

CONTENTS

SECTION 1. EQUIPMENT GUIDE

| | |
|--------------------------------|----|
| Introduction | 1 |
| Supplier Contact Details..... | 3 |
| Water Sampling Equipment | 4 |
| Velocity and Flow | 5 |
| Temperature | 6 |
| Turbidity..... | 7 |
| Conductivity (salinity)..... | 9 |
| pH..... | 11 |
| Dissolved Oxygen | 13 |
| Phosphorus | 15 |
| Nitrogen..... | 20 |
| Kits | 23 |
| Faecal Coliform Bacteria..... | 25 |
| Macroinvertebrates | 28 |
| Algae | 29 |

SECTION 2. HOME MADE EQUIPMENT

SECTION 3. SUPPLIERS' INFORMATION FLYERS & PAMPHLETS

INTRODUCTION

This **Waterwatch Equipment Manual** contains a selection of field water testing equipment that is appropriate for most community groups for most purposes. The equipment listed will test the following parameters: phosphorus, nitrogen, dissolved oxygen, conductivity, temperature, pH, turbidity, macroinvertebrates, algae, faecal coliform bacteria, *E.coli* and flow rate. The equipment listed is by no means exhaustive and new equipment is continually coming on to the market.

Your equipment decisions will depend on a host of factors such as:

- your purpose for monitoring;
- who will use the data and how;
- the most relevant parameters to test;
- the quality of the data required;
- the skills of your group and the complexity of the testing procedures;
- available funding - there are several equipment options for any given water quality indicator;
- the expected concentration range of the parameter to be measured. Equipment should match the expected levels; your program will not succeed if results are continually 'not detected';
- safety issues as some test use potentially hazardous chemicals such as acids;
- robustness of the equipment and care required to maintain it eg. pH meters require constant care.

Make a list of all the equipment that fulfils the above criteria. Testing of water samples is usually carried out on the river bank with field equipment, but many groups also use a local school laboratory for some tests such as bacteria and total phosphorus, particularly if the weather is unfavourable. Common laboratory equipment includes glassware, incubators, hot plates, and autoclaves, all of which are needed for faecal coliform testing. Sharing equipment is one of the benefits of community groups linking with schools in developing a Waterwatch program.

Field testing equipment can be easily purchased from suppliers listed. Costs range from a few dollars for latex gloves to more than \$1700 for a colorimeter. Code numbers for equipment given relate to the particular supplier named but the same item of equipment is often available from a number of sources. You may be able to gain a better price for your purchases through direct negotiation with the distributor and by shopping around. Note that prices quoted here do not include sales tax or freight.

The draft 1998 Waterwatch Victoria Quality Assurance/Quality Control Strategy and 1999 QA/QC Guidelines will provide Waterwatch groups with a means to produce data of a known quality. Procedures outlined in the Guidelines will allow monitors to establish accurate data. In all cases, kits or instruments should be checked for calibration against standard solutions and any corrections made as necessary. In circumstances where agency or sponsor instruments are available, take the opportunity to test duplicate samples to verify the accuracy of your results.

When you've purchased equipment, spend a day setting it up and running the tests on a few samples. This will help you identify and work out problems. A dry run will also help you identify additional equipment needs. Try to do this at least two weeks before the first training session to allow enough time to order missing equipment and supplies. Make sure to label all the equipment purchased with your Waterwatch group name and a good idea is to keep an equipment register.

TO NOTE:

As price and code details of equipment are continually changing please ensure that you confirm information contained within this guide upon ordering from a supplier. This guide is intended as a reference and provides equipment as examples, it will be necessary for you to research the equipment you wish to buy and ensure that it is suitable for your requirements.

Many suppliers will offer a discount to Waterwatch programs, for example Selby Biolab a 15% discount. Ensure that when ordering for your Waterwatch Program that you inquire about discounts available to Waterwatch groups. Prices for Merck are expected to change very soon, once their new flyer is printed prices will rise.

Supplier details and prices listed in this manual were updated on 23/3/99. Phone and fax numbers and prices may change without notice.

SUPPLIER CONTACT DETAILS

AUSTRALIAN ENTOMOLOGICAL SUPPLIES - Alan Frazer

Phone..... 02 6684 7650
Fax 02 6684 7188

CROWN SCIENTIFIC

Phone..... 03 9764 4722
..... 1800 134 175
Fax..... 03 9764 4733

MERCK

Phone..... 03 9728 5855
..... 1800 335 571
Fax..... 03 9728 7611

MICRO DIAGNOSTICS PTY LTD

Phone..... 1800 812 519
Fax..... 07 3254 1911

MILLIPORE

Phone / Fax..... 03 9848 4219
..... 1800 222 111

MR GOOD TIMES - Bob Hunter

Phone / Fax..... 5442 1393

SELBY BIOLAB

Phone..... 132 991
Fax 1800 067 639

SOUTHERN BIOLOGICAL SERVICES

Phone..... 03 9877 4597
Fax..... 03 9894 2309
Email..... southernbiological@bigpond.com

STATE PURCHASING & SALES

Phone..... 03 6336 2977
Fax..... 03 6343 0820

TECHNOLAB PTY LTD

Phone..... 03 6229 7437
Fax..... 03 6229 2748

VENDART - Colin Tyerman

Phone..... 02 9679 1139
Fax..... 02 9679 1139

WATER SAMPLING EQUIPMENT

The way you collect your sample can have a tremendous influence on your results. It is important to collect samples so that they are representative of the water you are monitoring. That means that the sample should be collected in places that are typical of the waterway and that your sampling procedure does not influence the parameter that you are measuring.

Water samples are collected in 500 ml high density polyethylene or polypropylene bottles. Most tests are done on site but if you transport samples back to a lab you must number each container with the site number, time of collection, parameter to be tested and other details to avoid mix ups. Use a bottle on a pole to sample away from the riverbank in the main current as close as possible to the middle of the stream.

Water sampler (sample bottle and detachable holder, code WS01) \$22.60
Sample bottle and detachable holder is designed to clip onto extension pole which can also be used for a macro-invertebrate sampling net.

Available from Vendart

Poles for water sampler described above

4'-8' extension al. pole (code V-48E) \$19.45
6'-12' extension al. pole (code V-72E) \$22.00
8'-16' extension al. pole (code V-96E) \$26.50

Available from Vendart.

Home made bottle attached to long pole

Useful for collecting deep water samples or from bridges.

Home made weighted bucket or bottle and line

Useful for collecting deep water samples or from bridges.

Cooler

Insulated cooler for storing water samples for testing back at a lab

Available from various domestic suppliers. eg K-mart

Sample Bottle

Wide mouth plastic sample bottles, 1litre, screw top lid, code no PJHD/1L.....\$1.35each

NB: Polyethylene bottles are the best for water collection

Whirlpaks 500 twist sample bags 7"x3" wide, code no HAC22331-00..... \$156.50

Available from Selby Biolab

VELOCITY AND FLOW

Flow is the volume of water a stream or river discharges over a given amount of time. Flow is measured in cubic metres per second (m^3/s) or megalitres per day (ML/d). One megalitre is one million litres and an Olympic sized swimming pool is about 2.5 ML.

Velocity is the distance that water travels over a given period of time; ie the speed of the water. Velocity is measured in metres per second (m/s).

Because velocity and flow have a significant impact on water quality, it is important that you record them at the time of sampling and if possible, during the previous few days. It is particularly valuable to know if flows are at low, moderate or flood level.

Flow is determined by measuring the velocity and cross sectional area of the stream. Flow data may be available from your local water authority if your monitoring site is near a gauging station. However, if you collect your own data, a measurement of both the average velocity and the cross-sectional area of the stream are required to calculate flow.

