North Central Waterwatch and Community Stream Sampling Project–Interpretation and Methods Manual

North Central Waterwatch is supported by:

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1. Introduction

Welcome to the North Central Waterwatch water quality monitoring network. Undertaking a water monitoring program involves the collection of valuable water quality data over an extended period of time. Collecting water quality data facilitates a better understanding of local and regional waterways for all water stakeholders. A good understanding of regional waterways through community water monitoring, leads to better water management. North Central Waterwatch has a range of community monitors undertaking a water monitoring program. These monitors include schools, landholders, urban residents, environmental groups and Landcare groups.

This document is designed to complement the North Central Waterwatch Data Confidence Plan, and provide helpful information that will assist community monitors in undertaking a water quality monitoring program. The information in this document includes:

- North Central Waterwatch Staff
- Why monitor water quality?
- Aims of community water quality monitoring
- Health and Safety Guidelines
- Water sample collection, preservation and storage
- Chemical, physical and biological water quality parameters and tests
- Water quality data and information
- Interpretation of water quality data

2. North Central Waterwatch Staff and our Role

The North Central Waterwatch team consists of a Regional Coordinator and three Local Facilitators covering the Loddon/Campaspe – Irrigation, Loddon Campaspe – Dryland and Avoca/Avon-Richardson catchments. See Appendix 1 for Waterwatch Coordinator/Facilitator service boundaries and contact details.

The North Central Waterwatch team is committed to facilitating a prosperous community based water quality monitoring program. The North Central Waterwatch Team will:

- provide and service water quality equipment;
- provide Quality Assurance/Quality Control water quality training;
- update training as required;
- facilitate further water quality learning through activities and events;
- provide support and advice on water quality monitoring; and
- provide a well-managed water quality database (Waterwatch Database).

3. Why monitor water quality?

Water is the source of all life. Fresh water is our most valued and sought-after renewable resource. We are dependent on good quality water for economic prosperity, environmental integrity and for social enjoyment.

A big challenge facing Australians, over the next century, is to manage water carefully. This is particularly important with the predicted climatic forecasts relating to global warming. The importance of effectively managing water resources now and in the future has been captured in the Victorian Government's White Paper- *Securing our Water Future Together* and the *Victorian River Health Strategy.* Essentially, we *need* to manage our water resources sustainably. Water quality is a vital factor in the management of all water resources.

Current and past land-use practices have impacted on our surface water and groundwater resources. Impacts include altered flows and drainage, degradation of native vegetation (and habitat), increased sediment and salt loads, elevated nutrient levels and the introduction of a myriad of other pollutants.

Water quality data helps to build a picture of the health of waterways and catchments. After careful interpretation of water quality data, it is possible to plan and implement practical actions that aim to maintain and improve water quality and catchment condition.

Waterwatch data plays a very important role in assessing river health and catchment condition across our region. Depending on the standard of data collected and the regularity of monitoring, the information gathered by Waterwatch monitors can vary in use. High quality data may be used to complement the formation of waterway management and project plans, where

lower quality data may be used as a rough indication of river health that may trigger further investigations if necessary (refer to North Central Waterwatch Data Confidence Plan for details).

Furthermore, a water quality monitoring program such as North Central Waterwatch has the potential to bring together water stakeholders - schools, community groups, urban residents, landowners, local and State government agencies - in managing our water resources.

4. Aims of community water quality monitoring

The guiding principles of the Waterwatch Program are:

- to develop community awareness and ownership of water quality issues;
- to empower communities, through dissemination of water quality monitoring skills and river health knowledge;
- to provide opportunities to better understand water quality issues, including river health;
- to identify areas where water degradation exists and to identify causes/sources;
- to encourage and assist communities to take remedial actions.

In particular, Waterwatch aims to:

- survey streams and water sources to assess their present condition;
- identify areas where water degradation or pollution exists and identify the causes or sources;
- provide a comprehensive database from which to analyse trends in water quality;
- indicate areas where water quality needs improvement and the ways that this can be achieved.

5. Choosing and describing your monitoring site(s)

Once you have worked out your monitoring program – that is, what you want to monitor and how – you are ready to choose your monitoring site(s) in readiness for conducting stream habitat and biological surveys; and the physical and chemical tests.

If you lack previous data about your stream, you may decide to collect baseline data. 'Baseline data' refers to the natural or 'normal' water quality conditions. Baseline conditions may vary considerably between streams and even reaches of the same stream. Baseline data collection will also identify any seasonal changes in water quality experienced in your stream. It is very important to have knowledge of baseline conditions so any degradation or improvement in water quality can be identified. If you decide to conduct baseline monitoring, you need your reference sites to be as natural as possible. The important features to look for listed in the text box over page.

Alternatively, you may wish to conduct 'investigative monitoring', where a water quality issue has been identified, or you have reason to believe that water quality may be compromised – or improved - in the future. Examples of investigative monitoring include: monitoring stormwater drains, monitoring downstream of developments or land use changes, monitoring rehabilitation areas. Investigative monitoring may also include 'event monitoring'. The most common type of event monitoring is rainfall 'event monitoring'. Water quality can be strongly altered following rainfall events: sediments and nutrients can be washed into the stream; conductivity levels can be altered, and dissolved oxygen levels can vary. Testing just prior to a rainfall event and then immediately after rainfall we can get an idea of how water quality is affected and what impacts this may have on the environment. If you are interested in event monitoring, please contact your Waterwatch Facilitator or Coordinator to discuss the structure of your monitoring plan.

Criteria for selecting a reference site

It should be:

- representative of that reach of your stream;
- subject to as little human-related disturbance as possible;
- easy to reach and safe for sampling;
- at least 50 meters upstream or 300 meters downstream of: any ford; a dam, weir or waterfall higher than 5 meters; livestock-watering areas; significant diversion or additional flow; or areas with channelling, dredging or weed removal;
- free from human regulation causing large differences in water flow, such as release from dams upstream;
- upstream of an identifiable source of pollution, or far enough downstream (10km or more in small streams and 20km in larger rivers) to let your stream's biological community recover.

When you have identified the appropriate type of sampling site for your baseline study or for an investigative monitoring program (for example, downstream of a drain), you are ready to choose your specific sites. Your choice of a particular monitoring site is very important. Ideally, it will provide suitable conditions for biological surveys should you wish to conduct them.

You will probably have some sites in mind by now. It is a good idea to have three or four options, as some may not be suitable. For each site, work through the following questions; you may need to visit the site or use a map to answer them.

Is the water still or flowing?

In a stream, the water quality and physical state of the water in a flowing section will differ very much from those in a still pool. In lakes and wetlands, the water is not as well aerated and nutrients and sediments tend to settle to the bottom. Samples taken from the edge of a stream will be different from those taken near the middle. Water velocity and depth at the edges create different conditions for plant growth and animal life; for example, still water will have lower dissolved oxygen levels. If most of the stream is flowing rather than still, measure water quality along a flowing section to gain a representative sample.

Is the site accessible all year round?

If your monitoring program aims to record seasonal changes, make sure the site is accessible at all the relevant times.

Can you safely carry out field tests at the site?

Does the site have adequate open space? Is it suitable for conducting the chemical tests and biological surveys? Is the water easily accessible from the banks? Refer to section 6 for further Health and Safety information.

Are you far enough downstream from a drain or tributary?

Check the entry points of drains. Water-quality measurements should be taken far enough downstream from drains or tributaries to allow for mixing of the waters, otherwise you will be taking a sample of the drain or tributary, not the stream. As a 'rule of thumb', measure at least 100 metres downstream from any drain, pipe or tributary entering your stream.

Are you far enough upstream from other waterways?

Where a stream enters another water body, such as a lake, a bay or another stream, you need to take the sample well back from where the two meet to exclude any influences from the other water body - for example, changes in turbidity where a highly turbid stream enters a clear stream.

6. Health and Safety Guidelines

The North Central Waterwatch Team cares about the health and safety of community monitors. Therefore, we have provided some recommendations to ensure you are safe while undertaking your water monitoring. These recommendations do not intend to replace any Acts or Regulations developed by Government.

Safety is paramount. Ensure that you are sampling in a safe area and in a safe manner.

Monitoring sites all have potential hazards. Identifying these hazards will assist in determining whether your site is safe to monitor. Below is a 'Site Hazard Identification Checklist', which lists hazards that are commonly associated with waterway monitoring sites.

Site Hazard Identification Checklist

- Deep or fast flowing water
- Drowning hazards
- Falling tree limbs
- Sharps and other dangerous pollutants
- Unknown pollutants
- Exposure to hazardous water testing chemicals
- Biologically contaminated water
- Dangerous animals or plants, such as snakes or blackberries
- Steep or unstable banks
- Exposure to UV radiation
- Blue green algae

Please check your site for the hazards listed above and take the following actions to reduce the Health and Safety Risks:

General Health & Safety Considerations/Actions

- Make sure someone knows where you are.
- Wear appropriate clothing and footwear for outdoor activities.
- Always wear sun protection and sunscreen.
- Carry a first aid kit and a mobile phone in case of an incident.
- Carry adequate drinking water.
- Beware of sharp objects (eg. glass) that may be present in the area.
- Be conscious of unstable or steep banks, holes in the ground and uneven and slippery surfaces. Use the safest path to the waterway.
- Beware of animals and plants that may cause injury or harm eg. snakes and prickly vegetation.
- Chemical and physical water quality tests do not require you to enter into the water. Even slow flowing water can be dangerous. *Do not* enter the water while collecting samples for any reason.
- Beware of water that may be of hazardous quality. If the water has a questionable smell or appearance, contact your local Waterwatch Facilitator or Regional Coordinator before conducting your tests.
- Wearing gloves while handling water samples is advisable especially in urban areas and after rainfall. Any cuts or abrasions should be covered with waterproof dressings.
- Do not sample water that is known to contain high levels of blue-green algae.
- Beware of unstable tree limbs.

