WATER QUALITY PARAMETERS & INDICATORS

Water quality determines the 'goodness' of water for particular purposes. Water quality tests will give information about the health of the waterway. By testing water over a period of time, the changes in the quality of the water can be seen.

Parameters that may be tested include temperature, ph, turbidity, salinity, nitrates and phosphates. An assessment of the aquatic macroinvertebrates can also provide an indication of water quality.

TEMPERATURE

Temperature of a waterway is significant because it affects the amount of dissolved oxygen in the water. The amount of oxygen that will dissolve in water increases as temperature decreases. Water at O^{o}C will hold up to 14.6 mg of oxygen per litre, while at 30^{o}C it will hold only up to 7.6 mg/L.

Temperature also affects the rate of photosynthesis of plants, the metabolic rate of aquatic animals, rates of development, timing and success of reproduction, mobility, migration patterns and the sensitivity of organisms to toxins, parasites and disease. Life cycles of aquatic organisms are often related to changes in temperature.

Temperature ranges for plants and animals can be affected by manmade structures such as dams and weirs and releases of water from them.

SALINITY

Salinity is a measure of the dissolved salts in the water. Salinity is usually highest during periods of low flows and increases as water levels decrease. Salinity is measured as either TDS (Total Dissolved Solids), which measures the amount of dissolved salts in the water, or as EC (Electrical Conductivity), which is the property of a substance which enables it to serve as a channel or medium for electricity. Salty water conducts electricity more readily than purer water. A sample's EC can be converted to TDS and vice versa.

Some EC and TDS Ranges

Water type	EC (µs/cm)	TDS (mg/L)
Pure rainwater	< 15	< 10
Freshwater rivers	0 - 800	100 – 1,000
Brackish water	1,600 – 4,800	1,000 – 3,000

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Saline water	> 4,800	> 3,000
Seawater	51,500	35,000

Sources of salinity include urban and rural run-off containing salt, fertilisers and organic matter. Land use issues related to high levels of salinity include clearing of vegetation and the resultant rise in the water table, excessive irrigation, groundwater seepage and runoff containing dissolved solids from industry, sewage, agriculture and stormwater. Areas in the tidal limit of rivers which flow into the sea will experience fluctuations in salinity between high and low tide.

While an appropriate concentration of salts is vital for aquatic plants and animals, salinity that is beyond the normal range for any species of organism will cause stress or even death to that organism. Salinity also affects the availability of nutrients to plant roots.

Water containing a TDS level of over 500 mg/L is unsuitable for irrigation of many plants and tastes unpleasant to drink. Some of the maximum levels of TDS which different plants can tolerate are in the following table. Due to the sensitivity and tolerance of different plants to TDS, plants can be used as indicators of soil salinity.

Tolerance levels of some plants and animals to TDS

0 - 500 mg/L	500 - 1500 mg/L	1500 – 3500 mg/L	3500 – 6,000 mg/L	6,000 – 10,000 mg/L
Humans	Mulberry	Poultry	Pigs	Beef cattle
Lettuce	Apple	Oats	Horses	
Potatoes	Cauliflower	Wheat	Dairy cows	
Peas	Cabbage	Rye	Ewes with lambs	
Celery	Tomato	Lucerne	Seashore paspalum	
Sweet corn		Millet	Saltwater couch	
			Date palm	
			Salt she oaks	

Source: ANZECC 1992

High levels of salinity in water may have adverse impacts upon fresh water flora and fauna, which are not salt tolerant. High levels of salinity also have implications when using water for stock watering.

pH

pH is a measure of the acidity or alkalinity of water. It is usually measured by using a colorimetric test - litmus paper changes colour with increased acidity or alkalinity. pH varies naturally within streams as a result of photosynthesis. There are a number of reasons that water may have extreme pH values:

Acidic values

- Geology and soils of the catchment affect pH. Acid soils (these are different from Acid Sulphate Soils) and rocks such as basalt, granite and sandstone contribute to lower pH in water.
- Acid sulphate soils are a major problem in estuarine areas. These soils form in anaerobic environments that are rich in sulphur, such as at the bottom of estuaries. If these soils are not disturbed and are left in anaerobic conditions, they do not pose any threat. However, when they are uncovered and oxidised, they release sulfuric acid into adjoining water ways.

