Streamwatch SMART Kit Manual

Contents

1. Collecting Water Samples

There are two sample types which may be collected:

a. Dissolved oxygen using a 25 mL DO vial
b. General water sample using the Streamwatch sample bottle

The above samples need to be taken in different ways. If you are taking all three samples, it is good practice to do them in the order written above. Instructions on how to take each water sample are given below.

Important

Collect your water samples from the same location and at a similar time of day, if possible, for each site visit. Also, where safe to do so, sample from a flowing section of the water body that has enough depth to fill the bottle without disturbing the sediment below. Avoid eddies and bank influence where feasible. Always have another adult present.

Equipment

- Disposable Gloves
- Safety Glasses
- Thermometer
- Sample bottles
- 25ml DO vial
- Sampling pole or similar

1.a. Dissolved Oxygen Water Sample

Collect your sample from the stream bank as far as you can safely reach into the stream.

It is important to take your temperature reading at this time and in the same location as your DO sample because temperature is directly related to DO % sat.

Be ready to add reagents immediately to your sample after collecting. You will also need to take a temperature reading when collecting your sample.

Method

1. Rinse the 25 mL DO sample vial and lid with sample water 3 times and recap. Always pour the rinse water downstream of where the water sample is taken.
2. With the lid on, turn the DO vial on its side and lower it into the water until it is fully immersed and well below the surface to avoid floating film or matter.

3. Unscrew the lid of the vial allowing the water to enter.
4. Turn the DO vial upright while still under the water to allow it to fill completely and release all the trapped air. You may need to tap the vial to dislodge small bubbles.
5. Recap the vial while it is immersed under the water.
6. Remove the vial from the water and turn it upside down to check that no bubbles have been trapped inside. Repeat steps 2 to 5 if bubbles are observed.
7. Move away from the edge of the water and move to a safe area to continue.
8. Remove lid and add **2 drops of reagent 1 (Manganous Sulphate Solution)** and **2 drops of reagent 2 (Alkaline Potassium Iodide).** Do this over your liquid waste container. Hold reagent bottles vertically when delivering drops.
9. Recap the DO vial and invert several times to mix well. A precipitate will form.
10. Keep the DO vial cool until you are ready to continue to the next stage of the test. A small insulated cooler bag is ideal especially in warmer weather.

1.b. General Water Sample

Most other water quality tests will be performed using the water collected in your Streamwatch sample bottle including pH, electrical conductivity, turbidity and phosphorus. To collect your general water sample, you will need:

- Sampling extension pole with sample bottle holder.
- Streamwatch sample bottle.

Method

1. Open the sample bottle lid and lower the sample bottle into the water upside down. This ensures that surface scum does not enter the bottle as it is immersed.
2. When fully immersed, turn the sample bottle onto its side to allow water to enter the bottle.
3. To rinse, fill the sample bottle almost completely.
4. To avoid spilling, turn the bottle upright before lifting the bottle out of the water.
5. Pour out the contents of the bottle downstream of where you are sampling. Rinse 3 times
6. To collect the water sample, repeat the same steps above except for step 5. Replace the lid of the sample bottle, move away from the edge of waterway and begin water testing activities.

2. Testing Methods

Between each test, ensure the beaker is rinsed with sample water and refilled with fresh sample water. To rinse the beaker, fill the beaker halfway with sample water, swirl, then pour contents in liquid waste container.

2.a. Measuring Temperature

Equipment

- Disposable Gloves
- Thermometer
- Clean water
- Paper towel

Method

1. Hold the thermometer in the water for at least 1 minute. Do this at the same time and depth that the water sample for dissolved oxygen test was collected.
2. Read the temperature while the thermometer's bulb is still immersed in the water.
3. Record the result.

Important

If the fluid in the thermometer separates, heat the thermometer bulb in an upright position in warm water. Allow the liquid column to rise until the separated portion of the column enters the expansion chamber at the top of the thermometer.

Remember To:

- Rinse the thermometer thoroughly with clean water and carefully dry with paper towel
- Return all equipment to the kit after use.

2.b. Measuring pH

Equipment

- Streamwatch sample bottle (general water sample)
- pH strips including container
- Disposable Gloves
- Safety glasses
- Small beaker
- Liquid waste container
- Stopwatch
- Clean or deionised water

Method

1. Fill the beaker with sample water.
2. Take one strip out of the container.
3. Do not touch the coloured squares on the end of the strip.

4. Immerse the coloured squares on the strip into the sample water as specified on the pack.
5. Match the colours on the strip to the colours on the chart provided on the container by holding the strip against the chart as shown on pH test strip storage container.
6. Record the result.

Important

Use method as described on pH test strip storage container. Also, if the colours on the squares do not exactly match the colours on the chart, the result can be recorded as halfway between these two values (e.g. between 7 and 8 would be 7.5).

