

Water Safety Plan

Benneydale Drinking Water Supply



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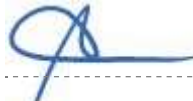
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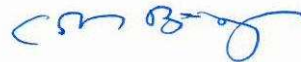
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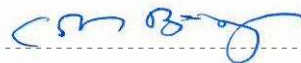
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1. Revision Details

VERSION NO	DESCRIPTION	APPROVED	REVISION DATE
V1	Prepared in 2009	2007	Apr 2012
V2	Prepared in October 2014	Not Approved	Jan 2015
V3	Prepared in March 2011	June 2011	Jan 2016
V4	For approval by Drinking Water Assessor (DWA)		Jun 2023

This plan will be revised and submitted for approval before 31 December 2022.

Assessment of the performance of the plan

Assessment of the performance of this Water Safety Plan (WSP) plan will be undertaken annually. The assessment will consider any events, non-compliances, near misses and unexpected situations that have occurred, progress against the improvement schedule and any changes to any of the supply elements. Any matters requiring attention will be included into the Annual Plan, the Asset Management Plan for Water Supplies and if requiring significant capital funding, the Council Long Term Plan.

Reporting of the plan

A brief report on the performance of the plan, including information from the assessment of the plan will be provided by the Manager Water Services to the General Manager Infrastructure Services annually on the anniversary of finalisation of the plan. The report will cover the items listed above in the assessment of the performance of the plan. The Manager Water Services will be responsible for ensuring that any matters requiring attention will be appropriately included into the Annual Plan or the Asset Management Plan for Water Supplies. If significant capital funding is required, the Manager Water Services will include the matter into the Council approval process and the Council Long Term Plan.

Links to other quality systems

This WSP will be linked to the Annual Plan, the Asset Management Plan for Water Supplies, the Council Long Term Plan and the Council Emergency Response Plan.

2. Introduction

This WSP has been prepared for the Benneydale drinking-water supply to identify potential events that present public health risks to the consumers of the drinking water. Waitomo District Council is committed to the WSP and to the future improvements to the supply that have been identified in this WSP.

The Benneydale water supply provides water to the small community of Benneydale in Waitomo District. The supply is classified as a small drinking-water supply under the Health (Drinking Water) Amendment Act 2007 and provides water to a population of approximately 280 normally resident people.

Water is sourced from a local stream, passes through a storage dam and is filtered, UV disinfected, chlorinated and then stored prior to being distributed to consumers in Benneydale.

The scheme is administered at the main Council offices in Queen Street, Te Kuiti and managed by the Manager Water Services.

The maintenance and operation of the Benneydale drinking-water supply is carried out by Council's Water Services Business Unit (WSBU), supported by external contractors for the provision of reticulation services, McIndoe Group and Neustroski Plumbing and Gas.

3. Supply Details

Table 1. Summary of Benneydale water supply details

Supply Details		
Supply Name	Benneydale	
WINZ Community Code	BEN002	
Supply Owner	Waitomo District Council	
Manager Water Services	Andreas Senger	
Water Supply Operator	Christo de Beer	
Population Served by Supply	280 (WINZ register 23 April 2018)	
Source Details		
Source Name	Benneydale, unnamed stream	
Source WINZ Code	S00416	
Type of Source	Stream	
Consent Number	116844	
Consent Expires	2031	
Maximum Consented water take:	Maximum rate of 180 m ³ /day	
Grid Reference of Source (NZTM)	Easting: 2716703	Northing: 6294390
Source Details – Bore		
Source Name	Benneydale Bore	
Source WINZ Code	GO1921	
Type of Source	Groundwater	
Depth of Bore	17 metres	
Consent No.	116274	
Consent Expires	2022	
Maximum Consented water take:	Maximum rate of 180m ³ /day	
Grid Reference of Source (NZTM)	Easting: 2716628	Northing: 6294471
Treatment		
Plant Name	Benneydale	
Plant WINZ Code	TP00705	
Location	Maniaiti Road, Benneydale	
Treatment Processes	Adsorption clarifier; DE filtration; UV disinfection; chlorination	
Average Daily Volume	80 m ³ /day	
Distribution		
Distribution Zone Name	Benneydale	
Distribution Zone WINZ Code	BEN002BE	
Distribution Zone Population	280 (WINZ register 23 April 2018)	

4. Description of the Benneydale Water Supply

The Benneydale drinking water supply was first established in 1948, abstracting water from an unnamed tributary of the Mangapehi Stream. The supply then consisted of a dam/weir, concrete reservoir and distribution network which served the local coal mining community. During the late 1980's the water supply was upgraded to include a treatment plant consisting of sand filtration and chlorination. The intake dam structure was also upgraded with the construction of the current earth dam structure with a concrete weir/spillway. Water is gravity fed to the treatment plant from the intake located in the impounded section of the stream.

In 2005 the treatment plant underwent another significant upgrade to improve the quality of the treated water. This upgrade consisted of the installation of an adsorption clarifier and a diatomaceous earth (DE) filter. The existing sand filters were converted into sedimentation tanks to reduce the turbidity loading on the clarifier and DE filter. The chlorine dosing control system was also upgraded and a chlorine analyser installed. Chlorine is dosed in the form of sodium hypochlorite solution to the inlet of the polyethylene chlorine contact tank.

A further upgrade in 2013 added a UV disinfection reactor to provide 3-log inactivation of protozoa.

The current arrangement abstracts water from a small impoundment formed by an earth dam in the Mangapehi Stream. The catchment is relatively steep and consists primarily of native bush with a small area of farmland at the top of the catchment. The quality of water provided by the catchment is considered relatively good and is expected to have a very low level of protozoa contamination, if any. An assessment of the catchment carried out 2015 identified that the supply requires bacterial treatment and protozoa removal to log 3.

Water flows from the impoundment to settling tanks where the retention time allows some settling of solids. From the settling tanks, water flows to an adsorption clarifier. This is not a clarifier as such but a roughing filter. It is backwashed from time to time based on the turbidity leaving the filter. From the adsorption clarifier water flows to a wet well prior to further treatment processes.

Water can also be abstracted from a bore located adjacent to the primary stream source approximately 500 metres downstream from the impoundment area. The bore abstracts water from a depth of 17 metres and supplies it to the wet well. It is used to supplement the supply when the stream water and hence the impoundment water has high turbidity. The turbidity of the stream water is continuously monitored and if levels exceed 10 NTU, the stream source is isolated and the bore pump activated. This trigger point can be adjusted by the operator. The turbidity of the bore water and the treated water are also continuously monitored and discharged to waste prior to the DE filter if turbidity in the treated water exceeds 1 NTU.

As the bore is relatively shallow and located within the flood plain for the stream, the catchment for the bore water is considered the same as the stream source.

From the wet well the water then flows to a diatomaceous earth (DE) filter. The DE filter uses a pre-coat of DE material loaded on to socks within the filter for the removal of particulate material. From the DE filter water flows to a single, non-validated UV reactor. UV intensity, flow rate and transmittance are continuously monitored. The water is then dosed with sodium hypochlorite. The sodium hypochlorite is purchased in 200 litre containers and dosed via a small dosing pump. The dose rate is manually adjusted to a set point by the operator.

Sodium Hydroxide (caustic soda) is dosed to maintain a pH of between 7.0 and 8.0 to ensure effective disinfection and provide water that is pleasing to consumers thus avoiding substitution with potentially unsafe sources of water.

Water is pumped from the treatment plant to several storage tanks which store a total of 130m³, or about 40 hours supply. This provides more than 30 minutes chlorine contact time. The storage capability of the supply was increased during 2007 with the installation of additional polyethylene water tanks at the original reservoir site. Water is then gravity fed to the distribution system.