Volume of flow measurements can be combined with nutrient concentration results to estimate the loss of nutrients from the catchment in kg per hour per hectare.

Cross Sectional area of your stream

Posts (2 eg. star picket)

String

Retractable measuring tape (10 m)

Available from various hardware suppliers

Velocity

Retractable measuring tape (10m) or ten metre length of line

Available from various hardware suppliers

TEMPERATURE

Water temperature is a simple indicator to measure. It is important because it affects the rate of many biological and chemical processes in the waterway and the amount of oxygen gas that can dissolve in the water. The well-being of aquatic life, from bacteria to fish, depends on temperature. Each living thing has a range of temperatures that is best for its health and a maximum temperature that it can tolerate before it dies or its growth and reproduction are severely affected.

Temperature is measured directly in the river with a thermometer or a meter. It is measured in degrees Celsius (°C). Alcohol-filled thermometers are preferred over mercury-filled ones because they are less hazardous if broken. Armoured thermometers for field use can withstand more abuse than unprotected glass thermometers and are worth the additional expense. Meters for other tests, such as pH or dissolved oxygen, may also measure temperature and can be used instead of a thermometer.

Temperature should be measured as part of any monitoring work. In deep areas or lakes, several measurements from the top to the bottom of the water column can be made to obtain a temperature profile.

DIGITAL THERMOMETER

Digital thermometers, some with remote probes give a clear digital read out and are available for around \$60.00 but tend to give problems in time and batteries need replacing. No preferred brand is specified. Check the sensitivity of the electronic thermometer to see if it meets your requirements and calibrate it against other types before use.

GLASS THERMOMETER

A good glass thermometer that is treated with care is satisfactory. Thermometers with protective cases that contain alcohol instead of mercury are preferred in case of breakage.

| Supplier/Code | Equipment | Range, units | Calibration | Cost |
|---|---|---|-------------------------------------|---------|
| Southern Biological code: G9.25 | Red spirit glass thermometer | -10 to 110°C | check against other thermometers | \$7.50 |
| Vendart code: 1066 | Enviro- safe,armoured glass thermometer | -5 to50 °C | check against other thermometers | \$28.50 |
| Crown Scientific code:44/401 code:44/403 code:44/406 | Red spirit glass thermometer | -10 to 50°C -10 to 110°C -10 to 150°C | check against other thermometers | \$5.25 |
| Merck code:T268 | Digital thermometer | -20°C to 100°C | check against other thermometers | \$47.00 |

TURBIDITY

Turbidity is a measure of water clarity ie. how much the particles suspended in the water decreases the passage of light through the water. Particles include soil particles (clay, silt and sand), algae, plankton, microorganisms, and other substances. To the naked eye, turbidity appears as cloudy or muddy water. It differs from colour; water can have high colour and low turbidity eg. tannin rich waters that flow through peaty areas are naturally brown but can have very low turbidity. Although turbidity measures the effect the particles in the water have on water clarity, it does not actually measure the concentration of these particles.

Turbidity is measured with a turbidity tube which is calibrated in terms of nephelometric turbidity units NTU's, a turbidimeter as (NTU's), colorimeter as Formazin Units (FTU's), or with a Secchi disk as meters depth. Natural (or background) turbidity levels in waterways vary from less than 1 NTU in mountain streams to more than hundreds of NTUs during rainfall events. The units used for reporting turbidity are equipment specific. There is no direct correlation between units.

TURBIDITY TUBE

For the turbidity tube test, simply collect water and pour into the tube until you can barely see the squiggly lines on the bottom. The height of the water column in the tube can be read as NTUs. No calibration is required and the tube reads from 7 - 400 NTU's. The main limitation is that the tube is not as precise as meters and does not read low turbidity levels (< 7 NTU's) common in natural waterways and coastal rivers. The turbidity tube is adequate for most purposes but, if your waterways are generally very clear, then you may consider using a turbidimeter or colorimeter.

SECCHI DISK

The Secchi disk is used to measure the depth that a person can see into the water (transparency). The Secchi disk is a black and white 20 cm diameter disk that is lowered into the water by hand to the depth where it disappears from sight (vanishing point). This depth is measured in meters. The clearer (less turbid) the water, the greater the distance.

The main advantage of Secchi disks is that they are cheap and easy to use. For river monitoring however, they have limited use because the river bottom is often visible and the disk is swept downstream by the current making accurate measurements impossible. In addition, the depth reading in metres cannot be correlated easily with the standard unit of turbidity (NTU). You may consider using a Secchi disk if you wish to monitor clarity of a lake or deep slow moving river or estuary, and the water is too clear for accurate turbidity tube readings (< 7 NTU), and if your group cannot afford to buy a turbidimeter or colorimeter.

COLORIMETER

Colorimeters can more precisely measure turbidity by measuring the transmittance of light through a sample. However, measurements are usually made in Formazin Turbidity Units (FTU) which is a major disadvantage because FTUs cannot be compared with the standard unit of measurement for turbidity - NTU. Colorimeters are useful for comparative studies at a site over time or distance particularly when turbidity is quite low or you need more precise results than can be gathered using a Waterwatch turbidity tube and comparison with other readings is not required.

TURBIDIMETER

A turbidimeter is a dedicated instrument for measuring turbidity and will provide accurate results to very low levels but is also very expensive.

| Equipment/ Supplier/Code | Method | Range, Units | Sensitivity | Calibration | Cost |
|--|--|--------------------|--------------------------------|-------------------------------------|-----------|
| Waterwatch Turbidity Tube Waterwatch Victoria | visual check | 10 - 400NTU | Standard deviation of 4 NTU | none | \$25.00 |
| Secchi disk Southern Biological code:ENV.8.10 | visual check | 0 metres + | unknown | none | \$55.00 |
| La Motte Smart Colorimeter Vendart code:1911 | measures amount of light transmitted through sample | 0 -400 FTU | 0.8 FTU | calibrate against blank sample | \$1750.00 |
| La Motte DC 1600 Colorimeter Vendart code:1785 | measures amount of light transmitted through sample | 0 -400 FTU | 0.8 FTU | calibrate against blank sample | \$1235.00 |
| HACH DR890 Colorimeter Selby Scientific Code: HAC48470 | measures amount of light transmitted through sample | 0-1000 FTU | 2 FTU | calibrate against a blank sample | \$1955.00 |
| La Motte Turbidimeter Vendart code:1799-EX2 | measures amount of light scattered at right angles from a beam | 0 - 199.9NTU | 0.05 NTU | use standards supplied | \$1440.00 |
| Hach Turbidimeter 2100P Selby Scientific code:46500-00 | measures amount of light scattered at right angles from a beam | 0.01 - 1000 NTU | 0.01 NTU | use standards supplied | \$2540.00 |

NB: it is also possible to make your own Secchi disk.

CONDUCTIVITY (SALINITY)

The basic unit of measurement for conductivity is microsiemens per centimetre ($\mu\text{S}/\text{cm}$) or electrical conductivity (EC) units. This measure is the inverse of the amount of resistance an electric charge meets in travelling through the water.

Distilled water has a conductivity in the range of 0.5 to 3 $\mu\text{S}/\text{cm}$. The conductivity of rivers in Australia generally ranges from 30 to 2000 $\mu\text{S}/\text{cm}$. Estuaries have a higher conductivity than freshwater since as salinity increases, conductivity also increases. Sea water typically has a conductivity of 51 500 $\mu\text{S}/\text{cm}$. Industrial waters can range as high as 10,000 $\mu\text{S}/\text{cm}$. Conductivity of bore water varies but can be very high and unsuitable for drinking.