- Runoff from bushland areas is slightly acidic. This is due to tannic acids (tannins) which are found naturally in leaves. Tannins are also responsible for giving water a tea-like colour.

Alkaline values

- Basic rocks such as limestone contribute to higher pH values.
- Runoff such as fertilisers and detergents cause increased alkalinity

Extreme values of pH can cause problems for aquatic fauna. For example, fish may develop skin irritations, ulcers and impaired gill functioning as a result of water that is too acidic. Death of most aquatic fauna may result from extremely acid or alkaline water.

The pH scale ranges from 0 to 14:

Acidic: **0 to 6.9**
Neutral: **7**
Alkaline: **7.1 to 14**

A ph range of 6.5 – 8 is optimal for freshwater. A range of 8 – 9 is optimal for estuarine and sea water.

TURBIDITY

Turbidity is a measure of the ability of light to pass through water, that is, a measure of the water's murkiness. Measuring murkiness gives an estimate of suspended solids in the water. Turbidity is measured in Nephelometric Turbidity Units (NTU's).

Suspended Solids usually enter the water as a result of soil erosion from disturbed land or can be traced to the inflow of effluent from sewage plants or industry. Suspended solids also occur naturally in the water from bank and channel erosion; however, this process has been accelerated by human use of waterways. Turbidity measurements also take into account algae and plankton present in the water.

Pollutants such as nutrients and pesticides may bind with suspended solids and settle in bottom sediments where they may become concentrated.

Suspended sediments can also smother aquatic plants as they settle out in low flows, and clog mouthparts and gills of fish and aquatic macroinvertebrates.

High turbidity affects submerged plants by preventing sufficient light from reaching them for photosynthesis. High turbidity also has the capacity to significantly increase water temperature. Water temperature needs to remain fairly constant so aquatic fauna can survive.

Though high turbidity is often a sign of poor water quality and land management, crystal clear water does not always guarantee healthy water. Extremely clear water can signify very acidic conditions or high levels of salinity.

Category	NTU's
Excellent	≤ 10 NTU's
Fair	15-30 NTU's
Poor	> 30 NTU's

DISSOLVED OXYGEN (DO)

The amount of oxygen in water, to a degree, shows its overall health. That is, if oxygen levels are high, one can presume that pollution levels in the water are low. Conversely, if oxygen levels are low, one can presume there is a high oxygen demand and that the body of water is not of optimal health.

Apart from indicating pollution levels, oxygen in water is required by aquatic fauna for survival. In conditions of no or low oxygen availability, fish and other organisms will die.

Oxygen enters water as a result of two processes:

1. **Diffusion** - diffusion of oxygen into water is accelerated when the water turbulence is increased (moving through rapids and waterfalls) and when there is a strong wind blowing. Additionally, oxygen will diffuse into cold water at a higher rate than it will into warm water.

2. **Photosynthesis** - during daylight hours, aquatic plants use the sun's energy to create energy they can use for growth. A by-product of this process is oxygen which is released into surrounding water.

Ecosystem Type	Dissolved oxygen trigger value range (DO%)
Upland River	60 – 120
Lowland River	60 – 120
Lakes and Reservoirs	90 – 110
Estuaries	60 – 120
Marine	90 - 110

When the level of Dissolved Oxygen is above or below these ranges, the waterway will become increasingly stressed.

NUTRIENTS

The three main plant nutrients are nitrogen, phosphorus and potassium. Of these, only phosphorus is tested by Waterwatch groups. Nutrient levels in Australian waters are naturally very low. However, due to human impacts these levels are often too high, resulting in algal blooms and excessive growth of water-plants including weed species such as Water Hyacinth and *Salvinia*.

