Code of Practice for Water Reticulation Disinfection

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1 Introduction

The bulk water supply to the Watercare network is chlorinated before it reaches the areas of local reticulation. Watercare monitors the water throughout the city on a daily basis to ensure a minimum residual level of chlorine is maintained. A minimum level of chlorine of 0.2 mg/l is required to act as a barrier to contamination and meet the requirements of the Drinking Water Standards of New Zealand (DWSNZ).

Watercare does not do additional chlorine dosing to the network supply. It is therefore imperative that any works carried out on the network follow the best practices as outlined in this Code of Practice in order to preserve the existing water quality and safeguard the water from contamination.

Failure to follow these identified best practices exposes the public water supply to a risk of contamination, both chemical and bacteriological.
2 Objectives

Water supply authorities are required by law to ensure that the water supply system is free from conditions that may be hazardous to public health.

The objectives of the Code of Practice are to:

1. Prevent contamination of the water supply system by defining the minimum requirements for the disinfection of new watermains
2. Prevent contamination of the water supply system by defining the minimum requirements for the disinfection of existing watermains and fittings following planned or reactive maintenance
3. Prevent contamination of the water supply system by defining required best practices for workers and materials that come in contact with water
4. Comply with regulatory requirements under:
   - Health (Drinking Water) Amendment Act 2007
   - Networks Water Safety plan
   - Drinking Water Standards for New Zealand 2005 (Revised 2008)
   - Draft Guidelines for Drinking Water Quality Management for New Zealand 2005
   - Resource Management Act 1991
5. Minimise demerit points under the requirements of:
   - Public Health Grading of Community Drinking Water Supplies 2003

2.1 Areas of Application

1. Installation of new mains and connections
2. Reticulation repairs/maintenance
3. Valve and hydrants inspections/repairs
4. Reticulation inspections involving cutting of live mains
5. Service connections and meters
6. Temporary supplies

This Code of Practice does not apply to the disinfection of water storage reservoirs.

2.2 Roles and Responsibilities

All water supply contractors must adhere to the Disinfection Code of Practice for all work on the Watercare water supply network.
Supervisors shall audit the disinfection practices to ensure the Code is being followed. Records must be kept of audit results.

Contractors shall be responsible for the annual medical clearance of their water reticulation workers. Contractors shall ensure on a daily basis that their water reticulation workers are in a medically fit condition for work. Refer section 3.2 Water Reticulation Workers – Hygiene and Health.

Any problems or transgressions from the outlined procedures must be reported to the Watercare Water Quality and Compliance Manager.

Any confirmed or suspected contamination to the water supply network must be escalated according to the Watercare Incident Management Plan, Water Quality Incident Response Plan and Public Health Risk Management Plans.

2.3 Reporting

Water supply workers shall report any gastrointestinal illness (vomiting, diarrhoea etc.) to their employer. Refer section 3.2 Water Reticulation Workers – Hygiene and Health.

All microbiological test results must be sent to the Watercare Water Quality and Compliance Analyst for assessment and/or approval.

2.4 Notification

Any bacteriological transgression identified as a result of testing after a repair will be investigated. A true transgression will be notified to the Auckland Drinking Water Assessor by the Watercare Water Quality and Compliance Analyst.

If E.coli contamination is higher than 10MPN/100ml Watercare may be required to issue a “Boil Water” notice to customers in the affected area.

2.5 Assessment of Level of Risk

Disinfection is a key element in preventing contamination of the water supply during maintenance but it cannot compensate for improper procedures and poor practices.

For all work carried out on the Water network including (but not limited to):

- Emergency or planned repairs on watermains
- Maintenance or replacement of fittings
- New service connections
- New main connections
- Disconnection of redundant mains

The Contractor shall assess the risk of contamination on a case by case basis using the procedure in Section 8.1 and then follow the corresponding recommended disinfection procedures outlined in Sections 8.2 - 8.4.

The procedure for work and requirement for bacteriological testing depends upon the level of risk of contamination to the network.
3 Water Reticulation Workers

3.1 Qualifications

Water supply workers are expected to have completed the Level 3 National Certificate in Water Reticulation – Service Person Qualification. As a minimum the site supervisor or foreman shall hold this qualification and supervise all disinfection practises.

3.2 Hygiene and Health

The contractor and all subcontractors shall comply with the following requirements which relate to workers employed on the maintenance or repair of existing watermains and the construction of new watermains.

All contractors shall have current inoculations as specified by Watercare.

Maintenance workers on the water reticulation system must obtain medical clearance to attest that they are not carriers of any waterborne disease:

1. prior to employment on the water supply system, and on an annual basis thereafter
2. following any gastrointestinal illness (vomiting, diarrhoea etc)
3. following overseas travel to countries with endemic waterborne disease.

