What is Water Quality?

Water quality is the measurement of pollution in a water resource. This includes natural sources of freshwater and salt water, as well as reservoirs and the water that comes out of our taps. Poor drinking water and bathing water quality can pose risks to human health, and ecosystems can be affected by pollution in natural water bodies such as rivers, lakes and seas.

Tests for water quality include finding out the oxygen concentration, water temperature, the amount of suspended material in the water, pH, nitrates, salt, and the presence of harmful types of bacteria or parasites.

It is important to monitor and improve the quality of water as we have limited water supplies on our planet. We need freshwater for drinking but pollution can result in the water being hazardous to our health. Pollution in saltwater can affect the supply of fish and seafood for us to eat, and disrupt recreational activities such as swimming in the sea.

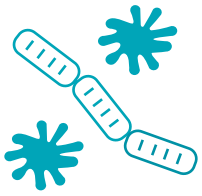
Types of Water Pollution

Pollution in water can come from a variety of sources. The sources of pollution are classed as point sources or non-point sources. Point sources are where pollution comes from a specific place such as an oil spill. Non-point sources do not have a single identifiable point of pollution, such as agricultural runoff made of soil and fertiliser, or storm water drains collecting urban pollution of oils and metals. Non-point sources are sources of diffuse pollution where the pollution gradually builds up and is difficult to control.

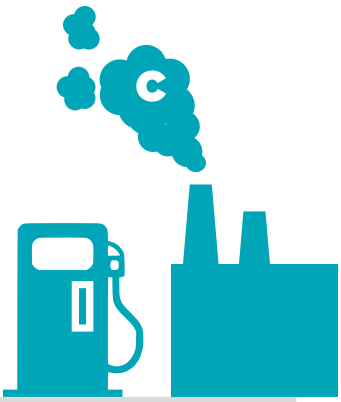
point sources

non-point sources

Water pollutants can be classed as pathogens, organic, inorganic, or macroscopic:

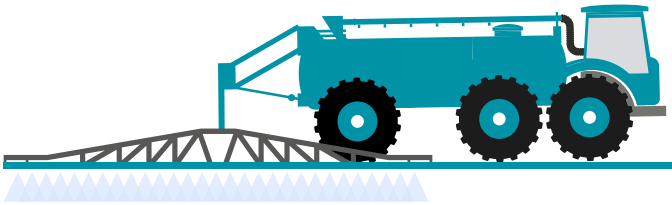


Pathogens are bacteria and viruses that cause illness in humans and animals. Diseases such as cholera and typhoid are bacterial infections caused by ingesting water usually contaminated by sewage. Cholera, *Vibrio cholerae*, inflames the intestines and causes diarrhoea, which can lead to dehydration and even death. Typhoid, *Salmonella typhi*, can cause fever and pain, and sometimes confusion.



Organic pollutants are substances that contain carbon. These include hydrocarbons such as petrol or diesel, detergents, fats and grease from food production, plastic microbeads, and pesticides. Microbeads are small plastic particles used in cosmetics and toiletries, which are too small to be caught by water filters in treatment facilities. Microbeads accumulate in rivers and the sea, and can even make their way into the food chain through ingestion by fish and other aquatic species. Organic pollutants, and other waste, can collect in sewers and create blockages known as fatbergs.

Fatbergs are large masses of fat and grease, food and domestic waste that have been poured down the sink, or flushed down the toilet. They are costly to remove and are completely avoidable, as long as people dispose of their food and waste properly. In 2017, a fatberg found in London was longer than Tower Bridge and weighed almost as much as a blue whale (source).



Inorganic pollutants are substances that do not contain carbon. These include fertilisers that use nitrates or phosphates, heavy metals from mine drainage, and chemical waste from industrial practises. In Wales there is a strong history of mining coal and metals. There are 1300 abandoned metal mines in Wales that are thought to affect 200 Km of rivers. Zinc, lead and cadmium levels are increased in rivers and lakes, where metal from the mines has leached into the water or surrounding land. An example is the Cwm Rheidol mining complex near Aberystwyth. It is currently undergoing remediation by Natural Resources Wales in an attempt to improve the quality of the River Rheidol, which failed the European Water Framework Directive standards for zinc and cadmium levels. Discharges from areas of the mines are being captured to prevent release into the surrounding environment, as well as a stream being diverted so it would not flow into the mine and increase the amount of contaminated fresh water.

