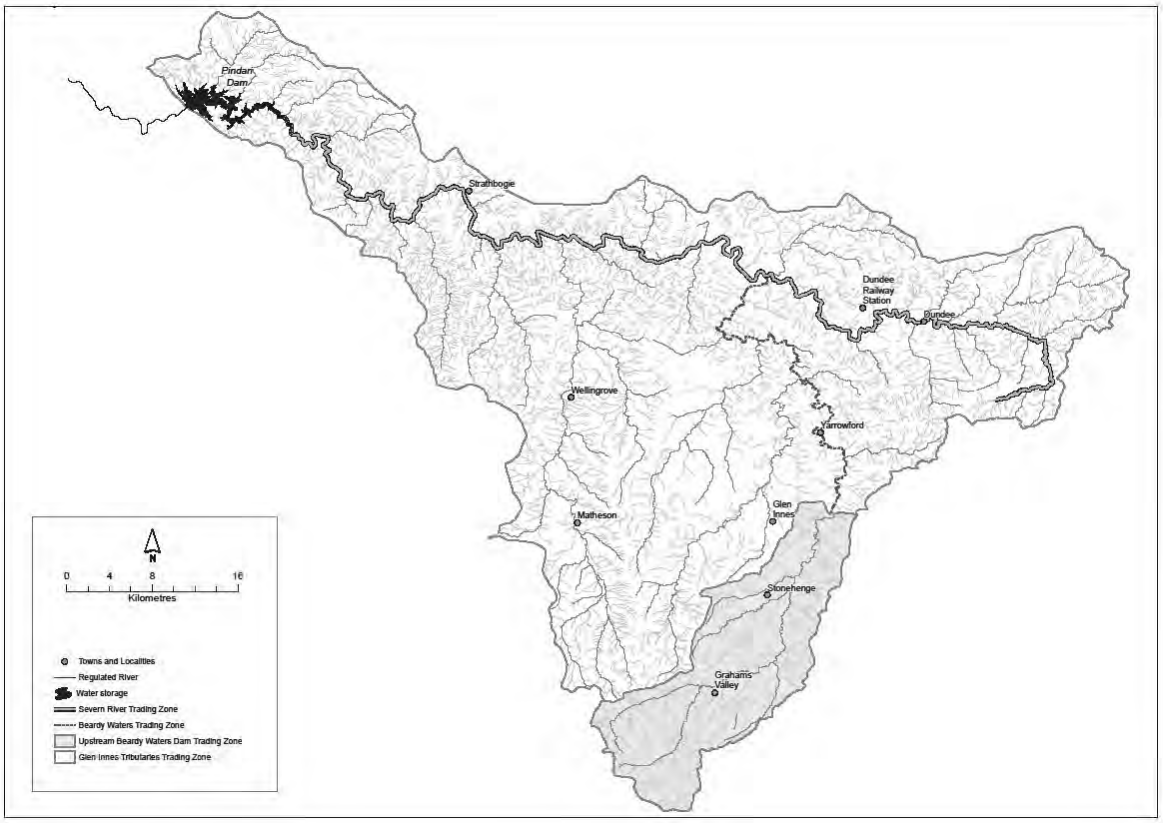

Figure 2 Glen Innes Water Source Trading Zones

3.2.1.2 Source Water

The Glen Innes WTP sources raw water from Beardy River, which flows into the off-stream storage at Beardy Waters Weir, built in 1932. Beardy Waters Weir has a design capacity of 650 ML; however, siltation has reduced the operating capacity to 488 ML. In 2004, Council installed an aerator at Beardy Waters Weir to reduce blue-green algae outbreaks. The aerator is also used to control manganese levels in the Beardy Waters Weir.

In July 2011, GISC purchased the Glen Innes Aggregates Quarry to increase storage capacity for the Glen Innes town water supply. Currently the Southern Pit is in use as a storage reservoir for town water, holding approximately 200 ML. Water from Beardy Waters Weir is pumped to the Southern Pit, known as the Glen Innes Aggregates Off-stream Storage. Water from the Off-stream Storage is pumped via a 4.2 km rising main to the Glen Innes WTP, located at Martin's lookout. It was constructed in 1982. The pump station consists of two pumps operating in series.

GISC also has licence to draw groundwater from Red Range Road Bore. The bore was constructed in 2006, commissioned in 2011 and has a final drilled depth of 89 m below surface level. Water is drawn into the bore at 56 m and 85 m below surface level through a stainless steel screen. Water from Red Range Road Bore is supplied at a rate of 5 litres per second via a rising main to the Glen Innes WTP. The rising main consists of 2 pumps operating in duty/standby.

Under normal operating conditions, the Glen Innes drinking water supply system's primary water sources are Beardy Waters Weir and Red Range Road Bore, with the Glen Innes Aggregates Off- stream Storage being used for emergency storage.

3.2.1.3 Water Treatment

The WTP at Glen Innes can receive water from three sources: Beardy Waters Weir, Eerindii Ponds (Off-stream storage) and Red Range Road Bores.

In 2004 Council installed an aerator in the Beardy Waters Weir to manage blue-green algae outbreaks. The aerator also serves to oxidise high levels of manganese found in source waters.

The Glen Innes Water Treatment Plant has a capacity of 10 ML per day (GISC, 2013c) with average daily demand at 2-3 ML per day (GISC, 2008).

The treatment process at Glen Innes WTP comprises the following process steps:

- All raw surface water pumped to the Glen Innes WTP is dosed with aluminium sulphate (alum) and flows through a mixing well to promote flocculation
- After the mixing well, polymer is dosed prior to clarification. Online monitoring of turbidity and pH occurs at the outlet to the clarifier, and bore water flows directly into the clarifier also
- Clarified water then gravitates through three sand filters
- Filtered water is discharged into a distribution well after pH correction using soda ash and disinfection with chlorine gas. Turbidity, pH and chlorine residual are monitored online at the distribution well
- The distribution well can transfer water to three clear water storage tanks with a combined capacity of 6.4 ML. The clear water storage tanks distribute the treated water to consumers in the township of Glen Innes
- Treated water is also transferred to Blue Hills Reservoir on the western side of town via the reticulation system. Blue Hills Reservoir has a capacity of 0.91 ML

The fluoride dosing system is currently offline due to safety concerns with the aging equipment. Council is currently investigating an upgrade of the dosing system.

3.2.1.4 Water Distribution

The Glen Innes Water Supply system distributes drinking water to the Glen Innes Township. The Glen Innes drinking water supply provides services to approximately 6,284 people (GISC, 2007), with an estimated peak population of 7,000 persons (GISC, 2013c).

Glen Innes WTP has three clear water tanks located on Martin's Lookout with a combined capacity of 6.4ML. The clear water tanks receive treated water from the distribution well. Currently, only two clear water tanks are in service, with the third clear water tank being kept offline for emergencies. From the clear water tanks, treated water is distributed via gravity to consumers within the Glen Innes Township.

There is an additional 0.91 ML service reservoir located at Blue Hills shown in Figure 3. The Blue Hills Reservoir was originally built in 1932. Treated water is transferred to this reservoir via the reticulation system.

According to Council's Water Asset Management Plan (2011b), there are 89 km of water reticulation mains in the Glen Innes drinking water supply system that were originally constructed in 1930. Many of these original mains are still in use at the present time. These old mains can often introduce discolouration into drinking water supply due to the release of iron scale. Council manages the iron scale release by performing a regular mains flushing program.

The water reticulation mains in Glen Innes range from 75 mm to 375 mm in diameter and mainly consist of asbestos concrete, cast iron and PVC pipes. The pipe network is shown in Figure 3. Mains breaks are recorded and used to forecast when mains rehabilitation is required.

Figure 4 displays the process flow of the Glen Innes Drinking Water Supply from catchment to consumer.

Figure 3 Glen Innes Drinking Water Infrastructure Map

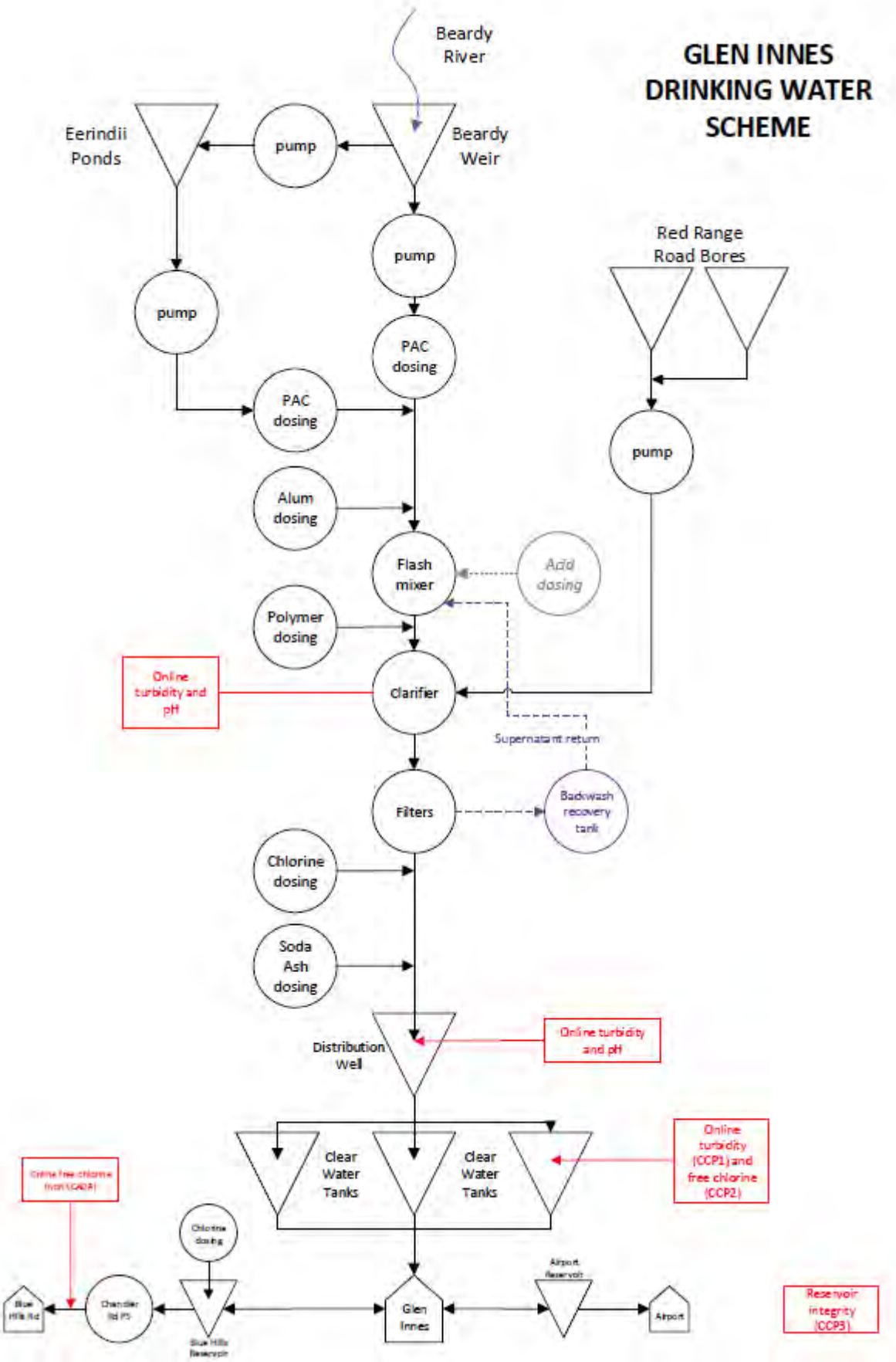

Figure 4 Glen Innes Schematic

3.2.2 Assessment of Water Quality

Water quality was assessed to inform the Risk Assessment Workshop process and identify issues within the Glen Innes drinking water supply system. A detailed assessment of water quality was compiled and provided to the Risk Assessment Team (document reference – "Risk Assessment Briefing Document, Glen Innes Severn Council, 21 May 2018" [Bligh Tanner 2018]).

3.2.2.1 Baseline Monitoring

According to ADWG, baseline assessment of the source water quality is recommended. ADWG recommends water suppliers to undertake a baseline assessment of microbial, physical, chemical, radiological, pesticides and disinfection by-products parameters.

No baseline data for Beardy Waters Weir, Eerindii Ponds or Red Range Road Bore were available for analysis. Council has undertaken baseline assessment of the source water but results were unavailable at the time of writing.

3.2.2.2 Operational WTP Monitoring

Since 1996 Glen Innes WTP operators have been recording a limited number of operational monitoring results electronically, as recommended by the ADWG 2011.

Operational water quality monitoring at Glen Innes WTP recorded electronically includes:

- Raw water (combined dam and bore water) – pH, turbidity, colour
- Filtered/treated water – turbidity, colour, free chlorine, aluminium, iron, manganese

Glen Innes WTP operators also record the following parameters:

- Clarified water – turbidity, colour, pH

Monitoring of water quality is not undertaken at the storage reservoirs or within the reticulation system as part of the Council's operational monitoring regime.

3.2.2.3 Raw Water

Council undertakes raw water monitoring for pH, turbidity and colour. Set out in Table 7 is the operational monitoring (turbidity and colour only) results for Beardy Waters Weir from July 2003 to June 2013, which was prepared for the original DWMS.

Table 7 Raw Water Monitoring: Beardy Waters Weir (2003-2013)

Parameter	Count	Min.	Mean	Median	95%ile	Max.
Turbidity (NTU)	3546	0	10.5	4.9	37	432
Colour (HU)	3485	0	92	57	276	1605

From the baseline monitoring it is evident that the Weir has relatively stable turbidity, with some significant spikes. Colour is slightly more variable, with spikes occurring at corresponding times to turbidity spikes. This is likely an indication of increased organic matter and suspended solids within the Dam due to rainfall.

Water quality issues at Beardy Waters Weir include blue-green algae and manganese concentrations. Prior to 2004, the presence of blue-green algae was an issue within the source water. A surface aerator was installed at the Dam in 2004, which has been able to control the algae problems. In January 2013, weather patterns within the region caused an increase in organic material within the source waters, resulting in elevated manganese concentrations in excess of the ADWG values. Council followed procedures to minimise the impact on consumers and utilised the surface aerator to reduce incoming manganese concentrations.

In recent years, Council has utilised the Eerindii Ponds off-stream storage exclusively, as this mitigates raw water quality impacts from most events in the Beardy Waters Weir. Water can be selectively transferred to the ponds when water quality is adequate.

Operational raw water quality data for the period 2015 to 2018 is presented in Table 8:

Table 8 Raw Water Monitoring: Combined (2015-2018)

Parameter	Count	Min.	Mean	Median	95%ile	Max.
Turbidity (NTU)	1078	1.2	8.6	6	21	154
Colour (HU)	1078	6	95	72	229	1342
pH	1078	7.1	8.5	8.6	9.1	9.7

3.2.2.4 Treated Water

Council undertakes operational treated water monitoring for pH, turbidity, colour, iron, manganese, aluminium and free chlorine. Table 9 sets out the operational monitoring results (turbidity and colour only) for treated water from July 2003 to June 2013 as prepared for the original DWMS.

Table 9 Operational Treated Water Monitoring: Glen Innes WTP (2003-2013)

Parameter	Count	Min.	Mean	Median	95%ile	Max.
Turbidity (NTU)	3489	0	0.7	0.6	1.4	8.2
Colour (HU)	3324	0	1	0	5	30

Recent, more comprehensive data (2015-2018) is provided in Table 10:

Table 10 Operational Treated Water Monitoring: Glen Innes WTP (2015-2018)

Parameter	Count	Min.	Mean	Median	95%ile	Max.
pH	1078	7.2	7.8	7.8	8.1	8.7
Colour (HU)	1078	0	2.7	2.0	8.0	22
Turbidity (NTU)	1078	0	0.1	0.04	0.27	1.5
Iron (mg/L)	239	0	0.02	0.01	0.07	0.17
Manganese (mg/L)	260	0	0.04	0.03	0.08	0.44
Aluminium (mg/L)	264	0	0.05	0.03	0.11	0.88
Free chlorine (mg/L)	1077	0.74	1.7	1.7	2.3	3.6

3.2.2.5 Turbidity

In relation to health considerations, turbidity can have a significant effect on microbial quality of drinking water. Elevated turbidity can interfere with the detection and treatment of bacteria and viruses.

The ADWG 2011 recommends that in order to remove waterborne pathogens where filtration is used as part of the water treatment process, the turbidity leaving individual filters should be less than 0.2 NTU and should not exceed 0.5 NTU at any time.

At times the raw water entering the Glen Innes WTP is elevated with a max 432 NTU in August 2007. Significant spikes have also occurred within the treated water with a max 8.2 NTU in August 2005. The last spike of 6.8 NTU was observed in February 2013. Since January 2016 there have been no results recorded greater than 0.5NTU.

Turbidity is effectively reduced through the treatment process from a mean of 8.6 NTU to 0.1 NTU (2015-2018 data). The 95th percentile of 0.27 NTU shows that recent performance is approaching the ADWG recommendation of 0.2 NTU, which is a significant improvement over the last few years.

3.2.2.6 Colour

At times colour is above the ADWG guideline criteria. The ADWG value of 15 HU (Hazen Units) for True Colour is based primarily on aesthetic considerations, where 15 HU is the limit at which colour is just noticeable in a glass of water.

Although not a health consideration, consumers use colour as an indication of water quality. According to ADWG 2011, water with colour above 15 HU may give rise to higher consumer complaints and may prompt people to seek other, possibly less safe, sources of drinking water.

Generally the colour of treated water at GISC is below the ADWG value, however, large spikes were observed in January 2013 due to an increase in the concentration of manganese in the source water. Aeration of source waters in Beardy Waters Weir and increased mains flushing are used to control the discolouration caused by elevated levels of manganese.

3.2.2.7 Free Chlorine

Council monitor free chlorine online in the treated water at the Glen Innes WTP and via daily grab samples. Though data for the 2003-2013 period was not available, the 2015-2018 data shows that chlorination is effectively controlled, such that the minimum result was 0.74mg/L and the mean was 1.7mg/L.

According to Council, operators target a chlorine residual of 1.5mg/L in the clear water reservoirs. The treated water receives approximately two days contact time prior to distribution. There can be challenges maintaining chlorine residual through the reticulation system, notably at the Blue Hills Reservoir, however this has improved in recent years. Operators manually dose the Blue Hills Reservoir twice a week with chlorine tablets to maintain some residual in supply.

3.2.2.8 NSW Health Drinking Water Monitoring Program

Point-of-supply data from the NSW Health Drinking Water Monitoring Program was analysed from 1 August 2003 to 30 September 2013. Free chlorine is measured by Operators at the time of sample collection at three reticulation sites. Results are presented in Figure 5 and show a trend of improvement over the period 2013-2018.

A summary of the NSW Health Drinking Water Monitoring Program data was prepared for the original DWMS, covering the period of 2003-2013 (refer Table 11). A review of data from 2009-2018 was undertaken recently, with summarised data presented in Table 12. Although the data periods overlap, it was decided to present the information this way as many of the parameters were not included in the original analysis.

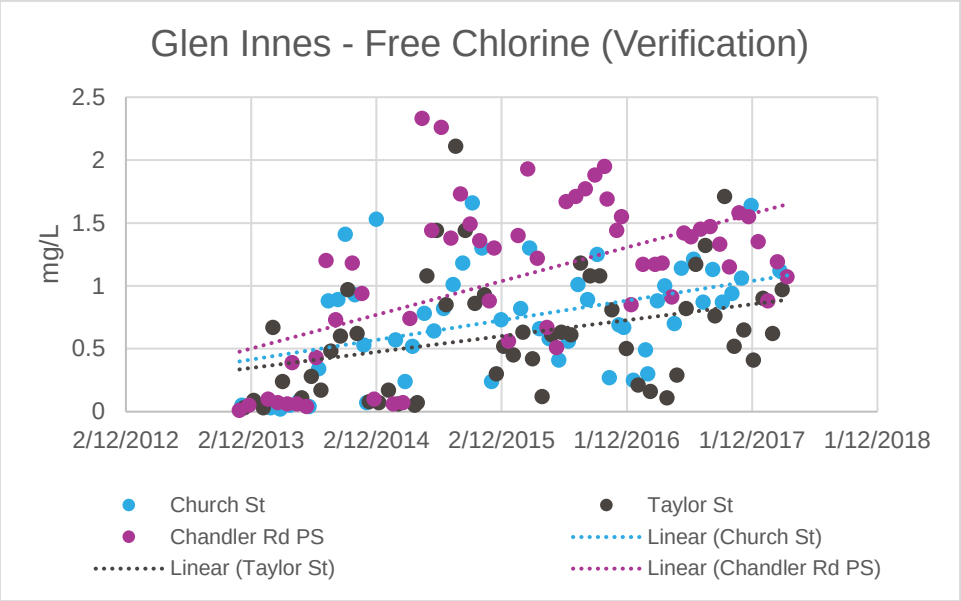

Figure 5 Glen Innes distribution system free chlorine results

Table 11 NSW Drinking Water Monitoring Program Data (2003-2013)

Parameters	ADWG Value**	Count	NC*	Min.	Mean	95%ile	Max
E. coli (mpn/100mL)	< 1	508	14	< 1	< 1	< 1	19
Total Coliform (mpn/100mL)	-	508	170	< 1	10	62	> 200
Free Chlorine (mg/L)	0.2 - 5	8	Low: 2	0.10	0.56	1.01	1.10
Total Chlorine (mg/L)	5	2	0	0.20	0.55	0.86	0.89
pH	6.5 - 8.5	119	13	7.4	8.2	8.7	10.6
True Colour (HU)	15	114	2	1	3	5	68
Turbidity	5	115	2	0.1	0.7	1.9	29.6
Hardness (mg/L CaCO3)	200	115	0	43	130	175	186
Fluoride (mg/L)	0.9 - 1.5	116	Low: 23 High: 1	0.05	0.95	1.18	1.93
Fluoride Weekly (mg/L)	0.9 - 1.5	680	Low:261 High: 2	0	0.92	1.03	1.28
Iron (mg/L)	0.3	115	1	0.01	0.04	0.08	1.65
Aluminium (mg/L)	0.2	115	8	0.01	0.09	0.27	1.17
Manganese (mg/L)	0.5	115	0	0.003	0.027	0.068	0.318

* NC = non-compliances

** Fluoride lower limit of 0.9mg/L is required under the NSW Code of Practice for Fluoridation of Public Water Supplies; and free chlorine lower limit of 0.2mg/L is required by Department of Industry (Water) under Circular LWU 18 – *Assuring the safety of drinking water supplies*.

Table 12 NSW Drinking Water Monitoring Program Data (Glen Innes, 2009-2018)

Parameter*	ADWG Value	Count	NC**	Min.	Mean	Max.	Stdev
Aluminium	0.2	69	0	0.01	0.04	0.14	0.03
Antimony	0.003	69	0	0.001	0.001	0.001	0.000
Arsenic	0.01	69	0	0.001	0.001	0.001	0.000
Barium	2	69	0	0.003	0.014	0.050	0.008
Boron	4	69	0	0.05	0.05	0.05	0.00
Cadmium	0.002	69	0	0.000	0.000	0.001	0.000
Calcium	N/A	69	N/A	16	26	39	4
Chloride	250	69	0	6	12	21	3
Chromium	0.05	69	0	0.003	0.003	0.005	0.000
Copper	2	69	0	0.00	0.01	0.14	0.02
E. coli (mpn/100mL)	<1	263	0	0	0	0	0
Fluoride	0.9-1.5	69	***	0.05	0.39	1.22	0.44
Fluoride (weekly WU)	0.9-1.5	358	***	0.22	0.96	1.16	0.54
Free Chlorine	0.2-5	164	Low:31	0.01	0.82	2.33	0.55
Iodine	N/A	69	N/A	0.01	0.02	0.05	0.01
Iron	0.3	69	0	0.01	0.02	0.23	0.04
Lead	0.01	69	0	0.001	0.001	0.005	0.001
Magnesium	N/A	69	N/A	10	20	29	4
Manganese	0.5	69	0	0.00	0.03	0.20	0.04
Mercury	0.001	69	0	0.0001	0.0001	0.0004	0.0000
Molybdenum	0.05	69	0	0.003	0.003	0.005	0.000
Nickel	0.02	69	0	0.005	0.005	0.010	0.001
Nitrate	50	69	0	0.50	0.71	2.90	0.50
Nitrite	3	69	0	0.05	0.05	0.30	0.03
pH (unitless)	6.5-8.5	234	High:4	7.0	8.0	9.0	0.2
Selenium	0.01	69	0	0.001	0.001	0.003	0.000
Silver	0.1	69	0	0.001	0.001	0.010	0.001
Sodium	180	69	0	10	31	58	9
Sulfate	250	69	0	27	44	64	9
Total Chlorine	5	162	Low:31	0.01	0.82	2.33	0.56
Total Coliforms (mpn/100mL)	<1	264	52	0	7	201	30
Total Dissolved Solids (TDS)	600	69	0	151	209	304	29
Total Hardness as CaCO3	200	69	2	80	146	216	28
True Colour (HU)	15	69	0	0.5	2.2	12	1.7
Turbidity (NTU)	5	234	2	0.00	0.63	8.27	1.02
Uranium	0.017	6	0	0.003	0.003	0.003	0.000
Zinc	3	69	0	0.01	0.05	0.52	0.08

* units in mg/L unless stated otherwise

** NC = non-compliances

*** fluoridation was ceased therefore lower boundary is no longer relevant

Note: the fluoride weekly results have omitted the two exceedances of 97 and 10.9 mg/L that occurred on 29 Oct 2008 and 9 Oct 2012, respectively. It is considered these readings are a result of typing input error.

Table 13 summarises the key water quality issues.

Table 13 Glen Innes Water Quality Overview

Parameter	Comments
E. coli	From a total of 508 samples, 14 detections occurred from 2003 to 2013. The majority of detections occurred in 2004. It is noted that prior to 2008, there were at least 2 exceedances per year. Since 2009, there have been no detections.
Total Coliforms	Since 2009, 52 of 264 samples returned a positive total coliform result. However since 2014 there has only been a single detection of 3mpn/100mL on 16 January 2018. This indicates that disinfectant residual management has improved in recent years.
Free Chlorine	Prior to 2013, free chlorine results were not recorded with the NSW drinking water quality monitoring samples. Since Council started recording results in 2013, the mean result is 0.82mg/L and 31 of 164 samples were below the 0.2mg/L threshold. As shown earlier in Figure 5 though, this trend is improving over time. The ADWG recommend a chlorine residual of ≥ 0.2 mg/L at the point of supply to ensure a disinfectant barrier remains. This is also the lower threshold specified by DoI (Water) in Circular 18.
pH	From 2009-2018 only 4 of 234 samples exceeded 8.5 with a maximum of 9 and a mean of 8. pH impacts on disinfection effectiveness due to the dissociation of hypochlorous acid to hypochlorite ion as pH increases. At pH 7, approximately 80% of chlorine is present in the effective hypochlorous acid form (strong disinfectant) while at pH 8, this drops to 20%. At pH 9, almost no hypochlorous acid remains. The ADWG recommend keeping pH between 6.5 and 8.5 to minimise corrosion and encrustation of plumbing systems and water reticulation mains. The ADWG also state that pH above 9.5 can cause a bitter taste in drinking water and can cause skin or gastrointestinal irritation in sensitive individuals.
Turbidity	Of 234 samples collected between 2009-2018, only 2 exceeded the aesthetic guideline of 5 NTU. In relation to health considerations, elevated turbidity can interfere with pathogen disinfection. *E. coli* and total coliform were not detected on the days of turbidity exceedances, indicating that disinfection was effective. Elevated turbidity in distribution systems is often related to disturbance of settled sediments, but potentially could indicate ingress of external contaminants.
Fluoride	The fluoridation system has been offline since 2013. Prior to this time, there were no exceedances of 1.5mg/L (the result of 10.9mg/L was considered to be data entry error – e.g. more likely to have been 1.09mg/L).