This clearance should be obtained from a licenced medical practitioner.

Until clearance is obtained workers shall be placed on work not directly involving the water supply network.

All contractors shall inform their workers of the need for a high standard of personal hygiene and the dangers of contamination. A high standard of personal hygiene shall be maintained by all people employed on the water supply network.

Water supply workers with running/septic skin infections or wounds shall not work on the water supply network unless the infection or wound is effectively dressed and in a location unlikely to be immersed.

The Watercare Water Quality and Compliance Analyst may, at any time where he or she believes a significant contamination risk exists, require water supply workers to produce a medical clearance against being carriers of potentially waterborne diseases including Shigella, Salmonella, Campylobacter, Hepatitis A, Giardia and Cryptosporidium.

Workers previously employed on stormwater or wastewater works (reticulation and treatment) shall not work on any water supply works until medical clearance as described above has been obtained and new or disinfected PPE provided for the worker(s).
4 Property and Equipment

4.1 Vehicles

Separate vehicles must be used for water reticulation and wastewater reticulation works.

A high standard of cleanliness shall be maintained in the interiors of all vehicles used for water reticulation works.

Vehicles must be equipped with sanitary wipes or antibacterial liquid for hand sanitation when working on site.

All fittings carried in vehicles must be boxed, capped or sealed with plastic wrapping. All pipes must be capped.

4.2 Stores

A high standard of cleanliness shall be maintained in the interior of all stores.

Water supply and wastewater equipment shall be stored separately.

All materials shall be stored and handled so as to minimise contact with foreign materials. Fittings shall be boxed, capped or sealed with plastic wrapping. All pipes shall be capped.

4.3 Tools and Equipment

Separate tools and equipment must be used for water reticulation and wastewater reticulation works.

All tools used in the construction or maintenance of the main and fittings that come into contact with the treated water must have been thoroughly disinfected and sprayed or rinsed in a 0.1% chlorine solution (1,000ppm) prior to use. Larger items of plant and equipment including excavators shall be steam cleaned before use on potable water jobs. Disinfected tools must not be placed directly on the ground prior to use.

4.4 Materials

All materials, including tools, used in the construction or maintenance of the main and fittings that come into contact with the treated water must have either:

1. Been sealed by the manufacturer under hygienic conditions and are not uncovered until immediately before use,

   Or

2. Been thoroughly disinfected and sprayed or rinsed in a 0.1% chlorine solution (1,000ppm) prior to use. Disinfected items must not be placed directly on the ground prior to installation.

All materials used must conform to the Watercare Approved Materials List in the Water and Wastewater Code of Practice for Land Development and Subdivision.
A bactericidal lubricant is to be used on all rings and gaskets coming into contact with the reticulated water. The lubricant used should be compliant with AS/NZS 4020:2005.

4.5 Disinfection and Neutralising Chemicals

An 0.1% solution for disinfection of tools, equipment, fittings and materials to be used in connection with service work is one made up of 1 part chlorine solution (i.e. commercially available Sodium hypochlorite solution of 12-15% available chlorine) to 9 parts water and shall have a pH value of between 7 and 8. A freshly prepared solution shall be made available at least weekly and the old solution disposed of after dechlorination (refer Appendix C).

Chemical neutralising of chlorine solution (dechlorination) should only be carried out using the chemicals listed in Appendix D.

4.6 Standpipes

All standpipes used on fire hydrants other than those used for flow testing, must be fitted with a metred standpipe fitted with a non-return valve and connected to a section of hose pipe to direct the flow to the designated drainage/collection system.

4.7 Water Tankers for Emergency Supply of Potable Water

Any tanker used to provide emergency water supply for Watercare customers must be a tanker water carrier that only carries Class 1(a) water as defined by the Ministry of Health:

Class 1(a) is water taken from a reticulated supply that complies with the DWSNZ and is listed in the Register of Community Drinking water Supplies and Suppliers in New Zealand.

Please note that water tanker suppliers engaged by Watercare directly or Watercare contractors must be currently registered on the Ministry of Health Register of Community Drinking-water Supplies and Suppliers under the Class 1(a) category. Refer to the Ministry of Health website: www.moh.govt.nz/water

4.8 Water Tankers for Super-chlorination

The preferred option for water chlorination tankers is a tanker supplier dedicated to carry only water from a source that complies with the Drinking Water Standards New Zealand 2005.

If such a supplier is not available then a truck and tanker may be used provided:

1. Assurance is given from the supplier that the tanker has not previously been carrying hazardous substances (Carrier log book to be inspected).

2. A visual inspection is done to ensure the truck and tanker is clean and free of any potential source of water contamination.

