Testing Drinking Water for Domestic Use

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Water is a limited natural resource and a public good fundamental for life and health. The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights.

UN Committee on Economic, Social and Cultural Rights General Comment 15 (2002)

DRINKING WATER GUIDELINES

The Australian Drinking Water Guidelines (ADWG) was developed by the National Health and Medical Research Council (see https://www.nhmrc.gov.au/guidelines/publications/eh52) and provides a framework for good management of drinking water supplies. Chapter 4 provides a framework for the management of drinking water quality to small water supplies, namely those serving fewer than 1000 people, e.g. caravan parks, school camps, tourist attractions, roadhouses and household supplies. The sources of these supplies can include groundwater, surface water and rainwater.

Those responsible for small water supplies should adhere to ADWG as far as possible; however, it may not be practical or necessary to implement all aspects of the framework. Analysis of the water supply system, identification of potential hazards and risk assessment are essential for good management of all supplies.

SOURCES OF CONTAMINATION

Water supplies can be polluted by sewage, seepage from septic tanks, animal faeces, intensive farming practices (e.g. fertiliser, manure and pesticides), blue-green algae and industrial wastes. These pollutants can introduce disease-causing microorganisms or harmful chemicals into the water. Also pollution with leaves and other organic materials which contain nutrients encourage microorganisms to grow more vigorously.

Some salts that occur naturally in water, including sulfates and nitrates, can be harmful if they are present in large quantities. Some dissolved salts can make the water hard resulting in scale build-up, while others can make the water soft resulting in possible corrosion in pipes, which can release harmful metals such as lead and copper into the water.
The quality of a water supply may also vary throughout the year. Heavy rain may wash pollution into a water source and during the warmer months the growth of blue-green algae can make drinking water from surface water sources unsuitable for humans and stock.

Other disease-causing microorganisms such as Giardia, Cryptosporidium, Salmonella, Shigella, Campylobacter, some strains of *Escherichia coli* (*E. coli*), Cyanobacteria (blue-green algae), Rotavirus, Norovirus and Hepatitis A Virus can cause diarrhoea, vomiting and other gastrointestinal upsets. Some of them can also lead to more serious illnesses and even death. The health effects from microorganisms generally occur quickly.

Health effects from water contaminated with heavy metals and other chemicals may take much longer to become apparent. Disinfection kills most disease causing microorganisms in water but does not remove or inactivate toxic chemicals. It is therefore important to ensure that the supply system is not contaminated with chemicals.

**Rainwater (e.g. tanks)**

If water from a rainwater tank is clear, has little taste or smell, is free from suspended material and comes from a well-maintained catchment (roof and gutters) it is unlikely to cause illness. However, this is not a guarantee of safety as contamination is not always visible.

Sources of contamination include:
- roof and gutters, e.g. build-up of organic matter such as leaves, dirt, faecal material from birds and small animals;
- roof materials, e.g. lead sheeting, peeling paint;
- build-up of sludge in tank, dirt in inlet strainers and/or insect screens;
- tank materials, e.g. pH of water with concrete tanks, high metals from metallic tanks, corrosion of metals from pipes; and
- insects and animals in system, e.g. dead animals, mosquito breeding.

**Groundwater (e.g. bore, wells, spear points, springs)**

Groundwater from **confined or deep aquifers** is generally free of pathogenic microorganisms and providing the water is protected during transport microbial quality should be assured. However groundwater from **shallow or unconfined aquifers** is readily contaminated by agricultural, industrial and urban activities and generally should not be used as a source of drinking water unless recently tested for microbial and chemical quality. Also, in some parts of Australia concentrations of naturally occurring elements such as arsenic, fluoride and uranium may exceed safe levels and salinity is an important aesthetic parameter. As a result if groundwater is the source of supply, chemical quality should be assessed as a priority.

Sources of contamination include:
- surface water seepage, e.g. wastewater, rubbish tips and landfill sites;
- subsurface contamination: industrial, farming land usage, landfill;
- backflow water, e.g. from animal water troughs and surface water storage;
- leaching from bore casings, pipes or plumbing materials, e.g. metals, pH; and
- naturally occurring elements.