Water testing/monitoring Health & Safety Considerations

- Use water monitoring equipment in the manner that has been specified by the manufacturer and by Waterwatch Staff. It is good idea to review your procedures on a regular basis.

- Use safety equipment (gloves & glasses). If you need more safety equipment, please do not hesitate to contact your Waterwatch Facilitator or Coordinator.
- Always conduct your tests on a stable surface.
- Report any equipment defects to Waterwatch Staff immediately.
- Please take rubbish with you.
- Use the waste container for all leftover solutions used in the water quality tests. For example, standard solution and residue from the phosphate tests.

Note: If you are unsure about these health and safety guidelines or you have health and safety concerns about your water monitoring program, please contact your Waterwatch Staff promptly. We are only too happy to help.

7. Water sample collection, preservation and storage

The method of collecting water samples is important in ensuring accurate water quality results. Below are some guiding principles for collecting water samples and short-term storage. All water quality tests can be carried out at the monitoring site or a sample can be taken for tests to be performed indoors. However, it is important that water samples taken from the site are tested *immediately* after collection for the most accurate results.

Equipment

Various containers can be used to collect water samples. For Standard 1 and 2 monitors, a bucket may be used to collect your sample. Ideally, if using a bucket, replicate tests should be performed and the results averaged (take the median value).

For Standard 3 and 4 monitors, a plastic bottle should be used to collect samples. Please ask your local facilitator for advice on choosing a bottle. The bottle should be fastened to a pole, which allows it to reach to the middle of the stream.

Collecting water samples- Guiding Principles

A water sample collected should be representative of the waterbody being tested. This means that the water sample taken should be a true reflection of waterbody in characteristics.

- Attempt to **take a sample from about the middle of the stream** or as far from the bank as possible. If the water is deep, take the sample from about 100-200mm below the surface.

- **All sample bottles** and buckets should be **rinsed three times with stream water** prior to collecting samples for testing. Discard rinse water downstream of your sample position.

- Be careful not **to disturb the stream sediments** when collecting your sample. Sediments introduced to your sample will significantly alter your results.

- **Fill your sampling container to the top** before capping to prevent loss of dissolved gases.

- **Standard 3 and 4** monitors should ensure that sample bottles are free of scratches (inside).

- **Standard 3 and 4** monitors should ensure that sample containers are washed in weak acid (5-10% HCL or cleaning vinegar are common choices) to ensure the highest level of accuracy. Washing sample containers is very important if your stream contains high levels of phosphorus or sediment.

Note: If you do not feel that your sample is representative, please note it on your results sheet. This helps us assess the water quality data.

Do not take your sample from:

- non-flowing water near the stream edge
- the surface of the water.

All water samples should be tested as soon as possible after collection.

Helpful Hints

- **Direct sunlight can affect samples,** so store and perform all chemical tests in the shade.
- If samples must be taken from several sites before testing, **label all samples** immediately after collection with site name or number, date and time of sampling.
- If the weather is poor and a sample needs to be tested indoors, take a thermometer to the site so temperature can be measured on collection.

Water sample preservation and storage

If the site is inconvenient to do the water quality tests, then water samples may need to be taken indoors or to another location. Transporting water samples using a small esky and in darkness is recommended for short-term preservation of the sample.

Below are the recommended methods for preserving water samples. If testing the water is delayed then it is important to note the maximum storage time.

Parameter	**Container**	**Preservation**	**Maximum Storage Time**
Ammonia	P,G	Store between 1°C and 4°C	6 hours
Electrical Conductivity	P,G	Store between 1°C and 4°C	28 days
pH	P,G	Analyse immediately	2 hours
Turbidity	P,G	Analyse immediately or store in dark for 24 hours at 1°C and 4°C	24 hours
Temperature	P,G	Analyse immediately	no storage
Reactive Phosphorus	P,G	Preferably, filter on site with 0.45µm filter. Store in the dark at between 1°C and 4°C	24 hours

G = glass P = plastic (polythene or equivalent)

(Based on the EPA Victoria standards outlined in "A GUIDE TO THE SAMPLING AND ANALYSIS OF WATERS, WASTEWATERS, SOILS AND WASTES")

8. Chemical & Physical Water Quality Parameters

Your water monitoring program may involve testing the biological, chemical and physical characteristics of your local waterway. The physical and chemical tests performed in the North Central region include:

- Electrical Conductivity
- Turbidity
- Temperature
- pH
- Reactive or Orthophosphate
- Ammonia

Water data interpretation has many important considerations. The two main considerations include the affects on water quality from natural processes and systems and impacts induced from human activities. Other considerations include:

- Adequate amount of collected water data over time
- Variations between water quality parameters and their interrelationships

<u>Local catchment variations:</u>

- Catchment profile
- Current and past land use
- Geology and soil characteristics
- Vegetation (Native and introduced)
- Water source/s
- Waterway characteristics
- Climatic and seasonal variations

The following section will describe each of the water quality parameters and discuss the factors that affect each of them.

8.1 Electrical Conductivity

Electrical Conductivity (EC) measures the amount of dissolved ions such as, Calcium, Magnesium, Potassium, Sodium, Chlorides and Bicarbonates that are present in a waterbody.

Electrical Conductivity is measured with a digital EC meter, which measures the flow of electricity between the electrodes on the meter. Electrical Conductivity is reported as EC units and is measured in micro-siemens per centimetre (µS/cm). Some meters will give EC results in the milli-siemens (m/S). One milli-siemen equates to 1000µ/S. Electrical Conductivity is a relative measure of salinity, which is normally measured in mg/L. Electrical conductivity can be roughly converted to salinity by multiplying your result (in µS) by 0.68.

Salt occurs naturally in the Australian environment and is derived through three major processes in inland areas:

- The first of these processes is the weathering of rock during the process of soil formation. Many rocks will release salts during weathering, which is then dissolved in groundwater and transported to streams.

- Many areas are affected by salts that were deposited during periods of higher sea levels. Large areas of Victoria were once under sea, leading to very high levels of salt in rock formations and soil profiles.

- Water evaporated from the sea also contains a small percentage of salt that is deposited on the land via rainfall.

Variation in EC levels can be the result of changes in geological weathering (normally a very long term process), seepage of groundwater, industrial and agricultural effluent, rural runoff, stormwater runoff and sewage effluent flowing into streams and changes in rainfall patterns. Areas of the North Central Region are also affected by Dryland and Irrigation Salinity, which has a huge impact on stream EC levels.

Many aquatic species can survive only within certain salinity ranges so changes in salinity levels may result in changes to the variety and types of species present. Furthermore, crops and pastures have tolerance ranges, so salinity levels are important for agricultural production.

See Appendix B for salinity guidelines for animal stock and various crops.

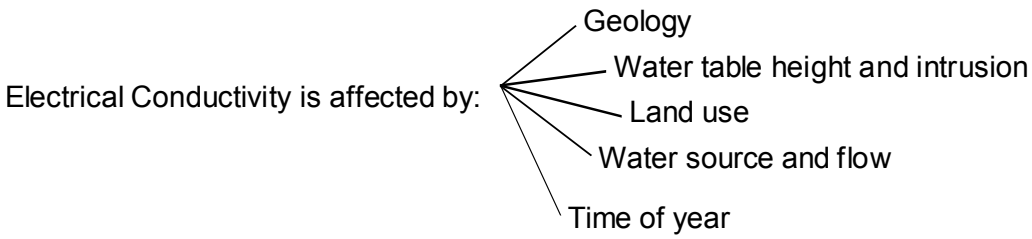
Dryland Salinity

Deep rooted plants effectively act as natural water pumps, sucking water from the ground and keeping the watertable low. When deep rooted trees are removed and replaced by shallow rooted pastures or crops, especially from groundwater recharge areas (recharge is the term used when soil pores are full, causing excess water to percolate into the saturated zone or groundwater) more water enters the groundwater system, causing the watertable to rise. A rising watertable brings large amounts of salt from underground water storages to the ground surface. After the water evaporates, high concentrations of salt remain which can eventually find its way into waterways.

Irrigation Salinity

Irrigation practices in some areas can lead to salinity problems. Problems arise when the volume of irrigation water exceeds evaporation and transpiration by plants, especially in areas with poor lateral drainage and naturally low watertables. The excess water from irrigation, if not effectively drained, will enter the groundwater system and cause the watertable to rise.

Factors affecting Electrical Conductivity



Geology – Weathering of some rocks will cause them to leach salt over time and cause increases in EC.

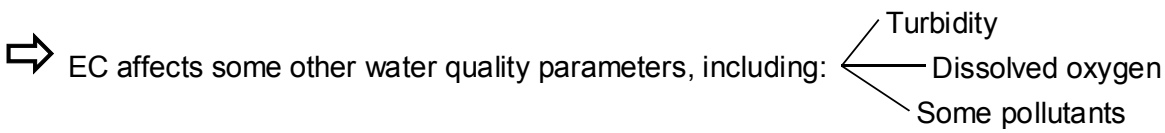
Watertable height and intrusion - Groundwater is one of the major influences on EC in surface water. The height of the watertable and the salinity of the groundwater can dramatically affect EC in surface waters. During summer, when the surface flows are very low, groundwater intrusion can account for most of the water entering the stream, causing an increase in EC.

Landuse - Runoff from some land-uses, particularly areas that are irrigated, or areas subject to dryland salinity will increase EC**.**

Water source and flow - Low flow in streams (normally over summer) will result in higher evaporation and concentration of the salts in the remaining water. Rainfall and the resulting input of surface water to streams may result in the dilution of salts and a reduction in EC.

Time of year – During summer EC is generally higher due to evaporation concentrating salt levels, whilst EC levels are generally lower during winter due to dilution of salt by rainfall.

