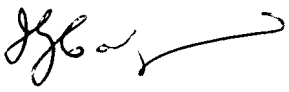
Masterton Drinking-water Supply

Water Safety Plan

Prepared By



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Contents

Figures

Tables

1 Revision Details

Version No	Description	Approved	Revision Date
V2	First plan developed in response to Cryptosporidium incident	2004	2009
V3	For approval by DWA	2009	2014
V4	For approval by DWA	2014	2018
V5	For approval by DWA		2023
V5.1	Changes made for approval by DWA		2023

This plan will be revised and submitted for approval before 1 January 2023.

Assessment of the performance of the plan

Assessment of the performance of the 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 Water and Wastewater Treatment Operations Manager to the Asset Manager 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 Water and Wastewater Treatment Operations Manager 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 Asset Manager will include the matter into the Council approval process and the Council Long Term Plan.

Links to other quality systems

This Water Safety Plan (WSP) will be linked to the Annual Plan, the Asset Management Plan for Water Supplies and the Council Long Term Plan. The daily operations of the Masterton WTP (Water Treatment Plant) are available in SOP (Standard Operational Procedures) held at the treatment plant.

2 Introduction

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

Masterton is a moderately sized rural town situated about 100 kilometres northeast of Wellington by road on State Highway 2. The community includes residential housing, a business district, schools, a hospital and light industry. The community provides support services to the adjacent rural area.

The Masterton drinking water supply is classified as a large drinking-water supply under the Health (Drinking Water) Amendment Act 2007 and provides water to a total population of approximately 19,000 people. The water is sourced from a local river and undergoes conventional treatment before being stored and distributed to consumers in the Masterton Community.

The scheme is administered at the main council offices in Chapel Street, Masterton and managed by the Asset Manager.

The management, maintenance and operation of the Masterton drinking-water supply are the responsibility of:

- Asset Manager – David Hopman
- Water and Wastewater Treatment Operations Manager – Kevin Godfrey
- Treatment Plant Operators – Kevin Crosby, Andrew Cutfield

3 Supply Details

Table 1. Summary of Masterton water supply details

Supply Details		
Supply Name	Masterton	
WINZ Community Code	MAS002	
Supply Owner	Masterton District Council	
Asset Manager	David Hopman	
Water and Wastewater Treatment Operations Manager	Kevin Godfrey	
Treatment Plant Operators	Kevin Crosby Andrew Cutfield	
Population Served by Supply	19,000 (WINZ database 26 June 2017)	
Source Details		
Source Name	Waingawa River	
Source WINZ Code	S00383	
Type of Source	Surface water	
Consent Expires	WAR 940080; March 2023	
Maximum Consented water take:	30,000m^3/day reduced to 22,500m^3/day when river flow drops to 1900l/s	
Grid Reference of Source (NZMG)	**Easting** : 2722567	**Northing** : 6032421
Treatment		
Plant Name	Kaituna	
Plant WINZ Code	TP00631	
Location	Upper Plain Rd, Kaituna, 8 kilometres West of Masterton	
Treatment Processes	Raw water storage and settlement, coagulation, flocculation, filtration, chlorination, pH correction, fluoridation	
Average Daily Volume	13000 m^3/day	
Peak Daily Volume	22,000 m^3/day	
Distribution		
Distribution Zone Name	Masterton	
Distribution Zone WINZ Code	MAS002MA	
Distribution Zone Population	19,000 (WINZ database 16 April 2018)	

4 History of the Supply

The first water supply for Masterton was constructed in the early 1900s in the form of a weir, open channel and pipelines. There was no treatment until the 1920s when a slow sand filtration system was installed downstream of the existing plant.

During the late 1960s and early 1970s the first treatment plant was built along with an intake, raw water ponds, and an unlined below-ground clear water reservoir. The treatment plant provided direct filtration through three circular filters. From 1980-1982 the current treatment plant was constructed with the addition of two rectangular filters and the treatment building. An inability of the plant to treat high turbidity water resulted in the construction of the clarifier from 1984-1985.

In August and September 2003 the Council dealt with the discovery of Cryptosporidium species contamination in the Masterton urban water supply. Subsequently, a number of risk factors were reduced through upgrading of plant and operating procedures. This included the construction of a new treated water (aka clearwater) reservoir and three rectangular filters and better treated water monitoring.

The last Public Health grading was "Aa" in 2012/13. The treatment plant has had no microbiological, chemical or cyanobacterial issues in the past year.

5 Description of the Masterton Water Supply

Water is abstracted from the Waingawa River by a siphon which draws water into a concrete lined steel pipe with fully wielded joints having replaced the rubber ring jointed concrete delivery main I 2010. The river catchment lies in the eastern part of the Tararua Range west of Masterton. The 600mm 7km delivery main, constructed in 1971-72, provides water to the Kaituna water treatment plant raw water storage ponds under gravity flow. The three raw water storage ponds have a total capacity of 60,000 cubic metres and retain a stored capacity for a minimum of 3 -4 days.

The plant is a conventional coagulation, clarification, sedimentation, sand filtration and chlorination design. As water flows (under gravity) from the raw water ponds, coagulants PACl (poly aluminium chloride) and polyelectrolyte (B570) are dosed. The dose rate is manually set but the dosing pump-rate adjusts to the plant flow rate which is determined by a magflow meter on the water entering the clarifier. The demand for flow is from the Upper Plain Reservoir but to halt rapid fluctuations the inlet is governed by an adjustable valve which has a pre-set maximum.

The water then flows to five rapid sand filters and then to a clear water reservoir. The sand filters operate as enhanced individual filtration units and are backwashed daily with an air scour and 12 minute backwash period. Water used for a backwash is taken from the clear water reservoir. The backwash process is automated via computer control but is initiated by operational staff. Backwash is routinely performed daily but can be triggered earlier due to turbidity issues or differential pressure, both of which alarm the operator to initiate the backwash sequence - refer to SOP.

Backwash waste is collected in a pond whereby settlement is permitted before solids are concentrated to be sent to a sludge pond for storage, concentration via evaporation and eventual disposal to landfill. The settled backwash water is discharged to the river as per Resource Consent WAR 120241 which expires September 2029. Backwash water is not recycled.

Prior to the clear water reservoir, pH is corrected by dosing powdered lime via a screw feeder into carry water and then using a venturi dosing system. The carry-water flowrate is constant but the screw feeder rate is controlled by pH meter to a control set point. Gas chlorine is then dosed and

the water is fluoridated. The chlorine dose is delivered via a rotameter, and the rate is adjusted based on on-line monitoring results. Gas chlorine is provided from two 920 kg drums which are installed in a duty standby arrangement with an auto change over. The tanks are also located on a weight measure scale so that the gas quantity can be monitored. At least one spare 920 kg chlorine gas drum is retained on site. Hydrofluorosilicic acid (HFA) is used to provide fluoride to the supply and is dosed via a metering pump with a manual adjustment.

A standby generator capable of operating the treatment plant and three portable generators capable of operating the siphon are available to cope with a power failure event. The emergency standby power capacity is insufficient to operate the backwash pumps or the air-scour compressor. UPS operates the plant electrical controls and monitoring equipment.

The turbidity of water leaving the filters and free available chlorine (FAC), pH, and turbidity of water in the clear water reservoir and boost pump station are continuously monitored on-line and alarmed through SCADA to the duty operator.

Operators are available "24/7" although they may not be physically at the plant as operators have remote operation capability. During working hours (8am to 5 pm) the treatment plant is manned. The treatment plant has the capacity to treat 35,000 m^3/day though the demand from the Masterton urban area varies between 13,000 m^3 and 22,000 m^3/day.

Following treatment, the water flows to a 1,000 m^3 clear water reservoir and then under gravity to the 9,600 m^3 Upper Plain Reservoir, which was constructed in 1980-82, and is located on Upper Plain Road five kilometres west of Masterton. A by-pass pipe allows water from the plant to flow directly to the Upper Plain Reservoir to facilitate maintenance and cleaning of the treated water reservoir. The Upper Plain Reservoir is constructed of pre-stressed reinforced concrete panels. The supply storage is supplemented by one 2,250 m^3 reservoir on Lansdowne Hill (Titoki St) and two 250m^3 Timber Tanks at Manuka Street, all within the Masterton reticulation.

The Upper Plain Reservoir is fed from the clear water reservoir by a 450 millimetre gibault jointed concrete-lined steel pipe which has a gravity fed capacity of 25,000m^3/day. An on-line booster pump, and by-pass is incorporated into the pipeline and when demand exceeds 25,000m^3/day, the booster pump is operated to increase the supply. From the Upper Plain Reservoir, water flows to the Masterton reticulation system and reservoirs in Titoki Street which provide storage to feed the high-level zone of Lansdowne.

