Technical Note: T21-1

TESTING AND TREATING WATER FOR RURAL DOMESTIC DWELLINGS

Figure 1 Roof drainage with fine screens viewed in insert

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1. Introduction

Rural and semi-rural properties in Australia rely upon a variety of water sources for domestic use, the quality of which may be highly variable from location to location and over time, and at times, questionable quality. Water for human consumption may vary in its chemistry without serious health implications, except perhaps for some trace elements. Taste is another matter. With respect to biological security, drinking water that is contaminated by faecal coliforms or *Escherichia coli* (*E.coli*) and other harmful bacteria needs to be treated before consumption.

This paper presents an overview to assist occupants, of homes supplied with water from sources other than reticulated municipal supplies, with some simple methods to maintain a supply of clean and safe domestic water, while providing some direction as to how to rectify unhealthy conditions.

The Australian Drinking Water Guidelines (ADWG, 2011) provide detailed discussion about drinking water supplies, well beyond the overview provided in this paper.

2. Sources of Domestic Water

Domestic water in large towns and cities is generally a chlorinated, treated water supplied from a municipal authority in a reticulated supply. Regularly tested to comply with local health specifications with respect to bacteria, many chemical properties of the supply reflect the climate and geology of the source of the raw water, and the chemicals used in its treatment. For a single house outside the reticulated network, reliance upon either rain water, shown in Figure 1, and/or surface or groundwater sources is critical. Each of the sources available has unique properties that may make the water more or less favourable for drinking, bathing, laundry and toilet flushing. We know that bacteria in drinking water can cause illness, so too can water used for the other purposes because of transport as aerosols (from the shower, from around the tap, from the flushing toilet) and physical attachment during showering or bathing, or in laundry work. It may be necessary to separate drinking water from its other uses, treating each use for the task at hand.

Of course, the domestic water may be a mix of rainwater, surface water or bore water, often depending upon the availability and storage from each source, and its intended domestic use. It is not unusual that high quality water is used for drinking and the kitchen, lesser quality water for bathing and laundry and lower quality water for flushing toilets and garden irrigation. It would not be prudent to treat all water to drinking water quality if water can be separated for lower use with less treatment.

2.1 Rainwater captured on roof

The volume of water collected from a dwelling's roof will depend upon the roof area, the rainfall pattern (summer and winter variance) and annual total rainfall (allowing for annual variation). Planning and modelling the size of water storage in tanks in relation to roof area and typical rainfall is outside the scope of this paper.

The roof, washed by rain, is a source of dust (solids and pollutants), bird droppings (bacteria), leaf litter decay (colour, odour and taste), rats, bats and other creatures frequenting the roof. The television aerial or chimney is an ideal resting site for birds with the appropriate collection of droppings on the roof underneath; gutters may, in dry times be ideal sites for birds or rats to nest; and dust raised from surrounding animal activity may also be captured. We now have both bacteria, dissolved and suspended solids to separate. The chemical variation in rainwater depending upon location, close to the sea, or inland is only a very minor concern. Close to industry the sulphur dioxide (SO_2) emissions may dissolve in rain to form sulphuric acid (H_2SO_4) as ***acid rain*** (pH <4.5), capable of etching metals and concrete. On old roofs previously painted with lead based paints, with lead flashings around chimneys and other protrusions in the roof, lead in the rainwater may be a concern.

What materials have been used for the roof of the house or shed that may collect rainwater? Galvanised iron slowly releases zinc, but unlikely to cause concern because we need zinc in our normal diet. Zincalume is the modern derivative of galvanized iron, being a composition of zinc and aluminium used for roof cladding, gutters and flashings. Under normal circumstances the dissolution of zinc and/or aluminium into the rainwater is mostly miniscule. Colorbond™ is a coloured protective coating on iron roofing and imparts no chemicals to the water. Some translucent sheets are made from polycarbonate that is safe for water collection, however, fibreglass sheeting weathers to expose the fabric used in its manufacture. The small fibres that enter the storage generally sink to the bottom with other contaminants and do not remain suspended. Perhaps they only become important health considerations when the last of the tank water is reached. These fibres are effectively removed through 5 µm (micron) filters; filtering is recommended.

Figure 1 shows the roof catchment's gutter and downpipe leading to a small screen that removes larger rubbish from the rainwater prior to entering the catchment. Additional treatment is discussed later.

