



# Drinking Water Treatment



*When most Australians turn on a tap, clean, clear water runs out. But how does the local water supplier make sure the water is safe and pleasant to drink? The answer is likely to include some form of treatment.*

## **FROM CATCHMENT TO TAP**

Most urban communities collect their water from a natural waterbody in the catchment, whether a stream, river or an underground aquifer. The water collected may then be stored for some time in a reservoir.

Unless it is already of very high quality, the stored water will undergo various treatment processes that remove any chemicals, organic substances or organisms that could be harmful to human health. The water is then delivered to the community through a network of mains and pipes called a distribution system.

## **HISTORY OF WATER TREATMENT**

The importance of good drinking water in maintaining health was recognised early in history. However, it took centuries before people understood that their senses alone were not adequate for judging water quality.

The earliest water treatments were based on filtering and driven by the desire to remove the

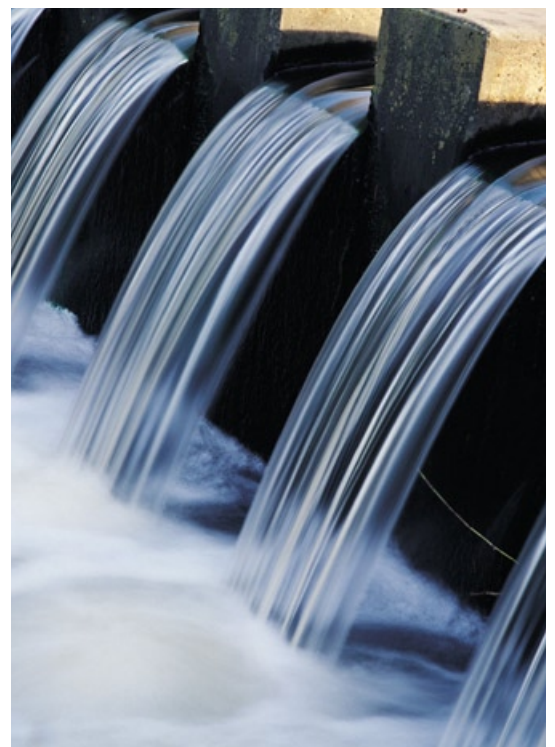
taste and appearance of particles in water. Filtration was established as an effective means of removing particles from water and widely adopted in Europe during the nineteenth century.

Exactly why a clean and reliable water supply was needed, apart from looking and tasting better, was not understood until the second half of the nineteenth century. That was when the nature of infectious disease was recognised and the ability of water supplies to transmit diseases such as cholera and typhoid was first demonstrated.

After this, concerns about the quality of drinking water focused on disease-causing microorganisms (pathogens) in public water supplies.

Scientists discovered that visible cloudiness, or turbidity, not only made the water look unappealing, it could also indicate a health risk. The turbidity was caused by particles in water that could harbour pathogens.

As a result, drinking water treatment systems were designed to reduce turbidity, thereby removing pathogens that were causing typhoid, cholera and other waterborne illnesses.



## FILTRATION

By the early twentieth century, better protection of water supplies from sewage pollution and simple but effective methods of water treatment (chlorination, sand filtration) had greatly reduced rates of waterborne disease in developed nations. Since then, scientists and engineers have been developing ways of processing water more quickly, more effectively, in a more controlled way and at lower cost.

## WATERTREATMENT PROCESSES

The processes and technologies used to remove contaminants from water and to improve and protect water quality are similar all around the world. The choice of which treatments to use from the great variety available depends on the characteristics of the water; the types of water quality problems likely to be present and the costs of different treatments.

The most widely applied water treatment process is a combination of some or all of the following: coagulation, flocculation and sedimentation, plus filtration, and has been used routinely for water treatment since the early part of the twentieth century.

### Sedimentation, coagulation and flocculation

Some particles will spontaneously settle out from standing water (a process called sedimentation). When particles settle very slowly or are non-settling, chemicals (coagulants), such as alum, are added to the water. These react with the unwanted particles to form larger particles, called floc. The larger size and weight of the flocs then cause them to settle rapidly.

Coagulation and flocculation are very effective at removing fine suspended particles that attract and hold bacteria and viruses to their surface. They can remove up to 99.9 per cent of bacteria and 99 per cent of viruses from water supplies. They also remove some of the organic matter that gathers as water travels across the landscape, from raindrop to river. However, certain taste and odour problems may remain.

### Filtration

Filtration occurs as the water passes through a substance that helps remove even smaller particles. One of the oldest and simplest processes used to treat water is to pass it through a bed of fine particles, generally sand. Sand filtration usually removes fine



Photo courtesy AWQC

suspended solid matter as well as some other particles, such as larger microorganisms. Filters can also be made of layers of sand, gravel and charcoal.

The development of new synthetic materials has led to an increased range of filter materials and methods, which are being used increasingly to treat water for urban and industrial purposes.

In membrane filtration, water is filtered through tiny holes (pores) in a membrane wall rather than a bed of sand. The smaller the pore size, the more particles are held by the membrane as the water passes through.

Of the different kinds of membrane filtration processes, microfiltration is the most widely used in water treatment in Australia, becoming increasingly popular for small-scale water treatment plants supplying smaller communities in rural and regional Australia. This is because it is an effective treatment and is simpler to operate.