Conductivity is useful as a general measure of water quality. Each river tends to have a relatively consistent conductivity range that, once established, can be used as a baseline for comparison with regular measurements of conductivity. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a waterway.

CONDUCTIVITY METERS

Conductivity is measured using a meter containing two electrodes. A voltage is applied between the electrodes and the voltage drop caused by resistance of the water is used to calculate its conductivity per centimetre that is displayed on the meter. Some conductivity meters display the reading as total dissolved solids (mg/L) by using an inbuilt conversion factor.

Your meter should also measure temperature and automatically compensate for temperature in the conductivity reading. Most meters automatically compensate for sample temperature (ATC) and should be purchased in preference to non-compensating meters. If you have a non-compensating meter, the water temperature needs to be measured at the same time. When comparing salinities of different samples, it is important to standardise the reading to 25°C. When standardising, increase the reading by 2% per degree for samples with temperatures below 25°C, and reduce it by 2% per degree for samples above 25°C.

Separate meters are available for fresh water (0 - 1990 $\mu\text{S}/\text{cm}$) and brackish (slightly salty 0 - 19 900 $\mu\text{S}/\text{cm}$) and sea water. Use a meter that matches the expected conductivity range of your waterway.

CALIBRATION

Use a conductivity calibration solution (usually potassium chloride) to calibrate the meter at 25 °C to the range that you will be measuring. For example, a 0.01 molar KCl solution will have a conductivity of 1413 $\mu\text{S}/\text{cm}$, and a 0.001 molar KCl solution will have a conductivity of 147 $\mu\text{S}/\text{cm}$. Conductivity standard solutions will last three months if kept in the fridge between uses. You will need to rinse the electrodes with deionised water.

| Equipment/ Supplier/Code | Method | Range, units | Sensitivity | Calibration | Cost | Comments |
|--|-------------|---------------------|-------------|-------------------|----------|---|
| Eutech Cybernetics Conductivity Meter Vendart code:TD Scan3 | EC meter | 10-1999 μ S | 10 μ S | Lab. standards | \$98.00 | For Rivers |
| Water proof version of the TD ScanWP3 | EC meter | 0 - 1990 μ S | 10 μ S | Lab. standards | \$135.00 | Fully Waterproof- Low Range |
| Eutech Cybernetics conductivity Meter Vendart code:TD Scan 20 | EC meter | 10 μ S-19.90 mS | 10 μ S | Lab. standards | \$140 | This instrument is dual range for both rivers (10 - 1990 μ S) and brackish (2.00 - 19.90 mS) |
| Eutech Cybernetics Conductivity meter Vendart Code:TD Scan 4 | EC meter | 0.1 - 19.90mS | 0.1mS | Lab. Standards | \$98.00 | For Brackish Waters 0.1 - 19.90 mS |
| Water proof version of the TD ScanWP4 | EC meter | 0 - 19.90 mS | 0.1 mS | Lab. Standards | \$135.00 | Fully Waterproof- Rivers to Brackish water |

Replacement batteries (type AC675E Cat No. S3038, 1.4 V, zinc-air, set of 4) \$3.35

Zinc-air batteries for hearing aids are cheap and have a long shelf life. To use, remove a tab which covers a small air hole in the battery.

Available from *Dick Smith* Phone - 1300 366 644

Calibration solution

Calibration solutions should be similar to the range you are testing.

- 0.01 M KCL = 1413 μ S/cm at 25 °C (dissolve 0.7456 g of KCL dried overnight at 105 °C in freshly boiled deionised water and dilute to 1 L).
- 0.001 M KCl = 147 μ S/cm at 25 °C (dissolve 0.07456 g of KCL dried overnight at 105 °C in freshly boiled deionised water and dilute to 1 L).

Have this made up at a school laboratory or buy from commercial suppliers.

Deionised water pack (Palintest PT500)..... \$29.90

Used for rinsing test tubes used in nutrient testing and for testing a blank sample to detect contamination of equipment.

Palintest PT500 makes a total of approximately 5 Litres from tap water.

Available from *Crown Scientific*. D.I water also available from supermarkets and Laboratories

pH

Measurements of pH tell us a lot about the natural condition of a water body as well as indicating whether there is any pollution from acids or alkalis.

The pH of natural waters is largely determined by the geology and soils of the catchment. Water running off limestone areas would, for example, have relatively high pH levels. On the other hand, streams and lakes in coastal dune areas may have very low pH values (sometimes less than 5) due to the presence of humic acids. These cause the brown tea-tree colour in water.

Increasing salinity causes an increase in pH. In a typical estuary, pH would rise in line with increasing salinity levels from values of 6.5 to 7.5 in the upstream fresh water reaches, to between 8 and 8.5 in downstream fully saline coastal areas.

The photosynthetic activities of plants and algae can cause significant variations in pH. This happens over the 24-hour daily cycle. It is due to the removal of dissolved carbon dioxide (which causes acidity) from the water by plants. As with dissolved oxygen, highest pH values usually occur at mid-afternoon. The range from pH 5-9 is the critical range for fresh water monitoring.

A variety of methods to measure pH are available. Some options are described below. Choose the equipment that is best for your purposes.

pH PAPER

pH paper is a paper strip coated with a solution called an indicator. This changes colour as the pH changes and the colour is then compared to a colour scale. pH paper has long shelf life (3 years) if stored in cool dry conditions. pH papers give reliable results for monitoring groups. Your pH paper should be suitable for weakly buffered waters.

pH METER

A pH meter measures the electric potential (in energy expressed as millivolts) across an electrode when immersed in a water sample. This electric potential is a function of the hydrogen ion activity in the sample. Therefore, pH meters can display results in either millivolts (mV) or pH units.

A pH meter consists of a potentiometer, which measures electric voltage; a glass electrode, which senses the electric potential where it meets the water sample; a reference electrode, which provides a constant electric potential, and a temperature compensating device, which adjusts the readings according to the temperature of the sample (since pH varies with temperature). The reference and glass electrodes are frequently combined into a single probe called a combination electrode.

Meters vary a great deal, but the most important part is the electrode. Buy a good, reliable electrode and follow the manufacturer's instructions for proper maintenance. Infrequently used or improperly maintained electrodes are subject to corrosion, which renders them highly inaccurate. Meters tend to last only 1 or 2 years.

A good quality pH meter can detect minimum variations of 0.1 pH units in river water and can be calibrated at two points giving more accurate readings over a wider range than one point calibration meters.

| Equipment /Supplier/Code | Method | Range, units | Sensitivity | Calibration | Cost | Comments |
|--|--------|--------------------|--------------|---------------------------------|----------|--|
| pHydrion Lo Ion, paper for unbuffered waters Vendart | paper | 5.0 - 9.0 pH units | 0.5 pH units | none | \$24.20 | Uses a colour chart, 60 tests, code no LI 5900 |
| Refill for the above Vendart code LI6900 | | | | | \$26.70 | 5 rolls of paper, 300 tests |
| pH Indicator Strips Merck code:9533 | paper | 5 - 10 pH units | | none | \$30.30 | 100 tests If purchasing 10 packs cost is \$27.30 per pack |
| pH Universal Indicator Strips Merck code:9535 | paper | 0 - 14 pH units | | none | \$27.40 | 100 tests If purchasing 10 packs cost is \$22.40 per pack |
| Scan 2 Eutech Cybernetics Vendart code:PHSCAN2 | meter | 0 - 14 pH units | 0.1 pH units | Standard buffer solutions | \$119.00 | |
| Water proof version of the PHSCAN2 Vendart code: PHSCANWP2 | meter | -1 - 15 pH units | 0.1 units | Standard buffers up to 3 points | \$155.00 | Fully waterproof with replaceable electrode which saves \$. |

CALIBRATION SOLUTIONS

pH meters require buffer solutions for calibration as below. These are available from a range of suppliers - two options are listed below:

Option 1 Available from Crown Scientific.