3. The tanker is cleaned and flushed thoroughly using potable water prior to filling.

4. That all openings and connections are protected from contamination during loading, transportation and delivery.
5. When the tanker is filled from the Watercare network a non-return valve must be fitted to the standpipe.

4.9 Bottled Water

All bottled water given to customers will be supplied by Watercare. It must have sealed caps and be stored as per supplier’s instructions, out of direct sunlight, and not used beyond expiry date.
5 Work Practises

Good trade practices are to be applied at all times in main laying and maintenance/repair procedures.

In the event of a confirmed or suspected contamination of the reticulation the immediate area shall be isolated and the Watercare Water Quality and Compliance Manager contacted. This situation will be escalated as per the Watercare Incident Response Plan.

All connected valves that have been used to isolate reticulated water from a main being disinfected or a contaminated area shall be tagged and/or recorded by the site supervisor responsible for the disinfection and then signed off at re-commissioning.

5.1 Backflow Prevention Devices for Temporary Connections

All temporary connections of reticulated water to mains under construction and/or maintenance shall incorporate testable double check backflow devices to prevent contamination of the existing reticulation. This includes water being used for hydrostatic pressure testing, flushing and disinfection. See Figure 1 below for suggested temporary set up.

![Figure 1: Suggested temporary flushing / dosing connection](image)

For permanently installed backflow prevention devices refer to the NZ Water and Wastes Association – Backflow Prevention for Drinking Water Supplies – Code of Practice.
5.2 Air Scouring

During a programme of air scouring the contractor shall ensure:

1. A trial shutdown is completed and shutdown notifications given to ensure scouring operations do not adversely affect public health.

2. All valves to be operated and isolated must be operable to contain scour waters.

3. All service connections are to be isolated before air scouring (where possible).

4. All fittings used including the standpipes and sample taps must be disinfected with 0.1% chlorine solution prior to use.

5. The compressor pressure shall be set at 200 kPa less than the mains pressure to eliminate any risk of backflow.

6. All mains must be purged of scour waters following the air scouring to ensure mains are returned to service in a hygienic state.

7. Scour water shall be filtered through a 12 micron filter bag as per the Auckland Council requirements and discharged to the stormwater system.

8. Chlorine residual sampling must be undertaken post scouring to check that sufficient disinfection (minimum 0.2 mg/L of chlorine) is maintained before re-commissioning the scoured watermains.
6 Disinfection Procedures for New Network Watermains

Connection of new network watermains to the existing reticulation will not be permitted until all of the following requirements have been successfully completed (refer to Figure 6.1 in Appendix A).

For the disinfection procedures applicable to transmission watermains, reservoirs and fittings refer to Specification 291 in Appendix E.

6.1 Flushing

The main shall first be thoroughly flushed in sections through hydrants with sufficient velocity of water to remove all foreign matter. The volume of water used must be equivalent to at least three pipe volumes. The flow of water shall be from one direction at any time, and depending on the position of the flushing point(s), flushing may be required alternatively from opposite directions to ensure all of the water is completely flushed out of the main. Following successful flushing, the main shall be chlorinated.

6.2 Chlorination

Each section of new watermain, including all fittings and service connection pipes, shall be disinfected no more than 10 days before being put into service.

The preferred option is for the main to be drained completely, then slowly filled with potable water that has been pre-mixed with chlorine in a tanker. The water should be tested for chlorine concentration before use and should contain sufficient free available chlorine (FAC) to produce a uniform concentration of between 25-50 mg/litre in the main. The chlorinated water shall be introduced at the lowest point of the section of main to be disinfected to ensure no air is trapped. Chlorine levels shall be tested and recorded along the length of the main at a minimum of 150m intervals to ensure effective distribution of the chlorine.

If pre-mixed chlorinated water is not used the chlorine solution must be injected at a continuous rate to ensure a concentration of 25-50mg/litre is in contact with every part of the main (Refer to Appendix C for chlorine dosage). This can be achieved by pumping in the chlorine solution or by using a chlorine injector while the main is being filled with water. Once the main is filled chlorine tests shall be carried out along the length of the main at 150m intervals to ensure effective distribution of the chlorine.

Under no circumstances will the use of hypochlorite powder, granules or tablets dumped into the pipe or hydrants be acceptable practice.

After 24 hours contact time the pH of the water shall be recorded. The effectiveness of hypochlorite as a disinfectant is greatly reduced above pH 8.0. A pH level greater than 9.0 will not be accepted as compliance with the disinfectant requirements and must be repeated using a solution with a pH less than 9.0.