**Surface Water (e.g. dams, rivers, creeks)**

Assurance of quality from surface water sources is more difficult than from most groundwater and rainwater systems. In general, surface waters require at least disinfection, and in some cases filtration, to assure microbial safety.

After treatment or disinfection, water should be protected during delivery to consumers in the same manner as groundwater, by ensuring that distribution systems are enclosed.

In some cases, water subjected to contamination from human or livestock waste, e.g. dams, rivers and creeks, can contain a wide range of pathogenic organisms including chlorine-resistant Cryptosporidium. Water of this type may not be suitable for drinking even after disinfection.
Sources of contamination include:
- surrounding land use, e.g. intensive farming, urban areas, industrial sites sewage discharge, effluent from factories, milking sheds and urban stormwater drains;
- pump and plumbing materials, e.g. piping, pump components;
- animal faeces;
- animal carcases;
- urban traffic, e.g. lead contamination; and
- flues from wood heaters.

**TESTING THE QUALITY OF DRINKING WATER**

The ADWG states that the greatest risk to consumer health is pathogenic microorganisms.

Chemical and physical tests provide a good indication of the palatability or taste quality of your water and also determine its overall quality. A standard range of tests include pH, turbidity, total dissolved solids, hardness, sodium, potassium, calcium, magnesium, iron, chlorine, sulfate, nitrate and fluoride.

It is recommended that an initial comprehensive analysis is undertaken to identify any chemical contaminants. The list of chemicals may need to be expanded to include other chemicals that are found in the vicinity of your water source, e.g. pesticides or industrial chemicals.

The guideline values for the tests have been adopted from the ADWG. They represent the most likely contaminants in private drinking water supplies. Guideline values for many other contaminants are also provided in the ADWG.

- **A health guideline value** is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of consumers over a lifetime of consumption.
- **An aesthetic guideline value** is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, such as appearance, taste and odour.

If you need advice on testing, or if your water exceeds a health value, consult your local water or environmental health authority:

- **NSW** 1300 066 055 www.health.nsw.gov.au/environment/water/Pages/default.aspx
- **WA** 08 9222 4222 public.health.wa.gov.au/2/1062/2/water.pm
- **NT** 08 8999 2400 www.health.nt.gov.au/Environmental_Health/Index.aspx
- **TAS** 1300 135 513 www.dhhs.tas.gov.au/peh/water/drinking

**Microbial Characteristics**

**Heterotrophic Plate Count**

*Heterotrophic plate count* is a test used to detect a number of micro-organisms present in water. Results of this test can vary seasonally and are not specific for detecting disease-causing organisms nor has any bearing on the presence of faecal contamination.

The result of a *heterotrophic plate count* test does not represent a health risk but provides useful information on the general microbiological content of the water and hence a measure of the effectiveness of disinfection.

Although the ADWG does not set a guideline value for *heterotrophic plate count*, it is their recommendation to establish numbers on a system-specific basis and investigate any marked increase in numbers following disinfection.
Total Coliforms

*Total coliforms* refer to a large group of bacteria that can be of faecal or non-faecal origin. Many of the non-faecal organisms grow naturally in the environment, including water.

*Total coliforms* do not present a direct health risk, but can provide information on the efficiency of drinking water disinfection.

The ADWG does not set a guideline value for *total coliforms* but recommends establishing numbers on a system-specific basis and investigating any increase in the number of *total coliforms*.

Thermotolerant Coliforms

*Thermotolerant coliforms* are a subgroup of *coliforms* that includes *Citrobacter*, *E.coli*, *Enterobacter* and *Klebsiella*. These may be present in the environment or intestinal tracts of animals and therefore present in animal faeces. *E.coli* is the most common *thermotolerant coliform* in the group and is regarded as the most specific indicator of recent faecal contamination because it is not capable of growth in the environment.

The ADWG states that *thermotolerant coliforms* should *not be detected in 100 mL of drinking water*.

