Water quality information sheet 38

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Contamination in drinking water sources

> *The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised.*[1]

This information sheet discusses some of the common sources of contamination that may occur in Western Australia's drinking water sources. This includes public drinking water source areas (PDWSAs)[2] which are constituted under legislation, and non-constituted sources such as small communities, mine sites and caravan parks. It supports:

- drinking water source protection reports (one for each of WA's 140 PDWSAs), and equivalent management strategies
- Water quality protection note (WQPN) 11: *Assessing and managing risks in PDWSAs*
- WQPN 77: *Risk assessment process for PDWSAs*.

How does contamination affect drinking water?

Human development, land and water uses and activities can cause a wide range of microbiological, chemical and physical contamination. In a drinking water source, contamination directly affects the quality of water and the treatment that is required to make that water safe to drink. Contamination affects the ability to provide safe, affordable and reliable drinking water to consumers.

The less contamination, the less water treatment required. Treatment can be expensive and relying on it is less safe than preventing contamination. It is important that a comprehensive risk assessment, based on prevention, is conducted for land uses and activities in drinking water source areas so we can understand all potential sources of contamination. If we understand the risks, we can make sure they are avoided, minimised or managed.

[1] *Australian drinking water guidelines*

[2] Surface water catchments and groundwater aquifers that supply drinking water are called 'public drinking water source areas' (PDWSAs). They are constituted under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.

Sources and effects of contamination

Contaminants from land uses and activities can reach a drinking water source through direct emission into water sources, runoff over the ground, infiltration through the soil, or a combination of all three.

Some contaminants in drinking water can affect human health, resulting in illness, hospitalisation and even death. Others are not hazardous to health but will affect the water's aesthetic qualities, that is, its appearance, taste, smell and 'feel'. For example, turbid water with a distinctive odour or strong taste may not be harmful to health, but clear, pleasant-tasting water may contain harmful microorganisms that are undetectable by sight, taste or smell.[3]

Contaminants can also interfere with water treatment processes, making the processes less effective, and cause damage to water treatment systems and supply infrastructure. Systems may need to be taken offline for repairs, disrupting supply. In extreme cases, sources can be rendered permanently unusable.

The *Australian drinking water guidelines* provide the basis for determining the quality of water supplied to consumers in Australia to protect human health, manage aesthetics and maintain water supply infrastructure. Public drinking water supplies in WA must meet these standards.

Microbiological contamination

The greatest risk to consumers of drinking water is pathogens[4]. Pathogens are types of microorganisms that can cause illness and include bacteria, protozoa and viruses. The consequences for drinking water that is contaminated with pathogens vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and even death. For example, seven people died and about 2500 became ill in Walkerton, Canada, during 2000 after the town's water supply was contaminated by a pathogenic strain of Escherichia coli and Campylobacter, and the water was not sufficiently treated prior to distribution [4].

The types of pathogens that are likely to cause harm to people are commonly found in the faeces of humans and domestic animals (such as cattle and pigs). These pathogens can enter drinking water supplies from faecal contamination anywhere within a drinking water source area, either directly or indirectly.

Directly: When people or domestic animals come into contact with a body of water, pathogens can enter that water source. This occurs through the direct transfer of faecal material from the person or animal into the water. It can occur through swimming or wading in a water source. Even trace amounts of faecal material from healthy individuals can contain pathogens.

Indirectly: Pathogens run off over the ground or infiltrate the soil, and find their way into water supplies, such as from septic tanks or animal manure deposited in paddocks.

A number of pathogens are known to contaminate water supplies worldwide. These include bacteria (for example *Salmonella*, certain strains of *Escherichia coli* and cholera), protozoa

[3] *Australian drinking water guidelines*

[4] Hrudey, SE & Hrudey, EJ 2004, *Safe drinking water – Lessons from recent outbreaks in affluent nations*, IWA Publishing.

(such as *Cryptosporidium* and *Giardia*) and viruses (such as rotavirus and virus causing Hepatitis A). Monitoring of water supplies, for example for the presence of *E. coli*, provides an important indication of the level of recent faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the environment.

The percentage of humans in the world that may carry pathogens varies. It is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia*.[5]

The survival and movement of pathogens in drinking water sources is influenced by:

- the species (*Salmonella* may be viable for two to three months in the natural environment, *Giardia* may still infect after a month and *Cryptosporidium* oocysts[6] can survive weeks to months in fresh water[7])
- its inactivation rate[8] (in certain conditions, pathogens can migrate considerable distances, for example, bacteria have been reported to travel as much as 600 m in a sandy aquifer[9])
- groundwater and surface water properties (such as flow rate, temperature and pH)
- soil properties (such as porosity, amount of carbon in the soil).