Buffer tablets \$73.50
(pH 4.0, bag of 50, each makes 100 mL of buffer solution, code no 33154).
Buffer tablet..... \$73.50
(pH 7.0, bag of 50, each makes 100 mls of buffer solution, code no 33155).

Option 2 Available from Vendart.

Buffer tablets \$28.50
(pH 4.0, bag of 50, each makes 20 mls of buffer solution, code 3893-H)
Buffer tablets \$28.50
(pH 7.0, bag of 50, each makes 20 mls of buffer solution, code no 3894-H)
Buffer tablets \$28.50
(pH 10.0, bag of 50, each makes 20 mLs of buffer solution, code no 3895-H)
Buffer tablets \$18.50
(pH 4.0, 7.0, 10.0, ten of each, 30 total, each makes 20 mls of buffer solution, code no 3893-4-5)

Replacement batteries (type AC675E, Cat No. S3038 1.4V, zinc-air , set of 4) \$3.35
Available from *Dick Smith* Phone 1300 366 644

DISSOLVED OXYGEN

Oxygen is necessary for all living things and for many of the chemical processes that happen in water eg. converting nutrients to useful forms and converting chemicals to less harmful forms. Most aquatic animals breathe the oxygen gas dissolved in the water (dissolved oxygen). Waters with consistently high dissolved oxygen are generally considered healthy ecosystems, capable of supporting many different kinds of aquatic animals.

Equipment is used to measure the dissolved oxygen levels of streams directly and to measure the biochemical oxygen demand.

WINKLER METHOD

The Winkler method involves filling a sample bottle completely with water (no air is left to affect the test). The dissolved oxygen is then "fixed" using a series of reagents that form an acid compound that is titrated. Titration involves the drop-by-drop addition of a reagent that neutralises the acid compound and causes a change in the colour of the solution. The point at which the colour changes is the "endpoint" and is equivalent to the amount of oxygen dissolved in the sample. The sample is usually fixed and titrated in the field at the sample site. It is possible, however, to prepare the sample in the field and deliver it to a lab for titration.

A kit that uses an eye dropper-type or syringe-type titrator is suitable. The kit is easy to use, reasonably cheap per test and has good learning applications for school groups. The low cost of this type of dissolved oxygen field kit is attractive if you are sampling a number of sites at the same time.

Some colorimeters measure the intensity of colour produced by the chemicals to indicate dissolved oxygen levels but the instruments are more expensive in the initial outlay.

Safety

The Winkler Titration test uses a number of potentially hazardous chemicals so take care when handling the chemicals and follow all safety precautions - wear safety glasses and rubber gloves.

METER AND PROBE

A dissolved oxygen meter is an electronic device that converts signals from a probe placed in the water into units of dissolved oxygen in milligrams per litre or % saturation . Most meters and probes also measure temperature. The probe is filled with a salt solution and has a selectively permeable membrane that allows dissolved oxygen to pass from the river water into the salt solution. The dissolved oxygen that has diffused into the salt solution changes the electric potential of the salt solution and this change is sent by electric cable to the meter, which converts the signal to milligrams per litre or % saturation.

DO meters are more expensive than the Winkler method and prone to problems inherent with any electronic equipment.

| Equipment/ Supplier/Code | Method | Range, units | Sensitivity | Calibration | Cost |
|---|---|--------------------------|-------------------|--|--|
| Merck Aquamerck Kit & Flask Merck Aqua Merck Kit code:14662 Oxygen Flask code:14663 | Reaction of 3 separate chemicals and color compared with supplied color chart 50 tests | 1 - 12 ppm | | calibrate against a saturated solution | \$54.60 \$28.60 |
| Hach DO kit OX-2P Selby Scientific code:1469-00 | Modified Winkler Method and eye dropper | 0 - 20 mg/L 100 tests | 1 mg/L | calibrate against a saturated solution | \$160.00 |
| La Motte DO test kit Vendart code:5860 | Modified Winkler Method and syringe titrator. 50 tests, all liquid reagents | 0 - 20 mg/L | 0.2 mg/L | calibrate against a saturated solution | \$88.00 |
| La Motte DO reagent refill kit Vendart code:R5860 | | | | | \$51.46 |
| WTW electronic dissolved oxygen meter Merck code:200232 | DO meter | 0-199 % | 1 % saturation | calibrate against a saturated solution | \$1348.00 <i>(Waterwatch price)</i> |

Biochemical Oxygen Demand

Black BOD bottle (has tapered stopper and plastic covering) \$31.00

Available from Vendart

Any clean bottle with an air tight lid and wrapped with foil is also suitable.

Safety goggles \$6.00

Necessary for testing dissolved oxygen, phosphate and nitrate samples

Available from State Purchasing and Sales (SPS) or various suppliers.

Protective Goggles, code no V-006..... \$7.50

Available form Vendart

Safety gloves (latex, box of 100) \$10.00

Necessary for testing dissolved oxygen, phosphate and nitrate samples

Available from Chemists or SPS

Safety gloves (latex, box of 50), code no V-015. \$7.50

Available from Vendart

PHOSPHORUS

Monitoring phosphorus is challenging because it involves measuring very low concentrations—down to 0.01 milligram per litre (mg/L) or even lower. Even such very low concentrations of phosphorus can have a dramatic impact on waterways. Your first consideration is the purpose of monitoring for phosphorus and the levels of P likely to be found. For example, if your group is monitoring for changes in P levels in a catchment, an environmentally significant increase in P of say 100% may go undetected if your instrument is not sensitive enough. There is little to be gained if the levels of P are persistently less than the detection limit of your instrument or levels are right on the detection limit where accuracy is often less than compared to mid range values.

- For urban sites or polluted sites in the waterway eg. storm water run-off in urban streams, waste water treatment outfalls, and some farm runoff, a colour comparator or colorimeter is useful for levels greater than 0.02 mg/L as P.
- Concentrations in near natural catchments are often beyond the limit of most field nutrient test equipment and you will need to take samples to a professional lab for analysis.

A colorimeter measures the amount of light transmitted or absorbed at a wavelength of 700 - 880 nanometres (nm) depending on manufacturer's directions. Some meters require that you prepare and analyse known standard concentrations before testing in order to convert the transmittance readings of your river sample to milligrams per litre. Other meters read percentage transmittance of light through the sample which can then be converted to milligrams per litre of P using a chart. The most convenient meters directly display the sample concentration as mg/L of P.

ORTHOPHOSPHATE

The term "orthophosphate" is a term that refers to the phosphate molecule all by itself. The standard method for measuring orthophosphate is the ascorbic acid method. Briefly, a reagent (either liquid or powder) containing ascorbic acid and ammonium molybdate reacts with orthophosphate in the sample to form a blue compound. The intensity of the blue colour is directly proportional to the amount of orthophosphate in the water.

Waterwatch recommends testing an untreated water sample in the field for orthophosphate using the ascorbic acid method. The ascorbic acid method is suitable for testing ground water, drinking water, surface water, sea water and waste water.

Filtering samples prior to adding reagents is not recommended unless turbidity interferes with your reading of results. This tends to occur at turbidities greater than 15 NTU's.

TOTAL PHOSPHORUS

Total phosphorus includes all forms of phosphorus, including orthophosphate and phosphorus bound to fine soil particles (particulate phosphorus) in water samples. Much particulate phosphorus is not readily released from soil particles into the water and is therefore not a potential source of nutrient for eutrophication.