2.2 Surface water – dams and wells, rivers and streams

Native and domestic animals' faecal material is easily transported in overland flow conditions during rainfall events, accumulating in dams, streams and rivers. Together with vegetative material that subsequently decays to release tannins (colour) and organic compounds (nitrate, phosphates), untreated surface water may be less than ideal aesthetically (colour, taste and odour) but may be highly contaminated with harmful bacteria.

Figure 2 Surface water contaminated by native and domestic animals

The source and transit of the surface water is likely to reflect the geology of the terrain, including sub-surface drainage that enter the main channels.

Water that drains through urban area is likely to be contaminated with hydrocarbons (fuel and oil residues), excreta from domestic and native animals and birds, and decomposing organics from gardens and parklands. Faecal contamination is highly likely from these sources.

Water from a shallow aquifer, accessed from a well, can be as contaminated as surface water and needs to be treated appropriately.

2.3 Groundwater

Deep groundwater, deeper than about 10 m and accessed by a bore rather than a well, is unlikely to be contaminated by bacteria from the surface but is more likely to have a chemistry very different from rainwater or surface water. With respect to bacteria, it is unusual for pathogens (harmful bacteria) to survive the long transit (percolation) from the surface to groundwater, even from a nearby septic tank, although, if in doubt, have the water tested. Other bacteria live in the groundwater, those that consume iron and manganese that give rise to red or black stained water, affecting the aesthetics of the water and unlikely to contribute a health risk.

The chemistry of the groundwater will reflect the geology. Groundwater from a basalt landscape is likely to have high calcium and magnesium that impart a 'hardness' to the water. The 'hardness' (an aesthetic property) may affect taste but is more likely to affect its use in the laundry and bathroom. Hard water will cause soaps to form a scum around the bathtub, on the walls of the shower, on your skin (maybe causing an itch) and in your hair (making it like wire wool). Hard water will also leave residues where it is sprayed onto shiny surfaces and allowed to dry. White blotches, streaks and stains are the calcium and magnesium salts in the water.

Groundwater from an aquifer in a sedimentary or granite landscape, the 'hardness' may be variable, and in some cases the water will be very soft (very little calcium and/or magnesium), in others hard, reflecting the parent material.

The water may also have iron and/or manganese that need simple removal mechanisms, such as aeration and settling. Simply running the water from the bore through a cheap sprinkler in the top of the tank will usually provide sufficient aeration to oxidise the iron that will slowly drop out of suspension.

See additional information on hardness at http://www.lanfaxlabs.com.au/hardness.htm

3. Testing Domestic Drinking Water

3.1 Testing for chemical properties

We need to differentiate between the chemicals that are naturally occurring in the surface water and groundwater because of the chemistry of the geology of the landscape. Other chemicals are acquired by surface water from vegetation, animal excreta, run-off from paved areas and contamination from other surface activities such as spraying the roses, poisoning weeds or spreading fertilisers.

Some chemicals such as arsenic, iron, manganese, phosphorus, fluoride, chloride and many others may dissolve naturally in aquifers and from the surface landscape, potentially contaminating the water for human consumption. Likewise for the bacterial assessment, we cannot analyse for all the known natural chemicals in surface and groundwater, only those known for our locality and just those than may affect the domestic use of the water.

From the small range of tests performed on the water, one needs to be able to assess its benefits or restrictions for domestic use. The assessment of the usual suite of chemical properties for domestic water relate to indicator levels of pH (acid/base status), salinity (dissolved salts, measured as electrical conductivity), total suspended solid (chemical, inorganic and organic), elements that relate to hardness (calcium and magnesium), sodium (for its osmotic effects) and a range of metals (iron, aluminium, copper, zinc, manganese), and anions (nitrates, sulphates and chlorides). The range of tests will vary with the proposed use of the water and its source. While arsenic (a trace element) and heavy metals may present a health hazard, determination in a water sample is usually based upon some pre-determined expectation of their presence. Testing for organic contamination from agricultural and industrial sources needs to be addressed relative to a likely source.

3.2 Testing for biological contaminants

Other than the bacteria discussed in Section 3.1, other organic contaminants include a range of protozoa (single-celled organisms), cyanobacteria (blue-green algae), algae and other water borne flora and fauna. The testing for viruses is highly specialized and chasing for 'a needle in a haystack' will be very expensive.