Effects of Electrical Conductivity on Other Parameters



Turbidity – High EC levels result in a high ionic strength. Higher ionic strengths force suspended material to settle out of solution. This means that high EC waters generally have relatively low turbidity and suspended solids readings.

Dissolved Oxygen – Higher EC waters cannot dissolve as much oxygen in them, due again to the higher ionic strength. For this reason, salt waters generally have lower DO readings than freshwaters.

Some pollutants – Electrical Conductivity can affect the forms of various pollutants, so that at different ionic strengths, some pollutants become more or less toxic.

Appendix 3 contains detailed instructions on the use of Electrical Conductivity meters.

8.2 Turbidity

Turbidity is a measure of the cloudiness of water. High turbidity causes water to appear murky or cloudy. Turbidity levels are commonly measured with a turbidity tube or turbidity meter. The standard unit of measurement in Australia for turbidity, is the nephelometric turbidity unit or NTU.

An increase in suspended matter results in an increased turbidity level. The suspended matter mainly consists of inorganic and organic material made up of: algae, soil particles from erosion, some types of pollution, faeces, bacteria, zooplankton, fungi etc. Essentially, an increase in turbidity equates to an increase in the amount of incident light that is scattered or refracted by materials present in the water column.

Soil erosion is the major input of sediments into a waterway. Removal of stream bank vegetation exposes the soil to erosion and an increase in turbidity. Livestock using stream banks as access to water can also contribute sediments through erosion. Limiting stock access with fencing can reduce the amount of bank erosion by protecting the stream bank from damage.

Groundwater turbidity is generally very low, whereas runoff from agricultural and urban areas can have very high turbidity. Turbidity is generally higher during storm events when flows are typically much higher than base flows, increasing the erosive capability and carrying capacity of the water. Instream erosion of river banks, or wind and wave-induced erosion of lake shores can significantly increase turbidity.

Urban runoff can wash sediments from roads increasing turbidity in receiving waters. High nutrient levels and water temperatures may lead to an increase in algal growth, leading to an increased turbidity level, as can an abundance of destructive bottom feeders such as carp. Revegetation of verges and eroded banks can help reduce the amount of sediments entering a waterway by acting as a filtering system that traps nutrients and sediments and stabilises the bank.

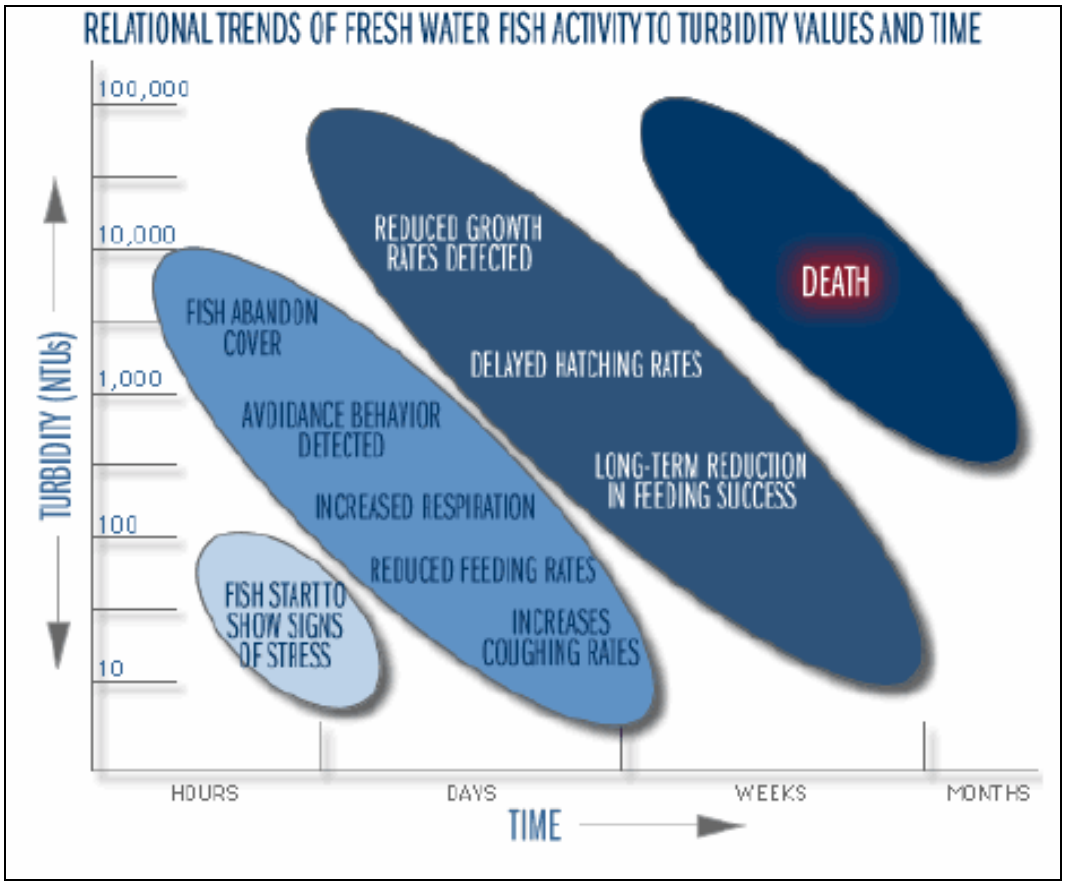
Organic materials present in the water column that affect turbidity contain nutrients such as phosphorus and nitrogen. Phosphorus in particular tends to adsorb onto suspended particles in the water. During storm water events with significant runoff, both turbidity and phosphorus levels can become quite high.

Turbidity limits the amount of light able to penetrate through the water, which can affect plant growth by reducing the rate of photosynthesis, reducing the amount of oxygen released into the water column and amount of habitat available for certain species. High turbidity can also result in higher temperatures, which lead to a reduction in dissolved oxygen concentration.

High turbidity can limit the visibility in the water column, affecting many animals that rely on eyesight for navigation, hunting, reproduction etc.

Increased turbidity may also lead to the smothering of benthic habitat as the particles settle out of the water column. Fish and other animals may also suffer from clogged gills because of high turbidity, be more prone to disease, and have egg and larval development stages negatively affected.

Increased turbidity may also increase water temperature, which results in a reduction in dissolved oxygen saturation, subsequently affecting oxygen dependent organisms; or, there may be an increase in algae growth, leading to higher turbidity levels and its associated issues.



Note: the most common measuring tool for turbidity used by community monitors is the Turbidity Tube. Technically, turbidity tubes measure TRANSPARENCY, not TURBIDITY. Transparency is a measure of all materials present in the water column that have the ability to hinder the transmission of natural light. While turbidity is a measure of undissolved suspended matter, transparency also measures the effect of dissolved materials such as: tannins, organic acids, and other coloured chemicals. Transparency is proportional to turbidity; however, the relationship between the two is directly affected by the presence of dissolved solids that have the ability to hinder light transmission. Care must be taken when comparing turbidity results from Turbidity Tubes with those from turbidity meters. This is especially important for streams that have a high level of tannin or organic acid. Please contact your local Waterwatch Facilitator if you would like any more information.

Appendix 4 contains detailed instructions on the use of Turbidity Tubes.

8.3 Phosphorus

Phosphorus is a nutrient that occurs naturally at low concentrations in water and is essential for life. Phosphorus is derived from the weathering of rocks and from the decomposition of organic matter such as plant litter. Phosphorus is present in streams as soluble phosphates or ortho-phosphates, phosphorus bound to sediments and phosphorus occurring in living organisms. Elevated phosphorus levels may result from: erosion and the subsequent introduction of sediment containing phosphorus; accidental sewage discharge; detergents, urban stormwater drains can be a source of phosphorus through illegal sewer connections, large amounts of animal wastes or chemicals such as detergents; industrial waste; sewage effluent; and from rural runoff containing fertilizers and animal and/or plant material. Under certain conditions, characteristically low oxygen conditions, phosphorus can be released from sediments into the water column. It is thought that much of this release of phosphorus from sediments is due to bacterial activity.

Where there is an excessive amount of phosphorus in the water, plant growth is likely to increase. This may lead to streams becoming blocked with excess macrophyte growth, or result in algal blooms. Certain types of algal blooms can lead to serious problems. The most common of these are the 'blue-green' algal blooms. Certain species of blue-green algae – which is actually a type of bacteria called phyto-bacteria - can produce extremely toxic chemicals that are harmful to humans and live stock (please contact your local Waterwatch Facilitator if you would like any further information concerning blue-green algae).

Reactive Phosphorus or **Orthophosphate** measures only soluble forms of phosphate and is indicative of the readily available and biologically active phosphorus. It has the advantage of being a simple test to conduct. This is the form of Phosphorus that most monitors will test for.

Total Phosphorus includes all forms of phosphorus including particulate forms in unfiltered samples. The method requires an initial digestion to free phosphorus that is bound to soil particles. Most community monitors do not conduct total phosphorus test due to the more complex method involved.

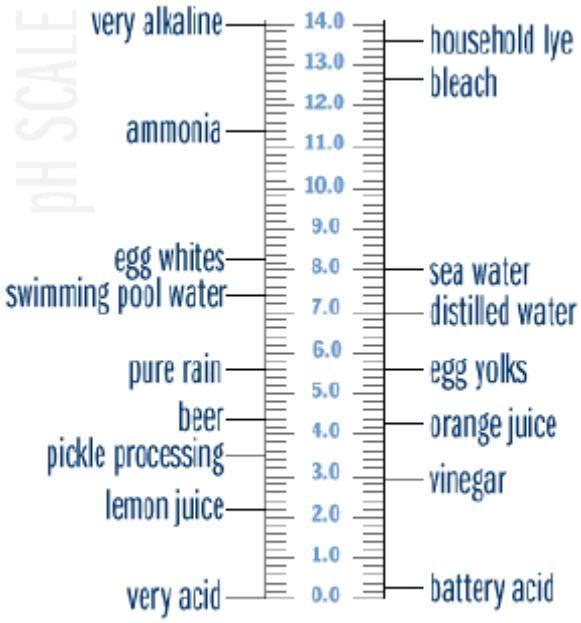
Appendix 5 contains detailed instructions on how to perform Reactive Phosphorus tests.