The total phosphorus test is normally done in a lab and measures all the forms of phosphorus in the sample. This is done by first "digesting" the sample (heating the sample in acid) to convert all the other forms to orthophosphate. The sample is neutralised, then the orthophosphate is measured

by the ascorbic acid method. Because the sample is not filtered, the procedure measures both dissolved and suspended orthophosphate.

Because of the digestion step, measurement of Total-P is not easily carried out under field conditions and should be done in a lab. Extreme caution must be taken when carrying out the total P test. Also take care with the disposal of waste from the reactions.

You should consider whether measuring orthophosphate directly or measuring total phosphorus is best for your purposes. Total P concentrations are often many times higher than orthophosphate in the same sample. Therefore, total P readings are more likely to come within the measuring range of your instrument. However, this involves purchasing more equipment and transporting the samples to a lab for digestion and measuring. Great care must be taken when working with the hazardous reagents used in this test.

Dedicated sample bottles and containers

All containers that will hold water samples or come into contact with reagents used in this test must be dedicated. That is, they should not be used for other tests, This is to eliminate the possibility that reagents containing phosphorus will contaminate the containers. All bottles and containers should be acid-washed with 10% Hydrochloric acid (HCL).

| Equipment/ Supplier/code | Method | Range, units | Sensitivity | Calibration | Cost |
|--|---|------------------------|--------------|---------------------------------|-----------|
| Merck Aquaquant Merck code:P14445 | color comparator ascorbic acid method 200 tests | 0.015 - 0.14 mg/L P | 0.015 mg/L P | Laboratory standard solution | \$126.00 |
| Merck Aquamerck | color comparator 100 tests | 0.25-3.0ppm | 0.25 | Laboratory standard solution | \$42.50 |
| HACH DR890 colorimeter Selby Biolab code: HAC48470-00 | colorimeter ascorbic acid method | 0.05 - 2.50 mg/L P | 0.05 mg/L P | Laboratory standard solution | \$1955.00 |
| HACH DR890 Reagent Kit code: HAC21060-69 | 100 tests Phosver3 | | | | \$53.30 |
| La Motte Smart colorimeter vendart code:1911 | colorimeter ascorbic acid method | 0.02 - 3.00 mg/L P | 0.02 mg/L P | Laboratory standard solution | \$1750.00 |
| La Motte reagent kit Vendart code:3653-SC | 50 tests | 0-3.0ppm | | Laboratory standard solution | \$40.07 |
| Refill phosphate reagent kit for both colorimeters Vendart code:R3653-SC | 50 tests | 0 -3.0ppm | | | \$21.55 |

NB: Quality control checks have shown that the SMART colorimeter is more accurate than the DC 1600 for orthophosphate. However both meters should be calibrated against known standards and a calibration chart prepared in order to interpret the results.

FILTERING SAMPLES

Two options for purchasing filtering equipment are given below:

Option 1 *Available from Technolab*

Syringes 20 mL, pack of 25.....\$17.00 per pack
Syringe filter (Glass fibre filter, pore size of 1.0 µm, 25mm diameter to fit 20 mL syringe above, 50 per pack.)\$117.00 per pack
Disposable but can be used several times before clogging of filter.

Option 2 *Available from Crown Scientific*

PT600 Palintest filtration set..... \$63.75
One 20mL Luerlok syringe, 2.5 cm filter holder, 100 GF/B glass fibre filter papers 1µm. This is a syringe with replaceable filters for multiple use.

TOTAL PHOSPHORUS DIGESTION EQUIPMENT

Hach produce a kit that contains the chemicals and equipment to carry out the required digestion in the field and to determine the orthophosphorus present using a colour comparator.

Hach Total Phosphorous Kit (code PO-24)..... approx \$350.00
Available from Selby Biolab

Monitoring groups can assemble a kit themselves by purchasing the digestion chemicals used in the PO-24 total phosphorus kit and use the Merck Aquaquant test kit for measuring the level of phosphorus.

NB: Safety glasses and gloves must be worn when carrying out this test.

The kit detailed below uses a combination of the chemicals and digestion methodology of the Hach PO-24 total phosphorus kit and the Merck Aquaquant phosphorus test kit. Please refer to the methods manual for detailed instructions.

EQUIPMENT

Hach test kit for Total Phosphorus

25ml conical flask
25 mL measuring cylinder
50 mL measuring cylinder
Filter funnel
Filter paper
Potassium persulphate
5N Sodium Hydroxide
5.25 N Sulphuric acid
Hot Plate

The LaMotte kit detailed below contains chemicals and equipment required to carry out the digestion of the sample prior to testing for orthophosphate. A heat source is required to boil the sample.

LaMotte Phosphorous Digestion Equipment (code 7884) \$198.00
Available from Vendart

Replacement reagents for the LaMotte kit (Model APT/Code 7884) are listed below.

| Quantity | Contents | Code |
|------------|----------------------------------|----------|
| 50 mL | *Sulfuric Acid, 36% | 7885-H |
| 15 mL | *Phenolphthalein Indicator, 1% | 2246-E |
| 100 mL | *Sodium Hydroxide, 15% | 7886-J |
| 30 g | *Ammonium Persulfate | 6566-G |
| 100 mL | Deionized Water | 5115PT-J |
| 10 g | Boiling Chips | 7888-D |
| 2 | Pipets, 1 mL, plastic | 0354 |
| 1 | Spoon, 0.5 g, plastic | 0698 |
| 1 | Funnel | 0459 |
| 2 | Erlenmeyer Flasks, 125 mL, glass | 0431 |
| 100 sheets | Filter paper, 11 cm | 0463 |
| 1 | Graduated Cylinder, 50 mL, glass | 0418 |

*** Warning:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

ASSEMBLING REAGENTS

You can assemble the necessary reagents yourself if you have access to the glassware. These are listed below. All chemicals can be purchased in powder pillow or ampoule form. Suggestions are made for the type of container or dispenser that could be used for each chemical.

| | |
|---|--|
| Sulfuric acid (H ₂ SO ₄) | dropper bottle with 1 mL markings on the dropper tube |
| Sodium hydroxide (NaOH) | dropper bottle |
| Phenolphthalein | dropper bottle |
| Potassium persulphate | screw top small plastic jar with spoon attached to lid |
| 2 x 100 mL conical flasks | 2 x small plastic funnels |
| 2 x 50 mL measuring cylinders | 1 x packet of No 41 Whatman filter papers |

Heat source for digestion of water samples for phosphorus

Heating the sample in a lab is safer but you can digest the sample in the field using the equipment listed below as a heat source. Another option is to digest the sample at home using the stove or a hot plate making sure all the necessary safety precautions are followed . If taking the sample to a lab, put the water sample in an Eski on ice and test within 24 hours.

| | |
|---------------------------------------|---------|
| Trangia burner with stand..... | \$25.70 |
| Folding windshield for above..... | \$16.60 |
| Wire gauze (non asbestos centre)..... | \$12.50 |

| | |
|----------------------------|---------|
| Safety Goggles..... | \$7.50 |
| Stainless steel tongs..... | \$14.20 |

Sample bottles for nutrient sampling (high density polyethylene or polypropylene, wide mouth, 500 mL)

Sample bottles for nutrients should be dedicated to nutrient sampling only and must be free of any trace of nutrients that may contaminate your sample.