Remember to:

- Dispose of strips into a solid waste container. Never leave the strips on the bank of the stream.
- Empty the contents of the beaker into the liquid waste container and rinse with clean water.
- Return all equipment to the kit after use.

2.c. Measuring Electrical Conductivity

Equipment

- Disposable Gloves
- Safety glasses
- Conductivity calibration standard solution
- Small beaker
- Liquid waste container
- EC scan or Eco Test conductivity meter
- Clean water
- Clean or Deionised water
- Streamwatch sample bottle (general water sample).

Calibration

You must first calibrate the conductivity meter before you test your sample. Calibrate the meter by checking and adjusting the meter to ensure that it measures the same as the provided Conductivity Standard. You will need to do this before each use to ensure the accuracy of the data collected. Each Streamwatch group is provided with a bottle of Conductivity Standard solution. Ensure that Conductivity Standard is kept cool and out of sunlight.

As per Conductivity Standard solutions - For the ECScan Low and EcoTest ECLow meters, your reading should be 500µS/cm +/- 10µS/cm.

For the ECScan High meter, your reading should be 12.90 +/- 0.2mS/cm.

1. Shake the Conductivity Standard solution.
2. Rinse the beaker with a small quantity of Conductivity Standard solution over the liquid waste container 2 times. Fill the beaker halfway with Conductivity Standard solution.
3. Remove the cap from the conductivity meter and turn it on (by pressing the 'On/Off' button).
4. Insert the electrodes into the beaker of Conductivity Standard solution making sure the electrodes do not touch the bottom of the beaker.
5. Swirl the meter once and when the reading in the display window stabilises, read the result.
6. If the meter does not read the same as the Conductivity Standard, follow calibration guide in kit. If your meter reads the same as the Conductivity Standard, go straight to Method section.

Method

1. Rinse electrodes with deionised water 3 times over the liquid waste container.
2. Shake the Streamwatch sample bottle. Rinse the beaker with a small quantity of this sample water over the liquid waste container.
3. Fill the beaker halfway with sample water.
4. Insert the meter into the sample water making sure the electrodes are fully covered but not touching the bottom of the beaker.
5. Swirl the meter once and when the reading in the display window stabilises, press the 'Hold' button and read the result.
6. Record the result and the units.

Important

- Conductivity Standard solution should be kept cool and out of sunlight.
- Make sure the conductivity meter is measuring in µS/cm, press the MODE/CAL button to select.
- If 'Or' appears in the display window, the reading is over range. The sample will need to be diluted with a known volume of deionised water. Mix the sample thoroughly (salt water is more dense than distilled water and will sink to the bottom) before taking another reading. An appropriate calculation will need to be done, based on the dilution volume. For example, 10mL sample: 30mL distilled water - multiply the reading by 4.

2.d. Measuring Dissolved Oxygen

Equipment

- Disposable Gloves
- Safety glasses
- DO sample bottle

- Liquid waste container
- DO reagent No. 1 (Manganous Sulphate Solution)
- DO reagent No. 2 (Alkaline Potassium Iodide Azide)
- Paper towel and microfibre lens cloth
- DO reagent No. 3 (Sulphuric Acid)
- Clean water
- DO colorimeter tube (yellow lid)
- Blank colorimeter tube (black lid)
- Smart colorimeter
- Cooler bag

Method

Steps 1-3 should be performed immediately after taking the dissolved oxygen sample. If so, go to Step 4.

1. Hold the DO sample tube above the liquid waste container and carefully remove the lid.
2. Add 2 drops of DO reagent No. 1 (Manganous Sulphate Solution) and 2 drops of DO reagent No. 2 (Alkaline Potassium Iodide Azide) to the sample water while holding over the liquid waste container.
3. Recap and invert the DO sample vial several times to mix the solution – a brown precipitate will appear.
4. Stand the DO sample vial and wait until the precipitate has settled to at least halfway down the bottle. This will take 5 or more minutes if the water is saline.
5. Add 8 drops of DO reagent No. 3 (Sulphuric Acid) to the sample water while holding over the liquid waste container.
6. Gently shake the DO sample tube for one minute and place in cooler bag for preservation and wait 5 minutes until the precipitate has completely dissolved. If the precipitate has not dissolved after 5 minutes, add an extra 2 drops of DO reagent No. 3 (Sulphuric Acid) and invert until the precipitate is dissolved. Repeat if needed.
7. Rinse the 10mL DO colorimeter tube (yellow dot) with treated sample over the liquid waste container 2 times and then fill to the 10mL mark with treated sample. Recap both tubes and stand on a stable surface.
8. You will now create a Blank sample to calibrate your Colorimeter. Using the 60mL syringe, draw up approximately 40mL of the General Sample Water. Attach and hold a new 0.45-micron filter to the syringe.
9. Rinse the 10mL Blank Colorimeter tube (black lid) with this filtered sample water over the liquid waste container 2 times. Gently expel a small portion of this sample water through the filter into the liquid waste container before expelling a 10mL portion into the dissolved oxygen colorimeter tube. This is the Blank sample.