Protozoa (single-cell organisms) are found in water and soil, some are beneficial while others have harmful outcomes. Harmful parasites common in polluted waters include *Cryptosporidium* and *Giardia*. The methods for determining the presence of these parasites are very expensive and the results not always conclusive of infectious levels. Filtration at 5 µm is an efficient method to remove these protozoa from water. Relatively inexpensive water filters can remove to this size.

Figure 3 Cyanobacteria on Malpas Dam

Blue-green algae (C*yanobacteria*) are common in soil and water ecosystems. They can be **toxic** during "blue-green algal blooms" and their distinctive smell (like musty old leather) can be a simple identifying signature.

These organisms are easily seen under a light microscope and with the use of a special microplate device, their concentration can be enumerated. Cyanobacteria should not be treated with chlorine before removal by filtration as the toxin released into the water is then very difficult to eliminate or detoxify. The toxin is known to affect liver function.

Larger flora (weeds, algae) and fauna (larvae, insects, and worms) are easily removed by screening (for large items first) and staged filtration with the final filter being 5 µm. Self-cleaning disc filters are more suited to 'dirty' water (organisms, solid particles) than textile or wound-paper filters.

3.3 Testing for bacterial contamination

It would be very expensive and time consuming to test for all the known bacteria and viruses that could cause illness in the community. Instead, ***indicator organisms*** are colonised in a special process and by their presence or absence the water can be classed as non-potable or potable respectively. Potable simply means it can be put in a pot for human consumption.

The water sample must be collected in a sterile container and stored in the dark at about 4°C and tested within about 12-24 hours. The aim is to avoid the multiplication or death of the organisms between sampling and testing.

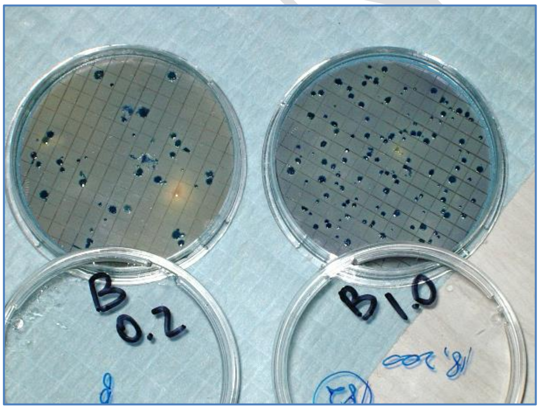


Figure 4 Faecal coliforms after 24 h incubation

In the laboratory, the water sample is filtered through a 0.45 micron filter, placed on a growth medium and incubated for 24 hours at elevated temperatures, hence called 'thermotolerant' bacteria. Bacteria grow as colonies, enabling their numbers to be counted and reported as colony forming units (cfu).

Faecal coliforms are used as indicators of possible contamination. The source of these coliforms is from the gut of warm-blooded animals. A positive value indicates contamination from this source. The drinking water guideline is less than 1 cfu/100 mL.

Neither sample in Figure 4 is fit for human consumption, and probably not even for swimming.

E. coli are specific thermotolerant bacteria, again sourced from the gut of warm-blooded animals. These bacteria can cause illness, usually vomiting or diarrhea, when ingested from contaminated water. The drinking water guideline for *E. coli* is less than 1 cfu/100 mL.

Total coliforms are a group of bacteria that live and survive in the general environment, working as decomposers. They are not generally associated with pathogens and their enumeration is usually used to evaluate disinfection processes, measuring their number before and after disinfection. Values up to 100 cfu/100 mL are common in clean rainwater storages and perhaps many thousands per 100 mL in surface water.

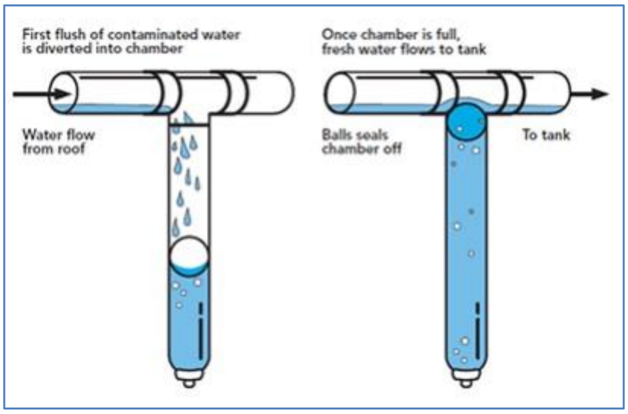
For a water sample to be assessed as potable, both faecal coliforms and *E.coli* enumeration need to be less than 1 cfu/100 mL. Positive indication of either will require the water to be treated prior to human consumption.

