Tenterfield Water Supply

DWMS Subplan

March 2021

Tenterfield Water Supply

DWMS Subplan

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Executive Summary

The Drinking Water Management System (DWMS) demonstrates Tenterfield Shire Council's compliance with the *NSW Public Health Act 2010* 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).

DWMS Overall Manual

There is an overall DWMS Manual which contains or references the overarching elements common to the management of drinking water quality for all TSC supplies.

DWMS Subplan – Tenterfield Water Supply

This document is the Tenterfield Water Supply DWMS Subplan. It contains system specific information to management the risks to the Tenterfield water supply.

Critical Control Points

Tenterfield water supply critical control points (CCPs) are included in this document. The corrective actions for managing CCP breaches are included in the relevant CCP standard operating procedures (SOPs), which are also included in this document.

Drinking Water Quality Incidents

Drinking water quality incidents and emergencies are managed through the Drinking Water Quality Incident Response Plan.

Improvement Plan

An improvement plan forms part of the DWMS and is available as a separate excel spreadsheet.

Document Review

The document is reviewed internally at least on an annual basis when the DWMS Annual Report is prepared, or earlier upon significant system change.

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Document History and Status

Revision	Date	Reviewed by	Initials	Details
0.1	01/11/18	Tasleem Hasan	TH	Subplan created following 2018 DWMS review workshop facilitated by Viridis.
1.0	5/12/18	Gillian Marchant Melissa Blum	GM MB	Review of the updated DWMS Subplan
1.1	29/3/21	Tasleem Hasan	TH	Section 3.2 updated - CCP procedures updated to include the revised reporting to PHU process.

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1. Introduction

This DWMS Subplan applies to the management and operation of the Tenterfield drinking water supply scheme and forms part of Tenterfield Shire Council's DWMS.

2. Element 2 – Assessment of the Supply Scheme

2.1. Overview

Tenterfield Shire Council manages the Tenterfield township drinking water supply system. The Tenterfield Water Treatment Plant (WTP) is a conventional plant located next to the Tenterfield Dam, on Scrub Rd, Tenterfield. The Tenterfield WTP treats water from the Tenterfield Dam and the Shirley Park Bore (during times of drought) and distributes it through a network of reticulation to consumers.

Table 1 Overview of the Tenterfield Drinking Water Supply System

Category	Detail
Water Source	Tenterfield Dam
Treatment Processes	Tenterfield WTP (5 ML/day): • Coagulation • Flocculation • Clarification • Filtration • pH correction • UV disinfection • Fluoridation • Chlorination
Reservoirs	One reservoir with 2 ML (less than 1 day) storage
Customers	Township of Tenterfield Population of 4,000 (approx.) Average demand of 2.6 ML/day

2.2. Process Flow Diagram

The process flow diagram (PFD) or schematic of the Tenterfield drinking water supply scheme is shown in Figure 1.

