HOUSEHOLD

WATER SUPPLIES

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The selection, operation, and maintenance of individual household water supplies

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MINISTRY OF HEALTH
MANATŪ HAUORA

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Contents

1 INTRODUCTION

This book offers you information about the supply of safe drinking-water to households other than those connected to town water supplies. Information on water sources and treatment has also been included. For greater detail and more information, see *Guidelines for Drinking-water Quality Management for New Zealand*. (Published by the Ministry of Health, held by public libraries, local authorities and public health services.)

2 HOUSEHOLD REQUIREMENTS

The main requirements for household water and the number of litres people use on an average per day are shown in Table 1. As you can see, only a small part of the total needs to be biologically and chemically safe.

Table 1

HOUSEHOLD USE	MAIN REQUIREMENTS	LITRES / PERSON / DAY
Drinking	Biologically & chemically safe	2
Cooking	Biologically & chemically safe	2
Food preparation	Biologically & chemically safe	1
Bathing	Biologically safe	}
Showering	Biologically safe	} 100
Cleaning	Biologically safe	}
Toilet flushing	Not discoloured or stain causing	} 145
Clothes washing	Not discoloured or stain causing	}
General use	No special requirements	50
	Total	**300**

As well as using water for everyday domestic purposes, isolated households may need water for garden maintenance and stock watering purposes. Typical volumes and quality requirements are shown in Table 2.

Table 2

OTHER USES	MAIN REQUIREMENTS	VOLUME / DAY
Garden watering	Boron and salinity not excessive	5 litres / m^2
Stock drinking	Not biologically contaminated by other stock	Up to 50 litres / stock unit

These figures can be used to calculate total daily usage. For example, the total daily requirements for an isolated farmhouse with five people, 100 m^2 of garden requiring watering and stock troughs for eight head of dry stock (40 stock units) would be:

Five people 300 litres	=	1500 litres
100 m^2 x 5 litres per m^2	=	500 litres
40 stock units x 50 litres per unit	=	2000 litres
Total required		4000 litres per day

3 CONTAMINATED WATER

Your drinking water can be affected by contaminants which will make it undesirable or even dangerous to use.

You can find contaminants, their sources and the problems they may cause listed in Table 3 below.

Table 3

DETERMINAND	SOURCE	PROBLEMS
Arsenic	Geothermal areas	Health problems
Bacteria	Septic tanks, bird and animal faeces, back flushing from incorrectly connected W.C. bowls, sewage discharges	Diarrhoea Gastroenteritis Other waterborne disease
Boron	Geothermal areas	Health problems
Carbon dioxide	Atmosphere and decaying vegetation	Corrosion
Chemicals	Backflow (suck-back) from incorrectly connected dosing equipment, cattle feeding systems, garden hoses dangling in container etc.	Health problems depending on the nature of chemical contaminants
Colour	Decaying vegetation	Appearance
Copper	Dissolved from pipes or taps by aggressive water	Staining, taste
Faecal material	Backflow (suck-back) from incorrectly connected waste disposal equipment, animal washdowns, etc.	Diarrhoea Gastrointestinal infection
Hardness	Dissolved rocks	Soap demand Scale formation in kettles and hot water tanks
Iron	Dissolved rocks, especially in bore water	Taste Staining Clogging of pipes and valves
Manganese	Dissolved rocks	Taste Staining
Nitrates	Fertilisers, clover septic tank soakage	Can cause health problems for bottle fed babies
pH	Atmosphere, decaying vegetation or dissolved rocks	Corrosion if too low Scale forming if too high
Protozoan cysts, eg, *Giardia, Cryptosporidium*	Septic tanks; bird and animal faeces on roofs, in streams; sewage discharges	Diarrhoea Protozoan infection
Taste and odour	Algae	Unpleasant to drink Can be toxic
Turbidity	Dirt	Appearance (usually biologically contaminated as well)
Viruses	Sewage, bird and animal faeces	Gastroenteritis Other waterborne diseases

4 WATER SOURCES

Your water source needs to provide the following:

- Enough quantity to meet requirements (normally 300 litres per person per day).
- Good quality water or water that you can have simply treated to a good quality standard.

Table 4 below shows water sources and compares their quality.

Table 4

RAW WATER SOURCE	BIOLOGICAL QUALITY	CHEMICAL QUALITY	AESTHETIC QUALITY
Mains supply*	Usually good	Usually good	Usually good
Roof water	Usually poor	Usually good	Corrosive
Shallow bore or shingle aquifer	Often poor	Can be high in nitrates, iron etc	Variable - can be turbid & discoloured
Deep bore	Usually good	Often high in iron/carbon dioxide, manganese and ammonium	Hard / corrosive
River	Usually poor	Variable	Can be turbid & discoloured
Stream	Variable	Usually good	Can be turbid & discoloured
Lake	Variable	Usually good	Usually good

* For details of your supply consult the Ministry of Health *Register of Community Drinking-water Supplies* in your local library.

5 WATER QUALITY TESTING

If you need to have a water source checked for suitability as a household supply, contact a specialist water testing laboratory. See Laboratories Analytical and Laboratories Testing in the yellow pages, or contact your local public health service.

Choose a laboratory experienced in water analysis for your local area and ask for an estimate of the work to be done.