4. Treating Contaminated Water Supplies

4.1 Primary treatment

The first choice for a domestic water supply is one that will not "make us sick" (be free of pathogens or nasty chemicals), or cause scaling problems in pipes, fittings and hot water services. Domestic s water should be clear of suspended solids (clays, organics), colourless, odourless and looks "sparkling". But clear water does not guarantee the water is free from nasty bacteria.

Screens on gutters, to reduce leaves and other debris clogging the gutter and rotting in place, is the first line of defence.



First flush devices capture some of the first runoff from the roof and prevents it from entering the water tank as shown in Figure 5. Unfortunately, the volume captured as first flush is most likely less than the first millimetre of rain that falls on the roof, therefore, the effectiveness of this first flush may be relatively poor. As an example, if the roof area of your home is 200 m^2, you really need to be able to capture the 200 litres that first falls on the roof (that's the simplest of calculation) and divert it away from storage.

Unfortunately, most ***first flush devices*** are less than 10 L You may now understand why they are ineffective, but may have a 'feel good' value.

Figure 5 First flush diverter
Source:**https://www.nationalpolyindustries.com.au/2018/06/14/what-is-a-rainwater-first-flush-diverter/**

The third mechanism is placing coarse screen filters (Figure 1) between the roof collection and the storage tank to capture smaller rubbish from the gutters. Water should enter the top of the tank, not immediately above the outlet, to avoid fresh rainwater agitating the stored water and causing settled particles to re-enter the water body. Larger storages are more effective in allowing water to settle and the foreign materials to settle to the bottom.

Filtration through porous materials can be used to remove solid particles and some bacteria but not viruses. Filters 5 µm (micron) or smaller can remove a large proportion of parasites, however, bacterial regrowth on the filters may occur if they are not replaced regularly. The slime build-up on the surface of the filter is an added benefit, enhancing the filtration process, so do not replace filters too often.

It is very expensive to test for organic contaminants. Their removal in a carbon filter is one way of protecting our water drinking water. Rainwater can be contaminated by tastes of rotting leaf litter or soot from chimney residues. Activated carbon filters will remove most odours and tastes but only some bacteria.

Figures 6 and 7 show a disc filter, made up of about 100 thin plastic discs, each of which has grooves cut in both surfaces (opposing direction). When acting together the suspended solids become trapped in the grooves. As the resistance to water flow increases, the water can be turned off, the screw on the disc cylinder is removed and the disc filter removed, washed and replaced.

Figure 7 shows the disc assembly after six months of operation. The discs were cleaned and replaced. When inserted into its carrier, the discs are pushed hard against each other and the 120 µm filter is operational again. A human hair is about 80 µm diameter. The stack of discs avoids the waste of discarding blocked fibre filters.

Figure 6 Disc filter unit

Figure 7 Disc filter, easily separated for regular cleaning (Source Figure 5:ebay.com.au, Figure 6 author)

See the YouTube video by Netafim, at the following site, to understand the benefits of a disc filter. In larger systems these devices can be automated so that when the inlet pressure increases to a given value, the device activates into self-cleaning mode, backwashing the filter and rejecting the waste. View https://youtu.be/X66chc6oGA4 as at 10JAN21

At the very least, insert a filter on the cold water line under the kitchen sink so that there is at least one tap suitable for drinking and food preparation.

4.2 Choose another source.

It may be that the source of contamination is an intermittent or continuing problem. Water from a shallow well or surface water (dam, creek or river) may be temporarily or permanently contaminated by faecal coliforms or *E. coli*. A sample taken after a major rain event may have washed animal manures into the water and the results is likely to be that the water is highly contaminated and not fit for human consumption. It may not be possible to clean up the source in the short term.