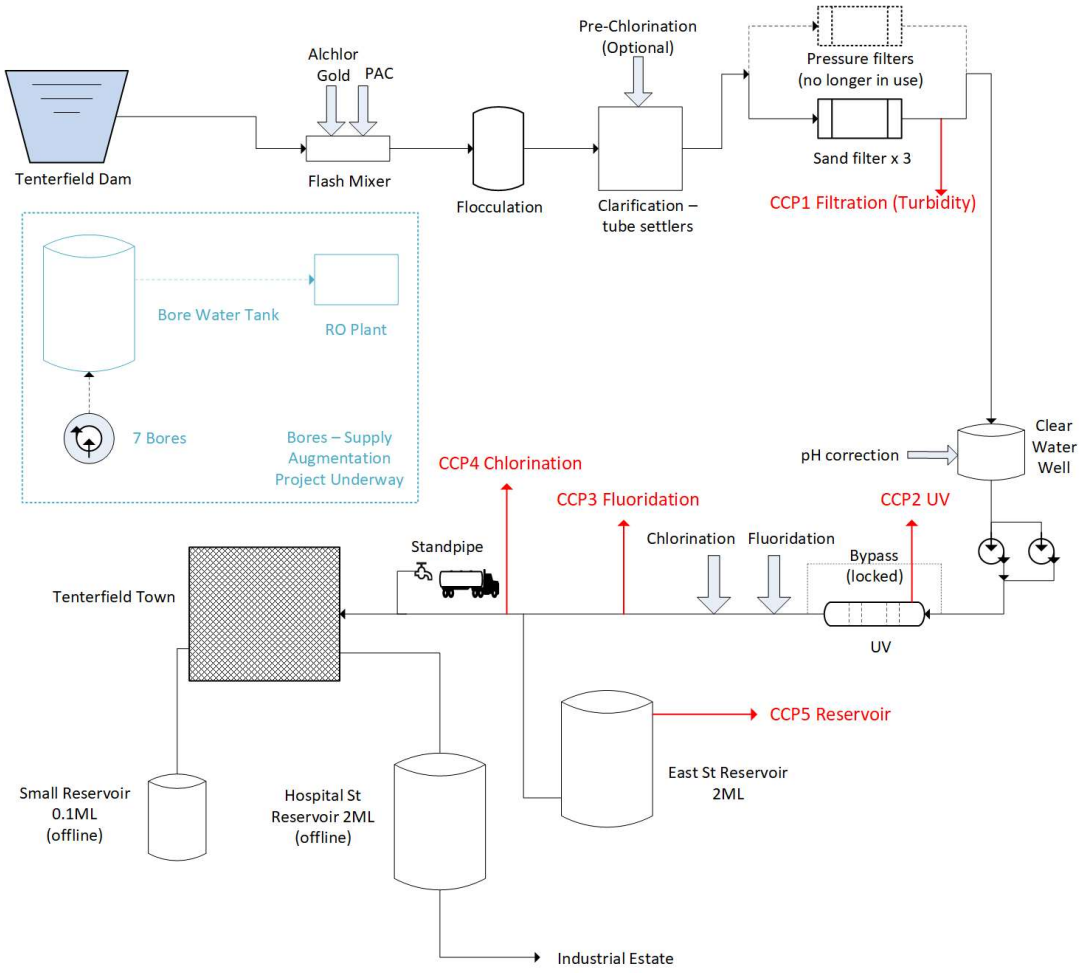


Figure 1 Tenterfield DWSS process flow diagram

2.3. Drinking Water Catchment

Tenterfield sources raw water from the Tenterfield Dam (off the Tenterfield Creek) and the Shirley Park Bore (secondary source).

Tenterfield Creek is in the east of the Border Rivers catchment and is a tributary of the Dumaresq River, which forms part of the state border between Queensland and NSW.

Tenterfield Creek's total catchment area to town is 83 km^2 of which 33 km^2 drains into the upstream water supply dam. The other tributary catchments draining into the town catchment are Groombridge's Creek (19 km^2), Currys Gap Creek (17 km^2) and two other unnamed creeks east of the town (14 km^2).

The dominant land use in the catchment is cattle grazing. Tenterfield Creek experiences extended periods of low flow with the dam being prone to algal outbreaks. The dam is prone to effects from both drought and flood.

There is farming and estate housing close to the dam. Currently the housing estate has low density but this may increase in the future. Agriculture is the predominant activity upstream.

A secondary source of water supply for emergency purposes is from Council's production bore installed in the early to mid 1990's at Shirley Park. The bore was drilled to a total depth of 96 m and the bore is equipped with a submersible pump at 62 m below ground level. The bore is sealed at the surface with a concrete pad, and the bore is constructed with a PVC casing. Housing, school and more parkland surround Shirley Park.

As-constructed documentation for the bore identifies a sustainable yield of 6 L/s, and is only capable or augmenting, not replacing, the surface water supply. It is likely the bore taps an area of significant fracturing. The longest period the bore has been operated by Council is 70 days, with the long period of continuous use being 20 days.

The maximum extraction from Shirley Park bore in recent year has been around 65 ML/year. The supply tank at Shirley Park also supplies stock water and a small amount of bulk water for road works when other supplies have been exhausted.

In January 2011 the Shirley Park bore was damaged during the floods. Council undertook investigations and plan to bring the bore back online in the near future.

2.4. Water Treatment Process

Raw water is sourced from Tenterfield Creek and treated before distribution. The off-take level from the dam is variable and is gravity fed to the WTP. Pumping from the creek is controlled via telemetry based on levels in the reservoir.

The Tenterfield WTP has a capacity of 5 ML per day and is currently capable of meeting demand for the scheme in the medium term. A process flow diagram of the treatment process at the WTP is shown in Figure 1.