The reticulation pipes vary in diameter from 300 mm to 40 mm on ridermains, with pipe materials of cast iron, steel, asbestos cement, PVC and polyethylene. Pipe ages range from the late 1800s up to the present day.

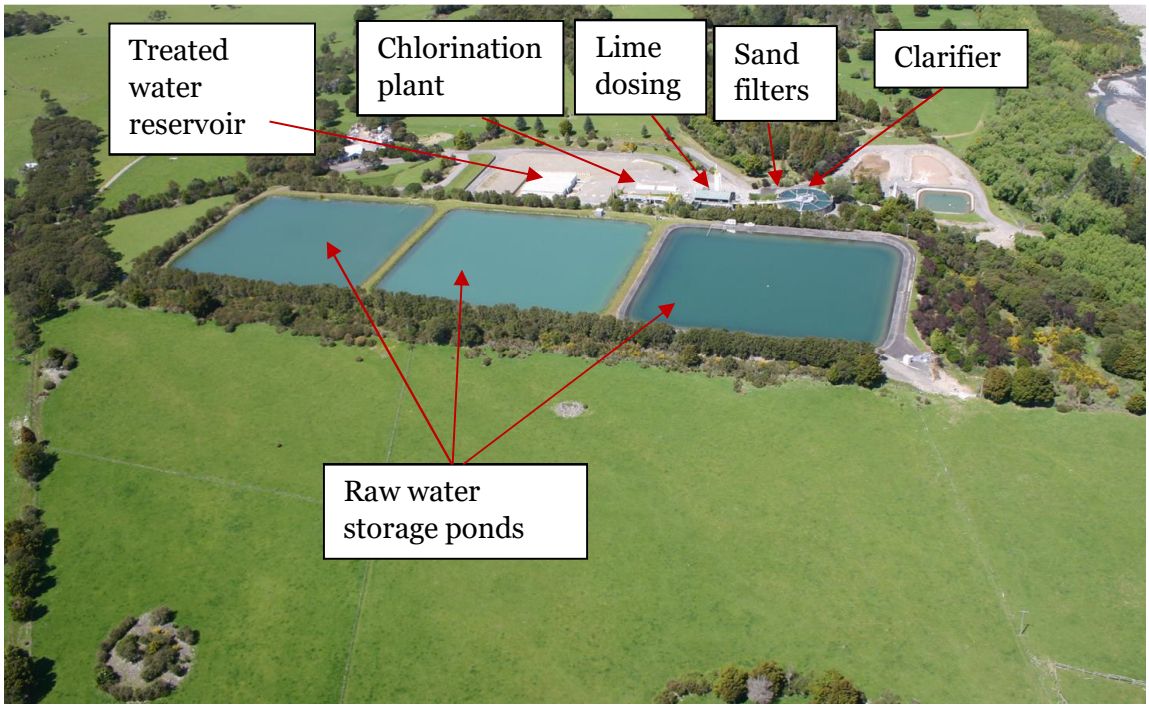


Figure 1. Masterton WTP site

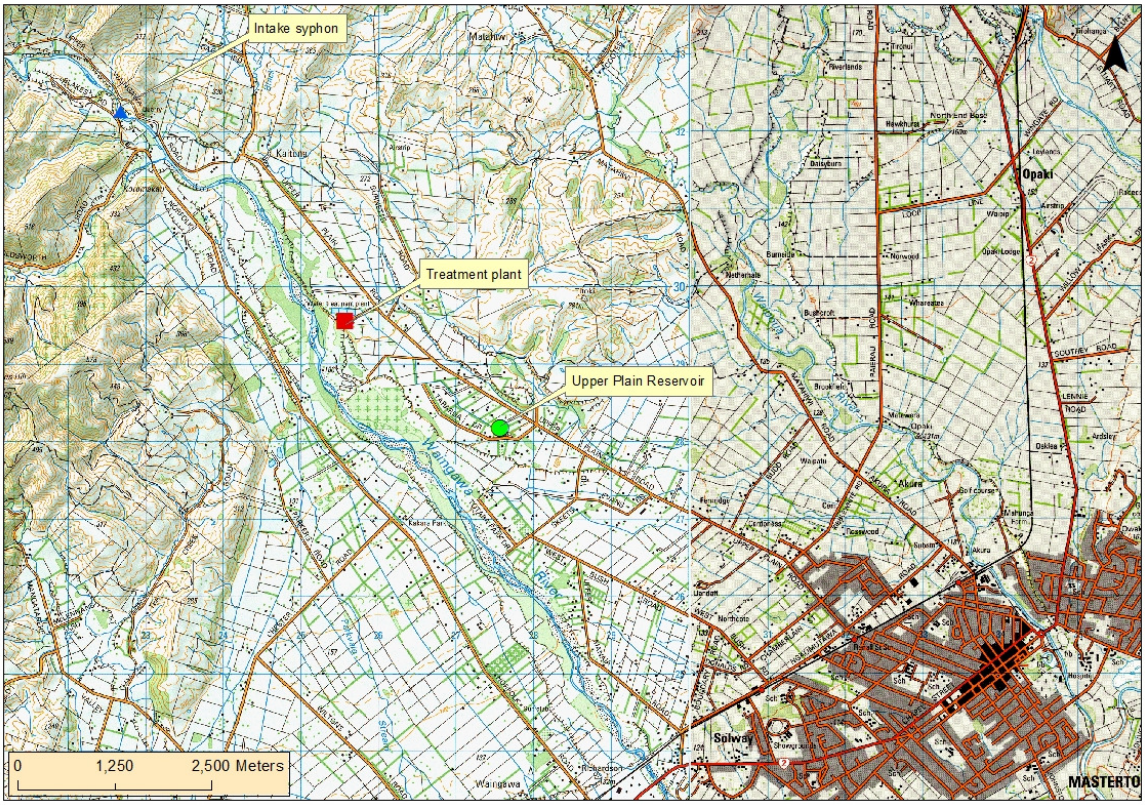


Figure 2. Location of the Masterton drinking water supply infrastructure.

6 Photographs of Masterton Water Supply

The following photographs were taken on site visits to the Masterton drinking-water supply by Opus staff, the latest being on 15 March 2018.