A laboratory representative will give you instructions on where to go and on how to take water samples.

S/he will also give you containers for the samples.

Testing will reveal the quality of water and the treatment needed to make it safe for you to use.

You can also contact the water testing laboratories for advice on water analysis and interpretation.

Table 5 lists some determinands, the problems they cause and the typical levels at which they cause concern.

Table 5

DETERMINAND	PROBLEM	LEVEL OF CONCERN
Arsenic	Health problems	0.010 mg/L
Bacteria	Waterborne disease	Any faecal coliforms
Boron	Health problems	1.4 mg/L
Carbon dioxide	Corrosive	20 mg/L
Colour	Appearance	03 hazen units
Copper	Possible health problems Taste and staining can occur at lower levels	2.0 mg/L
Hardness (total)	Scale, excessive soap use	200 mg/L as $CaC0_3$
Iron	Staining, taste, pipe clogging	0.5 mg/L
Lead	Poisonous to humans, especially infants, young children and unborn children	0.010 mg/L
Manganese	Staining, taste	0.4 mg/L
Nitrates	Bottle fed infants can have breathing problems	11 mg/L as N
pH	Corrosion of plumbing materials possibly causing copper or lead to be dissolved into water, OR Scale formation on hot water cylinders and heating elements causing reduced efficiency and early failure	below 6.5 above 8.5
Protozoan cysts, eg, *Giardia, Cryptosporidium*	Waterborne disease	Any cysts
Taste and odour (many causes)	Taste and odour	Objectionable
Turbidity	Appearance, masking disease-causing organisms, reducing effectiveness of any disinfection	5NTU
Viruses	Waterborne disease	Any virus from faecal sources

6 TREATMENT METHODS

If you cannot get a good quality supply reticulated to your house, you will probably have to treat the water yourself.

The table below lists common determinands in some waters and treatment which can remove or reduce them.

Table 6

DETERMINAND	TREATMENT
Bacteria	Ultraviolet radiation / (only effective in low turbidity waters) Chlorine / reverse osmosis / boil
Carbon dioxide	Aerate carbon / akdolit granules
Colour	Activated carbon / reverse osmosis
Copper	Make water less corrosive, treat as for carbon dioxide / other methods can remove if this is not effective
Hardness	Ion exchange
Iron	Aerate & filter / chlorinate & filter / ion exchange
Lead	Make water less corrosive, treat as for carbon dioxide / other methods can remove if this is not possible
Manganese	Ion exchange / chlorinate & filter / potassium permanganate & filter
Nitrates	Ion exchange
pH	If too low, treat as for carbon dioxide, if too high, treat as for hardness
Protozoan cysts	Reverse osmosis / boil / cartridge filter
Taste and odour (many causes)	Activated carbon / boil / reverse osmosis
Turbidity	Cartridge filter / reverse osmosis / ultrafiltration
Viruses	Chlorine / reverse osmosis / boil / ultraviolet radiation / ultrafiltration

7 POINT OF USE DEVICES

A point of use device is like a mini-treatment plant. It can be used to treat all household water, or you can put it on the end of a tap for treating drinking water only.

You probably already have one cheap, effective point of use device in your own kitchen - your electric kettle.

If you boil your drinking water for one minute, all biological and most gaseous contaminants will be removed or destroyed. Electric jugs with automatic cut-off are fine especially if the water is left to cool for some minutes before use. Do not hold down the cut-off switch to keep jug boiling.

Regularly check and maintain your point of use devices - this will keep them working efficiently.

You will find that point of use devices vary in quality. Some devices may also require pumping to get a sufficient flow through.

See Section 9 for maintenance requirements of these devices.

Before buying a point of use device, ensure that you get a written statement from the salesperson which states clearly what the device **will** achieve and what it **will not** achieve in the way of water purification. The device should provide some means of indicating when it will no longer function according to specification. It is important to rigidly adhere to the manufacturer's maintenance instructions. Check that it complies with AS3497: *Domestic type water treatment appliances* and has been tested to AS/NZS4348: *Water supply - Domestic type water treatment appliances - Performance requirements* for the purpose which the appliance is to be used.

Table 7

DETERMINAND	POINT OF USE DEVICE TYPE AND EFFICIENCY								
	Activated Carbon (1)	Boiling (4)	Ceramic Candle (2)	Filtration (plain) (2)	Ion Exchange (8)	Reverse Osmosis (8)	Ultra Filtration (8)	Ultra Violet (6)	Calcium Filtration (9)	Magnetic Treatment
Arsenic (11)	P	N	N-G	N-G	N-G	Ex	N-G	N	P-G	?
Bacteria	N(1)	Ex(4)	G	P	P-M	Ex	Ex	Ex(6)	P	N
Boron	N	N	N	N	Ex	N	N	N	N	N
Carbon Dioxide/ Corrosivity	P	G	N	N	P	P	N	N	G	N
Colour	M	N	N	N	P	G	P-M	N	N	N
Hardness	P	M(5)	N	N	G(7)	M	M	N	N	G
Iron, soluble	P	N	N	N	G(7)	G	M	N	M	M
Manganese, soluble	P	N	N	N	G(7)	G	M	N	M	M
Nitrate	P	N	N	N	G(7)	G	P	N	N	N
Protozoan Cysts/Oocysts	G(2)	Ex(4)	Ex	G(2)	N	Ex	Ex	P(6)	P(10)	N
Taste & Odour	G(3)	M	N	N	P	M	P	N	P	N
Turbidity	M	N	P	P	G	Ex	Ex	N	P	N
Viruses	M	Ex(4)	P	P	M	Ex	Ex	Ex(6)	P	N

Terms used in table:

Ex - excellent removal, where equipment is in good condition

G - good removal to an acceptable level

M - moderate removal, constituent may still give a problem

P - poor performance, most of constituent levels unaffected

N - no removal at all

Explanation of notes:

1 Activated carbon filters should not be exposed directly to water containing biological contaminants. Carbon can act as a growth medium for bacteria.