The treatment process at the Tenterfield WTP comprises the following process steps:

- Raw water is dosed with Soda Ash, Alchlor Gold and Powdered Activated Carbon (PAC) as it enters the WTP to aid coagulation and flocculation
- The dosed water flows to the flocculation chamber and clarification-tube settlers where it undergoes settling
- The clarified water is filtered through three sand filters
- The filtered water undergoes pH correction using caustic
- The filtered water passes through the UV disinfection unit
- UV disinfected water is fluoridated and chlorinated

Figure 1 shows the process flow of the Tenterfield drinking water supply system from source to consumer, as well as the critical control points (CCPs).

The treatment plant at Tenterfield is fenced to prevent vandalism or deliberate contamination of drinking water.

2.5. Distribution

The Tenterfield distribution network is comprised of the East St Reservoir (Concrete, 2 ML) and 56 km of water mains.

2.6. Risk Assessment

The original risk assessment was undertaken as a workshop in 2013 and details included in the Risk Register (excel spreadsheet), available in Council's shared network drive relevant folder. The Risk Register is reviewed periodically.

A risk review of the unacceptable residual risks from 2013 was undertaken in August 2018 as part of the DWMS review process and the Risk Register updated accordingly. Operators play a crucial role in risk assessment and management and are part of the core ongoing risk assessment team.

3. Element 3 – Preventive Measures

3.1. Preventative Measures and multiple barriers

The preventive measures were identified and assessed during the risk workshop and have been documented, alongside the significant risks that they address, in the Risk Register.

The key barriers include: treatment process steps, maintaining integrity of the distribution network and reservoir and maintaining an adequate residual chlorine level in the network.

3.2. 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.

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

- *Target Level:* representing day to day operational limits and procedures. This is what is to be achieved
- *Alert Level:* deviation to this level 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
- *Critical Limit:* deviation from the critical limit indicates loss of control and the potential of unacceptable health risks. If the critical limit is exceeded, corrective actions should be immediately activated, and the PHU notified immediately.

The CCPs were reviewed in August 2018, with consensus from the combined knowledge of the risk team.

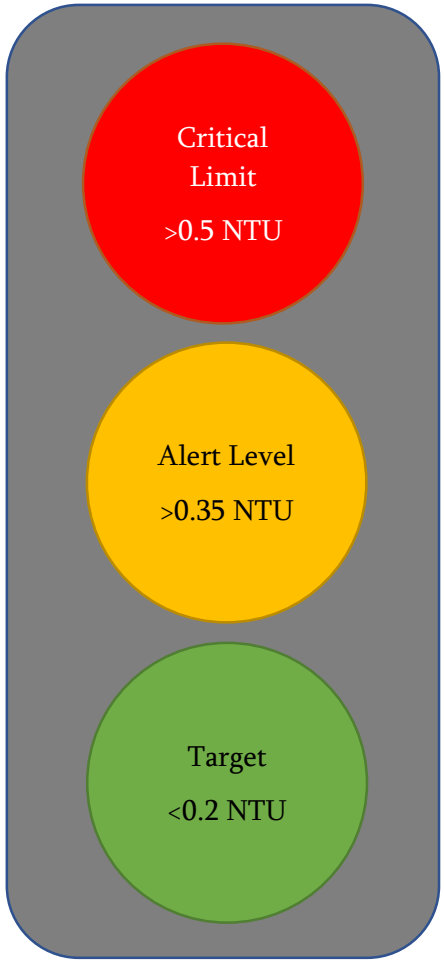
The CCP and CCP SOPs for the Tenterfield supply are included below and is summarised in Table 2.

Table 2 Tenterfield drinking water scheme Critical Control Points (CCPs)

CCP	Control Parameter	Location	Target	Alert Level	Critical Limit	Justification
Filtration	Turbidity	Filter outlet	<0.2 NTU	>0.35 NTU	>0.5 NTU	Critical limit is set to ensure protozoa control and effectiveness of disinfection.
UV	Lamp intensity	At UV Reactor	100%	<93%	<86%	Critical limit set to ensure effectiveness of disinfection for bacterial and protozoan pathogens.
Fluoridation	Fluoride	WTP outlet	1.0 mg/L	<0.9 mg/L or >1.1 mg/L	>1.5 mg/L	Critical limit is set to ensure compliance with ADWG health-based target for fluoride.
Disinfection	Free chlorine	First customer	2.3 – 3.5 mg/L	<2.3 or >3.5 mg/L	<1.8 mg/L	Critical limit ensures adequate C.*t* and having at least 0.2 mg/L at network extremities.
Reservoir	Integrity	Reservoirs	No breach	Poor reservoir condition	Evidence of vermin	NSW Health advice and guidance.