When water is in short supply, it is better to use poor quality water for toilet flushing and the laundry and save the best quality for drinking. For that reason, a permanent water filter on the kitchen tap is most important.

Herbicide and pesticide contamination of water is expensive to identify. If in doubt, don't use possible or probable contaminated water for drinking or washing.

Figure 8 Boiling water - rolling boil

4.3 Boiling water

Boiling is the least expensive disinfecting technique for small volumes of water, however, a 'rolling boil' is generally required for it to be effective as shown in Figure 8.

Allow the boiled water to cool before consuming, and place water in clean container in the refrigerator for later consumption.

Boiling is not effective for water contaminated by "blue-green algae" because the boiling does not inactivate the toxins.

4.4 Chemical treatment

Chemical treatment involves dosing the water with a chemical that will kill bacteria, but not be harmful to human health. Chlorine is used in town water supplies, but chlorine only kills some of the bacteria and is poor at treating viruses and protozoa. Chlorine is an extremely hazardous gas and not easily used at the domestic level as it requires precise doses to be effective but at levels not harmful to humans. At domestic level chlorine is available as bleach (sodium hypochlorite) in liquid or powder form. Handle with care and avoid using in confined spaces.

4.4.1 Add a chlorinating agent.

A reliable source of chlorine is either domestic chlorine bleach, usually about 4% active chlorine, or pool chlorine (12% active chlorine). Be aware that pool chlorine that contains *isocyanuric acid* is NOT a suitable product for treating drinking water, isocyanuric acid is added to stabilise chlorine in swimming pool water management. The amount of required to treat water depends upon the type of chlorinating agent and the volume being treated. The ideal final concentration of chlorine in the potable water is about 0.5 mg/L, the same as you would find in a chlorinated town water supply. You can purchase a chlorine test kit at most hardware stores in the 'swimming pool chemicals' section for less than $20. Pet stores also sell chlorine test kits mainly for testing water suitable for an aquarium, as chlorine is poisonous to fish.

Too much chlorine will leave a foul smell and taste, but some residual chlorine is necessary to ensure effective disinfection in the supply line and reduce the incidence of bacterial regrowth in the pipes.

Using liquid chlorine. A useful source of information about treating domestic water supplies is available at https://www.health.nsw.gov.au/environment/water/Publications/private-water-supply-guidelines.pdf The following information is taken from this source.

When you use a 4% liquid bleach, the volume added depends upon how contaminated the water is that will be treated. Initially you should be aiming towards about 1 mg/L initial chlorine concentration. The chlorine dissipates quite rapidly in the water and most is lost after about one hour.

Table 1. Dosing rate for 4% bleach in drinking water

Volume of water to be treated	Required dose of 4% liquid chlorine	Volume of water to be treated	Required dose of 4% liquid chlorine
1000 L	25 mL	32 000 L	800 mL
5000 L	125 mL	80 000 L	2000 mL
10 000 L	250 mL	240 000 L	6000 mL

4.4.2 Add an oxidising agent

Hydrogen peroxide (H_2O_2) is an oxidising agent, a bleach and an antiseptic. A commercial product called *TankSafe™* is a low concentration of 7.9% hydrogen peroxide that oxidises ('burns') organic material from the water, classified as 'Hazardous". Be careful with this product as it may 'burn' your skin, leaving visible burns as white blotches where the product has reacted with your skin. Hydrogen peroxide is also used to whiten teeth, but be careful of the strength used. We treat fouled washing with a similar product to 'burn/bleach' organics from clothes before putting them in the wash.

Napisan™ is a 'percarbonate' that reacts with water to form hydrogen peroxide, that removes faecal material, blood stains and disinfects, but Napisan™ should not be used to disinfect drinking water because of its other components. Refer to: http://www.rb-msds.com.au/uploadedFiles/pdf/Vanish%20Napisan%20Plus%20Powder-v2-D8341587.pdf

How to use TankSafe™: The following table has been extracted from the brochure provided by Puretec.