2 Either plain or activated carbon cartridge type filters can remove protozoan cysts, as long as the nominal particle retention size of the filter is 1 micron or less, however, see note 1 above.

3 Activated carbon will eventually become full of contaminants and must be replaced or the contaminants will start returning to the water.

4 Boil water to a rolling boil for at least one minute.

5 Boiling hard water removes some of the hardness. This process forms a scale on the jug element making the element less efficient and advances the time of failure.

6 Ultra violet disinfection is upset by anything which shields biological contaminants from ultraviolet light. These include dissolved iron and manganese, colour, and turbidity. Keep these constituents low or remove them before the UV device. The lamp must be kept clean.

7 Ion exchangers can remove a range of chemical contaminants if the appropriate resins are chosen. General purpose resins are often not suitable.

8 While some treatment methods work well for some contaminants, they can be upset by the presence of others. For example, ion exchange, reverse osmosis, and ultra filtration, are capable of effectively removing a range of contaminants. When fouled with excess turbidity and bacterial growths their performance efficiency falls off dramatically and they can break down.

9 This treatment uses the form of calcium in calcium carbonate, marble or dolomite.

10 This treatment is of variable effectiveness, depending upon exact details of filter.

8 SYSTEM DESIGN

This section explains how you can design your total water treatment system yourself, should you wish to do so.

Information covered includes: intakes, pumpworks and connections, pipeworks and connections, storage tanks, point of use devices and use of dual sources.

The intake is an important part of your system. Usually, providing a good intake is not much more expensive than providing a poor one, yet a great many of the problems caused by turbidity and other contaminants can be avoided by careful intake design.

The following illustration shows recommended intake designs for roof water, stream or other surface waters and bore or well waters.

Locate your stream intake and bore away from potential contaminants. For example, ensure that your bores are well away from any septic tank soakage areas, and that there is no seepage in filtration down the outside of the casing at the well head.

Pumps

Pumps are used to bring water up to points higher than the point it is being taken from, or to boost the pressure through your system so that sufficient flow can be carried over flat gradients.

The most common type of pump used for small water systems is the centrifugal pump.

A pump supplier can advise you on the type of pump required as long as you have supplied all the information needed to make the calculations. This includes:

- Height difference between the pump and the water surface from where the water is taken.
- Height difference between the pump and where the water is to go, or the highest point along the way.
- On line pumps: the maximum flow rate required through all possible outlets and the minimum pressure required at the point of outlets.
- Storage tank pumps: requires the daily flow out of the tank, refer Section 2.
- Internal diameter and type of pipes intended for use.
- Total length of pipes for both the suction and discharge sides of the pump.

It may be necessary for you to pump to another tank which will gravity feed through the system. Alternatively, you could operate a pressurised line with a pressure switch to control the pump.

When water is taken out of the ground, the maximum lift that you can achieve on the suction side of a pump is approximately eight metres.

If your water level is below this the pump must go down the well.

Deep wells require multi-stage pumps.

You need to check how corrosive your well waters are, as this will affect the materials that the pump needs to be made from.

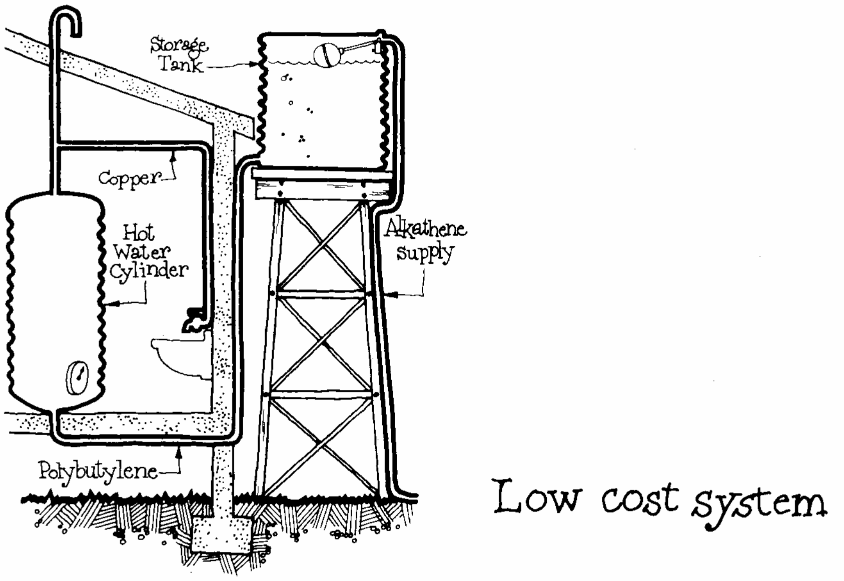
Pipework and Connections

Waters which are not treated in a full-scale municipal treatment plant are often corrosive.