10. Clean and dry the sample and blank colorimeter tubes with microfibre lens cloth to remove all smudge marks and fingerprints. Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.

11. Place the Blank colorimeter tube into the colorimeter and cover with the black cap.
12. Follow the Smart Colorimeter instructions below:

Smart 2 & 3 Colorimeter Instructions

a) Press and hold ON button until colorimeter turns on.
b) Press ENTER to start.
c) Press ENTER to select TESTING MENU.
d) Select ALL TESTS from testing menu.
e) Scroll alphabetically to and select DO from menu.
f) Insert blank tube into colorimeter, close lid and select SCAN BLANK.
g) Press ENTER.
h) Remove blank tube from colorimeter.
i) Clean the DO colorimeter tube with microfibre lens cloth to remove all smudge marks and fingerprints.
j) Insert DO colorimeter tube into colorimeter chamber, close lid.
k) SCAN SAMPLE.
l) Press ENTER.

Remember to: Turn the colorimeter off by pressing the Off button (3 times for Smart3 and once for Smart 2). Rinse colorimeter tubes twice with distilled water over the liquid waste container. Return all equipment to the kit after use.

2.e. Measuring Available Phosphate

Equipment

- Disposable Gloves
- Safety glasses
- Streamwatch sample bottle (general water sample)
- Phosphate colorimeter tube (blue lid)
- 60mL syringe and 0.45-micron filter
- Liquid waste container
- Phosphate Acid reagent and 1mL syringe
- Phosphate Reducing reagent and 0.1g spoon
- Stopwatch
- Blank colorimeter tube (black lid)
- Clean water

- Paper towel and microfiber lens cloth
- SMART colorimeter
- Small beaker.

Method

1. Shake the sample bottle well to mix.
2. Remove the phosphate colorimeter tube (blue dot) and the 60mL syringe from the kit.
3. Using the 60mL syringe, draw up approximately 40mL of sample water. Attach and hold a new 0.45-micron filter to the syringe. Gently expel a small portion of this sample water through the filter into the liquid waste container and then dispense a small amount into the phosphate colorimeter tube (blue dot). Rinse and discard. Dispense a 10mL portion into the colorimeter tube.
4. Rinse the blank colorimeter tube (black lid) with filtered sample water over the liquid waste container. Then fill this colorimeter tube to the 10mL mark with filtered sample water. This is your Blank sample to calibrate the colorimeter for analysing your phosphate results. You could also use the same Blank sample from the DO test.
5. Remove the Phosphate Acid reagent and the 1mL syringe/pipette from the kit. Be very careful avoid direct contact (refer to SDS for more information).
6. If using pipette, squeeze all air out of the pipette and insert the tip of the pipette into the Phosphate Acid Reagent bottle. Slowly allow pipette to draw reagent from the bottle stopping when the 1ml line on the pipette is reached. Remove pipette and screw lid back on to reagent bottle.
7. If using syringe draw the plunger back halfway and insert the tip of the syringe into the small hole in the top of the bottle. Push the plunger in to expel the air into the bottle.
8. Carefully turn the bottle and syringe vertically upside-down and while supporting both, slowly pull back on the plunger until the top of the black stopper is aligned with the 1mL line. If bubbles form on the black stopper, push the plunger in and redraw the phosphate acid reagent. This may have to be done several times to eliminate the bubbles.
9. Turn the bottle upright and carefully remove the syringe by pulling from its base. Add this 1mL of Phosphate Acid reagent to the phosphate colorimeter tube (blue lid).
10. Recap the tube and invert several times to mix.
11. Get the stopwatch ready to time the reaction as once the phosphate reducing reagent has dissolved, the reaction will take exactly 5 minutes.
12. Remove the Phosphate Reducing reagent and the 0.1g spoon from the kit. Add one level spoonful of Phosphate Reducing reagent to the phosphate colorimeter tube (blue lid).
13. Recap and invert several times until the crystals are dissolved.
14. Time this 5-minute reaction with the stopwatch.

15. Clean and dry the blank colorimeter tube by patting dry with paper towel and then using microfiber lens cloth to remove all smudge marks and fingerprints. Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.
16. While waiting for the reaction, follow the relevant Smart Colorimeter instructions below:

Smart 2 & 3 Colorimeter Instructions

a) Press and hold ON button until colorimeter turns on.
b) Press ENTER to start.
c) Press ENTER to select TESTING MENU.
d) Select ALL TESTS from testing menu.
e) Scroll down alphabetically and select PHOSPHATE-L or LR (LR= LowRange) from menu.
f) Insert Blank tube into colorimeter, close lid and select SCAN BLANK.
g) Press ENTER.
h) Remove Blank tube from colorimeter.
i) Clean the phosphate colorimeter tube with microfibre cloth to remove all smudge marks.
j) Insert phosphate colorimeter tube into colorimeter chamber, close lid.
k) SCAN SAMPLE.
l) Press ENTER.