High levels of heavy metals in water can be toxic for many species as the metals can disrupt bodily processes. Lead can interfere with the development of the central nervous system, and can disrupt the function of organs. Lead toxicity in drinking water is a problem in many areas of the world, including Hong Kong (source). The water is cleaned, and is safe to drink, until it is transported through pipes in domestic buildings that are not up to standard. Lead from the pipes can leach into the water supply making it toxic to drink. Due to lead's impact on the development of the nervous system this is a particular concern for children.

Macroscopic pollutants are pollutants that are easily visible to the naked eye. These include domestic waste, such as bottles and packaging, as well as larger items, from machinery to sunken ships. Plastic waste is a global problem with large islands of plastic waste, miles wide, building up in oceans. Animals can mistakenly ingest plastics, which can lead them to starve. Common examples are sea turtles mistaking plastic bags for jellyfish, and albatrosses feeding plastic to their chicks thinking it to be food.

Diffuse Pollution

Diffuse pollution comes from non-point sources of pollution where pollutants diffuse into the surrounding environment from indistinct places. Examples of diffuse pollution are agricultural and urban runoff.

Agricultural runoff

Agricultural practises can create large amounts of loose soil when fields are ploughed, crops harvested, or used for livestock. Soil and crops can be treated with fertilisers and pesticides to feed and protect plants, thereby increasing the amount of produce harvested. Loose soil can become runoff when rain washes the soil, pesticides and fertilisers into nearby water sources. Loose soil can increase the sediment level in a river, the sediment being soil, gravel, and other naturally occurring matter.

Nitrates and phosphates are common types of fertiliser. Once they have been washed from farmland into lakes or rivers, they continue to act as fertilisers and boost the growth of aquatic life, including phytoplankton algae. Algal blooms are common in water bodies that have been contaminated by agricultural runoff. The algae coats the surface of the water, preventing sunlight from reaching plants beneath the water. These plants die, and the oxygen levels are depleted, which are then further depleted by the plants decomposing. Low oxygen levels create an inhospitable habitat and the population numbers of species can decline. This process is known as eutrophication and can be disastrous for aquatic habitats.

Some species are sensitive to chemical and sediment changes in freshwater.
Two examples are salmon and pearl mussels.

The life cycle of salmon is divided between freshwater and salt water. Salmon begin life in rivers and then migrate to the oceans, but they return to the river where they were born in order to breed. The female salmon creates a nest, known as a redd, in the riverbed by fanning her tail to create a dip in the gravel or silt. The male salmon fertilises the eggs the female has laid, and the redd is covered by a very precise layer of gravel. This layer provides enough coverage to protect the eggs but still allow a steady flow of water for oxygen. Sediment levels in a river can increase due to agricultural runoff, and this sediment can completely cover the redd, preventing any oxygen from reaching the eggs. Salmon numbers can decline when there is too much agricultural runoff, as many eggs die before they mature due to this lack of oxygen.

The pearl mussel is a freshwater species of mussel. Population numbers severely decline when water quality is poor as these mussels need clear, clean water and a strong surface on which to attach. Rivers with high agricultural runoff will contain high levels of nitrate and loose sediment, both of which interfere with the pearl mussel's development. Salmonid fish such as trout and salmon also play a key role in the pearl mussel's life cycle, as the larval stage of the pearl mussel, known as the glochidia, attach to the gills of the fish until they are sufficiently developed to attach to a surface in the river. Pearl mussel populations are therefore strongly influenced by the salmonid population density, which is itself influenced by the water quality.

Urban runoff

Oils, petrol, diesel and metals are deposited on roads and other surfaces in urban areas by vehicle use and industrial practises. Rain water washes the roads and pavements collecting the oils and metals, which then wash down the drains. The drains often lead to freshwater, such as rivers. This is known as surface water and it has a different drainage route than sewage water from a building. If surface water is contaminated it can affect freshwater ecosystems. Sediment from construction sites can be washed into surface water drains, and can impact on fish spawning in the same manner as agricultural runoff.

To raise awareness of how surface water contamination can cause pollution, the Environment Agency launched the Yellow Fish Campaign. Across the UK, images of yellow fish have been painted above surface water drains to highlight that surface water drains are only intended to carry rain water, not to have other substances poured down them.

Authorities and Legislation

Water Framework Directive (WFD)

The EU Water Framework Directive (2000) sets out guidelines, targets and limits for countries in the European Union to ensure good water quality. Water quality is assessed chemically and ecologically and need to reach "good" status. The diversity of ecosystems across the EU means that ecological and chemical criteria vary between countries.