As corrosive waters can leach out metals from metallic pipes and from taps you really need to use plastic pipes for cold water reticulation purposes.

The most commonly used plastics are unplasticised polyvinylchloride (UPVC), low density polyethylene (alkathene), medium density polyethylene (MDPE), high density polyethylene (HDPE) and polybutylene.

Select your pipe according to cost, availability in the size required, resistance to handling, trenching and superimposed loads, flexibility and ease of laying, ease of connection and resistance to frost. While an experienced master plumber or plumbing goods supplier should be able to give you useful advice, a low cost quality system might consist of low density polyethylene (alkathene) pipe, approximately 20 mm internal diameter for main runs, 15 mm internal diameter for spurs. For long runs or high flow 25 mm pipe connecting the source and the house may be desirable. The pipe should be buried (at least 400 mm) from the source to the storage tank, followed by reticulation to, and throughout the house, of polybutylene on the cold water side and copper or copper and polybutylene on the hot water side.



Storage Tanks

The storage tank, an important part of your system, is usually situated at a level approximately two to four metres above the level of the highest outlet, either on a tank stand, the house roof or on adjoining level ground.

Alternatively, the storage tank may be at or below ground level with a pumped feed to the house.

When selecting and locating a storage tank, you should consider:

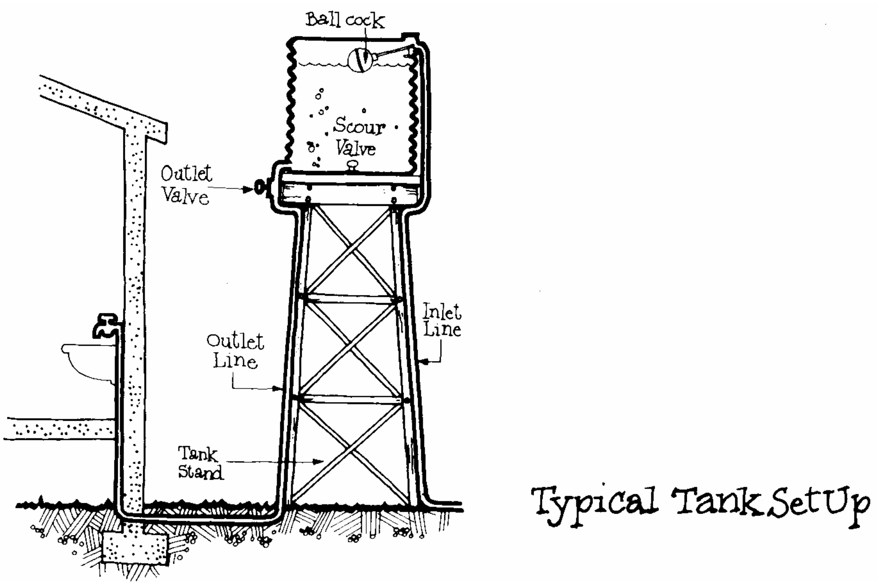
- Location, elevation and the size of the tank
- Materials used in building the tank
- Safety during earthquakes
- How the tank will be cleaned out
- Inaccessibility by vermin.

Details of inlets and outlets

A large tank will provide plenty of storage should your supply fail for a short period.

A long retention time in the tank also allows some water contaminants to settle to the bottom of the tank.

As water weighs one tonne for every 1000 litres, a large tank, sitting on a roof tank stand or hillock at the back of your house, should be adequately secured to prevent it toppling over during earthquakes or high winds and should be adequately supported at all times.



The most commonly used tank materials are:

- Plastic, e.g. polyethylene
- Fibreglass
- Galvanised iron
- Concrete

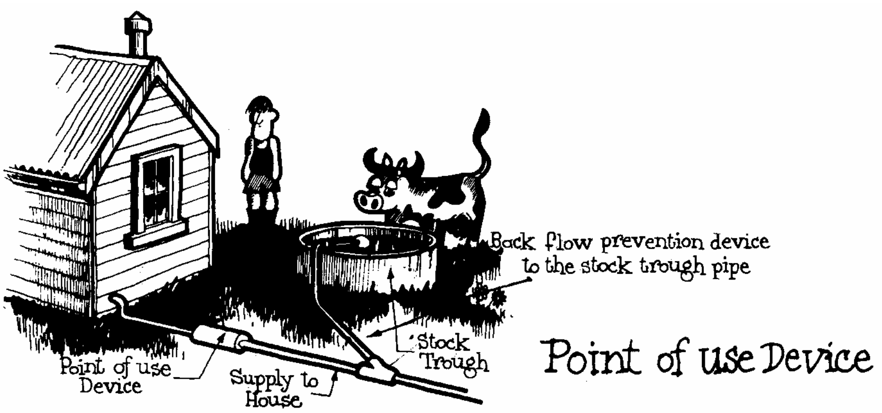
You will find that plastic, fibreglass and some of the galvanised iron tanks are relatively light and can be easily transported and located in position.

All tanks have a limited life span, especially light-weight galvanised iron tanks.