After 24 hours the residual chlorine concentration must at least 20mg/L. If this requirement is not achieved, the chlorination procedure shall be repeated. If this requirement is achieved, the main and service connection pipes shall then be flushed until the chlorine concentration of the water is less than or equal to 1.0mg/litre (test required). Mains should again be flushed with water equivalent to three pipe volumes.
6.3 Disposal of Super-chlorinated Water

All water with a residual chlorine concentration greater than 1.0mg/litre shall be discharged to the sanitary sewer system. The rate of discharge to the sanitary sewer shall be limited to a maximum of 10 litres per second.

If chlorinated water cannot flow to the sanitary sewer system by gravity, then the water shall be pumped to the sanitary sewer system, or pumped into a tanker to be disposed into a conveniently-located sanitary sewer.

If the disposal of super-chlorinated water into the sanitary sewer system or a tanker is not achievable then the water must be de-chlorinated to a maximum residual of 0.2 mg/L before dumping to ground or a stormwater system. Refer to Appendix D for de-chlorination procedure.

Any discharge of highly chlorinated water onto the ground, into a watercourse, or into any stormwater system would contravene Section 15 of the Resource Management Act, and would be subject to maximum penalties of $200,000 fine and/or two years imprisonment.

Following discharge of the super-chlorinated water, the main shall be flushed with reticulation water for a minimum of three pipe volumes or until a chlorine concentration of less than 1.0mg/litre is achieved.

6.4 Sampling and Testing

Sampling and testing of water from new mains includes testing for chlorine, pH and bacteria (total coliforms and E.coli and HPC).

All chlorine, pH and bacteriological testing shall be done by accredited laboratories approved by Watercare. The contractor shall organise (including appropriate advance notice) and pay for the testing, and forward copies of the results to the network engineer for approval as soon as practicable after the tests are completed. Copies of the successful test result must also be sent to the Watercare project engineer.

Following a successful chlorination procedure and flushing, the main shall be charged with fresh mains water with a chlorine concentration of less than 1.0mg/litre. The water shall then be tested for the presence of E.coli at a minimum of two locations. One bacteriological test shall be carried out for every 300m of pipe disinfected including the extremity of any branches. The contractor must provide Watercare with a site plan showing the location of the new main as well as the sampling points.

The tests will take approximately 24 hours. A satisfactory result is E.coli <1MPN/100ml or an “E.coli Absent” result. If this requirement is not achieved, the disinfection procedure shall be repeated and a further bacteriological test done until a satisfactory result is achieved. A satisfactory pH result is pH 9.

If the newly chlorinated main has not been connected to the existing reticulation within 10 days, the main shall be retested for E.coli as per the initial testing. If any of the new samples fail the E.coli test the disinfection procedure must be repeated.

All sample results must be received before approval for the main to be hooked up can be given.
6.5  New Main Hook Up

The connection of a new main to existing reticulation may be treated as a medium risk (refer to Section 8.1 for Risk classification) situation provided sanitary construction procedures are followed ensuring no contamination of either the new or existing main by foreign material or groundwater.

New main hook-up procedure:

1. Excavate trench and dig sump under the section of the existing pipe to be removed to allow for the connection. The sump shall be of a depth at least 400mm.

2. Thoroughly clean and disinfect existing connecting pipework/fittings.

3. Any new fittings to be installed shall be kept clear of the sump and when unwrapped placed on a clean surface (e.g. impervious plastic sheet) until installed.

4. Reduce the pressure in the existing pipe through a hydrant or isolation valve.

5. Drain the existing pipe at the lowest point. If the lowest point is at the location of the new connection then drain into the sump ensuring the sump is dewatered by pump with the level of the water always remaining lower than any open pipework.

6. Empty the new main within the shutdown period, preferably immediately prior to the hook-up. If the main is to be drained into the sump, the sump must be dewatered by pump to avoid any entry into and contamination of the cut pipe.

7. Spray all surfaces of fittings, and wipe the interior of open ends of the new and existing watermains with 0.1% Chlorine solution (Refer to Section 4.5).

8. After completion of the work, the watermain must be flushed out through hydrants downstream of the new connection. The volume of water used must be equivalent to at least three pipe volumes.
7 Disinfection Procedures for Temporary Watermains

When a project requires the use of a temporary watermain, all temporary fittings shall be disinfected, as per section 4.4, prior to connection to the existing reticulation (refer to Figure 7.1 in Appendix A).

7.1 Flushing

The temporary watermain shall be flushed with a volume of water equivalent to three pipe volumes of the temporary supply and flushed through all practical outlets to remove any foreign materials that may have entered during storage. (Refer to Appendix B for flushing volumes).

7.2 Chlorination

The temporary watermain and fittings shall be disinfected with a chlorine dose of 100 mg/L for a minimum period of 30 minutes. After the 30 minute contact time the water within the temporary watermain shall be retested and the residual FAC must not have dropped by more than 20mg/L. Field tests will be acceptable as confirmation of this dose. Disposal of the super-chlorinated water shall be in accordance with the guidelines given under Section 6.3: Disposal of Super-chlorinated Water.