8.4 pH

When we measure pH we are measuring, how acidic or alkaline the water is. pH is a measure of the hydrogen ion (H^+) concentration. The concentration of hydroxyl ions (OH^-) determines how alkaline the water is. As the hydrogen ion concentration increases, the hydroxyl ion concentration decreases and vice-versa. A solution with a pH between 0 and 7 contains more H^+ ions than OH^- ions, while a solution with a pH between 7 and 14 the solution contains more OH^- ions than H^+ ions. The pH scale is from 0-14; pH of 7 is neutral, zero is the most acidic and 14 is the most alkaline.

The pH scale is logarithmic. When a pH value changes by a unit of 1, say from 6 to 5, this equals an increase in H^+ concentration of 10 times. So a pH of 5 is 10 times more acidic than pH of 6, a pH of 4 is 100 times more acidic than the pH of 6. With alkaline substances it is the same, a pH of 14 is 10 times more alkaline than a pH of 13 and 100 times more alkaline than a pH of 12. So a large increase or decrease in pH outside the normal range of a stream will have a dramatic effect on the number and diversity of species found within the waterbody. To maintain a healthy diversity of life, pH must be kept within the range of the natural variation for the waterbody.

The pH Scale



Carbon dioxide is one of the major natural drivers of pH change in freshwater environments. When carbon dioxide levels increase, (usually due to increased respiration by plants and bacteria) pH will decrease. This is due to some of the carbon dioxide transforming into carbonic acid, increasing the concentration of H+ ions, thus decreasing the pH.

When there is a high level of plant growth in a water body, photosynthetic consumption of carbon dioxide can lead to an increase in pH. This process leads to a diurnal (variation during the course of a single day) pattern of pH levels in many waterways, especially those with high levels of plant growth and/or low buffering capacities. The pH will be higher in the afternoon due to increased consumption of carbon dioxide, and will be lower in the morning due to increased respiration and production of carbon dioxide overnight.

Carbonate acts as a natural buffer to pH change in freshwater environments. Carbonate or bicarbonate present in the water column breakdown (hydrolyse) to form OH- ions. These ions then act to resist any changes in pH. Limestone deposits will leach over time providing a carbonate source to freshwater environments. Catchments rich in limestone will generally have waterways with slightly elevated pH

levels which resist acidification due to higher concentrations of carbonates. Catchments lacking sources of carbonates may experience larger fluctuations in pH levels due to the reduced buffering capacity of their waters.

The decomposition of organic materials in well oxygenated waters leads to the production of carbon dioxide, decreasing pH; however, the decomposition of organic material in anaerobic (low oxygen) waters will lead to the consumption of H+ ions, thus increasing pH levels.

As salinity increases, pH levels will generally increase, due to addition of carbonate ions. Some waterways may drain areas that have been affected by 'soil acidification'. If they are poorly buffered, pH levels may gradually decrease. The same is true of streams that drain areas with acid sulphate soils. Most acid sulphate soils in Victoria are located in low lying coastal areas.

Other mechanisms for pH change in freshwater environments include: production of organic acids; inputs of atmospheric acids formed by industrial pollutants and vehicle exhausts; chemicals introduced through the stormwater system; runoff from agricultural land containing excess fertilisers; acidic leachate from mining operations; and sewage overflows.

The normal range of pH levels in a stream should be about 6.5 – 8.5. Any strong deviation from this range for an extended period may be detrimental to the plants and animals living in the waterway. Some animals are extremely sensitive to pH changes and will migrate out of a system if the pH level deviates outside their preferred range. Others are tolerant of pH change but may be chronically affected if pH remains outside of their preferred range. Some chronic effects of altered pH levels include: interruptions to breeding cycles, altered development, and decreased fitness.

Decreases in pH can lead to the increased toxicity of many heavy metals, cyanide and aluminium, while an increase in pH increases the toxicity of ammonia.

See appendix 6 for instructions on measuring pH.

8.5 Temperature

Temperature is an integral factor in the functioning of aquatic ecosystems. Temperature not only regulates many of the biological and chemical reactions occurring in the aquatic environment, but impacts on the habits, activities, mobility and responses of many aquatic organisms. Temperature is reported in degrees centigrade (°C) in Australia.

As with many other water quality parameters, aquatic organisms have a preferred temperature range. When temperatures rise or fall outside of this preferred range, a wide range of affects may ensue, including: change in growth rate; disruption of reproduction cycle; change in, or total interruption of, migration patterns; change in mobility; changes to metabolic rate and energy use; and with extreme temperature change, death.
Increases in water temperature may increase the rate of plant growth, causing many role-on effects through the entire ecosystem. Decreases in temperature may reduce plant growth, resulting in a loss of habitat and food, consequently impacting on a range of biota within the system.

Water temperatures also have an impact on the rate of chemical reactions and therefore biological activity. Increased water temperatures can increase the toxicity of many chemicals to aquatic life and will invariably reduce the saturation level of oxygen. The concentration of oxygen that can be dissolved in water at a constant pressure varies with temperature and salinity. As temperature increases, the maximum amount of oxygen that can be dissolved in water (the saturation point) decreases dramatically. Lower oxygen levels may negatively affect many aquatic organisms. Temperature related oxygen drops, have been implicated in many fish kills around Victoria.

Temperature change can occur naturally as part of ‘natural’ diurnal or seasonal changes, or by human activities. The major human induced increases to temperature in our waterways are a result of: decreased vegetation coverage; release of warm coolant waters from power plants and other industries; and changes

to climatic conditions through global warming. The main mechanisms responsible for temperature decrease in our waterways include: increased foliage cover from introduced species, providing excess shade; and release of deep, cold, water from reservoirs and lakes.

8.6 Ammonia

Ammonia (NH_3^+) is the most readily available form of nitrogen for assimilation during plant and bacterial growth. Ammonia concentrations are generally very low in waterways as it is very quickly assimilated by plants and bacteria. Ammonia levels will rise dramatically when certain organic pollutants are present in a water body, particularly animal wastes, sewage and some industrial wastes. Some fertilisers may also raise ammonia levels if they enter waterways.

Ammonia, at low levels, is not harmful to the environment. Elevated levels of ammonia can have quite severe negative effects. In water, ammonia (NH3+) will hydrolyse to ammonium (NH_4^+). Ammonium is quite non-toxic and poses little threat to aquatic organisms; however, ammonia (NH_3^+) is acutely toxic to many aquatic organisms at high concentrations and can cause chronic effects at quite low concentrations. The degree to which ammonia hydrolyses to ammonium is governed mostly by pH conditions. The higher the pH, the less ammonia hydrolyses and the higher the concentration of toxic NH_3^+. Levels of ammonia less than 1mg/L can be lethal to some organisms within hours. The ANZECC low risk recommended level of ammonia/ammonium lowland rivers in South Eastern Australia is only 0.013mg/L.

Ammonia is the most readily tested form of nitrogen in our waterways. There are test kits available to measure nitrate and nitrites, but, they contain dangerous chemicals and are not recommended for community monitors. Ammonia tests are not recommended for all monitors, due to the very low levels present in most waterways. Ammonia tests may be appropriate if there is a history of high ammonia in your waterway, or if there is a change in land use that may result in elevated ammonia levels.

If you are interested in conducting ammonia tests on your waterway, please contact your local Waterwatch Facilitator.

8.7 Physical Survey- Habitat

Habitat surveys serve as a useful indicator for the physical and biological condition of your sampling site. A Habitat Survey involves visually assessing the habitat value of your monitoring site.

The survey considers the condition of the bank, verge and in-stream vegetation, as well as, riffles, pools and bends in flowing streams. The survey involves giving various sections of the waterway a score (from the Habitat Survey Field Guide). These scores are tallied and a rating of habitat quality is then given. The ratings range from 8 – 40.

If you are interested in undertaking a Habitat Survey of your site, please contact your local Waterwatch Facilitator.

8.8 Biological Survey- Macroinvertebrates (Waterbugs)

Macroinvertebrates are effective indicators of a stream's biological health because they occupy a central role in the food chains of aquatic systems. With varying tolerance to pollution levels, macroinvertebrates are sampled to determine water quality, therefore, complementing physical and chemical water tests.

The variety and number of macroinvertebrates found in a water body can be used to indicate the presence of pollution. Chemical testing can then be conducted to confirm the presence and particular type of pollution. Macroinvertebrate sampling complements chemical sampling because it can detect the presence of most environmental stresses and may provide general indications about the type of pollutant. By contrast, chemical and physical tests are highly specific (for example, a test for pH or one for soluble phosphate levels). If the pollutant is not measured by

one of the chemical or physical tests conducted at the site then it may go undetected if you were to only conduct these tests.

Macroinvertebrates' life span of up to a year, together with their relative lack of mobility, can make them useful indicators of intermittent pollution. For example, a 'slug' of toxic waste released into a stream after an accident may have an impact on the variety and numbers of the macroinvertebrate community that remains evident for several months. By contrast, chemical monitoring, unless conducted when the toxicant is present, is far less likely to detect the event.

The two methods for collecting macroinvertebrates using nets include Kick and Sweep sampling. The types of macroinvertebrate collected determine the water quality, which is based on the SIGNAL Index score. To get a SIGNAL Index score, macroinvertebrates are identified to the family level and are each given a score based on the sensitivity or tolerance to pollution. The scores are then added up and divided by the number of families- SIGNAL Index score.