Figure 3. Tararua Ranges Catchment

Figure 4. Waingawa River looking upstream

Figure 5. Waingawa River siphon intake

Figure 6. Raw water pipeline to WTP

Figure 7. Raw water storage pond 1

Figure 8. Polymer mixing facility

Figure 9. Coagulant (PACl) dosing

Figure 10. Clarifier

Figure 11. Rapid sand filters

Figure 12. Turbidimeter

Figure 13. Turbidity readings for each filter

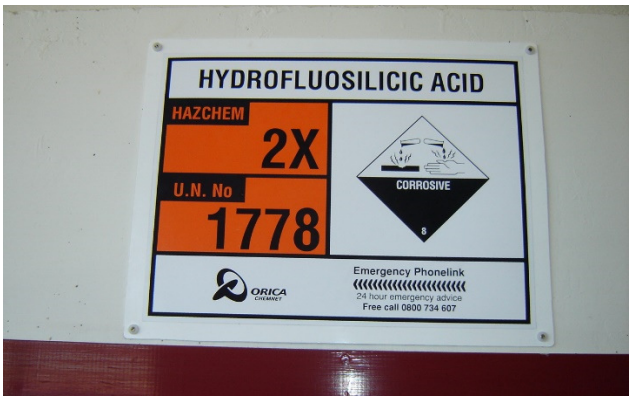


Figure 14. Fluoride dosing room

Figure 15. pH control to Lime feeder

Figure 16. Lime feeder dosing point

Figure 17. Plant building & lime storage tower

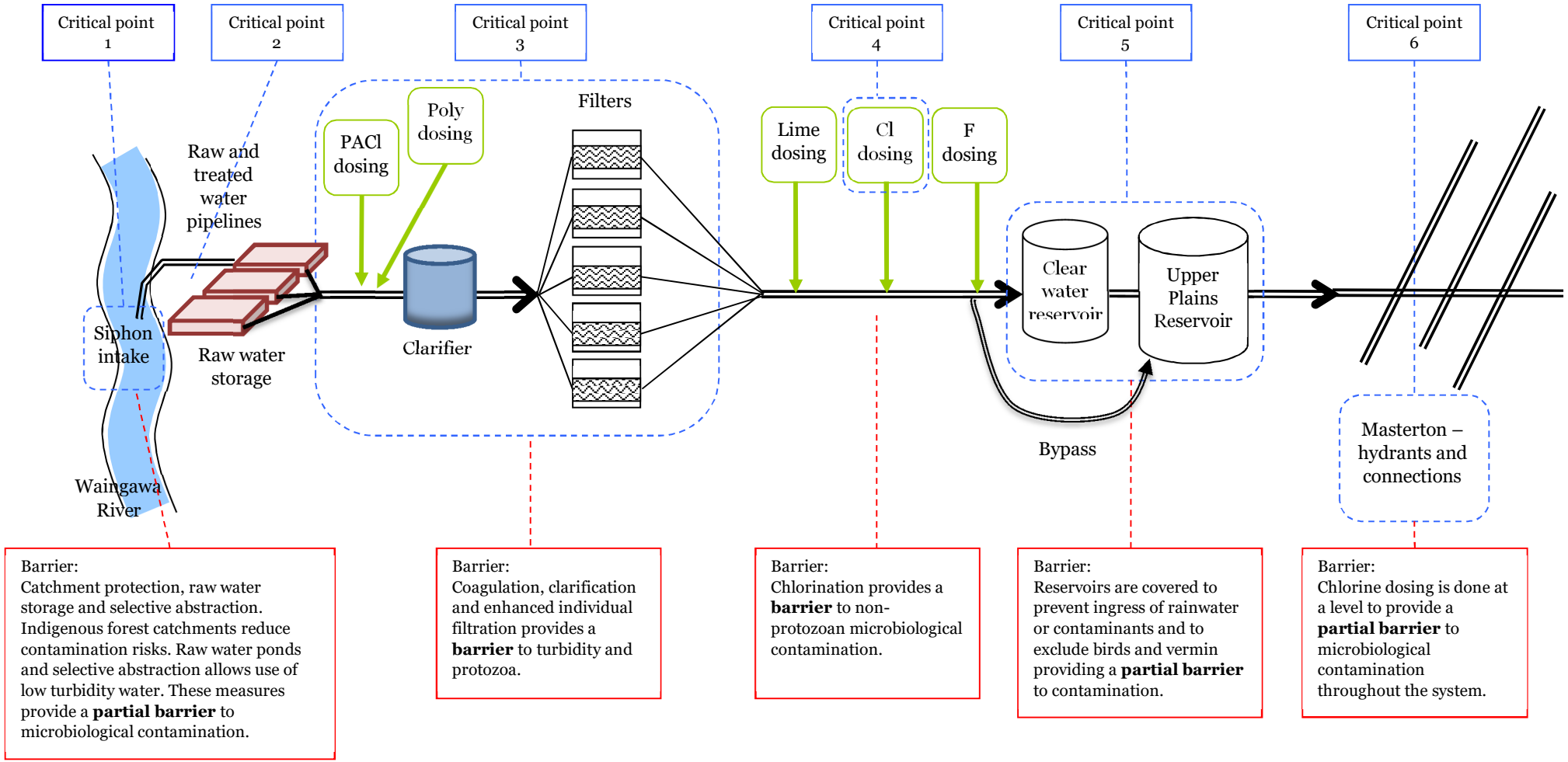
Figure 18. Chlorine residual analyser

Figure 19. Gas chlorine drums

Figure 20. Treated water reservoir

7 Flow Chart/Schematic of the Supply

Figure 21. Supply schematic



8 Barriers to Contamination

Table 2. Critical points

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

	Critical Point	Description
1.	Vacuum intake	*Loss of siphon pressure or damage to structure could result in loss of water supply to raw water ponds.*
2.	Raw and treated water pipelines	*Damage to pipelines or failure could reduce water supply to raw water ponds, Upper Plain Reservoir or Masterton reticulation.*
3.	Coagulation, clarification and filtration	*Failure or compromise of these treatment processes could result in inadequate turbidity and protozoa removal.*
4.	Chlorination and pH correction	*Failure will result in a lack of bacterial and viral control. Overdosing may exceed chemical MAV.*
5.	Treated water storage	*Possible point for microbiological contamination*
6.	Distribution system connections	*Possible access point for contamination due to backflow*

Existing barriers to contamination include:

1. Catchment Protection

Indigenous forest catchments provide good quality water and reduce contamination risks. Raw water ponds and selective abstraction allows use of low turbidity water. These measures provide a **partial barrier** to microbiological contamination.

2. Coagulation, clarification and filtration

Coagulation, clarification and enhanced individual filtration removes particulate material and protozoa (oo) cysts providing a **barrier** to turbidity and protozoa.

3. Chlorination and pH correction

Chlorination disinfects the water for non-protozoan microbiological organisms. pH correction ensures the chlorination is effective. 30 minutes contact time is provided in the clear water reservoir. This provides **a barrier** to bacterial and viral contamination.

4. Prevention of contamination of treated water in storage

The reservoirs are covered to prevent unauthorised access, ingress of rainwater or contaminants, and to exclude birds and vermin. These measures contribute to provision of a **partial barrier** against re-contamination of water following treatment.

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

Residual chlorine protects the water against microbiological contamination throughout the storage and reticulation providing **a partial barrier** to re-contamination.

9 Critical Control Point Process Control

The Masterton Water supply has three critical control points over which process control can be made. The critical control points are coagulation/separation, filtration, and chlorine disinfection which provide barriers within the supply system to microbiological contamination.

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.

Filtration

9.1 Process objectives

To provide a **particulate removal control point** to capture bacterial, viral and protozoan pathogens that may have entered the water supply system upstream of the clarifier by enmeshing in a chemical floc. If not running optimally will compromise the efficacy of subsequent disinfection barriers.

Operational day-to-day monitoring of control processes	
What	• Coagulant/polymer dose • Turbidity of settled water from ponds • Turbidity of water leaving each filter.
When	Coagulant dose is continually monitored; turbidity is continually monitored of water leaving on each filter.
Where	Turbidity settled water from ponds and after each filter.
How	Continuous on-line monitoring analysers with alarms to the operators if measurements approach designated parameters.
Who	Results are telemetered to central computer and are available to operators on their laptop computers.
Records	All data are recorded digitally in the Masterton WTP data management system and provided to Masterton District Council management on request as required

Process performance criteria at the operational monitoring point.		*Correction required if performance criteria are not met.*
Target Range	• Turbidity: <0.02 to <0.04 NTU • optimum floc size (visual)	Duty operator to check dose levels meet target levels stated and as necessary to make adjustments to achieve target range.
Action Limits	• Turbidity: >0.04 to <0.09 NTU • floc size unusual (visual)	Duty operator to respond by adjusting dose rate, performing jar testing, and making informed observations to get readings back to Target Range.
Critical Limits	• Turbidity: > 0.09 NTU • floc not forming Note: one filter >0.09 NTU requires action whereas all filters >0.09 NTU means shutting the plant	High incoming turbidity, duty operator considers shutting down treatment plant and operates supply from storage until parameters return within target range. Duty operator notifies Water Supply Engineer.

Chlorination

9.2 Process objectives

To provide a **primary disinfection control point** to inactivate bacterial, viral and some protozoan pathogens that may have entered the water supply system upstream of the Chlorination dosing system and to provide residual protection in the reticulation system. pH is measured prior to coagulation but is not adjusted. FAC is measured firstly for control at the weir into the clear water reservoir, at the mid-point of the clear water reservoir, and again at the Compliance point (Boost Pump Station). It is also measured at the Upper Plain Reservoir, Manuka St Reservoirs, and middle of town, all continuously and online.

Operational day-to-day monitoring of control processes	
What	• Chlorine residual (FAC) in mg/L.
When	• Chlorine residual continuously monitored and adjusted to target range automatically. • The analyser is manually calibrated 2 monthly • Chlorine dosing chemical volume is checked daily
Where	In the chlorine treatment plant room.
How	Continuous on-line monitoring analysers with alarms to the operators if measurements approach critical limits.
Who	Results are telemetered to central computer and are available to operators on their laptop computers.
Records	All data are recorded digitally in the Masterton WTP data management system and provided to Masterton District Council as required

Process performance criteria at the operational monitoring point.		*Correction required if performance criteria are not met.*
Target Range	• FAC 0.75 - 1.1 mg/L (ideally 0.9 mg/L) • pH 7.6 - 7.7	**Duty operator** to check accuracy of reading. Operator to adjust dosing system to achieve target range if identified as outside of target range during routine checking procedures or if system indicates outside of target range.
Action Limits	• FAC <0.6 mg/L (> 15 m) • FAC >1.1 mg/L (> 1 h) • pH >7.7 (> ½ h)	Duty operator to check accuracy of reading and, as required, **adjust dose rate** to achieve target range. Operator to check to see issue causing the problem Duty Operator to notify **Duty Supervisor**.
Critical Limits	• FAC <0.4 mg/L (> 15 m) • FAC >1.6 mg/L (> 1 h) • pH >8.4 (>1h)	**Duty supervisor** considers shutting the plant and operates supply from storage until parameters return to acceptable levels "Out of spec" water is backwashed to waste.

9.3 Supporting programs

Validation and calibration of analysers according to manufacturer's specifications.
Assessment of the competence of operators to calibrate on-line analysers.
Training of operators in;

- reading and understanding the significance of continuous on-line monitoring data and data trends, and
- response to alarms, and
- using the treatment plant's SOPs.