Parameter	Comments
Aluminium	There were no results above 0.2mg/L between 2009 and 2018. Although not a health value; the ADWG strongly recommends keeping aluminium concentrations as low as possible, preferably below 0.1 mg/L. Exceedances in Aluminium may be an issue for dialysis patients. Council maintains a register of dialysis patients in the Local Government Area to be informed if Aluminium exceeds guidelines.
Manganese	From a total of 69 samples, there were no exceedances in the supply water from 2009 to 2018. Although there were no exceedances of Manganese for ADWG Health guideline values, there were occasional exceedances of the ADWG aesthetic guideline values. Literature suggests that manganese should ideally be managed below 0.02mg/L to prevent distribution system dirty water issues over time. The mean result of 0.03mg/L is higher than this figure, and has not changed since the original 2003-2013 review.
True Colour	From a total of 69 samples, there were no recorded exceedances from 2009 to 2018. Although not recorded by the NSW Health data, high manganese levels in source waters in Jan 2013 caused elevated colour results.
Other	There were no significant issues with other parameters; the only other exceedances of ADWG guidelines was two total hardness results above 200mg/L CaCO3.

3.3 Deepwater Drinking Water Supply System Analysis

3.3.1 Description

The Deepwater drinking water supply is a village water supply that was originally constructed in 1968. In December 2011, Glen Innes Severn Council commissioned a new Dissolved Air Floatation and Filtration (DAFF) WTP at Deepwater. The sections below provide an overview of the Deepwater drinking water supply including source water, treatment process and distribution system.

3.3.1.1 Drinking Water Catchment

The Deepwater drinking water supply is sourced from the Deepwater water supply catchment, which covers an area of 217 square kilometres. (Melaleuca Enterprises, 2009). This water supply catchment is a part of the Border Rivers Catchment Area, as discussed in section 3.2.1.1.

3.3.1.2 Source Water

The Deepwater WTP draws raw water from Deepwater River, which is located west of the township of Deepwater. The raw water intake structure is via Deepwater Weir and is pumped to the Deepwater WTP via a pump station consisting of 2 pumps operating in a duty-standby configuration. Figure 6 shows the Deepwater drinking water supply, including the location of Deepwater pump station, Deepwater WTP and town reservoir.

Figure 6 Deepwater Drinking Water Supply System

3.3.1.3 Water Treatment

The Deepwater drinking water supply was first constructed in the 1960s, with the current scheme commissioned in December 2011. The new Deepwater WTP includes a 0.7ML per day capacity DAFF plant and treated water is disinfected via chlorination. The drinking water supply is not fluoridated.

The treatment process at Deepwater WTP comprises of the following process steps:

- Raw water is pumped from Deepwater Weir to Deepwater WTP
- Incoming raw water is pre-dosed with soda ash and coagulant (Ultrion) before entering the DAFF tank
- After dosing the raw water is mixed in the half plate flash mixer in the raw water pipe

- The flocs are then removed using a sludge flotation system where coagulated flocs are floated to the surface, creating a sludge blanket that is hydraulically removed periodically at operator-set intervals
- The water then gravitates through a sand filter
- Filtered water from the DAFF tank is pH corrected using soda ash and then transferred to a 0.5ML clear water storage tank
- Treated water is disinfected with sodium hypochlorite as it is pumped from the clear water storage tank to the 0.6ML Deepwater Reservoir via a dedicated inlet main. From here it is reticulated to consumers in the village of Deepwater

3.3.1.4 Water Distribution

The Deepwater water supply system distributes drinking water to the village of Deepwater. According to the NSW Health Database, the Deepwater drinking water supply provides potable water to a population of approximately 350 people.

Treated water is stored in one steel service reservoir with a capacity of 0.6 ML. In 2009 Glen Innes Severn Council constructed a roof on top of the Deepwater Reservoir to eliminate recontamination of treated water and maintain chlorine residuals. Currently, Deepwater Reservoir requires removal of bitumen lining and repainting.

According to Council's Drought Management Plan (2013c), there is 8.7 km of reticulation mains in the Deepwater drinking water supply, constructed in 1968. The water reticulation mains are mainly asbestos cement pipes. Figure 6 shows the water mains supplying the Deepwater township from the WTP. Main breaks are recorded in log sheets and used to forecast when mains rehabilitation is required.

Figure 7 displays the process flow of the Deepwater drinking water supply from catchment to consumer.

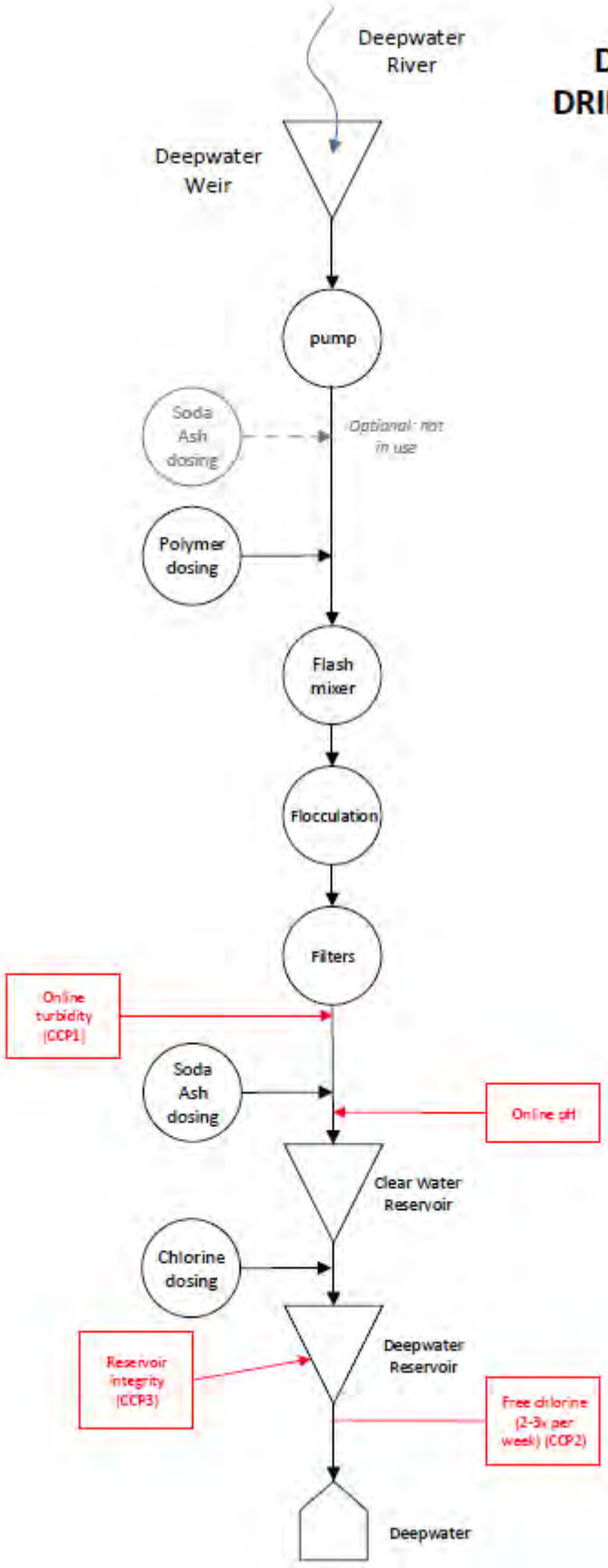

Figure 7 Deepwater schematic

3.3.2 Assessment of Water Quality

Water quality was assessed to inform the Risk Assessment Workshop process and identify issues within the Deepwater drinking water supply. A detailed assessment of water quality was compiled and provided to the Risk Assessment Team (document reference – "Risk Assessment Briefing Document, Glen Innes Severn Council, 21 May 2018" [Bligh Tanner 2018]).

3.3.2.1 Baseline Monitoring

According to ADWG, baseline assessment of the source water quality is recommended. ADWG recommends water suppliers to undertake a baseline assessment of microbial, physical, chemical, radiological, pesticides and disinfection by-products parameters.

Some basic data was collected through the Section 60 process required for the Deepwater WTP. The data period was not recorded, though based on timing of events this would be expected to have been around the period 2009-2011. The available data is summarised in Table 14:

Table 14 Raw water quality data: Deepwater Weir (circa 2010)

Parameter	ADWG Value	Minimum	Mean	Maximum
pH	6.5 - 8.5	3.8	6.6	6.7
True Colour (HU)	15	1	51.25	195
Turbidity (NTU)	5	0.6	8.6	34
Aluminium (mg/L)	0.2	0.12	0.51	1.8
Fluoride (mg/L)	1.5	0.10	0.14	0.68
Iron (mg/L)	0.3	0.01	1.19	7.2
Manganese (mg/L)	0.5	0.01	0.04	0.5
Zinc (mg/L)	3	0.02	0.2	1.6

3.3.2.2 Operational Supply Monitoring

Deepwater WTP operators previously recorded all daily monitoring results manually in onsite workbooks. As of mid-2018, Council records all water quality monitoring results electronically to provide for quality analysis.

Deepwater WTP operators record the following parameters:

- Raw water – turbidity, colour, pH
- Clarified water (sampled from DAFF tank above the filter) – turbidity, colour, pH
- Filtered water – turbidity, colour, aluminium, iron, manganese

Operational data was manually entered from hardcopy records into a spreadsheet log by GISC staff in 2018, for the period July 2014 to May 2018.

Raw water pH, colour and turbidity results are summarised in Table 15:

Table 15 Operational raw water quality data: Deepwater WTP (2014-2018)

Parameter	ADWG Value	Count	Minimum	Mean	Maximum
pH	6.5 - 8.5	568	6.2	7.2	11.2
True Colour (HU)	15	700	13	151	432
Turbidity (NTU)	5	639	1.5	6.7	33

Clarified and filtered water operational monitoring results are summarised in Table 16 and Table 17:

Table 16 Operational clarified water quality data: Deepwater WTP (2014-2018)

Parameter	ADWG Value	Count	Minimum	Mean	Maximum
pH	6.5 - 8.5	525	4.5	7.2	7.7
True Colour (HU)	15	550	0	6.3	27
Turbidity (NTU)	5	568	0	0.2	1.7

Table 17 Operational filtered water quality data: Deepwater WTP (2014-2018)

Parameter	ADWG Value	Count	Minimum	Mean	Maximum
True Colour (HU)	15	568	0	5.6	27
Turbidity (NTU)	5	576	0	0.18	1.4
Aluminium (mg/L)	0.2	85	0	0.01	0.29
Iron (mg/L)	0.3	86	0	0.05	0.15
Manganese (mg/L)	0.5	84	0	0.03	0.56

Final operational water quality data from the Deepwater Reservoir is summarised in Table 18. This data was not as consistently recorded in the electronic data sheets compared with the raw and process monitoring data, resulting in fewer results to summarise.

Table 18 Operational final water quality data: Deepwater Reservoir (2014-2018)

Parameter	ADWG Value	Count	Minimum	Mean	Maximum
Free chlorine (mg/L)	5	27	0.08	2.9	7.8
pH	6.5 - 8.5	15	7.53	7.8	8.1
Turbidity (NTU)	5	26	0	0.30	0.86

3.3.2.3 NSW Health Drinking Water Monitoring Program

Verification monitoring data from the NSW Health Drinking Water Monitoring Program was analysed from January 2012 to March 2018, since the commissioning of the new Deepwater WTP. A summary of the NSW Health Drinking Water Monitoring Program data is available in Table 19. Water quality issues at point-of-supply are described in Table 20.

Table 19 NSW Drinking Water Monitoring Program Data (Deepwater, 2012-2018)

Parameter*	ADWG Value	Count	NC**	Min.	Mean	Max.	Stdev
Aluminium	0.2	18	5	0.01	0.25	1.04	0.35
Antimony	0.003	18	0	0	0	0	0
Arsenic	0.01	18	0	0	0	0.001	0
Barium	2	18	0	0.009	0.015	0.050	0.010
Boron	4	18	0	0	0	0	0
Cadmium	0.002	18	0	0	0	0	0
Calcium	N/A	18	N/A	1.3	2.0	3.4	0.5
Chloride	250	18	0	7	16	24	4
Chromium	0.05	18	0	0	0	0.005	0.001
Copper	2	18	0	0.003	0.013	0.050	0.013
E. coli (mpn/100mL)	<1	149	0	0	0	0	0
Fluoride	1.5	18	0	0.05	0.08	0.16	0.04
Free Chlorine	0.2-5	134	Low:45	0.01	0.62	4.77	0.82
Iodine	N/A	18	N/A	0.01	0.01	0.02	0.00
Iron	0.3	18	0	0.01	0.05	0.15	0.04
Lead	0.01	18	0	0.001	0.001	0.005	0.001
Magnesium	N/A	18	N/A	0.7	1.1	2.2	0.4
Manganese	0.5	18	0	0.003	0.006	0.024	0.005
Mercury	0.001	18	0	0	0	0.0005	0
Molybdenum	0.05	18	0	0.003	0.003	0.005	0.001
Nickel	0.02	18	0	0.005	0.005	0.005	0.000
Nitrate	50	18	0	0	0	0	0
Nitrite	3	18	0	0	0	0	0
pH (unitless)	6.5-8.5	155	1	7.0	7.8	8.7	0.2
Selenium	0.01	18	0	0	0	0	0
Silver	0.1	18	0	0	0	0	0
Sodium	180	18	0	5	26	66	17
Sulfate	250	18	0	1	16	76	23
Total Chlorine	5	93	Low:40	0.01	0.73	4.77	0.96
Total Coliforms (mpn/100mL)	<1	149	6	0	1	201	16
Total Dissolved Solids (TDS)	600	18	0	40	78	170	37
Total Hardness as CaCO3	200	18	0	6	10	18	3
True Colour (HU)	15	18	0	1	3.5	10	3.0
Turbidity (NTU)	5	152	3	0	0.53	18	1.7
Uranium	0.017	1	0	0	0	0	0
Zinc	3	18	0	0.005	0.013	0.030	0.008

*Units in mg/L unless stated otherwise

** NC = non-compliances

Table 20 Deepwater Water Quality Overview

Parameter	Comments
E. coli	From a total of 149 samples, no detections have occurred since the commissioning of the new plant.
Total Coliform	From a total of 149 samples, 6 detections occurred from Jan 2012 to March 2018. The highest total coliform reading of >200 mpn/100mL occurred on 10 Apr 2012, and the most recent detection was in March 2015. Detection of coliforms may represent release from pipe or sediment biofilms, and may be part of the normal flora of the drinking-water distribution system. They can also indicate an increased chlorine demand in the distribution system. The lack of detections since 2015 indicates more effective management of disinfectant within the Deepwater system.
Aluminium	Aluminium was a significant problem in the early period following WTP commissioning, with multiple exceedances occurring. Council commented that since changing the coagulant from an aluminium sulphate to Ultrion there has been no Aluminium exceedances. Exceedances in Aluminium may be an issue for dialysis patients. Council maintains a register of dialysis patients in the Local Government Area to be informed if Aluminium exceeds guidelines.
pH	From a total of 155 samples, only one result >8.5 was recorded (8.7). pH impacts on disinfection effectiveness due to the dissociation of hypochlorous acid to hypochlorite ion as pH increases. At pH 7, approximately 80% of chlorine is present in the effective hypochlorous acid form (strong disinfectant) while at pH 8, this drops to 20%. At pH 9, almost no hypochlorous acid remains. The ADWG recommend keeping pH between 6.5 and 8.5 to minimise corrosion and encrustation of plumbing systems and water reticulation mains. The ADWG also state that pH above 9.5 can cause a bitter taste in drinking water and can cause skin or gastrointestinal irritation in sensitive individuals.
Free Chlorine	From a total of 134 samples, low concentrations of free chlorine have been detected 45 times from Jan 2012 to Mar 2018. The Severn St and Tenterfield St sample sites maintain a free chlorine average of around 0.2mg/L, with the other network sites maintaining an average of 0.3-0.5mg/L. This indicates chlorine decay within the network, given that the residual leaving the reservoir is generally above 1mg/L. Both the ADWG and DoI Water (via Circular 18) recommended that drinking water must reach the consumer with at least 0.2 mg/L of free chlorine to ensure appropriate disinfection.
Turbidity	From a total of 152 sample results collected between 2012 and 2018, the aesthetic guideline of 5 NTU was exceeded 3 times. In relation to health considerations, elevated turbidity can interfere with pathogen disinfection. *E. coli* and total coliform were not detected on the days of turbidity exceedances, indicating that disinfection was effective. Elevated turbidity in distribution systems is often related to disturbance of settled sediments, but potentially could indicate ingress of external contaminants.
Other	All other results were within ADWG aesthetic and health guidelines.

4 RISK MANAGEMENT AND CONTROLS

4.1 Risk Assessment and Preventive Measures

The original DWMS risk assessment was undertaken in October 2013. The workshop was facilitated by HydroScience Consulting and involved participants from Glen Innes Severn Council, NSW Health Water Unit, Local Public Health Unit and DPI Water. A risk review was undertaken in May 2018 with a group of participants from the same agencies, and was facilitated by Bligh Tanner. The risk assessment team involved in the 2018 review is stated in Table 21.

Table 21 2018 Risk Assessment Team

Name	Position	Organisation	Attended days
Winsome Herde	Manager of Technical Services	Glen Innes Severn Council	1 & 2
Keith Appleby	Director of Infrastructure Services	Glen Innes Severn Council	1 & 2
Ian Trow	Environmental Officer	Glen Innes Severn Council	1 & 2
Glenn Wilson	Coordinator of Integrated Water Services	Glen Innes Severn Council	1 & 2
Glenn George	Regional Manager Water & Sewerage (North)	Department of Industry (Water)	1 & 2
Terry Call	Water & Sewerage Inspector	Department of Industry (Water)	1 & 2
Josh Tickell	Senior Project Officer	NSW Health Water Unit	1 & 2
Fidelis Jaravani	Environmental Health Officer	Hunter New England Local Health District PHU	1 & 2
Sean Hinton	Facilitator	Bligh Tanner	1 & 2
Travis Robinson	Facilitator	Bligh Tanner	1 & 2
Winsome Herde	Manager of Technical Services	Glen Innes Severn Council	1 & 2

Council uses the ADWG 2011 (NHMRC, NRMMC, 2011) risk assessment methodology. The definitions are summarised in Table 22 and Table 23 below. The resultant risk matrix is shown in Table 24.

Table 22 Risk assessment methodology - likelihood

Descriptor	Definition
Almost Certain	Expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Possible	Might occur or should occur at some time
Unlikely	Could occur at some time
Rare	May occur in exceptional circumstances

Table 23 Risk assessment methodology - consequence

Descriptor	Definition
Catastrophic	Major impact for a large population, complete failure of systems
Major	Major impact for a small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
Moderate	Minor impact for a large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
Minor	Minor impact for a small population, some manageable operational disruption, some increase in operating costs
Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operational costs

Table 24 Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	**Moderate**	**High**	**Very High**	**Very High**	**Very High**
Likely	**Moderate**	**High**	**High**	**Very High**	**Very High**
Possible	**Low**	**Moderate**	**High**	**Very High**	**Very High**
Unlikely	**Low**	**Low**	**Moderate**	**High**	**Very High**
Rare	**Low**	**Low**	**Moderate**	**High**	**High**

Both maximum and residual risks were assessed within the system.

- Maximum risk: risks that is present without preventive measures and controls.
- Residual risks: risks that is present after implementing the system's preventive measures and controls.
- Preventive measures and controls: are those actions, activities and processes used to prevent the identified hazards or reduce them to acceptable levels?

The risk registers are presented in Appendix B.

The ADWG note that protection of water sources is of paramount importance in reducing risks. Catchments can be protected by limiting access by humans and animals, limiting land uses to non-polluting types that will not contribute to risk and the use of buffer zones. Development controls can be used to ensure that development is appropriate. Planning Instruments such as Local Environmental Plans (LEPs) may be used to help protect catchment integrity, for example inclusion of local provisions which restrict land use within catchments to types that will not pose a risk to water quality. Water catchment areas can be declared under the Local Government Act 1993 section 128 which may provide a layer of protection against land uses that pose risks to water quality.

The Glen Innes and Deepwater drinking water supply systems support a multi-barrier approach for the protection of the drinking water, as promoted by ADWG. The strength of this approach is that a failure in one barrier may be compensated by effective operation of the remaining barriers, minimising the likelihood of contaminants passing through to consumers. The key barriers for Glen Innes are extraction management, coagulation, flocculation, filtration, disinfection, sealed storages and maintenance of chlorine residual. The key barriers for Deepwater are selective raw

water intake, coagulation, flocculation, filtration, disinfection, sealed storages and maintenance of chlorine residual.

4.2 Key barriers

The NSW Department of Industry (Water) issued Circular LWU 18 'Assuring the safety of drinking water supplies', (4 June 2014) with corresponding protocols that are to be implemented by all local water utilities providing a drinking water supply. The Circular is available in Appendix D. Council must meet the minimum requirements in order to achieve the three key barriers outlined below (NSW Department of Industry (Water), 2014):

- Effective disinfection to kill or remove pathogens in the raw water
- Ensure distribution system integrity to prevent contamination
- Maintenance of free chlorine residual in the reticulation system

Council is required to ensure the SOPs meet the minimum requirement for each key barrier as outlined by NSW Department of Industry (Water).

4.2.1 Effective Disinfection

To achieve effective disinfection, NSW Department of Industry (Water) recommends that Council operates the drinking water supply systems to achieve the targets as summarised in Table 25.

Table 25 Monitoring for Effective Disinfection

Parameter	Target	Unit	Notes
Chlorine residual	≥ 0.5	mg/L	Target is prior to first consumer. It is recommended that Council monitors chlorine demand after changes in raw water quality and adjust chlorine dosing as required. It is recommended that free chlorine tests be performed at representative sample points in each drinking water supply system at least once per week.
C.t.	> 15	mg/L/min	C.t. is a measure of free chlorine residual concentration (C) and contact time (t). The C.t. values can be achieved by adjusting chlorine dose or contact time.
pH	< 8.5	pH units	Disinfection effectiveness is compromised at pH above 8.5, with the desirable pH range for disinfection between 7.8 - 8.2
Temperature	> 10	°C	Monitoring is recommended when < 10 °C, as disinfection decreases after this point
Turbidity	< 0.2	NTU	NSW Department of Industry (Water) recommends turbidity target to be as low as practicable, but preferably below 0.2 NTU after filtration and below 1 NTU at the time of disinfection

4.2.2 Distribution System Integrity

Once water is effectively disinfected, the only avenue for pathogens to enter the drinking water supply system is through a breach in the distribution system. It is therefore extremely important for Council to protect the integrity of their drinking water distribution system. Council is required to undertake the actions listed below to maintain the integrity of the distribution system (NSW Department of Industry (Water), 2014).

4.2.3 Free Chlorine in Distribution System

Maintaining chlorine residual is important to protect drinking water from minor contamination due to breaches in system integrity (NSW Department of Industry (Water), 2014). It is recommended by the NSW Department of Industry (Water) and ADWG that free chlorine of ≥ 0.2 mg/L be achieved at all points within the reticulation, and that a sudden large drop in chlorine residual should be an indicator to water operators that contamination may have occurred.

If chlorine residual at dead ends consistently remain below 0.2 mg/L but above 0.05 mg/L and no *E. coli* detections have occurred, Council review system integrity on an annual basis. If free chlorine results are consistently below 0.05 mg/L with no *E. coli* detections, Council must review system integrity on a four-monthly basis in addition to flushing extremities and looping dead ends. Refer to Appendix D for more details.

4.3 Critical Control Points

Critical Control Points (CCPs) are activities, procedures or processes where the operator can apply control, and are essential processes in reducing risks to an acceptable level.

In order to define acceptable from unacceptable performance at each point, target levels, alert levels and critical limits have been identified for Council's drinking water supply systems.

Critical Control Points were identified in consultation with Glen Innes Severn Council, NSW Health and NSW Department of Industry (Water) and documented in Appendix C. Table 27 and Table 28 summarise the CCPs for Glen Innes and Deepwater, respectively.

Three different limits have been set for each CCP within Council's drinking water supply systems:

1. Target Level: Representing day to day operational limits and procedures. This is what the WTP aims to achieve.
2. Alert Level: Deviation from the Alert Limit indicates a trend towards loss of control and corrective actions should be immediately taken to resolve the problem and restore control to the Drinking Water Supply System.
3. Critical Limit: Deviation from the Critical Limit indicates loss of control and the potential of unacceptable health risks. If the critical limit is exceeded, incident and emergency plans should be immediately activated.

In 2018, NSW Health published updated guidance for setting critical limits for CCPs (refer to this link – current as of January 2019). This information was used when reviewed CCP critical limits.