3.2.1. Procedure: Tenterfield Filtration CCP

What is being measured?	Post filter turbidity
Where/how is it measured?	Filtered water turbidity (individual filters and combined), grab Sample (daily)
What is the control point?	Filtration
What are the hazards?	Pathogens, turbidity



- If >0.5 NTU is observed on the PLC (when the PLC screen is viewed and/or reviewed for the day), verify the timeframe for the >0.5 NTU event. If the turbidity spike shows >0.5 NTU for >15 mins, then it is/was a CCP critical limit breach.
- Report to the PHU ASAP. See the Drinking Water Incident Response Plan for further details on the reporting process.
- Repeat corrective actions from alert level (below)
- Consider shutting down plant.
- Check turbidity and chlorine residual in the reservoirs and reticulation
- Increase monitoring until system conforms
- Reporting/records: See the Drinking Water Incident Response Plan for further details on the reporting process. Fill in the Water quality incident reporting form. Call the NSW Health PHU (EHO on duty on 02 6764 8000). DPIE Water can be contacted for operational advice.

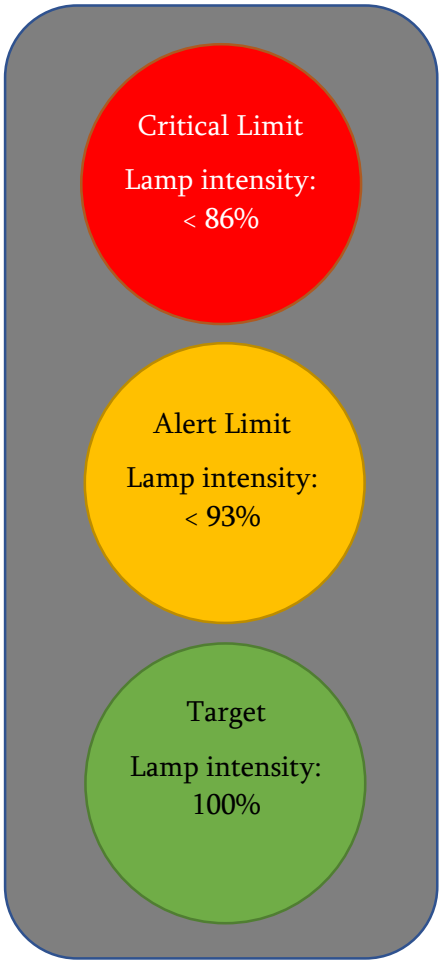
Alert Level

- If >0.35 NTU is observed on the PLC (when the PLC screen is viewed and/or reviewed for the day), verify the timeframe for the >0.35 NTU event. If the turbidity spike shows >0.35 NTU for >15 mins, then it is an alert limit breach.
- Re-test immediately with a grab sample to verify result.
- Check calibration records and re-calibrate test equipment if required.
- Check status of backwash, backwash if required
- Check status of coagulation and flocculation processes, adjust using jar testing as required
- Inform Supervisor/Manager as soon as possible
- Increase monitoring until system conforms.
- Maintain records as relevant.

- Daily plant checks and duties
- Daily process and treated water monitoring

3.2.2. Procedure: Tenterfield UV CCP

What is being measured?	UV Lamp Intensity (%)
Where/how is it measured?	At UV reactor – online (continuous)
What is the control point?	UV disinfection
What are the hazards?	Pathogens (chlorine resistant)



- Report to the PHU ASAP. See the Drinking Water Incident Response Plan for further details on the reporting process.
- Repeat corrective actions from alert level (below)
- Consider shutting down plant
- Check chlorine residual in the reservoirs and reticulation
- Increase monitoring until system conforms
- Reporting/records: See the Drinking Water Incident Response Plan for further details on the reporting process. Fill in the Water quality incident reporting form. Call the NSW Health PHU (EHO on duty on 02 6764 8000). DPIE Water can be contacted for operational advice.