10 Improvement Schedule

The improvement schedule outlines improvements that have been recommended for preventing, reducing or eliminating the identified public health risks in the Masterton drinking water supply. Possible improvements to the water supply have been identified in the **"Corrective Actions"** column of the risk tables. The most suitable option to improve the management of each unmanaged or partially managed 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.

Few improvements have been identified for the Masterton drinking-water supply. This is partly because this is the fourth WSP (coded version 5.1) that has been prepared for the supply and because MDC is active in ensuring the supply is well managed and operated.

The inclusion of "Participate in the establishment and maintenance of a Joint Working Group for Drinking water" is in reflection of outcomes of the Havelock North Inquiry 2017. The aim and purpose of the Joint Working Group for Drinking water is to share current knowledge and information around water supply-related topics such as regional and district plan changes, catchment activities, legislative changes and so forth. While not involved in decision making process representatives from the local district health boards/DWA are invited to attend these meetings to give their insight, as appropriate.

Table 3. Recommended Improvements

AM: Asset Manager WOM: Water and Wastewater Treatment Operations Manager TPO: Treatment Plant Operator EHO: Environmental Health Officer

Priority	Risk level	Water Supply area	Reference to risk table	Proposed works	Person responsible	Expected cost	Intended completion date
1	Moderate	Pre-treatment storage	3.6	Investigate more effective wildlife control methods, if required, based on results from monitoring levels of wild-life that could potentially affect the raw water quality.	WOM, TPO	Staff time	Ongoing
2	Moderate	Catchment	1.8	Investigate the availability of alternative sources of water supply to the treatment plant that could be used in an emergency. Participate in the establishment and maintenance of a Joint Working Group for Drinking water	AM, WOM	$50,000	2025
3	Moderate	Pre-treatment Storage	3.4	Staff to be involved in information accuracy of the latest Asset Management Plan.	AM, WOM, TPO	Staff Time	Ongoing
4	Moderate	Reticulation/ other	11.4, 12.2	Staff to Review and update SOP (where appropriate) to reflect latest Asset Management Plan	AM, WOM, TPO	Staff time	Ongoing
5	Moderate	Clarification	4.8	Investigate whether a second clarifier is justifiable	AM	$10,000	2020
6	Moderate	Treated water storage	9.5, 11.2	Increase treated water storage capacity - MDC Water LTP includes provision for new reservoir at Lansdowne in 2025. Timing is subject to supply resilience requirements.	AM	$1 million	2025

11 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 improvements which largely require the investigation of options to reduce risk will ensure the water provided by the supply continues to be potable, palatable and DWSNZ compliant.

12 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.

Risk tables have been prepared which identify the event, cause, risk without preventative measures, indicators that the event may be occurring, preventative measures that are currently in place to prevent the event, whether the risk is controlled, the residual risk, additional measures that could be put in place and the person(s) who is primarily responsible for managing that risk. The risk without preventative measures provides an indication of the risk level of the event related to that cause if nothing was in place to prevent the event. The residual risk is the remaining level of risk, taking account of the measures that are in place to prevent the event related to that cause.

Indicative cost estimates and implementation timeframes have been prepared for the required improvement measures and included in the improvement schedule. 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 Water and Wastewater Treatment Operations Manager is responsible for implementation of the Improvement Schedule within the timeframes indicated, subject to community and council approvals, funding constraints and availability of resources. The Asset Manager is responsible for on-going review and updating of the WSP.

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 acute risk to public health. The Water and Wastewater Treatment Operations Manager and the Asset Manager 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, intake siphon, pre-treatment storage, coagulation/clarification/sedimentation, filtration, chlorination, pH adjustment, fluoridation, bulk main, storage reservoirs, reticulation and other.

13 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 4. 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 25 years).
Rare	Only in exceptional circumstances (once in 50 years).

Table 5. 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 6. Risk Level Allocation Table

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

14 Drinking Water Standards and Grading

At the time this WSP was prepared, the Masterton water supply fully complied with DWSNZ.

Table 7 below shows a summary of the compliance. The treatment plant and distribution zone at Masterton are currently graded "Aa" (WINZ database 09 April 2018).

Table 7. Summary of Compliance with DWSNZ

Standards compliance assessed against	**DWSNZ 2005 (R2008)**
Bacterial compliance criteria used for water leaving the treatment plant	Criterion 2A
Protozoa log removal requirement required for the supply	Log 4
Protozoa treatment process	Coagulation, clarification, sedimentation, sand filtration, pH adjustment, chlorination.
Compliance criteria 6A or 6B is used for water in the distribution zone.	Criterion 6A
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.	Yes
Bacteria compliance for water in the distribution zone has been achieved for the last 4 quarters.	Yes
P2 determinands allocated to supply	Yes. Fluoride.
Chemical compliance achieved for the last 4 quarters.	Yes
Cyanobacteria identified in the supply	Yes
Cyanobacterial compliance has been achieved for the last 4 quarters.	Yes

http://www.drinkingwater.org.nz/supplies/supplycomplyforcy.asp?ccode=MAS002

15 Consultation

On 15 March 2018 a site visit to the Masterton water supply was carried out by Ian Couling of WSP-Opus. The treatment plant was inspected with operator Kevin Crosby and discussions were held with the Water and Wastewater Treatment Operations Manager Kevin Godfrey.

An inspection of the raw water storage ponds, treatment plant, treated storage and other parts of the supply was undertaken. Operation of the supply was discussed with both Kevin's including the operation and performance limits, the critical points, the treatment barriers, the risks that have been identified, how these risks are managed currently and the improvements that are proposed to be put in place. Previous iterations of the water safety plan were discussed and changes made to the plans described.

The information provided during this consultation was used to compile the risk tables.

Subsequent to this consultation in person (13th August 2018) 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 Kevin Godfrey prior to completion.

16 Contingency Plan

Masterton Water Supply Contingency Plan	
Type of Event	***Required Contingency Action***
Inadequate chlorination **Indicators: Low FAC (<0.4mg/L) or no FAC reported from treatment plant monitoring.**	• Inspect chlorination system to identify cause of problem and rectify as quickly as possible • Hand dose sodium hypochlorite to the treated water reservoir • Advise DWA and prepare to issue boil water notice if appropriate, ie if cannot reinstate adequate chlorination • Make arrangements for provision of emergency treatment or alternative water supply • Keep customers informed and advise once regular service is restored
Severe turbidity of source water and high turbidity in treated water. **Indicators: Highly turbid water in reticulation.**	• Cease abstraction while source is turbid and supply from treated water storage • Monitor storage level. Monitor source water turbidity. • If storage is low and effective treatment cannot be provided advise DWA and issue Boil Water notice while problem is resolved. • Keep customers informed and advise once regular service is restored
E. coli **transgression in water in distribution zone** **Indicators:** ***E. coli*** **transgression reported following routine monitoring.**	• Follow transgression response procedure in DWSNZ • Advise Drinking Water Assessor (DWA) • Commence daily *E. coli* testing at WTP • Use an enumeration test method • Sample in distribution system • Investigate cause, inspect plant and source • Take remedial action • Continue to sample for E. coli until 3 consecutive samples are free of *E. coli* • If *E. coli* is found in repeat samples consult with DWA, intensify remedial action, increase disinfection, consider 'Boil Water' notice, consider alternative supply
Severe microbiological contamination of source water (such that treatment is ineffective) **Indicators: A contamination event in the catchment may be observed by or reported to MDC staff. May also be indicated by reported illness among consumers or positive** ***E. coli*** **monitoring results.**	• Issue "Boil Water' notice • Advise Drinking Water Assessor (DWA) • Investigate river source and catchment to identify source of contamination and rectify problem as quickly as possible • Consider provision of emergency treatment or alternative water supply (eg tankers) • Disinfect contaminated reservoir and flush mains • Keep customers informed and advise once regular service is restored

Masterton Water Supply Contingency Plan	
Type of Event	***Required Contingency Action***
Chemical contamination of source water **Indicators: A contamination event in the catchment may be observed by or reported to MDC staff. May also be indicated by reported water quality concerns from consumers (taste, odour, and colour) or illness among consumers.**	• Advise Drinking Water Assessor (DWA) • Assess situation and advise customers regarding use/treatment/disposal of contaminated water • Arrange emergency water supply (tankers) if necessary • Investigate river source and catchment to identify source of contamination and rectify problem as quickly as possible • Flush contaminated reservoir and mains • Keep customers informed and advise once regular service is restored
Identification of cyanobacteria or cyanotoxins in the source river or raw water ponds at unacceptable levels	• If cyanobacteria is in the river at unacceptable levels, cease abstracting and utilise water from the raw water ponds. If cyanobacteria is in the raw water ponds, abstract water directly from the river. Undertake cyanotoxin sampling of raw water ponds and treated water • Advise DWA
Insufficient water available for abstraction and treatment or loss of ability to take water from the Waingawa River **Indicators: Observed or reported low abstraction levels**	• Advise customers to conserve water • Implement demand management strategies as required • Arrange emergency water supply (tankers) if necessary • Keep customers informed and advise once regular service is restored
Earthquake, flood or other natural disaster	• Refer to Council Emergency Response Plan