If you are interested in macroinvertebrate sampling, contact your local Waterwatch Facilitator for more information and equipment.

9. Water Quality Data & Information

One of the most important aspects of a water monitoring program is recording and storing of water quality data. All data is stored in the Waterwatch Database and is entered and managed by Waterwatch Staff.

Waterwatch community monitors record their water quality test results on a results sheet. The results sheet is then made available to Waterwatch Staff. Community monitors have several options in getting the results sheet to Waterwatch Staff. The options include:

- Mail (through self addressed envelopes)
- Email
- Fax

Note: If you require result sheets or self-addressed envelopes, contact your local Waterwatch facilitator.

Helpful Hints

- The Hanna EC/Temp meters measure Electrical Conductivity in milli- siemens per centimetre (mS/cm). **Remember to multiply the meter's reading by 1000**. This will convert the EC units to the standard unit of micro siemens per centimetre (μS/cm).

- Recording additional comments/observations on your results sheets is really helpful. It is amazing how these little comments build a big picture, about your local waterway, over time.

Monitor Feedback- Year Summary

North Central Waterwatch will provide a summary report of your results each year. Primarily, this yearly summary will provide in the form of graphs, statistics (averages) and water quality related information for the site/s being monitored. The level of information reported back to the monitor will depend on the length of your monitoring program and amount of monitoring in your local catchment.

Further water-quality information

The North Central Waterwatch Team endeavours to fulfil requests for additional water quality related information. If you require further information, please do not hesitate to contact our staff. If we cannot fulfil your request, we can often refer you to the relevant organisation or specialist.

10. Interpretation of Water Quality Data

Interpreting water quality provides meaning to your data and provides understanding of the factors affecting your results and the health of your waterway.

How does your water quality rate?

Assigning ratings or determining objectives for the water quality of your waterway is not an easy task. In most cases, it is impossible without a detailed, long term, investigation of the levels and environmental effects of a variety of parameters at a local level. This involves assessing the study site against a 'control' or 'reference' site; this is a site that is as similar as possible to the study site but without human impact. Unfortunately, it may be hard to find a site that is void of all human impact; in this case, a site that has desirable conditions may be used. If there are no sites similar enough, then to maintain the background water quality levels becomes the objective.

Two documents give broad regional water quality objectives or 'trigger values' upon which local objectives can be developed. These documents are:

- Victorian Government (2003), "State Environment Protection Policy (Waters of Victoria)" *Victorian Government Gazette: No S 107*.

- Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000), "Australian and New Zealand Guidelines for Fresh and Marine Water Quality"

The State Environment Protection Policy (SEPP) "…provides a legal framework for State and local government agencies, businesses and communities to work together to protect and rehabilitate Victorians surface water environments.." (SEPP 2003); is an instrument of the Environmental Protection Act 1970; and is administered by the

Environmental Protection Authority, which is responsible for its overall implementation.

The water quality objectives outlined in the (SEPP) guidelines have been assigned to broad segments or bioregions. These objectives "describe the level of environmental quality needed, in most surface waters, to avoid risks to *beneficial uses* and to protect them" (SEPP 2003). It is noted in the guidelines that:

- where the environmental quality of a stream is better than the objectives, the objective should be a close as possible to the background levels;
- the environmental quality objectives for some surface waters may not be attained due to natural variation. In these cases, the background level becomes the environmental quality objective;
- the environmental quality objectives for some surface waters may not be attained due to extensive environmental modification.

If the objectives are not met, then there might be a potential risk to environmental health, and further investigation should be initiated. Based on local environmental conditions, the objectives may be tailored, using a risk based assessment, to better suit the site. A risk based assessment involves the determination of water quality levels that will lead to certain issues developing (eg nuisance plant growth or effects due to increased salinity).

SEPP Environmental quality objectives for rivers and streams - water quality

Segment	**Indicator**			
	Total Phosphorus (mg/L)	Electrical Conductivity (µS/cm)	Turbidity (NTU)	pH (pH units)
Cleared Hills and Coastal Plains				
Uplands of the Avoca, Loddon and Campaspe	≤0.025	≤500	≤10	≥6.5, ≤8.3
Murray and Western Plains				
Lowlands of the Avoca, Campaspe and Loddon	≤0.45	≤1500	≤10	≥6.5, ≤8.3

Note: The SEPP guidelines give Total phosphorus at the phosphorus indicator. Generally, Waterwatch monitors will be measuring Reactive Phosphorus (see page 24). As a rule, Total Phosphorus will always be greater than or equal to the Reactive Phosphorus level.

The SEPP guidelines have been based on the ANZECC guidelines. Trigger values were outlined in the ANZECC guidelines and are defined as "concentrations that, if exceeded, would indicate a *potential* environmental problem, and so 'trigger' a management response, e.g. further investigation and subsequent refinement of the guidelines according to local conditions". They are designed as a starting point for waterway managers to determine their own localised trigger points and water quality objectives. The ANZECC guidelines give a framework from which waterway managers can tailor water quality guidelines to local environmental conditions.

The following tables have been taken from the ANZECC Guidelines (2000).

Table 3.3.2 Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems. Trigger values are used to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystem types. Data derived from trigger values supplied by Australian states and territories. Chl *a* = chlorophyll *a*, TP = total phosphorus, FRP = filterable reactive phosphate, TN = total nitrogen, NO_x = oxides of nitrogen, NH_4^+ = ammonium, DO = dissolved oxygen.

Ecosystem type	Chl *a*	TP	FRP	TN	NO_x	NH_4^+	DO (% saturation)[l]		pH	
	($\mu g\ L^{-1}$)	($\mu g\ P\ L^{-1}$)	($\mu g\ P\ L^{-1}$)	($\mu g\ N\ L^{-1}$)	($\mu g\ N\ L^{-1}$)	($\mu g\ N\ L^{-1}$)	Lower limit	Upper limit	Lower limit	Upper limit
Upland river	na[a]	20[b]	15[g]	250[c]	15[h]	13[i]	90	110	6.5	7.5[m]
Lowland river[d]	5	50	20	500	40[o]	20	85	110	6.5	8.0
Freshwater lakes & Reservoirs	5[e]	10	5	350	10	10	90	110	6.5	8.0[m]
Wetlands	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Estuaries[p]	4[f]	30	5[j]	300	15	15	80	110	7.0	8.5
Marine[p]	1[n]	25[n]	10	120	5[k]	15[k]	90	110	8.0	8.4

na = not applicable;
a = monitoring of periphyton and not phytoplankton biomass is recommended in upland rivers — values for periphyton biomass (mg Chl *a* m^{-2}) to be developed;
b = values are 30 μgL^{-1} for Qld rivers, 10 μgL^{-1} for Vic. alpine streams and 13 μgL^{-1} for Tas. rivers;
c = values are 100 μgL^{-1} for Vic. alpine streams and 480 μgL^{-1} for Tas. rivers;
d = values are 3 μgL^{-1} for Chl *a*, 25 μgL^{-1} for TP and 350 μgL^{-1} for TN for NSW & Vic. east flowing coastal rivers;
e = values are 3 μgL^{-1} for Tas. lakes;
f = value is 5 μgL^{-1} for Qld estuaries;
g = value is 5 μgL^{-1} for Vic. alpine streams and Tas. rivers;
h = value is 190 μgL^{-1} for Tas. rivers;
i = value is 10 μgL^{-1} for Qld. rivers;
j = value is 15 μgL^{-1} for Qld. estuaries;
k = values of 25 μgL^{-1} for NO_x and 20 μgL^{-1} for NH_4^+ for NSW are elevated due to frequent upwelling events;
l = dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs should assess this potential variability (see Section 3.3.3.2);
m = values for NSW upland rivers are 6.5–8.0, for NSW lowland rivers 6.5–8.5, for humic rich Tas. lakes and rivers 4.0-6.5;
n = values are 20 μgL^{-1} for TP for offshore waters and 1.5 μgL^{-1} for Chl *a* for Qld inshore waters;
o = value is 60 μgL^{-1} for Qld rivers;
p = no data available for Tasmanian estuarine and marine waters. A precautionary approach should be adopted when applying default trigger values to these systems.

Note: to covert µg to mg, you must divide by one thousand. Filterable Reactive Phosphate is similar to Reactive Phosphorus; however, samples must be filtered prior to testing. The two units are not directly comparable.

Table 3.3.3 Ranges of default trigger values for conductivity (EC, salinity), turbidity and suspended particulate matter (SPM) indicative of slightly disturbed ecosystems in south-east Australia. Ranges for turbidity and SPM are similar and only turbidity is reported here. Values reflect high site-specific and regional variability. Explanatory notes provide detail on specific variability issues for ecosystem type.

Ecosystem type	Salinity (μScm^{-1})	Explanatory notes
Upland rivers	30–350	Conductivity in upland streams will vary depending upon catchment geology. Low values are found in Vic. alpine regions (30 μScm^{-1}) and eastern highlands (55 μScm^{-1}), and high values (350 μScm^{-1}) in NSW rivers. Tasmanian rivers are mid-range (90 μScm^{-1}).
Lowland rivers	125–2200	Lowland rivers may have higher conductivity during low flow periods and if the system receives saline groundwater inputs. Low values are found in eastern highlands of Vic. (125 μScm^{-1}) and higher values in western lowlands and northern plains of Vic (2200 μScm^{-1}). NSW coastal rivers are typically in the range 200–300 μScm^{-1}.
Lakes & reservoirs	20–30	Conductivity in lakes and reservoirs is generally low, but will vary depending upon catchment geology. Values provided are typical of Tasmanian lakes and reservoirs.
	Turbidity (NTU)	
Upland rivers	2–25	Most good condition upland streams have low turbidity. High values may be observed during high flow events.
Lowland rivers	6–50	Turbidity in lowland rivers can be extremely variable. Values at the low end of the range would be found in rivers flowing through well vegetated catchments and at low flows. Values at the high end of the range would be found in rivers draining slightly disturbed catchments and in many rivers at high flows.
Lakes & reservoirs	1–20	Most deep lakes and reservoirs have low turbidity. However, shallow lakes and reservoirs may have higher natural turbidity due to wind-induced resuspension of sediments. Lakes and reservoirs in catchments with highly dispersible soils will have high turbidity.
Estuarine & marine	0.5–10	Low turbidity values are normally found in offshore waters. Higher values may be found in estuaries or inshore coastal waters due to wind-induced resuspension or to the input of turbid water from the catchment. Turbidity is not a very useful indicator in estuarine and marine waters. A move towards the measurement of light attenuation in preference to turbidity is recommended.