Monitoring the Microbial Quality of Water by Testing for *E. coli*

Detection of *E. coli* indicates recent faecal contamination and the possible presence of other disease-causing micro-organisms, e.g. *Campylobacter*, *Salmonella*, *Shigella*, *Vibrio* and *Yersinia*.

The ADWG states that *E. coli* should *not be detected in a 100 mL sample of drinking water* and if detected, immediate action should be taken to identify potential sources of faecal contamination.

Chemical Characteristics

As well as the impurities below, NMI also tests for the following which are of lower health concern but have an influence on water quality: aluminium (Al, aesthetic guideline value 0.2 mg/L), chloride (Cl⁻, aesthetic guideline value 250 mg/L), iron (Fe, aesthetic guideline value 0.3 mg/L), sodium (Na, aesthetic guideline value 180 mg/L) and zinc (Zn, aesthetic guideline value 3 mg/L).

Chlorine (health guideline value 5 mg/L, aesthetic guideline value 0.6 mg/L) comes from chlorination of water supplies or is the result of pollution. Chlorine is best tested on-the-spot because samples lose chlorine quickly.

<table>
<thead>
<tr>
<th>Impurity</th>
<th>Health guideline value (mg/L)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony (Sb)</td>
<td>0.003</td>
<td>Can occur naturally in groundwater and is used in various manufacturing processes.</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>0.01</td>
<td>Harmful. Long-term consumption of water with a high concentration (&gt; 0.3 mg/L) produces acute and chronic toxic effects which include systemic irreversible damage. Found in soil and rocks. Released by burning fossil fuels, drainage from old gold mines and some types of sheep dip.</td>
</tr>
<tr>
<td>Barium (Ba)</td>
<td>2</td>
<td>Naturally occurring in rocks, soils and groundwater. At high concentrations can cause vasoconstriction, convulsions and paralysis.</td>
</tr>
<tr>
<td>Beryllium (Be)</td>
<td>0.06</td>
<td>Comes from weathering of rocks, atmospheric deposition and chemical plant effluents.</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>4</td>
<td>Low levels can occur naturally in groundwater. High levels may be associated with seawater intrusion.</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.002</td>
<td>Can occur naturally in groundwater or enter drinking water due to the corrosion of galvanised pipes and fittings.</td>
</tr>
<tr>
<td>Chlorite (ClO₂⁻)</td>
<td>0.8</td>
<td>By-product of chlorination – only to be tested for chlorine-treated waters.</td>
</tr>
<tr>
<td>Chromium (as Cr VI)</td>
<td>0.05</td>
<td>Toxic heavy metal. Found in small amounts in most rocks and soils, and has been used in many industrial processes and water pipes.</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>2</td>
<td>Common metal that can cause ill effects (nausea, abdominal pain and vomiting). Found in many rocks and soils and is frequently used in plumbing.</td>
</tr>
<tr>
<td>Fluoride (F⁻)</td>
<td>1.5</td>
<td>Important for preventing dental decay and strengthening teeth, but can be harmful at high concentrations. Found naturally in rocks and waters and is sometimes present in industrial air pollution.</td>
</tr>
<tr>
<td>Impurity</td>
<td>Health guideline value (mg/L)</td>
<td>Comment</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Iodide (I⁻)</td>
<td>0.5</td>
<td>Occurs naturally in some groundwater.</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.01</td>
<td>Toxic heavy metal. Can occur in groundwater as a natural component, but it is most likely to be in drinking water due to corrosion of pipes and fittings.</td>
</tr>
<tr>
<td>Manganese (Mg)</td>
<td>0.5</td>
<td>Occurs naturally in groundwater. Levels above the aesthetic guideline value may cause taste issues and staining of fittings.</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>0.001</td>
<td>Can occur naturally in groundwater or enter drinking water as a result of industrial emissions or spills.</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>0.05</td>
<td>Occurs naturally in soil and groundwater and is used in agriculture and mining.</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.02</td>
<td>Occurs naturally. Increasing in some waters (particularly groundwater) from intensive farming and sewage effluent. Guideline value will protect bottle-fed infants under 3 months from methaemoglobinaemia. Adults and children over 3 months can safely drink water with up to 100 mg/L nitrate. If the value is higher than 50 mg/L nitrate and the water source is located in an area of intensive agricultural use, also test for pesticides.</td>
</tr>
<tr>
<td>Nitrate</td>
<td>50</td>
<td>Occurs naturally. Increasing in some waters (particularly groundwater) from intensive farming and sewage effluent. Guideline value will protect bottle-fed infants under 3 months from methaemoglobinaemia. Adults and children over 3 months can safely drink water with up to 100 mg/L nitrate. If the value is higher than 50 mg/L nitrate and the water source is located in an area of intensive agricultural use, also test for pesticides.</td>
</tr>
<tr>
<td>Nitrite</td>
<td>3</td>
<td>Rapidly oxidised to nitrate.</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>0.01</td>
<td>Can occur naturally in groundwater.</td>
</tr>
<tr>
<td>Silver (Ag)</td>
<td>0.1</td>
<td>Occasionally found in groundwater.</td>
</tr>
<tr>
<td>Uranium (U)</td>
<td>0.017</td>
<td>Occurs naturally in some groundwaters, from release from mine tailings and combustion of coal and phosphate fertiliser.</td>
</tr>
</tbody>
</table>