Table 2. Dosing rate for TankSafe™ in drinking water storage

Volume of water to be treated	Required dose of TankSafe™	Volume of water to be treated	Required dose of TankSafe™
1000 L	65 mL	32 000 L	2000 mL
5000 L	330 mL	80 000 L	5000 mL
10 000 L	650 mL	240 000 L	15 000 mL

Allow 24 hours contact time. Use only as directed by the manufacturer. Refer to: https://puretec.com.au/TK2000

4.5 Reverse osmosis

Small domestic and commercial reverse osmosis (RO) devices are readily available but have a drawback in that only a small proportion of water passing though the device is treated and the larger proportion is rejected as waste. The water that has been treated by RO is not only clear of bacteria and viruses but also of all its other chemical properties; it is really only just very clean water. The treatment comes at a cost in that only a portion of the water passing through a reverse osmosis system is collected as treated water, nearly 80-90% is rejected and runs to waste. In non-urban areas, this 'waste' can be collected and used on gardens.

If you install a RO system, only connect to treat the cold water tap in the kitchen and leave other water lines untreated. You may wish to use the RO water when cleaning your teeth if the normal water is contaminated.

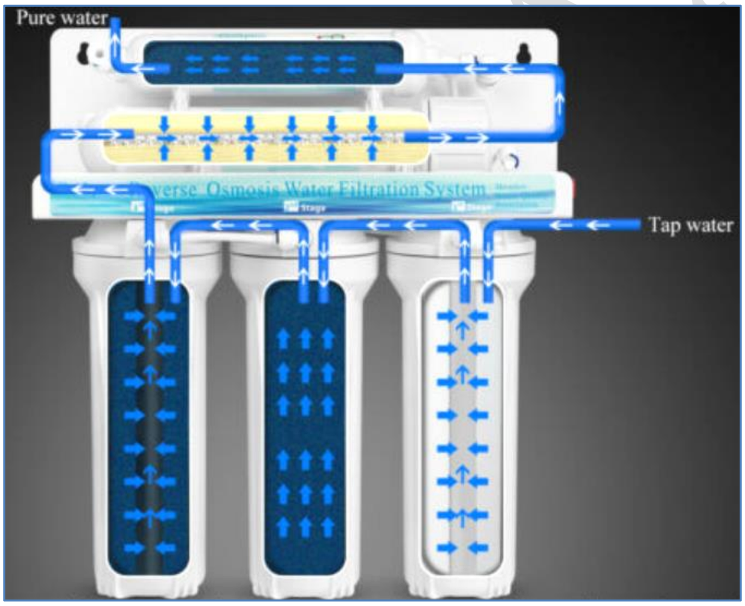


Figure 9 shows a typical under-sink RO system. The purpose of the three filter units is to progressively clean the water of: (1) dust, sand, silt, algae, rust; (2) granulated carbon filter to remove odour, suspended particles, chlorine and colour; and (3) residual chemicals, tastes and odours.

The water then passes to the RO membrane where 99.9% of all dissolved minerals are removed and ejected with the waste stream.

A final post carbon filter removes any residual tastes and odours, resulting in very clean water that has no taste or odour of the original water.

The filters and membrane will need to be replaced as the flow becomes restricted by dirt and other particles. Replacing the filters early will protect the more expensive membrane unit.

Figure 9 Under sink reverse osmosis system
Source: https://i.ebayimg.com/images/g/IwwAAOSw5ohekD2V/s-l640.jpg accessed 9th January 2021.

A search of the internet for domestic under-sink reverse osmosis units will reveal some inexpensive units for the kitchen, as in Figure 9. If your domestic water systems operates at low pressure, a reverse osmosis unit with its own in-built pump is a worthy option that reduces the proportion of waste generated. The RO water is stored in a separate tank because the rate of water treatment is slower than required for immediate use.

It is absolutely pointless using RO to treat water for showers, laundry or toilet flushing as a very expensive commercial system will be extremely expensive to operate and maintain, and the waste of the reject water will be significant.

4.6 Ultra-violet irradiation

Ultra-violet (UV) light is a reliable and effective chemical free method of inactivating bacteria, viruses and parasitic micro-organisms, provided the water stream is free from suspended solids and colour. Inexpensive UV units are available for installation under sink or larger version for treating the whole domestic supply where the plumbing cannot be separated to isolate the toilet, for example which will not benefit from the UV treated water. UV irradiation has no residual power to disinfect, the only killing power is within the cone of UV light as clear water flows past. Normal household water flow is about 12-15 L/min, so any UV system that will treat that flow will suit the home.