Table 26 NSW Health and DOI Water agreed critical limits (2018)

Hazard	Control	Monitoring characteristic, location	Critical limit
Chlorine sensitive pathogens	Chlorination	Chlorine concentration after contact time (e.g. at outlet of clear water tank)	Minimum free chlorine concentration for C.t (concentration and contact time) of 15 mg.min/L
Naegleria fowleri	Chlorination		Minimum C.t of 30mg.min/L
Chlorine sensitive pathogens	Chlorination	Turbidity at point of chlorination	Turbidity less than 1 NTU
Chlorine resistant pathogens	Filtration	Turbidity at individual filter outlet	Turbidity less than 0.5 NTU
Pathogens from vermin	Integrity of reservoirs	Regular inspection of reservoirs	Evidence of contamination

Table 27 Glen Innes CCPs and Limits

Parameter	Frequency	Target Limit	Operational Procedures	Alert Limit	Corrective Actions	Critical Limits	Corrective Actions
CCP 1 Turbidity (in clear water tank)							
Turbidity (NTU)	Continuous	<0.2	▪ Trained operator onsite when plant operational ▪ Start of day plant checks ▪ Daily visual check of plant and equipment ▪ Constant visual check of clarifier and filter operation ▪ Daily calibration of pH meter ▪ Monitor manually: turbidity, colour, pH in raw water ▪ Monitor: treated water turbidity when plant is operational for at least 1.5 hours ▪ Monitor manually: pH, turbidity in clear water tank ▪ Contractor (ABB) calibrates probes 3-monthly	≥0.2	▪ Check dosing equipment -feeders, clutch, pumps ▪ Check raw water quality - pH, colour, turbidity tests ▪ Check and calibrate pH, turbidity equipment ▪ Investigate clarifier and filter operation ▪ Consider initiating a backwash ▪ Increase monitoring until system reaches target	**>0.5**	▪ Consider plant shut down ▪ Notify supervisor, NSW Health (PHU) ▪ Repeat corrective actions from alert level ▪ Consider using offline reservoir as alternative storage ▪ Increase monitoring until system reaches target

Parameter	Frequency	Target Limit	Operational Procedures	Alert Limit	Corrective Actions	Critical Limits	Corrective Actions
CCP 2 Disinfection (at clear water tank)							
Free chlorine residual (mg/L)	Continuous	1.0	▪ Trained operator onsite when plant operational ▪ Start of day plant checks ▪ Daily visual check of plant and equipment ▪ Monitor daily: chlorine residual, pH and turbidity in reservoir ▪ Adjust chlorine dose based on free chlorine test ▪ Monitor weekly: chlorine residual at one reticulation sample point ▪ Clean chlorine analyser daily ▪ Check chlorine level in tank (scales) and flow ▪ in chlorine room	<0.6	▪ Perform free chlorine test ▪ Adjust chlorine dosing, if necessary ▪ Check dosing equipment ▪ Check turbidity and pH ▪ Consider manually dosing with granular chlorine in reservoir and clear water tanks if chlorine system has failed ▪ Sample free chlorine at supply - if free chlorine is <0.2mg/L, contact NSW Health ▪ Increase monitoring until system reaches target	**<0.4**	▪ Notify supervisor, NSW Health ▪ Immediately collect microbiological sample ▪ Check free chlorine in reservoir and clear water tanks ▪ Repeat corrective actions from alert level ▪ Discuss with NSW Health the possibility of issuing a boiled water alert ▪ Increase monitoring until system reaches target

Parameter	Frequency	Target Limit	Operational Procedures	Alert Limit	Corrective Actions	Critical Limits	Corrective Actions
CCP 3 Integrity of Reservoirs							
System Integrity (Sealed and Secure)	Weekly	No evidence of breach or vermin	▪ Ensure clear water tank hatch is closed ▪ Visual inspection of reservoir for vermin, snakes, possums, birds ▪ Ensure fences, hatches locked ▪ Reservoirs emptied and cleaned every 2 years by Aqualift and integrity report is generated	Visual identification of breach or vermin access to reservoir	▪ Notify supervisor ▪ Breaches to be fixed within one week ▪ Increase monitoring until system conforms	Visual identification of vermin or contaminant in reservoirs	▪ Notify supervisor ▪ Breaches to be fixed within one week ▪ Increase monitoring until system conforms

Table 28 Deepwater CCPs and Limits

Parameter	Frequency	Target Limit	Operational Procedures	Alert Limit	Corrective Actions	Critical Limits	Corrective Actions
CCP 1 Filtered water turbidity							
Turbidity (NTU)	Continuous	<0.2	▪ Start of day plant checks ▪ Visually check floc at plant start-up and continually during operation ▪ Daily visual check of plant and equipment ▪ Daily visual check of all chemical dosing systems ▪ Clean turbidity meter daily prior to operation ▪ Calibrate turbidity meter weekly ▪ Monitor daily: turbidity, colour, pH ▪ Monitor twice a week: chlorine residual at WTP tap and in reservoir ▪ Check level of media in filter - top-up if required ▪ Manually scrape sides of flotation tank during float wash	≥0.5 >30 min	▪ Notify supervisor ▪ Stop delivering water to clear water tank ▪ Circulate water through DAFF plant and adjust dose rates until system reaches target ▪ Consider initiating float and backwash ▪ Increase monitoring until system reaches target	**>0.5**	▪ Notify supervisor, NSW Health ▪ Stop delivering water to clear water tank ▪ Test raw water turbidity. If >250 NTU, stop pumping raw water to plant ▪ Repeat corrective actions from alert level ▪ Increase monitoring until system reaches target

Parameter	Frequency	Target Limit	Operational Procedures	Alert Limit	Corrective Actions	Critical Limits	Corrective Actions
CCP 2 Disinfection (at Reservoir Outlet)							
Free chlorine residual (mg/L)	Daily (when WTP attended)	1.0	▪ Start of day plant checks ▪ Daily visual check of plant and equipment ▪ Daily check of chlorine dosing pumps ▪ Drop test chlorine pumps weekly ▪ Monitor twice a week: chlorine residual at WTP tap and in reservoir	<0.7	▪ Adjust chlorine dose rate ▪ Consider checking chlorine strength ▪ Check chlorine residual at WTP tap ▪ Check raw water quality: pH, turbidity, colour ▪ Consider flushing mains ▪ Check raw water quality ▪ Increase monitoring until system reaches target	**<0.5**	▪ Notify supervisor, NSW Health ▪ Top-up chlorine at reservoir. If required, back-up chlorine available at public pool ▪ Repeat corrective actions from alert level ▪ Discuss with NSW Health the possibility of issuing a boiled water alert ▪ Increase monitoring until system reaches target
CCP 3 Integrity of Deepwater Reservoir							
System Integrity (Sealed and Secure)	Weekly	No evidence of breach or vermin	▪ Ensure tank hatch is closed ▪ Visual inspection of reservoir for vermin, snakes, possums, birds ▪ Ensure fences, hatches locked ▪ Reservoirs emptied and cleaned every 2 years by Aqualift and integrity report is generated	Visual identification of breach or vermin access to reservoir	▪ Notify supervisor ▪ Breaches to be fixed within one week ▪ Increase monitoring until system conforms	Visual identification of vermin or contaminant in reservoirs	▪ Notify supervisor, NSW Health ▪ Immediately perform bacto test ▪ Check free chlorine in reservoir ▪ Repeat corrective actions from alert level ▪ Discuss with NSW Health the possibility of issuing a boiled water alert ▪ Increase monitoring until system reaches target

5 MONITORING OF DRINKING WATER SYSTEMS

The sections below outline the operational and verification monitoring for the GISC drinking water supply systems. Operational monitoring includes the planned sequence of measurements and observations to assess and confirm the performance of preventive measures. Verification monitoring assesses the overall performance of the system and the quality of the drinking water being supplied to the consumer. Council undertakes both operational and verification monitoring in the Glen Innes and Deepwater drinking water supply systems.

5.1 Operational Monitoring

Operational monitoring of water quality is undertaken manually in both the Glen Innes and Deepwater drinking water supply systems. Data is recorded electronically and manually for the Glen Innes system and manually for the Deepwater system.

The operational monitoring regimes for the Glen Innes and Deepwater drinking water supply systems is summarised in Table 29 and Table 30, respectively.

Table 29 Operational Monitoring Program – Glen Innes

Monitoring Point	Parameters	Frequency	Sampling / Recording Method
Raw water (combined)	pH	Daily	Manual sampling / electronic record
	Colour (HU)	Daily	
	Turbidity (NTU)	Daily	
	Blue green algae (visual present/absent)	Daily	Visual assessment / electronic record
Clarified water	pH	Daily	Manual sampling / electronic record
	Colour (HU)	Daily	
	Turbidity (NTU)	Daily	
Filtered water	pH	Daily	Manual sampling / electronic record
	Colour (HU)	Daily	
	Turbidity (NTU)	Daily	
	Iron (mg/L)	1-2 x weekly	
	Manganese (mg/L)	1-2 x weekly	
	Aluminium (mg/L)	1-2 x weekly	
Final water (Clear water tank)	Free chlorine (mg/L)	Daily	Manual sampling / electronic record
	pH	Daily	
Blue Hills Reservoir	Free chlorine (mg/L)	Weekly	Manual sampling / electronic record

Table 30 Operational Monitoring Program – Deepwater

Monitoring Point	Parameters	Frequency	Sampling / Recording Method
Raw water	pH	Daily (when WTP attended)	Manual sampling / electronic record
	Colour (HU)		
	Turbidity (NTU)		
Clarified water	pH	Daily (when WTP attended)	Manual sampling / electronic record
	Colour (HU)		
	Turbidity (NTU)		
Filtered water	pH	Daily (when WTP attended)	Manual sampling / electronic record
	Colour (HU)		
	Turbidity (NTU)		
	Iron (mg/L)	As required	Manual sampling / paper record
	Manganese (mg/L)	As required	
	Aluminium (mg/L)	As required	
Deepwater Reservoir	Free chlorine (mg/L)	Daily (when WTP attended)	Manual sampling / electronic record
	Turbidity (NTU)		
	pH		

5.2 Verification of Drinking Water Management

The verification of drinking water quality supplied to the consumer assesses the overall performance of the system. Verification provides an important link back to the operation of the water supply system and additional assurance that the preventive measures and treatment barriers have worked and are supplying safe quality water.

Glen Innes Severn Council monitors water quality at the point of supply as part of the NSW Health Drinking Water Monitoring Program which provides ongoing independent verification of the treatment process. Frequency of sampling is based on population. The Program assesses 36 parameters for microbial, physical and chemical properties of the water as detailed in Table 31. The results can be accessed at www.drinkingwaterdb.nsw.gov.au.

Table 32 lists the sampling sites for verification monitoring, including six sites in the Glen Innes reticulation system and seven sites in the Deepwater reticulation system.

Council's Environmental Health Unit is responsible for the collection of samples for the NSW Health Drinking Water Monitoring Program. Samples are submitted in accordance with the "Guide for Submitting Water Samples to FASS for Analysis" (Sydney West Area Health Service, 2010) and the Council water procedures for samples

Table 31 NSW Health Drinking Water Monitoring Program Analytes

Parameters		
Microbial		
E. coli	Total coliforms	
Disinfection		
Free chlorine	Total chlorine	
Physical		
pH	Total Dissolved Solids	Turbidity
True Colour	Total Hardness	
Chemical (metals)		
Aluminium	Copper	Molybdenum
Antimony	Cyanide	Nickel
Arsenic	Fluoride	Nitrate
Barium	Iodine	Nitrite
Boron	Iron	Selenium
Cadmium	Lead	Silver
Calcium	Magnesium	Sodium
Chloride	Manganese	Sulphate
Chromium	Mercury	Zinc

Table 32 NSW Health Drinking Water Monitoring Program Sites

NSW Health Drinking Water Monitoring Program Sites			
Glen Innes			
4	Chandler Rd (off Blue Hills Rd)	9	187 West Ave – After school care
7	136 Church St – Council offices	10	85 Taylor St – District Hospital
8	12 Coronation Ave – Council depot	998	Undefined
Deepwater			
101	Apex Park	105	50 Tenterfield Street
102	18 Severn	106	WTP – Carl Beer Circuit
103	55 Gough Street	998	Undefined
104	31 Ward Street		

5.3 Consumer Satisfaction

Glen Innes Severn Council details targeted levels of service in the Water Strategic Business Plan (GISC, 2012f), as summarised in Table 33. Council has a Complaints Policy (Resolution Number: 8.08/12) (2012b) for complaints submitted by the community. Complaints can be lodged in person, by telephone, facsimile, email or letter. Council's Public Officer is charged with recording

the number and type of complaints received within Council's Complaints Register. All water-related complaints are recorded in Council's customer management software and allocated to the Manager Integrated Water and Sustainability Services. If the complaint cannot be resolved immediately, Council aims to respond to the complaint within 10 to 14 days, if an external agency is not required to review the complaint. If the complaint is not actioned within 10 to 14 days, the complaint is automatically escalated to senior management.

Table 33 Levels of Service for Water Operations

Levels of Service	
Availability of Supply	
Pressure	Pressure of between 12 - 90 m head in reticulation with a minimum of 6 L/min flow in residential connections under normal conditions.
Consumption restrictions during drought	Restrictions should be imposed for no more than 5% of the time and not more than once every 10 years. Council should be able to supply 80% of demand under conditions of the worst drought on record.
Peak day demand	Peak day demand of 3 kL per occupied residential tenement
Interruptions of supply	Planned: domestic customers receive 48 hours' notice and industrial customers receive 7 days' notice. Unplanned: not to occur over 3 times per year per customer, and not to last for greater than 12 hours
Water Quality	
Water quality	Water supplied should meet ADWG
Response Times to Customer Complaints of Supply Failure	
Response times to customer complaints of supply failure	Priority 1 – water main break (discharging large quantity of water) ▪ During normal working hours – 1 hour ▪ After hours – 2 hours Priority 2 – water service break (affecting single customer): ▪ During normal working hours – 2 hours ▪ After hours –2 hours Priority 3 – Slow leak in water service or water main: ▪ Two working days
Customer Complaints and General Inquiries	
Customer complaints and general inquiries	Respond to 95% of written complaints or inquiries within 10 days.

5.4 Short Term Evaluation of Results and Corrective Action

Council evaluates water quality data on receipt of monitoring results. Water quality results from the NSW Health Drinking Water Monitoring Program are reported to Council's Manager Integrated Water and Sustainability Services and delegated to the Coordinator Integrated Water Services or on call operator when the Manager is absent.

Any exceedances are recorded and acted upon immediately with the appropriate regulatory authorities notified. All test results are recorded in the NSW Health Drinking Water Database which is completely independent of Glen Innes Severn Council. The NSW Health Drinking Water Monitoring Program provides the following response protocols, accessible to Council:

- Managing pathogen risks in drinking water: Response protocol for water utilities and public health units (March 2018)
- NSW Health Response Protocol: for the management of physical and chemical quality (September 2015)
- NSW Code of Practice for Fluoridation of Public Water Supplies (April 2018)

E. coli exceedances require immediate re-testing (using the “Form for urgent sample submission to FASS”) as stipulated in the NSW Health response protocol for the management of microbiological quality of drinking water. Council should immediately discuss any *E. coli* exceedances with NSW Health, which may result in a boil water alert. This protocol also includes actions in response to failure of treatment, disinfection or poor or rapidly changing source water quality.

6 OPERATIONAL PROCEDURES AND PROCESS CONTROL

6.1 Operational Procedures

As part of the development of the DWMS, key operating procedures and corrective actions were established for each Critical Control Point (CCP) within the Glen Innes and Deepwater drinking water supply systems. These included operational procedures required to achieve the target levels and corrective actions in the event that alert or critical limits are reached.

The CCPs for each system are:

- Glen Innes - turbidity in clear water tanks; disinfection at clear water tank; and integrity of reservoirs
- Deepwater – turbidity in filtered water; disinfection at reservoir outlet; and integrity of reservoir

The operational procedures and corrective actions for the Glen Innes and Deepwater CCPs are available in Table 27 and Table 28, respectively. CCP wall charts can be found in Appendix C. Additional Standard Operating Procedures (SOPs) have been developed for key processes and are attached in Appendix E.

Council has hard copies of the Operations and Maintenance (O&M) manuals for both Glen Innes and Deepwater WTPs, located at their respective treatment plants and in the Council office, however as identified in the 2018 risk review, these require update.

6.2 Equipment Capability and Maintenance

Council's objective is to ensure all equipment purchased performs adequately and provides sufficient flexibility and process control.

Council maintains a water supply asset register which records the age, type, location and material of the water supply assets managed by Council including treatment plants, reservoirs and pipelines. Council has a Water Asset Management Plan (2011b) that covers reticulation mains, weirs, pump stations, rising mains and groundwater bores. The Asset Management Plan guides Council on the routine and emergency maintenance, as well as developing a renewal and replacement plan for water infrastructure assets. Currently, no ranking or priority has been given to assets in the renewal program. It is recommended that Council develop a planned renewal and replacement program with prioritised assets to ensure equipment is maintained in a state that is able to deliver Council's required levels of service.

6.3 Materials and Chemicals

Council's objective is to ensure all equipment purchased performs adequately and provides sufficient flexibility and process control. According to the Asset Management Plan (2011b), all work is carried out in accordance with AS/NZS 3500, AUS-SPEC0071 Water Supply – Reticulation and Pump Stations (Design) (NATSPEC) and Australian Standards in the purchasing of materials.

The use, including transport and storage, of chemicals listed as "Dangerous Goods" under the Work Health and Safety Regulation 2012 (NSW) (WH&S Regulation), including chlorine and fluoride, is dictated by the provisions of the WH&S Regulation and Work Cover. Storages and trucks are licensed according to the WH&S Regulation.

Council purchases water treatment chemicals through reputable suppliers i.e. Omega Chemicals, Orica Australia, Redox.

NSW Health recommends that all chemical deliveries are attended by a trained water treatment plant operator, and that the following procedures are followed:

- A certificate of analysis is provided by the supplier at the time of delivery for each batch of chemical supplied and that the chemical satisfies the criteria specified in Chapter 8 of the ADWG, prior to the commencement of unloading
- The operator is to check and confirm the correct chemical is being delivered into the appropriate storage
- If relevant, the operator is to check that the correct concentration has been supplied

Chemical suppliers are chosen based solely on demonstrated quality and service delivery over an extended period of time. If a supplier is known to offer acceptable quality and service lower priced options are not considered.

Material Safety Data Sheets (MSDS) and appropriate chemical signs are displayed in a MSDS register at the WTP and within the vicinity of chemical storage areas. Personal Protective Equipment (PPE), first aid kits, chemical spills kits, safety showers and eye wash stations are located at the Glen Innes and Deepwater WTPs in the event of an emergency.

Chemicals used in the supply of drinking water at Glen Innes and Deepwater are listed in Table 34 and Table 35.

Table 34 List of Chemicals used in Glen Innes Drinking Water Supply System

Chemical	Purpose	Dosing Concentration
Aluminium sulphate (alum)	Coagulation	20 – 150 mg/L
Polymer	Coagulation	2 mg/L
Chlorine gas	Disinfection	5 – 6 mg/L
Soda ash	pH adjustment	10 – 70 mg/L

Table 35 List of Chemicals used in Deepwater Drinking Water Supply System

Chemical	Purpose	Dosing Concentration
Soda ash	Post-dose pH	10 mg/L
Ultrion 44560	Coagulation	5 – 35 mg/L
Sodium hypochlorite	Disinfection	5 mg/L

7 MANAGEMENT OF INCIDENTS AND EMERGENCIES

7.1 Communication

NSW Health's response protocols and the NSW Code of Practice for Fluoridation of Public Water Supplies include communication protocols for water quality incidents. Council will ensure these protocols are followed in the case of emergencies and/or incidents.

Council's primary contact for water quality incidents is the on-call water operator on 0418 162 794. The secondary contact is the Manager of Integrated Water and Sustainability Services on 0408 144 251.

Council also maintains a contact list for emergencies, reviewed every 3 months.

Council rely on NSW Health Response Protocols in the event of a water quality incident.

7.2 Incident and Emergency Response Protocols

Council responds to water quality incidents according to the following NSW Response Protocols:

- Managing pathogen risks in drinking water: Response protocol for water utilities and public health units (March 2018)
- NSW Health Response Protocol: for the management of physical and chemical quality (September 2015)
- NSW Code of Practice for Fluoridation of Public Water Supplies (April 2018)

E. coli detections require immediate re-testing as stipulated in the NSW Health response protocol: for the management of microbiological quality of drinking water. Council should immediately discuss any *E. coli* exceedances with NSW Health to determine appropriate public health response, including the need to issue a boil water alert.

For physical and chemical exceedances, Council follows the NSW Health Response Protocol: for the management of physical and chemical quality.

The Peel District Emergency Management Committee has developed a local disaster plan (Displan) in accordance with the State Emergency and Rescue Management Act (NSW) 1989. The latest revision was updated in September 2006. The Peel District Displan details the arrangements for the prevention of, preparation for, response to and recovery from emergencies within the Shire area. In relation to drinking water quality emergencies, the Displan identifies the roles of key responsible agencies in the events described in Table 36.

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Table 36 Roles and Responsibilities of Agencies in Drinking Water Quality Emergencies

Hazardous Event	Responsible Agency	Responsibility
Bush, grass or rural fires	Glen Innes Severn Council	Require landowners to clear firebreaks and remove fire hazards Regulate burning off Regulate property development and building construction through LEPs and DSPs
	Bush Fire Management Committees and Regional Fire Associations	Coordinate bush fire fuel management strategies
	Rural Fire Services NSW Fire Brigades National Parks and Wildlife Service State Forests of NSW State Water Corporation	Implement bush fire fuel management programs
Contamination of water supply/ waterways	Glen Innes Severn Council Hunter New England Health – Public Health Unit NSW Office of Environment and Heritage State Water Corporation	Monitor water supply at water treatment plants Erect warning signs at sites of contamination water e.g. lagoons Surveillance of waterways through testing of water samples
Flood - Riverine	Glen Innes Severn Council	Regulate property development and building construction through LEPs and DSPs
	Department of Finance and Services	Development and maintenance of flood mitigation works Preparation of floodplain management plans
	Department of Primary Industries	Preparation of mitigation schemes and floodplain management plans
Flood – Dam failure	Dam owners	Updating safety standards
	State Water Corporation Glen Innes Severn Council	Advising SES re the need to develop dam failure plans Provide information to be included in SES Flood Plans

(Peel District Emergency Committee Management Committee, 2006)

In the event of an emergency incident for drinking water quality described in the Local Emergency Management Plan, media liaison, including the coordination of media briefings and liaisons will be the responsibility of the Local Emergency Management Officer (LEMO).

8 SUPPORTING REQUIREMENTS

8.1 Employee Awareness and Training

Council is an equal opportunity employer and recruits based on the policies outlined in their Equal Employment Opportunity Management Plan (Resolution 7.12/12) (GISC, 2012d). Their Aboriginal Employment Strategy (Resolution Number 20.09/13) (GISC, 2013a) extends their commitment to increasing the number of Aboriginal and Torres Strait Islander people.

Glen Innes Severn Shire Council recognises that its success is largely due to the effective contribution of its staff. Their Human Resources Policy Statement Register (Resolution Number: 9.12/12) (GISC, 2012e) details a framework to ensure an appropriate work climate to maximise staff effectiveness and productive relationships throughout the Council. It details the following:

- Recruitment, induction and transfers
- Conditions of employment
- Remuneration and benefits
- Employee development, including Training and Development and Study Incentives policies
- Employee separation
- Leave
- Health and safety
- Employee relations
- Code of conduct

WTP operators currently undertake NSW Department of Industry (Water) “Water Treatment Operator Courses” and will transfer to the “National Certification for Operators of Drinking Water Treatment Facilities” as appropriate. Specialist training and certification, including fluoridation and chemical dosing is regularly refreshed, as required. Training requirements are identified each year through the annual performance review of each employee by their direct supervisor. Training requirements for each employee are then factored into Council’s budget for the proceeding financial year.

8.2 Community Involvement and Awareness

Council addresses the communication and consultation needs of residents through their Community Engagement Strategy (2012), which includes details for the levels and methods of community engagement and the appropriate stakeholders. The Community Strategic Plan (GISC, 2011a) was developed through community surveys and engagement surveys. Council’s response to issues raised by the community is the following actions:

- Securing a long-term water supply for Glen Innes
- Finalise the water supply upgrades at Deepwater
- Review storm water drainage
- Look at total water and waste reticulation management

8.2.1 Council’s Ordinary Meetings

Ordinary meetings of Glen Innes Severn Shire Council are normally held on the fourth Thursday of the month, commencing at 5.15 pm and are open to the public. Upon request, members of the public can also present to Council on issues of concern. The minutes of Council meetings are available on the Council website.

8.2.2 Council's Website

GISC's website has a page committed to "Water Services", which provides information on:

- Glen Innes and Deepwater water supply systems
- Drought Management Plan
- Using water wisely
- Integrated Water Management Strategy
- Water Restrictions
- Asset Management Plan

No additional information is available on the website regarding current water quality in the Glen Innes and Deepwater drinking water supply systems. It is recommended that Council provides water quality monitoring data on the website as recommended by the ADWG.

8.3 Research and Development

8.3.1 Investigative Studies and Research Monitoring

The following items have been identified as requiring investigative research projects:

- Investigate optimisation of clarifier performance at Glen Innes WTP
- Undertake a research projects to ensure chlorine residual is maintained in Glen Innes distribution system. This may require Council considering treatment for removing manganese from the raw water
- Investigate options to keep chemical dosing systems online at Deepwater in the event of a power failure
- Investigate cause for high and variable chlorine consumption in Deepwater reservoir - possible partnership with NSW Health to monitor Dissolved Organic Carbon (DOC)

8.3.2 Validation of Processes and Equipment

Validation requires the evaluation of system processes and equipment to prove the performance under all conditions expected to be encountered during operations. Validation should be undertaken on new processes and equipment, when upgrades occur and on a regular basis to ensure continual performance.

Validation should be undertaken when there is a:

- Change in raw water quality
- Modification to the water treatment processes
- Change to the delivery, storage and distribution systems of treated and untreated water
- Change in the use of treated water
- Change in water quality standards
- New research or understanding of water quality issues
- Receipt of information that indicates a health risk associated with the quality of the drinking water

Validation of new or upgraded processes and equipment is undertaken by qualified, experienced engineers and operators through:

- System design according to industry guidelines and standards

- Individual process and equipment specification against CCP target limits
- Procurement of equipment/chemicals from approved suppliers
- Market pre-validation by suppliers, particularly associated with water treatment chemicals

Ongoing validation processes to ensure safe and acceptable drinking water is supplied to the customer are:

- Review of scientific literature on treatment processes and industry best practice
- Evaluation of the effectiveness of CCPs in eliminating or controlling risks
- Assessment of research and development work to ensure CCP limits remain appropriate

8.3.2.1 Primary Disinfection Contact Time

In treated water, a combined available residual chlorine level of 0.5 mg/L after a contact time of 30 minutes is considered sufficient to ensure microbial control, given a clean distribution system and no significant recontamination. C.t is a measure of free chlorine residual concentration (C) and contact time (t). A primary disinfection contact time greater than 15 mg.min/L is required to be consistent with ADWG requirements of 30 mins contact time at 0.5 mg/L.

The two drinking water supplies operated by GISC have adequate chlorine contact time for microbial removal. The C.t for each drinking water supply has been calculated as follows:

Glen Innes Drinking Water Supply

Total C.t. has been calculated using the three Clearwater tanks at the Glen Innes WTP (which are balanced, and operate essentially as one large tank). No consumers extract prior to the point of calculation.

- Clear water reservoir volume: 6.4ML (sum of individual tanks - 3.32ML, 1.53ML, 1.53ML)
- Minimum reservoir level: 18.5%
- Baffle factor: 0.3 (angled inlet to direct inflow away from outlet, both on bottom of tank)
- Peak flow rate out of reservoirs: 71L/sec
- CCP Low Limit: 0.4mg/L
- Minimum C.t: 33.35mg.min/L

Deepwater Drinking Water Supply

Total Ct has been calculated using the treated water reservoir. The flow rate used in the calculation could not be provided, and so has been assumed based on known daily water demands and typical peaking factors for small reticulation systems.

- Reservoir volume: 0.5ML
- Minimum reservoir level: ~80%
- Baffle factor: 0.1 (inlet and outlet at tank bottom, approx. 60° from one another)
- Peak flow rate out of reservoir: 10L/sec (assumed figure based on population size, average water consumption, and typical peaking factors)
- CCP Low Limit: 0.5mg/L
- Minimum C.t: 35mg.min/L

8.4 Documentation and Reporting

8.4.1 Management of Documentation and Records

Council maintains an online central register for all Council documents, which records the version number and adoption date for each document, policy and procedure. The DWMS will be integrated into Council's existing document management system. The DWMS documents information pertinent to all aspects of drinking water quality management for the Glen Innes and Deepwater drinking water supply systems. The DWMS is a living document and should be maintained in-line with actual operations and management. Any changes to the drinking water supply systems should be updated and documented within this DWMS.

8.4.2 Reporting

Daily water quality monitoring results are recorded on log sheets at the water treatment plant, and transferred to an electronic file (spreadsheet) on a monthly basis, with monthly reporting to Council.

Council undertakes reporting as required by NSW Health and NSW Department of Industry (Water). In line with Council's responsibilities the following reports are produced:

- Council Annual Report: available electronically on Council's website
- NSW Health compliance reporting for drinking water quality monitoring: drinking water quality within the Glen Innes Severn is monitored and the results are recorded in the NSW Health Drinking Water Database. Water quality reports can be produced from the database, which is located at the following web page: http://www.drinkingwaterdb.nsw.gov.au
- Water Supply and Sewerage NSW Performance Reporting: Council's water supply service performance is detailed in the NSW Water Supply and Sewerage Performance Monitoring Report annually. This report is available for public access from the NSW Department of Industry (Water)
- Strategic Business Plan for Glen Innes Water Supply
- Water Asset Management Plan
- Integrated Water Cycle Management Plan

9 REVIEW AND AUDIT

9.1 Evaluation and Audit

Water quality results at Glen Innes and Deepwater WTP are recorded daily in log books located at the respective plants. A limited number of water quality parameters are recorded electronically, as described in Table 29 and Table 30. The electronic data is located on Council's intranet.