In 2006, significant water losses from the distribution system were identified as a major risk to the supply. In 2007 Waitomo District Council, supported with funding from the Ministry of Health, replaced the aging concrete reticulation network in Benneydale. The rising main between the treatment plant and the reservoir site was also replaced. When this work was completed the average daily demand reduced by approximately 60%. The distribution system is some 5,800m consisting of MDPE and PVC pipes. The network condition is assumed to be excellent due to the age of the pipes.

There are some 122 connections, with no major industrial users on this supply. The supply feeds one primary school.

Treated water turbidity and FAC are continuously monitored and alarmed with outputs telemetered to the operators and Waitomo District Council. Weekly sampling for *E. coli* is taken from water leaving the treatment plant and water in the distribution zone.

The supply currently complies with the bacterial and chemical requirements of the Drinking Water Standards for New Zealand 2005 (Revised 2008). Validation certification has not been obtained for the UV disinfection unit, and this is required to confirm that protozoa requirements are met.

The land on which the plant components are located is owned by Waitomo District Council.

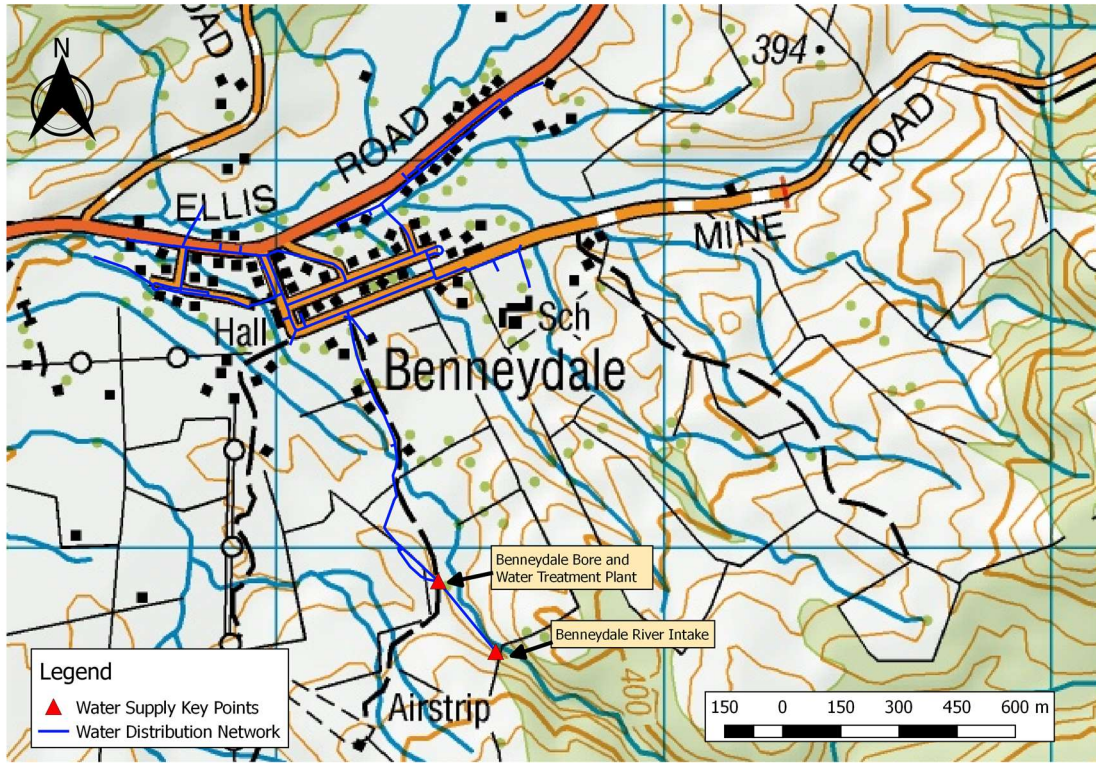


Figure 1. Location of Benneydale drinking water supply and source catchment

5. Benneydale Water Supply Photos

The following photos were taken on a site visit to the Benneydale water supply on 21 June 2017.



Figure 2. Dam and impoundment



Figure 3. Treatment plant



Figure 4. Bore head



Figure 5. UV reactor



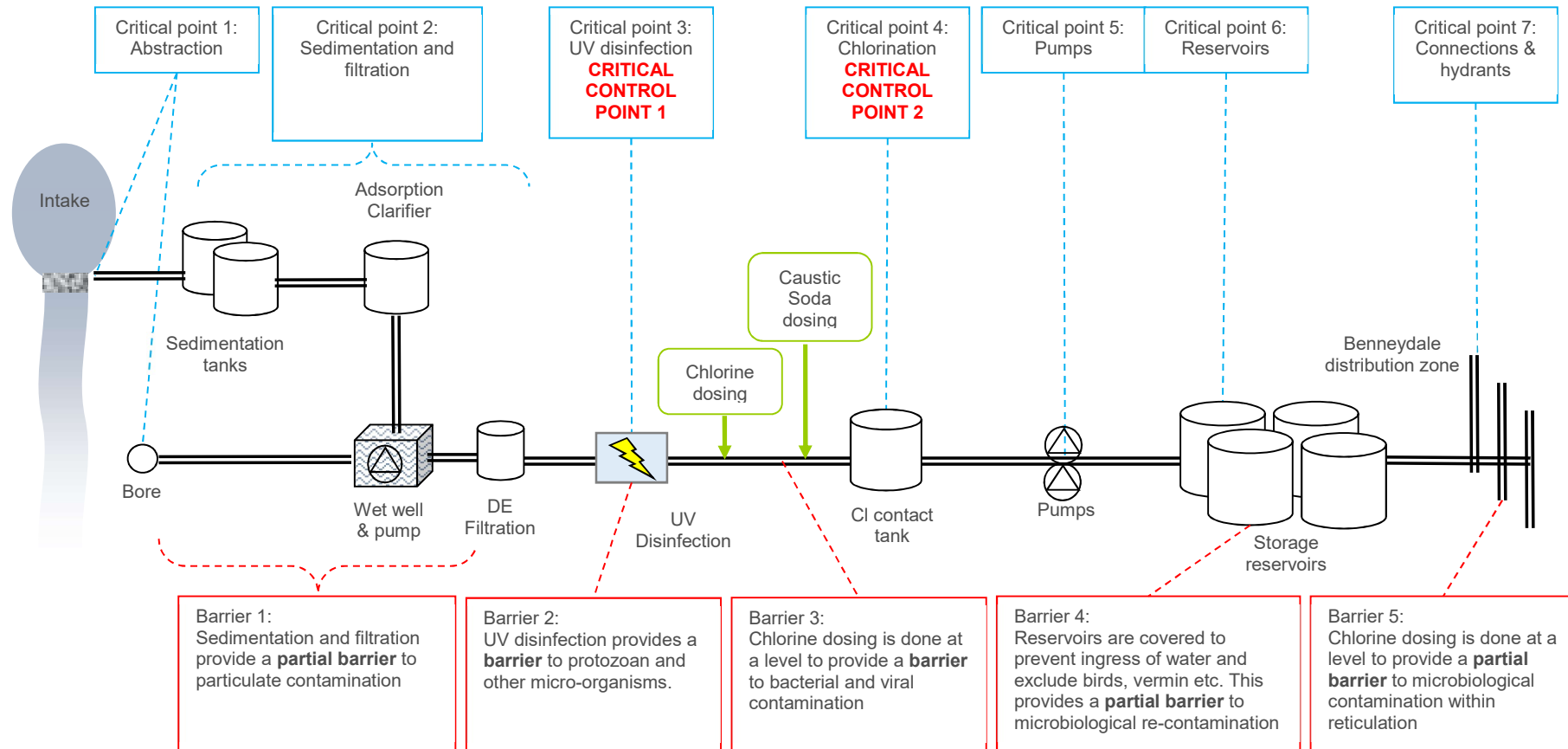
Figure 6. Online monitoring equipment



Figure 7. Treated water reservoirs

6. Flow Chart/Schematic of the Supply

Figure 8. Supply schematic



7. Barriers to Contamination

Table 2. Critical points

Critical points where hazards can be eliminated, minimised or isolated include:

	Critical Point	Description
1.	Intake and bore	<i>Failure of intake, intake pipe or bore means reduced source water availability</i>
2.	Sedimentation and filtration	<i>Failure will result in reduced particle removal</i>
3.	Critical Control Point 1 UV Disinfection	<i>Failure will remove protozoal, bacterial and viral barrier</i>
4.	Critical Control Point 2 Chlorine dosing and pH adjustment	<i>Failure will reduce bacterial and viral control Overdosing may exceed chemical MAV</i>
5.	Pumps	<i>Pumps provide water from the treatment plant to the storage reservoirs. Failure can lead to a loss of supply</i>
6.	Treated water storage	<i>Possible point for microbiological contamination</i>
7.	Distribution system hydrants and connections	<i>Possible access point for contamination and backflow</i>

Existing barriers to contamination include:

Sedimentation, Filtration

The treatment plant uses sedimentation tanks to enable settling of larger particles from the raw water prior to treatment. Adsorption clarification (filter) and DE filtration further remove particulate matter, micro-organisms and organic matter. These treatment processes provide a **partial barrier to protozoan and particulate contamination**.

Inactivation of pathogenic microbiological organisms

UV light disinfects the water of protozoan and other microbiological organisms. UV provides a **barrier (3-log protozoa) to microbiological contamination**.

Chlorination

The treatment plant uses chlorination to disinfect the water of non-protozoan microbiological organisms. There is at least 30 minutes contact time before the chlorinated water is distributed to consumers, which provides a **barrier to bacterial and viral contamination**.

Prevention of contamination of treated water in storage

The reservoir is covered to prevent unauthorised access and to exclude birds and vermin. This provides a **partial barrier against recontamination** of the water.

Prevention of contamination of treated water while it is in the network reticulation

Maintaining a chlorine residual at a level to protect against microbiological contamination and training of those who work on the reticulation system provides a **barrier against recontamination** of the water in the distribution zone.

8. Critical Control Point Process Control

A Critical Control Point is a point, step or procedure at which controls can be applied and a drinking water safety hazard can be prevented, eliminated or reduced to acceptable (critical) levels. The most common CCPs are filtration and disinfection, where water suppliers designate critical limits.

The Benneydale supply has two critical control points over which process control can be made. The critical control points are:

- UV disinfection which provides a primary barrier to micro-organisms
- Chlorination which provides a barrier to bacterial and viral organisms

8.1. UV Disinfection

Process Objectives

To provide a **primary disinfection control point** to inactivate bacterial, viral and protozoan pathogens that may have entered the water supply system upstream of the UV reactor.

Table 3. UV CCP

OPERATIONAL DAY-TO-DAY MONITORING OF CONTROL PROCESSES		
What	UV intensity (fluence) UV transmittance Turbidity of water entering the UV reactor	
When	Intensity, transmittance and turbidity are continuously monitored	
Where	At the UV reactor	
How	Continuous on-line monitoring analysers with alarms to the operators if measurements approach designated parameters.	
Who	Results are stored on the plant SCADA machine, are transmitted and stored at the Te Kuiti Offices, and are available to operators on their laptop computers.	
Records	All data is recorded digitally to the SCADA historian.	
Process performance criteria at the operational monitoring point.		
Correction required if performance criteria are not met.		
Target Range	• UV intensity: greater than 48mJ/cm ²	No action required
	• UV transmittance: 95%	
	• Turbidity: <0.3 NTU	
Action Limits	• UV intensity: 45mJ/cm ²	Duty operator to regularly monitor intensity dose rate if transmittance or turbidity approach action limits Duty operator notifies the Manager Water Services.
	• UV transmittance: 94%	
	• Turbidity: 0.3 NTU	
Critical Limits	• UV intensity: 42mJ/cm ²	Operator shuts down treatment plant and operates supply from storage until parameters return to within critical limits Duty operator notifies Manager Water Services The Manager Water Services notifies DWA if inadequately treated water needs to be supplied or has been supplied to the community and considers with DWA the need to issue a boil water notice.
	• UV transmittance: 92%	
	• Turbidity: 1.0 NTU	

8.2. Chlorination

Process objectives:

To provide a **disinfection control point** against bacterial and viral pathogens and some protozoan pathogens that may have entered the water supply system upstream of the treatment plant.

Table 4. Chlorination CCP

OPERATIONAL DAY-TO-DAY MONITORING OF CONTROL PROCESSES		
What	Turbidity pH FAC	
When	Turbidity, pH and FAC are continuously monitored	
Where	Post dosing (before the contact tank)	
How	Continuous on-line monitoring analysers with alarms to the operators if measurements approach designated parameters.	
Who	Results are stored on the plant SCADA machine, are transmitted and stored at the Te Kuiti Offices, and are available to operators on their laptop computers.	
Records	All data is recorded digitally to the SCADA historian.	
Process performance criteria at the operational monitoring point.		Correction required if performance criteria are not met.
Target Range	• Turbidity less than 0.1 NTU	No action required
	• FAC between 0.6 – 1.2 mg/L	
	• pH between 7.0 – 7.5	
Action Limits	• Turbidity greater than 0.1 NTU for up to 15 minutes	Refer CCP for filtration and UV
	• FAC between 0.3 – 0.6 mg/L	Operator to respond by checking for faults in dosing system Operator adjusts chlorine dose rate. Operator notifies the Manager Water Services
	• pH greater than 7.5 or less than 7.0	Operator to respond by checking for faults in dosing system. Operator adjusts Sodium Hydroxide dose rate. Operator notifies the Manager Water Services
Critical Limits	• FAC less than 0.2	Operator shuts down treatment plant and operates supply from storage until parameters return to within critical limits Duty operator notifies Manager Water Services The Manager Water Services notifies DWA if inadequately treated water needs to be supplied or has been supplied to the community and considers with DWA the need to issue a boil water notice.
	• Turbidity greater than 1.0 NTU for more than 72 minutes in a day	
	• Turbidity greater than 2.0 NTU for more than 3 minutes	

8.3. Supporting programs

Critical instrumentation is calibrated annually by the suppliers EMC, weekly verification and monthly calibration is performed by the Operators following the process set out in the manufacturers manuals.

9. Improvement Schedule

The improvement schedule outlines improvements that have been recommended for preventing, reducing or eliminating the identified public health risks in the Benneydale water supply. Possible improvements to the water supply have been identified in the 'Additional Measures That Could Be Put in Place' column of the risk tables. The most suitable option to improve the management of each unmanaged risk has then been included in the improvement schedule. It should be noted that costs are estimates only. Each project is ranked according to the priority to which projects should be completed.

MWS – Manager Water Services

TPO – Treatment Plant Operator

RC – Reticulation Contractor

Table 5. Recommended Improvements

PRIORITY	RISK LEVEL	WATER SUPPLY AREA	REFERENCE TO RISK TABLE	PROPOSED WORKS	PERSON RESPONSIBLE	EXPECTED COST	INTENDED COMPLETION DATE
1	Very high	Other	10.5	Develop model training and skills maintenance plan for existing and new operators.	MWS	Staff time	October 2018
2	High	Catchment	1.8	Participate in the establishment and maintenance of a Joint Working Group for Drinking Water with Regional Council and Drinking Water Assessor	MWS	Staff time	End 2018
3	Moderate	Catchment	1.7	Prepare a schedule for monitoring for the presence of Cyanobacteria in the stream water impoundment	MWS	Staff time	End 2018
4	Moderate	UV disinfection	6.7	Obtain validation certification for the UV reactor	MWS	Staff time	End 2018
5	Moderate	Reticulation	9.5	Prepare and implement a formal backflow protection policy that identifies all risk sites, ensures suitable backflow protection devices are installed and all backflow protection devices are tested appropriately	MWS	Staff time	End 2018

10. Benefits of Proposed Improvements

The proposed improvements will provide public health benefits by reducing the risk of adverse health outcomes associated with poor drinking water quality.