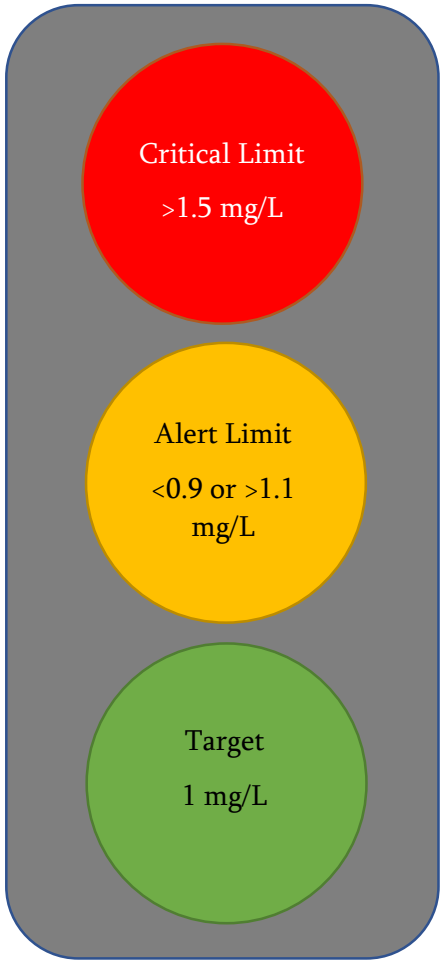
Alert Level

- Detailed inspection of the UV system to fix any issues.
- Ensure external surfaces of the lamp sleeves and other wetted components are not fouled.
- Ensure upstream treatment processes are working effectively.
- Determine need to replace lamp
- Re-check intensity reading
- Inform Supervisor/Manager as soon as possible
- Increase monitoring until system conforms
- Maintain records as relevant.

- Daily plant checks and duties
- Daily process and treated water monitoring

3.2.3. Procedure: Tenterfield Fluoridation CCP

What is being measured?	Fluoride (mg/L)
Where/how is it measured?	WTP outlet – Grab Sample (Daily)/continuous (online)
What is the control point?	Fluoridation
What are the hazards?	Fluoride



- Report to the PHU ASAP. See the Drinking Water Incident Response Plan for further details on the reporting process.
- Repeat corrective actions from alert level (below)
- Turn off fluoride dosing plant.
- Check fluoride in reticulation to ensure it is not > 1.5 mg/L.
- Follow Fluoride Overdose Response Plan in NSW Code of Practice for the Fluoridation of Public Water Supplies and in Councils DWQ Incident Response Plan.
- Fill out Form 5 from NSW Code of Practice for the Fluoridation of Public Water Supplies
- Reporting/records: See the Drinking Water Incident Response Plan for further details on the reporting process. Fill in the Water quality incident reporting form. Call the NSW Health PHU (EHO on duty on 02 6764 8000). DPIE Water can be contacted for operational advice.

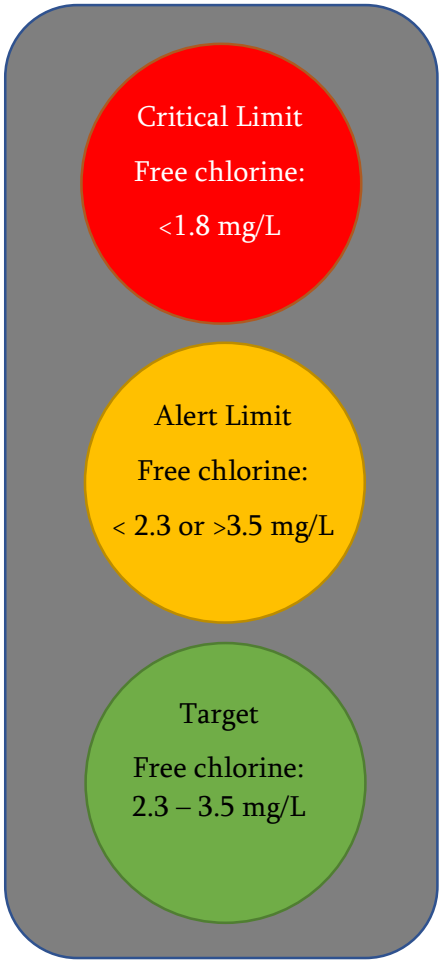
<u>Alert Level</u>

- Re-test immediately to verify result.
- Check fluoride dosing unit
- Recalibrate fluoride meter
- Perform drop test on fluoride dosing pumps and adjust stroke as required
- If > 1.1: Check natural fluoride levels, Decrease dose, as relevant
- If < 0.9: Check for clumping in fluoride tank and break up clumps to ensure adequate batching concentration, Increase dose, as relevant
- Troubleshoot system to find problem and implement corrective actions
- Increase monitoring until system conforms
- Maintain records as relevant