The DWMS will be internally audited by the Manager Integrated Water and Sustainability Services, Risk Manager and Director Development Regulatory and Sustainability Services annually in conjunction with the NSW Benchmark reporting. The review will assess Council's performance in relation to:

- CCPs and their exceedances
- Improvement Plan
- Record keeping
- NSW Performance Monitoring

An external audit of the DWMS will be undertaken in future as directed by NSW Health. The external audit of the DWMS will be carried out by an independent auditor approved by NSW Health.

NSW Department of Industry (Water) Inspector carries out external assessment of the WTP on quarterly basis. NSW Department of Industry (Water) and the NSW Health Public Health Unit may check key elements of the DWMS such as whether CCPs are implemented correctly and whether the improvement plan is being implemented. The NSW Health Regulation allows NSW Health to review a DWMS at any time.

9.2 Review by Senior Management

As part of the requirements of Council's reporting procedures, as detailed above, the Manager of Technical Services, Risk Manager and Director Development Regulatory and Sustainability Services will review the effectiveness of the management system and the underlying policies. This review will be undertaken annually and will focus on reviewing of effectiveness and implementation of the DWMS.

A complete review of the DWMS will take place every four years in line with the review of the Strategic Business Plan.

10 DRINKING WATER QUALITY MANAGEMENT IMPROVEMENT PLAN

Improvement actions for the Glen Innes Severn Council water supplies are listed in Table 37. Priorities have been determined based on the risks as identified through the workshop process.

The Council's Manager of Technical Services is responsible for the Improvement. The Improvement Plan is used by the Council to monitor the implementation of the drinking water management system. The Improvement Plan is subject to an annual review by the Integrated Water Services Section as a team activity.

Table 37 Improvement Plan

Priority	No.	Action	Timeframe
Glen Innes Scheme			
Very High	1	Commence turbidity sampling after individual filters (grab-samples initially).	30/06/2019
	2	Install continuous turbidity monitoring after individual filters	30/06/2020
	3	Review options for filter media replacement and/or inspection by qualified contractors	30/06/2020
	4	Review filter turbidity SCADA trends and current turbidity alarm (from 4 NTU to ideally below 0.5 NTU)	30/06/2020
	5	Filter walls to be relined	30/06/2020
	6	Review CCP after turbidity analysers installed	30/06/2020
	7	Council and NSW Health to review reinstatement of fluoride dosing	30/06/2019
	8	Grout and reline clear water tanks	30/06/2019
	9	Seal and bird-proof tanks/reservoir to prevent access by vermin	30/06/2019
	10	Contractor to clean and inspect reservoir; request contractor advises appropriate inspection frequency based on condition	30/06/2019
	11	Confirm backflow prevention is present at hospital, pump stations and dump points	30/06/2019
High	12	Discuss with NSW Health testing of toxin from BGA in treated water when trigger level reached	30/06/2019
	13	Initiate 5 yearly radiological analysis (Red Range bores raw water)	30/06/2019
	14	Initiate 12 monthly sampling of bore water for microbiological indicators and standard water analysis	30/06/2019
	15	Configure HMI alarms to send SMS alerts/alarms	30/06/2019
	16	Examine possibility of auto-shutoff of alum dosing at low pH in clarifier water	30/06/2019
	17	Consider implementing automatic plant shutdown if pH in clarifier is out of desired range	30/06/2019
	18	Investigate automation of acid dosing	30/06/2019

Priority	No.	Action	Timeframe
	19	Consider whether additional controls can be implemented on supernatant return	30/06/2020
	20	Consider installing roof on backwash recovery tank	30/06/2020
	21	Review clarifier outlet current setpoint of 30NTU	30/06/2019
	22	Repair remaining baffles within clarifier (eastern side)	30/06/2021
	23	Reline western portion of clarifier	30/06/2021
	24	Consider best method to analyse turbidity at chlorine dosing point (i.e. potential impact from soda ash).	30/06/2019
	25	Review chlorine sampling point(s).	30/06/2019
	26	Apply conditional formatting to chlorine cylinder weight spreadsheet to flag when reordering required	30/06/2019
	27	Council to install automatic plant shutdown when chlorine dosing fails.	30/06/2020
	28	Investigate methods to flash and mesh all clear water tank openings	30/06/2019
	29	Blue Hills Reservoir - investigate inlet pipe reconfiguration options to prevents short circuiting, and/or reservoir mixing options.	30/06/2019
Low	30	Investigate automatic shutdown of raw water pumps when power failure occurs at WTP	30/06/2019
Deepwater scheme			
Very High	31	Investigate sewage pump station integrity (SPS upstream of drinking water intake)	30/06/2019
	32	Consider establishing connectivity of sewer pump station high level alarms to SMS/SCADA	30/06/2020
	33	Consider program for full remote SCADA visibility and alarming of water and sewage. Liaise with NSW DOI regarding opportunities under Safe and Secure funding	30/06/2021
	34	Consider increasing minimum height of water in clear water tank to allow for increased WTP shutdown time in emergencies	30/06/2019
	35	Consider programming automatic plant shutdown on filtration failure	30/06/2020
	36	Consider installing online pH and chlorine monitoring after disinfection (and chlorine monitoring after reservoir)	30/06/2019
	37	Consider diluting chlorine to 6% instead of using 12%, and wasting old chlorine to sludge lagoon	30/06/2020
High	38	Consider a pressurised system to allow full reservoir capacity to be utilised.	30/06/2020
	39	Structural inspection of weir	30/06/2021
	40	Obtain standby pump for polymer dosing	30/06/2019
	41	Confirm if spare soda ash pump can be used for poly dosing	30/06/2019

Priority	No.	Action	Timeframe
	42	Consider turbidity analyser on raw water input, with setpoints determined to enable optimisation of control.	30/06/2020
	43	Investigate potential for obtaining spare components (DAFF / blower / air saturator)	30/06/2019
	44	Organise for external contractor to complete internal inspection & clean of Clear Water Storage	30/06/2019
	45	Contact NSW Health to examine TOC/DOC and for DBP (treated water)	30/06/2019
	46	Consider safe and secure funding for Deepwater reservoir relining and operational optimisation.	30/06/2019
	47	Investigate options for optimum inlet pipework (Deepwater Res)	30/06/2019
	48	Examine integrity of access hatches (Deepwater Res)	30/06/2019
	49	Commence sampling for total as well as free chlorine	30/06/2019
Moderate	50	Undertake excavation of silt build-up at weir	30/06/2019
	51	Review asset replacement program and ensure the priority given to Deepwater is appropriate	30/06/2020
Documentation / Training / Whole-of-System			
Very High	52	Undertake urgent filtration performance improvement investigations (both WTPs), and provide a summary of outcomes of investigations to NSW Health. Aim to implement filtration CCP critical limits of 0.5NTU as soon as this can be operationally achieved.	30/04/2019
	53	Develop SOPs for: ▪ formalised reservoir (external) inspection ▪ filtration (incl backwash) ▪ chlorine disinfection instrument calibration & maintenance	30/06/2019
	54	Prepare and adopt a backflow prevention policy	30/06/2019
	55	Undertake targeted water meter replacement programs	30/06/2020
	56	Consider review of backwash triggers (time, turbidity, pressure) at both WTPs	30/06/2019
	57	Review current CCPs and alarm set-points	30/06/2019
High	58	Discuss review of OSSMS with GISC Manager Regulatory Management Services	30/06/2019

Priority	No.	Action	Timeframe
	59	Develop SOPs for: ▪ removal of dead animals from Weirs ▪ alum dosing ▪ start of day plant checks ▪ mains flushing and mains break repairs ▪ incident response to suspected contamination ▪ Deepwater raw water abstraction (<20NTU, <300HU) ▪ WTP management during/after power failure ▪ Verification monitoring & communication ▪ Return to Beardy Weir supply ▪ All other treatment plant operations (including existing informal SOPs	30/06/2019
	60	Council to maintain algae identification skills among operators (particularly for new operators); Investigate opportunities to undertake further algae identification training	30/06/2019
	61	Develop (or update) O&M manual for WTP including routine maintenance tasks	30/06/2020
	62	Calculate and validate chlorine C.t. values (through individual tanks, and in conjunction with pH data)	30/06/2019
	63	Review operational monitoring process, for example regular manager review of operational datasheets	30/06/2019
	64	Increase chlorine residual monitoring in reticulation system	30/06/2020
	65	Continue with ring main program. Continue with replacement of cast iron fittings of network.	30/06/2020
	66	Ensure all operators training is up-to-date.	30/06/2019
	67	Provide notices on internet notifying of dump point locations (Deepwater)	30/06/2019
	68	Develop emergency water carting plan for Deepwater (guidance from DOI templates)	30/06/2019
	69	Develop framework to develop on-boarding of staff.	30/06/2020
	70	Competency assessment of staff against SOP's	30/06/2020
	71	Undertake a Secure Yield Analysis as part of IWCM process	30/06/2020
Moderate	72	Ensure fluoride dosing O&M manual developed and provided at commissioning; Develop SOPs as required	30/06/2019

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APPENDIX A
DRINKING WATER QUALITY POLICY

GLEN INNES SEVERN COUNCIL
Drinking Water Quality Policy

RESOLUTION NUMBER:	***25.06/12***	***MEETING:***	***28 June 2012***

INTRODUCTION

The NSW Public Health Act 2010 introduces new and more stringent requirements for Local Water Utilities in the provision of drinking water to the public. The associated regulations (still in draft form) require utilities to undertake their activities using the risk based approach outlined in the Australian Drinking Water Guidelines. This policy describes the local interpretation of those guidelines to the Glen Innes and Deepwater drinking water systems, and also outlines Council's responsibility to manage private water suppliers as defined under the act.

AIMS OF POLICY

The aim of this policy is to ensure that all reticulated drinking water supplied within the Glen Innes Severn local government area is supplied according to the framework described in the Australian Drinking Water Guidelines, and meets the quality parameters stated in those guidelines.

POLICY STATEMENT

Glen Innes Severn Council is committed to managing its water supply effectively to provide a safe, high-quality drinking water that consistently meets the NHMRC/NRMMC *Australian Drinking Water Guidelines*, and consumer and other regulatory requirements.
To achieve this, in partnerships with stakeholders and relevant agencies, Council will:
• manage water quality at critical control points along the delivery chain from source water to the consumer;
• use a risk-based approach in which potential threats to water quality are identified and managed;
• establish regular monitoring of the quality of drinking water and apply effective reporting mechanisms to provide relevant and timely information, promoting confidence in the water supply and its management;
• develop appropriate contingency planning and incident response capability;
• continually improve our practices by assessing performance against ADWG guidelines.

Council will implement and maintain a drinking water quality management system consistent with the 12 elements contained within the *Australian Drinking Water Guidelines* to manage effectively the risks to drinking water quality.

All managers and employees involved in the supply of drinking water are responsible for understanding, implementing, maintaining and continuously improving the drinking water quality management system.

APPLICABILITY

The policy shall apply to all reticulated drinking water supplied within the Glen Innes Severn Local Government Area from 1/7/2012.

VARIATION AND REVIEW

The policy shall be reviewed at intervals not exceeding two years. The associated plan shall be reviewed annually or at such times as changes in legislation dictate.

.....
General Manager

5-7-2012
Date

Reference Number:	Version Number: 1 Date: 28/6/12	Review Date: June 2014	Responsible Officer: MIWSS
Related Documents:			

APPENDIX B
DRINKING WATER RISK ASSESSMENTS

Glen Innes Severn Council DWMS Risk Assessment Attendance Sheet

28th 29th May 2018

Name	Position	Organisation	Days
Winsome Herde	Manager of Technical Services	Glen Innes Severn Council	1 & 2
Keith Appleby	Director of Infrastructure Services	Glen Innes Severn Council	1 & 2
Ian Trow	Environmental Officer	Glen Innes Severn Council	1 & 2
Glenn Wilson	Coordinator of Integrated Water Services	Glen Innes Severn Council	1 & 2
Glenn George	Regional Manager Water & Sewerage (North)	Department of Industry (Water)	1 & 2
Terry Call	Water & Sewerage Inspector	Department of Industry (Water)	1 & 2
Josh Tickell	Senior Project Officer	NSW Health Water Unit	1 & 2
Fidelis Jaravani	Environmental Health Officer	Hunter New England Local Health District Public Health Unit	1 & 2
Sean Hinton	Facilitator	Bligh Tanner	1 & 2
Travis Robinson	Facilitator	Bligh Tanner	1 & 2

Unmitigated Hazard Assessment

Hazard	Type of Hazard	Sources of Hazard	Unmitigated Risk			Comments
			Consequence	Likelihood	Risk	
Algal toxins	Chemical	Algal blooms in source waters	Catastrophic	Likely	Very High	Relevant to Glen Innes only
Aluminium	Chemical	Coagulant overdose, resuspension of accumulated sediments	Moderate	Possible	High	
Bacteria/ Virus (Source Water)	Biological	Agricultural activities, on-site sewage systems	Catastrophic	Almost Certain	Very High	
Bacteria/ Virus (Bore Water)	Biological	Agricultural activities, on-site sewage systems	Major	Rare	High	
Bacteria/ Virus (Reticulation)	Biological	Faecal ingress into water mains or reservoirs (e.g. breaks, depressurisation)	Major	Unlikely	High	
Chlorate	Chemical	Sodium hypochlorite breakdown	Moderate	Possible	High	
Chlorine	Chemical	Chemical overdose	Moderate	Unlikely	Moderate	Risk score considers reputational risk
Colour	Physical	Source water, corrosion, biofilm / sediment disturbance	Moderate	Possible	High	
Disinfection byproducts	Chemical	Elevated organics and long detention times	Moderate	Likely	High	
Fluoride	Chemical	Naturally occurring, fluoride dosing	Moderate	Possible	High	Fluoride dosing is being considered for reinstatement at GISC water treatment plants, risk score also considers reputational risk
Fluoride (not dosing)	Chemical	Not dosing fluoride	Moderate	Almost Certain	Very High	Based on evidence of fluoride efficacy at reducing incidence of dental caries
Heavy metals	Chemical	Catchment activities (e.g. mining) asset corrosion, leaching from plumbing	Moderate	Unlikely	Moderate	
Iron	Chemical	Naturally occuring, asset corrosion	Moderate	Almost Certain	Very High	
Manganese	Chemical	Naturally occuring, oxidation in network; network accumulation over time from source water	Moderate	Almost Certain	Very High	
MIB / Geosmin	Chemical	Algal blooms in source waters	Moderate	Likely	High	Relevant to Glen Innes only
Opportunistic Pathogens (e.g. *Mycobacteria, Naegleria, Legionella*)	Biological	Growth in network when water temperature is warm	Major	Rare	High	
Pesticides	Chemical	Agricultural activities, dumping	Minor	Unlikely	Low	
Organic chemicals	Chemical	Catchment activities (e.g. spills or unauthorised dumping), maintenance activities, pump failure	Minor	Unlikely	Low	
pH	Physical	Source water chemistry, chemical dosing, network impacts (e.g. cement lined mains & water age), drought	Moderate	Possible	High	
Protozoa (Source Water)	Biological	Agricultural activities, on-site sewage systems	Catastrophic	Likely	Very High	
Protozoa (Reticulation)	Biological	Faecal ingress into water mains or reservoirs (e.g. breaks, depressurisation)	Major	Unlikely	High	
Radiological	Radiological	Naturally occurring	Major	Rare	High	
Taste and odour	Physical	Source water characteristics, water age	Moderate	Almost Certain	Very High	
Turbidity	Physical	Raw water quality, treatment failure, network ingress, sediment disturbance	Minor	Almost Certain	High	
Loss of supply	Supply	Asset failure	Major	Unlikely	High	Risk score considers reputational risk

Glen Innes Drinking Water Scheme - Risk Register

Process Step	Source of Hazard/Event	Primary hazard	Other hazards managed by same barriers	Maximum Risk	Primary Preventive Measure	Other Preventative Measures	Document Reference / Procedure	Residual Risk			Comments	RMIP		
								Consequence	Likelihood	Risk Level		Immediate	Short Term	Long Term
Catchment	On-site sewage management system discharges and failures	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Catchment management, 5 yearly inspection of on-site sewage/septic treatment/disposal systems	Attenuation (Eerindii Ponds), coagulation, flocculation, clarification, filtration, disinfection (bacteria/virus only)	Onsite Sewerage Management (OSSM) policy; Local Environment Plan (LEP)	Catastrophic	Rare	High	Approximately 300 OSSMS within catchment area. GISC inspects OSSMS within Council area and assess systems that are low, medium or high risk; letters are sent to high risk systems to ensure their systems are updated. It is believed that Council follows up high risk systems more often to check for compliance.	Discuss review of OSSMS with Manager Regulatory Management Services		
Catchment	Unrestricted livestock access	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Attenuation (Eerindii Ponds), coagulation, flocculation, clarification, filtration, disinfection (bacteria/virus only)		Local Environment Plan (LEP)	Catastrophic	Rare	High	Possible causes: sheep and cattle. No major stockyards in water catchment. Stock graze to river and weir edge. GLENRAC continually looking at funding opportunites to fence off access to water courses. Considered **ALARP** at this point in time			
Catchment	Flooding event, storm flows, including high river events/releases	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Eerindii Ponds	Settling in Eerindii Ponds; coagulation; flocculation; clarification; filtration; disinfection		Minor	Rare	Low	Flood event risk consequence adjusted as impact will be minimised through use of Eerindii Ponds. Unforeseeable health hazards			
Catchment	Chemical spill in catchment eg. Fuel truck spillage, farm drum spillage, etc Service station fuel tank leakage	Organic chemicals	Pesticides	Low	PAC dosing at Eerindii Ponds	Remainder of treatment process	Emergency Management Plans	Minor	Rare	Low	Possible causes: large farms with fuel storage, fuel storage at Glen Innes Aggregates Quarry, major highways before catchment PAC dosing occurs during summer months but can be turned on if required Past incident: truck running off Shannon Vale Rd			
Catchment	Point sources eg mines, dip sites	Heavy metals	Pesticides/ herbicides	Moderate	Some removal through treatment process (e.g. Arsenic through Alum removal)		Contaminated Land Register	Moderate	Rare	Moderate	Possible causes: only a few old sheep dip sites (out of use for > 20 years). Public health testing indicates negligible levels of heavy metals present			
Catchment	Farming practices leading to fertilisers in source water, resulting in cyanobacterial bloom	Algal toxins	MIB / Geosmin	Very High	PAC dosing	Coagulation, flocculation, clarification, filtration, chlorination	WRA algal management wallchart	Catastrophic	Rare	High	Possible cause: high levels of phosphorus coming through raw water. No forestry upstream or broad acre farming of catchment. Study performed by Council found the quantity of 25 bags/hour of phosphorus is flowing down river - education campaign held by Council (phone surveys, public meeting, and letterbox drop) had limited effect. Algal bloom at weir is almost certain in summer periods. Toxic species of algae have been detected in raw water (known through lab tests performed).	Discuss with NSW Health testing of toxin from BGA in treated water when trigger level reached		
Catchment	Drought, and coincidental failure of Eerindii Ponds	Manganese		Very High	Return Eerindii Ponds to operation as soon as possible	Consider water restrictions to enable reduced flows from Beardy Weir and increased ratio of bore water	Drought Management Plan	Moderate	Rare	Moderate	Likelihood reduced due to nature of extent being assessed	SOP for returning to Beardy Weir supply		
Source Water - Beardy Weir	Primary and secondary contact: eg. fishing, swimming	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Eerindii Ponds	Dilution; coagulation; flocculation; clarification; filtration; disinfection; daily visual inspection		Catastrophic	Rare	High	Intake area is fenced off and perimeter of weir is privately owned. People are rarely observed in the water. However, recreation is not prohibited. At this time, Council do not consider this an issue. Based on NSW initial draft cryptosporidium risk assessment, treatment barriers are believed to be adequate **ALARP**			
Source Water - Beardy Weir	Dead animals in the weir	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Eerindii Ponds	Dilution; coagulation; flocculation; clarification; filtration; disinfection (bacteria/virus only)		Catastrophic	Rare	High	Possible causes: cattle grazing right down to weir site, turtles, fish, and water birds.	Develop SOP for dead animal removal		
Source Water - Beardy Weir	Seasonal water chemistry changes	pH		High	Raw water turbidity and pH monitoring & ability to reactively dose acid into flash mixer	Jar testing		Moderate	Rare	Moderate	Currently experiencing seasonal changes in pH. Situation worsens following periods of low rainfall following increased contact time with ground	Develop SOP's for water treatment operations		
Source Water - Beardy Weir	Malicious and deliberate contamination of source water	Bacteria/ Virus (Source Water)	Pesticides	Very High	Dilution in Eerindii Ponds	Coagulation; flocculation; clarification; filtration; disinfection		Catastrophic	Rare	High	One threat to contaminate the water supply at the weir has occurred. Likelihood reduced due to nature of event rather than controls. **ALARP**			
Source Water - Beardy Weir	Accidental or negligent contamination - e.g. weed spraying	Pesticides		Low	Dilution; coagulation; flocculation; clarification; filtration; chlorination	Council contractors trained in appropriate use of herbicides		Minor	Rare	Low	Possible causes: Council contractors spray for weeds within intake area; all contractors use best practice, according to Council.			
Source Water - Eerindii Ponds	Contamination entering Eerindii Ponds from quarry	Organic chemicals	Heavy metals	Low	Eerindii Ponds are bunded	Dilution; coagulation; flocculation; clarification; filtration		Minor	Rare	Low	Chemical and radiological baseline studies have been performed on Eerindii Ponds			
Source Water - Eerindii Ponds	Algal bloom in Eerindii Ponds	Algal toxins		Very High	PAC dosing initiated in summer or in response to bloom	Chlorination; coagulation; flocculation; clarification; filtration	WRA algal management wallchart	Catastrophic	Rare	High		Discuss with NSW Health testing of toxin from BGA in treated water when trigger level reached		
Source Water - Eerindii Ponds	Power failure	Loss of supply		High	Backup diesel pump set	Reservoir storage	Drought management plan	Insignificant	Rare	Low	Can't forseeably lose supply to township based on preventative measures			
Source Water - Red Range Road Bores	Radiological contaminants	Radiological		High				Major	Rare	High	Bore operates at times when plant is not operating, bores are approximately 5 years old. Bores are operated as backup and supplementary water source, not as primary source	Undertake 5 yearly radiological analysis		

Glen Innes Drinking Water Scheme - Risk Register

Process Step	Source of Hazard/Event	Primary hazard	Other hazards managed by same barriers	Maximum Risk	Primary Preventive Measure	Other Preventative Measures	Document Reference / Procedure	Residual Risk			Comments	RMIP		
								Consequence	Likelihood	Risk Level		Immediate	Short Term	Long Term
Source Water - Red Range Road Bores	Contamination through bore head or casing	Bacteria/ Virus (Bore Water)		High	Bore integrity	Filtration, disinfection		Major	Rare	High	Bore operates at times when plant is not operating, bores are approximately 5 years old. Bores are operated as backup and supplementary water source, not as primary source	12 monthly sampling of bore water for microbiological indicators and standard water analysis		Consider further actions at next risk review
PAC Dosing	Failure of PAC dosing	Algal toxins	MIB / Geosmin	Very High	Critical faults will alarm to treatment plant. Daily visual monitoring; some critical spares located at WTP	Dilution; coagulation; flocculation; clarification; filtration. Water restrictions	Drought management plan. Algae ID informal procedure	Minor	Likely	High	Possible causes: mechanical or electrical failure, blockages. Issues with PAC plant on commissioning, however these have been resolved without issue for approx 2 months Taste and odour issues occur seasonally during summer. No standby available for PAC dosing. Spares could likely be obtained overnight	Council to maintain algae identification skills among operators (particularly for new operators). Develop informal procedures into Council SOP's. Incorporate alarms to HMI to SMS alerts/alarms	Investigate opportunites to undertake further algae identification training	
PAC Dosing	PAC overdose	Colour		High	Critical faults will alarm to treatment plant. Daily visual monitoring; some critical spares located at WTP	Dilution; coagulation; flocculation; clarification; filtration.		Minor	Rare	Low	No standby available for PAC dosing. Spares could likely be obtained overnight			
Alum dosing	Alum overdose	Aluminium	pH	High	Clarifier water pH alarm	Alum drop test		Moderate	Possible	High		Examine possibility of auto-shutoff of alum dosing at low pH in clarifier water. SOP for alum dosing		
Alum dosing	Failure of alum dosing (failure to dose or underdose)	Protozoa (Source Water)	Turbidity	Very High	Continual pH monitoring in clarifier ; standby pump available	Filtration; jar testing undertaken as required and alum dose adjusted; drop test performed each time dosage is changed; daily plant checks; operator present when plant is running; well-trained operators; 3 days storage in water supply		Catastrophic	Rare	High	Possible causes: mechanical, electrical fault, line breaks, power failure, running out of chemical.	Consider implementing automatic plant shutdown if pH in clarifier is out of desired range	Develop Standard Operating Procedure (SOP) for start of day plant checks.	
Acid dosing	Acid overdose	pH		High	Jar testing and calculate dose	Clarifier pH monitoring		Moderate	Possible	High		Investigate automation of acid dosing		
Supernatent return	Concentration of pathogens	Protozoa (Source Water)		Very High	10% rate of supernatent return, dilution	Clean sludge out of tank periodically (currently approx every 2 years)		Catastrophic	Rare	High	Approximately 10% rate of return	Develop filtration SOP including backwashing	Consider if additional controls are required on supernatent return. Also consider if backwash recovery tank can have roof installed	
Poly dosing	Failure of poly dosing	Protozoa (Source Water)	Turbidity	Very High	Redundancy - duty/standby dosing pumps available;	Ability to double dose poly; daily plant checks; operator onsite when plant operational; well-trained, experienced operators (dose needs to be adjusted constantly); filtration. Poly batched at half strength to prolong shelf-life		Catastrophic	Rare	High	Possible causes: mechanical, electrical failure, incorrect dosing, blockage, inconsistent dosing due to system set-up	Develop SOP's for water treatment operations		
Clarification	Sludge build-up and carryover of floc due to insufficient sludge withdrawl or failure of vaccum pumps	Protozoa (Source Water)	Turbidity	Very High	Automated sludge withdrawl process, visual checks of sludge volume in hopper	Daily plant checks; operators present when plant is operating; redundancy - duty/ standby; polymer pipework cleaned approximately every 2 - 3 mths; clarifier cleaned every 3 months - water super chlorinated when clarifier being cleaned; online turbidity monitoring at clarifier - alarmed to operator's phone at 30 NTU; well-trained, experienced operators; filtration		Catastrophic	Rare	High	Possible causes: mechanical, electrical fault, line breaks, power failure, running out of chemical, inconsistent dosing due to system set-up (manually adjustable dosing line to each clarifier), broken baffles at bottom of clarifier (eastern side), flow too high through clarifier process. If filters block and clarifier level builds up, plant will shutdown	Develop O&M manual, complete SWMS (incorporate sludge disposal). Review SCADA trends. Examine option to review clarifier outlet current setpoint of 30 NTU	Examine possibility of failure alarms being routed to SMS	Repair remaining baffles within clarifier (eastern side). Reline western portion of clarifier
Clarification	Loss of sludge blanket following maintenance	Protozoa (Source Water)	Turbidity	Very High	Continual monitoring of sludge blanket, higher frequency of filter backwashes; plant checks, operator knowledge	Operators present when plant is operating		Catastrophic	Rare	High		Develop SOP following maintenance to clarifier		
Filtration	Filter breakthrough either due to excessive loading, insufficient backwashing or loss of media	Protozoa (Source Water)	Turbidity	Very High	Inline turbidity analyser, alarmed at 4 NTU	Operator-initiated backwash; operator present for backwash; well-trained, experienced operators; visual inspection of backwash; 3 days storage in supply with one tank in reserve	WTP O&M manual (developed 1982 at plant commissioning, currently partially outdated)	Catastrophic	Possible	Very High	Possible causes: blockages from carry-over of clarifier flocs, overdose of polymer, carry-over from clarifier, backwash failure. May need to consider impact of soda ash dosing on in-line turbidity readings. Backwash currently triggered manually on daily basis, not on headloss/turbidity. Likelihood scored as possible due to high uncertainty. Risk assessment team to review likelihood after analysis of grab sample results	Turbidity sampling after individual filters (grab-samples initially). Consider review of backwash triggers (time, turbidity, pressure)	Install continuous turbidity monitoring after individual filters; Review options for filter media replacement and/or inspection by qualified contractors. Review turbidity SCADA trend and current turbidity alarm (from 4 NTU to ideally below 0.5 NTU). Filter walls to be relined. Review CCP after turbidity analysers installed	
Filtration	Filter blockage	Loss of supply	Turbidity	High	Monitor filter performance; operator present for backwash	Operator-initiated backwash; clear water tank storage		Minor	Unlikely	Low	Likelihood of hazard occurring reduced with use of Eerindii Ponds	Develop clarifier maintenance SOP (incorporate media filter actions). Develop backwash SOP and sludge disposal procedure		