17 Risk Tables

AM: Asset Manager, WTM: Water & Wastewater Treatment Operations Manager, TPO: Treatment Plant Operator, EHO: Environmental Health Officer

JWGDW = Joint Working Group for Drinking Water; GWRC = The Greater Wellington Regional Council

Table 8. Risk Tables

1. Catchment

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Microbiological Contamination	1.1	Surface runoff from catchment	Very High (almost certain x major)	High raw water *E. coli* results Turbidity in raw water. Illness in community	Pre-settlement ponds Effective treatment process to remove contaminants and disinfect water Contingency: Participates in JWGDW together with GWRC and local authorities	Yes	Moderate (almost certain x insignificant)	None required	WOM TPO
Microbiological contamination	1.2	Discharges from community wastewater systems, dairy effluent ponds or septic tank systems.	Very high (possible x major)	High raw water *E. coli* results. Turbidity in raw water Illness in community	Catchment monitored land-owners informed. No community wastewater discharges in catchment No dairy effluent discharges directly to rivers or streams in catchment Effective treatment process to remove contaminants and disinfect water	Yes	Low (unlikely x minor)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Chemical contamination	1.3	Surface runoff containing chemical contaminants from agricultural activities. (e.g. pesticides, fertilisers etc)	Very high (possible x major)	Taste and/or odour. Complaints or information provided by public about activities in catchment.	Chemical suite is analysed at regular intervals MoH P2 programme did not identify any chemical contaminants related to agricultural activities	Yes	Moderate (unlikely x medium)	None required	WOM TPO
Chemical Contamination	1.4	Naturally occurring chemical contaminants	High (almost certain x medium)	Taste and/or odour. Results of raw water chemical testing Results of MoH P2 chemical testing programme	Chemical suite is analysed at regular intervals MoH p2 programme did not identify any naturally occurring chemical contaminants Refer Catchment Risk Assessment	Yes	Moderate (unlikely x medium)	None required	TS TPO
Chemical Contamination	1.5	Chemical spill contaminates source water	High (unlikely x major)	Chemical spill is reported Regular testing identifies unexpected contaminant Complaints of taste or odour	Catchment does not include activities likely to result in a chemical spill Systems in place for notification to council if chemical spill is identified Intake can be closed if required; 3-4 days raw water storage	Yes	Low (unlikely x minor)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Chemical Contamination	1.6	Aerial application of 1080 poison for pest control contaminates source water	High (unlikely x major)	Known aerial 1080 application	1080 pest control activities are controlled (MOH approval required) and include water testing Council notified of aerial 1080 application and ceases abstraction until water quality is satisfactory; 3-4 days raw water storage 1080 breaks down rapidly when in contact with water	Yes	Low (unlikely x minor)	None required	AM WOM
Loss of Supply	1.7	Drought reduces quantity of water that can be abstracted from river	High (unlikely x major)	Low flows in Waingawa River Loss of siphon vacuum pressure Prolonged drought conditions Reduced/no flow to treatment plant.	3-4 days of raw water storage in ponds In-river rock dam ensures suitable depth for abstraction by siphon Contingency: Water conservation measures can be implemented during drought conditions	Yes	Moderate (unlikely x medium)	None required	AM WOM

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of Supply	1.8	Major slip in catchment blocks river and/or affects quality and quantity of water available for abstraction	High (unlikely x major)	Low flows in Waingawa River Loss of siphon vacuum pressure Report of major slip in catchment High raw water turbidity Reduced/no flow to treatment plant.	In-river rock dam ensures suitable depth for abstraction by siphon 3-4 days of raw water storage and attenuate turbidity Treatment plant can cope with high turbidity source water Participate in Joint Working Group for Drinking water Contingency: Water conservation measures can be implemented during drought conditions	Partially	Moderate (unlikely x medium)	Investigate the availability of alternative sources of water supply closer to the treatment plant that could be used in an emergency	AM WOM
Cyanotoxin Contamination	1.9	Cyanobacteria growth in source water.	Very High (Likely x major)	Visible algal growth on river rocks Taste and/or odour complaints from consumers. Advice from the Regional Council of cyanobacteria in Waingawa River	3-4 days raw water storage facilitates selective abstraction to avoid taking river water if cyanobacteria or cyanotoxins are mobilised in river Monthly sampling (Cawthron tests) in summer. Refer to Cyanobacteria Management Protocol Contingency: P.A.C. dosing available xWellington at 2 days' notice.	Yes	Moderate (Possible x minor)	None required	AM WOM EHO

2. Intake siphon

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of Supply	2.1	Intentional vandalism or accidental damage to intake siphon structure or rock weir by flood debris in river	Very High (possible x major)	Obvious signs of damage to structure. Reduced/no flow to treatment plant. Equipment alarms Heavy machinery being used near intake	Intake structure is robust and designed to withstand impacts from flood debris. Rock weir and intake structure is inspected after river flood events. This deep pool around siphon would prevent heavy machinery use Structure is in a remote area not regularly visited by the public 3-4 days of raw water storage in ponds CCTV installed at siphon intake allows operators to view intake Contingency: Spare intake head stored at WTP. Contingency: Water can be pumped from the river adjacent to the "rocket" downstream of siphon	Yes	Moderate (unlikely x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of Supply	2.2	Damage to intake structure due to lack of maintenance	Very high (likely x major)	Obvious signs of damage and/or age to the structure. Reduced/no flow to treatment plant	Maintenance carried out on structure. 3-4 days of raw water storage in ponds	Yes	Moderate (unlikely x medium)	None required	AM WOM TPO
Loss of Supply	2.3	Failure of vacuum equipment (tanks for collection of air and pumps)	Moderate (unlikely x medium)	Reduced/no flow to treatment plant	Standby generator and pump available. Vacuum pumps serviced monthly Vacuum levels, river levels are checked remotely from WTP 3-4 days of raw water storage in ponds Regular onsite visual inspections made <u>Contingency:</u> pump river water from adjacent to the "rocket" downstream of siphon in such an emergency	Yes	Low (rare x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of Supply	2.4	Drought or extreme low water levels in river prevent abstraction	Very High (possible x major)	Low flows in Waingawa River Prolonged drought conditions Reduced/no flow to treatment plant	3-4 days of raw water storage in ponds <u>Contingency</u>: Water conservation measures can be implemented during drought conditions	Yes	Moderate (unlikely x medium)	None required	AM WOM
Loss of Supply	2.5	Failure of pipe between intake and treatment plant	High (likely x medium)	Reduced/no flow to treatment plant. Damage to bridge upon which the pipe is held by severe flood. Erosion along the raw water pipeline	3-4 days of raw water storage Bridge is well above normal river water level. <u>Contingency:</u> Spare pipes and couplings stored at WTP <u>Contingency:</u> pump river water from adjacent to the "rocket" downstream of siphon in such an emergency	Yes	Moderate (possible x medium)	None required	AM WOM TPO
Loss of right to take Water	2.6	Consent to take water is not renewed or is declined by Regional Council.	Very High (possible x major)	Regional Council raises issues about water consents prior to consent being renewed	Current consent is valid until 2023. <u>Contingency</u>: Participates in JWGDW together with GWRC and local authorities	Yes	High (unlikely x major)	None required	WOM