7.3 Post Chlorination Flushing

The watermain shall first be thoroughly flushed in sections from an independent water source with backflow prevention with sufficient velocity of water to remove all foreign matter. The volume of water used must be equivalent to at least three pipe volumes. The final flushing water shall be tested for residual chlorine levels and must be less than 1.0 mg/litre. If this has not been achieved flushing shall be continued until the residual is less than 1.0 mg/litre.
8 Disinfection Procedures for Emergency and Planned Repairs

8.1 Risk of Contamination

The procedure for work and requirement for bacteriological testing depends upon the level of risk of contamination to the network (refer to Figure 8.1 in Appendix A).

All high risk situations require bacteriological testing and must be escalated as an incident to the Watercare network manager. Bacteriological test results are required before the watermain is put back into service.

If any medium risk factors are present then bacteriological testing is required.

Low risk situations do not require bacteriological testing.

Table 1 provides a guideline to ascertain the level of risk and related procedure required. The most frequent risks are listed below however the contractor must assess every situation individually to identify any further risks and evaluate the risk category and associated disinfection procedure accordingly:

Table 1: Assessment of Level of Risk

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<th>Risk Description</th>
<th>Level of Risk Required</th>
<th>E.coli Testing Required</th>
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<tr>
<td>Confirmed or suspected contamination during repair or third party damage (sewage, chemical, hydrocarbons etc)</td>
<td>High</td>
<td>Yes. Watercare Operations to immediately arrange sampling in the downstream network using B2P</td>
</tr>
<tr>
<td>Pipe open and sump adequate i.e. level of drained water does not reach inlet of pipe</td>
<td>Medium</td>
<td>Yes</td>
</tr>
<tr>
<td>E.coli testing is <strong>not</strong> required for works while the watermain remains pressurised</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure in watermain maintained during works e.g. under pressure tapping</td>
<td>Low</td>
<td>No</td>
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8.2 High Risk Situations

High risk situations are where confirmed or suspected contaminant (liquid or solid) material has made contact with the cut area of pipe or has entered the pipe or fitting, i.e. contamination has occurred via sewer, hydrocarbons, chemicals, or large amounts of ingress has occurred in the pipe.

The recommended procedure is:

1. Escalate this incident to the Watercare network manager.
2. Isolate the watermain to prevent further travel of the contaminated water.
3. Isolate all affected service connections.
4. If a service connection cannot be isolated the customer must be advised not to use water until the main has been recommissioned.
5. Tag and record all valves used to isolate.
6. Dig sump to at least 400mm beneath the affected area.
7. Drain the watermain through the cut section, pumping if required, to ensure the groundwater remains well below the invert of the open pipe.
8. Isolate and/or remove the contaminant.
9. Thoroughly clean exterior of pipe and fittings to be connected to prior to start of the repair.
10. Wipe the interior of the open ends of the existing pipe and the new pipe with a clean rag or foam plug soaked in 0.1% chlorine solution. Wipe or spray fittings prior to installation with 0.1% chlorine solution (refer to Section 4.5). Place disinfected materials onto a clean surface e.g. an impervious plastic sheet, not directly onto the ground.
11. Water used for flushing must be fed using a remote hydrant or water tanker; it must not be through a valve used to isolate the area.
12. The remote hydrant or tanker used for filling the contaminated pipe should be fitted with a non-return valve or non-return configuration piping to prevent backflow of super-chlorinated water into the reticulation.
13. After completion of the repair work the main shall be thoroughly flushed. The volume of water used must be equivalent to at least three pipe volumes. The main must be slowly charged from a remote hydrant or tanker while flushing from an open hydrant as close as possible to the opposite end.
14. To ensure effective distribution of the chlorine, the watermain should be charged using pre-chlorinated water to a level of 125 -150 mg/L. When the highly chlorinated water is detected at the flushing hydrant, close the charging valve. Sample should be taken and tested for Free Available Chlorine (this test will need to be carried out by Watercare approved Laboratory).
15. Leave the section isolated for 60 minutes.
16. For safe disposal of the super-chlorinated water the procedure given in the section 'Disinfection Procedure for New Mains' must be followed.
17. Flush the section as per the flushing guidelines (Appendix B).
18. Check that the chlorine concentration is in the range of 0.2 ≥1.0mg/L. Continue flushing if the chlorine concentration is outside this range.
19. After flushing, obtain a water sample for bacteriological testing downstream of the repair from a hydrant fitted with a tap or from a service connection that has been isolated from the customer’s meter.
20. If in doubt of direction of flow, take a sample from both sides of the repair.