Glen Innes Drinking Water Scheme - Risk Register

Process Step	Source of Hazard/Event	Primary hazard	Other hazards managed by same barriers	Maximum Risk	Primary Preventive Measure	Other Preventative Measures	Document Reference / Procedure	Residual Risk			Comments	RMIP		
								Consequence	Likelihood	Risk Level		Immediate	Short Term	Long Term
Chlorine dosing	Disinfection failure or underdose	Bacteria/ Virus (Source Water)		Very High	Online chlorine monitoring at one clear water tank. Chlorine CCP levels and alarms	Heating system on tank; insulated building; visual level checks daily; visual inspection of dosing system daily; emergency backup chlorine supply available in neighbouring council (Inverell); supplementary dosing with granular chlorine, if required; 3 days storage in supply.		Catastrophic	Rare	High	Possible causes: run out of chemical, mechanical failure, freezing of pipework, blockages, clarification, and filtration failure. Past incident: Oct 2012 chlorine residual low in reservoir due to fault in chlorine dosing equipment.	Calculate and validate chlorine C.t. values (through individual tanks). Consider best method to analyse turbidity at chlorine dosing point (i.e. potential impact from soda ash). Review chlorine sampling point(s). Develop chlorine SOP (dosing and cylinder handling). Apply conditional formatting to chlorine cylinder weight spreadsheet to flag when reordering required. Review operational monitoring process, for example regular manager review of operational datasheets	Council to install automatic plant shutdown when chlorine dosing fails.	
Chlorine dosing	Overdose	Chlorine	Disinfection byproducts	Moderate	Clear water tank chlorine alarm	Daily plant checks		Moderate	Rare	Moderate	It is believed that the dose rate is limited by the delivery system such that a significant overdose would be unlikely to occur	Optimise chlorine sampling point. Develop chlorine SOP (dosing and cylinder handling).		
Chlorine dosing	Reaction with organic matter	Disinfection byproducts		High	Coagulation	PAC dosing during summer months		Moderate	Rare	Moderate				
Soda ash dosing	Failure of soda ash dosing	pH		High	Online pH monitoring in distribution well;	Daily plant check; drop test every few days and after every dose adjustment; operator present when plant operating; well-trained and experienced operator; duty/standby pumps		Moderate	Rare	Moderate	Possible causes: blockage in dosing line, mechanical, electrical failure, incorrect dosing, alum failure, line breaks, power failure, running out of chemical. Glen Innes WTP has an old dosing system so there is an increased chance of failure.	Develop O&M manual with routine maintenance schedule incorporated		
Soda ash dosing	Overdose of soda ash dosing	Bacteria/ Virus (Source Water)		Very High	Online pH monitoring in distribution well;	Daily plant check; drop test every few days and after every dose adjustment; operator present when plant operating; well-trained and experienced operator; duty/standby pumps		Catastrophic	Rare	High		Develop O&M manual with routine maintenance schedule incorporated. Examine historic pH values when calculating c.t.		
Fluoride dosing	Not currently dosing fluoride	Fluoride (not dosing)		Very High	N/A			Moderate	Almost Certain	Very High		Council and NSW Health to review reinstatement of fluoride dosing		
Fluoride dosing	Dosing reinstated in future	Fluoride		High	Appropriately designed fluoride dosing system with interlocks			Moderate	Rare	Moderate				Ensure fluoride dosing O&M manual developed and provided at commissioning; Develop SOPs as required
Clear Water Storage	Recontamination entering through distribution well	Bacteria/ Virus (Reticulation)		High	Distribution well is covered since last risk assessment	Chlorine residual; security cameras; security system alarms operator if plant perimeter is broken; ability to switch reservoirs		Catastrophic	Rare	High	Birds were found in open distribution well prior to it being covered.	Investigate methods to flash and mesh all openings		
Clear Water Storage	Sabotage and vandalism of clear water tank	Bacteria/ Virus (Reticulation)		High	Council has ability to switch reservoirs; security cameras; security fences; security system alarms operator if plant perimeter is broken; restricted access to site; chlorine residual			Catastrophic	Rare	High	Council has 4 reservoirs available: 3 clear water tanks at WTP and Blue Hills Reservoir. One clear water tank is offline to use for emergency supply. Past incidents: within the last 12 months, paint cans have been thrown into clarifier and equipment onsite has been sabotaged.	Develop incident response procedure for suspected water contamination		
Clear Water Storage	Groundwater infiltration between two clear water tanks	Bacteria/ Virus (Source Water)		Very High	Chlorine residual; maintenance of water levels in Clear Water Tanks			Catastrophic	Unlikely	Very High	Residual risk is very high due to uncertainty. Two of the clear water tanks located at Glen Innes WTP are constructed of porous concrete and are in a cracked and poor condition. It is suspected that water is transferred between the two tanks via the ground. One of the tanks is online whilst the other is offline, potentially depleting the chlorine residual in the online reservoir.	Grout and reline reservoirs		
Clear Water Storage	Breach of reservoir integrity eg recontamination by vermin (eg birds, rats, snakes)	Bacteria/ Virus (Reticulation)		High	Sealed storages	Chlorine residual; ability to switch reservoirs; tank annually cleaned by Aqualift (half of reservoir cleaned every year)		Major	Unlikely	High	Clear water tanks at WTP: bird proofing missing under corrugated roof; holes at inlet are big enough for wildlife to enter.	Investigate methods to flash and mesh all openings		
Blue Hills Reservoir	Breach of reservoir integrity e.g. recontamination by vermin/wildlife (birds, rats, snakes)	Bacteria/ Virus (Reticulation)		High	Sealed reservoir	Chlorine residual (low); manually dose Blue Hills Reservoir with granular chlorine two times a week; trees cleared around reservoir (within compound); weekly chlorine sample at Blue Hills Reservoir; tank inspected and cleaned by Aqualift (reservoirs cleaned periodically - time frame to be confirmed)		Major	Possible	Very High	Major risk is Blue Hills Reservoir: no bird proofing, easy access for wildlife to enter. Past incident: dead possum found in Blue Hills Reservoir.	Seal and bird-proof reservoirs to prevent access by vermin. Contractor to clean and inspect reservoir; request contractor advises appropriate inspection frequency based on condition. Develop formalised reservoir (external) inspection SOP		
Blue Hills Reservoir	Aged water due to short circuiting; stratification of reservoir with top layer of poor quality water.	Bacteria/ Virus (Reticulation)		High	Manual chlorine dosing			Major	Rare	High	Short circuiting due to 9 o'clock, 6 o'clock positioning of inlet and outlet, respectively. Have been experiencing irregular consumption of chlorine in Blue Hills Reservoir.	Investigate inlet pipe reconfiguration options to prevents short circuiting, and/or reservoir mixing options.	Increase chlorine residual monitoring in reticulation system.	

Glen Innes Drinking Water Scheme - Risk Register

Process Step	Source of Hazard/Event	Primary hazard	Other hazards managed by same barriers	Maximum Risk	Primary Preventive Measure	Other Preventative Measures	Document Reference / Procedure	Residual Risk			Comments	RMIP		
								Consequence	Likelihood	Risk Level		Immediate	Short Term	Long Term
Reticulation	Infrastructure (pipework, linings of valves, pump, and oils) leach components of materials due to chemical reaction.	Organic chemicals	Heavy metals	Low	Maintenance of pH in treated water; Australian Standards materials used within WTP and distribution system			Insignificant	Possible	Low	Currently experiencing pH increase through reticulation system - suspected cement pipe lining leaching into water			
Reticulation	Breach of pipelines through breaks, inappropriate maintenance, new or service works etc	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Chlorine residual; informal procedure for main breaks - flushing occurs on either side of break after repairs and a visual turbidity assessment; well-trained operators		Informal procedures	Major	Rare	High	Council only recently started recording and logging mains breaks. Approx 30 breaks annually.	Develop SOPs for mains flushing and main break repairs.		
Reticulation	Manganese oxidising in distribution system	Manganese		Very High	Aeration in Eerindii Ponds	Mains flushing programs at dead ends approx 6 monthly; reactive air scouring; trunk main renewal program in progress; dead end reduction program; aeration at weir; manual monitoring of manganese at weir twice weekly		Moderate	Rare	Moderate	Issue when sourcing directly from Beardy Weir, not an issue when sourcing raw water from Eerindii ponds			
Reticulation	Dead ends in retic system, leading to stagnation (aesthetic)	Taste and odour		Very High	Mains flushing program at dead ends occurs every 6 months; air scour occurs as required; chlorine residual; opportunistic looping of dead ends when new developments or existing works occur around dead ends; Dead End Reduction Program is part of capital works program		Mains flushing program	Moderate	Possible	High	92 dead ends in Glen Innes. Air scouring is reactive due to complaints.. Some cast iron infrastructure in some dead ends Reduction of complaints since last air scour. Ring mains being installed throughout network		Continue with ring main program. Continue with replacement of cast iron fittings of network.	
Reticulation	Compromised disinfection due to presence of high iron and manganese concentrations in source water	Bacteria/ Virus (Source Water)		Very High	Aeration in Eerindii Ponds	Contact time in clear water storages; verification monitoring of chlorine in reticulation		Moderate	Rare	Moderate	Consequence reduced as there is currently no evidence to suggest primary disinfection is impacted. Health consequence would rely on a concurrent network integrity breach which has been assessed elsewhere			
Reticulation	Contamination of water due to back flow or cross connection (e.g. septics, rainwater tanks)	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Recently installed meters will contain backflow prevention			Major	Possible	Very High	Level of backflow prevention currently not well known. Expect high number of cross connections to rainwater tanks. Consequence major as impacts from backflow would likely be limited to a defined area, not the entire scheme No potable water supply to STP or golf course where reuse water is being reused. Meters installed after late 1990's should contain backflow prevention	Confirm backflow prevention is present at hospital, pump stations and dump points; Prepare and adopt a backflow prevention policy.	Undertake targeted meter replacement program.	
Reticulation	Water age, loss of chlorine and warm water temperature	Opportunistic Pathogens (e.g. *Mycobacteria, Naegleria, Legionella*)		High	Chlorine residual through most of network; Mains flushing program at dead ends occurs every 6 months		Mains flushing program	Major	Rare	High	Water temperatures are not in the higher risk zone as advised by NSW Health **ALARP**			
Whole of System	Prolonged drought	Loss of supply		High	Drought Management Plan		Drought Management Plan	Major	Rare	High	**ALARP**			
Whole of System	Failure of online monitoring equipment (turbidity, pH, free chlorine)	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Operator monitors equipment daily; external contractors calibrate equipment approx. every 6 months; operator clean equipment fortnightly; coagulation; flocculation; clarification; filtration; disinfection; well-trained operators			Catastrophic	Rare	High	Possible causes: blockages, calibration issues, mechanical, electrical fault Equipment recently replaced: pH in clarifier; pH, turbidity and free chlorine in clear water tank.	Ensure all operators training is up-to-date.		
Whole of System	Loss of trained operators due to sickness, leave, retirement etc	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	3 well-trained operators, 1 trainee operator; scheduled leave; 3 days storage in supply		Annual leave register	Major	Rare	High		Ensure all operators training is up-to-date.		
Whole of System	Power failure	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Well-trained operators; generators available from Essential Energy, if required; operators present during plant operation; storage capacity in clear water tanks and reservoir			Minor	Rare	Low	If power failure occurs at WTP and not at raw water pumps, water will gravitate through WTP untreated	Investigate automatic shutdown of raw water pumps when power failure occurs at WTP	Develop SOP to aid operators during power failure	
Whole of System	Incorrect chemical use	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	3 well-trained operators, 1 trainee operator;			Catastrophic	Rare	High		Ensure all operators training is up-to-date.		
Whole of System	Water carting - contamination of water network by tankers	Bacteria/ Virus (Reticulation)		High	Air gaps in standpipes	AVDATA/ customer honesty system	NSW Health protocol for water carters	Major	Rare	High	**ALARP**			

Deepwater Drinking Water Scheme - Risk Register

Process Step	Source of Hazard/Event	Primary hazard	Other hazards managed by same barriers	Maximum Risk	Primary Preventive Measure	Other Preventative Measures	Document Reference / Procedure	Residual Risk			Comments	RMIP		
								Consequence	Likelihood	Risk Level		Immediate	Short Term	Long Term
Catchment	Sewage pump station overflow or leak (pump station upstream of intake)	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Ability to run from clear water tank if contamination suspected (7+ days depending on demand)	Extraction management; dilution; coagulation; flocculation; flotation; filtration; disinfection; reactive septic inspections.		Catastrophic	Unlikely	Very High	One sewerage pumping station upstream of intake that is susceptible to flooding; reduced risk as it is a common effluent system. High level alarms in sewer pump well	Investigate sewage pump station integrity.	Consider establishing connectivity of sewer pump station high level alarms to SMS/SCADA	Consider program for full remote SCADA visibility of water and sewage. Liaise with NSW DOI regarding opportunities under Safe and Secure funding
Catchment	On-site sewage management system discharges and failures	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Catchment management, 5 yearly inspection of on-site sewage/septic treatment/disposal systems	Coagulation, DAF, filtration, disinfection (bacteria/virus only)	Onsite Sewerage Management (OSSM) policy; Local Environment Plan (LEP)	Catastrophic	Rare	High	Approximately 300 OSSMS within catchment area. GISC inspects OSSMS within Council area and assess systems that are low, medium or high risk; letters are sent to high risk systems to ensure their systems are updated. Council will follow-up high risk systems more often to check for compliance.	Discuss review of OSSMS with Manager Regulatory Management Services		
Catchment	Unrestricted livestock access	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Coagulation, DA, filtration, disinfection (bacteria/virus only)	LEP; daily visual monitoring	Local Environment Plan (LEP)	Catastrophic	Rare	High	Possible causes: sheep and cattle. No major stockyards in water catchment. Stock graze to river and weir edge. GLENRAC continually looking at funding opportunites to fence off access to water courses. Considered **ALARP** at this point in time			
Catchment	Flooding event, storm flow, including high river events/releases	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Ability to run from clear water tank (approximately 4 days depending on demand)	Extraction management; daily visual monitoring of source water; daily plant checks; Drought Management Plan (DMP) - water restrictions can be put in place to avoid need to produce water; coagulation; flocculation; flotation; filtration; disinfection	Local Emergency Management Plan (LEMP); Drought Management Plan	Catastrophic	Rare	High	Storms events wash cattle/sheep manure into River. Increased risk of overflow from OSSM and sewerage pumping stations.	Develop SOP's to operate extraction and treatment plant operations	Council to consider a pressurised system to allow full reservoir capacity to be utilised.	
Catchment	Chemical spill in catchment eg. Fuel truck spillage, farm drum spillage, etc Service station fuel tank leakage	Organic chemicals	Pesticides	Low	Local Emergency Management Plan (LEMP); extraction management; Council emergency contact list; Deepwater residents have rainwater tanks; DMP - water restrictions can be put in place; coagulation; flocculation; flotation; filtration; disinfection		Local Emergency Management Plan (LEMP)	Minor	Rare	Low	Possible causes: trucks having accidents at highway crossings upstream from intake area. Petrol station located upstream.			
Catchment	Point sources eg mines, dip sites	Heavy metals		Moderate	Ultrion (coagulant) currently being dosed in WTP is proven to remove arsenic from water; coagulation; flocculation; flotation; filtration;	Verification sampling and communication/reporting of results	Contaminated Land Register	Minor	Rare	Low	Possible causes: history of arsenic and tin mining in catchment area, Deepwater industrial area, one operational service station and two decommissioned service stations. One decommissioned service station has been remediated. Slightly elevated lead levels most probably associated with deadend connection			
Catchment	Farming practices leading to pesticides/fertilisers in source water	Pesticides		Low	N/A			Minor	Rare	Low	Possible causes: erosion, land clearing. No large scale farming in catchment, mainly grazing. Heavy metals testing has been performed in Deepwater catchment. Cyanobacterial hazard has not been assessed as it has not been observed.			
Catchment	Controlled and uncontrolled fires	Turbidity		High	Ability to run from clear water tank (approximately 4 days depending on demand)	Extraction management; daily visual inspection; Ultrion dosing; coagulation; flocculation; flotation; filtration; disinfection		Minor	Rare	Low		Council to consider a pressurised system to allow full reservoir capacity to be utilised.		
Source Water - Deepwater Weir	Land clearing for agriculture	Turbidity		High	Ability to run from clear water tank (approximately 4 days depending on demand)	Extraction management; daily visual inspection; Ultrion dosing; coagulation; flocculation; flotation; filtration; disinfection		Minor	Unlikely	Low	Some increase in landclearing observed within catchment	Continue to monitor landclearing rates		
Source Water - Deepwater Weir	Dead animals in the weir	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Raw water intake upstream of weir	Daily visual inspection; settling at weir; dilution; coagulation; flocculation; flotation; filtration; disinfection		Catastrophic	Rare	High	Possible causes: cattle and sheep grazing right down to weir site, turtles, fish, and water birds. Past incident: dead sheep found in weir. **ALARP**			
Source Water - Deepwater Weir	Primary and secondary contact	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Dilution; constant flow at intake area; intake area fenced off; coagulation; flocculation; flotation; filtration; disinfection			Catastrophic	Rare	High	Very rare to see people using the river at weir. Increased number of free-campers upstream of raw water intake. Dump point established for free-campers to dispose of waste	Provide notices on internet notifying of dump point locations		
Source Water - Deepwater Weir	Malicious and deliberate contamination	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Daily visual inspection; coagulation; flocculation; clarification; filtration; disinfection			Catastrophic	Rare	High	**ALARP**			

Deepwater Drinking Water Scheme - Risk Register

Process Step	Source of Hazard/Event	Primary hazard	Other hazards managed by same barriers	Maximum Risk	Primary Preventive Measure	Other Preventative Measures	Document Reference / Procedure	Residual Risk			Comments	RMIP		
								Consequence	Likelihood	Risk Level		Immediate	Short Term	Long Term
Source Water - Deepwater Weir	Naturally occurring water quality above ADWG eg. Aluminium, Manganese etc	Manganese	Iron, Aluminium	Very High	Coagulation; flocculation; flotation; filtration; chlorination			Moderate	Rare	Moderate	History of high manganese and iron. Aluminium is high enough in raw water that Deepwater WTP cannot use alum as coagulant in treatment process. No operational testing for manganese or iron.	Undertake excavation of silt build-up at weir		
Source Water - Deepwater Weir	Weir failure	Loss of supply		High	Clear water storage, water carting plan			Major	Rare	High	Most houses have rainwater tanks	Develop emergency water carting plan (guidance from DOI templates)		Structural inspection of weir
Polymer dosing	Ultrion (coagulant) underdose or dose failure	Protozoa (Source Water)	Turbidity	Very High	Stop plant production temporarily	Well-trained operators; filtration; disinfection; informal SOP for when turbidity or colour is high.	Plant O&M manual (some information out of date)	Catastrophic	Rare	High	Possible causes: mechanical or electrical failure, blockages, run out of chemical, high turbidity in source water, human error - forget to manually batch coagulant. Coagulant failure can cause decrease in flotation effectiveness.	Develop SOP's for operation of plant (including chemical batching). As a guide, turbidity <20 NTU, colour <300 HU. Obtain standby pump for polymer dosing. Confirm if spare soda ash pump can be used for poly dosing.	Consider turbidity analyser on raw water input, with setpoints determined to enable optimisation of control.	
Polymer dosing	Overdose	Aluminium		High	Limited by pump capacity	Visual inspection of clarifier, dilution, turbidity monitoring on HMI	Plant O&M manual (some information out of date)	Moderate	Rare	Moderate			Consider turbidity analyser on raw water input, with setpoints determined to enable optimisation of control	
Flocculation	Flocculation failure in DAF	Protozoa (Source Water)	Turbidity	Very High	Filtration including online monitoring; well-trained operators	Periodic inspections	Plant O&M manual (some information out of date)	Catastrophic	Rare	High	Possible causes: mechanical, electrical failure. Plant will automatically shut down if power fails. Review of minimum height of water in tank	SOPs for WTP operations	Consider installing SCADA and alarm system	
Dissolved Air Flotation	Flotation failure, e.g. blower, air saturator, failure of outlet valve	Protozoa (Source Water)	Turbidity	Very High	Clearwater plus reservoir retention - approx 7 days under peak demand	Filtration; well-trained operators; drought management plan	Plant O&M manual (some information out of date); Informal SOP to bring saturator back online	Catastrophic	Rare	High	Possible causes: mechanical, electrical failure, pressure vessel failure, recycle pump to air saturator failure, coagulation failure. Currently on 30 minute float	Investigate potential for obtaining spare components.	Consider installing SCADA and alarm system	
Filtration	Filter breakthrough either due to excessive loading, insufficient backwashing or loss of media	Protozoa (Source Water)	Turbidity	Very High	Well-trained operators; filter media in-stock for filter top-up	Turbidity analyser, unit serviced regularly by external contractor (6 monthly)	Plant O&M manual (some information out of date)	Catastrophic	Unlikely	Very High	Possible causes: loss of media through backwash due to coagulant carrying over media. Operator is not always present when plant is operational. Backwash initiated on time basis	Develop Filtration SOP. Consider review of backwash triggers (time, turbidity, pressure). Review current CCP and alarm set-points. Consider increasing minimum height of water in clear water tank to allow for increased WTP shutdown time in emergencies	Consider installing SCADA and alarm system with automatic plant shutdown on filtration failure.	
Filtration	Filter blockage	Loss of supply		High	Clearwater plus reservoir retention - approx 7 days under peak demand		Plant O&M manual (some information out of date)	Minor	Unlikely	Low	Low water demand enables contingency measure of 5 truck loads per day to meet water usage requirements			
Soda ash dosing	Soda ash dosing failure	pH		High	Periodic visual check of dosing; periodic plant checks		Plant O&M manual (some information out of date)	Minor	Rare	Low	Possible causes: mechanical or electrical failure, blockages, run out of chemical			
Soda ash dosing	Overdose of soda ash dosing	Bacteria/ Virus (Source Water)		Very High	Online pH monitoring upstream of clear water tank;	Periodic plant check; drop test every few days and after every dose adjustment; well-trained and experienced operator; duty/standby pumps (manual changeover); dilution	Plant O&M manual (some information out of date)	Catastrophic	Rare	High		Update O&M manual with routine maintenance schedule incorporated. Examine historic pH values when calculating c.t.		
Clear Water Storage	Ingress of contaminants	Bacteria/ Virus (Reticulation)		High	Reservoir is roofed and is adequately vermin proofed			Major	Rare	High		Organise for external contractor to complete internal inspection & clean		
Chlorine dosing	Chlorine dosing failure or inadequate disinfection	Bacteria/ Virus (Source Water)		Very High	Redundancy - spare pump available; back up chlorine supply at pool; chlorine dose increased when chlorine strength reduced; operational and verification monitoring at WTP and reservoir; and measuring chlorine consumption between the two points; well-trained operators		Plant O&M manual (some information out of date)	Catastrophic	Unlikely	Very High	Possible causes: mechanical, electrical failure, blockages, running out of chemical. Chlorine is delivered in 500 L batches every 7 weeks (approx) - long time between delivery means chlorine can deteriorate in strength over time and will require adjustments in dosing. Likelihood based on high uncertainty	Consider installing online pH and chlorine monitoring after disinfection (and chlorine monitoring after reservoir)	Consider installing SCADA and alarm system. Develop chlorine SOP. Consider diluting chlorine to 6% instead of using 12%, and wasting old chlorine	
Chlorine dosing	Overdose	Chlorine		Moderate	Dilution factor in reservoir	Inspections 2-3 times per week	Plant O&M manual (some information out of date)	Moderate	Unlikely	Moderate	Pumps have capacity to overdose chlorine	Develop chlorine dosing SOP		
Chlorine dosing	Reaction with organic matter	Disinfection byproducts		High	Coagulation			Moderate	Possible	High	High likelihood assigned based on high uncertainty	Contact NSW Health to examine TOC/DOC and for DBP (treated water)		

Deepwater Drinking Water Scheme - Risk Register

Process Step	Source of Hazard/Event	Primary hazard	Other hazards managed by same barriers	Maximum Risk	Primary Preventive Measure	Other Preventative Measures	Document Reference / Procedure	Residual Risk			Comments	RMIP		
								Consequence	Likelihood	Risk Level		Immediate	Short Term	Long Term
Chlorine dosing	Breakdown of sodium hypo	Chlorate		High				Moderate	Possible	High	Chlorine dosing is adjusted towards end of 7 week period, suggesting chlorine decay & therefore chlorate formation	Consider diluting chlorine to 6% instead of using 12%, and wasting old chlorine to sludge lagoon prior to delivery (develop chlorination SOP)		
Deepwater Reservoir	Breach of reservoir integrity e.g. recontamination by vermin/wildlife (birds, rats, snakes)	Bacteria/ Virus (Reticulation)		High	Roofed, secure reservoir; flashing; closed hatches; chlorine residual; bird-proofing; chlorine testing in reservoir			Major	Rare	High	Tank has been cleaned since construction	Consider safe and secure funding for reservoir relining and operational optimisation. Examine integrity of access hatches		
Deepwater Reservoir	Aged water	Bacteria/ Virus (Reticulation)		High	Chlorine dosing at plant (approx 10-12 mg/L)	Chlorine testing in reservoir 2-3 times per week, verificaton monitoring		Major	Rare	High	Water supply in reservoir is approx six days, however mixing in tank is not effective, so only bottom portion of water is being extracted. Chlorine concentration in results may not be true reflection of actual chlorine levels due to holding time exceedence and chlorine decay	Investigate options for optimum inlet pipework. Commence sampling for total as well as free chlorine		
Reticulation	Contamination of water due to back flow or cross connection (e.g. septics, rainwater tanks)	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Recently installed meters will contain backflow prevention			Major	Possible	Very High	Level of backflow prevention currently not well known. Expect high number of cross connections to rainwater tanks. Consequence major as impacts from backflow would likely be limited to a defined area, not the entire scheme. Meters installed after late 1990's should contain backflow prevention	Prepare and adopt a backflow prevention policy.	Undertake targeted meter replacement program.	
Reticulation	Mains breaks	Bacteria/ Virus (Reticulation)		High	Flush following repair	Separate vehicles and equipment for sewer compared to drinking water repairs. Sump and clearance maintained in excavation during repairs, verification sampling and communication/reporting of results		Major	Unlikely	High	CCTV program currently being undertaken to determine location of drinking water and sewage network pipes	Develop mains repair SOP		
Reticulation	Corrosion of old fittings	Heavy metals		Moderate	Asset replacement program	Verification sampling and communication/reporting of results		Moderate	Unlikely	Moderate			Review asset replacement program and ensure the priority given to Deepwater is appropriate	
Reticulation	Water age, loss of chlorine and warm water temperature	Opportunistic Pathogens (e.g. *Mycobacteria, Naegleria, Legionella*)		High	Chlorine residual			Major	Rare	High	Water temperatures are not in the higher risk zone as advised by NSW Health **ALARP**			
Whole of System	Loss of trained operators due to sickness, leave etc	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	3 well-trained operators, 1 trainee operator; scheduled leave; significant storage in supply			Catastrophic	Rare	High		Ensure all operators training are up-todate. Develop O&M manual.	Develop framework to develop on-boarding of staff. Competency assessment of staff against SOP's	
Whole of System	Failure of online monitoring equipment (turbidity, pH)	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Operator monitors equipment 2-3 times per week; external contractors calibrate equipment approx. every 6 months; operator calibrate and clean equipment fortnightly		Site procedures for instrument calilbration	Catastrophic	Possible	Very High	Possible causes: blockages, calibration issues, mechanical, electrical fault.	Develop SOP for instrument calibration and maintenance	Consider installing online chlorine analyser after reservoir; Consider installing SCADA and alarm system	
Whole of System	Power failure	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	Automatic plant shutdown; well-trained operators	Power provider may provide back-up generator for long-term loss of power. Standby option to tanker water from Glen Innes in extreme event		Major	Unlikely	High	Most risk comes from human error: operators must restart batching of chemicals and ensure chemicals are transferred to day tanks after power failure.	Develop SOPs to support operators during power failure. Review plant operation processes following power failure.		
Whole of System	Drought	Loss of supply		High	Drought Management Plan	Option to tanker water from Glen Innes if required		Major	Rare	High			Undertake a Secure Yield Analysis as part of IWCM process	
Whole of System	Sabotage, vandalism or deliberate contamination of reservoir	Bacteria/ Virus (Reticulation)	Pesticides	High	Chlorine residual; locked, secure reservoir; locked ladder access to reservoir; reservoir is fenced off and locked			Major	Rare	High	**ALARP**			
Whole of System	Communication of verification testing results	Bacteria/ Virus (Source Water)	Heavy metals	Very High	Communication of verification results with NSW Health and other relevant Council departments			Catastrophic	Rare	High		Develop SOP for verfication monitoring including communication		
Whole of System	Incorrect chemical use	Protozoa (Source Water)	Bacteria/ Virus (Source Water)	Very High	3 well-trained operators, 1 trainee operator;			Catastrophic	Rare	High		Ensure all operators training is up-to-date.		