Water quality parameters should not be used in isolation from other environmental indicators when assessing ecosystem health. Habitat, flows, sediment pollution, biological communities etc. should all be taken into account when assessing the overall health of your stream. In most cases, it is best to contact your local Waterwatch Facilitator or Regional Coordinator to assist you with interpretation of your results. They are well trained in water quality analysis and have access to specialists if the need arises.

Appendix 1

Regional Co-ordinator

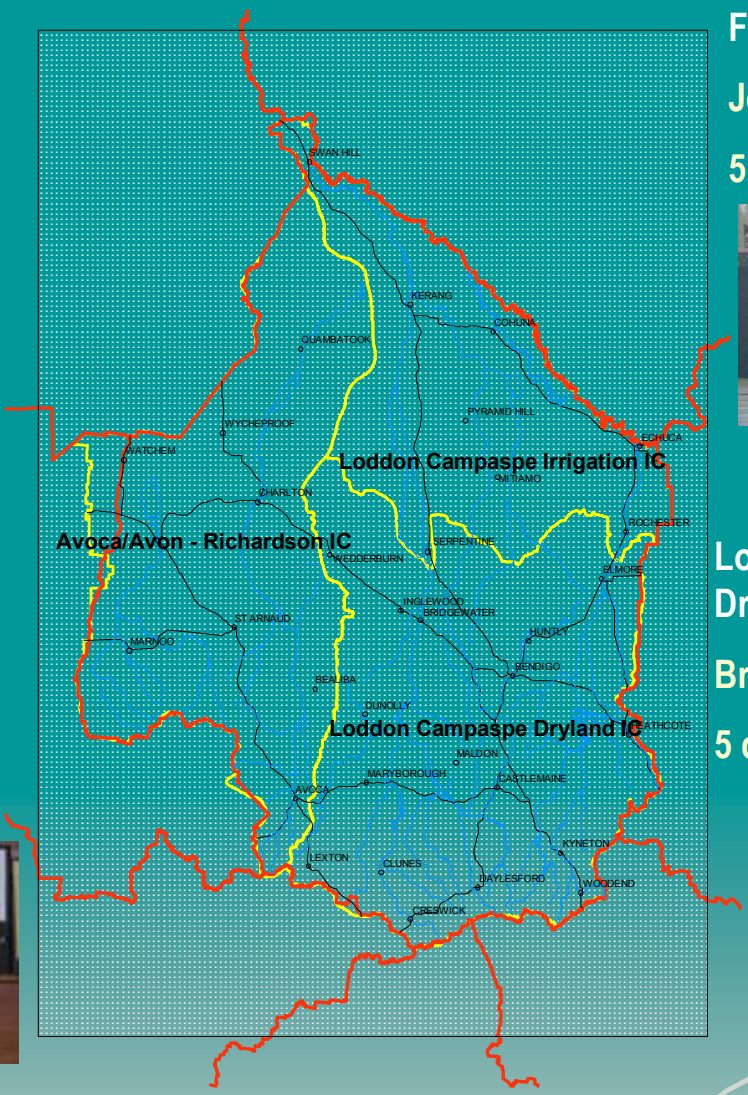
Leigh Mitchell

5 days/week

Loddon/Campaspe Irrigation Facilitator

Jennelle Carlier

5 day/week



Avoca / Avon-Richardson Facilitator

Melanie Barrot

5 days/week

Loddon/Campaspe Dryland Facilitator

Britt Gregory

5 days/week

The North Central Waterwatch Team

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Appendix 2 – Salinity impacts

Beef Cattle	
Initial Effect	<6 000 micro S/cm - no effect
Moderate Effect	6 000 -7 400 micro S/cm - reluctance to drink + scouring
Major Effect	7 400 - 15 000 micro S/cm - loss of production & condition
Dairy Cattle	
Initial Effect	<3 700 micro S/cm - no effect
Moderate Effect	3 700 - 6 000 micro S/cm - reluctance to drink + scouring
Major Effect	6 000 - 10 400 micro S/cm - loss of production & condition
Sheep	
Initial Effect	<7 400 micro S/cm - no effect
Moderate Effect	7 400 -15 000 micro S/cm - reluctance to drink + scouring
Major Effect	15 000 -19 400 micro S/cm - loss of production & condition
Horses	
Initial Effect	<6 000 micro S/cm - no effect
Moderate Effect	6 000 - 9 000 micro S/cm - reluctance to drink + scouring
Major Effect	9 000 - 10 400 micro S/cm - loss of production & condition
Pigs	
Initial Effect	<6 000 micro S/cm - no effect
Moderate Effect	6 000 - 9 000 micro S/cm - reluctance to drink + scouring
Major Effect	9 000 - 12 000 micro S/cm - loss of production & condition
Poultry	
Initial Effect	<3 000 micro S/cm - no effect
Moderate Effect	3 000 - 4 500 micro S/cm - reluctance to drink + scouring
Major Effect	4 500 - 6 000 micro S/cm - loss of production & condition

Source: Australian Commonwealth Government- Department of Environment & Heritage. Available: www.deh.gov.au

Appendix 3 – Measuring Electrical Conductivity

Conductivity measures the amount of dissolved ions such as, Calcium, Magnesium, Potassium, Chlorides and Bicarbonates that are present in a waterbody. It is measured by placing a conductivity probe in the sample and measuring the flow of electricity between the electrodes.

Conductivity is reported as micro siemens per centimetre (μS/cm), which can also be written as EC's.

Variation in conductivity can result through changes in geology of an area such as Basalt plains. It can also be due to seepage of groundwater, industrial and agricultural effluent, stormwater runoff and sewage effluent flowing into streams.

Hanna HI 98132 - EC/TDS and Temperature Meter:

Calibration

You will have a bottle of 12.88 mS/cm conductivity standard in your equipment box. This needs to stored in the refrigerator or a cool, dark place to maximise shelf life.

1. Place a small amount of calibration solution into the film canister provided.
2. From measurement mode, press and hold the MODE button (for 2 seconds) until CAL is displayed on the lower LCD.
3. Release the button and immerse the probe in the 12.88 mS/cm calibration solution – the CAL tag will blink.
4. The calibration will be performed automatically. The LCD will display OK for 1 second and the meter will return to normal measurement mode.
5. A CAL symbol will be displayed on the LCD when the meter is calibrated.

Discard the calibration solution (tip it down the sink) DO NOT tip it back into the bottle – this could contaminate the solution.

Measurement

1. Remove the cap from the end of the probe.

2. Do not immerse the probe section past the 'Waterproof' writing on the front of the probe. The machine is designed to be 'splashproof' not waterproof - ***don't immerse the whole probe***

3. Press and hold the MODE button for 2-3 seconds to turn the instrument on. Allow a few seconds to initialise.

4. Insert the probe into the water sample.

5. Select the mS (milli-siemens) mode with the SET/HOLD button. Wait until the stability symbol (small clock face) disappears. Record the mS and temperature (^{o}C) value.

6. Multiply the mS by 1000 to get the μS/cm (microsiemens) or EC value

7. Press the MODE button until you see a small OFF symbol in the lower part of the display, then release the button.

8. Rinse the probe with clean water to minimise contamination. Ensure probe is dry before replacing cap.

- Battery replacement: When the battery level is below 5%, a battery symbol will appear on the bottom left hand side of the display to indicate low battery condition. Attempt to replace these batteries as soon as possible. To change the batteries, remove the 4 screws located on the top of the meter. Carefully replace the 4 batteries, paying particular attention to their polarity. Replace the top, making sure that the gasket is properly seated in place, and tighten the screws.

Tracer Pocket Tester- EC/TDS and Temperature Meter

Calibration

You will have a bottle of 1413 or 12880 µS/cm Standard Solution in your equipment box. This needs to be stored in the refrigerator or a cool, dark place to maximise shelf life.

1. Turn the TRACER meter on
2. Fill the plastic cup to the 20mL line with the standard solution.

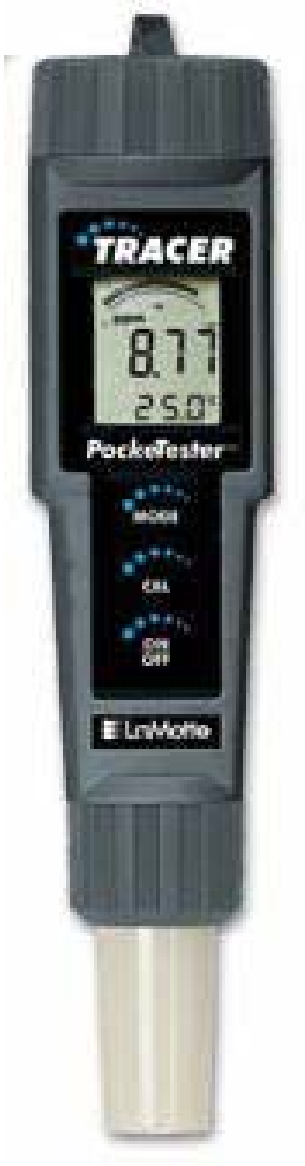
Note: The Tracer meter will calibrate at 3 points (84, 1413 and/or 12880µS/cm). If you wish to calibrate with more than one standard solution, then the lowest standard solution should be done first to obtain the best accuracy.