When pathogens enter a water source with the right conditions, they can multiply, increasing the likelihood of contamination. This is in contrast to chemical contaminants, which tend to dissipate and dilute when they enter a water source. It is therefore important to understand the surface water and groundwater systems of a drinking water source to be able to address pathogen contamination.

Given the serious consequences of consuming drinking water that is contaminated with pathogens, the most effective way to protect public health is to avoid introducing pathogens into a drinking water source.

Chemical contamination

Chemicals in drinking water can come from human or environmental sources. Human sources include land and water uses and activities while environmental sources include leaching of natural mineral deposits.

Chemicals can have harmful effects on people consuming contaminated drinking water. Some types of organic and inorganic chemicals can be toxic to people at certain concentrations.

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[5] Geldreich, EE 1996, 'Pathogenic agents in freshwater resources', *Hydrological Processes*, vol. 10, pp. 315-333.

[6] An oocyst is a cell containing reproductive spores.

[7] *Australian drinking water guidelines*

[8] The time it normally takes for a pathogen to decay; typical half-lives of pathogens range from a few hours to a few weeks.

[9] Robertson, JB & Edbery, SC 1997, Natural protection of spring and well drinking water against surface microbial contamination. I. Hydrogeological parameters, *Critical Reviews in Microbiology*, vol. 23(2), pp. 143–78.

The following table describes typical chemical contaminants that may be found in drinking water sources and their impacts on human health.

Table 1: Chemical contaminants that may occur in drinking water source areas

Type	Uses	Routes of contamination	Impacts on human health
Pesticides	Weed and pest control	Leaks and spills Using the wrong type, too much, or at the wrong times (i.e. before rainfall) Illegal dumping	Toxic
Hydrocarbons	Fuels and oils for machinery and vehicles	Traffic accidents Road runoff Leaks from storage tanks Service stations Spills from refuelling	Toxic
Nutrients	Fertilisers	Using too much fertiliser or at the wrong times Accidental spills Leaching from agriculture, market gardens Septic tanks, sewerage system leaks Livestock and domestic animals Naturally occurring	Nitrate and nitrite are two forms of nitrogen that can be toxic to humans at high levels, with infants younger than three months most susceptible.
Heavy metals	Industry	Leaching from industrial areas and landfills Leaks and spills Illegal dumping	Toxic
Emerging chemicals such as per- and polyfluoroalkyl substances	Products such as non-stick cookware, clothing and firefighting foams	Residues in the environment	Research is underway to develop better understanding and guidelines

Physical contamination

Turbidity is the result of soil or organic particles becoming suspended in water. Erosion from activities such as off-road driving and clearing of vegetation can cause turbidity in surface water sources. Increased turbidity in a drinking water source can:

- cause cloudy or muddy-looking water, which is not aesthetically appealing to consumers

- reduce the effectiveness of treatment processes such as disinfection[10] because contaminants can attach to soil particles and pass more easily through treatment processes
- cause water treatment systems to be shut down temporarily, taking a source offline
- smother riparian vegetation[11] and reduce the ability of light to penetrate the water column, affecting plant growth which in turn can affect water quality.

There are other physical properties of water that can affect supply infrastructure, or the aesthetics and taste of the drinking water, including:

- pH can contribute to the corrosion and encrustation of pipes
- iron and dissolved organic matter can affect the colour and smell of water
- salinity levels can affect the taste of water
- colour can affect the look of water, and have implications for disinfection processes
- the temperature of the water can affect disinfection processes.

Radiological contamination

Radioactive materials in drinking water can come from the environment (uranium, thorium, potassium) or from human sources (such as medical, industrial or mining activities).

The health effects of radiation can be serious. Exposure at low to moderate doses may increase the long-term incidence of cancer and the rate of genetic disorders[12]. Acute health effects occur at much higher doses and are therefore not a concern for drinking water except in extreme accidents[13].

Need more information?

A list of further reading is available in WQPN no. 8: *Further reading*.

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[11] Disinfection is designed to inactivate pathogens in drinking water supplies.

[12] The vegetation associated with a waterway; vegetation that adjoins, influences or is influenced by a waterway.

[14] *Australian drinking water guidelines*

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