The Benneydale treatment plant has recently been upgraded and further improvements to the infrastructure are not required. Improving data collection, developing a Cyanobacteria monitoring schedule, UV validation certificate and working with other agencies to protect the catchment will reduce risks at the supply or provide confidence that the supply is performing as required.

Preparation and implementation of a backflow prevention policy will reduce the risks of contamination of the supply due to a backflow event.

11. Methodology

This WSP has been prepared consistent with the approaches recommended by the Ministry of Health. Supporting documents include the WSP Guides and *A Framework on How to Prepare and Develop Water Safety Plans for Drinking-water Supplies*, Ministry of Health (2014).

A qualitative risk assessment approach has been taken following the guidance notes in Appendix 2 of the “Framework” allowing the prioritisation of improvement needs and development of the Improvement Schedule.

Indicative cost estimates and implementation timeframes have been prepared for the required improvement measures. These will be carried forward to the next Asset Management Plan (AMP) and Council Long Term Plan for approval and inclusion in annual budgets following the statutory public consultation process. Implementation of the Improvement Schedule is ultimately subject to Council funding approval.

The Manager Water Services is responsible for implementation of the Improvement Plan within the timeframes indicated, subject to community and council approvals, funding constraints and availability of resources. The Manager Water Services is also responsible for on-going review and updating of the WSP and associated Improvement Schedule.

Contingency Plans have been prepared to provide guidance in the event that control measures fail to prevent the occurrence of a risk event that may present an acute risk to public health. The Manager Water Services and the WTP Operators are responsible for implementation of the Contingency Plans when monitoring has identified the occurrence of a risk event.

Separate risk tables have been prepared for:

Catchment	Abstraction	Adsorption Clarifier
DE Filter	Bore	UV disinfection
Chlorination	Storage	Reticulation
Other		

12. Risk Ranking Procedure

Potential public health risks have been evaluated using the Likelihood and Consequence scales tabulated below to determine a risk level – low, moderate, high, very high or extreme. The assessed risk level allows prioritisation of the associated improvement measures.

Table 6. Likelihood Scale

Likelihood	Description
Almost certain	Is expected to occur in most circumstances.
Likely	Will probably occur (once in a year)
Possible	Might occur at some time (once in 5 years)
Unlikely	Could occur at some time (once in 15 years).
Rare	Only in exceptional circumstances (once in 25 years).

Table 7. Consequence Scale

Consequences	Description
Insignificant	Insignificant public health impact
Minor	Minor public health impact or inconvenience to supply users
Medium	Moderate public health impact and/or short-term loss of supply
Major	Major public health impact and/or loss of supply for a long period. Small number of water-borne illnesses
Catastrophic	Major public health impact. Significant water-borne illness

Table 8. Risk Level Allocation Table

Likelihood	Consequence				
	Insignificant	Minor	Medium	Major	Catastrophic
Almost certain	Moderate	Moderate	Very High	Extreme	Extreme
Likely	Low	Moderate	High	Very High	Extreme
Possible	Low	Moderate	Moderate	Very High	Very High
Unlikely	Low	Low	Moderate	High	Very High
Rare	Low	Low	Low	Moderate	High

13. Drinking Water Standards and Grading

The Benneydale water supply fully complies with DWSNZ. Table 10 below provides a summary of how compliance is demonstrated. The treatment plant has not yet been graded. The distribution zone has a grade of b.

Table 9. Summary of Compliance with DWSNZ

COMPLIANCE AREA	COMMENTS
Bacterial compliance criteria used for water leaving the treatment plant	Section 10 – Participating supply
Protozoa log removal requirement required for the supply	3-log
Protozoa treatment process	UV disinfection process provides 3-log
Compliance criteria 6A or 6B is used for water in the distribution zone.	Section 10 – Participating supply
Bacterial compliance for water leaving the treatment plant has been achieved for the last 4 quarters.	Yes
Protozoa compliance for water leaving the treatment plant has been achieved for the last 4 quarters.	No – UV reactor validation required
Bacteria compliance for water in the distribution zone has been achieved for the last 4 quarters.	Yes
P2 determinands allocated to supply	None
Chemical compliance achieved for the last 4 quarters.	Yes
Cyanobacteria identified in the supply	No
Cyanobacterial compliance has been achieved for the last 4 quarters.	N/A

14. Consultation

On 21 June 2017, a site visit to the Benneydale water supply was carried out by Mike Charteris of Opus with the Manager Water Services, Waitomo District Council.

An inspection of the source water, treatment plant and other parts of the supply was undertaken. The supply was discussed with the Manager Water Services, including the operation and performance limits, the critical points, critical control points, the treatment barriers, the risks that have been identified, how these risks are managed currently and the improvements that could be put in place. The information provided during this site visit was used to compile the risk tables.

Subsequent to this site visit, telephone discussions and email contact has been used to provide further information necessary for the preparation of this WSP. The WSP was then reviewed by Andreas Senger, Manager Water Services, and Kobus du Toit, General Manager Infrastructure Service, who hosted a workshop with the operators to obtain corrections and details to complete the plan.

15. Contingency Plan

Benneydale Water Supply Contingency Plan	
Type of Event	Required Contingency Action
<p>Inadequate chlorination</p> <p>Indicators: Low FAC (<0.2mg/L) or no FAC reported from treatment plant monitoring.</p>	<p>Manager Water Services: Advise DWA of situation</p> <p>Keep customers informed and advise once regular supply is restored</p> <p>Operator: Inspect chlorination process to identify cause of problem and rectify as quickly as possible</p> <p>Consider advising customers if changes to the character of the water supplied is significant</p>
<p>Severe microbiological contamination of source water (such that treatment is ineffective)</p> <p>Indicators: A contamination event in the supply dam may be observed by or reported to Waitomo District Council staff. May also be indicated by reported illness among consumers or positive <i>E. coli</i> monitoring results.</p>	<p>Manager Water Services: Issue boil water notice to consumers</p> <p>Advise DWA of situation</p> <p>Keep customers informed and advise once regular supply is restored</p> <p>Inspect are around and upstream of the dams/storage ponds to identify source of contamination and rectify problem as quickly as possible.</p> <p>Super chlorinate the reservoirs and distribution system and flush mains if they contain contaminated water</p>
<p>Chemical contamination of source water</p> <p>Indicators: A contamination event in the catchment may be observed by or reported to Waitomo District Council staff. May also be indicated by reported water quality concerns from consumers (taste, odour, colour) or illness among consumers.</p>	<p>Manager Water Services: Advise consumers not to drink the water supply</p> <p>Advise Drinking Water Assessor (DWA)</p> <p>Arrange emergency water supply (tankers) if necessary</p> <p>Assess situation and advise customers regarding use/treatment/disposal of contaminated water</p> <p>Keep customers informed and advise once regular supply is restored</p> <p>Operator: Inspect the supply to identify source of contamination and rectify problem as quickly as possible</p> <p>Flush reservoirs and mains</p>
<p>Insufficient water available for abstraction and treatment or loss of ability to take water from river or bore.</p> <p>Indicators: Observed or reported low river levels</p>	<p>Manager Water Services: Advise customers to conserve water</p> <p>Implement drought management plan and demand management procedures as required</p> <p>Arrange emergency water supply (tankers) if necessary</p> <p>Keep customers informed and advise once regular supply is restored</p>