17. Record the result. The result will appear in milligrams per litre (mg/L) or parts per million (ppm). ppm can be considered as equivalent to mg/L.

Important

The colorimetric tubes are made of special crystalline glass which allows light to pass directly through without being refracted. Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.

Remember to: Turn the colorimeter off by pressing the OFF button (3 times for Smart 3 and once for Smart 2). Rinse the colorimeter tubes twice with distilled water over the liquid waste container. Wipe the spoon with paper towel. Return all equipment to the kit after use.

2.e. Measuring Turbidity (NTU)

Equipment

- Disposable Gloves
- Nephelometric turbidity tube
- Streamwatch sample bottle (general water sample)
- Clean water
- Liquid waste container

Method

Conduct this test in the shade to ensure consistency and quality assurance.

1. Assemble the turbidity tube.
2. Place the bottom of the turbidity tube on the ground and hold the tube steady.
3. Shake the sample bottle to mix.
4. Uncap the sample bottle and pour the water sample into the tube gradually. As you add the water, wait for the water surface to become still and then look down the tube through the water.
5. Stop pouring water into the tube when the clear lines between the segments cannot be seen clearly.
6. Take the reading immediately below the water level, as your result.

Important

Always conduct the test in the shade for consistency and quality assurance.
The turbidity tube has a logarithmic scale running down the outside of the tube; therefore, readings cannot be estimated between two numbers. Read the number below the water level (e.g. read as 15 when the water level is between 10 and 15). Likewise, if the turbidity tube is filled with water, take the reading as 10.

Remember to:

- Rinse the turbidity tube with clean water before allowing to dry and returning to the kit
- Apply a small amount of petroleum grease or similar to tube join occasionally
- Add sample water slowly and repeatedly check visibility of symbol.

Supplemental Turbidity (FTU, FAU)

Equipment

- Disposable Gloves
- Streamwatch sample bottle (general water sample)
- Clean or deionised water
- Liquid waste container
- Blank colorimeter tube (black lid)

- Turbidity colorimeter tube (brown dot)
- Smart colorimeter
- Paper towel and microfiber lens cloth.

Method

1. You need to create a Blank sample to calibrate your Colorimeter. Using the 60mL syringe, draw up approximately 40mL of the General Sample Water. Attach and hold a new 0.45-micron filter to the syringe.
2. Rinse the 10mL Blank Colorimeter tube (black lid) with this filtered sample water over the liquid waste container 3 times. Gently expel a small portion of this sample water through the filter into the liquid waste container before expelling a 10mL portion into the colorimeter tube (black lid). **This is the Blank sample**.
3. Rinse the turbidity colorimeter tube (brown dot) with general water sample and fill to the 10ml line.
4. Clean and dry the blank colorimeter tube and the turbidity colorimeter tube by patting dry with paper towel and using microfiber lens cloth to remove all smudge marks and fingerprints. Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.
5. Follow the Smart Colorimeter instructions below:

Smart 2 & 3 Colorimeter Turbidity Instructions

a) Press and hold ON button until colorimeter turns on.
b) Press ENTER to start.
c) Press ENTER to select TESTING MENU.
d) Select ALL TESTS from testing menu.
e) Scroll to and select 98 Turbidity from menu.
f) Insert blank tube into colorimeter, close lid and select SCAN BLANK.
g) Press ENTER
h) Remove blank tube from colorimeter.
i) Clean the Turbidity colorimeter tube with microfiber lens cloth to remove all smudge marks and fingerprints.
j) Insert Turbidity sample colorimeter tube into colorimeter chamber, close lid.
k) SCAN SAMPLE.
l) Press ENTER

6. Record the Turbidity result.

Important

Your colorimeter may not be set to 98 Turbidity. If not, you will find Turbidity listed in alphabetical order.

3. Caring for your Equipment

3.a. Thermometers

Store the thermometer in a cool place. If the blue alcohol liquid in the tube develops bubbles or separates, run gradually warmer water along the tube until the bubbles disappear or the liquid rejoins.

3.b. Turbidity Tubes

Turbidity tubes should be kept clean. Rinse after use, and wash periodically in warm soapy water.

Apply petroleum jelly lightly to the join occasionally for ease of assembly.

3.c. pH Strips

Dispose of pH strips into a solid waste container. Don't damage strips by touching the coloured section of unused strips. Keep strips and colour chart out of direct sunlight to avoid colours fading. Always handle pH strips and tube with dry hands to avoid putting any moisture into the tube.

3.d. Electrical Conductivity (EC) Meters

Keep the meter in a cool place and replace batteries regularly as flat batteries will produce inaccurate results. Immerse only the probes of the meter in the water and rinse them with deionised water after use. Calibrate the meter before each test.