- Daily delivery water fluoride monitoring
- Weekly fluoride reticulation monitoring: enter results into NSW Health database
- Daily:
  - check fluoride plant, batch fluoride day tank, fill out fluoride log, fill out forms as per NSW Code of Practice for the Fluoridation of Public Water Supplies
- Weekly:
  - calibrate fluoride meter, stocktake chemical, fluoride calculations

3.2.4. Procedure: Tenterfield Chlorination CCP

What is being measured?	Chlorine residual (mg/L)
Where/how is it measured?	Chlorine: First Customer – Grab sample (daily)
What is the control point?	Disinfection
What are the hazards?	Pathogens (chlorine sensitive)



- Report to the PHU ASAP. See the Drinking Water Incident Response Plan for further details on the reporting process.
- Repeat corrective actions from alert level (below)
- Consider shutting down plant
- Check chlorine residual in the reservoirs and reticulation.
- Reporting/records: See the Drinking Water Incident Response Plan for further details on the reporting process. Fill in the Water quality incident reporting form. Call the NSW Health PHU (EHO on duty on 02 6764 8000). DPIE Water can be contacted for operational advice.

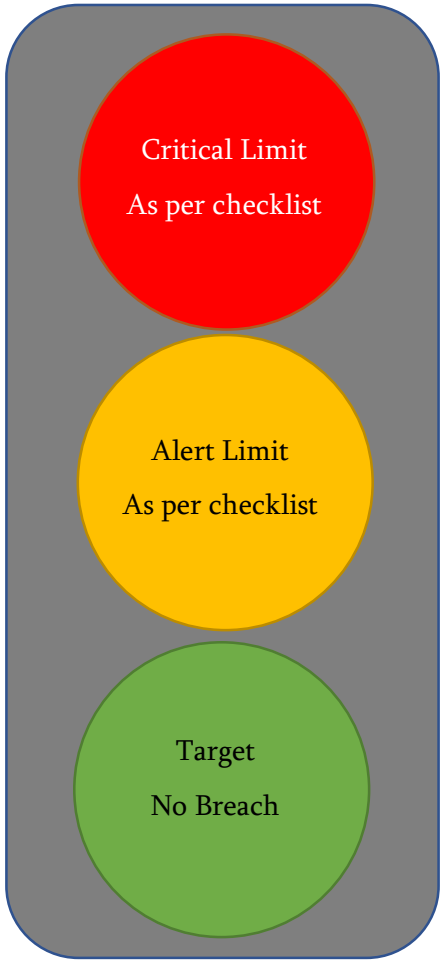
Alert Level

- Re-test immediately to verify result.
- Check calibration records and re-calibrate test equipment if required.
- Adjust chlorine dosing as necessary
- Detailed inspection of the chlorine dosing system to fix any issues.
- Rectify the issue as relevant.
- Inform Supervisor as soon as possible
- Increase monitoring until system conforms
- Maintain records as relevant.

- Daily plant checks and duties
- Daily process and treated water monitoring

3.2.5. Procedure: Tenterfield Reservoir CCP

What is being measured?	Integrity of Reservoirs as per the Reservoir Inspection Checklist
Where/how is it measured?	Reservoirs - Weekly (visual), Monthly (detailed using the checklist), Event based – visual following a significant storm/high winds
What is the control point?	Reservoirs
What are the hazards?	Pathogens, contaminants.



- Report to the PHU ASAP. See the Drinking Water Incident Response Plan for further details on the reporting process.
- Isolate reservoir, if possible
- Remove source of contamination and/or repair asset
- Repeat corrective actions from alert level (below)
- Bring storage back into service with the approval of the Manager
- For long repair times, increase operational monitoring frequency
- Review current security measures and procedures
- Reporting/records: See the Drinking Water Incident Response Plan for further details on the reporting process. Fill in the Water quality incident reporting form. Call the NSW Health PHU (EHO on duty on 02 6764 8000). DPIE Water can be contacted for operational advice.

Alert Level

- Repair asset
- If possible, take immediate action to rectify breach
- If unable to immediately repair, report breach to supervisor/manager
- Undertake testing of chlorine residual and consider micro test
- Manually dose reservoir or increase dosing at the plant and retest chlorine residual
- Review current security measures and procedures
- Maintain records as relevant

- Undertake regular reservoir inspections
- Ensure integrity is not compromised

3.2.6. Reservoir Inspection Checklist

Frequency: Weekly – visual, Monthly – using this checklist

If any question (Q) is marked "**No**" it means follow up action needs to be undertaken, the Supervisor/Manager should be contacted as soon as possible. Notify PHU ASAP for 'No' to Q1.