3. Pre-treatment Storage

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Insufficient water to meet demand	3.1	Quantity of water available from river is less than quantity of water drawn from ponds	High (unlikely x major)	Low flows in Waingawa River Prolonged drought conditions Reduced/no flow to treatment plant	3-4 days of raw water storage in ponds Low water level alarm in raw water ponds Contingency: Water conservation measures can be implemented during drought conditions	Yes	Moderate (unlikely x medium)	None required	AM WOM
Insufficient water to meet demand	3.2	Very high river water turbidity (occurs during nor-westerly storms) prevents abstraction for an extended period	Moderate (possible x medium)	Extended periods of nor-westerly storms Monitoring of intake water to raw water ponds indicates extended turbidity	Treatment plant can cope with intake water turbidity of 150 NTU Water up to 1800NTU can enter ponds with 150 NTU going to plant during 3-4 days storage Contingency: Water conservation measures can be implemented	Yes	Moderate (unlikely x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of stored raw water	3.3	Structural failure of raw water ponds	High (unlikely x major)	Evidence of increasing leakage from raw water pond(s) as ponds are known to leak Low water level alarm in raw water ponds	Visual inspections of raw water pond structures Having multiple ponds controls risk <u>Contingency:</u> Each of the 3 raw water ponds can be bypassed and/or individually isolated. Two ponds give 2-3 days storage.	Yes	Low (rare x medium)	None required	AM WOM
Loss of stored raw water	3.4	Pipe or valve failure on raw water line	High (unlikely x major)	Reduced/no flow to treatment plant	Council have accurate pipework records (refer Water Supply - Asset Management Plan) Regular inspections and lubrication programme for valves	Yes	Moderate (unlikely x medium)	Staff to be involved in information accuracy of the latest Asset Management Plan.	AM, WOM, TPO
Microbiological or chemical contamination	3.5	Deliberate contamination of water in the raw water ponds	High (unlikely x major)	Visual evidence of break in or vandalism	Plant is away from public view Treatment processes are robust and would remove or lessen most contamination Security cameras and beams in place to “announce” visitors to the site.	Yes	Moderate (unlikely x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Microbiological or chemical contamination	3.6	Incidental contamination of water in the raw water ponds from wildlife or aerial sources	Very high (Possible x major)	Visual inspection of wildlife, especially birds (actual observation or evidence such as feathers)	Vermin controlled via traps for possums, etc Education of local land-owners and users on potential impacts on raw water quality. Selective use of ponds which can be drained and water supplied directly from river if required Treatment processes are robust and would remove or lessen any contamination <u>Contingency</u>: Levels of wild-life monitored on raw water ponds, evidence of other wildlife that could potentially affect the raw water quality	Partially	Moderate (possible x minor)	Investigate more effective wildlife control methods if required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Reduced water quality	3.7	Re-suspension of raw water pond sediment	High (unlikely x major)	Visual evidence of high turbidity in raw water ponds Monitoring of plant intake water shows turbidity to be higher than usual	Approximately 2metres of 'sludge free board" exists below the intake level Removal of sediment is not likely to be required at more than 20 year intervals Re-suspension is likely to occur when maintenance is done in ponds and staff are aware of this risk	Yes	Low (unlikely x minor)	None required	WOM TPO
Reduced water quality	3.8	Algal growth in raw water ponds	Very high (possible x major)	Visual evidence of algal growth in ponds Taste and odour complaints	Rapid transit of water through ponds discourages the opportunity for algal growths to develop Ponds can be drained and water supplied directly from river if required	Yes	Moderate (Possible x minor)	None required	WOM TPO

4. Coagulation, Clarification and Sedimentation

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	4.1	Floc not formed due to poor coagulant mixing	Moderate (possible x medium)	No or poor floc formation. High turbidity in water leaving the clarifier or filters.	Dosing points are at sites of maximum mixing energy Turbidity is monitored online in water leaving the filters Filters operate best with floc-carryover.	Yes	Moderate (unlikely x medium)	None required	WOM TPO
Particles/ Protozoa not captured / removed	4.2	Floc not formed due to PACl or poly (polyelectrolyte B570) dose pump failure.	Moderate (possible x medium)	No or poor floc formation. High turbidity in water leaving the clarifier or filters.	Operator at plant daily Turbidity is monitored online in water leaving the filters Dosing pumps are well maintained and calibrated Backup and standby pumps are installed PACl and poly use same type of dosing pump so parts are interchangeable	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	4.3	Floc not formed due to inappropriate dose rate of coagulant chemicals.	Moderate (possible x medium)	No or poor floc formation. High turbidity in water leaving the clarifier or filters. Chemicals exceeding MAVs.	Operator at plant daily Poly pump stroke is manually adjusted but flow paced Pumps are routinely calibrated Turbidity is monitored online and alarmed in water leaving the filters Very small poly dose used because intake water turbidity is very low Jar tests undertaken as required	Yes	Moderate (unlikely x medium)	None required	TPO
Particles/ Protozoa not captured / removed	4.4	Clarifier fails to remove particles due to sudden change of raw water turbidity	Moderate (possible x medium)	Poor floc formation. Filters clog up unusually quickly High turbidity in water leaving filters	Raw water ponds attenuate turbidity Filter headloss monitored and alarmed Turbidity is monitored online in water leaving the filters	Yes	Moderate (unlikely x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	4.5	Floc not formed due to coagulant chemical supply exhausted.	Moderate (Possible x medium)	Poor floc formation. High turbidity in water leaving the clarifier or filters.	Operators at plant daily and monitor chemical storage Minimum of 3 months of all chemicals are held in bulk at treatment plant	Yes	Low (Rare x medium)	None required	TPO
Particles/ Protozoa not captured / removed	4.6	Poor Floc formation due to raw water pH incorrect for optimal coagulation	High (Likely x medium)	Poor floc formation. Excessive floc carryover to the filters High turbidity in water leaving the clarifier.	Raw water pH rarely changes Turbidity is monitored online in water leaving the filters	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	4.7	Poor flow distribution across clarifier, launders	High (Likely x medium)	Build of algae and scum causing launders to become blocked Poor clarifier performance with high turbidity in water leaving the clarifier	Turbidity is monitored online in water leaving the filters Launders are checked and cleaned as required, usually every 3-4 months Flow controlled to clarifier by demand from Upper Plain Reservoir	Yes	Moderate (possible x medium)	None required	TPO
Particles/ Protozoa not removed due to sludge not removed	4.8	Sludge scraper failure	Moderate (Possible x medium)	Sludge not being removed Sludge build-up in clarifier Scraping mechanisms have stopped. Alarms if VSD fails on the scraper drive	Regular greasing of gearbox and Annual inspection Slew gear was replaced in 2016 as preventative maintenance Contingency: Sludge can removed manually via a submersible pump Contingency: **emergency action only:** the clarifier can be bypassed, treatment plant can run via direct filtration. Should this happen consultation with the DWA will occur.	Yes	Low (Rare x medium)	Investigate whether a second clarifier is justifiable	TPO WOM AM

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	4.9	Floc not formed due to inappropriate or poor quality chemicals used.	Moderate (Possible x medium)	No or poor floc formation. High turbidity in water leaving the clarifier or filters.	Lime is delivered with analysis sheet. IXOM gives guarantee of chemical quality Turbidity of water filters is monitored Staff onsite when chemicals delivered and receive delivery dockets.	Yes	Moderate (Unlikely x medium)	None required	TPO
Particles/ Protozoa not captured / removed	4.10	Floc not formed due to loss of chemical from bulk storage tank.	Very high (possible x major)	Chemicals identified in tank bunding No or poor floc formation. Loss of water quality	Operators at plant daily Tank levels are monitored and alarmed Online instruments alarmed to significant changes	Yes	Moderate (unlikely x medium)	None required	TPO
Particles/ Protozoa not captured / removed	4.11	Floc not formed due to leaks in the supply line from the coagulant bulk storage to dose point.	Moderate (possible x medium)	No or poor floc formation. High turbidity in water leaving the clarifier or filters.	Loss of water quality will trigger alarms Lines replaced if any evidence of damage Poly and PACl have spare lines installed	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	4.12	Coagulation failure due to chemicals delivered to incorrect storage tank.	Very high (possible x major)	Coagulation does not occur or only partially occurs.	Operator on site when chemicals are delivered to ensure they are delivered to the correct tank. Delivery points are clearly marked Delivery hoses must match magnetic tags on delivery points before chemicals can be discharged into storage tanks	Yes	Moderate (rare x major)	None required	TPO

5. Filtration

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	5.1	Media loss from excessive backwashing rate or deterioration of filtration media.	Moderate (possible x medium)	High turbidity in water leaving the filter. Increased frequency of backwashing required.	Media depth is checked every 6 months Backwash water flow rate is constrained by (locked) valve	Yes	Low (rare x medium)	None required	TPO
Particles/ Protozoa not captured / removed	5.2	Failure of backwash air scour	Moderate (possible x minor)	Visual inspection of backwash process identifies backwash blower failure	Maintenance includes backwash air scour Backwashes are effective without air-scour for several weeks Contingency: Air blower can be repaired or replaced with off-the-shelf item	Yes	Low (unlikely x minor)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective	Who
Particles/ Protozoa not	5.3	Inability to backwash effectively due to power outage	High (likely x medium)	High turbidity in water leaving the filter.	Turbidimeters on each filter indicate filter performance <u>Contingency:</u> Can pump directly from treated water tank with diesel powered pump, that has purpose built pipework	Yes	Low (likely x insignificant)	None required	WOM TPO
Particles/ Protozoa not captured / removed	5.4	Caking or mud-balling of the filter media.	High (likely x medium)	Visual inspection shows caking or mud-balling. Irregular pattern of filter media fluidisation during backwash cycle Elevated filtered water turbidity.	Air scour and backwashing process fluidises filter media during backwash cycle Daily visual inspection undertaken of backwash cycle Turbidimeters on each filter indicate filter performance	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Particles/ Protozoa not captured / removed	5.5	Failure of filter support blocks or underdrains.	High (likely x medium)	Irregular pattern of filter media fluidisation during backwash cycle Elevated filtered water turbidity.	Daily visual inspection undertaken of backwash cycle. Turbidimeters on each filter indicate filter performance Filter headloss monitored and alarmed	Yes	Moderate (unlikely x medium)	None required	TPO
Unable to clean filters	5.6	Backwash pump failure	High (likely x medium)	Backwash cycle doesn't happen Increased post filter turbidity Turbidity spike initiates filter to waste	Regular maintenance of backwash pumps Pumps monitored for noise and vibration	Yes	Moderate (unlikely x medium)	None required	TPO