Normal tank sizes vary from a pressurised tank of about 100 litres, being refilled automatically from a pump and a completely reliable supply, to a tank of 10 or 20 cubic metres (10,000 to 20,000 litre capacity) for properties relying solely on roof water in areas of low rainfall. Your tank will need to be cleaned out and disinfected regularly (see System Operation page 12).

Point of Use Devices

You can locate your point of use device at any point within your system. Make sure it is accessible for maintenance. For example, if you have a system which first feeds stock watering troughs and then a household, you may wish to locate your point of use device downstream of the tee-off line running into the stock watering troughs.



Your device should be selected and located to provide the water quality recommended in Section 2. Where the source water is biologically suspect, a disinfecting device should treat part of the water as per Table 1.

Another alternative worth considering is to treat water for drinking and cooking purposes only.

For this, bench-top or undersink point of use device can be used or water can be boiled.

Your hot water cylinder should be set at 60°C or above to ensure that organisms do not grow within the hot water cylinder. To avoid scalding you should place a tempering valve on the discharge side of the hot water cylinder. This valve dilutes the 60°C water with cold water to 55°C prior to its use at any tap outlet. (The New Zealand Building Code requires the top outlet temperature for child care centres and old people's homes to be no more than 40°C to prevent scalding).

Unfortunately there is a problem with this compromise. The cold water, which may be used for showering, bathing or cleaning and which will temper down the hot water, could be biologically impure if it has not been treated.

Backflow Prevention Devices

Backflow prevention devices should be installed between the drinking-water tap and any place where the water supply is connected to equipment containing chemicals, faecal material, or other potential contaminant. Commercially purchased WC flushing cisterns have a backflow preventer built in, but any "do-it-yourself" device needs a backflow preventer.

Cattle shed devices dosing animal remedies into the animal watering system; hose connections where the hose is used to mix sprays, wash down animal or bird faeces etc should all have preventers fitted.

In many cases, the fitting of such a device to the specifications of AS3500.1 will meet the requirements of the building code under the First Schedule of the Building Regulations.

Dual Sources

Some New Zealand communities use dual water sources. The two sources are usually rainwater (reasonable quality but not always plentiful) and bore water (poorer quality but usually available).

One storage tank is used to service both sources, with a ball float dividing the tank in half. Rainwater feeds the top half of the tank and is used until dry spells occur.

When this happens and the water level falls, the ballcock at mid-height in the tank opens as the water is drawn off.

This relieves pressure on the pumping system and the bore pump starts up.

Dual water supplies can be corrosive. Get your laboratory to check this.

9 SYSTEM OPERATION

This section includes maintenance of intakes, roof painting and maintenance, cleaning out of storage tanks, disinfection using household bleaches, routine checks and replacement of point of use devices.

Intake Maintenance

A correctly designed intake will remove a lot of the large particulate material, but this material often clogs the intake so that you will need to clean it periodically.

You can clean manually by removal, cleaning and replacement, cleaning in situ, and in some cases back-flushing.

Where a bore has a screen, the screen can become fouled with bacterial encrustations. This build-up may not be harmful in terms of causing a disease, but it reduces the size of the well-screen until sufficient water cannot be drawn through the bore.

You can use chlorine down the bore to reduce this problem, but you should seek specialist advice first.

Bores clog over a period of time, depending on how well the bore was "developed" when it was drilled.

You will need a specialist well-drilling firm to deal with this problem.

Roof Painting and Maintenance

If you use a roof catchment for your water supplies, there are certain practices to avoid.

For instance, the metals, lead, chromium and cadmium are toxic and a roof painted with paint containing these metals should not be used as a source of drinking water.

While modern roof paints are generally labelled as to their suitability for drawing off a water supply, a technical representative from a paint manufacturer should be able to give you advice.

A roof used for your water supply requires routine cleaning, with the water flushed to waste.

Water should be set aside for cleaning and the line feeding the water storage tank should be disconnected.

You can use a scrubbing brush, broom and clean water to scrub down the roof and clean out and flush through the spouting.

This clears the roof of dirt, animal droppings, paint breakdown products and other potentially harmful rubbish.

Cleaning Out Storage Tanks

Your tank should be large enough to allow any material the opportunity to settle out, with its outlet set a little above the base and a scouring valve located at the bottom.

Your tank can be cleaned by removing all the water and then using clean water to sluice it and scrub it out. The sediment should be removed, and the tank cleaned, regularly.

Refill your tank with disinfected water. (This, however, is not always practical for roof supplies).

A long-handled clean broom can be used to push all the sludge on the bottom of your tank out through the scour valve.

Disinfection of Storage Tanks and Reticulation Lines

Tanks and pipework, servicing all biologically impure supplies, should be disinfected regularly to reduce the concentration of biological growth.

You will find that for normal disinfection purposes, a dose of 5 g/m^3 available chlorine is usually sufficient.

You can use plain household bleach for this job. In new containers these chemicals consist mainly of sodium hypochloride at a concentration of about three per cent. As opened or old containers will be significantly weaker than this, they should not be used.

A tank is always disinfected by volume. This may have been provided by the manufacturer or it can be calculated.

Calculating Your Tank Volume:

Square Tank:

Volume in litres is equal to length x width x depth of water x 1000. (All measurements of tank dimensions should be made in metres.)