APPENDIX C
CRITICAL CONTROL POINTS

CONTINUOUS

CCP 1 Turbidity in Clear Water Tank

TARGET	ALERT	CRITICAL
<0.2 NTU	≥0.2 NTU	>0.5 NTU
• Trained operator onsite when plant operational • Start of day plant checks • Daily visual check of plant and equipment • Constant visual check of clarifier and filter operation • Daily calibration of pH meter • Monitor manually: turbidity, colour, pH in raw water • Monitor: treated water turbidity when plant is operational for at least 1.5 hours • Monitor manually: pH, turbidity in clear water tank • Contractor (ABB) calibrates probes 3-monthly	• Check dosing equipment - feeders, clutch, pumps • Check raw water quality - pH, colour, turbidity tests • Check and calibrate pH, turbidity equipment • Investigate clarifier and filter operation • Consider initiating a backwash • Increase monitoring until system reaches target	• Plant shut down • Notify supervisor, NSW Health • Repeat corrective actions from alert level • Consider using offline reservoir as alternative storage • Increase monitoring until system reaches target

CONTINUOUS

CCP 2 Disinfection in Clear Water Tank Chlorine Residual

TARGET	ALERT	CRITICAL
1.0 mg/L	**< 0.6 mg/L**	**< 0.4 mg/L**
• Trained operator onsite when plant operational • Start of day plant checks • Daily visual check of plant and equipment • Monitor daily: chlorine residual, pH and turbidity in reservoir • Adjust chlorine dose based on free chlorine test • Monitor weekly: chlorine residual at one reticulation sample point • Clean chlorine analyser daily Check chlorine level in tank (scales) and flow in chlorine room	• Perform free chlorine test • Adjust chlorine dosing, if necessary • Check dosing equipment • Check turbidity and pH • Consider manually dosing with granular chlorine in reservoir and clear water tanks if chlorine system has failed • Sample free chlorine at supply - if free chlorine is < 0.2 mg/L, contact NSW Health • Increase monitoring until system reaches target	• Notify supervisor, NSW Health • Immediately perform bacto test • Check free chlorine in reservoir and clear water tanks • Repeat corrective actions from alert level • Discuss with NSW Health the possibility of issuing a boiled water alert • Increase monitoring until system reaches target

WEEKLY

CCP 3 Integrity of Reservoirs

TARGET	ALERT	CRITICAL
No evidence of breach or vermin	**Visual identification of breach or vermin access to reservoirs**	**Visual identification of vermin or contaminant in reservoirs**
• Ensure clear water tank hatch is closed • Visual inspection of reservoir for vermin, snakes, possums, birds • Ensure fences, hatches locked • Reservoirs emptied and cleaned every 2 years by Aqualift and integrity report is generated	• Notify supervisor • Breaches to be fixed within one week • Increase monitoring until system conforms	• Notify supervisor, NSW Health • Immediately perform bacto test • Check free chlorine in reservoir • Repeat corrective actions from alert level • Discuss with NSW Health the possibility of issuing a boiled water alert • Increase monitoring until system reaches target

CONTINUOUS

CCP 1 Filtered Water Turbidity

TARGET	ALERT	CRITICAL
< 0.2 mg/L	**≥0.5 mg/L**	**> 1.0 mg/L for > 30 mins**
• Start of day plant checks • Visually check floc at plant start-up and continually during operation • Daily visual check of plant and equipment • Daily visual check of all chemical dosing systems • Clean turbidity meter daily prior to operation • Calibrate turbidity meter weekly • Monitor daily: turbidity, colour, pH • Monitor twice a week: chlorine residual at WTP tap and in reservoir • Check level of media in filter - top-up if required Manually scrape sides of flotation tank during float wash	• Notify supervisor • Stop delivering water to reservoir • Circulate water through DAFF plant and adjust dose rates until system reaches target • Consider initiating float and backwash • Increase monitoring until system reaches target	• Notify supervisor, NSW Health • Stop delivering water to reservoir • Test raw water turbidity. If > 250 NTU, stop pumping raw water to plant • Repeat corrective actions from alert level • Increase monitoring until system reaches target

DAILY

at least 5 times/week

CCP 2 Disinfection in Reservoir
Chlorine Residual

TARGET	ALERT	CRITICAL
1.0 mg/L	**< 0.7 mg/L**	**< 0.5 mg/L**
• Start of day plant checks • Daily visual check of plant and equipment • Daily check of chlorine dosing pumps • Drop test chlorine pumps weekly • Monitor twice a week: chlorine residual at WTP tap and in reservoir	• Adjust chlorine dose rate • Consider checking chlorine strength • Check chlorine residual at WTP tap • Check raw water quality: pH, turbidity, colour • Consider flushing mains • Check raw water quality • Increase monitoring until system reaches target	• Notify supervisor, NSW Health • Top-up chlorine at reservoir. If required, back-up chlorine available at public pool • Repeat corrective actions from alert level • Discuss with NSW Health the possibility of issuing a boiled water alert • Increase monitoring until system reaches target

WEEKLY

CCP 3 Integrity of Deepwater Reservoir

TARGET	ALERT	CRITICAL
No evidence of breach or vermin	**Visual identification of breach or vermin access to reservoirs**	**Visual identification of vermin or contaminant in reservoirs**
• Ensure clear water tank hatch is closed • Visual inspection of reservoir for vermin, snakes, possums, birds • Ensure fences, hatches locked • Reservoirs emptied and cleaned every 2 years by Aqualift and integrity report is generated	• Notify supervisor • Breaches to be fixed within one week • Increase monitoring until system conforms	• Notify supervisor, NSW Health • Immediately perform bacto test • Check free chlorine in reservoir • Repeat corrective actions from alert level • Discuss with NSW Health the possibility of issuing a boiled water alert • Increase monitoring until system reaches target

APPENDIX D
CIRCULAR LWU 18

Department of Primary Industries
Office of Water

WS14/229

Circular No. LWU 18
Date 4 June 2014
Contact Bill Ho
Phone 8281 7326
Fax 8281 7351
E-mail bill.ho@water.nsw.gov.au

Assuring the safety of drinking water supplies

This Circular has been prepared to advise NSW local water utilities (LWUs) of an important new protocol for assuring the safety of all drinking water supplies in regional NSW. The protocol is robust and cost-effective and must be implemented by all LWUs providing a drinking water supply.

Protocol

Following its review of a number of recent boil water alerts[1] in regional NSW, the NSW Office of Water, in consultation with NSW Health and the NSW Water Directorate, has developed the new protocol, which is set out in Attachment 2 – Appendix E of the *2012-13 NSW Water Supply and Sewerage Benchmarking Report* (www.water.nsw.gov.au). Appendix E documents the minimum requirements for ensuring each potable water supply is safe from microbial contamination. Under this protocol, each LWU will need to ensure that the **standard operating procedures (SOP)** for its water supply systems meet these requirements in order to achieve the following three key barriers:

> **Barrier 1** – **Effective disinfection** to kill, inactivate or remove pathogens in the water supply prior to distribution.
>
> **Barrier 2** – Ensure **distribution system integrity** to prevent contamination.
>
> **Barrier 3** – **Maintain free chlorine residual** in the water in the distribution system to help protect against minor contamination and as an indicator of a potential breach in distribution system integrity.

Together, these 3 barriers operate to assure the safety of each water supply and to prevent microbial contamination.

The *Public Health Act (2010)* requires each LWU to develop and implement a risk based Drinking Water Management System in accordance with the *NSW Guidelines for Drinking Water Management Systems*, NSW Health and NSW Office of Water, 2013. Activities related to disinfection and distribution system integrity should be clearly defined in each water utility's Drinking Water Management System, in accordance with the above Appendix E.

[1] Attachment 1 is a copy of page 10 of the *2012-13 NSW Water Supply and Sewerage Benchmarking Report* which provides examples of recent failures of integrity of water supply distribution systems.

Once a water supply is effectively disinfected (Barrier 1), enteric pathogens should not reappear within the distribution system, unless there is a failure of the integrity of the distribution system. Maintaining the integrity of the distribution system (Barrier 2) is therefore the most important barrier to prevent contamination of a disinfected water supply. To verify and maintain integrity of all its distribution systems, each LWU must carry out the actions identified in section E3 of Appendix E as a matter of priority within **the next 12 months**. These actions include the following and need to be repeated at frequencies appropriate for each system, but no less than every **four (4) years**.

Carry out a careful and **detailed examination** of each service reservoir to ensure:

(1) the reservoir and its roof are secured from entry by birds, animals, vermin and windborne contaminants;

(2) rainwater cannot enter into the reservoir (i.e., no leaking roof or holes in the reservoir wall or gaps around the openings on the roof);

(3) roof is adequately drained especially near the openings and landings. The roof should extend beyond the reservoir wall;

(4) all inspection hatches are closed and locked at all times; and

(5) the reservoir site and roof are secured from unauthorised access.

Where reservoir cleaning has been a routine activity for a water utility, reports from past cleaning episodes should be reviewed to find any reservoir integrity problems that have been identified but not corrected. Recent reports from experienced reservoir cleaners may satisfy the requirement for a detailed examination.

Any **deficiency in the roof or mesh design** will need to be **rectified** by the LWU following such examination.

Action

Each LWU will need to extend the standard operating procedures (SOP) for its water supply systems to meet the minimum requirements in Appendix E (Attachment 2) and to carry out the actions in section E3 of Appendix E within the next 12 months in order to ensure the integrity of its distribution systems and the safety of its water supplies.

Reporting

Each LWU will need to complete the attached Summary Report (Attachment 3) following its detailed examination of the integrity of each of its water supply distribution systems in accordance with Appendix E (Attachment 2).

Further information on this matter is available from the NSW Office of Water by contacting Mr Bill Ho, Manager Water and Sewerage on 8281 7326 or bill.ho@water.nsw.gov.au.

Yours sincerely

Michael Bullen
A/Deputy Director General, Water

Encl. Attachments:

1 Copy of page 10 of 2012-13 NSW Benchmarking Report

2 Appendix E - Effective disinfection of a potable water supply and assuring integrity of the distribution system to prevent contamination of the supply

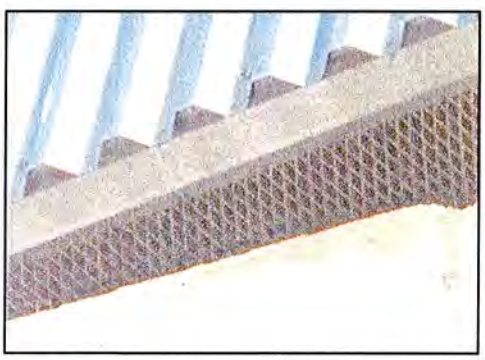
3 Summary Report – Distribution System Integrity

Examples of Failure of Integrity of Distribution Systems

Photo 1 (right) shows the **hatch** of a 20m high service reservoir, which has inadvertently been **left open** for a few weeks. The result was repeat detections of *E. coli* in the reticulated water supply and the need to issue a boil water alert.

Photos 2 and 3 below are underwater photos in the above service reservoir showing evidence of contamination by birds – **bird eggs** (left) and **dead birds** (right).

Photo 4 (below left) is a service reservoir where the **mesh openings** are **too large** and the roof design is deficient, allowing the entry of small birds, rainwater and windblown material to contaminate the stored water. The reservoir roof needs to be modified so that roof runoff and windblown material cannot contaminate the stored water. **Photo 5** (below right) shows mesh openings that are also too large, allowing entry of vermin, such as wasps and windblown material.



The continued detection of *E. coli* in reticulated water supplies and boil water alerts in the **last 2 years** have highlighted the need for a strategic approach for assuring the integrity of the distribution system to prevent contamination of a water supply that has been effectively disinfected. The recommended approach in Appendix E on page 277 was developed by the NSW Office of Water and NSW Health in consultation with the NSW Water Directorate and LWUs to provide a robust basis for assuring the safety of a water supply. As noted in the box on page 9, each LWU needs to review its present standard operating procedures (SOP) to ensure they address the minimum requirements in Appendix E for achieving safe water supplies:

Barrier 1 – **Effective disinfection** to kill, inactivate or remove pathogens in the water supply prior to distribution.

Barrier 2 – Ensure **distribution system integrity** to prevent contamination.

Barrier 3 – **Maintain free chlorine residual** in the water in the distribution system where practicable, to help protect against minor contamination and as an indicator of a potential breach in distribution system integrity.

Appendix E: Effective disinfection of a potable water supply and assuring integrity of the distribution system to prevent contamination of the supply

E1 Overview

This appendix highlights the key requirements for ensuring the effective disinfection[1] and assuring the safety of a potable water supply. Each NSW Local Water Utility (LWU) needs to ensure that the **standard operating procedures (SOP)** for its water supply systems **meet** these minimum requirements, in order to achieve the following three key barriers:

> **Barrier 1 – Effective disinfection** to kill, inactivate or remove pathogens in the water supply prior to distribution.
>
> **Barrier 2** – Ensure **distribution system integrity** to prevent contamination.
>
> **Barrier 3 – Maintain free chlorine residual** in the water in the distribution system to help protect against minor contamination and as an indicator of a potential breach in distribution system integrity.

Guiding principle 1 of the *Australian Drinking Water Guidelines* (below[1]) highlights the risks to consumers from pathogenic organisms and the paramount importance of protecting water sources and water treatment.

For **free chlorine** disinfection, **Figure 1** on page 283 shows how the above 3 barriers work together to provide a safe water supply.

In addition, as indicated in the *2012-13 NSW Water Supply and Sewerage Benchmarking Report* (page 9) each utility needs to develop and implement a risk based Drinking Water Management System in accordance with the *NSW Guidelines for Drinking Water Management Systems*, NSW Health and NSW Office of Water, 2013. These systems should include reference to sound standard operating procedures (SOP) in accordance with this Appendix and are required from 1 September 2014 under the *Public Health Act 2010*. Activities related to disinfection and distribution system integrity need to be clearly defined in each water utility's Drinking Water Management System (DWMS).

The *NSW Guidelines for Drinking Water Management Systems* is based on the Framework for the Management of Drinking Water Quality outlined in the *2011 Australian Drinking Water Guidelines* (ADWG) to assure the safety and quality of the water supplied to the consumers.

Effective disinfection of the source water and ensuring the integrity of the distribution system with or without a residual disinfectant are separate barriers (ADWG and above).

Effective disinfection of a water supply is essential to kill, inactivate or remove any pathogens in the water supply prior to distribution (Barrier 1 above). This could be achieved through a number of disinfection systems. Disinfection is a **critical control point** and must be appropriately monitored (ADWG).

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[1] Guiding principles 1 to 6 in Chapter 1 of the 2011 ADWG are listed below to provide an overall context to this Appendix:

- 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 consumer complaint about water quality.
- Ensuring drinking water safety and quality requires the application of a considered risk management approach.

Preventing ingress of contaminants at vulnerable points within the distribution system is a key **system integrity** barrier (Barrier 2). Service reservoir integrity is a critical control point for water supply that has been effectively disinfected and should be appropriately monitored (section E3).

Maintaining a disinfectant[2] residual throughout the distribution system (Barrier 3) helps protect the reticulated water against minor contamination, and is an indicator of a potential breach in distribution system integrity.

Sound operational monitoring and verification monitoring[3] programs are needed to assure that the minimum requirements in sections E2, E3 and E4 below for these three barriers[4] are met. The monitoring frequency for each water supply system is dependent on its key characteristics identified through analysis and should be reviewed as part of a comprehensive risk assessment. The guidance in sections E2, E3 and E4 provides the minimum requirements for each barrier for inclusion in each LWU's standard operating procedures (SOP) for its water supply systems. Following risk assessment for its systems, a LWU should include additional requirements in its SOP where warranted.

E2 Barrier 1 – Effective Disinfection

Disinfection is the single process that has had the greatest impact on drinking water safety. In Australia the common disinfection systems used include chlorination, chloramination, ultraviolet (UV) light irradiation and ozonation. The advantages and disadvantages for each of these systems are discussed in detail in ADWG.

When chlorination is used, a water supply is effectively disinfected when the required C.*t* values have been achieved (ADWG 2013, page 186). However, the C.*t* values used in the design of chlorine disinfection systems in Australia are generally higher than those required for effective disinfection (ADWG and WHO general recommendation is 0.5 mg/L of free chlorine residual after 30 minutes). The C.*t* values can be achieved by adjusting the chlorine dose or the contact time to provide a minimum C.*t* value of 15 mg/L/minute. The LWU should check and document the contact times for its systems for setting appropriate chlorine doses to achieve the required C.*t* values.

To achieve effective disinfection of a water supply with **free chlorine**, monitoring of the following parameters prior to the distribution of the water should be included in your LWU's SOP, as some variations in these parameters could affect disinfection efficiency and/or effectiveness:

- Maintain appropriate levels of free chlorine residual above 0.5 mg/L[5] prior to the first consumer for the available[6] contact time to provide a C.*t* value greater than 15 mg/L/minute.
- pH, temperature[7] and turbidity.

[2] Refer to page 186 of ADWG (Version 2.0, December 2013), under 'managing water supplies with no disinfection residual'.

[3] Each LWU's drinking water monitoring program testing for *E. coli* (i.e. sampling location, frequency and number of samples tested) needs, as a minimum, to be in accordance with the NSW Health requirements. These requirements are consistent with ADWG and the number of annual samples allocated for each LWU is shown in Appendix D1, *2012-13 NSW Water Supply and Sewerage Benchmarking Report*. Appendix D1 shows that the required number of samples has been collected and tested for almost all LWUs. Each water utility should assess its monitoring requirements to determine whether additional monitoring above this minimum is needed.

[4] For very small communities, typically serving a population of about 30, with a high quality source water such as groundwater from a confined aquifer, it may be cost-effective for the LWU to complete the actions outlined in section E3 on page 279 at 4-monthly intervals, rather than consistently maintaining a positive free chlorine residual disinfectant as long as the regular *E. coli* tests results continue to comply with ADWG. Refer also to the 4th paragraph of section E4 on page 281.

[5] Part IV Information Sheet 1.3, Disinfection with Chlorine, ADWG.

[6] If the source water does not contain pathogens (e.g., a good quality groundwater from a confined aquifer), no chlorine contact time is required.

[7] Efficiency of chlorine disinfection increases with increasing temperature. Monitoring of temperature is warranted for water of temperature < 10° C.

- For a filtered supply, keep turbidity as low as practicable as defined in the filtration critical control point (generally <1 NTU[8] is desirable for effective disinfection). Turbidity higher than 1 NTU is acceptable for unfiltered systems where the source water is free from faecal contamination or where the effectiveness of chlorination has been validated[9].
- Keep pH <8.5[10]

Disinfection is a **critical control point** and must be adequately monitored, preferably continuously, to ensure effective disinfection (refer section E1). For **free chlorine** disinfection, in addition to an appropriate operational monitoring program, the minimum requirements to be included in the SOP are as follows:

1. For a filtered water supply, check that turbidity of the water being disinfected remains below the critical limits for the system. Take appropriate corrective actions if the critical limits are exceeded.
2. Check the chlorine demand of the water supply being chlorinated as the raw water quality changes and adjust the chlorine dose rate accordingly to achieve effective disinfection.
3. Check the pH of water to be disinfected where a pH correction facility has been provided.
4. Confirm correct functioning of each chlorination plant.
5. Verify that the required chlorine dose rate has been added to the water supply[11].
6. Provide continuous monitoring and/or daily testing of free chlorine residual at representative sampling points after the appropriate chlorine contact time.

For other types[12] of disinfection systems appropriate SOPs need to be developed to ensure effective disinfection.

E3 Barrier 2 - Distribution System Integrity

Once a water supply is effectively disinfected (Barrier 1), enteric pathogens should not reappear within the distribution system unless there is a failure of the integrity of the distribution system (ADWG 2013, page 186). Maintaining the integrity of the distribution system (Barrier 2) is therefore the most important barrier to prevent contamination of a disinfected water supply. To verify and maintain integrity of all its distribution systems, each LWU must carry out the following actions as a matter of priority within **the next 12 months**. Thereafter, **repeat** these actions at frequencies appropriate for each system but no less than every **four (4) years**.

a. Carry out a careful and **detailed examination**[13] of each service reservoir to ensure:

[8] Table 10.5, ADWG.

[9] Implementation of the requirements of this Appendix and monitoring test results which consistently find no *E. coli* in a water supply would validate the safety of the supply.

[10] For efficient disinfection pH should be as low as possible, but this needs to be tempered by the need for corrosion control. In most cases a pH of 7.8 to 8.2 is desirable.

[11] Check to ensure the storage tanks or cylinders have adequate chlorine. For sodium hypochlorite dosing plants complete a drop test to verify the accuracy of the chlorinator dosing rate as in some instances the released oxygen could interfere with the actual dosage rate. Also check the concentration of the sodium hypochlorite solution in the storage tank and adjust the dosage rate to allow for any loss of chlorine strength.

[12] Refer to Part IV Information Sheets 1.4 to 1.8 of ADWG.

[13] Note that the careful and detailed examination of each service reservoir in steps (1) to (5) on page 280 should be carried out in addition to the routine inspections identified in LWU Drinking Water Management Systems. The process described here is a detailed examination of each reservoir to detect and rectify any breaches of reservoir integrity that may not be identified during routine inspections.

It is essential all service reservoirs are designed and constructed to prevent ingress of contaminants. Additionally, for each service reservoir, a careful examination of the reservoir roof, wall and mesh is essential in order to detect any breaches to the reservoir's

(1) the reservoir and its roof are secured from entry by birds, animals, vermin and windborne contaminants;

(2) rainwater cannot enter into the reservoir (i.e., no leaking roof or holes in the reservoir wall or gaps around the openings on the roof);

(3) roof is adequately drained especially near the openings and landings. The roof should extend beyond the reservoir wall;

(4) all inspection hatches are closed and locked at all times; and

(5) the reservoir site and roof are secured from unauthorised[14] access.

Where reservoir cleaning has been a routine activity for a water utility, reports from past cleaning episodes should be reviewed to find any reservoir integrity problems that have been identified but not corrected. Recent reports from experienced reservoir cleaners may satisfy the requirement for a detailed examination.

Any **deficiency in the roof or mesh design** needs to be **rectified** by the LWU following such examination.

b. Check the air valves and ensure they are functioning in accordance with the manufacturer's standard operating procedures.

c. Check any testable backflow prevention devices[15] and ensure they are operating in accordance with the manufacturer's standard operating procedures, tested in accordance with AS3500 and there is no cross contamination.

d. Check and ensure all potable water connections with a risk of cross contamination such as connections to sewerage facilities (pumping station, treatment works, etc.), livestock watering and other non-drinking uses are provided with appropriate backflow prevention devices and are regularly tested in accordance with AS3500.

e. Check and ensure all potable water connections to top up alternative water systems such as rainwater tanks/automatic switching device on premises are provided with backflow prevention devices (refer to Circular LWU 17) and are operating in accordance with the manufacturer's standard operating procedures, tested in accordance with AS3500 and there is no cross contamination.

f. Review the reservoir maintenance standard operating procedures to ensure they are sound and fit for purpose[14, 16].

g. Review the standard operating procedures for repair and re-instatement of distribution system infrastructure that comes into contact with potable water such as mains and reservoirs to ensure the procedures are sound and fit for purpose[16]. Thoroughly clean and super-chlorinate before use, all new and repaired distribution system infrastructure, such as mains and reservoirs, that is in contact with potable water.

h. Undertake all remedial works to assure system integrity as a matter of **priority**.

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integrity. In most cases the breach of reservoir integrity has been found to be not visible from ground level and required use of mobile lifting equipment in order to detect the breach.

A confirmed detection of ***E. coli*** in a microbiological test sample should **trigger** a careful **review** by the LWU of whether the requirements of section E3 above have been met.