3.e. Bottles and Tubes

Wash all equipment with clean or deionised water after use. Turn the bottles and tubes while rinsing to ensure all surfaces are washed. Dry the outside of containers with paper towel – do not dry the inside of the bottles and tubes.

After each bottle or jar has been used, replace its lid and return it to its specific place in the kit. This avoids lids going on the wrong bottles and contaminating the contents.

Always hold colorimeter bottles by the lid or neck to avoid putting finger marks on the glass, as this will affect the results.

4. Scientific Rationale

Background to the tests

4.a. Temperature

Definition

Thermal energy or heat determines temperature. The dynamic relationship between the heat input, heat output and heat storage is exhibited as changes in temperature. The heat inputs are predominantly derived from solar radiation, whereas heat outputs can be in the form of evaporation, reflection, radiation, conduction and convection of heat out of the water. In Australia, temperature is measured on a metric scale in degrees Celsius (˚C).

Why test temperature?

Temperature has a major influence on biological activity and growth of aquatic organisms. Temperature is important because:

- Higher temperatures diminish the solubility of dissolved oxygen and thus decrease its availability
- Elevating temperature increases the metabolic rate, respiration and oxygen demand of aquatic life. Rates generally double for a 10° C. rise in temperature
- Unusual temperatures can affect rates of development, timing and success of reproduction
- Unusual temperatures can affect rates mobility and migration of aquatic organisms
- The solubility of toxic substances can increase with temperature elevation
- Sensitivity of organisms to toxins, parasites and diseases can change with temperature.

Most aquatic organisms are cold blooded, that means they are unable to internally regulate their core body temperature. All species of aquatic organisms have preferred temperature ranges. As the temperature gets too far above or below the preferred range, available habitat can be reduced, resulting in local species reduction or loss.

Water temperature is affected by:

- Depth
- Flow rate
- Amount of sunlight or shade
- Turbidity (cloudiness of the water)
- Altitude
- Season

- Time of day
- Incoming waters
- Source water (stormwater run-off from hot urban surfaces will warm receiving waters).

4.b. pH

Definition

pH is the hydrogen ion (H+) concentration and is expressed on a log scale of 0 (acid) to 14 (base), with the neutral point at 7. Alkalinity is not the same as pH as water does not need to be strongly basic (high pH) to have high alkalinity. Alkalinity can be considered as the capacity of water to neutralize an acid. In other words it is a measure of how much acid can be added to a water sample without causing a significant change in pH.

Why test pH?

The pH range for most organisms in Australian freshwaters is 6.5 – 8.0. Changes in pH outside this usual range will likely cause a reduction in species diversity. Acidic water can cause fish and other aquatic organisms to suffer from skin irritations and damage, tumours, ulcers and impaired gill function. Extremely high or low pH levels will lead to the death of aquatic life.

Small changes in pH can greatly influence the solubility and biological availability (amount that can be utilised by aquatic life) of nutrients (e.g. phosphorus, nitrogen and carbon) and heavy metals (e.g. lead, copper and cadmium). Levels of pH below 5.5 can cause heavy metals trapped in sediments to be released in forms that can be toxic to aquatic organisms. Aluminium will clog fish gills below pH 5.5.

Changes in pH (particularly reduced pH) can result in the toxicity of several other pollutants (e.g. ammonia, cyanide, aluminium) to significantly increase.
pH can be influenced by:

- Agriculture (Agricultural practices that lead to soil acidification can impact on stream pH. Soil acidification results when anions are leached into the subsoil, beyond the root zone)
- Geology (Limestone catchments typically contain alkaline waters whereas basaltic and sandstone catchments typically contain slightly acidic waters)
- Characteristics of the catchment (In forested catchments, waterways may be slightly acidic as water drains through leaf litter)
- Urban run-off (Run-off containing pollutants such as detergents can increase pH while fertilisers can lower the pH of waterways)
- Acid sulphate soils (When exposed to the air, these soils can leach sulphuric acid into the waterway, resulting in decreased pH levels)
- Photosynthesis (During peak periods of photosynthesis, levels of carbon dioxide in the water will decrease, resulting in an increase in pH).

4.c. Electrical Conductivity (EC)

Definition

Similar to metal, water under certain conditions can conduct electricity. Salts are ionic compounds made up of both positive and negative ions. When a salt is dissolved in water the ions are free to disassociate and move within the solution. The free movement of these charged particles allows for the conduction of an electric current. Pure water with absolutely no salts, will not conduct electricity. When we measure conductivity, we are measuring how easily electricity is flowing through the solution of dissolved salts. From this, we can get an indirect estimate of how many salts are in the water. The salts naturally come from rocks that have been broken down by water flowing over them.

Sodium Chloride (NaCl) is the main contributor to water salinity, but other mineral salts will also be present.