- For example, a cubic tank measuring 1m x 1m x 1m would have a volume of 1 x 1 x 1 x 1000 = 1000 litres.

Circular Tank:

Measure the diameter and the depth of water. The tank volume in litres is equal to 0.785 x diameter x diameter x depth x 1000.

- For example a tank 1 metre in diameter and 1 metre deep would have a volume of 0.785 x 1 x 1 x 1 x 1000 = 785 litres.

  The Disinfection Tables, Appendix II and III, pages 17 and 18, can be used to calculate the amount of bleach or pool chlorine you would need.

- For example, a tank with a volume of 1000 litres requiring $5 g/m^3$ for disinfection purposes needs 167ml of plain household bleach.

An accurate measure, such as a graduated measuring container, should be used to measure the bleach. As a rough guide, cups are approximately 250ml and milk bottles 600ml. A 167ml measure is approximately two-thirds of a cup.

After you have dosed your tank and mixed it well, the dosed water should be run through all your household lines so that the newly-disinfected water comes through the taps.

Isolated water supplies also need regular dosing. How often this is done depends on your water source, but it should be done at least once a month. Even though water looks clear, it still may have high concentrations of bacteria or viruses. If you use chlorine to clear out the tank and the pipe work, it can make the water undrinkable, so boil the water before use.

Point of Use Device Checks and Replacement

When you select a point of use device, consideration should be given to the length of time it will operate before parts of it need replacing, and how much the cost of these replacement parts will be.

Equipment manufacturers and reputable suppliers should be able to give you an indication of how long the equipment will last with your particular water supply.

You will find that replacement is required periodically on filter cartridges including activated carbon types, reverse osmosis and ultrafiltration membranes, ion exchange resins, and the tubes used in ultraviolet light apparatus.

These items will need regular checking and should be replaced as recommended by the manufacturer.

Where a replacement item is expensive such as a reverse osmosis membrane, water quality tests as shown in Section 5, page 4, should indicate whether the equipment requires replacement or not.

10 INFORMATION

Information should be:

- convenient to you
- knowledgeable, ie correct.

Table 8 gives a list of people and places to contact for information.

Table 8

SOURCE	EXPERTISE	HOW TO FIND THEM IN TELEPHONE DIRECTORY
Environmental health officers	All aspects	Your local authority (city or district council)
Health protection officers	All aspects	Your public health service
Water testing laboratories	Water analysis and interpretation	Analytical laboratories
Regional council	Local water sources and likely contaminants, restrictions on use	Regional council
Specialist water treatment equipment suppliers	Capabilities of their equipment	Water treatment
Specialist environmental consultants	All aspects, especially system design	Environmental consultants
Master plumber	System installation cost	Plumbers

For further information on drinking water quality the *Drinking Water Standards for New Zealand 2000* is available from Bennetts Government Bookshops and all public libraries. The standards are also available on the Ministry of Health's drinking-water website at www.moh.govt.nz/water under 'Publications'.

For further information on farm supplies, see the *Guide to Farm Water Supplies*, NZ Farmer, August 8, 1985.

The Ministry of Health has published an 850 page book on drinking water management: *Guidelines for Drinking-Water Quality Management for New Zealand* which provides detailed information on drinking-water. This is available from Information Services, Ministry of Health.
Copies are also held by public libraries, local authorities and public health services.

APPENDIX 1: GLOSSARY

AERATION: Usually used with bore waters to drive off Carbon Dioxide (CO^2) or change dissolved iron into a solid form before filtering it out.

AESTHETIC: Water constituents which affect the water's appearance, taste, or the economics of its use, but are not directly a health concern.

ALGAE: Small plants which can live in natural surface waters. They can cause discolouration, taste and odour problems. Blue green algae can be toxic.

ACTIVATED CARBON: Activated carbon is a form of charcoal. Charcoal is the black material left behind from partly burnt wood. To produce activated carbon certain types of charcoal are steam treated at high temperatures. This makes the material extremely porous and reactive. Activated carbon is available in two forms; granular activated carbon and powdered activated carbon. Granulated activated carbon comes in small lumps or granules. The sizes vary but are usually about 3 to 5 mm in diameter. Powdered activated carbon is a very fine powder which is normally impregnated on to a cartridge.

AKDOLIT: A proprietary material which can be used for filtration or suspended in a tank to reduce corrosivity. The New Zealand agents for Akdolit are Robert Bryce and Company Ltd with branches in Auckland, Wellington and Christchurch.

BACTERIA: Bacteria are a type of biological contaminant which in some cases are capable of causing waterborne disease. Bacteria are usually very small, about 1000th of a millimetre in size, and cannot be seen with the naked eye. They are capable of reproducing at an astonishingly fast rate and are responsible for such waterbone diseases as cholera, typhoid and camplyobacteriosis or gastritis.

BIOLOGICAL CONTAMINANTS: Biological contaminants are unwanted living organisms. Capable of causing waterborne disease, biological contaminants can also cause slimes and odours and affect taste. Examples include bacteria, viruses, protozoa and worms.

BORE: A bore is a small diameter hole. Sunk into the ground to some depth, a bore taps into a layer of water and (usually with the aid of a sunken pump) pushes that water to the surface for use.