[14] Where access to third parties (e.g., telephone companies, SES, NSW Police, etc.,) has been given to install equipment, appropriate written reinstatement and communication protocols need to established between the LWU and each third party to ensure the reservoir integrity is not compromised. The LWU must conduct regular audits to ensure the protocols are being effectively implemented. Similar protocols should also be effected between the LWU and any service providers authorised by the LWU to access its service reservoir. A financial penalty should be imposed for any failures to comply with the protocol as these may breach the distribution system integrity and result in contamination of the supply and the need for a boil water alert. A model 'service reservoir integrity protocol' will be prepared by the NSW Office of Water to assist LWUs.

[15] Annual testing of any testable backflow devices such as a Reduced Pressure Zone (RPZ) device or a double check valve assembly is required in accordance with section 4.4.6 of AS3500. Such testing does not generally apply for a household rainwater tank, where a standard air gap is generally used for backflow prevention (section 4.4.6 of AS3500).

[16] As noted in section E2 on page 278, ensure your LWU's standard operating procedures including contracts with service providers include super chlorination and effective disinfection of any new and repaired or replaced water mains and other distribution system infrastructure that is in contact with potable water before the infrastructure is commissioned or the water service is reinstated.

A LWU should maintain records (including photos) of all distribution system examinations and inspections undertaken, the results obtained, any deficiencies identified, and the rectification works implemented.

E4 Barrier 3 – Maintain a Free Chlorine Residual in the Water in the Distribution System

A residual disinfectant such as chlorine is maintained in the water within the distribution system to help protect against minor contamination due to a breach in the distribution system integrity. Where there is a significant risk of *Naegleria fowleri* and water temperature exceeds 30°C, a free chlorine residual of 0.5 mg/L or higher will control *N. fowleri*, provided the disinfectant residual persists throughout the distribution system (ADWG 'Disinfection with Chlorine' Information Sheet, page 191). **Monitoring of free chlorine residual** of the water in a distribution system on at least a weekly basis provides one of the key indications of the proper operation of the chlorination system, of system integrity, and provides data to help the utility to carry out timely corrective action. More frequent monitoring will provide more information to make better and timely decisions on changes to chlorine dosage required to protect public health. On-site testing of free and total chlorine residual (and if possible pH and turbidity) should be carried out and recorded each time a microbiological sample is collected for testing by the NSW Health Drinking Water Monitoring Program. The ADWG suggests that:

- a minimum free chlorine residual of about 0.2 mg/L[17] be maintained in the water throughout the distribution system. Re-chlorination may be necessary to achieve this chlorine residual in very extensive water supply distribution systems with long detention times.
- a sudden large drop in free chlorine residual in water in the distribution system may be an indicator of an increase in the chlorine demand of the water, a major breach in distribution system integrity, or a fault in the chlorination system,

When it is difficult to maintain the desired target free chlorine residual level of ≥ 0.2 mg/L at the extremities of your system, your LWU should using a trial and error process, increase the free chlorine concentration at the dosing points. Increased chlorine concentration can lead to community complaints about taste and odour. Advice can be given to community members about storing water in clean vessels before use so that the chlorine taste dissipates. Increased chlorine concentrations in systems that have routinely experienced low concentrations may lead to marked biofilm sloughing, leading to dirty water complaints. These problems should not last for long, especially if adequate chlorine concentrations are maintained and some flushing is carried out.

Once the desired free chlorine residual of the dosed water has been achieved and if the free chlorine residual at the extremities of the distribution system continues to consistently remain below 0.2 mg/L but not less than 0.05 mg/L with *E. coli* test results showing 100% compliance[3], then the LWU should undertake the actions outlined in section E3 on an **annual**[18] basis.

If however, the free chlorine residual level is consistently below 0.05 mg/L at the extremities of the distribution system, with *E. coli* test results showing 100% compliance[3,19] and the LWU can demonstrate the continuous integrity of the water supply distribution system, the LWU should then undertake the actions outlined in section E3 on a **four monthly**[18] basis and should also complete the following:

1. inspect and flush as needed the extremities of the system to remove 'stagnant' water.

[17] Example in Table A1.10 on page A-20, ADWG. Such a chlorine residual can normally be achieved for the vast majority of consumers supplied by a water supply distribution system. However, as noted in the 2nd paragraph of section E4 above, it may be difficult to maintain such a residual at the extremities of a distribution system.

[18] The first action in section E3 [action 'a. (1)' on page 280] may be undertaken from ground level using a telescope, binoculars, etc.

[19] If the microbiological test samples regularly fail for *E. coli* then the LWU must investigate the reasons for the failures and consider maintaining a free chlorine residual of about 0.2 mg/L on a consistent basis. This could be achieved by one of many options such as early warning control/communication systems, secondary chlorination plants, sub-system cleaning including air scouring/swabbing of the pipeline, super chlorination, etc. It is expected the preferred option would be chosen on the basis of a cost-benefit analysis.

2. opportunistically install pipe loops to any existing dead-end mains (i.e. as part of your LWU's repair and/or renewal work).

The measures in the 2 preceding paragraphs are warranted in order to minimise capital and operating expenditure, while assuring safety of the water supply.

E5 Develop a Verification Monitoring Program

Water Utilities should comply with the sampling frequency and sample site advice set out in the NSW Health Drinking Water Monitoring Program: http://www.health.nsw.gov.au/environment/water/Documents/october-2011-dwmp-booklet.pdf The verification monitoring program developed by a LWU for each distribution system should include the following:

- Parameters to be monitored (e.g. disinfectant residual, pH and turbidity)[20].
- Sampling frequency.
- Sampling locations including system extremities[21].
- Sampling methods and equipment.
- Schedules for sampling.
- Methods for quality assurance and validation of sampling results.
- Requirements for checking and interpreting results.
- Responsibilities and necessary training[22] of staff including induction of contractors.
- Requirements for documentation and management of records, including how monitoring results will be recorded and stored.
- Requirements for reporting and communication of results.

E6 Field Tests

- Test kits for measuring chlorine residual, pH and turbidity are available.
- Chlorine residual, pH and turbidity measurements need to be done in the field.
- Ensure the operators have a thorough understanding of the field test kits, especially the range they can measure, detection limits, error and interference tolerances.

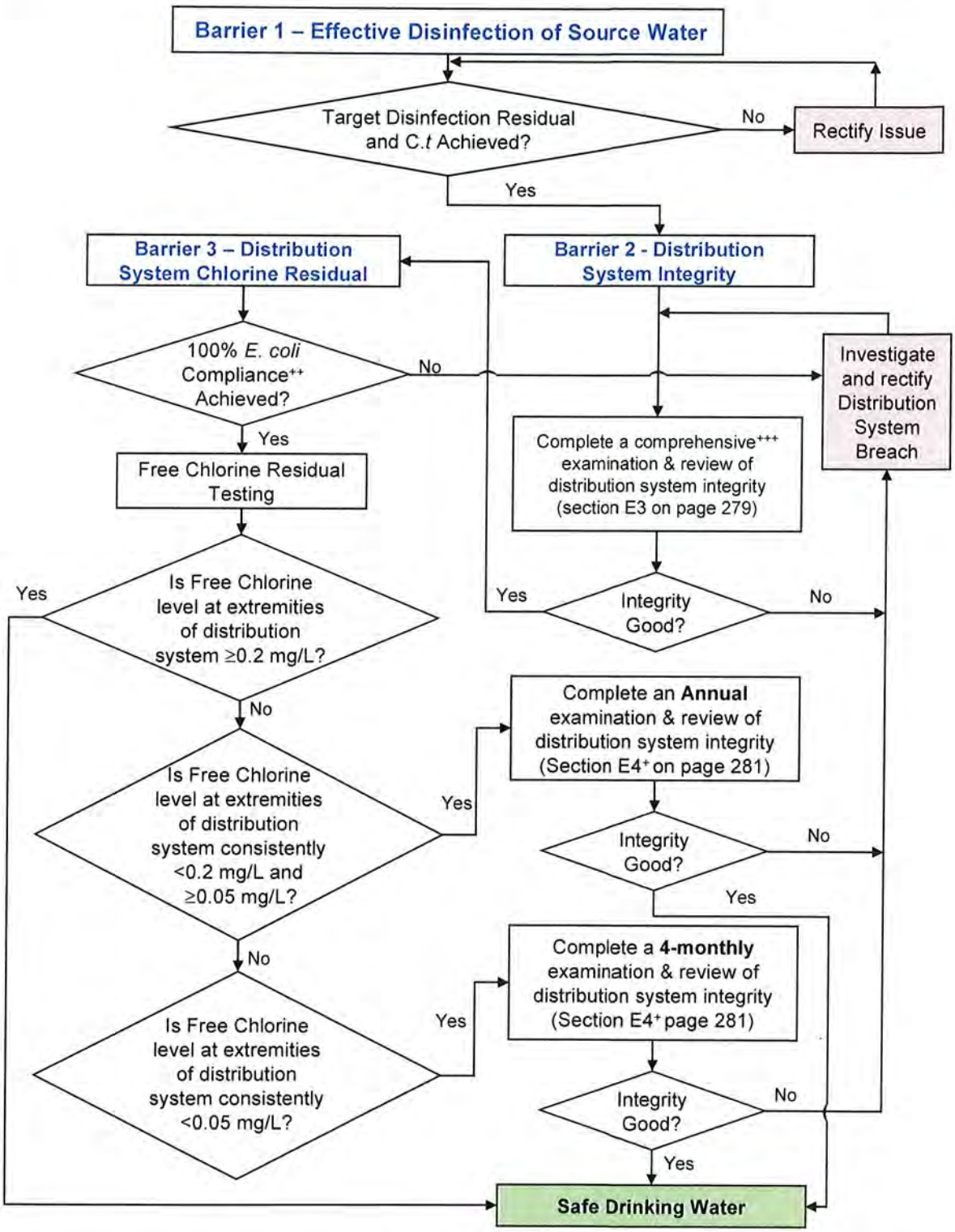
If you wish to discuss any aspects covered in this Appendix, please contact the Manager Water and Sewerage, NSW Office of Water on telephone: (02) 8281 7326 or email: bill.ho@water.nsw.gov.au.

[20] All filtered water supplies should meet the filtration critical control point target for the supply (generally <1 NTU is desirable for effective disinfection).

[21] Each LWU's sampling locations for monitoring microbiological water quality for reporting in the NSW Water Quality Database would be suitable for this purpose.

[22] LWU water treatment operators need to have appropriate skills and qualifications in accordance with page 23 of the NSW Guidelines for Drinking Water Systems, 2013. Refer also to page 35 of the *2012-13 NSW Water Supply and Sewerage Benchmarking Report* (www.water.nsw.gov.au) in regard to National Certification of Water Treatment Operators.

Figure 1 – Effective disinfection[1] of a potable water supply and assuring integrity of the distribution system to prevent contamination of the supply



+++ The first comprehensive examination and review of water supply system integrity should be completed within 12 months in order to assure system integrity.

++ The 100% *E. coli* compliance requirement refers to test results where any failures in distribution system integrity have been detected and rectified by the LWU.

+ The actions in the 3rd and 4th paragraphs of section E4 on page 281 should be undertaken by the LWU over the next 12 months or 4 months respectively in order to assure continuing distribution system integrity. These actions are only applicable for the extremities of a distribution system where the free chlorine residual is consistently below 0.2 mg/L.

1 Figure 1 is on the basis of disinfection with free chlorine.

ATTACHMENT 3

SUMMARY REPORT[1] ON ASSURING INTEGRITY & SAFETY OF WATER SUPPLY DISTRIBUTION SYSTEMS

LWU -
Contact Officer -

Date -
Phone -
Email -

- Water Supply Distribution **System** -

- Detailed examination of service **reservoirs** :

  - Date completed -

  - Key **Deficiencies** Identified -

  - **Rectification** Works Completed -

- Addressed all the requirements of **Circular LWU 18**? Y/N Date -

- Standard Operating Procedures (**SOP**) updated to address the requirements of Circular LWU18? Y/N Date -

[1] This summary report has been prepared in response to NSW Office of Water Circular LWU18 of June 2014 and is to be retained in your LWU's records.

The first Summary Report prepared by a LWU for each of its water supply distribution systems is to emailed to: Bill.Ho@water.nsw.gov.au

APPENDIX E
STANDARD OPERATING PROCEDURES

	MANAGEMENT OF DEEPWATER WTP & CLEAR WATER STORAGE	**Doc No.: W001** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** The Deepwater Water Treatment Plant (WTP) discharges filtered water to a 0.5ML Clear Water Tank to allow selective abstraction and treatment when raw water quality is adequate. When required, water is pumped from the Clear Water Tank to the Deepwater Reservoir, and disinfected in-pipe adjacent to the pumps.
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with: • Routine plant operation based on raw water quality and Clear Water Storage levels. • Event-based management of the WTP. • Management of un- or under-treated water in the Clear Water Tank.
3.0	**Scope** This procedure applies to GISC staff involved with operational management of the Deepwater WTP. Specific treatment processes are covered in other procedures.
4.0	**Responsibilities** • Treatment Plant Operators are responsible for carrying out the tasks detailed in this procedure. • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Slip and fall • Water contamination
6.0	**Procedure**
6.1	**Raw Water Quality** • On each day that the WTP is attended, test raw water pH, colour and turbidity and record results in the WTP Operating Log. • Visually inspect weir for contaminants, e.g. dead animals, debris, etc.
6.2	**Routine Operation** • Operate the WTP as required when raw water turbidity is <20NTU and colour <300HU. • Adjust chemical dosing as required in response to raw water quality variation, as detailed in other Deepwater WTP procedures. • Maintain levels in the Clear Water Tank between 90% and 100%

Item Number	Title
6.3	**Event** • If a significant wet weather event is anticipated, increase production to raise levels in the Clear Water Tank. • If raw water quality exceeds either 20NTU or 300HU, discuss with Coordinator of Integrated Water Services and undertake a risk assessment considering available treated water volumes, with the likelihood of an extended period of poor raw water quality. • If it is decided to continue producing water, proceed with caution and increase monitoring and jar testing frequency.
6.4	**Un- or Under-treated Water in Clear Water Storage** • In the event of a treatment failure (water >1NTU post-filtration) in which un- or under-treated water may have contaminated the Clear Water Storage, action will need to be taken to protect public health. Relying on dilution of the un- or under-treated water with the treated water in the Clear Water Tank is not able to safeguard consumers. Chlorination is **not** effective against protozoa. • Follow the actions as per the Deepwater Filtration CCP, including discussions with the Public Health Unit. • The options may be limited to 1) disposal of water, or 2) continue supply under a boil water alert.
6.5	**Chlorination of Clear Water Storage** In certain circumstances, chlorination of water stored in the Clear Water Storage tank may be appropriate. Examples include: - Failure of chlorine dosing system - Deepwater Reservoir taken offline for maintenance Refer to the Deepwater WTP Disinfection Procedure for details on manual dosing of the Clear Water Tank.
7.0	**Documentation/References** • Glen Innes Severn Council Drinking Water Management System • Water Quality Incident Response Procedure • Deepwater WTP Critical Control Points • Deepwater WTP Poly Dosing Procedure • Deepwater WTP Filtration Procedure • Deepwater WTP Disinfection Procedure
8.0	**Training Requirements** • Treatment Plant Operators are required to hold, or be in the process of obtaining, a Certificate III in Water Operations.
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	DEEPWATER WTP - DISINFECTION	**Doc No.: W002** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** Disinfection at the Deepwater Water Treatment Plant is achieved through the use of sodium hypochlorite dosing as water is pumped to the Deepwater Reservoir. Contact time is achieved both in the pipeline between the WTP and reservoir, and in the reservoir itself. A single 7.5L/hr Grundfos dosing pump pulls approx.13.5% sodium hypochlorite from a 1,000L storage tank within the WTP shed. The dosing point is on the suction side of the clear water pumps. Disinfection is a Critical Control Point for Deepwater, as detailed in Council's Drinking Water Management System.
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with: • Chlorine dosing system inspections • Adjustment of chlorine dose rate • Verification of chlorine dose rate (drop test) • Chemical quality checks • Non-routine chlorination of Clear Water Storage
3.0	**Scope** This procedure applies to GISC staff operating, inspecting and maintaining the Deepwater WTP disinfection process. The Deepwater Disinfection Critical Control Point procedure details the actions that should be taken to protect public health.
4.0	**Responsibilities** • Treatment Plant Operators are responsible for carrying out the tasks detailed in this procedure. • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • 12% sodium hypochlorite solution • Electrical • Working at heights (dosing of clear water tank)
6.0	**Procedure**
6.1	**Storage Tank** • Top up sodium hypochlorite tank as required, though avoid keeping the tank 'always full' as this may increase chemical age and deterioration. Aim to keep the tank level at approximately 2 weeks' supply, and fill on a weekly basis. • Periodically, allow the tank level to drop to a low level (ensure disinfection is not compromised).

Item Number	Title
	• Temporarily insert the suction line for the dosing pump into a 20L hypo drum (if the plant is going to be operating). • Pump out the contents of the 1000L tank, pour in 40L of clean water, pump out the contents again, and repeat twice more. This is to remove any settled impurities and clean the base of the tank. • Once cleaned, refill the 1000L tank to its usual operating level with fresh hypochlorite solution.
6.2	**Dosing System Inspections** Each day on which the WTP is attended, a general inspection should be performed on the chlorine dosing system. This should include: • Inspect dosing lines for cracks; • Inspect joins and fittings for leaks; • Inspect interior of hypochlorite storage tank. Visible sediment or sludge should prompt tank cleaning as per section 6.1 of this procedure. • Inspect base of storage tank for any visual sign of tank leakage within the bunded area.
6.3	**Dose Rate Adjustments** • Dose rate is fixed by the Operator, as opposed to feedback or set point control. • Changing source water quality, or deteriorating chlorine strength, may necessitate changes to dose rates. The primary indicator will be the chlorine residual at the tap adjacent to the Deepwater Reservoir. Aim to keep free chlorine between 0.4mg/L and 1.5mg/L, making slight adjustments to dose rates as necessary to achieve this. • To adjust dose up or down, turn the stroke rate dial clockwise (up) or anti-clockwise (down). It is important to make only **minor** adjustments to prevent significant over or under-dosing. Following an adjustment, monitor chlorine levels in the drinking water supply more frequently.
6.4	**Drop Tests** • Once per week, verify the chlorine dose rate by undertaking a drop test. • This will take less than 20 seconds on average, and will not require any special considerations if the pumps are filling the Deepwater Reservoir (the time that dosing will be interrupted will be insignificant given the volumes and dedicated rising main to the reservoir). • Ensuring that the dosing pump calibration cylinder is filled to the 10mL mark, close the valve at the injection point. • Simultaneously open the valve at the base of the calibration cylinder and start a timer. • Stop the timer when the level in the calibration cylinder reaches 0mL. • Calculate dose rate based on the following calculation (where t = time taken in seconds for the cylinder to go from 10mL to 0mL): **Dose rate (L/hour) = 36 / t** • Verify this figure against the dose rate displayed on the screen of the dosing pump. • Return the valves to their original position to resume normal chlorination operations.
6.5	**Chemical Quality** Sodium hypochlorite should be stored in cool conditions, and out of direct light. From time to time, the quality of purchased hypochlorite should be verified. The following tests can be performed relatively easily: • *Active strength* – Using clean (deionised water rinsed) volumetric flasks and an Eppendorf pipette, perform a 100,000x dilution of the neat chemical by undertaking successive (serial) dilutions of 1 in 100, and then 1 in 1000. Test this 1 in 100,000 diluted solution for free chlorine using the standard DPD method. The chlorine result

Item Number	Title
	in mg/L, multiplied by 10 will give you the % strength of the original solution. For example, a free chlorine result of 0.9mg/L on your 1 in 100,000 dilution would equate to a chemical strength of 9% active chlorine. Perform the test in duplicate to ensure the result is accurate. Solution strength should be close to the nominated strength as sold. • *pH* – Can typically be measured directly on neat solution, though take care to limit the length of exposure of the probe to the solution as it is highly alkaline. Consult the instrument manual to check the tolerance of the probe. If used, rinse the pH probe multiple times in separate volumes of clean water. Fresh sodium hypochlorite pH (12.5% solution) should have a pH of approximately 12 though this may vary by supplier. • *Specific gravity* – Hydrometers can be purchased that will accurately measure specific gravity of a solution. If a hydrometer is unavailable, a direct weight method can be applied. Accurately weigh exactly 10mL of sodium hypochlorite solution on a scale with sensitivity to at least 0.1g. Alternatively, weigh 100mL of chemical on a scale with sensitivity to at least 1.0g. Fresh sodium hypochlorite should have a specific gravity of close to 1.2; that is 100mL of solution should weigh 120g. As chemical ages, this will decrease. • *Chlorate* – A sample of the 1 in 100,000 dilution prepared for the active strength test could be submitted to an external laboratory for chlorate analysis. At the dose rates typically applied at Deepwater, a chlorate result of above 0.1mg/L in the 1 in 100,000 dilution would indicate unacceptably high chlorate levels (e.g. likely that 0.7mg/L would be exceeded when dosed to drinking water). If any of the chemical quality tests indicate unusual results (as described above), the supplier should be contacted and requested to explain the discrepancy.
6.6	**General maintenance** • Periodically remove the dosing injector and check for blockages or calcification. Replace lines or injector as necessary. • Service chlorine dosing pump as necessary – i.e. valve balls, valve seats, valve guides. Replace parts as necessary.
6.7	**Chlorination of Clear Water Storage** • If the decision is made to chlorinate the Clear Water Storage, the dosage will need to be calculated based on the volume stored, and the operational scenario. • *Deepwater Reservoir offline* – in this scenario, water will be supplied direct to customers and chlorine concentrations will need to be appropriate for consumption (below ADWG health guideline of 5mg/L). • *Chlorine dosing system offline* – in this scenario, water will be diluted in the Deepwater Reservoir (as normally occurs) and dose rate will be in line with the typical dose rate applied by the dosing system (ranges from 5-12mg/L). • Dose calculation – for every 1mg/L desired dose rate, add 1L of 10-12% sodium hypochlorite per 100kL of stored water. For example, a target dose of 4mg/L in 200kL of stored water will require the addition of 8L of sodium hypochlorite. If multiple dosing events are required, the existing chlorine level in the Clear Water Storage will need to be considered, as it will have an additive effect. • Application of chlorine – chlorine will need to be diluted and mixed into water (at least 1 in 10) and poured into the reservoir via the roof hatch. Dilution before dosing is critical, as neat 12% hypochlorite is 20% heavier than water and will sink and pool on the bottom of the tank.
7.0	**Documentation** • Glen Innes Severn Council Drinking Water Management System • Deepwater Disinfection Critical Control Point Procedure • Water Quality Incident Response Procedure

Item Number	Title
8.0	**Training Requirements** • Treatment Plant Operators are required to hold, or be in the process of obtaining, a Certificate III in Water Operations.
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	DEEPWATER WTP – DISSOLVED AIR FLOATATION & FILTRATION	**Doc No.: W003** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** The Deepwater WTP is a Dissolved Air Floatation & Filtration (DAFF) Plant. Polymer is injected into the raw water main, after which dosed water enters the first chamber (rapid mixer) for coagulation. Floc formation occurs via gentle mixing in the second chamber, and coagulated floc is floated via microscopic bubbles to the surface of the final chamber (floatation tank). From the final chamber, float (sludge) is periodically scraped into the float collection chamber and wasted. Clarified water passes through a dual media filter at the base of the floatation tank. Filtered water is pumped to the 0.5ML Clear Water Tank. A small volume of filtered water is 'recycled' from the balance tank into the Air Saturator along with compressed air. This solution is introduced back into the floatation tank where the sudden loss in pressure releases the compressed air from solution in the form of the microscopic bubbles required for floc floatation. The filter is backwashed using air and filtered water, on a time basis. Council is considering implementing additional backwash triggers based on turbidity and head loss. Filtration is a Critical Control Point for Deepwater, as detailed in Council's Drinking Water Management System.
2.0	**Purpose** The purpose of this procedure is to outline the routine operational and maintenance tasks associated with the management of the Deepwater DAFF plant, including the following components: • Rapid Mixer • Floc Tank • Floatation Tank • Filter • Air Compressor • Air Saturator • Recycle Pump
3.0	**Scope** This procedure applies to GISC staff operating, inspecting and maintaining the Deepwater WTP disinfection process. Chemical dosing is covered in other procedures.
4.0	**Responsibilities** • Treatment Plant Operators are responsible for carrying out the tasks detailed in this procedure. • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.

Item Number	Title
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Electrical • Slip and Fall • Compressed Air • Burns (hot pump / air compressor casing) • Water quality
6.0	**Procedure**
6.1	**Rapid Mixer** • Inspect the rapid mixer • Confirm mixer is operating and check for abnormal noise or vibrations
6.2	**Floc Tank** • Verify mixer is operating and check for abnormal noise or vibrations • Visually confirm floc formation appears normal *Note: management of coagulation including dose rate verification through jar testing is covered in the Deepwater WTP Poly Dosing Procedure.*
6.3	**Flotation Tank** • Visually inspect sludge quality and water level • Verify even distribution of bubbles
6.4	**Filter** • Monitor clarified water quality (pH, colour & turbidity) and record the results in the WTP Operations Log. • Monitor filtered water quality (colour & turbidity) and record the results in the WTP Operations Log. • Cross check turbidity analyser with hand held turbidity kit (refer to Instrument Calibration and Maintenance Procedure) • Backwashing is automatically initiated after 10 hours of filter operation • Some filter media is lost during backwash cycles. Add granular activated carbon to maintain appropriate filter bed depth. Historical experience has shown that approximately 20kg every three months is required (based on visual inspections).
6.5	**Air Compressor, Air Saturator and Recycle Pump** • Drain condensate water from the air compressor receiver weekly • Check air compressor oil weekly, and top up as required • Check pressure gauge on air saturator (during normal operation this runs at around 490kpa)
6.6	**Periodic Maintenance** • Hose down filter tank walls on a monthly basis • Drain float tank and clean air release nozzles every six months or if needed after visual inspection • Every 6 months, the oil in the flocculator drives should be checked and topped up as necessary. • Compressor - replace air inlet filter and oil on an annual basis. • Following drain down of the DAFF tank for maintenance, restart the plant with filtrate directed to waste for 60 minutes (this is not periodic – carried out after replacing filter medium or working on/replacing nozzles). This requires manual operation of the

Item Number	Title
	valves on the filtered water line to isolate the Clear Water Tank and open the connection between the filtered water and waste lines.
7.0	**Documentation/References** • Deepwater Critical Control Point 1 - Filtration • Glen Innes Severn Council Drinking Water Management System • Water Quality Incident Response Procedure • Deepwater WTP Poly Dosing Procedure • Management of Deepwater WTP and Clear Water Storage Procedure • Instrument Calibration and Maintenance Procedure
8.0	**Training Requirements** • Treatment Plant Operators are required to hold, or be in the process of obtaining, a Certificate III in Water Operations.
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	DEEPWATER WTP – POLY DOSING	**Doc No.: W004** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** The Deepwater WTP uses a polymer blend, Ultrion 44697 or Ultrion 44560 (both polyamines) to achieve coagulation. Previously aluminium sulphate (alum) was used however aluminium carryover into treated water was an issue that could not be resolved. Chemical is batched in a 500L tank at approximately a 1 in 20 dilution with water, then transferred over to the dosing storage tank. A single Grundfos pump doses polymer at a set dose rate (Operator adjustable). The dosing point is into the raw water pipework on the back wall of the WTP shed, approximately 5m upstream of where the pipe enters the first mixing vessel in the DAFF tank. Dosing lines are red in colour so that Operators can clearly identify and distinguish the line from the soda ash dosing lines (green).
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with the polymer dosing process, including: • Chemical batching • Dosing system inspections • Dose rate verification • Dose rate adjustment • Chemical reorder • General maintenance
3.0	**Scope** This procedure applies to GISC staff operating, inspecting and maintaining the Deepwater WTP poly dosing process.
4.0	**Responsibilities** • Treatment Plant Operators are responsible for carrying out the tasks detailed in this procedure. • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Chemicals • Water quality • Electrical NSF International / American National Standards Institute (Standard 60) restricts the product's use to a dose rate no higher than 84mg/L. NALCO's product labelling advises not to exceed a dose rate of 40mg/L.
6.0	**Procedure**

Item Number	Title
6.1	**Chemical batching** • Polymer (Nalco 44560) is batched as required by adding one 18kg drum of polymer to 375L of water in the poly batch tank (water level is controlled by level sensors) • Start the mixer and run for 20 minutes until chemical is fully mixed. • Turn off the mixer, and then transfer mixed chemical from the batch tank into the storage tank by running the transfer pump. *Note: pumps and tanks are labelled with "alum" as per the original plant design.*
6.2	**Dosing System Inspections** Each day on which the WTP is attended, a general inspection should be performed on the poly dosing system. This should include: • Inspect dosing lines for cracks; • Inspect joins and fittings for leaks; • Inspect interior of poly storage tank. Visible sediment or sludge should prompt tank cleaning. • Inspect base of storage tank for any visual sign of tank leakage within the bunded area.
6.3	**Drop test** • Once per month, verify that the pump is accurately delivering its stated dose rate. • Ensure calibration cylinder is filled to the "0mL" mark, or alternatively make note of the starting level. • Isolate the poly storage tank by closing the blue valve on the outlet pipe at the base of the tank. • Open the blue valve at the base of the calibration cylinder and simultaneously start a timer. • Run for ~10 minutes (depending on dose rates) and record the volume at the conclusion of this time period. • Convert back to dose rate in mg/L and verify against the dose pump settings.
6.4	**Dose rate adjustment** • Dose rates are fixed by the Operator, by adjusting the setting on the dosing pump face. The rate can be increased or decreased by pressing the '+' or '-' keys as required until the display denotes the desired rate in mg/L. Ensure only small incremental changes are made so that the effect can be assessed before adjusting further. • On a monthly basis, or as raw or clarified water quality changes, conduct a jar test to verify that the dose rate remains appropriate. • Follow the standard jar test protocol (as per the DoI training material). • Based on the results from the jar test, adjust the dose rate to reflect the level which provides optimal floc formation and settling. • Record the dose rate change in the Deepwater WTP Operational Log.
6.5	**Reorder** • Order additional coagulant when 10 drums remain.
6.6	**General Maintenance** • Periodically remove the dosing injector and check for blockages or scale build up. Replace lines or injector as necessary. • Service poly dosing pump as necessary – i.e. valve balls, valve seats, valve guides. Replace parts as necessary.