Two other types of membrane filtration, involving membranes with even smaller pores – ultrafiltration and nanofiltration – are not widely used in Australia, because of the lower levels of synthetic chemicals, such as pesticides, present in our water and the high cost of these membrane processes.

### Other treatments for unusual cases

While coagulation, often combined with filtration, will remove most of the troublesome contaminants from water, these processes do not usually remove all the material dissolved in the water.

If the water contains undesirable impurities, additional treatment such as adsorption and oxidation may be required.

Adsorption is a form of chemical filtration that involves removing dissolved substances by chemically or physically binding them to the filter material.

It is quite different from the similar-sounding process of absorption. In water treatment, specialised adsorbent materials such as activated carbon and ion exchange resins are used to remove a range of soluble contaminants from water.

One way of using activated carbon is to percolate water through a bed of carbon granules. Once the carbon is saturated with the contaminants, it needs to be replaced or regenerated by heating it to a high temperature.

If water contamination occurs only occasionally, and is detected by a regular monitoring program, a common approach to removing the contaminant is to add powdered activated carbon to a conventional coagulation/flocculation process when a problem arises. The saturated carbon is collected in the filters and then discarded with the normal sludge from the water treatment plant. This form of intermittent dosing is used widely in Australia where there are occasional problems with blue-green algal blooms, which can cause taste and odour problems, and are sometimes toxic.

Oxidation with chemicals such as ozone or chlorine dioxide, a common treatment technology in Europe, has appeared in Australia relatively recently. Strongly reactive chemicals such as ozone are used to disinfect water and to destroy soluble contaminants such as algal toxins, taste and odour compounds and, particularly in Europe, traces of pesticides.

**Water stabilisation**

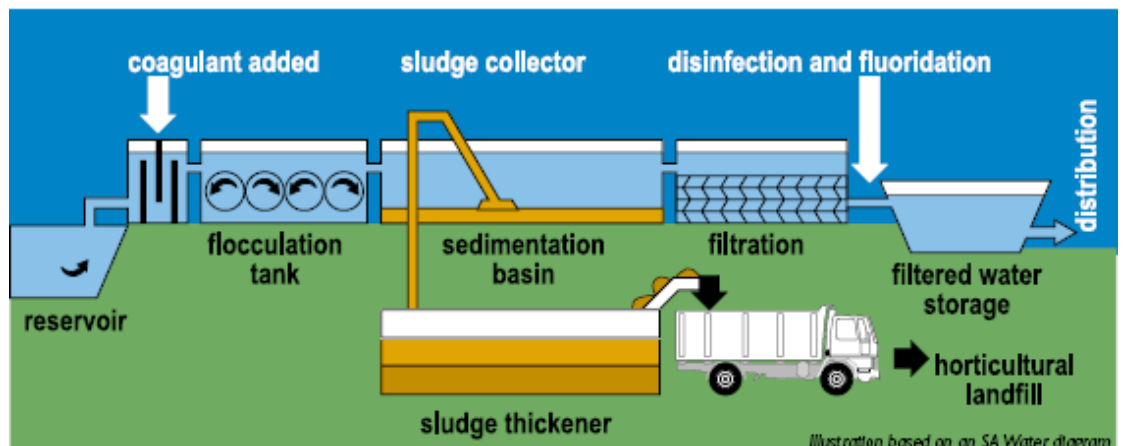
Some water supplies can become acidic or alkaline by dissolving or reacting with metal pipes and surfaces they are in contact with. This can cause piping systems and hot water services to corrode and dissolved metals to appear in the water.

For example, a common sign of copper corrosion is a bluish stain where a tap drips onto a surface. To prevent corrosion, many waters are chemically stabilised to a particular pH before distribution – by adding lime and sometimes carbon dioxide.

**Disinfection**

Water is disinfected to kill any pathogens that may be present in the water supply and to prevent them from regrowing in the distribution system. Without disinfection, the risk from waterborne disease is increased.

The two most common methods to kill microorganisms in the water supply are oxidation with chemicals such as chlorine or ozone or irradiation with ultra-violet (UV) radiation.



*Illustration based on an SA Water diagram*

## The Cooperative Research Centre for Water Quality and Treatment

The most widely used chemical disinfection systems in Australia are chlorination, chloramination and ozonation.

There is no all-purpose disinfectant and each has its own advantages and disadvantages. The goal is always to protect public health and the choice depends on the individual water quality and water supply system.

For a water supplier, the key factors in selecting a disinfection system are:

- Its effectiveness in killing a range of microorganisms
- Its potential to form possibly harmful disinfection by-products
- The ability of the disinfecting agent to remain effective in the water throughout the distribution system
- The safety and ease of handling chemicals and equipment
- Cost

### NEW TREATMENTS

Innovative water treatment technologies are becoming more important in Australia and overseas. In Australia research is conducted within Universities, Private Companies, Water Authorities and in organisations such as Water Quality Research Australia, where scientists, technologists and engineers are developing new water treatment technologies and improving existing ones. Their work will ensure the best water quality for many communities and lower costs for households and businesses.



*Photo courtesy Melbourne Water*

### FOR MORE INFORMATION

visit the Web site:  
[www.waterquality.crc.org.au](http://www.waterquality.crc.org.au)



The Cooperative Research Centre (CRC) for Water Quality and Treatment is Australia's national drinking water research centre. An unincorporated joint venture between 30 different organisations from the Australian water industry, major universities, CSIRO, and local and state governments, the CRC combines expertise in water quality and public health.

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