Why Test Electrical Conductivity?
Salt concentrations will affect osmotic pressure within animal and plant cells. This consequently determines which species can survive at differing concentrations. Aquatic organisms adapted to low concentrations (freshwater) will have difficulty keeping water inside them under higher salinities, causing stress and possible death. Many aquatic species can only survive in a very narrow range of salt concentration. Salinity can develop naturally, but where human activity has disturbed natural ecosystems, the movement of salts into rivers and onto the land surface, has been accelerated.

Some causes of salinity include:

- Removal of deep-rooted vegetation resulting in the rise of salty groundwater
- Flood irrigation of agricultural land
- Industrial effluent discharge into waterways
- Sewage effluent discharge into waterways
- Overuse of fertilisers leading to an increase in concentrations of phosphate, nitrate and ammonium ions
- Seawater penetrating beyond the historical limit.

4.d. Turbidity

Definition

Turbidity is a measure of the cloudiness or muddiness of water. Turbidity can be caused by silt, mud, clay, algae or fine particles of organic matter. The greater the load of suspended and colloidal particulates in the water, the higher the turbidity. Colour is not

turbidity. Tannin stained waters can be very dark but low in turbidity. Turbidity tends to increase after rain mainly due to soil washing from the surrounding landscape. Industrial activity, urban development, agricultural and mining activity can elevate turbidity levels.

Why Test Turbidity?

High turbidity can reduce light penetration, clog gills of aquatic organisms, suffocate eggs and smother benthic habitats. If light penetration is reduced significantly, plant and algal growth will decrease, impacting on the organisms that are dependent on the plants for food or shelter. Reduced light will result in a reduced rate of photosynthesis by plants, reduced growth and subsequently lower quantities of available dissolved oxygen in the water.

Very high levels of turbidity for short periods associated with rain events are normal; however extended periods of high turbidity can reduce biodiversity. Ongoing high turbidity combined with extreme turbidity after rain events is indicative of catchments suffering high soil mobility.

4.e. Dissolved Oxygen (DO)

Definition

Oxygen (O2) from the atmosphere naturally dissolves into streams and rivers. Dissolved oxygen is also a waste product of the process known as photosynthesis. Just like their terrestrial counterparts, aquatic plants and algae also produce oxygen as they are photosynthesising. Similarly, just like animals and humans living on land, animals that live in water need oxygen to survive. It is the dissolved oxygen in water that fish and other aquatic animals use to breathe. The oxygen atom within the water molecule H2O is not dissolved oxygen. It remains locked in a molecular bond and is not available for respiration processes.

Why Test Dissolved Oxygen?

Dissolved oxygen is vital for the survival of aquatic organisms. Some aquatic species are more sensitive to oxygen depletion than others, but some general guidelines to consider when analysing test results are:

- 5 – 6 ppm — Sufficient for most species
- <3 ppm — Stressful to most aquatic species
- <2 ppm — Fatal to most species

Dissolved oxygen can also be expressed as a percentage saturation (%Sat).

The following indicator guidelines may apply when DO is expressed as a percentage:

- 80 – 120 %Sat Normal
- 120 – 135 or 55 – 80 %Sat Some pollution
- > 135 or < 55 %Sat High pollution

How can oxygen be more than 100% saturated?

Dissolved oxygen is measured as "percentage of air saturation". 100% saturation (in a simple world) would occur when the oxygen concentration of a water body was in equilibrium with the overlying air, at a given temperature. Air is approximately 21% oxygen, so water would equilibrate with this concentration. Photosynthetically-active species (plants, algae etc.) produce pure oxygen rather than air. Hence dissolved oxygen readings of greater than 100% air saturation can occur in environmental water because of the production of pure oxygen by photosynthesis. Well oxygenated water, whether biologically or mechanically, can be out of equilibrium with the overlying air if the rate of oxygenation or temperature increase is greater than the rate that the water can release oxygen to the atmosphere. Hence dissolved oxygen readings >100% can arise from this dis-equilibration.

How do the dissolved oxygen concentrations vary?
The transfer, production and consumption of oxygen in water bodies influence the amount of dissolved oxygen present. Dissolved oxygen levels in waterways depend on the physical, chemical and biochemical activities that are occurring in the water body. Various processes are involved.

These include:

- Absorption – There is continuous exchange of oxygen between water and surrounding air. The greater the contact between the water and the air, the more oxygen that can dissolve. Thus, a turbulent stream will tend to have a higher oxygen concentration than a still body of water
- Photosynthesis – This process carried out by aquatic (and land) plants results in oxygen directly entering the water. Those things that reduce the amount of sunlight able to penetrate the water (e.g. turbidity) will lower the rate of photosynthesis and hence lower oxygen concentration. As photosynthesis takes place only during the day, the concentration of DO will vary over the 24 hour cycle. Levels peak early afternoon and are lowest just before sunrise.

Oxygen is consumed by:

- Respiration – all organisms (aquatic and terrestrial) consume oxygen during respiration
- Decomposition – the decomposition of plant and animal waste (whether from living or dead organisms) is carried out by bacteria and other micro-organisms that use oxygen to oxidise the organic matter.