River basins and groundwater supplies are protected under the WFD. Groundwater is the supply of water under the ground in layers known as aquifers, whilst river basins are areas of land drained by rivers. Under WFD, there are river basin districts that include all rivers, lakes, coastal water and groundwater in a given area. These districts are focus areas to improve water quality. In Wales there are three river basin districts, two of which are shared with England along the border.

The Water Resources Act (WRA)

Water Resources Act (1991) is a UK government act that regulates water resources, water quality, and flood defences. As part of the WRA, Dee Water Protection Zone was established in Snowdonia. There are strict regulations of what the land in the area surrounding the River Dee can be used for in order to protect the water quality of the river Dee. If land is to be used for industrial purposes, water and sewage treatment, or research and development then permission must be obtained before using substances that could contribute to water pollution.

Nitrates Directive

The Nitrates Directive (1991) aims to protect waters vulnerable to pollution by nitrates from agricultural runoff. Once waters that are vulnerable to nitrate pollution have been identified, farmers of nearby land are encouraged to voluntarily follow Codes of Good Agricultural Practice that reduce agricultural runoff. These codes include crop rotation, limiting the use of nitrate fertilisers, and limiting where fertilisers can be used for example avoiding areas of land close to water. Every four years the member states of the European Union report on the nitrate pollution levels in the nitrogen vulnerable zones (NVZs).

Water Suppliers

The water and sewerage industry was privatised in 1989, meaning it is now run by companies rather than by the government. Companies such as Wessex Water, Dŵr Cymru Welsh Water, and Thames Water supply fresh water, and clean sewage water, for specific areas of the UK. The Drinking Water Inspectorate ensures the water companies are delivering clean drinking water, and The Water Services Regulation Authority (Ofwat) monitors the economic side of water supply.

Environment Agencies

Monitoring the environmental impact of water quality is undertaken by the Environment Agency in England and Northern Ireland; the Scottish Environment Protection Agency in Scotland; and by Natural Resources Wales in Wales. They distribute licences for recreational activities, such as fishing, that can impact on the aquatic habitats, and are also in close contact with farmers and riparian (adjacent to water courses and wetlands) landowners. Advice for the landowners on their responsibility towards protecting water resources helps to maintain water quality.

Global Water Supply

The Earth is 80% covered by water, but most of this water is undrinkable. It is a costly process to remove salt from sea water, so our drinking water is all freshwater. Globally there is a crisis of water scarcity, with inadequate supplies of clean drinking water, and water to be used for irrigating fields for growing crops. The United Nations estimated that 1.2 billion people live in areas of physical water scarcity (source), meaning that there is little rainfall or access to clean water; and another 1.6 billion people live in areas of economic water scarcity where the countries don't have the resources to draw on freshwater to supply to the population. If water is scarce, it is also common for sewage to be improperly disposed of or cleaned, which can then contaminate the water supply and lead to disease being spread. Global water stress is only getting worse, and one of the ways to help the problem is by ensuring the water resources available are of high quality and free of pollutants.

One of the most polluted rivers in the world is the River Ganges, or Ganga, in India. It is a river of cultural and religious importance and runs through 29 cities including Varanasi, a city where many Hindus are cremated on the river bank and ashes scattered in the Ganges. The Ganges is polluted by sewage, industrial runoff, and religious practises of bathing and cremation. In 1985 the Ganga Action Plan was set in motion with the aim to improve the water quality of the Ganges. In 2009 the Indian government established the National River Ganga Basin Authority, which is entirely focussed on preventing pollution and cleaning the Ganges.

The cleanest river in the world is the Tara River that goes through Montenegro, Bosnia, and Herzegovina. The river runs through the Tara River Canyon, one of the deepest river canyons in the world and is protected in Durmitor National Park in Montenegro, which is a UNESCO World Heritage Site. The level of protection for this river means there is minimal pollution and very high water quality. It is also a popular river for white water rafting.

The River Thames in the UK is a success story in improving water quality. In 1957 the Thames was declared biologically dead by the Natural History Museum. Damage from bombs during World War Two had destroyed some of the Victorian sewer structures meaning that sewage was pouring straight into the Thames. In the 1960s the sewers in London were rebuilt as part of post-war restoration. Water quality slowly improved and by the 1980s there were strict regulations on agricultural runoff. In the 2000s metal pollution was reduced due to stricter industrial regulations. There are now 125 species of fish in the Thames, as well as dolphins, seals, porpoises and, sometimes, even whales. The biggest problem now is macroscopic pollution in the form of plastic waste, a problem that the Cleaner Thames Campaign (2015) aims to improve. See also Port of London Authority, and Thames 21.

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