21. Customers’ service connections are to remain closed until the results of the bacteriological testing is received by the Network Operations Manager.

22. The Network Operation Manager must approve the recommissioning of the watermain into service including the opening and flushing of the customers’ service connections through their taps or meters until the chlorine concentration is in the range of 0.2 \( \geq 1.0 \text{mg/L} \).

23. All tagged valves must be signed off and reinstated following completion of the work.

24. All actions taken during a High Risk situation must be recorded on the Water Quality Audit Form.
8.3 **Medium Risk Situations**

Medium risk situations are where the pressure in the pipe has been depressurised through a hydrant or isolation valve and then controlled by draining of the pipe into the trench excavation under the point where the pipe is cut.

The recommended procedure is:

1. Excavate while maintaining positive water pressure.
2. Reduce water level and inspect and clean pipe with 0.1% chlorine.
3. Visually inspect flushing water for contaminants and discolouration and repeat flushing if necessary.
4. Thoroughly clean exterior of pipe and fittings to be connected to.
5. After cutting pipe or disconnecting fittings, swab interior of the open ends of the pipe with a clean rag or foam plug soaked in 0.1% chlorine solution. Swab or spray all pieces of new pipe and fittings prior to installation with 0.1% chlorine solution as *(Refer Section 4.4)*. Place disinfected materials onto a clean surface e.g. an impervious plastic sheet, not directly onto the ground.
6. After completion of the work, the main shall be thoroughly flushed through hydrants. The volume of water used must be equivalent to at least three pipe volumes.
7. After flushing, obtain a water sample for bacteriological testing downstream of the repair either from a customer’s outside tap or from a hydrant fitted with a tap.
8. If in doubt of direction of flow, take a sample from both sides of the repair.
9. The watermain may be returned to service prior to the completion of bacteriological testing in order to minimise disruption to customers.
10. Open and flush the customers’ service connections through their taps or meters until the chlorine concentration is in the range of 0.2-1.0mg/L.
8.4 **Low Risk Situations**

Low risk situations are where pressure in the watermain is maintained while carrying out work which involves cutting the live main (e.g. installing service connection, or a branch connection using live tapping techniques). This includes repairs using full circle clamps, sleeves etc.

The recommended procedure is:

1. Thoroughly clean exterior of pipe fittings to be worked on prior to start.
2. Spray all surfaces of fittings and exterior of the watermain with 0.1% Chlorine solution.
3. Carry out the repair or installation and return to service.

8.5 **Bacteriological Sampling Procedure**

For Medium Risk situations, the existing main may be returned to service prior to the completion of bacteriological sampling in order to minimise disruption to customers.

For high and medium risks sampling **must** be done by a Watercare approved Laboratory and sampled for: Chlorine Residual, pH, turbidity, *E.coli*, Total Coliforms and HPC.

Samples shall be obtained before the watermain is put back into service.

During working hours samples shall be delivered to the authorised laboratory within 2 hours of the sample being collected.

Samples obtained after hours shall be stored at the maintenance contractor’s premises until the laboratory opens the following day. Samples must be kept refrigerated until tested and delivered to the Laboratory by 8am as *E.coli* must be analysed within 24 hours to be a valid test.
APPENDIX A: Disinfection Flow Charts

Disinfection Procedures for New Watermains

New Watermain constructed, pressure tested and ready for disinfection

First thoroughly flush main in sections through new hydrants

Introduce pre-chlorinated water to a Free Available Chlorine concentration of 25 – 50mg/L and a pH of less than 9.0

Chlorinated water is left in new watermain for 24 hours

Requirements not met

After 24 hours contact time the pH of the water shall be less than 9.0 and the residual FAC must be at least 20mg/L

Requirements met

Watermain is flushed with potable mains water until chlorine concentration is less than 1.0mg/L

All water with a residual chlorine greater than 1.0mg/L shall be discharged to the sanitary sewer system

Carry out bacteriological testing (total coliforms and E.coli) at 2 locations by an accredited laboratory

Satisfactory result of E.coli <1/100ml or "E.coli absent" result received by Network Engineer

Connect new watermain to existing Network within 10 days

No

Yes

Yes

Repeat the chlorination procedure

After 24 hours contact pH is less than 9.0 and FAC is at least 20mg/L

Investigate cause of failed results (eg swab or CCTV new watermain to find potential contaminant)

Remove contaminant, flush the main and repeat the chlorination procedure until passes

No

Yes

Satisfactory E.coli result achieved

Investigate cause of failed results and repeat bacteriological testing

Figure 6.1
**Disinfection Procedures for Temporary Watermains**

Project requires the use of a temporary watermain.

Flush the temporary watermain with a volume of water equivalent to three pipe volumes of the temporary supply.