Benneydale Water Supply Contingency Plan	
Type of Event	Required Contingency Action
<p>Pipe break or other failure posing a risk of an outage of more than 8 hours</p> <p>Indicators: Observed high flow rates or customer complaints</p>	<p>Manager Water Services: Advise customers to conserve water</p> <p>Assess the likely duration of the outage and if necessary, arrange the purchase of bottled water from a major retailer(s) in Te Kuiti (The Warehouse, New World and/or Super Value) and delivery to affected customers.</p> <p>If the number of consumers affected is large, arrange emergency water supply from tankers.</p> <p>Keep customers informed and advise once regular supply is restored.</p>
<p>E. coli transgression in water leaving treatment plant or distribution zone</p> <p>Indicators: E. coli transgression reported following routine monitoring.</p>	<p>Manager Water Services: Advise Drinking Water Assessor (DWA)</p> <p>Operator: Follow transgression response procedure in DWSNZ</p> <p>Commence daily <i>E. coli</i> testing at WTP</p> <p>Use an enumeration test method</p> <p>Sample in distribution system</p> <p>Investigate cause, inspect plant and source</p> <p>Take remedial action</p> <p>Continue to sample for <i>E. coli</i> until 3 consecutive samples are free of <i>E. coli</i></p> <p>If <i>E. coli</i> is found in repeat samples consult with DWA, intensify remedial action, increase disinfection, consider 'Boil Water' notice</p>
<p>Loss of power supply to treatment plant</p>	<p>Manager Water Services: If it is possible that power outage will exceed 24 hours implement demand management</p> <p>Operator: Determine likely length of power outage.</p> <p>Connect portable generator to supply power to the plant</p>
<p>Earthquake, flood or other disaster</p>	<p>Refer to Council Emergency Response Management Plan</p>

Benneydale Water Supply Contingency Plan	
Type of Event	Required Contingency Action
Cyanobacteria/Cyanotoxin contamination identified in source water	<p>Manager Water Services: Advise Drinking Water Assessor (DWA)</p> <p>Assess situation and advise customers regarding use/treatment/disposal of contaminated water</p> <p>Arrange emergency water supply (tankers) if necessary</p> <p>Implement a cyanobacteria monitoring plan and undertake analysis for cyanotoxins to determine the level of toxin contamination</p> <p>Keep customers informed and advise once regular supply is restored</p> <p>Operator: Inspect the supply to identify extent of cyanobacterial growths</p> <p>Flush reservoirs and mains</p>

16. Risk Tables

MWS – Manager Water Services

TPO – Treatment Plant Operator

RC – Reticulation Contractor

Table 10. Risk Tables

1. Catchment											
Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Microbiological Contamination	1.1	Surface contamination from farmland in the catchment and adjacent area	Very high (likely x major)	High raw water <i>E. coli</i> results. Turbidity in raw water Illness in community	The majority of the catchment is covered in native vegetation with no human activities Supply is filtered, chlorinated and UV disinfected FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant	If there is evidence of microbiological contamination post treatment, issue a boil water notice to all consumers	Telemetry readings	Yes	Moderate (likely x minor)	None required	TPO
Microbiological contamination	1.2	Contamination from animals in the area around the intake impounding reservoir	High (likely x medium)	High raw water <i>E. coli</i> results. Turbidity in raw water Illness in community	Supply is filtered, chlorinated and UV disinfected Impoundment area is fenced to exclude stock FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant	If there is evidence of microbiological contamination post treatment, issue a boil water notice to all consumers	Land use changes within the catchment	Yes	Moderate (likely x minor)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Chemical contamination	1.3	Surface runoff containing chemical contaminants from agricultural activities. (e.g. pesticides, fertilisers etc)	Moderate (unlikely x medium)	Taste and/or odour. Complaints or information provided by public about activities in catchment.	Chemical suite is analysed on a five-yearly basis The majority of the catchment is covered in native vegetation with no human activities	If there are any indications of chemical contamination of the source water which exceeds the DWSNZ MAVs consumers must be advised and the supply disconnected at each connection until the issue has been resolved	Chemical suite results provide a five-yearly check, otherwise evidence of a chemical spill or taste and odour complaints indicate contaminants in water	Yes	Low (rare x medium)	None required	MWS
Chemical Contamination	1.4	Naturally occurring chemical contaminants	Moderate (unlikely x medium)	Taste and/or odour. Chemical analysis identifies chemical contaminants in excess of 50% of DWSNZ MAV	Chemical suite is analysed five-yearly Analysis has not identified any naturally occurring chemicals in the source water	If there is evidence of unacceptable contamination of the source water consumers must be advised and the supply disconnected until the issue is better understood	Chemical suite results provide a five-yearly check, otherwise taste and odour complaints indicate contaminants are in stream source water	Yes	Low (rare x medium)	None required	MWS
Chemical Contamination	1.5	Chemical spill contaminates source water upstream of dam	Moderate (rare x major)	Chemical spill is reported Complaints of taste or odour	Dam is distant from any vehicle tracks and there is no bulk storage of chemicals	If there are any indications of chemical contamination of the treated water, consumers must be advised and the supply disconnected at each connection until the issue has been resolved	Notifications of chemical spills in catchment Taste and odour complaints	Yes	Low (rare x minor)	None required	MWS

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of Supply	1.6	Drought reduces quantity of water that can be abstracted	High (unlikely x major)	Prolonged drought or low rainfall conditions Reduced flows to treatment plant/low reservoir level	Bore water source can be used to supplement stream source during periods of low flow Drought Management Plan can be implemented during drought or low rainfall conditions	Implement water demand management measures	Cumulative rainfall Stream levels Groundwater levels	Yes	Moderate (rare x major)	None required	MWS
Cyanobacterial or Cyanotoxin contamination	1.7	Cyanobacterial growth in the dam	High (unlikely x major)	Visible presence of cyanobacteria Taste and/or odour complaints from customers	Bore water can be used if the surface water source becomes contaminated with cyanotoxin Sampling programme has not identified Cyanobacteria in supply	If there are any indications of cyanotoxins in the supply, consumers must be advised and the supply disconnected at each connection until the issue has been resolved	Growth of Algal mats on the dam Algal count Cyanotoxin analysis	Partially	Moderate (rare x major)	Prepare a schedule for monitoring for the presence of Cyanobacteria in the stream water impoundment	MWS
Contamination of source waters	1.8	Poor application of the NES for Sources of Human Drinking Water to upstream activities	High (unlikely x major)	Lack of regular communication with Regional Authority Consents are granted for catchment activities without robust controls	Regular contact is maintained with the Regional Council consents team Council is a member of the Central North Island Water Managers Working Group who will actively seek establishment of Joint Working Groups with DWA and Regional Councils	Initiate regular meetings with Regional Council	Consent notifications in local media Regional Council resource consent maps Frequency of meetings	Partially	High (unlikely x major)	Participate in the establishment and maintenance of a Joint Working Group for Drinking Water with Regional Council and Drinking Water Assessors	MWS

2. Abstraction

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of Supply	2.1	Intentional vandalism or accidental damage to the intake structures resulting in inability to draw water	Low (unlikely x minor)	Reduced/no flow to treatment plant Obvious signs of damage to structure. Telemetry transmitting low reservoir level	Intake is a simple structure that would be hard to damage Intake is remote and not easily accessed, and access is past the farmhouse Bore provides alternative source of water	Use bore water while repairs are completed	Flow to treatment plant	Yes	Low (rare x minor)	None required	TPO
Loss of Supply	2.2	Damage to intake or pipeline from natural event (flood, slip) resulting in inability to draw or convey water	Moderate (possible x medium)	Reduced/no flow to treatment plant Obvious signs of damage to structure. Telemetry transmitting low reservoir level	Bore provides alternative source of water Regular maintenance regime in place	Use bore water while repairs are completed	Flow to treatment plant Maintain watch on slope stability	Yes	Low (possible x minor)	None required	TPO
Loss of supply	2.3	Silt/debris build up behind the dam/weir reduces the ability to abstract water	Very high (possible x medium)	Reduced/no flow to treatment plant Telemetry alarm	Impoundment reservoir was recently cleaned (2017) Bore provides an alternative source of water. Regular maintenance regime in place.	Use bore water while dam is cleaned	Flow to treatment plant Silt levels	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of right to take Water	2.4	Consent to take water is not renewed or is declined by the Regional Council.	Very High (possible x major)	Plan to renew consent is not being actioned 1 year prior to consent expiry	Stream consent is valid until 2031, and bore consent is valid until 2022 Application for replacement consents will be made prior to existing consents expiring	Renew consent before it expires	Nothing to check	Yes	High (unlikely x major)	None required	MWS