**Physical Characteristics**

As well as the physical characteristics below, NMI also tests for electrical conductivity (EC), a measure of the capacity of water to conduct electrical current. It is directly related to the concentration of salts dissolved in water and therefore to total dissolved solids.

<table>
<thead>
<tr>
<th>Physical characteristic</th>
<th>Guideline value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>250 mg/L (aesthetic)</td>
<td>Can be found in high concentrations in groundwater and catchments.</td>
</tr>
<tr>
<td>pH</td>
<td>6.5-8.5 (aesthetic)</td>
<td>A pH of 7 is neutral, &gt;7 is alkaline and &lt;7 is acidic. Drinking water with increased acidity (pH &lt;6.5) can corrode plumbing fittings and pipes. Apart from the damage caused, this can release harmful metals such as lead or copper. Drinking water with increased alkalinity (pH &gt;8.5) can lead to encrustation of plumbing fittings and pipes. A pH &gt;11 may cause corrosion and &gt;8 can decrease the efficiency of chlorine disinfection.</td>
</tr>
<tr>
<td>Sulfate</td>
<td>500 mg/L (health)</td>
<td>Although harmful at higher concentrations, the guideline value for sulfate ions is set to avoid an undesirable taste in water. Under some conditions it can also contribute to corrosion of plumbing fittings. Sulfate at levels &gt;500 mg/L can have purgative effects. Sulfate ions are likely to enter water supplies from natural sources. The highest concentrations are likely to be seen in groundwater.</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>600 mg/L (aesthetic)</td>
<td>Dissolved material, usually salts, in the water supply can affect the water’s taste. It can also develop scale on the inside of plumbing fittings and pipes or lead to excessive corrosion.</td>
</tr>
<tr>
<td>Hardness (as CaCO₃)</td>
<td>200 mg/L (aesthetic)</td>
<td>Hard water can contribute to the formation of scale in hot water pipes and fittings, and makes lathering of soap difficult. Hardness is the measure of calcium and magnesium in the water and comes from the dissolving of these materials from soil and rocks.</td>
</tr>
<tr>
<td>Turbidity</td>
<td>5 NTU, &lt;1 NTU (desirable)</td>
<td>Turbidity is the measure of dirtiness or cloudiness of water. It indicates the amount of suspended solids present in the water. This can affect the taste of the water and can make the water look ‘dirty’. It can also reduce the efficiency of chemical and UV disinfection. Unusual increases in turbidity can indicate a disturbance in the water supply system.</td>
</tr>
</tbody>
</table>
NMI’S WATER TESTING SERVICE

To ensure the highest level of accuracy water samples should be tested at a laboratory accredited by the National Association of Testing Authorities (NATA).