6. Chlorination

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Inadequate Chlorination	6.1	Inadequate contact time	High (likely x medium)	Calculation of retention time determines contact time is inadequate E. coli detected in reticulation	Contact time is provide in the storage reservoirs	Yes	Moderate (unlikely x medium)	None required	WOM
Inadequate Chlorination	6.2	Chlorine gas supply exhausted.	Very High (likely x major)	Illness in community. FAC is < 0.4 mg/L for greater than 15 minutes in water in reticulation.	Two 920 kg drums arranged in duty/ standby with auto change over and at least one spare tank FAC monitored online in water in leaving the treatment plant Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Inadequate Chlorination	6.3	Dosing system failure.	Very High (possible x major)	FAC is < 0.4 mg/L for greater than 15 minutes in water in reticulation.	FAC monitored (triple validation) and alarmed online in water leaving the treatment plant Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L Slam-shut valve diverts treated water to waste at an FAC <0.4 mg/L Venturi systems are very reliable. Spares are kept at the WTP.	Yes	Moderate (unlikely x medium)	None required	TPO
Inadequate Chlorination	6.4	Chlorine dose rate incorrect	High (likely x medium)	FAC is < 0.4 mg/L for greater than 15 minutes in water in reticulation.	Chlorine dose rate is automatically adjusted based on on-line monitoring results FAC monitored online in water leaving the treatment plant Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Inadequate Chlorination	6.5	Chlorine demand exceeds chlorine dose due to high raw water turbidity	High (likely x medium)	High turbidity in water. FAC is < 0.4 mg/L for greater than 15 minutes in water in reticulation.	Robust treatment processes remove turbidity prior to chlorination Turbidity monitored post filtration Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L	Yes	Moderate (unlikely x medium)	None required	TPO
Inadequate Chlorination	6.6	Lack of chlorine due to dosing line failure or leak.	High (likely x medium)	FAC is < 0.4 mg/L for greater than 15 minutes in water in reticulation. Strong chlorine smell at treatment plant	FAC monitored online in water leaving the treatment plant Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Over Chlorination	6.7	Dosing system failure.	High (likely x medium)	FAC level high (>1.6 mg/L for >1 hr). Odour and taste complaints	FAC monitored online in water leaving the treatment plant Chlorination equipment is simple venturi system with low failure rate Chlorination equipment is regularly maintained Slam-shut valve diverts treated water to waste if the FAC is considered too high	Yes	Moderate (unlikely x medium)	None required	WOM TPO
Over Chlorination	6.8	Chlorine dose rate incorrect	High (likely x medium)	FAC >1.6 mg/L for >1 hr in water leaving the treatment plant Odour and taste complaints	Chlorine dose rate is automatically adjusted based on on-line monitoring results FAC monitored online in water leaving the treatment plant Slam-shut valve diverts treated water to waste if the FAC is considered too high	Yes	Moderate (unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Formation of disinfection by-products	6.9	High load of organic material in treated water	High (likely x medium)	Results of disinfection by-product analysis High loads of organic material is known to pass the filters	Treatment processes are known to remove organic and particulate material Turbidity meters on water leaving each filter Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L	Yes	Moderate (unlikely x medium)	None required	TPO

7. Fluoridation

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Fluoride adjustment too High or Low	7.1	Dosing system failure	Moderate (Possible x Medium)	Fluoride levels in final water is outside prescribed limits	Fluoride manually tested daily. Dosing pump adjusted accordingly High and low pH alarms	Yes	Moderate (unlikely x medium)	None required	TPO
Fluoride Adjustment too High or Low	7.2	Incorrect dosing rate.	Moderate (possible x medium)	Fluoride levels in final water is outside prescribed limits	Fluoride manually tested daily. Dosing pump adjusted accordingly.	Yes	Moderate (unlikely x medium)	None required	TPO
Fluoride level not maintained	7.3	Inappropriate or poor quality HFA used	Moderate (Possible x medium)	Fluoride levels in final water is outside prescribed limits	Quality of HFA guaranteed by IXOM	Yes	Moderate (Unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Fluoride Level not maintained	7.4	HFA supply exhausted	Moderate (Possible x medium)	Fluoride levels in final water is below prescribed limits.	Operators monitor quantity of stored HFA Delivery of HFA usually 3 working days after ordering	Yes	Moderate (Unlikely x medium)	None required	TPO

8. pH Adjustment

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
pH Adjustment too High or Low	8.1	Dosing system failure	Moderate (Possible x Medium)	pH of the water entering the clarifier or leaving the treatment plant outside required parameters	pH continuously monitored before clarifier and in water leaving treatment plant High and low pH alarms.	Yes	Moderate (unlikely x medium)	None required	TPO
pH Adjustment too High or Low	8.2	Incorrect dosing rate.	Moderate (possible x medium)	pH of the water entering the clarifier or leaving the treatment plant outside required parameters	Dosing is adjusted by on-line pH analyser and VSD on auger motor pH of water from filters is monitored on-line	Yes	Moderate (unlikely x medium)	None required	TPO
Impurities in pH adjusting chemicals	8.3	Inappropriate or poor quality lime used	Moderate (Possible x medium)	High or low pH in water leaving the treated water reservoir	Quality analysis provided with each lime load pH of water in the treated water reservoir is monitored on-line	Yes	Moderate (Unlikely x medium)	None required	TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
pH Adjustment too High or Low	8.4	Lime supply exhausted	Moderate (Possible x medium)	pH not adjusted and outside intended parameters	Operators monitor quantity of stored lime 3 months bulk supply of lime is held at treatment plant Delivery of lime is usually 3 working days after ordering	Yes	Moderate (Unlikely x medium)	None required	TPO
pH Adjustment too High or Low	8.5	Deterioration of lime in bulk storage	Very high (possible x major)	pH adjustment is inefficient Change to quantity of lime being used High or low pH in water leaving the treated water reservoir	Operator checks condition of lime storage regularly On-line continuous pH monitoring	Yes	Moderate (unlikely x medium)	None required	TPO

9. Treated water Storage Reservoirs

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Microbiological contamination	9.1	Leakage through reservoir roof or other parts of structure or access by birds or vermin.	Very high (possible x major)	E. coli in water leaving reservoir Decreased FAC in water in reticulation	Residual chlorine in water. Reservoirs are covered and all entry hatches are secured and alarmed against ingress Regular inspection of reservoirs is carried out	Yes	Moderate (possible x medium)	None required	WOM TPO
Microbiological contamination	9.2	Vandalism to reservoir.	Moderate (possible x medium)	E. coli in water leaving reservoir. Decreased FAC in water leaving reservoir. Reports from the public.	Residual chlorine in water. Upper Plain Reservoir is hidden from the public view but close to rural residential houses Other reservoirs are in public view and close to urban houses All reservoirs are difficult to access by unauthorised persons and are alarmed	Yes	Moderate (unlikely x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Microbiological contamination	9.3	Sediment accumulation within reservoirs	Moderate (possible x medium)	Visible suspended matter in water exiting reservoir. Decreased FAC in water leaving reservoir. Complaints from consumers	Treatment processes ensure water entering reservoir has very low particulate load Regular inspection of reservoirs is carried out and cleaning undertaken if required	Yes	Low (unlikely x minor)	None required	WOM TPO
Microbiological Contamination	9.4	Contamination through insanitary maintenance or sampling procedures.	Moderate (Possible x medium)	E. coli in water leaving reservoir Decreased FAC in water leaving the treatment plant	Residual chlorine in water Access to reservoirs is restricted to trained staff.	Yes	Low (Unlikely x minor)	None required	TPO
Loss of supply	9.5	Insufficient storage for peak demand	Very high (likely x major)	Loss of water or pressure in reticulation Frequent low reservoir levels	Gravity treatment from 3-4 days raw water storage plus ½ days treated water storage at maximum flow rate. Contingency: MDC Water LTP includes provision for new reservoir at Lansdowne in 2025. Timing is subject to supply resilience requirements.	Yes	Moderate (unlikely x medium)	None required	AM WOM

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of supply	9.6	Failure of reservoir	Very high (Likely x major)	Complaints from consumers about loss of supply or pressure Obvious signs of leakage or failure at reservoir site	Reservoirs have been constructed to required standards and are checked for structural integrity as required (internally after cleaning or visually from the outside)	Yes	Moderate (Unlikely x medium)	None required	AM WOM