Available from Selby Scientific, Crown Scientific or similar supply companies

Phosphate-free detergent

This is used for cleaning test tubes and sample bottles used in nutrient (phosphate and nitrate) testing.

| | |
|-------------------------------------|---------|
| Decon 90 (1 Litre), code D901 | \$17.00 |
| Decon 90 (5 Litre), code D905..... | \$77.95 |

Available from Crown Scientific or various suppliers

Hydrochloric acid

A 10% solution is used for washing glassware that has been used for sampling or has been contaminated with phosphorus eg from contact with household detergent.

Available from various supply companies or from a school laboratory

| | |
|-----------------------------|--------|
| Safety goggles | \$7.50 |
|-----------------------------|--------|

Necessary for protection testing dissolved oxygen, phosphate and nitrate samples

Available from Vendart or various suppliers

| | |
|--|---------|
| Safety gloves (latex, box of 100) | \$10.00 |
|--|---------|

Necessary for protection when testing dissolved oxygen, phosphate and nitrate samples

Available from Chemists

| | |
|--|--------|
| Safety gloves (latex, box of 50), code no V-015. | \$7.50 |
|--|--------|

Available from Vendart

| | |
|--|---------|
| Deionised water pack (Palintest PT500)..... | \$29.90 |
|--|---------|

Used for rinsing test tubes used in nutrient testing and for testing a blank sample to detect contamination of equipment.

Palintest PT500 makes a total of approximately 5 Litres from tap water.

Available from Crown Scientific. DI water also available from supermarkets and laboratories

NITROGEN

Monitoring nitrate is challenging because it can involve measuring very low concentrations—down to 0.01 milligram per litre (mg/L). Your first consideration is the purpose of monitoring for nitrate and the levels of N likely to be found. For example, if your group is monitoring for background changes in N levels in a catchment, an environmentally significant increase in N of 100% may go undetected if your instrument can only measure more than 0.05 mg/L. There is little to be gained if the levels of N are persistently less than the detection limit of your instrument or levels are right on the detection limit where accuracy is often less than compared to mid range values.

Waterwatch groups who have chosen to test for nitrate usually use one of two methods: the cadmium reduction or zinc reduction. Both methods produces a colour reaction that is then measured either by comparison to a colour wheel (or bar) on a colour comparator or by use of a colorimeter. Cadmium reduction method appears to be more accurate at lower concentrations of nitrate than zinc reduction but is far more hazardous as cadmium is very toxic. The zinc reduction method is not suitable for testing in saline water as salt interferes with the settling of reagents and it becomes difficult to make an accurate colour match. A newer colorimetric immunoassay technique for nitrate screening is also now available and might be applicable.

Note: nitrate tests based on the zinc reduction method have proved to be generally inaccurate for measuring low levels. The test based on the cadmium reduction method is more accurate but involves the use of a very toxic chemical -cadmium and for this reason extreme caution should be taken.

CADMIUM REDUCTION METHOD

The cadmium reduction method is a colorimetric method that involves contact of the nitrate in the sample with cadmium particles, which cause nitrates to be converted to nitrites. The nitrites then react with another reagent to form a red colour whose intensity is proportional to the original amount of nitrate. The red colour is then measured either by comparison to a colour wheel with a scale in milligrams per litre that increases with the increase in colour hue, or by use of an colorimeter that measures the amount of light absorbed.

COLOUR COMPARATOR

For heavily polluted sites in the waterway eg. storm water run-off in urban streams, and waste water treatment outfalls a colour comparator with a colour wheel or colour cubes is useful for identifying high concentrations (greater than 1 mg/L).

Matching the colour of a treated sample to a comparator can be subjective, especially at low concentrations, and can lead to variable results.

This method requires that the samples being treated are clear. If a sample is turbid (>15 NTU), it should be filtered through a 1.0 micron filter. Be sure to test whether the filter is nitrate free. If copper, iron, or other metals are present in concentrations above several mg/L, the reaction with the cadmium will be slowed down and the reaction time will have to be increased.

The reagents used for this method are often pre-packaged for different ranges, depending on the expected concentration of nitrate in the water. You should determine the appropriate range for the waterway being monitored.

COLORIMETER

Use a colorimeter for more precise results and if lower concentrations are expected. A colorimeter measures the amount of light transmitted or absorbed at a wavelength of 543 nanometres (nm). Some meters require that you prepare and analyse known standard concentrations before testing in order to convert the transmittance readings of your river sample to milligrams per litre. Other meters read percentage transmittance of light through the sample which can then be converted to milligrams per litre of N using a chart. The most convenient meters directly display the sample concentration as mg/L of N.

Although colorimeters can be used in the field, they have certain disadvantages. These devices are more fragile than the colour comparators and are therefore more at risk of breaking in the field. They must be carefully maintained and must be calibrated before each sample run and, if you are doing many tests, between sampling. This means that samples are best tested in the lab.

Groups can use colorimeters for other parameters besides P and N eg. turbidity, copper, oxygen etc.

For many rivers, lakes and estuaries environmentally significant changes in nitrate levels are very low. Measuring low levels can be achieved by sending a sample to a professional lab for testing.

Dedicated sample bottles and containers

All containers that will hold water samples or come into contact with reagents used in this test must be dedicated. That is, they should not be used for other tests, This is to eliminate the possibility that reagents containing nitrate will contaminate the containers. All bottles and containers should be made from polyethylene and acid-washed in HCL

| Equipment model | Method | Range, units | Sensitivity | Calibration | Cost |
|---|---|--|---------------------------|------------------------------|-----------|
| La Motte Nitrate test kit Vendart code:3354 | colour comparator, zinc reduction | 1 - 15 mg/L N | 1 mg/L N | Laboratory standard solution | \$96.60 |
| HACH DR890 Colorimeter Selby Biolab code:HAC48470 | colorimeter, cadmium reduction NO3-N | 0.01 - 0.50 mg/L Low Range 0.2 - 5.0 mg/L Mid Range | 0.01 mg/L 0.2 mg/L | Laboratory standard solution | \$1955.00 |
| La Motte Smart Colorimeter Vendart code:1911 | colorimeter, cadmium reduction | 0.02 - 3.00 mg/L N | 0.02 mg/L N | Laboratory standard solution | \$1750.00 |
| Merck Merckoquant code:010020 | indicator strips 100 tests | 10-500ppm | 10 | | \$48.00 |

Nitrate 1 tablets (50 tablets), code 2799-H..... \$9.90

Nitrate 2 tablets (50 tablets), code NN-3703-H \$16.45

Reagent kit for nitrate (20 tests, code 3649) \$55.70

Refill nitrate reagent kit, 20 tests (code R-3649-SC) \$38.66

Available from Vendart

Reagent Kit for DR890

Low Range Nitrate Reagent Set, (100 tests, Code 24298-00)..... \$129.00

Sample bottles for nutrient sampling (high density polyethylene or polypropylene, wide mouth, 500 mL)

Available from Selby Scientific, Crown Scientific or similar supply companies

Phosphate-free detergent

This is used for cleaning test tubes and sample bottles used in nutrient (phosphate and nitrate) testing

Decon 90 (1 Litre), code D901 \$17.00

Decon 90 (5 Litre), code D905 \$77.95

Available from Crown Scientific or various suppliers

Hydrochloric acid

A 10% solution is used for washing glassware that has been used for sampling or has been contaminated with nitrate.

Available from various supply companies or from a school laboratory

Safety goggles \$7.50

Necessary for protection when testing dissolved oxygen, phosphate and nitrate samples

Available from Vendart or various suppliers

Safety gloves (latex, box of 100) \$10.00

Necessary for protection when testing dissolved oxygen, phosphate and nitrate samples

Available from Chemists or Supermarkets

Safety gloves (latex, box of 50), code no V-015. \$7.50

Available from Vendart

Deionised water pack (Palintest PT500)..... \$29.90

Used for rinsing test tubes used in nutrient testing and for testing a blank sample to detect contamination of equipment.