The solubility of gases, including oxygen, in water is affected by a number of factors and this, in turn, affects dissolved oxygen measurements. Factors affecting the solubility of oxygen in water include:

- Temperature – increasing solubility with decreasing temperature
- Atmospheric pressure (altitude) – the greater the pressure the higher the solubility (i.e. there will be more oxygen at lower altitudes)
- Salt concentration – the lower the salt concentration the higher the oxygen concentration.

The science behind the test

The first step in a DO titration is the addition of Manganous Sulfate solution (reagent No.1) and Alkaline Potassium Iodide Azide solution (reagent No. 2) to the sample. These reagents react to form a white precipitate of manganous hydroxide Mn(OH)2. This reaction can be written as:

MnSO4	+	2KOH	>	Mn(OH)2	+	K2SO4
Manganous Sulfate		Potassium Hydroxide		Manganous Hydroxide		Potassium Sulfate

At the same time the precipitate is formed, the oxygen in the water reacts with the manganous hydroxide to form brown-coloured manganic hydroxide. Chemically, this reaction can be written as:

4Mn(OH)2	+	O2	+	2H20	>	4Mn(OH)3
Manganous Hydroxide		Oxygen		Water		Manganic Hydroxide

After the brown precipitate is formed, sulfuric acid (reagent No. 3) is added to the sample. The acid converts the manganic hydroxide to manganic sulfate. This is called “fixing” the oxygen in the sample. Chemically, this reaction can be written as:

2Mn(OH)3	+	3H2SO4	>	Mn2(SO4)3	+	6H2O
Manganic Hydroxide		Sulfuric Acid		Manganic Sulfate		Water

At the same time, iodine from the potassium iodide in the Alkaline Potassium Iodide Azide solution (reagent No.2) is oxidized by manganic sulfate, releasing free iodine into the water. The amount of iodine released is directly proportional to the amount of oxygen present in the original sample. The release of free iodine is indicated by the sample turning a yellow-brown colour. Chemically, this reaction can be written as:

$Mn_2(SO_4)_3$	+	2KI	>	$2MnSO_4$	+	K_2SO_4	+	I_2	
Manganic Sulfate		Potassium Iodide		Manganous Sulfate		Potassium Sulfate		Iodine	

The wavelength of the yellow-brown colour is measured using a colorimeter. A darker or more orange sample means that there is more Iodine and hence more dissolved oxygen in the sample.

4.f. Phosphates

Definition

Phosphates are nutrients that are essential to the growth of plants and animals. Total phosphates is a measurement of all forms of phosphate compounds in a sample - orthophosphate, condensed phosphates and organically bound phosphates. Available phosphates is a measurement of the phosphate compounds that are soluble in water and therefore available to be absorbed by plants. *Streamwatch tests for available phosphates only*.

Why test for Phosphates?

Phosphates occur naturally in low concentrations in Australian soils and water. Native vegetation (both aquatic and terrestrial) has adapted to these low levels. In contrast, many introduced plants and weeds are adapted to the higher phosphate levels in the Northern Hemisphere.
Phosphates are derived from the weathering of rocks and the decomposition of organic material. These compounds limit and control the rate and the abundance of plant growth.

The most common problem associated with high phosphate levels is the stimulation of growth of cyanobacteria and nuisance plants such as macrophytes and algae. When they grow to nuisance proportions (or “bloom”) they can:

- Overgrow and displace native species
- Obstruct waterways and affect fish movement
- Reduce light availability for other species
- Reduce habitat quality for fish and invertebrates
- Create odours and unsightly appearances
- Some cyanobacteria and algae release toxins into the water rendering it unfit for consumption
- Cause fluctuations in pH and dissolved oxygen
- Deplete the oxygen concentration when large amounts of biomass are degraded by bacteria.

Phosphate concentrations can increase because of:

- Sediment from erosion
- Manure from feedlots, dairies and pet droppings
- Sewage
- Phosphate-based detergents
- Decaying plant material
- pH changes
- Disturbance of bed sediments
- Fertilisers i.e. superphosphate
- Industrial waste

The science behind the test

The phosphate acid reagent is composed of sulphuric acid and ammonium molybdate written chemically as H2SO4 and (NH4)2MoO4. The sulphuric acid in the phosphate acid reagent is added to acidify the water sample.

The concentration of phosphate in a filtered water sample can be determined via a colorimetric technique. The technique involves the reaction of the hydrogenphosphate ion, in the presence of acid, with ammonium molybdate to form molydophosphate.