3. Adsorption Clarifier

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Particles not removed	3.1	No coagulant is dosed prior to the adsorption clarifier	High (likely x medium)	High sediment carry over to DE filter DE filter requiring more frequent media replacement	Turbidity is continuously monitored in raw and filtered water The plant automatically switches to bore supply which bypasses the clarifier when high turbidity is detected in the stream FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant	Change to bore source if turbidity approaches 1 NTU If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry readings	Yes	Moderate (possible x medium)	None required	MWS
	3.2	Fluctuating flow rate	High (likely x medium)	High sediment carry over to DE filter DE filter requiring more frequent media replacement	Turbidity is continuously monitored in both raw and filtered water Settling tanks prior to clarifier provide a buffer against flow rate fluctuations FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant Bore supply available which bypasses clarifier	Change to bore source if turbidity approaches 1 NTU If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry readings	Yes	Moderate (unlikely x medium)	None required	TPO

Event No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Particles not removed	3.3 Insufficient head to backwash filter adequately.	Moderate (possible x medium)	High sediment carry over to DE filter DE filter requiring more frequent media replacement	Backwash water is supplied from a tank located at the elevated reservoir site. Bore supply available which bypasses clarifier	Change to bore source if turbidity approaches 1 NTU If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry readings	Yes	Moderate (unlikely x medium)	None required	TPO
Particles not removed	3.4 Deterioration or loss of clarifier filter media from successive backwashing	Moderate (possible x medium)	High sediment carry over to DE filter DE filter requiring more frequent media replacement	Filter media installed in 2005.	Cease treatment if turbidity exceeds 1 NTU and supply from stored water Top up or replace media If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry readings	Yes	Moderate (unlikely x medium)	None required	TPO
No water flow through clarifier	3.5 Clarifier blockage	Moderate (possible x medium)	No flow from clarifier Clarifier blockage alarm activated	Bore supply available which bypasses clarifier Wet well level alarms	Use bore water while attending to clarifier blockage Force manual backwash Check for other cause of blockage	Telemetry readings Backwash tank level	Yes	Low (rare x medium)	None required	TPO

4. Diatomaceous Earth Filter

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Particles not removed	4.1	High suspended solids load and/or flow rate fluctuations during periods of high demand.	Very high (Possible x major)	High sediment carry over to UV disinfection Filter requiring backwashing more frequently	Turbidity is continuously monitored in both raw and treated water Sedimentation tanks buffer against flow changes Bore supply is automatically started during high turbidity in stream FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant	Cease treatment if turbidity exceeds 1 NTU and supply from stored water If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry readings	Yes	High (unlikely x major)	Not required	TPO
Particles not removed	4.2	Mechanical failure of wet well pump prevents water from being supplied to DE filter.	Very high (possible x major)	No/reduced flow leaving treatment plant	Flow through treatment plant and pump activity is continuously monitored and telemetered to WDC Duty/standby pumps More than 24 hours treated water storage Operator at treatment plant daily	Replace pump	Telemetry readings	Yes	High (unlikely x major)	Not required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Particles not removed	4.3	Insufficient DE pre-coat loaded into filter	High (likely x medium)	High turbidity in water leaving the DE filter or treatment plant	Turbidity is checked after new DE pre-coat is installed. Written instructions for installing DE pre-coat are available to operator Operator checks differential pressure manually when at the plant.	Reapply DE pre-coat	Turbidity	Yes	Moderate (unlikely x medium)	Not required	WSO

5. Bore

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Microbiological Contamination	5.1	Inadequate bore head construction	Moderate (possible x medium)	Contamination of bore water from surface water ingress. E. coli identified in water from bore	Concrete apron surrounds bore head with slope to shed water away Filtration, chlorination, and UV disinfection FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant Stock fence excludes animals from bore and treatment plant area.	Use stream intake If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Regular assessment of bore head integrity Telemetry readings	Yes	Moderate (unlikely x minor)	Not required	TPO
Microbiological Contamination	5.2	Vandalism to bore head.	Low (unlikely x minor)	High <i>E. coli</i> readings. Obvious signs of damage to bore or control box. Illness in community.	Bore is located on private land out of view from public road Stream intake Filtration, chlorination, and UV disinfection FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant	If there is evidence of microbiological contamination, issue a boil water notice to all consumers Use stream water while repairs are carried out	Regular assessment of bore head integrity Telemetry readings	Yes	Low (unlikely x insignificant)	Not required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of Supply	5.3	Vandalism to bore head or control box resulting in inability to draw water from bore.	Low (unlikely x minor)	Reduced/No flow from bore. Obvious signs of damage to bore or control box.	Bore is located on private land out of view from public road Stream intake Bore flow is monitored continuously at the treatment plant	Use stream water while repairs are carried out	Regular assessment of bore head integrity Telemetry readings	Yes	Low (unlikely x insignificant)	Not required	TPO
Loss of Supply	5.4	Failure of pump due to power failure.	Moderate (possible x medium)	No flow from bores. Telemetry transmitting no pump activity	Stream intake Bore flow is monitored continuously at the treatment plant Supply has more than 24 hours storage Plant can be powered by portable generator	Use Stream intake Use generator if required	Telemetry readings	Yes	Low (unlikely x minor)	Not required	TPO
Loss of Supply	5.5	Mechanical or electrical failure of bore pump	Moderate (possible x medium)	Reduced/No flow from bore/s Telemetry transmitting no pump activity	Stream intake Bore flow is monitored continuously at the treatment plant Regular maintenance regime in place	Use stream water while repairs are carried out	Telemetry readings	Yes	Moderate (possible x minor)	Not required	TPO
Loss of Right to Take Water	5.6	Consent to take water expires and is not renewed or is declined by Regional Council.	Moderate (possible x medium)	Consent expiry date. Information provided by Regional Council.	Existing consent in place is valid until 2022. Stream intake	Apply for consent one year prior to expiry Use stream intake	Expiration date	Yes	Moderate (possible x minor)	Not required	MWS

6. UV disinfection

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Inadequate Disinfection	6.1	UV intensity insufficient due to build-up of deposits on sleeve	Moderate (possible x medium)	Visible build-up of deposits on sleeve UV intensity sensor indicates sub-optimal UV intensity	UV Intensity monitored and alarmed to operator	Manually clean sleeve if UV intensity drops below operational level	UV intensity	Yes	Moderate (unlikely x medium)	None required	TPO
Inadequate Disinfection	6.2	Excessive turbidity in water decreases the effectiveness of the treatment	Moderate (possible x medium)	High turbidity levels detected in water at treatment plant or distribution system	Turbidity and UV intensity is continuously monitored Bore is automatically used if source turbidity exceeds 1 NTU Low UV intensity alarm	Cease treatment if turbidity exceeds 1 NTU and supply from stored water If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Turbidity of water at UV treatment plant Operation of clarifier/bore	Yes	Moderate (unlikely x medium)	None required	MWS TPO
Inadequate Disinfection	6.3	Flow rate through UV unit too rapid for effective treatment	Moderate (possible x medium)	Flow rate through plant greater than UV unit maximum	UV reactor is restricted to an optimal flow rate	Reduce flow rate if there is any indication that it is higher than what is specified for the UV unit	Flow rate	Yes	Moderate (unlikely x medium)	None required	MWS