3. Insert the electrode into the standard solution,
4. Press and hold the CAL button for approximately 5 seconds until the display begins to flash.
5. The meter will then automatically recognize and calibrate to the standard solution. The display will briefly indicate “SA”, END and then return to the measurement mode.

Note: “SA” will not appear if the calibration fails.

Measurement

1. Fill the plastic cup to the 20mL line with the test/water sample.
2. Remove the cap from the end of the probe and turn the meter on (ON/OFF button)
3. Immerse the TRACER electrode in the sample. Make sure the electrode is completely submersed.
4. Slowly stir the sample with the TRACER to remove air bubbles.
5. The meter will autorange to the proper range and the reading will be displayed. The display will flash “0000” while autoranging.
6. Wait until the temperature stabilises, then take your reading.
7. Rinse the electrode in distilled water. Replace the cap.



Tracer Pocket Tester- pH/EC/TDS and Temperature Meter

Use same method as Tracer EC meter, ensuring that the meter is set to Conductivity Mode. You can change modes on this meter by pushing and holding the Mode button. Stop when µS symbol is displayed on the screen.

Note: **the probe should be cleaned thoroughly before use or calibration to ensure that there is no pH, reference solution (a highly concentrated salt solution that oozes out of the pH probe) present on the probe end.**

Eutech EcoScan Con 6- EC/TDS and Temperature Meter

Calibration

You will have a bottle of 1413 or 12880 µS/cm Standard Solution in your equipment box. This needs to be stored in the refrigerator or a cool, dark place to maximise shelf life.

1. Turn the EcoScan meter on
2. Select the most appropriate calibration solution for your site (please ask your Waterwatch Facilitator for advice on standard solution selection)
3. Fill a plastic container with Standard solution to a level that will immerse both metal strips on the conductivity probe

Note: The meter can be calibrated at 5 points (84, 1413 and/or 12880µS/cm plus two higher range settings that can be programmed into the meter). If you wish to calibrate with more than one standard solution, then the lowest standard solution should be done first to obtain the best accuracy. Your Waterwatch Facilitator will advise you if a high level standard solution is required for your site. Your meter may need to be programmed if this is the case.

4. Insert the electrode into the standard solution
5. Press the CAL button; the display should begin to flash
6. The meter will then automatically recognize and calibrate to the standard solution. Press the hold/enter button and the meter will be calibrated and ready to use

Measurement

1. Fill a sample bottle with the test/water sample.
2. Turn the meter on (ON/OFF button) and ensure that the probe is clean (rinse with sample water)
3. Immerse the probe in the sample. Make sure the two metal strips are completely submersed.
4. Slowly stir the sample with the probe to remove air bubbles.

5. The meter will autorange to the proper range and the reading will be displayed. Wait until the temperature stabilises, then take your reading. (you can check the temperature by pushing the Mode button)
6. Rinse the electrode in distilled or low salt (below 400µS/cm) tap water.

Advanced methodology and maintenance

These notes are intended for monitors that wish to achieve a Standard 3-4 data confidence level.

- Calibration should be carried out before *each test*. This is especially important if the EC range is widely different between sites.

- When calibrating, the EC probe should be rinsed in the standard solution before the calibration measurement is taken.

- As above, the probe should be rinsed in sample water before taking sample measurement.

- Probe should be cleaned quarterly or as required. Probes will need more regular cleaning if your sample water contains oils or other scums that may build up on the terminals.

- Probes should be cleaned by placing them in alcohol (methylated spirits is sufficient) for 15 mins. Rinse the probe in tap water before use or storage.
- See section 7 for sample collection techniques.
- Calibration logs should be kept.
- Meters should be calibrated at the level closest to readings observed. For example: streams with EC levels of around 1000µS/cm should be calibrated with 1413µS/cm standard solution.

Appendix 4 – Measuring phosphorus

Phosphorus is a nutrient that occurs naturally at low concentrations in water and is essential for life. Phosphorus comes from the weathering of rocks and from the decomposition of organic matter such as plant litter. Phosphorus is present in streams as soluble phosphates, phosphorus bound to sediments and phosphates occurring in living organisms. We measure phosphorus in milligrams per litre (mg/l).

Macherey-Nagel VISOCOLOR HE Phosphate test (low range 0.01-0.25mg/L P)

Caution: this kit contains dangerous chemicals. Please ensure that you have read the safety requirements and Material Safety Data Sheets provided with your kit. If you are missing MSDS's, please contact North Central Waterwatch for replacements.

Equipment

- Safety gloves and glasses
- Distilled Water
- Syringe Filter and syringe (If needed)

Measurement

1. Collect sample
2. Open the phosphorus kit and set up.
3. Place the colour wheel in the foam box.
4. Rinse both test tubes with sample water 2-3 times (with lid in place).
5. Fill both test tubes with river water up to the black line.

Caution: Wear safety gloves and glasses while undertaking this test.

5. Add 1 level microspoon of reagent PO4-1 to the sample tube on the right (or on the inside of the colour wheel). Shake to dissolve.
6. Add 15 drops of Reagent PO4-2 into the same tube and mix.
7. Leave the solution to stand for five minutes to allow full colour development. If phosphorus is present sample will turn a shade of blue.
8. Turn the wheel until the closest possible colour match is achieved between the two open tubes viewed from above.
9. Read off the value shown on the scale displayed on the colour wheel. Record the number as mg/L P (phosphorus) and record in your result book.
10. If the value obtained is equal to or more intense than the darkest colour on the scale (0.25 mg/L), repeat the measurement on a fresh diluted sample, eg. Dilute the sample 1:5 by adding 10mL of sample to 40mL of distilled water in a 50mL measuring cylinder. Remember to multiply your answer by the dilution factor, in this case multiply by 5. Alternatively, you could repeat the test with a high range kit.

11. Repeat this dilution if the colour is still too intense.

Note: The colour remains stable for about 30 minutes.

Macherey-Nagel VISOCOLOR HE Phosphate test (high range 0.05-1.0 mg/L)

Caution: this kit contains dangerous chemicals. Please ensure that you have read the safety requirements and Material Safety Data Sheets provided with your kit. If you are missing MSDS's, please contact North Central Waterwatch for replacements.

Equipment

- Safety gloves and glasses
- Syringe Filter and syringe (If needed)

Measurement

1. Collect sample
2. Open the phosphorus kit and set up.
3. Place the colour wheel in the foam box.
4. Rinse both test tubes with sample water 2-3 times (with lid in place).
5. Fill both test tubes with river water up to the black line.

Caution: Wear safety gloves and glasses while undertaking this test.

6. Add 6 drops of reagent P-1 to the sample tube on the right (or on the inside of the colour wheel). Mix.
7. Add 6 drops of reagent P-2 into the same tube and mix.
8. Leave the solution to stand for ten minutes to allow full colour development. If phosphorus is present sample will turn a shade of blue.
9. Turn the wheel until the closest possible colour match is achieved between the two open tubes viewed from above.
10. Read off the value shown on the scale displayed on the colour wheel. Record the number as mg/L P (phosphorus) and record in your result book.

There are other methods to measure phosphorus, but many of these require expensive equipment. Groups that are interested in purchasing high quality testing equipment may be able to apply for funding through several grants. Please contact your Regional Waterwatch Coordinator for further details.

Advanced Methodology and Maintenance

- Glassware should be acid washed and rinsed with distilled water on a regular basis. Your Waterwatch Facilitator should do this every 6 months.
- Standard 3 and 4 monitors should acid wash their glassware once a quarter. Either 10% hydrochloric acid or high quality cleaning vinegar (acetic acid) will be sufficient. Glassware should be washed more frequently if very high levels of phosphate are observed.
- For best results, reactive phosphate tests must be carried out at temperatures between 18 and 30 degrees centigrade.
- Highly turbid sample waters should be filtered before testing. Please talk to your local Waterwatch Facilitator if you think you may require filters. There are special procedures that need to be taken if they are to be used.
- Ensure that test kits are kept cool and dry.
- Ensure that no moisture is introduced to the Reagent 2 container of the low range test.

Appendix 5 – Measuring Turbidity

Turbidity is a measure of the 'cloudiness' of your sample. An increase in suspended matter increases the turbidity of the water. High turbidity causes water to appear murky or cloudy. **Turbidity is measured in nephelometric turbidity units.**

Measurement

1. Collect sample in a clean bucket or sample bottle.
2. Ensure sample is well mixed before testing.
3. Gradually pour the sample into the turbidity tube while looking vertically down the tube. Hold the tube out of direct sunlight during this procedure.

4. Stop pouring at the point where the black mark on the bottom of the tube is just visible.
5. Note the reading from the scale on the side of the tube.
6. Record the reading as NTU.
7. If the reading is above 200, dilute the sample 1:1 with tap water. Repeat testing procedure and multiply the final result by 2.
8. If you fill the turbidity tube to the top or past the last reading and the black lines are still visible, take the reading as less than the last number, eg <10 NTU.

Advanced methodology and maintenance

- Wash the turbidity tube thoroughly with tap water, ensure tube is kept clean, and is free from contamination.

- Turbidity tubes should be replaced when they become overly scratched.

- Advanced monitors (Standard 3 + 4) should compare results with a turbidity meter to ensure that transparency results equate to turbidity results.