NMI’s NATA-accredited water testing laboratory provides analysis for microbial, chemical and physical contaminants commonly found in Australia. We can tell you how safe your water is for drinking and give details of the levels of contamination and the aesthetic qualities of your water.

Before Sampling

Before collecting any samples, it is important to be aware of any specific requirements or protocols for sampling, the type and size of sample bottle that should be used, how much water should be collected for each test, how the sample should be stored and how quickly it should be delivered to the laboratory.

So, contact us via our on-line form, customerservice@measurement.gov.au or 1300 722 845 to discuss your requirements, obtain a quote and to order any containers and preservatives you may require (fee may apply).

During Sampling

- Wash your hands thoroughly before sampling or wear disposable gloves.
- Do not allow the screw cap or mouth of the sample container to touch anything that may contaminate the sample.
- Do not to rinse out or spill preservatives.
- Avoid cross-contaminating bottles (e.g. nitric acid used for metals can contaminate nitrate analysis).
- Some tests must minimise exposure to air to avoid analyte losses.
- If tests require the addition of preservatives prior to sampling, contact NMI beforehand to facilitate supply of appropriate containers.
- Many of the preservatives are hazardous chemicals (e.g. strong acids, alkaline solutions) and they must be handled with care — we recommend you wear safety glasses and gloves.

Testing for *E. coli*

- If the water has been treated with chlorine we will provide sample bottles which contain sodium thiosulfate.
- To ensure the sample bottles remain sterile, they should not be opened until they are required for filling.
- If a number of samples for various purposes are being collected from the same sampling point, collect the samples for microbiological examination first.
- If filling from a tap, swab the tap with an alcohol swab. Let the water run for 20 sec and then fill the bottle, leaving a headspace of about 2 cm from the neck of the bottle. Immediately replace the screw cap.
- If sampling from a storage tank, hold the sample container in one hand at an angle of 45° and the screw cap in the other hand. Plunge the container in vertically to a depth of approximately 20 cm, allow it to fill without rinsing and immediately replace the screw cap.
- Collect a minimum of 200 mL.
Chemical and Physical Testing

Surface water samples can be taken by holding the bottle near its base and plunging it, neck downwards below the surface, then turning the neck slightly upwards and filling it with a slight forward motion. Below are sampling size, preservation procedures and holding times for chemical and physical tests.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample size and container</th>
<th>Preservation procedure</th>
<th>Holding time (maximum time from collection until analysis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity, pH, hardness, electrical conductivity, total dissolved solids</td>
<td>500 mL plastic bottle</td>
<td>cool to &lt;4 °C, store in dark, pH &lt;2 (HNO₃), cool to 4°C</td>
<td>2 days</td>
</tr>
<tr>
<td>Metals</td>
<td>250 mL plastic bottle</td>
<td>pH &lt;2 (HNO₃), cool to 4°C</td>
<td>28 days</td>
</tr>
<tr>
<td>Nitrate, sulfate, fluoride, chromium VI, iodine, chloride and other inorganics</td>
<td>500 mL plastic bottle</td>
<td>cool to 4°C</td>
<td>2 days</td>
</tr>
<tr>
<td>Chlorite</td>
<td>250 mL plastic bottle</td>
<td>EDA, cool to 4°C</td>
<td>14 days</td>
</tr>
</tbody>
</table>

After Sampling

- Label the container with:
  - what the sample is (i.e. water);
  - where it was collected (address);
  - location of collection (i.e. tap or storage location);
  - who collected the sample; and
  - date and time of sample collection.

- Place in ice immediately after sampling.
- Cool to <4 °C.
- Deliver to NMI within 24 hours of sampling.
- Use ice bricks when dispatching by air and over long distances, and when couriers will not freight ice.
- Have at least half the recommended holding time remaining when relinquished to NMI.
- Avoid delivering time-critical samples to NMI late on Fridays.

FOR MORE INFORMATION

T: 1300 722 845
E: customerservice@measurement.gov.au
W: www.measurement.gov.au/food