Event No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Inadequate Disinfection	6.4 UV lamp failure	Moderate (possible x medium)	Lamp failure alarm UV intensity alarm Information in SCADA indicates lamp failure	UV systems are maintained at regular intervals More than 24 hours treated water storage Spare lamps are held by WDC	Replace UV lamp	Lamp operation on UV data screen	Yes	Moderate (unlikely x medium)	None required	TPO
Inadequate Disinfection	6.5 UV intensity sensor failure	Moderate (possible x medium)	UV intensity alarm	UV systems are maintained at regular intervals with sensor checked or replaced annually More than 24 hours treated water storage	Replace sensor if faulty	UV intensity	Yes	Moderate (unlikely x medium)	None required	TPO
Inadequate Disinfection	6.6 Power failure resulting in UV unit being unable to operate	High (likely x medium)	Notice of power failure Power failure alarm	Treatment plant cannot operate during power failure Portable generator can be installed More than 24 hours treated water storage	None required	Not required	Yes	Moderate (unlikely x medium)	None required	TPO
Inadequate Disinfection	6.7 Unable to provide evidence of validation of UV reactor	Moderate (almost certain x minor)	Insufficient certification of validation	Turbidity and UV intensity is continuously monitored DE filtration	Obtain certification	Not required	No	Moderate (almost certain x minor)	Obtain validation certification for the UV reactor	MWS

7. Chlorination

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Inadequate Chlorination	7.1	Inadequate contact time	High (likely x medium)	<i>E. coli</i> detected in water leaving the treatment plant	Contact time is provided in the storage reservoirs	Ensure chlorine dose remains above 0.5 mg/L and storage reservoir is in service	Nothing to check	Yes	Low (rare x medium)	None required	TPO
Inadequate Chlorination	7.2	Sodium hypochlorite supply exhausted.	Moderate (unlikely x medium)	Visual inspection of hypochlorite tanks indicates low level Illness in community FAC is less than 0.2mg/L or <i>E. coli</i> detected in water in the distribution system. Low chlorine alarm activated	Operator visits the plant at least weekly to check hypochlorite levels. Low chlorine alarm FAC, UV irradiance, and turbidity is monitored continuously at the treatment plant UV disinfection system	Replenish hypochlorite supply Flush network until FAC is greater than 0.2mg/L	Amount of hypochlorite available FAC monitoring results from treatment plant	Yes	Low (rare x medium)	None required	TPO
Inadequate Chlorination	7.3	Dosing system failure.	Moderate (unlikely x medium)	FAC is less than 0.2mg/L or <i>E. coli</i> detected in water in the distribution system <i>E. coli</i> detected in water leaving treatment plant Chlorine alarm to operator	FAC is continuously monitored and alarmed for high or low chlorine levels UV disinfection system	Repair chlorine dosing system	Operation of chlorine dosing system Operation of UV system FAC monitoring results from treatment plant	Yes	Low (rare x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Inadequate Chlorination	7.4	Chlorine dose rate incorrect	High (likely x medium)	FAC is less than 0.2mg/L or <i>E. coli</i> detected in water leaving the WTP <i>E. coli</i> detected in water leaving treatment plant Chlorine alarm to operator	FAC is continuously monitored and alarmed for high or low chlorine levels UV disinfection system	Adjust dose rate as required Ensure UV is operating to specification	FAC level at treatment plant and in distribution system	Yes	Low (rare x medium)	None required	TPO
Inadequate Chlorination	7.5	Chlorine demand exceeds chlorine dose due to high raw water turbidity	Very high (almost certain x medium)	High turbidity in water in distribution system FAC is less than 0.2mg/L or <i>E. coli</i> detected in water leaving the WTP	Dose rate is flow proportional and adjusted by operators based on-line FAC results Treatment process provides stable turbidity post filtration Bore water used if surface water turbidity exceeds 20NTU	Cease treatment if treated turbidity exceeds 1 NTU and supply from bore If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Turbidity of water at treatment plant and in distribution system FAC level at treatment plant and in distribution system	Yes	Moderate (unlikely x medium)	None required	TPO
Inadequate Chlorination	7.6	Lack of chlorine due to dosing line failure or leak.	Moderate (unlikely x medium)	FAC is less than 0.2mg/L or <i>E. coli</i> detected in water leaving the WTP Strong chlorine smell at treatment plant	Operator visits treatment plant at least weekly UV disinfection system	Repair chlorine dosing line Flush network until FAC is greater than 0.2mg/L	FAC level in distribution system and at treatment plant	Yes	Low (rare x medium)	None required	MWS TPO
Over Chlorination	7.7	Dosing system failure	High (likely x medium)	FAC level high Taste and odour complaints	Dosing system is simple FAC is continuously monitored and alarmed for high or low chlorine levels	Advise consumers of high chlorine and FAC in system Flush network until FAC is lower than 0.5mg/L	FAC in water leaving treatment plant	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Over Chlorination	7.8	Chlorine dose rate incorrect	High (likely x medium)	FAC level exceeds 1.5mg/L Taste and odour complaints	Dose rate is adjusted by operators based on-line FAC results FAC is continuously monitored and alarmed for high or low chlorine levels	Advise consumers of high FAC level in the distribution system Flush network until FAC is lower than 1.2mg/L	Operation of chlorine dosing system FAC level in distribution system	Yes	Moderate (unlikely x medium)	None required	TPO
Production of disinfection by-products	7.9	Organic material in raw water results in the production of disinfection by-products	Moderate (likely x minor)	Testing identifies THMs which exceed 50% of DWSNZ MAV	Filtration process removes organics	Review treatment system performance and chlorine dose rate	Level of THMs in treated water remains below 50% of MAV	Yes	Low (unlikely x minor)	None required	MWS

8. Storage

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Microbiological contamination	8.1	Leakage through reticulation reservoir roof or other parts of structure or access by birds or vermin.	Very high (possible x major)	Visual evidence of leakage <i>E. coli</i> in water leaving reservoir Decreased FAC in water leaving reservoir.	Residual chlorine in water. Reservoir is covered and all entry hatches are secured and locked against ingress Regular inspection of reservoirs is carried out	Repair any reservoir leaks or bird and vermin access points without delay	Leakage from reservoirs Access points for birds and vermin Evidence of birds or vermin inside reservoirs	Yes	High (unlikely x major)	None required	TPO
Microbiological or chemical contamination	8.2	Vandalism to reservoirs.	Moderate (possible x medium)	<i>E. coli</i> in water leaving reservoir Decreased FAC in water leaving reservoir Reports from the public	Residual chlorine in water Reservoirs are located on private farmland away from public road	Inspect reservoir in response to reports of suspicious activity	Access hatches	Yes	Moderate (unlikely x medium)	None required	TPO
Microbiological contamination	8.3	Sediment/slime accumulation within reservoirs	Moderate (possible x medium)	Visible suspended matter in water exiting reservoir Decreased FAC in water leaving reservoir. Complaints from consumers	Residual chlorine in water Regular inspection of reservoir is carried out and cleaning undertaken if required	Isolate and clean reservoirs as required	Check accumulation of sediment in reservoirs every 5 years	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of supply	8.4	Failure of reservoir	High (unlikely x major)	Complaints from consumers about loss of supply or pressure Obvious signs of leakage or failure at reservoir site	There is a total of three reservoirs at the treatment plant	Isolate faulty reservoir and use others	Structural integrity of reservoirs	Yes	Moderate (rare x major)	None required	TPO
Loss of supply	8.5	Insufficient storage for peak demand	Very high (likely x major)	Loss of water or pressure in reticulation Frequent low reservoir levels	More than 24 hours of stored treated water Drought management plan Low reservoir alarm	Implement water restrictions in accordance with drought management plan	Reservoir levels and alarms	Yes	High (unlikely x major)	None required	TPO
Failure to Fill	8.6	Failure of rising main from treatment plant.	Moderate (possible x medium)	Low water level in storage reservoir	Rising main between the treatment plant and storage reservoirs was replaced in 2005 Information on pump activity and reservoir water level is transmitted to WDC via telemetry	Repair rising main	Telemetry readings	Yes	Moderate (unlikely x medium)	Not required	TPO