This is a complex reaction and may be represented as follows: (NB this is not a balanced equation)

MoO42-(aq) + HPO42- (aq) > [P(Mo3O10)4]3- (aq)

The molybdophosphate ion, [P(Mo3O10)4]3-, is then reduced with the absorbic acid in the phosphate reducing agent. This reduction reaction, as follows, produces the intensely blue-coloured phosphorus molybdenum blue, (MoO2.4MoO3)2.H3.PO4:

[P(Mo3O10)4]3- + 11H+ + 4 Sn2+ > (MoO2.4MoO3)2.H3PO4 + 2MoO2 + 4Sn4+ + 4H2O

The intensity of the blue colour is proportional to the concentration of phosphate in the filtered water sample and hence the colorimeter can give the concentration of phosphate in the sample.

5. Interpreting Your Results

Water quality data collected by Streamwatch groups can be used by various stakeholders, including agencies and local councils, to assess the quality of the water tested, and in some cases detect pollution incidents. To assist in identifying possible concerns, Streamwatch relies on "trigger values" outlined by The Australia and New Zealand Environment and Conservation Council (ANZECC), 2000 for Aquatic Ecosystems in Southeast Australia.

ANZECC uses the term "trigger value" to describe a concentration that if exceeded would indicate a potential environmental problem, and "trigger" a management response. It is important to remember that these trigger values are to be used as a guideline only and not intended to be applied as a regulatory criterion. In addition, these values have been developed in the context of ecosystem health and are not intended to indicate acceptable levels for human health, including drinking water and recreational activities.

The ANZECC Guidelines for Aquatic Ecosystems provide indicators on the level of protection for several ecosystem types: upland and lowland rivers, lakes and reservoirs, estuarine, and marine. **Aquatic ecosystems are complex and variable, and it is very difficult to apply a rigorous whole number guideline on which to compare physical and chemical stressors from every waterway in Australia.** ANZECC guidelines recognise this variability by providing guideline values for the level of protection for several ecosystem types, under differing degrees of disturbance.

Streamwatch references ANZECC values for "slightly to moderately disturbed" ecosystems. Many of the Streamwatch monitored sites do fit into this category. They can be described as ecosystems impacted by human activity and occur in catchments with slight to moderate clearing. Some sites do not fit this category and can be considered as "highly disturbed". There are no ANZECC guideline values for these sites.

Because it is not reasonable to equally apply the same trigger value used for streams running through national parks and urban streams receiving poor quality stormwater runoff, ANZECC recommends identifying site specific guidelines based on the water management goals. Unfortunately, this process relies on a significant amount of time and resources to perform rigorous testing, analysis of control sites and to achieve a holist understanding of the area through historical and spatial data. Therefore, the Streamwatch program has adopted ANZECC trigger values indicated for "Southeast Australia, slightly disturbed ecosystems" as a default reference to compare water quality measurements over time.

https://www.waterquality.gov.au/anz-guidelines/your-location

Refer to the table below for the Streamwatch Guidelines.

Appendix

Summary of Water Quality Parameters

Table 1: Sourced from WaterWatch field Manual (2010) Department of Environment, Climate Change and Water NSW.

Upland >150 m	**Healthy**	**Fair**	**Poor**
Temperature (°C)	18–22	N/A	>22 <15 human impact
Turbidity (NTU)	<10	10–25	>25
EC (µS/cm)	<350	350–800	>800
EC (mS/cm)	<0.35	0.35–0.8	>0.8
pH	6.5–8.0	N/A	<6.5–>8.0
PO_4 (mg/L)	<0.05	0.05–0.3	>0.3
DO (% saturation)	90–110	N/A	<90–>110

Lowland <150 m	**Healthy**	**Fair**	**Poor**
Temperature (°C)	18–22	N/A	>22 <15 human impact
Turbidity (NTU)	<10	10–50	>50
EC (µS/cm)	<300	300–800	>800
EC (mS/cm)	<0.3	0.3–0.8	>0.8
pH	6.5–8.5	N/A	<6.5–>8.5
PO_4 (mg/L)	<0.06	0.06–0.3	>0.3
DO (% saturation)	85–110	N/A	<85–>110
Lakes and dams	**Healthy**	**Fair**	**Poor**
Temperature (°C)	18–22	N/A	>22 <15 human impact
Turbidity (NTU)	<10	10–20	>20
EC (µS/cm)	<300	300–800	>800
EC (mS/cm)	<0.3	0.3–0.8	>0.8
pH	6.5–8.0	N/A	<6.5–>8.0
PO_4 (mg/L)	<0.015	0.015–0.3	>0.3
DO (% saturation)	90–110	N/A	<90–>110
Estuaries	**Healthy**	**Fair**	**Poor**
Temperature (°C)	N/A Affected by tides	N/A Affected by tides	N/A Affected by tides
Turbidity (NTU)	<10	10–20	>20 (may be influenced by tides)
EC (µS/cm or mS/cm)	N/A Affected by tides	N/A Affected by tides	N/A Affected by tides
pH	7–8.5	N/A	<7–>8.5
PO_4 (mg/L)	<0.02	0.02–0.3	>0.3
DO (% saturation)	80–110	N/A	<80 or >110