Palintest PT500 makes a total of approximately 5 Litres from tap water.

Available from Crown Scientific. D.I water is also available for supermarkets and laboratories

KITS

Merck produces a kit which comprises of the following test equipment:

| Parameter | Test Type | No. Tests | Range | Code No: |
|---|-------------------------------|-----------|---------------|------------------|
| Dissolved Oxygen | AquaMerck Kit Oxygen Flask | 50 | 1-12ppm | 014662 014663 |
| pH | Indicator Strip | 100 | pH 5-10 | 009533 |
| Temperature | Digital Thermometer | | -20°C-100°C | T268 |
| Conductivity | TD Scan Meter | | 0-19,900uS | TDSCcan.20 |
| Turbidity | Turbidity Tube | | 0-400 | TURBID.400 |
| Phosphorous | Aquaquant | 200 | 0.015-0.14ppm | 014445 |
| Carry Case, Gloves, & Safety Goggles | | | | 011002.0500 |

Kits are available without Dissolved Oxygen equipment.

Kit with Dissolved Oxygen, Code no 011002.1000,.....\$434.00

Kit without Dissolved Oxygen, Code no 011000.1000,.....\$286.00

La Motte Water Monitoring Kit available from Vendart.

| Parameter | Test Type | No. Tests | Range | Code No: |
|---|--------------------------------|-----------|-------------|----------|
| Dissolved Oxygen | Modified Winkler Titration | 50 | 1-20 mg/L | 5860 |
| pH | pH Meter | | pH 1- 14 | pHScan2 |
| Temperature | Thermometer | | -5°C - 50°C | |
| Conductivity | TD Scan Meter | | 0-1990 µS | TDScan3 |
| Turbidity | Turbidity Tube | | 0-400 NTU | |
| Flow | Stop Watch and Tape Measure | | | |
| Carry Case, Gloves, & Safety Goggles | | | | |

Kit Code No. 00253.....\$464.00

To Change pH meter to pHScanWP2 add \$36 and for TDScan WP3 add \$37.

To include phosphorus testing, purchase the Merck aquaquant test kit. (Code. 014445,
Cost. \$126.)

There are a number of different multi parameter meters available such as the La Motte SMART colorimeter and the HACHDR890 colorimeter. These types of meters test for a variety of parameters and may be worth some investigation depending on your monitoring plans.

FAECAL COLIFORM BACTERIA

Faecal bacteria are common in the intestines and faeces of both warm and cold blooded animals and are an indicators of possible sewage contamination. They are used to indicate the possible presence of pathogenic (disease causing) bacteria, viruses, and protozoa.

Monitoring water for the presence of pathogenic microorganisms is difficult because so many-different types exist and we risk exposure to them. Instead of testing for each type, we test for the presence of faecal bacteria which are excreted with any pathogenic organisms in the faeces (including humans).

If faecal material gets into surface water and you come into contact with that water, you run the risk of getting sick. Pathogens enter our body when we swallow contaminated water either by drinking it or accidentally when swimming, and through cuts. Testing the water for faecal indicator bacteria enables you to assess the risk of getting sick. Health risks associated with faecal-contaminated water include gastroenteritis, ear infections, typhoid fever, dysentery, and hepatitis.

Faecal bacteria types and what they indicate:

The most commonly tested faecal indicator bacteria are total coliforms, faecal coliforms and *Escherichia coli* (*E. coli*).

Total Coliforms

This is a group of bacteria that includes faecal coliforms and other non faecal bacteria that are widespread in the environment. All types may occur in human faeces, but some may also be found in animal manure, soil, and submerged wood. Thus, the usefulness of total coliforms as an indicator of sewage is limited.

Faecal Coliforms

This is a subgroup of total coliform bacteria more specific to faeces. However, it has one genus, *Klebsiella*, with species that are commonly associated with textile, pulp, and paper mill wastes. Faecal coliform is the main bacteria indicator for recreational waters.

***Escherichia coli* (*E. coli*)**

This is species of faecal coliform bacteria that occurs in high numbers in faeces of humans and other warm-blooded animals. *E. coli* are mostly harmless, although one strain causes acute diarrhoea. It does not normally grow in the natural environment and has been used as an indicator of faecal contamination for many years.

HOW ARE COLIFORM BACTERIA MEASURED?

As bacteria cannot be seen, they must be encouraged to grow into visible colonies using one of several techniques available. The method you choose depends on your purpose for monitoring and the accuracy required.

DIP SLIDES

If your goal is to raise awareness of bacteria in water and / or to monitor for the general presence of coliform bacteria then choose an easy to use method such as dip slides. These indicate the general number of coliform bacteria growing on the surface of the slide but do not allow you to count numbers.

MULTIPLE TUBE FERMENTATION (MOST PROBABLE NUMBER) METHOD

The Multiple Tube Fermentation method involves adding specified quantities of the water sample to a number of tubes containing a nutrient broth, incubating the tubes at a specified temperature for a specified time period, and then looking for the development of colour change and/or gas that the bacteria produce. The colour change and presence of gas in each tube is used to calculate the most probable number of faecal coliform bacteria per 100 mL. You need to have access to a lab and glassware (test tubes and durham tubes) to prepare the nutrient broth (Maconkey) and sterilise equipment prior to testing. This method is relatively cheap but time consuming.

COLISCAN® EASYGEL METHOD

An easy method involving little preparation is based on the presence of certain dyes in the media (Coliscan® Easygel method). A small amount of the water sample is added to pre-treated Coliscan® petri dish and kept warm. The faecal coliform and *E.coli* colonies can be identified by their colour and counted.

MEMBRANE FILTRATION METHOD

If human health issues are at stake and high quality data are required, water samples, use the membrane filtration method and be sure to carry out a quality assurance/quality control program. The membrane filtration method is used by most agencies that monitor bacteria for water contact health risk. It allows you to accurately count very low numbers of faecal bacteria.

In this method a sample of water is collected and a specific volume is filtered. Then the filter is placed on a nutrient medium that provides a good growing habitat for specific bacteria. The bacteria are incubated at a steady temperature in a dry oven and then a water bath. The individual bacteria on the filter grow into colonies, which become visible to the eye. Then the number of colonies is counted, and reported as the number per 100 millilitres of water.

Membrane filtration requires careful training in procedures and some expensive equipment - one or two incubators and an autoclave (or a pressure cooker). Often, a school and a community group purchase equipment and work together, housing the equipment at the school to use during the school year, and the community group to use for summer sampling. You can pool equipment with a number of schools or other groups and take turns processing the bacteria for all involved in the catchment.

| Parameter | Equipment method | Method | Range | Sensitivity | Calibration |
|--|-------------------------------|---|--------------------------------|----------------------|--------------------|
| Coliform bacteria | Microbiological dip slide | dip in sample, incubate and count colonies | from zero colonies per 100 mLs | unknown | none |
| Faecal coliform bacteria | Multiple Tube Fermentation | add sample to media, incubate and look for positive results | from zero colonies per 100 mLs | unknown | none |
| Faecal coliform bacteria and <i>E.coli</i> | Coliscan Easygel | add sample to media, pour onto plate, incubate and count colonies | from zero colonies per 100 mLs | 20 colonies /100 mLs | none |
| Faecal coliform bacteria and <i>E.coli</i> | Sartorius Faecal Coliform Kit | membrane filtration | from zero colonies per 100 mLs | 1 colony /100 mLs | none |