TARGET	ALERT	CRITICAL
No Breach	Site or reservoir condition poor. "No" for Q2 – Q6.	Evidence of vermin. "No" for Q1.

Drinking water supply: _____ Inspection date: _____

Reservoir name: _____ Inspected by: _____

Question	☐Yes	☐No	Comments
1. The reservoir (inside) is free from evidence of vermin e.g. birds, possums or other animals)? (no feathers, no start of a nest etc.).			
2. The reservoir and its roof are secure from entry by vermin? (i.e. no open holes/gaps or damaged screens)			
3. The reservoir is secure from entry of rainwater from roof runoff? (i.e. no leaks or holes in the roof, inspection hatch has a raised lip).			
4. Reservoir wall generally in good condition? (i.e. no leaks, major cracks, vegetation growth)			
5. Security measures, as relevant, are intact? (i.e. fence and gate closed, access ladder locked).			
6. Roof platforms, walkways, handrails, as relevant, in good condition?			

Additional notes (if any):

Follow up required by Supervisor: ☐ **Yes** ☐ **No**

Notify PHU for Critical breach

Follow up action/s:

Signature (date/time): _____

4. Element 4 – Operational Procedures and Process Control

4.1. Operational Procedures

Key SOPs available currently for use by operator are for all CCPs and reservoir inspection (refer to Section 3.2)

Other SOPs available are identified in the overall DWMS.

4.2. Operational Monitoring and Corrective Actions

Operational monitoring is conducted by Council for the Tenterfield scheme in accordance with the Tenterfield Water Filtration Plant – Weekly Analytical Sheet. This sheet includes the targets (or action triggers) for general key operational monitoring parameters. Corrective actions are then undertaken by the operators such as jar tests, process checks, dosing adjustments, investigations upstream of process, consultation with the supervisor (DPIE Water inspector, if needed).

Corrective of for CCPs are included in the CCP procedures as outlined in Section 3.2.

4.3. Inspection, Calibration and Maintenance

Inspections are undertaken by operators to check the functioning of the equipment and assets. Table 3 summarises the general schedule of the inspections for the Tenterfield supply scheme.

Table 3 Inspection Schedule

Activity	Frequency
Check all equipment at the WTP	Daily
Check dam structure integrity (visual)	Daily
Checks at reservoirs	Weekly (visual), monthly using the reservoir checklist
Leak detection	As required

Calibrations are undertaken periodically in house for benchtop monitoring equipment. Inline testing equipment is calibrated annually by external contractors. The operators and supervisor ensure that any testing equipment is calibrated when required. Checklists and recordings of calibrations results, including frequency of calibration are used.

4.4. Materials and Chemicals

All chemicals are packaged (dry and bagged) for the Tenterfield Supply System (Table 4). The chemicals are unloaded by the operators on duty and stored appropriately at bunded areas. Visual inspections are conducted on all chemicals when received. TSC receives a certificate of analysis from chemical suppliers. The SOP for chemical procurement is under development.

Table 4 Chemicals used in the Tenterfield drinking water supply scheme

Chemical	Purpose	Procurement*
Soda Ash	pH adjustment	Redox
Alum	Coagulation	Redox
Chlorine	Primary Disinfectant	Orica
Sodium Fluoride	Fluoridation for dental health	Redox
PAC	Odour and taste treatment	Filchem
Caustic	pH adjustment	Omega
UV Lamp	UV Disinfection	Prominent
***Supplier is subject to change**		

5. Element 5 - Verification of Drinking Water Quality

5.1. Drinking water quality monitoring

NSW Health Drinking Water Monitoring Program provides ongoing independent verification of the treatment process. Frequency of sampling is based on population. The Program assesses 36 routine parameters for microbial, physical and chemical properties of the water.

Microbial samples are collected weekly and chemical samples are collected twice a year by Council's Water Operator from various sites and sent to the Richmond Water Laboratories for testing.

Verification monitoring locations within the reticulation network were identified in consultation with the PHU to ensure appropriate representation of the system. The monitoring sites for the NSW Health Drinking Water Monitoring Program (tested on a rotational basis) are:

- Market Square
- Shirley Park
- Information Centre
- STP Tap
- Saddler Creek Park
- Rotary Park

5.2. Consumer satisfaction

Where any water quality complaint is received directly by the operators, the complaint is reported so that it is logged into Council's records management system.