The temporary watermain and fittings shall be disinfected with a chlorine dose of 100mg/L for a minimum period of 30 minutes.

After 30 minutes contact time the pH of the water shall be less than 9.0 and the residual FAC must not have dropped by more than 20mg/L.

Watermain is flushed with temporary supply water until chlorine concentration is less than 1.0mg/L.

All water with a residual chlorine greater than 1.0mg/L shall be discharged to the sanitary sewer system.

Connect temporary watermain to existing Network within 10 days.
Disinfection Procedures for Emergency and Planned Repairs

Emergency repair

Contractor notified of emergency or planned repair

Planned repair not cutting pipe open

Determine the type and risk rating of repair

Emergency repair

High Risk—where confirmed or suspected contamination during repair or third party damage (material has made contact with or entered pipe or fittings)

Planned or Emergency repair

Medium Risk—where pressure in pipe has been depressurised, pipe ends open and sump adequate

Low Risk—where pressure in the main is maintained while carrying out work (eg under pressure tapping)

Thoroughly clean area to be worked on prior to start

Spray all surfaces of fittings and exterior of watermain with 0.1% chlorine solution (1000ppm)

Carry out under pressure repair and return to service

Excavate while controlling positive pressure

Reduce water level, inspect and clean pipe with 0.1% chlorine

Visually inspect flushing water for contaminants and discoloration and repeat flushing if necessary

Thoroughly clean exterior and interior of open ends of pipe to be connected in 0.1% chlorine solution

After completion of the work, the main shall be thoroughly flushed through hydrants for at least 3 pipe volumes.

After flushing obtain a water sample for bacteriological testing downstream of the repair

After the appropriate procedures have been completed, the existing main may be returned to service prior to the completion of bacteriological testing in order to minimise the interruption to customers.

After the initial flush the main is to be disinfected with pre-chlorinated water to a level of 125-150 mg/L

Sample taken and tested for free available chlorine. Leave section isolated for 60 minutes.

Dispose of superchlorinated water in approved manner

Flush the section as per the flushing guidelines until the chlorine concentration is in the range 0.2-1.0mg/L.

After flushing obtain a water sample for bacteriological testing downstream of the repair

Watermain to remain isolated until E.coli test results received

Charge main and open and flush service connections as instructed by Network Operations Manager

Complete and submit Water Quality Audit form to Network Operations Manager

Figure 8.1
APPENDIX B: Flushing Guidelines

Flushing time guidelines in minutes for new works prior to disinfection

Table 2: Time in minutes to flush at 20 l/sec

<table>
<thead>
<tr>
<th>Pipe Diameter (mm)</th>
<th>Number of hydrants to achieve flushing velocity*</th>
<th>Length of Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>50m</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>200</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>300</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>35</td>
</tr>
</tbody>
</table>

*(assumes flow rate through 75mm hydrant of 20l/s)

*Note* flushing rates of 5l/s and 10l/s can be used effectively on 50 and 75mm lines respectively.
APPENDIX C: Chlorine Dosing

Amounts of Sodium hypochlorite shown in the Table 3 below are calculated to produce chlorine concentration of **25 mg/L** per 1m length of main:

Table 3: Chlorine Dosing

<table>
<thead>
<tr>
<th>Pipe Diameter (mm)</th>
<th>Volume of water per 1m length of pipe (Litre)</th>
<th>Volume of 12% Sodium Hypochlorite (ml)</th>
<th>Volume of 15% Sodium Hypochlorite (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1.96</td>
<td>0.41</td>
<td>0.33</td>
</tr>
<tr>
<td>75</td>
<td>4.41</td>
<td>0.93</td>
<td>0.74</td>
</tr>
<tr>
<td>100</td>
<td>7.85</td>
<td>1.64</td>
<td>1.31</td>
</tr>
<tr>
<td>150</td>
<td>17.67</td>
<td>3.69</td>
<td>2.95</td>
</tr>
<tr>
<td>200</td>
<td>31.41</td>
<td>6.55</td>
<td>5.24</td>
</tr>
<tr>
<td>250</td>
<td>49.08</td>
<td>10.23</td>
<td>8.18</td>
</tr>
<tr>
<td>300</td>
<td>70.68</td>
<td>14.73</td>
<td>11.78</td>
</tr>
</tbody>
</table>

Following completion of the repair, chlorine levels for disinfection can be tested by the maintenance crews using the field colorimetric indicator tests.

DPD Palintest for Chlorine levels 0 – 5.0mg/L
HR Palintest (Potassium Iodide) for Chlorine levels > 5.0mg/L

Note that improper or extended storage of the hypochlorite can cause a loss in available chlorine.