Coliform count dip slides

| | |
|-------------------------------------|------|
| Pack of 5 (code no ENV.5.81) | \$24 |
| Pack of 20 (code no ENV.5.82) | \$73 |

Available from Southern Biological Services and other suppliers

Multiple Tube Fermentation Method

| | |
|---|---------|
| Maconkey broth (purple, powder, 100 g, code MED 10.10)..... | \$39.50 |
|---|---------|

Available from Southern Biological Services and other suppliers

Coliscan® Easygel Method

| | |
|--|----------|
| Coliscan Easygel (Code 25001-1, pack of 20) | \$73.00 |
| Coliscan Easygel (Code 2500-2, pack of 40) | \$146.00 |

Available from Vendart

Membrane filtration method

| | |
|---|----------|
| Faecal Coliform kit (Sartorius) Code FC 00250 | \$775.00 |
|---|----------|

Kit inclusions

| | |
|------------|---|
| 16510 | Polycarbonate vac filter holder 250 mL complete |
| 16511 | Polycarbonate vac filter holder without flask |
| M2111 | Membrane forceps - stainless steel |
| BH0125N280 | Ethanol bottle 125 mL |
| 21801-365 | Laboratory bottle 250 mL X 2 |
| 21801-245 | Laboratory bottle 250 mL X 1 |
| 455-50 | Syringe 50 mL |
| PTT 0.1 | Pipette 0.1 mL |
| PTT 1.00 | Pipette 1.0 mL x 1 |
| PTT 10.00 | Pipette 10.00 mL X 2 |
| 9901 | Pipette filler - PI pump 10 mL |
| 1152 | Demineraliser bottle 100 mL |
| 1213 | Kit box |
| 1174 | Check valve |
| 14068047 | Nutrient pad set with membrane filter (50) |
| 1340047 | Pre filter disk (50) |
| 16534 | Syringe filter |

Consumables

| | | |
|----------|---|----------|
| | Replacement costs | |
| 14068047 | Nutrient pad set with membrane filter and petri dish (50) | \$133.00 |
| 14068047 | Nutrient pad set with membrane filter and petri dish (30) | \$87.00 |
| 13400047 | Pre filter disk (50) | \$29.80 |
| 16534 | Syringe filter (optional 10) | \$31.67 |
| V-JH | Faecal coliform incubator | \$692.00 |

Disinfectant

Bleach solution

Available from supermarkets

MACROINVERTEBRATES

Macroinvertebrates can be used to monitor changes in streams from headwaters to lowlands, and above and below pollution sites. They reflect all the changes and problems in the river. Monitoring can also raise awareness of life in the waterway.

Macroinvertebrates are good indicators of water quality because they:

- are affected by physical, chemical and biological conditions of the waterway;
- are a critical part of the aquatic food web - feeding on plants and being eaten by predators;
- can't easily escape pollution and therefore can show the effects of short and long term pollution events;
- are abundant, easily sampled and identified.

SAMPLING EQUIPMENT

Sampling net (460mm x 200 mm, 0.3 mm mesh, heavy duty code V-117) \$37.80
Replacement frame and net (code VR117) \$24.25

Handles for net described above.

4' fixed aluminium pole (code V-48) \$11.50
4'-8' extension al. pole (code V-48E) \$19.45
6'-12' extension al. pole (code V-72E) \$22.00
8'-16' extension al. pole (code V-96E) \$26.50

Available from Vendart. Other types of nets are available from Southern Biological and Australian Entomological Supplies.

Sampling net (home made)

You can make a net from nylon screening (mesh size 0.3 mm), heavy duty wire and a broom handle.

Artificial substrate samplers

These can be made at home for use as an artificial substrate in streams to collect macro-invertebrates. There are two types:

- **Multi plate structure** - These can be constructed from tempered masonite (pieces 20 cm's square alternating with pieces 5 cm's square and held together with a long eye bolt).
- **A rock basket** can be made from heavy duty window screening and a number of small rocks. It is held together with wire or heavy nylon thread.

SORTING IMPLEMENTS

White Sorting tray (large, flat bottom) \$7.20
Available from Nuplas (code-IH009)

Ice Cube tray (large cube size preferred) \$3.00

Plastic spoons (per pack) \$2.00

Available from supermarkets

Pipette (plastic pasteur, 140mm length, code number G10.73, 100 per box). \$9.30

Available from Southern Biological Services

Forceps (Feather light and Rounded nose)..... \$4.00

Available from Southern Biological and Australian Entomological Supplies

Paintbrushes (fine code G 10.60, 12 per set) \$14.50
Available from Southern Biological Services and other suppliers

Aeratorabout \$30.00
Battery powered: useful for keeping animals alive for long periods in eg. the car or for displays at shows.
Available from general aquarium suppliers

Tally Register (counter with chromium plated case, four digit, code G11.19)..... \$22.70
Available from Southern Biological Services

Hand lens Useful for close up work with macro-invertebrates.
Magnification x10 small folding plastic, 2.3 cm dia, code G 5.10) \$6.00
Magnification x10 small folding metal, 2.5 cm dia., code G 5.15)..... \$17.20
Magnification x10 reading size, 7.5 cm code G 5.25) \$10.50
Available from Southern Biological Services or similar general scientific supply companies.

Battat 2-Way Microscope. \$15.00
Available from Mr Good Times

ALGAE

Microscopic free floating algae (phytoplankton), are simple plants that grow with light and nutrients. They are natural to Australian waterways and are part of the aquatic food chain. Algae are very important to the aquatic environment as they are primary producers and all other organisms are dependent on them. Various types of algae are found in Australian waters including blue-green algae, green algae, flagellates and diatoms.

Blue-green algae are of major concern. Concentrations of blue-green algae are usually expressed in terms of algal cells per mL of water (cells/mL). The density of algal cells alerts water authorities to a problem and is used to guide their response. There are three alert levels. Numbers between 500 and 2000 cells/mL of blue-green algae (Alert Level I) are not considered a direct threat but the algae may be in a rapid growth phase and could soon pass into Alert Level II where they are considered unsafe for human consumption (2000-15 000 cells/mL). At concentrations greater than 15 000 cells/mL (Alert Level III) the water is also considered unsafe for stock, watering and domestic use.

Algal cells can be counted using a special microscope slide which has a fine grid etched into the glass known as a Sedgewick-Rafter Counting Chamber.

Sedgewick - Rafter Counting Chamber (code M.7.32) \$65.00
Plastic slide with central 50x20 mm cell of 1 mm depth, base ruled in 1 mm square grid, for algal counting) *Available from Southern Biological Services*

General microscope slides

Microscope slides (76 mm x 25 mm, box of 50, glass, code M 7.15) \$3.80
Microscope slides (76mm x 25 mm, box of 50 x 10 boxes, code M 7.25). \$33.50
Coverslips (22 mm square, 14 gm glass box, code M 7.11) \$4.70
Available from Southern Biological Services

Lugols solution

This is an iodine solution for preserving algal samples and precipitating algae for transfer to a microscope slide. It is available from most chemist shops or a school lab technician can make this up as follows; **Dissolve 20 gm of potassium iodine and 10 gm of iodine crystals in 180 mL of deionised water and 20 mL of glacial acetic acid.**

Field microscope

Available at a variety of suppliers such as Southern Biological Services and Olympus

Plankton net (20 cm diameter, s/s ring net length 35 cm gauge 150 microns. with 100 mL plastic sample bottle, code ENV 11.50) \$105
Available from Southern Biological Services

Glassware Note; these items are available from many supply companies

- Measuring cylinder** (100 mL plastic)
- Conical flask** (125 mL plastic)
- Thermometer** (alcohol filled 0-50 °C)
- Pipettes** (plastic)