CARTRIDGE FILTER: A cartridge filter is filtering material available in small cartridge form like a tube. This filter can be placed inside a point of use device and either removed and cleaned or discarded once the filtering material is clogged. Cartridge devices can be made from paper, spiral wound string, impregnated cotton or ceramic materials. Capable of removing materials down to 1000th of a millimetre (1 micron), they are a cheap and effective means of removing such contaminants as protozoan cysts.

CHEMICAL DETERMINANDS: Chemical determinands are usually dissolved in water and invisible to the naked eye. They may occur naturally, for example due to the slow leaching of chemicals out of rocks. Chemical determinands may cause staining and odour, affect taste and in some cases cause health problems.

CORROSIVE: Corrosive water will slowly dissolve metal pipes and cylinders, causing taste and staining problems. Most natural waters, particularly bore and rain waters, are corrosive to some extent.

DIARRHOEA: Diarrhoea is the excessive evacuation of liquid faeces. It is a symptom of an upset or illness and is usually caused by either irritations or infections by micro-organisms within the intestines. If diarrhoea is caused by microbiological infection then the person or animal will usually produce large quantities of the causative organism in the faeces.

DISINFECTION: Disinfection is the removal of inactivation of all biological contaminants in water capable of creating waterborne disease. Chlorine is one of the most commonly used chemicals for disinfecting water. Chlorine is readily available in the form of plain household bleach. Small quantities of these liquids can be safely used to disinfect contaminated tanks and pipes. (See Section 9, page 12, and Appendix II, page 17, and Appendix III, page 18).

DISTILLATION: Distillation is treating water by boiling and then recondensing it. Distillation can be an effective treatment process removing virtually all contaminants. It requires on-going power usage. A viable option for some people is to purchase distilled water from a pharmacy.

FAECES: Faeces is the solid waste material that comes from the bowels of humans and other animals. If an animal or person is carrying a disease which can be spread by a waterborne route, then their faeces will often contain high concentrations of disease-causing organisms.

FILTRATION: Filtration is where water is passed through a treatment device which screens or removes certain types and sizes of particles. Filters may be coarse and remove large particles, or fine, such as ultra filters, capable of removing most substances.

GERMS: Germs is a general term for the organisms that can cause disease.

g/m³: Grams per cubic metre. A measure of the concentration of a substance in water. Equivalent to parts per million (ppm) or milligrams per litre (mg/L).

HARDNESS: Hardness in a water is a form of chemical contamination, usually due to the presence of calcium and magnesium. Hardness does not cause health-related problems, but it does cause excessive use of soaps and detergents and the scaling and premature failure of hot water cylinders and heating elements.

HAZEN UNITS: A unit that measures the colour of water.

IRON: Iron is a chemical contaminant in water. It may occur naturally in ground and surface waters, or it may come from corrosive action where tanks and pipes are made of iron or steel. Iron can cause brown staining, undesirable tastes and smells, and may choke pipes and valves.

MAGNETIC TREATMENT: Magnetic treatment is where water is passed through a magnetic field, usually a permanent magnet, to reduce the formation of hard scale.

MANGANESE: Manganese is a chemical contaminant, often slowly leached out of rocks by the action of ground water. It may be present in bores and can cause taste and smell problems and black staining.

NTU: Nephelometric Turbidity Unit, is a scale of measurement for turbidity.

pH: A measure of the amount of reactive hydrogen in the water. This is present in all waters at some level, so it is a feature of the water rather than a contaminant. pH is measured on a scale of 0 – 14 with 7 being neutral. Low pH waters are acidic and corrosive, high pH waters are scale forming when heated. Rain water, drawn from a roof, for example, may have quite a low pH (around 6.0), and may therefore corrode metal pipes, dissolving the metal into the water.

PROTOZOA: Protozoa are single celled animals, some of which can cause waterborne disease in humans. Problem-causing protozoa are: *Entamoeba histolytica, Giardia lamblia* and *Cyptosporidium parvum.* These three protozoas are found in the environment in cyst form. The smallest one is approximately 4 microns in diameter. Once swallowed the cyst can hatch into mature protozoa which are then able to breed and cause internal diseases.

REVERSE OSMOSIS: Reverse osmosis occurs when water is forced through a semi-permeable membrane which allows only pure water, some gases and a few trace elements to pass. Only a small percentage of water put through a reverse osmosis device comes out in treated form. The rest is discarded.

SCALE: Scale is a solid precipitate which forms on the elements of jugs and hot water cylinders and around the insides of hot water cylinders and pipes. It usually occurs when the water being used is hard. Scale consists of the chemicals calcium carbonate and magnesium oxide. Although harmless to health, it can cause electric heating elements to burn out and hot water cylinders to perform poorly.

TURBIDITY: Turbidity, due to suspended material in water, causes cloudiness. Much of the suspended material cannot be seen with the naked eye, but as it reflects light, it is seen as cloudiness. Particles causing turbidity may include biological ones that can cause waterborne disease. As turbid water can also prevent disinfecting devices from acting on biological contaminants it is not desirable in drinking water.

ULTRAFILTRATION: Ultrafiltration uses a filter to remove particles down to the size of approximately 1/10,000th of a millimetre. Many ultrafilters are capable of removing all biological contaminants. They can clog quickly and should only be used with relatively clear water.