Appendix 6 – Measuring pH

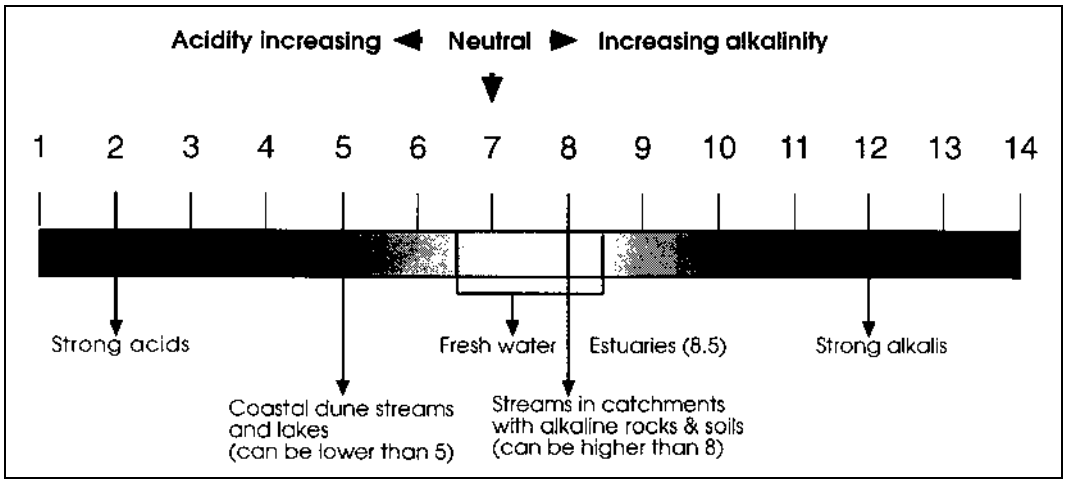
When we measure pH we are measuring how acidic or alkaline the water is. pH is a measure of the hydrogen ion (H^+) concentration.

The pH scale is from 0-14, pH of 7 is neutral, zero is the most acidic and 14 is the most alkaline.

When a pH value changes by a unit of 1, eg. from 6 to 5, this equals a change in strength by 10 times. So a pH of 5 is 10 times more acidic than pH of 6, a pH of 4 is 100 times more acidic than the pH of 6. With alkaline substances it is the same, a pH of 14 is 10 times more alkaline than a pH of 13 and 100 times more alkaline than a pH of 12.

A large increase or decrease in pH outside the normal range of a stream will have a dramatic effect on the number and diversity of species found within the waterbody. To maintain a healthy diversity of life, pH must be kept within the range of the natural variation for the waterbody.

The pH Scale



Macherey-Nagel pH strips

pH strips are a quick, easy and cost effective way to measure pH. Unfortunately, they do not have very good resolution (only large increments of measurement) and can be quite subjective, depending on the monitors' eyesight, time of day etc.

Measurement

1. Collect sample in a clean beaker or bucket.
2. Place indicator strip in sample and allow to sit for at least five minutes or until there is no further colour change.
3. Remove indicator strip from sample.
4. While moist, compare colour strip with chart on indicator packet.

Maintenance

- Store pH indicator strips in a dry moist free area. When using pH strips ensure the indicator packet is kept dry.
- Indicator strips have a shelf life of 3 years.

Tracer Pocket Tester- pH/EC/TDS and Temperature Meter

pH meters give a much more accurate reading measurement of pH. Most of the pH pocket testers' available measurement increments of 0.1 pH units. However, pH meters require regular maintenance and calibration. At sites where pH is an environmental issue or where monitors wish to gain accurate baseline pH data, it is recommended that a pH meter be used.

Calibration

You will have a bottle of 7 or 10 pH Buffer Solution in your equipment box. This needs to be stored in the refrigerator or a cool, dark place to maximise shelf life.

1. Turn the TRACER meter on and ensure it is set to pH measurement mode. Modes can be changed by pushing and holding the Mode button for

approximately 4 seconds. A small pH symbol will be shown when the meter is in pH measurement mode.

2. Fill the plastic cup to the 20mL line with the buffer solution.

Note: The Tracer meter will calibrate at 3 points (4, 7, 10pH). If you wish to calibrate with more than one buffer solution, the pH 7 buffer solution should be done first to obtain the best accuracy.

3. Insert the electrode into the buffer solution, slowly stirring and allowing the temperature to stabilise. When the temperature and pH readings have stabilised, record the value on your calibration log (Standard 3 + 4 monitors) and continue onto step 4.
4. Press and hold the CAL button for approximately 3 seconds until the display begins to flash.
5. The meter will then automatically recognize and calibrate to the buffer solution. The display will briefly indicate "SA", END and then return to the measurement mode.

Note: "SA" will not appear if the calibration fails.

Measurement

1. Fill the plastic cup to the 20mL line with the test/water sample.
2. Remove the cap from the end of the probe and turn the meter on (ON/OFF button)
3. Immerse the TRACER electrode in the sample. Make sure the electrode is completely submersed.
4. Slowly stir the sample with the TRACER to remove air bubbles.
5. Wait until the temperature stabilises, then take your reading.
6. Rinse the electrode in tap water. Always ensure that the sponge at the end of the cap is moist with pH buffer (either 4 or 7). Replace the cap.

Model Hanna HI 98130 - pH EC/TDS and Temperature Meter

Calibration

1. Place a small amount of pH buffer solution into the film canister provided.
2. From pH measurement mode (change modes by pressing the Set/Hold button), press and hold the MODE button (for 3 seconds) until CAL is displayed on the lower LCD.
3. Release the button and immerse the probe in the appropriate buffer solution – the CAL tag will blink.
4. The calibration will be performed automatically. The LCD display OK for 1 second and the meter will return to normal measurement mode.
5. A CAL symbol will be displayed on the LCD when the meter is calibrated.
6. Discard the buffer solution (tip it down the sink or into your waste container) DO NOT tip it back into the bottle – this could contaminate the solution.

Measurement and preventative maintenance

1. Remove the cap from the end of the probe.
2. Do not immerse the probe section past the 'Waterproof' writing on the front of the probe. The machine is designed to be 'splashproof' not waterproof - ***don't immerse the whole probe***
3. Press and hold the MODE button for 2-3 seconds to turn the instrument on. Allow a few seconds to initialise.
4. Insert the probe into the water sample.
5. Select the pH mode with the SET/HOLD button. Wait until the stability symbol (small clock face) disappears. Record the pH and temperature (^{o}C) value.
6. Press the MODE button until you see a small OFF symbol in the lower part of the display, then release the button.
7. Rinse the probe with clean water to minimise contamination and add a few small drops of pH buffer solution to the cap before replacing it.

Battery replacement: When the battery level is below 5%, a battery symbol will appear on the bottom left hand side of the display to indicate low battery condition. Attempt to replace these batteries as soon as possible. Please contact your local Waterwatch facilitator to organise a battery change.

Advanced methodology and maintenance

Standard 3 + 4 monitors should follow these methods.

- Most streams in the North Central region will have pH ranges between 7 and 10. It is recommended that the meter be calibrated with both 7 and 10 pH buffer solutions before each use. If the pH reading of the sample is lower than 7, you should recalibrate your meter with 4 pH buffer solution, then re-test your sample.
- Calibration logs should be kept. Report any regular *significant* (over 0.5 pH unit) drift to your local Waterwatch facilitator. Your probe may need replacing.
- Rinse the probe with pH buffer solution before calibration. This reduces cross-contamination that may affect your calibration.
- pH probes need to be cleaned regularly to ensure accuracy. Clean the probe by immersing it in alcohol for about 10 mins. Rinse with tap water then *dab* dry with a tissue or soft rag. ***Never* rub the glass bulb dry**.
- The probe of pH meters should always be kept moist (usually with pH buffer solution). Probes will not function properly if they are allowed to dry out.

Appendix 7 – Measuring Temperature

Temperature is measured with a thermometer. The most common thermometer used in the North Central Waterwatch program is the built in thermometer present in EC and pH probes. Glass thermometers may also be used.

Calibration

Calibrating thermometers is beyond quite difficult. If you think your thermometer is malfunctioning, please return it to your North Central Waterwatch.

Measurement

To ensure that you obtain an accurate reading, temperature should be measured *immediately* after sample collection. Depending on the thermometer used and the temperature of the sample, you should allow about 2-5 mins before taking your reading.

Appendix 8 – Measuring Ammonia

Ammonia (NH_3) is the most readily available form of nitrogen for assimilation during plant and bacterial growth. Ammonia concentrations are generally very low in waterways as it is very quickly assimilated by plants and bacteria. Ammonia levels will rise dramatically when certain organic pollutants are present in a water body, particularly animal wastes, sewage and some industrial wastes. Some fertilisers may also raise ammonia levels if they enter waterways.

Macherey-Nagel VISOCOLOR HE Ammonium test (low range 0.02-0.50mg/L NH_4^+)

This test actually gives you a total ammonia value. It is the combination of NH_3 and NH_4^+ present in the sample.

Caution: this kit contains dangerous chemicals. Please ensure that you have read the safety requirements and Material Safety Data Sheets provided with your kit. If you are missing MSDS's, please contact North Central Waterwatch for replacements.

Equipment

- Safety gloves and glasses
- Syringe Filter and syringe (if needed)

Measurement

1. Collect sample
2. Open the phosphorus kit and set up.
3. Place the colour wheel in the foam box.
4. Rinse both test tubes with sample water 2-3 times (with lid in place).
5. Fill both test tubes with river water up to the black line.

Caution: Wear safety gloves and glasses while undertaking this test.

6. Add 10 drops of reagent NH_4^+-1 to the sample tube on the right (or on the inside of the colour wheel). Mix.
7. Add one level measuring spoon of NH_4^+-2 into the same tube and mix.
8. Leave the solution to stand for 15 minutes to allow full colour development. If phosphorus is present, the sample will turn a shade of yellow through to green.
9. Turn the wheel until the closest possible colour match is achieved between the two open tubes viewed from above.
10. Read off the value shown on the scale displayed on the colour wheel. Record the number as mg/L NH_4^+ (phosphorus) and record in your result book.
11. Clean tubes thoroughly.