The effects of consistently high levels of nutrient levels are:

- water bodies choked with vegetation or algae - often weed species;
- changes in aquatic flora and fauna composition. This is often a change to a monoculture, that is a change to a system dominated by a single plant species;

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- increased fluctuations of dissolved oxygen levels. This places stress on aquatic fauna;
- an increase in total organic load, resulting in odours and reduced aesthetic quality.

PHOSPHATES: are often the limiting nutrients in Australian environments. Therefore, high phosphate levels could lead to the problems described above. The main sources of phosphorus in local catchments are:

- sediments from rocks and soil;
- effluent from waste water treatment plants and on site sewage disposal units;
- detergents and fertilisers that have been washed down drains or that have run off from properties due to poor land management practices and stormwater pollution;
- decaying organic matter.

Category	Total PO4 (mg/L)
Low	< 0.06
Medium	0.06 – 0.15
High	> 0.15 – 0.45
Very High	> 0.45

FAECAL COLIFORMS

Faecal Coliforms are naturally occurring bacteria found in the intestines of all warm blooded animals (including humans) and birds. The presence of Faecal Coliforms is an indicator of contamination by sewage waste.

Faecal Coliforms indicate a risk to human health. They are not pathogenic (disease causing) but indicate that pathogenic bacterial and viruses may be present.

Faecal Coliforms can enter streams and rivers via:

- sewer and septic systems
- feedlot and dairy run-off
- run-off from broad acre farming
- stormwater
- livestock defecating directly into the water

Category	Total FC/100 mL	Contact
Very Good	0	
Good	>0 to 35	Primary
Fair	< 35 - 230	Secondary
Poor	> 700	No contact

Primary contact refers to activities where you are completely immersed in water, e.g. swimming. Faecal Coliforms should not exceed 150/100 mL.
Secondary contact refers to activities where you come into contact with water but are not completely immersed in it. Faecal Coliforms should not exceed 1000/100 mL.

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AQUATIC MACROINVERTEBRATES (WATER BUGS)

Aquatic macroinvertebrates are:

- Animals without backbones
- Small but you can see them with your eyes
- Live in water

An assessment of the aquatic macroinvertebrates at the waterway can provide an indication of water quality.

Different macroinvertebrates have different tolerances to pollution. Highly sensitive bugs can only live in water with high water quality. Tolerant and very tolerant bugs can withstand lower water quality. A healthy waterway has a higher biodiversity of bugs.

Water bugs are rated according to their sensitivity to pollution. 'Pollution rating' numbers from 1 to 10 indicate how sensitive each bug is.

There are four 'grades':

- Very sensitive – 10, 9
- Sensitive – 8, 7, 6
- Tolerant – 5, 4, 3
- Very tolerant – 2, 1

WATER BUG POLLUTION RATINGS

Very Sensitive Bugs – 10, 9	Sensitive Bugs – 8, 7, 6	Tolerant Bugs- 5, 4 , 3	Very Tolerant Bugs – 2, 1
Stonefly Nymph	Alderfly Larva	Beetle Larvae	Diving Beetle
Mayfly Nymph	Caddisfly Larva	Common Water Strider	Flatworm
	Water Mite	Dragonfly Nymph	Freshwater Slater
		Freshwater Yabby	Freshwater Worm
		Whirligig Beetle	Hydra
		Damselfly Nymph	Waterboatman
		Water Scorpion	Backswimmer
			Leech

Stream Pollution Index (SPI) calculates a stream quality rating based on:

- Sensitivity of bugs to pollution
- Different types of bugs found (biodiversity)
- Number of bugs found (abundance)

Stream Pollution Index (SPI)	Stream Quality Rating
Less than 3	Poor
3 to 4	Fair
4 to 6	Good
More than 6	Excellent

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