UV light does not affect the chemistry of the water, only its power is to destroy bacteria and viruses. Hard water will still be hard after UV irradiation, but iron and manganese may disrupt the effectiveness of the disinfection. UV systems require 240 V electrical connection. Like all treatment systems, the UV lamp has an effective life as does any fluorescent or standard light bulb.
Additional information about the operation and performance of UV light is available at:
https://ww2.health.wa.gov.au/Articles/U_Z/Ultraviolet-disinfection-of-drinking-water accessed 11JAN21

4.7 Light exclusion and vermin barriers

Water storages need to be relatively light proof to minimise the growth of algae and other organisms that require visible light for their metabolism. Inlets and overflow outlets on the tank need to be sealed with mosquito mesh to reduce the water becoming a breeding area for mosquitoes and frogs.

4.8 Commercial tank cleaning businesses

In many areas commercial operators provide tank cleaning services, offering to remove sludge settled in the bottom of the tank. Using high volume pumps, the water from the bottom of the tank is pushed through self-cleaning filters, returning the filtered water back to the tank and discarding a small volume of waste. Many operators report that for the water volume treated, often as little as 5% is run to waste with the solids removed. Check the *Yellow Pages* for local operators.

4.9 Water for Animals

Drinking water for livestock should contain less than 100 cfu/100 mL, although many animals tolerate higher levels. Consult your veterinarian with regards to water quality for livestock.

5. Other Water Chemistry Problems

Other constituents in domestic wastewater may also concern the household occupants. Staining of clothes because of iron and/or manganese in the water supply, particularly white clothes may leave a ‘shabby’ look to the clothes.

Hardness makes for incomplete rinsing of soap residues because the ‘scum’ left from the interaction of the soap with the calcium and magnesium is insoluble, and more difficult to remove in cold water. Water softeners are available for removing the calcium and magnesium using salt (sodium chloride) replacement, but the waste stream, when recharging the system, should not be directed to the septic tank. See also http://www.lanfaxlabs.com.au/hardness.htm.

Other contaminants of the various sources of domestic water are outside the scope of this paper. This paper has not addressed other concerns about chemicals that may be in drinking water and has limited discussion to removing solids and inactivating bacteria, viruses and micro-organisms.

Additional information is available in the NSW Health publication *Private Water Supply Guidelines* with details on calculating water volumes for chemical treatment and general advice for water security.

See also *Guidance on use of rainwater tanks* as a Commonwealth Government publication, listed in References.

6. Conclusion

Rural and semi-rural dwellings require a self-contained water treatment system to complement rainwater collection and storage and the range of other sources that include stream flow, surface dams, and shallow and deep groundwater. While the colour and turbidity of the water resource is high on the agenda, the biological quality is paramount. Bacteria from birds, bats and rodents in tank water may be a problem, while bacterial contamination of surface waters is most likely. Deep groundwater is likely to be unaffected by activities on the surface.

While the source of water needs to be given high priority for drinking water, lesser quality water can be used in the laundry and for toilet flushing. Whether the whole water supply is treated for bacteria is a matter of scale, as the larger the volume will incur the large cost. Treating only the drinking water and kitchen supply may be the optimum solution for lowest cost.

At the least, screens on gutters, sealing of tanks against vermin, followed by primary filtration may be sufficient for many households. Further treatment through multi-stage filtration, reverse osmosis, or UV irradiation are more expensive but highly effective for poor water quality.

For a short term solution, treating the water storage with chemicals or using a commercial tank cleaning operator may provide sufficient security to the water quality. Sometimes the simple option may provide the relief required.

7. References

Australian Drinking Water Guidelines (ADWG, 2011) updated in 2019, accessed on 10JAN21:
https://www.nhmrc.gov.au/file/14288/download?token=OPCuW6hp

Environmental Health Committee (2004) *Guidance on use of rainwater tanks.* Australian Health Protection Committee, Commonwealth of Australia. Accessed on 10JAN21
https://www1.health.gov.au/internet/main/publishing.nsf/Content/0D71DB86E9DA7CF1CA257BF0001CBF2F/$File/enhealth-raintank.pdf

NSW Health (2015) NSW Private Water Supply Guidelines. NSW Health Sydney, accessed on 10JAN21
https://www.health.nsw.gov.au/environment/water/Pages/NSW-private-water-supply-guidelines.aspx