The Supervisor should ensure that the details are relayed back to the Council customer service staff.

5.3. Short-term evaluation of results and corrective actions

Water operators undertake short term review of water quality results/data against the targets/limits and enter operational data into log sheets, corrective actions are undertaken where required (e.g. using relevant CCP SOPs, as required).

Review of the results for the NSW Health Drinking Water Monitoring program is undertaken by the testing laboratory and any exceedance is notified by the laboratory to relevant Council staff and the local PHU.

Water quality incidents are managed as explained in Section 6. The communication and reporting lines are described in the relevant SOPs.

6. Element 6 - Management of Incidents and Emergencies

Water quality incidents are managed according to the *Drinking Water Quality Incident Response Plan* (separate document). The protocols are based on the NSW Health Response Protocols.

Relevant incidents are recorded in the water quality incident reporting form, included in the Plan.

Water staff use this form to record incidents, as relevant.

The need to issue (and withdraw) a boil water alert is assessed in consultation with the local PHU (explained in the Plan). Management of the significant incidents and emergencies is covered by Council's Emergency Management Plan.

Operators are also encouraged to discuss water quality issues and improvements with the Supervisor/Manager as relevant.

7. Element 7 - Employee awareness and training

Operators are encouraged to discuss any additional or further training needs with their supervisor.

8. Element 9 – Research and Development

Research is undertaken for the water scheme as identified during risk assessments to increase understanding of the system.

Operators are encouraged to take part in any research and also to discuss any relevant research idea with the Supervisor/Manager.

Investigation on the disinfection processes used was undertaken by Viridis Consultants. Disinfection for the Tenterfield supply includes two elements: chlorination and UV disinfection.

The effectiveness of chlorine-based disinfection depends on several factors. The concentration of the disinfectant, contact time, turbidity, temperature and pH can provide useful indication of microbial quality control. For effective chlorination, the turbidity should be <1 NTU and pH <8. The effectiveness of chlorination is generally predicted by contact time (C.*t*.).

The C.*t* concept describes the relative effectiveness of a specific disinfectant against different microorganisms under specified conditions. It is determined by multiplying the concentration of residual disinfectant (in mg/L) by the contact time (in minutes). C.*t* values for inactivation of bacteria and viruses are highly dependent on the temperature and pH of the water. C.*t* values for specific organisms exposed to particular disinfectants have been established through laboratory experiments, however generally in clean water, a residual chlorine level of 0.5 mg/L after a contact time of 30 minutes should be sufficient to ensure microbial control, given a clean distribution system and no significant recontamination (ADWG 2011).

The scheme at Tenterfield also includes UV disinfection via a medium-pressure UV reactor. The key predictor of disinfection capability for UV disinfection is UV dose, measured in mJ/cm^2, however disinfection performance is also affected by UV transmissivity (UVT).

A review of disinfection, including options for improving disinfection performance for the Tenterfield scheme was conducted by Viridis Consultants, and is available as a separate report.

The report provided the following recommendations:

- adjustment of the chlorine residual and CCP sampling point to ensure that a C.*t.* of 15 min/mg/L is achieved (included in the current revision of CCPs). The recommendation is to test for chlorine at the first customer point (until the plant is upgraded to provide a chlorine contact tank at the WTP site).
- adjustment of the UV disinfection CCP to improve the multi-barrier protection of the scheme (included in the current revision of CCPs). The recommendation is to undertake corrective actions as per the UV CCP SOP, the intensity should not be manually adjusted by the operator to correct a breach.
- reconfiguration of water reservoir to provide separate inlet and outlet (currently there is a common pipe)

9. Element 10 - Documentation and Record Keeping

This DWMS Subplan, including the CCPs and SOPs documents information pertinent to drinking water quality management for the Tenterfield water supply.

Operators are aware of these documents and implement them.

10. Element 12 - Continual Improvement

Operators are encouraged to discuss and notify upwards (e.g. Supervisor or Manager) on the need for any improvement to drinking water quality management practices.

The key major improvement for the Tenterfield supply (which is part of the Improvement Plan) is to:

> investigate replacement/upgrade of the Tenterfield plant due to issues with decreased plant capacity (as a result of decommissioning of pressure filters), health and safety reasons (some parts of the plant are inaccessible for routine maintenance), lack of online monitoring and SCADA, and high residual water quality risks. The Safe and Secure fund is being investigated for this.

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