9. Reticulation

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Loss of Supply	9.1	Pipe failure.	Moderate (possible x medium)	Complaints from consumers about loss of supply.	Pipe failures are repaired as a priority by contractor	Repair pipe failures without delay	Reports of pipe failures	Yes	Low (rare x medium)	None required	MWS
				Change in flow or pressure in reticulation.	Pipe renewals programme in place with large proportion pipes replaced in 2005						RC
Microbiological Contamination	9.2	Inadequate controls on maintenance and construction work.	Moderate (possible x medium)	Complaints from consumers about taste or odour	Maintenance and replacement work is supervised by a degree qualified Engineer, with work carried out by registered drain layers	Ensure satisfactory FAC level in distribution system whenever repairs or maintenance are undertaken	Sanitation procedures and sanitation practices of contractors	Yes	Moderate (unlikely x medium)	None required	RC
				<i>E. coli</i> present in reticulation system	Specialist contractors used when required						
Microbiological Contamination	9.3	Poor circulation leading to biofilm growth.	Very High (possible x major)	Contaminants present in the reticulation system	Routine flushing programme in place, carried out by contractor	Flush or air scour affected mains	FAC levels	Yes	High (unlikely x major)	None required	MWS
				Taste or odour complaints from consumers.	Residual chlorine in water	If there is evidence of microbiological contamination, issue a boil water notice to all consumers					RC
Microbiological Contamination	9.4	Contamination through insanitary sampling procedures.	Moderate (Possible x medium)	E. coli present in samples from the reticulation system.	Residual chlorine in water	If there is evidence of microbiological contamination, issue a boil water notice to all consumers	FAC levels	Yes	Moderate (unlikely x medium)	None required	MWS
					Sampler is qualified (Bachelor of Applied Science)						RC

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Chemical/Microbiological Contamination	9.5	Backflow from consumer connections.	High (likely x medium)	Contaminants identified in the reticulation system. Taste or odour complaints from consumers.	Work is underway to ensure all residential connections have double check valves and 50mm or larger connections have RPZ backflow preventers Chlorine residual in water	Maintain FAC in distribution system	Land-use and building use changes Test backflow devices	Partially	Moderate (unlikely x medium)	Prepare and implement a formal backflow protection policy that identifies all risk sites, ensures suitable backflow protection devices are installed and all backflow protection devices are tested appropriately	MWS
Supply of Turbid Water	9.6	Silt build up within reticulation pipes.	Moderate (possible x minor)	Reduced flows in reticulation. Complaints from consumer about quality of water	Routine flushing programme in place	Flush affected mains If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Dirty water complaints	Yes	Low (unlikely x minor)	None required	RC
Inadequate Supply of Water	9.7	Poor quality workmanship or inappropriate materials used for reticulation pipes and fittings	Moderate (possible x medium)	Contaminants identified in the reticulation system. Taste and odour complaints from consumers Reduced FAC in water	Waitomo District Council requires all work and materials used in reticulation to meet standard specifications Best practice approach taken to reticulation work	Redo work that has been poorly undertaken Replace any materials that do not meet minimum specifications	Quality of work undertaken Types of material used	Yes	Moderate (unlikely x medium)	None required	RC

10. Other

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Sampling Failure	10.1	Inadequate sampling programme, sample or data collection error	High (likely x medium)	DWSNZ compliance failure due to days of week, days between samples, insufficient samples, information gaps, positive results or sampling error	Sampling programme prepared and checked against standards. Chlorine, turbidity, UV intensity and pH continuously monitored at treatment plant.	Review sampling programme	Sampling programme against DWSNZ Data set is complete	Yes	Moderate (possible x medium)	None required.	MWS
Unidentified Operational Failure	10.2	Insufficient monitoring and alarming of key operational data	Very High (likely x major)	Contamination identified in supply. Operational near miss identified Inadequate information collected to provide confidence in supply operation	Chlorine, turbidity, UV intensity and pH continuously monitored at treatment plant	If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry alarms	Yes	High (unlikely x major)	None required	MWS TPO
Failure due to Inadequate Maintenance	10.3	Supply equipment fails due to inadequate asset information and inadequate maintenance planning	Moderate (possible x medium)	Unexpected plant equipment failure. Not having an asset register and maintenance programme	Planned and routine maintenance including basic lubrication and greasing of pumps undertaken by operator Plant maintenance and repairs are recorded in telemetry system	Attend to failure as a priority Plan to renew or improve assets as required	Condition and forward planning for asset renewal	Yes	Moderate (unlikely x medium)	None required	MWS

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Failure due to unavailability of spare parts	10.4	Inadequate spare parts held or spare parts unavailable	Moderate (possible x medium)	Plant is out of operation due to missing parts	Spare parts are held for critical components Replacement spares are usually available overnight More than 24 hours storage	Replace spare parts as used	Spares in stock and within use by date	Yes	Moderate (unlikely x medium)	None required	TPO
Operator Error or Mismanagement	10.5	Inadequate training, professional development and up-skilling of operators	Very high (possible x major)	Poor operation of plant Plant compliance failure Loss of supply Poor score on question about level of supervision in supply grading	One operator is qualified to certificate level, the other operator is currently working towards this. Manager Water Services is an experienced and qualified engineer	Provide in-house training where abilities are in deficit	Operator abilities, knowledge and training qualifications	Partially	Very high (possible x major)	Develop model training and skills maintenance plan for existing and new operators	MWS
Failure due to inadequate operating procedures	10.6	Inadequate, out of date or incorrect manual or operational procedures	Moderate (possible x medium)	Standard Operating Procedures (SOP) not used SOPs not up to date SOP copies are not the same	SOPs have been prepared for Benneydale water supply	Revise SOP/manual and provide refresher training	SOPs current and up to date	Yes	Moderate (unlikely x medium)	None required	MWS TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Corrective Actions	What to check	Risk Managed	Residual Risk	Additional Measures That Could be put in Place	Resp
Water not treated or supplied	10.7	Power outage prevents water treatment plant operating	Moderate (possible x medium)	Treated water not leaving treatment plant Telemetry alarm Telemetry does not provide any information	Flow through treatment plant is continuously monitored and telemetered to WDC More than 24 hours treated water supply which is gravity fed to reticulation Portable generator located in Te Kuiti which can operate plant	Use portable generator to maintain supply until fault is rectified	Power at plant Reservoir levels	Yes	Moderate (unlikely x medium)	None required	MWS
Total Plant Failure	10.8	Catastrophic natural disaster or failure including earthquake and flooding	High (rare x catastrophic)	Major natural disaster occurs Intense sustained weather Land slide, flooding, volcanic eruption Total plant failure is evident Warnings from Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police	Prior warning from Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police Robust secure plant structures and buildings Business continuity plan in place and exercised Emergency response plan	Implement all measures necessary to ensure plant continues to operate in a natural disaster	Prior warnings issued by Govt agencies incl Met Office, Niwa, Civil Defence, Regional Council or Police	Yes	Moderate (rare x major)	None required	MWS TPO RC
Unidentified operational failure	10.9	Control system fails to perform as expected	High (likely x medium)	Contamination identified in supply Operational near miss identified	Test alarms are transmitted to operators twice a day An alarm is transmitted if communication to the plant is lost	If there is evidence of microbiological contamination, issue a boil water notice to all consumers	Telemetry alarms functioning as expected Plant shutdown and diversions occur as expected	Partially	High (unlikely x medium)	None required	MWS TPO

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