10. Bulk Treated water Supply Main

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Insufficient pipe capacity	10.1	Pipe design capacity is insufficient to meet water demand	Very high (likely x major)	Difficulty in maintaining Upper Plain Reservoir near full capacity High pipe pressures due to high pumping volumes	600mm dia pipe is suitable for providing up to 25,000m^3/day	Yes	Low (rare x medium)	None required	AM WOM
Loss of supply due to Pipeline damage	10.2	Contractors excavate along pipeline route, damaging pipe	Very high (likely x major)	Loss of supply to Upper Plain Reservoir Heavy machinery observed operating close to pipeline route	Pipeline route is marked with underground tape Pipeline route is marked on Council GIS Contractors are required to undertake a service assessment before any excavation Local contractors are generally aware that pipeline is in area between plant and reservoir	Yes	Moderate (unlikely x medium)	None required	AM WOM

11. Reticulation

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of Supply	11.1	Pipe failure.	Moderate (Possible x medium)	Complaints from consumers about loss of supply. Change in flow or pressure in reticulation.	Pipe failures are repaired as priority Good asset knowledge is held on pipe ages, material and condition Failures, maintenance and renewals are recorded in council asset management system Pipe renewals programme in place (refer to Water Supply Asset Management Plan 2018) Leak detection undertaken	Yes	Moderate (Possible x minor)	None required	AM
Loss of Supply	11.2	Excessive demand in network or inadequate system capacity.	Moderate (possible x medium)	Complaints from consumers about low pressure or loss of supply. Change in flow or pressure in reticulation.	Gravity treatment from 3-4 days raw water storage plus ½ days treated water storage at maximum flow rate. <u>Contingency:</u> MDC Water LTP includes provision for new reservoir at Lansdowne in 2025. Timing is subject to supply resilience requirements.	Yes	Moderate (unlikely x medium)	None required	AM

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of Supply	11.3	Pipe failure due to excessive reticulation pressures.	Moderate (Possible x medium)	More than expected number of pipe breaks Pressure monitoring indicated pressure in excess of 900 kpa	Council has knowledge of system pressures (refer Water Supply Asset Management Plan 2018 + reports from staff performing routine sampling) Good asset knowledge is held on pipe ages, material and condition Leak detection undertaken	Yes	Moderate (Possible x minor)	None required	AM
Microbiological Contamination	11.4	Inadequate controls on maintenance and construction work.	Moderate (possible x medium)	Complaints from consumers about taste or odour E. coli present in reticulation system Less than expected FAC in reticulation	Maintenance and replacement work is undertaken by trained qualified and experienced Council staff Specialist contractors used when required SOP's written for maintenance and construction work Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L	Yes	Moderate (unlikely x medium)	Staff to Review and update SOP (where appropriate) to reflect latest Asset Management Plan	AM, WOM, TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Chemical or Microbiological Contamination	11.5	Backflow from consumer connections.	Very high (likely x major)	Contaminants identified in the reticulation system. Taste or odour complaints from consumers.	New or replaced connections have manifolds with check valves installed FAC maintained throughout the reticulation Backflow devices recorded and tested annually in accordance with Council Policy dated December 2011	Yes	Moderate (unlikely x medium)	None required	AM
Loss of or reduced supply	11.6	Unidentified leakage or illegal connections	Very high (likely x major)	Results of leak detection surveys. Per head consumption exceeds calculated expectation	Known breaks and leaks repaired as a priority. Leak detection programme in place Illegal connections identified and legalised	Yes	Moderate (possible x minor)	None required	AM
Supply of Turbid Water	11.7	Silt build up within reticulation pipes.	Moderate (Possible x minor)	Reduced flows in reticulation. Complaints from consumer about quality of water	Flushing undertaken in response to complaints Council has planned flushing programme Reports from staff performing routine sampling	Yes	Low (Unlikely x minor)	None required	AM EHO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Inadequate Supply of Water	11.8	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	MDC requires all work and materials used in reticulation to meet standard specifications Industry best practice reticulation approach taken to reticulation work which is currently contracted. Four online chlorine residual analysers monitor reticulated water FAC. Alarmed if FAC <0.4 mg/L Reports from staff performing routine sampling	Yes	Moderate (unlikely x medium)	None required	AM EHO

12. Other

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Insufficient knowledge of water quality	12.1	Inadequate sampling programme or sample 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.	Yes	Moderate (possible x medium)	None required	AM WOM EHO
Treatment Process Equipment Failure	12.2	Supply equipment fails due to inadequate asset information and inadequate maintenance planning	Very high (Almost certain x medium)	Unexpected plant equipment failure. Not having an asset register and maintenance programme	Updated and current information held on all water supply assets allowing maintenance to be planned and undertaken	Yes	Moderate (Unlikely x medium)	Staff to review and update SOP (where appropriate) to reflect latest Asset Management Plan	AM, WOM, TPO
Reduced water quality	12.3	Failure of on-line monitoring equipment	Very high (likely x major)	Inconsistent or unexpected on-line monitoring results On-line results differ from portable instrument results	On-line instruments regularly calibrated More than one instrument for most things being monitored	Yes	Moderate (Unlikely x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place	Risk Managed	Residual Risk	Corrective Actions / Contingency Actions	Who
Treatment Process Failure	12.4	Insufficient, inadequate, out of date. or incorrect manual of operational procedures	Very high (almost certain x medium)	Operational manuals not used. Operational Manuals not up to date. Operational manual copies are not the same.	SOPs have been prepared for all plant processes	Yes	Moderate (possible x medium)	None required	WOM TPO
Treatment Process Failure	12.5	Inadequate training, professional development and up-skilling of operators results in operator error and/or mismanagement	Very High (almost certain x major)	Poor operation of plant. Plant compliance failure. Loss of supply.	Two operators hold National Diploma in Drinking Water Treatment and one has National Certificate in Drinking Water Treatment Internal training provided as required Training records are kept	Yes	Moderate (unlikely x medium)	None required	AM WOM

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Failure to Provide Safe Water	12.6	Inadequate data collection, reporting and control systems	High (likely x medium)	Information about how the supply is operating is not available Manual collection and recording of data Manual operation of treatment plant	FAC and turbidity monitored online in water leaving the treatment plant Set point alarms are sent when monitoring show parameters are out of specifications All monitoring data is stored electronically for retrieval	Yes	Moderate (unlikely x medium)	None required	WOM EHO
Treatment Process Failure	12.7	Treatment processes are not sufficient to comply with the requirements of the DWSNZ	Very high (almost certain x major)	Treatment processes at the treatment plant do not comply with the DWSNZ	Treatment processes at plant meet DWSNZ compliance	Yes	Moderate (possible x minor)	None required	AM WOM TPO
Loss of Supply	12.8	Power failure	Very high (possible x major)	General power failure evident Water supply disrupted	Backup generator on site Gravity treatment from 3-4 raw water storage plus ½ days treated water storage at maximum flow rate.	Yes	Moderate (unlikely x minor)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Microbiological or chemical contamination	12.9	Vandalism to plant equipment	Moderate (possible x medium)	E. coli in water leaving reservoir Decreased FAC in water leaving reservoir Reports from the public Visible evidence of intentional damage	Treatment plant is obscured from public view and is well lit Security cameras and beams in place to "announce" visitors to the operational staff site.	Yes	Moderate (possible x minor)	None required	AM WOM
Accidental contamination at treatment plant	12.10	Inadvertent contamination of water supply at the treatment plant	Moderate (possible x medium)	Positive E coli results Unhygienic practices are observed	Staff are excluded from work if they have a diarrhoeal illness Staff and visitors are required to wash hands after using the toilet and good personal hygiene is a requirement	Yes	Moderate (unlikely x medium)	None required	WOM TPO

Event	No	Cause	Risk Without Preventative Measures	Indicators	Preventative Measures in Place / Contingencies	Risk Managed	Residual Risk	Corrective Actions	Who
Loss of supply to community	12.11	Earthquake or other natural disaster	Very high (possible x major)	Natural disaster occurs and water is not provided to Masterton Check of system after a natural disaster identifies significant damage which affects supply of water to community	Council has an operational emergency response plan Water supply staff have emergency procedures to follow in event of natural disaster and loss of supply	Yes	Moderate (possible x medium)	None required	AM WOM
Cross-contamination	12.12	Operators working on treatment plant sludge wastes (clarifier and filters) cross contaminate water post treatment	Moderate (possible x medium)	Positive E. coli results in treated water Evidence of practices which indicate potential for cross contamination	Operators are aware and visitors are informed of cross contamination risks Operators and visitors are required to wash hands and clean boots and remove soiled clothing after working with sludge wastes Operators are appropriately trained	Yes	Moderate (unlikely x medium)	None required	TPO