ULTRAVIOLET RADIATION: Ultraviolet radiation is used to disinfect water by treating biological contaminants so that they are unable to reproduce. In most cases being unable to reproduce effectively makes a contaminant harmless. An ultraviolet radiation point of use device must be used with relatively clean water. This enables the light to penetrate with sufficient intensity throughout the reaction chamber. The lamps degrade with time and must be replaced on a six monthly to a yearly basis. An efficient ultraviolet radiation device has a built-in monitoring system that warns of lamp failure.

VIRUS: Virus is an extremely small (less than 10,000th of a millimetre) particle capable of causing waterborne disease. The main source of virus is human and animal faeces already infected with the disease. Disease causing viruses which are capable of being transmitted through water include hepatitis A and poliomyelitis.

WELL: A well has a larger diameter than a bore and is usually to a shallower depth. For shallow wells, ie, less than 8 metres deep it may be possible to locate the pump at the ground surface and suck up the water. For deeper wells the pump must be placed down the well as for a bore.

APPENDIX II: DISINFECTION USING SODIUM HYPOCHLORITE (PLAIN HOUSEHOLD BLEACH)

Table 9 gives the number of millilitres to add (1 g/m³ = mg/L).

Table 9

TANK VOLUME LITRES / (GALLONS)		CHLORINE DOSE REQUIRED			
		1 g/m³	2 g/m³	5 g/m³	10 g/m³
50		2	3	8	12
100		4	7	17	33
150		5	10	25	50
200		7	13	33	67
250		9	17	42	83
300		10	20	50	100
350		12	23	58	117
400		13	27	67	133
450	(100)	15	30	75	150
500		17	33	83	167
600		20	40	100	200
700		23	47	117	233
800		27	53	133	267
900		30	60	150	300
1000		33	67	167	333
2000	(440)	67	133	333	667
3000		100	200	500	1000
4000		133	267	667	1333
5000	(1100)	167	333	833	1667
6000		200	400	1000	2000
7000		283	467	1167	2333
8000		267	533	1333	2667
9000		300	600	1500	3000
10000		333	667	1667	3333
20000		667	1333	3333	6667

To use table

1 Calculate volume of tank in litres (see Section 9, page 12 and select this on the left-hand side column).

2 Select dose rate required at top of the table:

- 1 g/m³ routine disinfection for clean water
- 2 g/m³ routine disinfection for reasonably clean water
- 5 g/m³ period disinfection for tanks and pipes
- 10 g/m³ superchlorination for biological contaminated tanks. Remove contamination, allow water to sit for 24 hours before drawing. Boil before drinking.

3 Read the amount of sodium hypochlorite (in millilitres) to be added where the dose required corresponds to the volume of the tank.

4 Add required millilitres of fresh plain household bleach and mix in thoroughly.

APPENDIX III: DISINFECTION USING CALCIUM HYPOCHLORITE (SWIMMING POOL CHLORINE)

Table 10 gives the number of grams to add (1 g/m³ = mg/L).

Table 10

TANK VOLUME LITRES / (GALLONS)		CHLORINE DOSE REQUIRED			
		1 g/m³	2 g/m³	5 g/m³	10 g/m³
50		0.08	0.15	0.4	0.8
100		0.15	0.3	0.8	1.5
150		0.2	0.5	1.2	2.3
200		0.3	0.6	1.5	3.1
250		0.4	0.8	1.9	3.9
300		0.5	0.9	2.3	4.6
350		0.5	1.1	2.7	5.4
400		0.6	1.2	3.1	6.2
450	(100)	0.7	1.4	3.5	6.9
500		0.8	1.5	3.9	7.7
600		0.9	1.9	4.6	9.2
700		1.1	2.2	5.4	10.8
800		1.2	2.5	6	12
900		1.4	2.8	7	14
1000		1.5	3	8	15
2000	(440)	3	6	15	30
3000		5	9	23	46
4000		6	12	30	60
5000	(1100)	8	15	40	80
6000		9	20	45	90
7000		10	20	50	110
8000		12	25	60	120
9000		14	30	70	140
10000		15	30	77	155
20000		30	60	154	310

To use table

1. Calculate volume of tank in litres (see Section 9, page 12, and select this on the left-hand side column).
2. Select dose rate required at top of the table:
   - 1 g/m³ routine disinfection for clean water
   - 2 g/m³ routine disinfection for reasonably clean water
   - 5 g/m³ period disinfection for tanks and pipes
   - 10 g/m³ superchlorination for biologically contaminated tanks. Remove contamination, allow water to sit for 24 hours before drawing. Boil before drinking.
3. Read the amount of calcium hypochlorite (in grams) to be added where the dose required corresponds to the volume of the tank.
4. Add weighed amount of calcium hypochlorite to a bucket of clean water and allow to dissolve for 6 hours.
5. Pour off the liquid from the top of the bucket.
6. Bury the sludge from the bottom of the bucket.

CAUTION:

Calcium Hypochlorite is a highly reactive and poisonous chemical. It should be stored by itself in a secure, dry area and on no account must it be allowed to come into contact with organic liquids such as petrol, diesel, or lubricating oils and hydraulic fluids.

Ensure that the chemical you are using is Calcium Hypochlorite at 65 percent available chlorine, with no other additives.