Item Number	Title
7.0	**Documentation** • Glen Innes Severn Council Drinking Water Management System • Water Quality Incident Response Procedure
8.0	**Training Requirements** • Treatment Plant Operators are required to hold, or be in the process of obtaining, a Certificate III in Water Operations.
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	GLEN INNES WTP – FILTRATION	**Doc No.: W005** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** The Glen Innes Water Treatment Plant utilises a conventional coagulation, flocculation and sedimentation process to treat raw water sourced from the Beardy Waters Weir via the Eerindii Ponds. Clarified water gravitates through three sand filters with filtered water exiting into a common distribution well for subsequent pH adjustment and disinfection. The filters are individually backwashed by Operators at their discretion, with the remaining two filters able to continue producing water. Backwashes utilise compressed air for scouring followed by a filtered water rinse cycle. Council is considering implementing automated backwash triggers based on time, turbidity and head loss. Filtration is a Critical Control Point for Glen Innes, as detailed in Council's Drinking Water Management System.
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with: • Filter inspections • Filter backwashing • Filter maintenance
3.0	**Scope** This procedure applies to GISC staff operating, inspecting and maintaining the Glen Innes WTP filtration process.
4.0	**Responsibilities** • Treatment Plant Operators are responsible for carrying out the tasks detailed in this procedure. • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Slips/falls • Drowning • Water quality/public health • Working at heights
6.0	**Procedure**

Item Number	Title
6.1	**Inspections** • Inspect filters daily for water clarity, signs of floc carryover, and the presence of any external objects/contaminants (remove as necessary). • Check filtered water pipework for signs of any leaks. • On a daily basis, check filtered water pH, colour, turbidity and follow Filtration CCP. Test for iron, manganese and aluminium on a weekly basis. Record all results in the WTP Operations Log. • Cross check and clean turbidity analyser as per the Instrument Calibration and Maintenance Procedure. • Visually inspect distribution well for particulates or any other unusual observations. • Check SCADA trends to confirm filter performance. • Record filter run hours in the WTP Operations Log.
6.2	**Filter backwash** • Backwash filters as required, ensuring sufficient volume in the Clear Water Tanks. • Monitor backwash water for evidence of excessive filter media loss. • Record date of filter backwash in the WTP Operations Log
6.3	**Filter maintenance** • Clean filter walls and launders of deposits / algal growth on a weekly basis. • Inspect filter media surfaces for any signs of bypass flow, media cracking, mudball formation, etc. • Top up filter sand as required to maintain filter bed depth. • Drain filters every 6-12 months and check media for evidence of cracking, clogging, mud-balling, uneven surface etc. Investigate further if necessary, e.g. by taking core samples. • Refill drained filters slowly to minimise disruption of the media.
7.0	**Documentation** • Glen Innes Severn Council Drinking Water Management System • Water Quality Incident Response Procedure
8.0	**Training Requirements** • Treatment Plant Operators are required to hold, or be in the process of obtaining, a Certificate III in Water Operations.
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	INSTRUMENT CALIBRATION AND MAINTENANCE	**Doc No.: W006** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** Operational management of critical water treatment processes relies on accurate measurements of water quality parameters. While most instruments begin with a relatively high degree of accuracy following initial purchase or a subsequent manufacturer's service/calibration, almost all instruments will experience a degradation in performance over time. It is important to monitor instrument performance at regular intervals, make adjustments and/or recalibrate when it is necessary to do so, and arrange external servicing and calibration as required.
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with instrument calibration and maintenance, specifically: • Routine quality control checks • Re-calibration following quality control check failure • Routine instrument maintenance • External servicing and calibrations
3.0	**Scope** This procedure applies to GISC staff involved with the maintenance and calibration of monitoring equipment. This procedure applies to both continuous online water quality analysers, as well as benchtop / hand-held test kits.
4.0	**Responsibilities** • Treatment Plant Operators are responsible for carrying out the tasks detailed in this procedure. • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Electrical • Chemicals
6.0	**Procedure**
6.1	**Routine Visual Checks of Online Analysers** • Each day that the plant is attended, walk around and briefly check each online instrument to confirm readings are within expected ranges, sufficient flow through each analyser, sample lines and flow cells are in good condition, clear and free of fouling, etc. • Low flow rates may indicate blockages or reduced pressure, which will require further investigation. • Sample lines should be replaced if there is any sign of deterioration.

Item Number	Title
6.2	**Online Analyser Cross Check** • Each week, cross check online pH, chlorine and turbidity analysers with an appropriately calibrated benchtop analyser. • Take a water sample at an appropriate location that is representative of the water flowing through the analyser. • Note the online instrument reading at the time of sample collection. • Test the sample using the benchtop analyser and record the result. • Operator's discretion will be required when deciding whether to adjust or recalibrate the analyser; frequent adjustments can sometimes cause problems, so it is not worth doing this for small differences in values. • A general principle for chlorine analysers is that a variance of 10% or 0.2mg/L (whichever is greater) between online and benchtop instruments is acceptable. • For turbidity analysers, it is not recommended to adjust based on benchtop analyser readings. However if the benchtop analyser is known to be reliable (e.g. it is accurately reading turbidity of freshly purchased standards), and the readings differ by more than 10% or 0.1NTU, calibration may be required. This should be undertaken according to the instrument manual, using appropriate standards.
6.3	**Routine Checks of Benchtop / Hand-Held Equipment** • At a minimum of once per week (typically every 3 days), calibrate the pH probe using purchased buffer solutions and record the pH probe slope. If the slope is outside of the 95-102% range, the probe should be cleaned, and calibration repeated. If successive recalibrations cannot achieve a slope within this range, it may need replacement. • Each week, check benchtop chlorine and turbidity analysers using purchased standards. Record the results of the cross checks.
6.4	**Re-calibration** • Recalibration of online instruments in-situ can be difficult and is ideally performed by appropriately qualified and experienced service technicians. • Every 6 months arrange for appropriately qualified service technicians to service and calibrate the chlorine, pH, and turbidity analysers (typically, the backwash flow transmitters and plant inlet flow transmitter are serviced also). • Chlorine analysers can often be recalibrated however it is important to perform calibrations when the chlorine concentration is at the higher end of its usual range. Calibrating at lower levels can cause significant inaccuracies at higher levels. • All adjustments to instruments should be recorded in the plant diary including the original reading, the adjustment, and the final reading.
6.5	**Routine Maintenance – online analysers** • No routine analyser maintenance is conducted by GISC staff. If maintenance is required, external contractors are engaged.
6.6	**Routine Maintenance – benchtop instruments** • Ensure vials are kept clean and relatively scratch free. Dirty vials may require a detergent or acid clean (refer to the manual), and scratched vials should be replaced. • Other than that, routine maintenance is not typically performed for benchtop instruments.
6.6	**External Servicing and Calibration** • Online analysers are externally serviced and calibrated at 12 month intervals. • Bench / hand-held test kits are sent away for service and calibration on an annual basis. • Dates of external servicing/calibration are designated by stickers on each instrument.

Item Number	Title
7.0	**Documentation** • Glen Innes Severn Council Drinking Water Management System • Manufacturer's manuals for all test equipment
8.0	**Training Requirements**
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	EXTERNAL INSPECTION OF RESERVOIRS	**Doc No.: W007** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** Water storage reservoirs can represent a high risk to water quality as they are depressurised, often open to atmosphere, and are vulnerable to contamination. In older structures, vermin proofing is often either not present, inadequate and/or has been retrofitted. Reservoirs are a Critical Control Point in the Glen Innes Severn Council Drinking Water Management System.
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with drinking water reservoir inspections, with a focus on preventing contamination of drinking water.
3.0	**Scope** This procedure applies to GISC staff and/or contractors with responsibilities for inspecting drinking water storage reservoirs.
4.0	**Responsibilities** • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Working at Heights • Contamination of Drinking Water • Slip and fall
6.0	**Procedure**
6.1	**External inspections from ground level** • Upon arrival at site, check for evidence of site access such as damaged fencing, cut locks, waste (e.g. bottles) around the site, etc. • General check of structure, look for cracks, leaks, vandalism, etc • Check overflow pipe and ensure the opening is secured with mesh • Walk around the base of the reservoir looking upwards at where the walls meet the roof. Check for gaps under the corrugations through which vermin, frogs or birds could enter. • Confirm any wall air vents (if present) are appropriately meshed also.
6.2	**Roof inspection** • Safely access the roof. • Inspect roof for holes (including missing screws) or damaged roofing sheets. • Check for low points that may allow water to pond (could indicate damage to roof support structure).

Item Number	Title
	• Check roof vent is appropriately secured. Roof vents are potential ingress points, so these should also be vermin proofed. • Check guttering (if present), confirm water flow is appropriately directed off the roof and clean any leaf debris that has built up.
6.3	**Hatch inspection** • Confirm hatch is locked and secure. • Remove any leaf debris from around the hatch that could fall in when the hatch is opened. • Check the integrity of the raised lip around the hatch and assess its ability to keep external contaminants from washing in during a rain event. • If safe to do so, open hatch and examine the water body. Look for any signs of animal entry, excess sediment build up on the reservoir floor, peeling internal wall coating, etc.
6.4	**Reporting faults** • Refer to the Glen Innes or Deepwater Reservoir CCP.
6.5	**Minor repairs** • Any identified faults in vermin proofing should be rectified immediately, ideally the same day, and absolutely within one week (as per CCP requirements). • The Coordinator or Supervisor must be informed of any defects and follow up actions undertaken or required.
6.6	**Major defects** • More significant structural defects, and/or internal issues should be brought to the attention of the Manager of Technical Services for capital works planning.
7.0	**Documentation** • Glen Innes Severn Council Drinking Water Management System • Glen Innes and Deepwater Critical Control Points - Reservoirs • Water Quality Incident Response Procedure
8.0	**Training Requirements** • Working at Heights
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	DRINKING WATER VERIFICATION MONITORING – SAMPLE COLLECTION PROCEDURE	**Doc No.: W008** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** Verification monitoring of drinking water is the final process of checking water quality at the delivery point. This provides feedback about the effectiveness of the drinking water production process and assists with identification of long-term trends. The verification monitoring process involves collection of drinking water samples from taps within the distribution system (reflective of water supplied to customers). Samples are sent to an external laboratory where a range of physical, chemical and microbial tests are conducted, and after the testing is concluded, results are provided to GISC.
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with: • Sample collection • Basic testing performed by GISC staff • Submission of samples to laboratory
3.0	**Scope** This procedure applies to GISC staff with responsibilities relating to drinking water quality verification monitoring of the reticulated water supplies in Glen Innes and Deepwater. This procedure does not cover operational/real-time monitoring of drinking water at Water Treatment Plants.
4.0	**Responsibilities** • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Burns (propane torch) • Traffic • Trip and fall
6.0	**Procedure**
6.1	**Preparation** • Verification monitoring samples are collected weekly in Glen Innes and fortnightly in Deepwater, on a rotation basis between designated sampling taps. The schedule is maintained by the Building and Environmental Health Officer. • Labels are provided by NSW Health. Ensure that appropriate, sterile sampling containers are available in sufficient numbers for the sampling event, and ideally, pre-label bottles so they are ready to go.

Item Number	Title
6.2	**Sample tap flushing and disinfection** • Upon arrival to site, briefly run the tap for a few seconds and then turn off the flow. • Carefully ignite the propane torch and flame the spout for approximately 10 seconds or until water in the tap head turns to steam. • Turn off the propane torch and set aside. • Turn on the tap and run for 2 minutes. • Turn the flow down to a steady, medium flow rate in preparation for sampling.
6.3	**Filling of sample bottles** • Fill each sample bottle without touching the inside of the lid or neck of the bottle. • Place samples in the esky with an ice brick. • Ensure only clean drinking water samples are packed in the esky, any other samples (e.g. raw water, wastewater) should be handled separately.
6.4	**Operator testing** • Water temperature should be measured on-site and clearly marked on the sample bottle label. • After returning to the Glen Innes WTP, perform free and total chlorine analysis on each sample, again writing the results clearly on the sample bottle label.
6.5	**Sample packing and submission** • Ensure samples are returned to the office by 2pm. • Package all samples along with fresh ice bricks into an esky, and arrange courier pickup.
6.6	**Incidents** • Verification monitoring results may lead to a Water Quality Incident being triggered, e.g. under the following circumstances: – Detection of *E. coli* in drinking water, – Detection of a chemical parameter above an ADWG health guideline value, – Detection of a physical or chemical parameter above an ADWG aesthetic guideline value, which may indicate compromised treatment or network integrity. • Refer to the Water Quality Incident Response Procedure in these circumstances.
7.0	**Documentation** • Glen Innes Severn Council Drinking Water Management System • Water Quality Incident Response Procedure • NSW Health (2011) *Drinking Water Monitoring Program* • NSW Health (2010) *Guide for Submitting Water Samples to DAL for Analysis*
8.0	**Training Requirements** • Drinking water sample collection (including disinfection of sample taps) is covered under the Certificate III in Water Operations, which is a mandatory requirement for all WTP Operators. • New or trainee Operators who are in the process of completing their Cert III, or other GISC staff, must be trained in sample collection on-the-job before collecting water samples unaccompanied.
9.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	WATER MAIN REPAIR - REACTIVE MAINTENANCE	**Doc No.: W009** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** Water mains breaks represent a high risk for contamination of the water network. Depressurisation can allow external contaminants into the drinking water supply which can endanger public health. It is of high importance that measures are taken to minimise or prevent the potential for contamination during repairs.
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with the repair of water mains, with a focus on contamination prevention.
3.0	**Scope** This procedure applies to GISC staff and contractors working on GISC water mains.
4.0	**Responsibilities** • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task. The following hazards are associated with this procedure: • Personal Safety - A range of site-specific safety hazards exist when working on water mains, including but not limited to: traffic, heavy machinery, pressurised water mains, asbestos, electrical and other services, trench collapse, power tools, confined spaces, sun exposure, dehydration, etc. Undertake a site-specific risk assessment at each worksite and implement appropriate hazard controls. • Water contamination – mains breaks are a high risk for contamination of the water network.
6.0	**Procedure**
6.1	**Preparation** • Locate the break. • Close the nearest downstream stop valve to prevent backflow. • Partially close the nearest upstream stop valve to constrict the flow of water exiting the break (do not fully close the valve at this point). • Advise residents via Facebook or other means by notifying Infrastructure office. • Secure the job site and identify affected area. • Obtain underground service details (dial before you dig) • Undertake a site-specific risk assessment and implement control measures for the identified hazards. • Ensure tools, equipment and staff to be utilised in the repair have not been contaminated from any works on the sewerage system (if yes, disinfection with chlorine will be required)

Item Number	Title
6.2	**Excavation** • After locating any services, carefully excavate to expose the water main • Ensure a sump of 150-300mm is created below the water main to allow dewatering & minimise the potential for dirty water to enter the main. Create a sump of approximately 500mm depth for larger main breaks. • Install sediment control where applicable i.e. if dewatering will result in dirty water running along road and into stormwater. • If the using the petrol driven flexi-drive pump make sure gas detector is used to detect carbon monoxide gas. Battery operated pump is preferable where practical. • Set up dewatering pump, ensure sediment controls are in place, and begin dewatering as required.
6.3	**Pipes and fittings** • Ensure pipes and fittings are clean. Remove any visible dirt with a clean dry rag. • Ideally, disinfect surfaces using dilute chlorine solution (typically 0.1 – 1%) applied via a spray bottle. • Lay pipes and fittings on a clean mat or plastic sheet ready for use.
6.4	**Repair under pressure if possible** If possible to do so, repairing a main under pressure is preferable to prevent contamination. Cracks are generally able to be repaired under pressure using a repair band, however larger breaks will require full depressurisation and cut in to the network.
6.5	**Cut-in** If not possible to repair under pressure, follow the below sequence of events: • Ensure dewatering pump is maintaining water level below the pipe. • Begin cutting into the pipe carefully, using ICS saw (quick cut deemed too dangerous), using BA gear including face shield. If water pressure is still too high, adjust the upstream valve to reduce flow. • When satisfied that the dewatering pump can keep up with the flow out of the main, fully close upstream valve. • Complete cut-in and remove affected section, ensuring water level in the trench is always kept below the open section.
6.6	**Repair** • Place bedding material to support new pipe section • Install clean pipe & fittings. Antibacterial lube is to be used. • Secure joints. Ensure torque wrench is utilised to ensure tightness meets specification (excess tightness can distort blue brute). • Backfill & ground compaction as necessary • Consider disinfection on a case by case basis. This can be undertaken by dosing granular chlorine into the new pipe before doing gibaults up. This should only be done in a high-risk scenario, and flushing should aim to remove any high chlorine water.

Item Number	Title
6.7	**Re-pressurisation and flushing** • Connect downstream standpipe ideally before the closed valve, if available, and open the standpipe valve. • Slowly re-open upstream valve to prevent pressure waves (water hammer). • Flush at least 1.5 x the volume of the isolated section or until turbidity and colour are clean (some older cast iron pipes can take longer). • Flushing can cease at this point, provided water is clean and clear • Ideally, confirm chlorine residual at locations before and after the repaired section. Results should be very close to one another (if not, this may be indicative of contamination in the system).
6.8	**Job completion** • Restore site as required • Remove barricading and clean up job site • Ensure all valves are returned to their original position • Advise impacted customers as required i.e. notify office so message can be sent out via social media. • Submit paperwork as required
7.0	**Documentation/References** • Glen Innes Severn Council Drinking Water Management System • Water Quality Incident Response Procedure • Any applicable documentation around asbestos handling and disposal
8.0	**Training Requirements** • Skilled labourer • Confined space may be required • Licenced operators to operate machinery
9.0	**Emergency** • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251

	WATER QUALITY INCIDENT RESPONSE	**Doc No.: W010** **Date: 15/05/2019**

Item Number	Title
1.0	**Introduction** On occasion, circumstances may arise that lead to actual or suspected contamination of the drinking water supply. The cause may be natural (fires or floods), asset-related (e.g. treatment or network failure) or human-related (error, deliberate contamination).
2.0	**Purpose** The purpose of this procedure is to outline the tasks associated with: • Incident identification • Immediate incident response • Stakeholder communications • Incident investigations
3.0	**Scope** This procedure applies to GISC staff involved with the management of incidents and emergencies related to drinking water safety and public health.
4.0	**Responsibilities** • The Coordinator of Integrated Water Services is responsible for the implementation of this procedure within the Water Services team. • The Manager of Technical Services is ultimately responsible for ensuring GISC's Standard Operating Procedures are developed, implemented, and reviewed, and that staff are aware of their responsibilities under the Drinking Water Management System.
5.0	**Hazards and Controls** All work must be conducted safely with PPE appropriate to the task.
6.0	**Procedure** The steps below outline the typical actions to be undertaken in an incident scenario. Refer also to the NSW Health Incident Response protocols, which provide additional information on all aspects of incident investigation and management.
6.1	**Incident Identification** A water quality incident is defined as any situation in which public health is, or may become endangered due to a compromised drinking water supply. An incident may be identified through any number of means, including: • Critical control point critical limit exceedance • Receipt of abnormal verification monitoring results • Failure of a treatment process, or physical asset (reservoir, pipelines) • Intentional contamination/sabotage A water quality incident may also be called in anticipation of a future event, e.g. deteriorating raw water quality, natural disaster, etc. The incident should be assigned a designated Incident Manager. The Incident Manager should engage additional support as needed, for example administrative support for record keeping and stakeholder communications.

Item Number	Title
6.2	**Immediate information gathering** The initial response to an incident will differ slightly depending on the circumstances, but will generally include: • Notification to GISC management; • Initial assessment of potentially impacted area; • If appropriate, water quality testing that can be conducted immediately and provide additional information about the severity and/or extent of the incident (e.g. chlorine testing following discovery of a contaminant in a reservoir).
6.3	**Public Health Unit notification** • Concurrently with the immediate information gathering actions, the Hunter New England Local Health District Public Health Unit should be notified. It may be more appropriate for this to occur at the Manager/Director level, while other staff continue with the investigations. • The Public Health Unit may require a Boil Water Alert, or Do Not Drink Alert be issued at this time, or at any time throughout the incident based on the available information. Ensure templates are pre-populated and ready to release to local media agencies (and/or letter box drops depending on the size of the affected area).
6.4	**Response Actions** If related to a Critical Control Point, follow the relevant CCP Procedure. In an incident it will be important to firstly try and minimise the exposure to consumers, provide an alternate water supply to affected customers if possible, remediate/resolve the issue, and resample to confirm water is safe. These steps are detailed below.
6.5	**Isolation** • If possible, isolate the affected asset or area from the remainder of the network. • For example, if a Clear Water Tank or Reservoir is contaminated, isolate the tank to prevent more contaminated water from entering the network. If raw water or treatment is compromised, consider whether the Water Treatment Plant can be shut down and supply maintained from the existing storage volume.
6.6	**Alternate Supply** • If possible, re-route drinking water within the network from an alternate location, providing it is known to be safe. Consider and manage any impacts from operating seldom used valves (e.g. dirty water build up either side of the valve, potential for breakage of older valves, etc). • It may be possible to provide an ongoing supply by boosting chlorine in other locations (e.g. reservoirs). As a guide, 2.5 litres of 10-12% sodium hypochlorite per 100kL of water will boost chlorine by approximately 2mg/L. Turbidity should be <1NTU for chlorine to be effective at disinfecting bacteria and viruses. • If a Do Not Drink alert is issued, and the existing supply cannot be reconfigured, an alternative drinking water supply will be required for the affected customers. Provide bottled water as required.

Item Number	Title
6.7	**Contamination Investigation/Sanitary Survey** If the source of contamination is not immediately apparent, conduct a contamination investigation and give consideration to the following: • *Treatment failure* – review SCADA / HMI information for treatment processes, visually inspect each stage of the treatment plant, check chemical tank levels and back calculate consumption to verify chemical dosing has occurred. • *Reservoir ingress* – perform an external check of reservoir integrity, ensuring vermin proofing is in place, roof and hatch structures are sound, and there is no evidence of tampering. Open hatch and inspect interior for obvious signs of contamination entry. Perform basic water quality tests (chlorine – to confirm within normal range; pH, turbidity and conductivity to confirm general baseline water quality). • *Backflow* – consider the possibility for backflow. Is it possible that loss of pressure occurred in the period prior to the incident being identified? • *Intentional contamination* – although less likely, some circumstances may require consideration be given to the possibility for intentional contamination. Review site security, and conduct basic water quality tests (chlorine, pH, turbidity, conductivity, odour). Contact the police if it is suspected that intentional contamination has occurred. The NSW Health publication – "Managing pathogen risks in drinking water: Response protocol for water utilities and public health units" provides additional useful information on conducting sanitary surveys.
6.8	**Rectification** • Once the source of contamination is identified, identify a method or plan for rectification. • In some cases, a temporary fix may be necessary while the longer-term solution is arranged. • Scouring of reservoirs / flushing of mains may be required to remove contaminated water from the system. This will need to be done safely and with recognition of any environmental requirements for disposal of water.
6.9	**Resampling / Water Quality Verification** • Resampling should be undertaken as soon as practical, to confirm the original result. Investigation actions should not be delayed however, as this could place public health at additional risk. The Public Health Unit can expedite urgent samples through the NSW Health Laboratory using the Urgent Water Analysis Request Form (www.health.nsw.gov.au/environment/water/Documents/FASS-request-urgenttesting.pdf) • Resampling should be undertaken again following rectification of any identified faults, to verify the effectiveness and prove water is again safe to consume. • If microbial contamination has occurred, or disinfection has been compromised, it will be necessary to verify disinfection C.t. has been achieved before water is supplied to customers. • Once water quality has been verified, and the Public Health Unit provides approval, any boil water alerts or do not drink alerts can be lifted and supply arrangements returned to normal.
6.10	**Incident debrief** After the incident is resolved, conduct a debrief with all staff involved in the incident, as well as NSW Health and DoI Water. The debrief should seek to identify the root cause of the incident, and measures that can be taken to prevent reoccurrence. Further, the debrief should also seek to objectively assess the effectiveness of the incident management team and response actions, so that key learnings can be taken and applied in future incident scenarios.

Item Number	Title
7.0	**Documentation/References** • Glen Innes Severn Council Drinking Water Management System • Glen Innes Severn Council Critical Control Point Procedures • NSW Health - Managing pathogen risks in drinking water: Response protocol for water utilities and public health units • NSW Health Response Protocol: For the Management of Physical and Chemical Quality
8.0	**Emergency** • On-call Operator - 0418 162 794 • Coordinator of Integrated Water Services – 0409 595 686 • Manager of Technical Services - 0422 184 829 • Director of Infrastructure Services - 0408 144 251 • Hunter New England Local Health District Public Health Unit – 02 6764 8000