The maintenance contractor shall ensure that:
- Contractors have chemical handling training
- Vehicles have MSDS sheets
- Contractors have appropriate PPE
APPENDIX D: Neutralising Chlorine

At the end of the 24 hours contact time, the chlorine in the water in the new main must be neutralised before the water is discharged to the receiving environment (the street channel or stormwater system). There are two options that can be used to de-chlorinate the water:

1. Chemical Neutralisation; or
2. Chlorine Dissipation

1. CHEMICAL NEUTRALISATION

Chemical Neutralisation as a method to de-chlorinate water involves dosing to the water as it is being discharged from the main. The most effective and most commonly used chemical to achieve dechlorination is Sodium Thiosulphite though there are two other alternatives:

Table 4: Chlorine Neutralisation Chemicals

<table>
<thead>
<tr>
<th>Name</th>
<th>Chemical Formula</th>
<th>Solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium thiosulphite pentahydrate</td>
<td>Na₂S₂O₃.5H₂O</td>
<td>200g/L</td>
</tr>
<tr>
<td>Anhydrous Sodium sulphite</td>
<td>Na₂SO₃</td>
<td>26.9g in 100g of water at 20°C</td>
</tr>
<tr>
<td>Sodium Sulphite heptahydrate</td>
<td>Na₂SO₃.7H₂O</td>
<td>30g/100mL</td>
</tr>
</tbody>
</table>

Procedure:

1. To prepare 15% w/v solution of any of the above three chemicals, the following steps should be taken:

   Step 1. Fill the solution tank approximately 2/3 full with water
   Step 2. Add the required amount of the neutralising chemical into the tank as specified in Table 5 below
   Step 3. Mix the solution until the added chemical has dissolved
   Step 4. Add the remainder of water and mix
   Step 5. Stir periodically to avoid the solution stratifying
Table 5: Amounts of Chemicals Required for Chlorine Neutralisation

<table>
<thead>
<tr>
<th>Solution Volume (L)</th>
<th>Sodium Thiosulphite (kg)</th>
<th>Anhydrous Sodium Sulphite (kg)</th>
<th>Sodium Sulphite Heptahydrate (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>15.2</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>200</td>
<td>30.3</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>300</td>
<td>45.5</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>400</td>
<td>61.0</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>500</td>
<td>76.0</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>600</td>
<td>91.3</td>
<td>90</td>
<td>180</td>
</tr>
<tr>
<td>700</td>
<td>106.2</td>
<td>105</td>
<td>210</td>
</tr>
<tr>
<td>800</td>
<td>121.2</td>
<td>120</td>
<td>240</td>
</tr>
<tr>
<td>900</td>
<td>136.0</td>
<td>135</td>
<td>270</td>
</tr>
<tr>
<td>1000</td>
<td>151.5</td>
<td>150</td>
<td>300</td>
</tr>
</tbody>
</table>

2. To add the neutralisation chemical to the super-chlorinated water, the following steps should be taken:

   **Step 1.** Calculate the flow rate required to add the neutralising chemical  (*Refer to the formula given below*)
   **Step 2.** Use a calibrated dosing pump to achieve the calculated required flow rate by adjusting the speed or stroke setting of a calibration chart.
   **Step 3.** Verify successful neutralisation by testing for FAC (Free available chlorine). Note that the FAC of the discharged water must be zero or at least <1mg/L chlorine level

**To Calculate Flow Rate:**

The following formula shows the rate at which the prepared neutralising chemical needs to be added to the water as it is being discharged from the main:

\[
\text{Flow (L/hr)} = \frac{\text{FAC (g/m}^3\text{)} \times 3 \times \text{draining flow rate of chlorinated water (L/min)} \times 60 \text{min/hr}}{\% \text{ Strength of the neutralising solution} \times 10,000}
\]

**Example:**

The FAC of the super-chlorinated water to be neutralised is 20mg/L (i.e.20g/m3). The super-chlorinated water is being discharged from the main at a flow rate of 100 L/min. The required flow rate of the 15% neutralising chemical solution is:

\[
\text{Flow} = \frac{20 \text{ g/m}^3 \times 3 \times 100 \text{ L/min} \times 60 \text{ min/hr}}{15\% \times 10,000} = 2.4 \text{ L/hr}
\]
2. **CHLORINE DISSIPATION**

This is an alternative method in dealing with the hyper chlorinated water which allows the chlorine to dissipate.

Capture the disinfected water on site prior to the discharge of the chlorinated water (e.g. in a tanker). It is suggested that the water is kept contained on site for a minimum of 2 days until the Free Available Chlorine concentration is reduced to the background level of <1 mg/L.
Disinfection of Transmission Watermains and Reservoirs

Refer to Watercare standard specification ‘WS-05-Disinfection of Reservoirs and Pipelines’